REGION 1

RECORD OF DECISION

NUCLEAR METALS, INC. SUPERFUND SITE

SEPTEMBER 2015

SDMS Doc ID 582996

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DECLARATION FOR THE RECORD OF DECISION

A. SITE NAME AND LOCATION

Nuclear Metals, Inc. Superfund Site

Concord, Massachusetts

CERCLIS ID # MAD062166335

B. STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the Nuclear Metals, Inc. Superfund Site (Site or NMI Site), in Concord, Massachusetts, which was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended (CERCLA), 42 USC §§ 9601 et seq., and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan, as amended (NCP), 40 CFR Part 300 et seq. The Director of the Office of Site Remediation and Restoration (OSRR) has been delegated the authority to approve this Record of Decision (ROD).

This decision was based on the Administrative Record, which has been developed in accordance with Section 113(k) of CERCLA, and which is available for review at the Concord Free Public Library and at the United States Environmental Protection Agency (EPA) Region 1 OSRR Records Center in Boston, Massachusetts. The Administrative Record Index (Appendix I to the ROD) identifies each of the items comprising the Administrative Record upon which the selection of the remedial action is based.

The Commonwealth of Massachusetts concurs with the Selected Remedy.

C. ASSESSMENT OF THE SITE

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

D. DESCRIPTION OF THE SELECTED REMEDY

This ROD sets forth the selected remedy for the Site, which involves the excavation and off-site disposal of approximately 82,500 cubic yards of low-level threat contaminated sediments, underground drain lines and debris, and non-Holding Basin soils in various areas of the Site which exceed human health and/or ecological risk standards; in-situ stabilization of principal threat source materials within the Holding Basin to prevent leaching of contaminants to groundwater; and containment of Holding Basin stabilized soils with a low-permeability vertical wall and horizontal cover to isolate the stabilized soils and further limit mobility of contaminants by removing the flow of groundwater. The selected remedy also includes extraction and *ex-situ* treatment of volatile organic compounds (VOCs) and 1,4-dioxane in overburden and bedrock aquifers, and *in-situ* treatment of depleted uranium (DU) in the overburden aquifer and natural

uranium in the bedrock aquifer, and long-term monitoring to monitor effectiveness of *in*- and *ex-situ* treatment. Institutional controls will be implemented to: 1) prevent unacceptable exposures to, and to prevent disturbance of, the Holding Basin area; 2) prohibit use of contaminated groundwater until cleanup levels are met; and 3) require installation of vapor mitigation systems should future structures be built above the VOC groundwater plume unless an evaluation of vapor intrusion risks is performed to show such systems are not required.

The selected remedy is a comprehensive approach for this Site that addresses all current and potential future risks caused by soil, sediment, and groundwater contamination. The remedial measures will prevent future leaching from the principal threat waste in the Holding Basin into the groundwater in excess of drinking water standards; restore groundwater within the contaminant plume to a level protective of human health and the environment, and that meets the performance standards; and ensure that exposure to low-level threat wastes in Site soils and sediments will be prevented; and will allow for restoration of the Site to beneficial uses. Institutional controls will be used as part of the selected remedy to prevent exposure to contaminated groundwater until the performance standards are met and to prevent exposure to stabilized soils in the Holding Basin.

The major components of the selected remedy are:

1. Excavation and off-site disposal of approximately 82,500 cubic yards of contaminated sediments, underground drain lines and debris, and non-Holding Basin soils (contaminated with DU, polychlorinated biphenyls (PCBs), and other contaminants of concern) in various areas of the Site;

2. *In-Situ* stabilization of DU contaminated soils in the Holding Basin via injection of a stabilization agent such as apatite (such as Apatite II™) or other comparable stabilization agent to prevent leaching of contaminants to groundwater, and containment of Holding Basin stabilized soils with a low-permeability vertical wall and horizontal sub-grade cover to isolate the stabilized soils and further limit mobility of contaminants by removing the flow of groundwater;

3. Extraction and *ex-situ* treatment of volatile organic compounds (VOCs) and 1,4-dioxane in overburden and bedrock aquifers, and *in-situ* treatment of DU in overburden aquifer and natural uranium in bedrock aquifer;

4. Long-term monitoring to monitor effectiveness of *in*- and *ex-situ* treatment; and

5. Institutional Controls to: 1) prevent unacceptable exposures to, and to prevent disturbance of, the Holding Basin area; 2) prohibit use of contaminated groundwater until cleanup levels are met; and 3) require installation of vapor mitigation systems should future structures be built above the VOC plume before groundwater cleanup levels are met, unless an evaluation of vapor intrusion risks is performed to show such systems are not required.

This ROD follows two time critical and one non-time critical removal actions which were

conducted between 2001 and the present. The Massachusetts Department of Environmental Protection also conducted a removal action at the Site from 2005-2006.

The selected remedy addresses principal and low-level threat wastes at the Site by: 1) the stabilization and containment of source soils in the Holding Basin to eliminate exposure to and leaching from the Holding Basin soils; and 2) the excavation and off-site disposal of remaining contaminated soils and sediments to eliminate exposure to these soils and sediments.

E. STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action (unless justified by a waiver), is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable.

The Holding Basin soils and groundwater portions of the remedy also satisfy the statutory preference for treatment as a principal element of the remedy (i.e., reduce the toxicity, mobility, or volume of materials comprising principal threats through treatment). Based on the volume of contaminated soils located outside the Holding Basin, EPA concluded that it was impracticable to excavate and treat the chemicals of concern in a cost-effective manner. Thus, excavation and off-site disposal of those soils was chosen as a component of the selected remedy, although it does not satisfy the statutory preference for treatment as a principal element of the remedy.

Because this remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure (and groundwater and land use restrictions are necessary), a review will be conducted within five years after initiation of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

F. SPECIAL FINDINGS

Issuance of this ROD embodies the following specific determinations:

Wetland Impacts

Pursuant to Section 404 of the Clean Water Act (CWA), 40 CFR Part 230 (Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material), 21 M.G.L. §§ 26-53, and 314 CMR 9.06(1-2) (Criteria for the Evaluation of Applications for Discharge of Dredged or Fill Material), EPA has determined that there is no practicable alternative to conducting work that will impact wetlands and/or result in the discharge of dredged or fill material into waters of the United States because significant levels of contamination exist within wetlands and waters of the United States and these areas are included within the Site's cleanup areas.

For those areas impacted by cleanup activities, EPA has also determined that the cleanup alternatives that have been selected are the least damaging practicable alternatives.

EPA will minimize potential harm and avoid adverse impacts on resources, to the extent practical, by using best management practices to minimize harmful impacts on the wetlands, wildlife, or habitat. Impacted areas will be mitigated consistent with the requirements of federal and state laws.

Toxic Substances Control Act

In accordance with the requirements under the Toxic Substances Control Act (TSCA) and 40 CFR § 761.61(c), EPA has made a finding that the manner of sampling, storage, cleanup, and disposal of PCB-contaminated sediment and soil as set out in this Record of Decision will not pose an unreasonable risk of injury to health or the environment as long as the following conditions are met:

- The selected contractor for the PCB remediation work shall submit a contractor work plan describing the containment and air monitoring that will be employed during PCB remedial activities, including but not limited to site control, excavation, handling, storage, and disposal activities. This work plan should also include information on how and where all PCB-contaminated wastes (both less than ("<") 50 ppm and ≥ 50 ppm) will be stored and disposed of, how stormwater controls and runoff will be managed, how dust levels will be controlled and monitored, and on how field equipment will be decontaminated.

- Two PCB-contaminated sediment and soil samples with ≥ 50 ppm PCBs are located in Areas of Investigation (AOIs) 4 and 8, as shown in **Attachment 1 of Appendix G.** Identified PCB-contaminated soils and sediments with ≥ 50 ppm shall be excavated and disposed off-site at a TSCA-approved disposal facility or a RCRA hazardous waste landfill in accordance with 40 CFR § 761.61(a)(5)(i)(B)(*2*)(*iii*). Confirmatory sampling shall be conducted in accordance with 40 CFR Part 761, Subpart O to document that all PCBs with ≥ 50 ppm have been removed.

- Compliance with the PCB regulations at 40 CFR Part 761 is maintained during all phases of work involving ≥ 50 ppm PCB-contaminated soils and/or sediments, including but not limited to:

    - 40 CFR Part 761 Subpart C – Marking of PCBs and PCB Items
    - 40 CFR § 761.50(b)(7) – PCB/Radioactive waste
    - 40 CFR § 761.65 – Storage for Disposal
    - 40 CFR § 761.79 – Decontamination Standards and Procedures
    - 40 CFR Part 761 – Subpart K, PCB Waste Disposal Records and Reports

G. ROD DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this Record of Decision. Additional information can be found in the Administrative Record file for this Site.

1. Chemicals of concern (COCs) and their respective concentrations.

2. Baseline risk represented by the COCs.

3. Cleanup levels established for COCs and the basis for the levels.

4. Current and future land and ground-water use assumptions used in the baseline risk assessment and ROD.

5. Land and groundwater use that will be available at the Site as a result of the selected remedy.

6. Estimated capital, operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected.

7. Decisive factor(s) that led to selecting the remedy.

H. AUTHORIZING SIGNATURES

This ROD documents the selected remedy for soil, sediment, and groundwater at the NMI Superfund Site. This remedy was selected by EPA with concurrence of the Massachusetts Department of Environmental Protection (MassDEP). A copy of MassDEP's concurrence letter is attached to this ROD.

U.S. Environmental Protection Agency

By: Nancy Barmakian Date: 09/28/15

Nancy Barmakian, Acting Director
Office of Site Remediation and Restoration
Region 1

DECISION SUMMARY FOR THE RECORD OF DECISION

A. SITE NAME, LOCATION AND BRIEF DESCRIPTION

Nuclear Metals, Inc. Superfund Site

2229 Main Street, Concord, MA 01742

CERCLIS ID # MAD062166335

Nuclear Metals, Inc. Superfund Site is PRP-lead.

The Nuclear Metals, Inc. Superfund Site (Site or NMI Site) includes a 46-acre property (NMI Property) located at 2229 Main Street in the western portion of the Town of Concord, Middlesex County, Massachusetts. The Site also consists of contaminated groundwater migrating to areas located off the NMI Property. Facility operations at the Site began in 1958 and ended in early November 2011. Nuclear Metals, Inc. (NMI) was originally a specialty metal research and development facility that was licensed to possess low-level radioactive substances including DU, but later developed into a large-scale industrial facility for the manufacturing of DU products.

The NMI Property is bordered by Main Street (Route 62) and several commercial and residential properties to the north, residential properties to the east, Town-owned open space and a health club with a children's summer camp to the south and southwest, and residential/woodland and commercial/industrial properties to the west. The Assabet River is situated approximately 300 feet north and at an elevation 20 to 30 feet below the NMI Property, on the opposite side of Route 62. The NMI Property is currently zoned light commercial/industrial and as currently configured includes eight interconnected buildings, several smaller outbuildings, paved parking areas, a Sphagnum Bog, a Cooling Water Recharge Pond, a former waste Holding Basin, and areas of fill and/or waste materials. The buildings are to be removed as part of an on-going Non-Time Critical Removal Action (Building NTCRA), a cleanup plan selected by EPA in 2008, and are not part of this remedy selection. Historical activities at the Site resulted in soil, sediment, and groundwater contamination. Groundwater is found both in the overburden and bedrock formations and migrates north/northwest, towards the Assabet River.

The Site was listed on the National Priorities List (NPL) on June 14, 2001, with the concurrence of the Governor of Massachusetts.

A more complete description of the Site can be found in Section 2 of the Remedial Investigation (RI) Report (*de maximis*, 2014)[1].

[1] *de maximis*, 2014. Remedial Investigation, Nuclear Metals Inc. Superfund Site; April 2014.

B. SITE HISTORY AND ENFORCEMENT ACTIVITIES

1. History of Site Activities

From 1957 to October 1972, the NMI Property was owned and operated by a succession of companies that were engaged principally in specialty metals research and development contract work. In September 1972, NMI employees purchased the operation. The focus of Site operations shifted from research and development to large-scale production in the mid-1970s. This included manufacture of DU shields, counter weights, armor penetrators, metal powders, beryllium and beryllium alloy parts production, and manufacture of specialty titanium parts.

In 1997, NMI was renamed Starmet Corporation (Starmet). Starmet's radioactive materials operations were historically regulated under a radioactive materials license from the U.S. Nuclear Regulatory Commission (NRC); however, in 1997, the NRC delegated regulatory authority to the Massachusetts Department of Public Health-Radiation Control Program (MADPH-RCP) as an agreement state licensee.

From the beginning of operations until a closed-loop system was installed in approximately 1985, an on-site holding basin was used to dispose of waste by-products, including DU, nitric acid, and copper. In late 1997, under the oversight of MassDEP and MADPH-RCP and with the financial support of the US Army, Starmet excavated approximately 8,000 cubic yards of soil contaminated with DU and copper from the Holding Basin and disposed of these soils at an off-site low-level radioactive waste disposal facility. The cleanup halted in late 1998 when Starmet determined that the cleanup level set by MassDEP could not be met without excavating significantly more material. Soon after the Site was listed on the National Priorities List (NPL) in June 2001, a time-critical removal action performed by EPA placed an interim cover over the Holding Basin. Anecdotal information indicates that volatile organic compounds (VOCs), which likely contained 1,4-dioxane as a stabilizer, used as solvents and degreasers were also discharged through floor drains to an on-site cooling water pond, resulting in contamination of an on-site supply well.

Other constituents were released or disposed of in ways that resulted in contamination that extends across multiple areas. Specifically, disposal or release of DU, PCBs, copper, lead, mercury, VOCs, and 1,4-dioxane appears to have occurred through: 1) direct disposal, spills or leaks from facility drain lines, drum burials, and waste storage areas; 2) dredging material and/or landfill disposal; and 3) aerial disposition and storm water runoff.

A more detailed description of the Site history can be found in Section 2 of the RI Report and Section 1 the Feasibility Study (FS).

2. History of Federal and State Investigations and Response Actions

Table B-1 provides a summary of Federal and State Site investigations and removal actions.

Table B-1

Date	Action	Legal Authority	Who Undertook	Results	Related Documents
2001-2002	Time-Critical Removal Action	CERCLA	EPA	Holding Basin interim cover, "Old Landfill" Cap and Fencing Installed	Pollution Reports
2004-2014	Remedial Investigation	CERCLA	PRPs	Remedial Investigation Report (April 2014)	Human Health and Ecological Risk Assessment Reports
2006	Removal Action	MCP 21E	MassDEP	Removal/Off-Site Disposal of DU drums and materials from facility buildings	
2007	Time-Critical Removal Action	CERCLA	EPA	Removal/Off-Site Disposal of Hazardous/Flam-mable Materials from facility buildings	Pollution Reports
2008	Non-Time Critical Removal Action	CERCLA	PRPs	Removal/Off-Site Disposal of remaining Facility building contents/equipment and building demolition	Action Memorandum
2014	Feasibility Study	CERCLA	PRPs	Evaluation of Remedial Alternatives	Proposed Plan
2015	Non-Time Critical Removal	CERCLA	To Be Determined	Acceleration of Groundwater Treatment for VOCs and 1,4-dioxane	Action Memorandum, Proposed Plan

3. History of CERCLA Enforcement Activities

EPA has performed a number of potentially responsible party (PRP) search related activities, including sending information requests pursuant to CERCLA Section 104(e), reviewing files,

and performing record searches. As a result of those PRP search activities, EPA issued notice of potential liability letters to: Starmet Corporation and Starmet NMI Corporation on May 1, 2001, the United States Army on May 25, 2001, MONY Life Insurance Company, Whittaker Corporation, and Textron, Inc. on July 23, 2001, and the United States Department of Energy on March 18, 2002. These parties either owned or operated the Starmet/NMI facility, generated wastes that were shipped to the facility, or arranged for the disposal of wastes at the facility of their potential liability with respect to the Site.

On February 20, 2002, EPA issued special notice letters requesting participation in negotiations for performance of a remedial investigation and feasibility study (RI/FS) and/or engineering evaluation and cost analysis (EE/CA) to these potentially responsible parties with the exception of the U.S. Dept. of Energy (its special notice letter was sent by EPA on March 18, 2002 along with the notice of potential liability mentioned above).

On April 3, 2002, Starmet Corp. (Starmet) filed a petition for relief under Chapter 11 of the U.S. Bankruptcy Code in the U.S. Bankruptcy Court for the District of South Carolina (Bankruptcy Court). DOJ filed a proof of claim in the bankruptcy on behalf of EPA. On December 20, 2002, the Bankruptcy Court dismissed Starmet's case because Starmet failed to file a plan and disclosure statement within 180 days of its bankruptcy filing date as required by procedural rules. Before the case was dismissed, however, the Bankruptcy Court entered an order approving the sale of all or substantially all of Starmet's assets, other than real estate, for $600,000, with proceeds to be paid to Starmet's secured creditor, Citizens Bank.

On May 12, 2003, the MADPH-RCP modified Starmet's radioactive materials license for manufacturing or operations, allowing only their possession on-site.

On June 13, 2003, the U.S. Army, MONY Life Insurance Co., Whittaker Corp., Textron, Inc. and the U.S. Dept. of Energy entered into an Administrative Order By Consent For RI/FS (U.S. EPA Docket No. CERCLA 01-2003-0021) for the Site, which was amended on February 13, 2008 and again on October 2, 2012 as set forth in the Amendment to Administrative Order By Consent for RI/FS, U.S. EPA Docket No. CERCLA 01-2008-0007, and the Second Amendment to Administrative Order By Consent for RI/FS, U.S. EPA Docket No. CERCLA 01-2012-0096 (jointly, these three agreements are referred to herein as the "AOC for RI/FS"). The AOC for RI/FS also requires the respondents to that agreement to perform one or more EE/CAs, if requested to do so by EPA.

In June 2006, based on newly acquired information, EPA determined that MONY should no longer be considered a PRP for the Site.

On August 20, 2007, as a result of additional PRP search activities, EPA issued notice of potential responsibility letters to: Applied Technology Management, LLC, Applied Materials Science, Inc., and Advanced Specialty Metals, Inc.

On March 3, 2009, EPA issued special notice letters to U.S. Army, U.S. Dept. of Energy, Whittaker Corp., and Textron, Inc. requesting participation in negotiations for performance of a

non-time critical removal action (Building NTCRA) to address the contaminated buildings at the Site.

In August 2011, EPA and U.S. Army, U.S. Dept. of Energy, Whittaker Corp., and Textron, Inc. signed an Administrative Settlement Agreement and Order On Consent For Non-Time Critical Removal Action for the performance of the Building NTCRA to address the on-site buildings. Work began in 2011 and is currently on-going with anticipated completion in 2016.

Under the terms of a Consent Decree with the Massachusetts Department of Public Health (MADPH), Starmet vacated the Site on November 2, 2011. MADPH terminated the radioactive materials licenses on November 8, 2011.

The PRPs (U.S. Army, U.S. Dept. of Energy, Whittaker Corp., and Textron, Inc.), have been active in the remedy selection process for this Site. The PRPs funded and/or performed the studies and investigations upon which the Feasibility Study and Proposed Plan was based.

C. COMMUNITY PARTICIPATION

Throughout the Site's history, community concern and involvement has been high**.** The PRPs and EPA have kept the community and other interested parties apprised of Site activities through informational meetings, fact sheets, press releases, and public meetings. Below is a brief chronology of public outreach efforts.

- In September 2004 EPA released a community relations plan that outlined a program to address community concerns and keep citizens informed about and involved in remedial activities.

- On September 10, 2003 EPA held an informational meeting in Concord, Massachusetts to describe the plans for the RI/FS.

- After the start of the RI/FS, EPA and the PRPs held bi-monthly informational meetings in Concord to discuss various topics regarding the Site, including but not limited to: the community's review of work plans and other subject deliverables; results of on-going RI work; reasonably anticipated future use and potentially beneficial groundwater use at the Site; and other work, including past and on-going removal actions performed by MassDEP, EPA and the PRPs.

- EPA has also produced a number of fact sheets and held a number of meetings on various removal actions that have been and/or are being performed at the Site, including, two time-critical removal actions in 2001 and 2008, respectively, and a non-time critical removal action which began in 2011 and is still on-going.

- On November 1, 2014, EPA made the administrative record available for public review at EPA's offices in Boston and at the Concord Free Public Library. The Concord Library will be the primary information repository for local residents and will be kept up to date by EPA and the PRPs.

- On November 6, 2014, EPA published a notice and brief analysis of the Proposed Plan in the Concord Journal and made the plan available to the public at the Concord Free Public Library.

- From November 12 to December 15, 2014, the Agency held a 30-day public comment period to accept public comment on the alternatives presented in the Feasibility Study and the Proposed Plan and on any other documents previously released to the public. An extension to the public comment period was requested and as a result, it was extended to January 14, 2015.

- On November 12, 2014, EPA held an informational meeting to discuss the results of the RI and the cleanup alternatives presented in the FS and to present the Agency's Proposed Plan. At this meeting, representatives from EPA, MassDEP, and the PRPs consultant answered questions from the public.

- On December 10, 2014, the Agency held a public hearing to accept oral comments on the Proposed Plan. A transcript of this meeting, the comments, and the Agency's response to comments are included in the Responsiveness Summary, which is part of this Record of Decision.

- Local residents formed the group Citizen's Research and Environmental Watch (CREW) to monitor Site activities. They applied for and have been awarded a technical assistance grant (TAG) and have retained a TAG consultant that attends all bi-monthly technical advisory group meetings.

D. SCOPE AND ROLE OF OPERABLE UNIT OR RESPONSE ACTION

The selected remedy was developed by combining components of different source control and management of migration alternatives to obtain a comprehensive approach for Site remediation. In summary, the remedy consists of:

- excavation and off-site disposal of approximately 82,500 cubic yards of contaminated sediments, underground drain lines and debris, and non-Holding Basin soils in various areas of the Site;

- *in-situ* stabilization of DU contaminated principal threat soils in the Holding Basin via

injection of a stabilization agent such as apatite (Apatite II ™ [2]) or other comparable stabilization agent to prevent leaching of contaminants to groundwater;

- containment of Holding Basin stabilized soils with a low-permeability vertical wall and horizontal sub-grade cover to isolate the stabilized soils and further limit mobility of contaminants by removing the flow of groundwater;

- extraction and *ex-situ* treatment of volatile organic compounds (VOCs) and 1,4-dioxane in overburden and bedrock aquifers, and *in-situ* treatment of DU in overburden aquifer and natural uranium in bedrock;

- long-term monitoring of the effectiveness of *in-* and *ex-situ* treatment; and

- Institutional Controls to restrict Holding Basin excavation, prohibit groundwater use until cleanup levels are met; and require installation of vapor mitigation systems should future structures be built above the VOC plumes unless an evaluation of vapor intrusion risks is performed to show such systems are not required.

As with many Superfund sites, the problems at the NMI Site are complex. As a result, EPA has performed a number of removal actions, including:

- **Time-Critical Removal Action #1, 2002- 2003:** EPA installed an interim cover over the Holding Basin and a temporary cap over an area containing buried material referred to as the "Old Landfill", and fenced in the Old Landfill area.
- **Time-Critical Removal Action #2, 2007-2008:** As the result of a fire at the facility in June 2007, EPA removed hazardous materials that could present a fire or chemical hazards risk and that could increase the risk of accelerating a fire due to chemical reactivity or explosion and/or a risk to personnel involved in firefighting or response activities.

[2]. Apatite II ™ is a phosphate mineral derived primarily from fish bones, a waste product of the commercial fishing industry, making it highly cost-effective. The use of apatite sequesters uranium in two ways: 1) dissolution of apatite and subsequent precipitation of U(VI)-phosphate minerals, such as autunite (which has very low solubility and dissolution kinetics); and 2) direct sorption of uranium on the apatite mineral itself. The apatite stabilization technique assumes that sorbed uranium on soils that could become solubilized would come in contact with the apatite media or phosphate in the porewater and become sequestered. Because autunite sequesters uranium in the oxidized form U(VI) rather than forcing reduction to U(IV), the possibility of re-oxidation and subsequent remobilization is very low. Extensive testing has demonstrated the very low solubility and slow dissolution kinetics of autunite. In addition to autunite, excess phosphorous may result in apatite mineral formation, which provides a long-term source of treatment capacity (Pacific Northwest National Laboratory. *Uranium Stabilization through Phosphate Injection*. June 2009). More detailed information regarding uranium sequestration using apatite is presented in Appendix J of the Feasibility Study.

- **Non-Time Critical Removal Action (NTCRA), 2011 to Present:** In August 2011, EPA, with the concurrence of MassDEP, entered into a Settlement Agreement and Order on Consent for a NTCRA for the demolition and off-site removal of the on-site buildings and their contents with Whittaker Corp., Textron Inc., the U.S. Department of Energy, and U.S. Army. EPA anticipates the Building NTCRA will be completed in 2016.

The Commonwealth has also undertaken a prior response action at the Site. In 2006, MassDEP conducted a removal of over 4,000 drums and containers as well as 645,000 pounds of DU metal from the facility buildings. This action was performed with U.S. Army funding under an agreement reached with MassDEP in 2005.

This ROD addresses groundwater, soil, and sediment contamination. Ingestion of water extracted from the overburden and bedrock aquifers poses a current and potential risk to human health because EPA's acceptable risk range is exceeded and concentrations of contaminants are greater than the Maximum Contaminant Levels (MCLs) for drinking water (as specified in the Safe Drinking Water Act). Exposure to site-wide soils also poses a future risk to human health, and exposure to site sediments poses a current and future risk to ecological and human health. This ROD presents a comprehensive remedy for this Site and addresses a principal threat at the Site through treatment and containment of source area soils within the Holding Basin.

The principal and low-level threat wastes that this ROD addresses are summarized in the following table:

Principal Threat Wastes	**Contaminant(s)**	**Action To Be Taken**
Holding Basin Soils	Depleted Uranium (DU)	Stabilization/Containment
Low-Level Threat Wastes	**Contaminant(s)**	**Action To Be Taken**
Sitewide Soils and Sediments	DU, PCBs, PAHs, Copper	Excavation/Off-Site Disposal

E. SITE CHARACTERISTICS

Section 1 of the Feasibility Study contains an overview of the RI. The significant findings of the RI are summarized below.

The chemicals of concern (COCs) in this ROD are summarized in **Tables G-1** through **G-4** for sediment; surface and subsurface soil, and groundwater, respectively, and include but are not limited to the following:

Natural uranium, as found in the Earth's crust, is a mixture largely of two isotopes: uranium-238 (U-238), accounting for 99.28% and uranium-235 (U-235) about 0.72%. It also contains a very small amount of U-234 (about 0.005%). The RI found that, as a result of Site activities, natural uranium in the bedrock has been released into the bedrock groundwater at levels that exceed the MCL for uranium of 30 micrograms/liter (ug/L).

Depleted Uranium is uranium that has been stripped of most of the radioactive isotope U-235, such that it is comprised of mostly U-238, the least radioactive of the three isotopes. It also contains a very small amount (less than 0.001%) of U-234. Depleted uranium contains approximately 0.2% U-235 and 99.78% U-238. It is about half as radioactive as natural uranium. The RI found that as the result of disposal activities in the Holding Basin that the overburden groundwater is contaminated with DU in excess of the MCL for uranium (listed above). There are also widespread contaminated soils and sediments throughout the Site in excess of risk-based cleanup levels. Metals other than DU/natural uranium found at the Site are thorium and arsenic; however, these compounds are only found at levels that are related to background concentrations, and are therefore not related to historical Site activities.

PAHs or Poly Aromatic Hydrocarbons are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. They can also be found in asphalt pavement and roofing products, and a few are used in medicines or to make dyes, plastics, and pesticides. PAHs were detected at low concentrations but above risk-based cleanup levels in surface soil at the Site, particularly in soils that received runoff from parking lots. The PAHs found in the Site soils are: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene.

PCBs or Polychlorinated Biphenyls are manmade chemicals that were used in electrical manufacturing and were banned in 1979. Areas of the Site such as the Cooling Water Recharge Pond and the Sweepings Piles that accepted wastewater and dredged materials from the Pond, respectively, have been contaminated with PCBs above the cleanup level of 1 ppm.

VOCs or Volatile Organic Compounds include a variety of chemicals that are used in glue, paint, solvents, and other products and easily evaporate. Common VOCs include trichloroethylene (TCE) and tetrachloroethene (PCE). Both of these compounds are found in on-site groundwater at concentrations that exceed the MCL of 5 ug/L for both chemicals.

SVOCs or Semivolatile Organic Compounds are chemicals that may vaporize when exposed to temperatures above room temperature. The SVOC 1,4-dioxane is present in groundwater at

the Site above the risk-based cleanup level of 0.46 ug/L, and is believed to have been included as a stabilizer in solvents historically used at the Site.

Conceptual Site Model

The Conceptual Site Model (CSM) for contaminated soil, sediment, and groundwater at the Site is provided in **Figure E-1 in Appendix C.** The CSM is a three-dimensional "picture" of site conditions that illustrates contaminant sources, release mechanisms, exposure pathways, and migration routes. Potential human and ecological receptors are presented in Section G of this ROD. It documents current and potential future site conditions and shows what is known about human and environmental exposure through contaminant release and migration to potential receptors. The risk assessment and response action for the contaminated soil, sediment, and groundwater at the Site is based on this CSM.

For the purposes of the RI, the Site was organized into Areas of Investigation (AOIs). The AOIs, including their sources and receiving media, are discussed below (and shown on **Figure E-2**):

- AOI 1 – Holding Basin Soil: Neutralized nitric acid solution containing dissolved copper and DU was discharged to an unlined Holding Basin between 1958 and 1985. Various facility drain lines from the buildings also appear to have discharged to the Holding Basin. The primary receiving media were vadose zone soils and saturated soil below, adjacent, and surrounding the Holding Basin, and groundwater below the Holding Basin. The Holding Basin contains the highest concentration of DU in on-site soil, with an average concentration of 93 mg/kg, and a maximum concentration of approximately 12,000 mg/kg. The volume of DU impacted soil in the Holding Basin is approximately 32,000 cubic yards.

- AOI 2 – Drum Burial Area Soil: In addition to drums in the Old Landfill area (AOI 3), drums containing beryllium and possibly other materials were found (and subsequently removed) in a buried trench located between the Cooling Water Recharge Pond and the Holding Basin. Soil and groundwater would be the primary receiving media from drums that may have leaked or been damaged. Concentrations of DU in this area are generally two-times the cleanup level of 2.7 mg/kg.

- AOI 3 – Old Landfill Soil: The Old Landfill was reportedly used for disposal of solid waste that could include materials from the research and development laboratories, drummed material containing various metals, including DU and beryllium, and municipal and office waste. Soil would be the primary receiving medium from drums that may have leaked or been damaged.

- AOI 4 – Cooling Water Recharge Pond Surface Water, Sediment, and Bank Soil**:** Building floor drains and roof drains discharged to the Cooling Water Recharge Pond. Roof drains are a potential source of metals, because if machining dusts were deposited on the roofing material, they would collect in the roof drain system. The Cooling Water Recharge Pond also received direct discharge from the Holding Basin on at least two

occasions. Non-contact cooling water pumped from on-site wells contained VOCs, DU, and natural uranium. The primary receiving media include surface water and sediment in the Cooling Water Recharge Pond, and groundwater below the pond. In addition, sediments from the Cooling Water Recharge Pond may have been dredged and placed on the banks surrounding the pond and in an area known as the "sweepings" area (AOI 8), in an effort to increase the capacity of the Cooling Water Recharge Pond. Therefore, soil surrounding the Cooling Water Recharge Pond may also be a primary receiving medium.

- AOI 5 – Septic Fields Soil: On-site septic disposal has been utilized since facility start-up in 1958 and therefore, septic systems could have received site-related chemical or radiological wastes. The primary receiving media were soil and groundwater in and beneath the leach fields.

- AOI 6 – Sphagnum Bog Surface Water and Sediment: Supernatant liquid from the Holding Basin was reportedly discharged to the Sphagnum Bog between 1958 and possibly as late as the 1970s. In addition, sink and floor drains from laboratories located in Building A discharged to the Sphagnum Bog between 1958 and approximately 1975. The primary receiving media were surface water, sediment, and peat in the Sphagnum Bog.

- AOI 7 – Former Waste Handling Area Soil: An area located to the south of and beneath Building E was formerly used for waste handling and storage, prior to the construction of Building E. During that time, this area was not paved. The primary receiving medium for material that may have been spilled or disposed is soil.

- AOI 8 – Sweepings and Fill Area Soil: An area southwest of the main parking lot contains piles that reportedly include sweepings from building floors. It was later discovered that this area received dredged sediments from the Cooling Water Recharge Pond. The deposited material has soil-like characteristics (e.g., sand and gravel).

- AOI 9 – Parking Outfall Areas: Surface water from the parking lot areas discharges to this minor tributary leading to the Assabet River. This outfall area could have received site-related contamination via overland transport of sediments in surface water runoff.

- AOI 10 – Northeast Wetland Soils/Sediment: This is a wet area to the north of the Cooling Water Recharge Pond and south of Route 62. One historical aerial photograph (1981) indicates that a pipe existed in the Cooling Water Recharge Pond and, although it is not clear what the function of the pipe was or where it may have discharged, a possible scenario is that the pipe controlled pond level and discharged to the wet area to the north. If the pipe functioned to drain or maintain the level of the Cooling Water Recharge Pond, it is possible that the surface water drained from the pond was discharged to the wetland

area. Under these circumstances, constituents present in the recharge pond surface water could have been discharged to soils/sediment in the wetland area.

- AOI 11 – Drain Lines Soil: Drain lines carried process wastes, cooling water and storm water from the facility buildings to the Holding Basin, Sphagnum Bog, and Cooling Water Recharge Pond. If contaminated liquids leaked from underground piping, they would be released to soil beneath the pipes, and potentially to groundwater. Drain lines are generally located beneath the area of land east of Buildings C and D.

- AOI 12 – Underground Storage Tanks Soil: The facility maintained two 10,000-gallon USTs to store heating oil, located north of Building B. If these tanks have leaked, the oil would migrate to soil surrounding and beneath the tanks.

- AOI 14 – Down-Wind Surface Soils: Particulate emissions from the air handlers and stacks on the facility buildings may have migrated in the ambient air and been deposited in surficial soils down-wind of the buildings.

- AOI 15 – Transformer Pads Soil: Two outside transformer pads are present. A pad with one transformer is located adjacent to Building B and dates from facility start-up in 1958. A second pad with three transformers is located east of Building D and dates from construction of that building in 1978. Additional electrical units are located on the former switchgear pad located in the paved yard behind Buildings C and D. It is not known if the transformers ever contained petroleum-based dielectric fluid or if the fluid contained PCBs, as no fluid was found in the transformers at the time of the RI. If dielectric fluid spilled, the fluid would have been released to surface soil around the transformers.

- AOI 16 – Groundwater: Although groundwater was not an original source of contaminants, leaching is known to have occurred in the Holding Basin, where continuous discharge of DU, copper, and nitrate, and possibly other chemicals, has resulted in elevated concentrations of these constituents in deep subsurface soils and groundwater beneath the Holding Basin. The sources of VOCs and 1,4-dioxane are likely related to historical disposal of chlorinated solvents such as tetrachloroethene and 1,1,1-trichloroethane (which likely contained 1,4-dioxane as a stabilizer) to the Holding Basin, Cooling Water Recharge Pond, and/or Old Landfill. A uranium plume in bedrock groundwater was identified. However, the uranium in bedrock groundwater exhibits a natural isotopic signature, suggesting that it is not directly related to release of DU at the Site. Evaluation of bedrock groundwater data suggests that the presence of elevated concentrations of natural uranium in bedrock groundwater may be a result of site-related activities that may have altered bedrock groundwater geochemistry, resulting in leaching of natural uranium from the bedrock.

- AOI 17 – Background Areas: Samples were collected from background reference areas for soil, surface water, sediment, and groundwater. Background reference areas were closely matched to the characteristics of the AOIs evaluated.

- AOI 18 – Assabet River: The Assabet River could have potentially received site-related contaminated surface water and sediment via the minor tributary where parking area surface water was discharged. The Assabet River could also serve as a discharge location for site-related contaminated groundwater.

The major aspects of the CSM for the Site are as follows:

- Primary Release Mechanisms (All Media). Constituents were released or disposed in ways that resulted in contamination that extends across multiple AOIs. Specifically, disposal or release of these contaminants appears to have occurred through:

    - Direct disposal, spills, or leaks from drain lines (AOI 1 – Holding Basin, AOI 2 – Drum Burial Area, AOI 7 – Former Waste Storage Area, AOI 11 – Drain Lines; AOI 15 – Transformer Pads);

    - Disposal of dredging materials and/or land filling (AOI 3 – Old Landfill, AOI 4 – Cooling Water Recharge Pond, AOI 8 – Sweepings and Fill Area); and

    - Aerial deposition (AOI 14 – Perimeter Soils), and subsequent storm water runoff and deposition (AOI 9 – Pavement Drain Outfalls).

- Primary Soil Impacts. Among the constituents released by these mechanisms, DU, PCBs, and PAHs show the greatest frequency of contamination in unsaturated soil.

- Primary Sediment Impacts. Among the constituents released by these mechanisms, PAHs, PCBs, and metals, including DU and copper are considered the primary contaminants of potential concern for human and ecological receptors, although VOCs were also detected but at low frequency or low concentrations.

- Primary Groundwater Impacts. Groundwater data suggest that DU migrated to the overburden groundwater, natural uranium migrated to the bedrock groundwater and chlorinated VOCs, and 1,4-dioxane migrated to the overburden and bedrock groundwater. The groundwater flow is toward the north and northwest, resulting in overburden and bedrock plumes of VOCs and 1,4-dioxane that extend off the facility property toward and beneath the Assabet River. The 1,4-dioxane plume associated with the Site extends to deeper overburden as evidenced by monitoring results from wells located just south and northwest of the Assabet River.

Site Overview

The NMI Site includes the 46-acre NMI Property located at 2229 Main Street, Concord, Massachusetts, and also includes contaminated groundwater migrating to areas located off the NMI Property. The NMI Property is approximately 46 acres and as currently configured, includes eight interconnected buildings, several smaller outbuildings, paved parking areas, a Cooling Water Recharge Pond, a former waste Holding Basin, and areas of fill and/or waste materials. The buildings are to be removed as part of an on-going Non-Time Critical Removal Action (Building NTCRA), a cleanup plan selected by EPA in 2008, and are not part of this remedy selection. The buildings will be removed before the Remedial Design/Remedial Action (RD/RA) begins. The NMI Property is bordered by Main Street (Route 62) and several commercial and residential properties to the north, residential properties to the east, town-owned open space and a children's summer camp to the south and southwest, and woodland and commercial/industrial properties to the west. The Assabet River is situated approximately 300 feet north of the NMI Property, on the opposite side of Route 62.

In addition to the above features, there are two wetlands at the Site, the Sphagnum Bog and the Northeast Wetland located north of the Cooling Water Recharge Pond. The Sphagnum Bog is a palustrine, broad-leafed evergreen, scrub-shrub, saturated, acidic wetland. The bog is located approximately 75 feet east of the Cooling Water Recharge Pond and the Holding Basin. The bog covers an area of approximately 3.5 acres. The bog is composed primarily of sphagnum peat. The substrate of the bog varies from growing sphagnum at the surface, to decomposed peat below the surface. The Sphagnum Bog has no inlets or outlets and receives the bulk of its moisture from precipitation and run-off.

The Northeast Wetland is located approximately 200 feet north of the Cooling Water Recharge Pond, and just south of Route 62. This wetland possibly was formed during the construction of Main Street to prevent further runoff to the north. It is a palustrine, forested, broad-leafed, deciduous wetland, subject to seasonal flooding. The low lying area associated with this wetland covers approximately 0.8 acres.

The existing land use at the NMI Property is a mix of industrial use property, fenced undeveloped property, and unfenced undeveloped property. The industrial portion of the NMI Property is represented by the buildings and associated paved parking lots, paved staging areas, and small landscaped areas (mowed grass). A security fence with locking gates restricts access to the southern and eastern sides of the portion of the property where the buildings are located. The fence extends from that area to the Sphagnum Bog, encompassing the Cooling Water Recharge Pond, Holding Basin, and Old Landfill areas (see **Figure E-3**). This area is essentially 'restricted' open space, and is unpaved with varying amounts of vegetation (e.g., brush and grass) and wooded areas. The unfenced portion of the property is located outside of the security fence. This area is open space that is generally wooded. The Northeast Wetland and the Sphagnum Bog are within this area.

Topography

The Site is located in the Assabet River basin. The topography of the Site is characterized by typical glacial kame and kettle features, consisting of irregular steep-sided hills and closed depressions. The surface elevation of the Site varies from approximately 137 feet above mean sea level (msl) to 213 feet above msl, rising generally from north to the south.

Geology

There are three major geologic units in the Assabet River Basin: surficial stratified glacial drift deposits, glacial till, and bedrock. The surficial deposits are the most permeable and are generally found in valleys bounded and underlain by till and bedrock.

The Site is located on the eastern side of the Assabet River Valley, which is a buried glacial valley typical of many in the area. Along the axis of the valley, roughly aligned with the present day Assabet River, thick deposits of stratified glacial drift overlie till and bedrock. Along the sides of the valley, the unconsolidated glacial deposits are thinner and, at the margins, till or bedrock may outcrop.

Hydrogeology

The Site lies within the Assabet River basin. No natural streams are present on-site. The only apparent surface water body that pre-dates development of the Site is a Sphagnum Bog located in the eastern-central portion of the Site. The Assabet River flows in an easterly direction and merges with the Sudbury River to form the Concord River approximately 3.5 miles downstream of the Site.

A surface water divide is located in the upland to the south of the Site. Surface water runoff from areas north of this divide flow north to the Assabet River. Surface water runoff from areas south of this divide flow south to Second Division Brook, which flows in an easterly direction, and then north to join with the Assabet River.

Groundwater is found both in the unconsolidated and bedrock formations and migrates north/northwest, towards the Assabet River.

Remedial Investigation Sampling Strategy

An extensive sampling effort has been completed to support the RI, Risk Assessments and Feasibility Study for the Site. Physical and analytical data have been collected to develop the conceptual site model and identify the nature and extent of site-related constituents in the environment. The first phase of the RI field program (Phase IA) occurred from September 2004 to May 2005. Phase IA activities focused on gathering data across various site media (surface and subsurface soil, sediment, surface water, and groundwater) to characterize the nature and

extent of contamination from historical Site activities at each of the 18 AOIs. Samples were analyzed for chemical constituents including VOCs, semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), inorganics and radionuclides. In May and June of 2004, on-site habitats were qualitatively assessed and a portion of the wetland boundary along the on-site Cooling Water Recharge Pond was delineated. Candidate background locations for Site wetland and upland areas were identified using public information and field reconnaissance of those areas. Based on results of the Phase IA investigation, a Phase IB field program was initiated in October to November 2005 to further characterize the extent of contamination at the Site. The Phase IB field event included additional sampling in surface water, sediment, soil, and groundwater for both chemicals (VOCs, SVOCs, PCBs, inorganics) and radionuclides. **Figure E-4** shows the locations of the groundwater monitoring wells. The Phase IC field investigation was undertaken in 2006 and 2007, with minor re-sampling activities in 2008. Phase IC included activities to address data gaps identified in the Screening Level Ecological Risk Assessment (SLERA), and as outlined in the Risk Assessment Study Design. Phase IC field activities included collection of soil, surface water, and sediment samples for chemical analysis of SVOCs, PCBs, and metals. Surface water samples were also collected for Frog Embryo Teratogenesis Assay – *Xenopus* (FETAX) analyses, and sediment was collected for toxicity tests using *Chironomus dilutus*. Aquatic invertebrate and frog tissue was collected and analyzed for SVOCs, PCBs, metals, and lipids. A benthic community survey was also performed as part of the Phase IC investigation. In addition, supplemental surface soil sampling for PCBs was conducted at AOI 14, east of Sphagnum Bog, in November 2009. **Figures E-5 through E-11** present the locations of RI surface soil, subsurface soil, sediment, off-site sediment, surface water, off-site surface water, and soil vapor sampling, respectively. More information regarding the overall RI sampling strategy can be found in Section 2.12 of the RI Report. Additional samples will be taken during design to verify the nature and extent of contamination.

Nature and Extent

***Soil*:** Phases IA, IB, and IC soil sampling (surficial, shallow and deep) have served to provide adequate vertical and horizontal delineation of contaminant extent in nearly all cases. With the exception of AOI 2 (Drum Burial Area) and AOI 11 (Drain Line Area), the delineation of soil contamination is generally defined by the horizontal and vertical extent of DU and PCBs at concentrations greater than the cleanup levels in **Table L-2 in Appendix B**. Other contaminants that were detected at concentrations greater than the cleanup levels are bounded by non-detects or concentrations below cleanup levels, and are within the overall area and depth of soil that is contaminated with DU and/or PCBs at concentrations greater than cleanup levels. Where vertical delineation has not been achieved, it is typically associated with soils greater than 10 feet below ground surface, where potential human and ecological receptor contact with soil is improbable.

***Sediment*:** The extent of contamination in sediments is largely defined by areas where copper, PCBs, and/or DU exceed cleanup levels in **Tables L-3 and L-4**. These areas are within the

Cooling Water Recharge Pond and the Sphagnum Bog. Other contaminants detected at concentrations in excess of the cleanup numbers fall within the areas bounded by copper, PCBs, or DU. Concentrations of DU ranged from non-detect to 129 mg/kg, and PCB concentrations ranged from non-detect to 437 mg/kg. The volume of sediment to be addressed is approximately 6,700 cubic yards.

***Surface Water*:** Sampling of surface water has indicated little impact due to site conditions. The exceptions to this are at locations where surface water is relatively stagnant and in closer equilibrium with contaminated sediments, for example: copper at AOI 4 (Cooling Water Recharge Pond). The nature and extent of surface water contamination generally mirrors sediment contamination, particularly for water soluble compounds. Statistical evaluation of the Assabet River surface water data upstream of the Site with surface water data in the downstream reach and adjacent reach of the river revealed no statistically significantly higher concentrations of analytes in either the adjacent or downstream reaches of the river. Therefore, the nature and extent of contamination in the Assabet River has been adequately delineated, and there has been no site-related impact on the river.

Groundwater

Overburden Groundwater: In general, the extent of overburden groundwater contamination is limited to areas of the Site where concentrations of DU, TCE, PCE, 1,4-dioxane, or nitrate exceed MCLs in overburden groundwater (the "overburden plume") or risk based cleanup levels in **Table L-1**. Other contaminants detected in overburden groundwater are generally present within the delineated overburden plume or have been detected at low concentrations and/or infrequently at other locations.

Most overburden groundwater samples at the Site contain elevated concentrations of DU. The extent of the DU plume exceeding the MCL of 30 µg/L is laterally constrained to a narrow zone extending from the Holding Basin at the southeast to the northwest. The DU plume extends downgradient to just beyond Building D (**see Figure E-12**). Historically elevated nitrate has long since migrated through the Site, with only slightly elevated nitrate concentrations currently found on-property, therefore nitrate has a very limited impact on groundwater. The VOCs PCE, TCE, and 1,1-DCE were detected in excess of MCLs (for VOCs) and vapor intrusion screening levels, and the SVOC 1,4-dioxane was detected in excess of the risk-based cleanup level for 1,4-dioxane in overburden groundwater (**see Figure E-13**). It should be noted that vinyl chloride was detected in the same areas as the other VOCs which exceed MCLs, but was not detected at a concentration above its MCL. However, the maximum detection of vinyl chloride was above USEPA's most recent (June 2015) vapor intrusion screening level. Pre-design monitoring will be performed to further define extents of contaminants when refining any remedial design. While the lateral extent of VOCs is constrained by monitoring wells where VOCs were not detected, the downgradient extent of 1,4-dioxane extends underneath the Assabet River.

At the time that the RI was completed, sampling and analysis of 1,4-dioxane indicated that the Assabet River was the receiving medium for this contaminant, however; subsequent sampling of monitoring wells on the northern (opposite) side of the river have shown that 1,4-dioxane is apparently migrating underneath the Assabet River toward the town of Acton public water supply wells. It is not known at this time whether this source of contamination is from the overburden or bedrock aquifers.

Soil Gas: The overburden groundwater on the NMI Property exceeds USEPA's vapor intrusion screening levels (see **Figure E-14** for areas that exceed vapor intrusion screening levels).[3] Therefore, two buildings (Building 1 and Building 2) that overlie a portion of the VOC groundwater plume downgradient and north of the NMI Property were sampled for soil gas (see **Figure E-11** for building locations where vapor intrusion investigations were conducted). In Building 1, TCE concentrations measured in discrete sub-slab soil gas samples averaged 29 $\mu g/m^3$ in the late fall of 2009 and approximately 13 $\mu g/m^3$ in late spring of 2010. The total average over all four samples is approximately 19 $\mu g/m^3$; however, as a conservative measure, the maximum value (29 $\mu g/m^3$) was used for screening indoor air. Using the conservative "generic" sub-slab-to-indoor air attenuation factor of 0.1 from the USEPA *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils* (USEPA, 2002),[4] the TCE concentration in sub-slab soil gas would need to be greater than 30 $\mu g/m^3$ to pose a potential ELCR above 1 in 1 million (10^{-6}). This threshold sub-slab soil gas concentration is more than any individual measurement from Building 1. As a protective measure, in August 2013, a mitigation system was installed in Building 1. This building is currently being used for light commercial purposes and the mitigation system started operation shortly after installation.

In Building 2, TCE was not detected in three sub-slab samples collected over two different seasons in 2009 and 2010. Two sub-slab soil gas samples were collected during the heating season and one in late spring (June). The lack of TCE in sub-slab soil gas, combined with the low VOC concentrations detected in groundwater samples, are strong evidence for an incomplete vapor intrusion pathway at this structure. No further action is recommended for this building.

Bedrock Groundwater: The extent of bedrock groundwater contamination is primarily limited to

[3] Note that **Figure E-14** was generated prior to generation of the most recent USEPA vapor intrusion screening levels (June 2015). While the screening levels presented on the figure are lower than the current screening levels, the extents presented are similar to current extents. As noted in other sections of this ROD, institutional controls require installation of vapor mitigation systems should future structures be built above the VOC plumes unless an evaluation of vapor intrusion risks (including comparison to the most current vapor intrusion screening levels) is performed.

[4] USEPA, 2002. United States Environmental Protection Agency, Office of Solid Waste and Emergency Response. Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance); EPA 530-D-02/004; November 2002.

areas of the Site where concentrations of natural uranium, TCE, 1,4-dioxane, or nitrate exceed MCLs in bedrock groundwater (the "bedrock plume"). Uranium detected in bedrock groundwater consistently has a natural isotopic signature. Uranium concentrations in bedrock groundwater are consistent with background conditions across much of the Site, with a zone of elevated natural uranium concentration extending southeast to northwest, from the region downgradient of the Holding Basin to just upgradient of the property boundary (**see Figure E-15).** Based on seven sampling rounds since 2005, these concentrations appear to be at steady-state. Slightly elevated uranium with a natural isotopic signature (12.8 µg/L) has been detected off-property. Nitrate exceeded the MCL in bedrock groundwater in only one location immediately downgradient of the Holding Basin. The VOCs TCE and 1,1,-DCE along with the SVOC 1,4-dioxane were detected at concentrations exceeding MCLs and the risk-based cleanup level, respectively, in bedrock groundwater, but at maximum concentrations lower than in overburden groundwater (**see Figure E-13**). The lateral and downgradient extent of the VOC plume is delineated by the monitoring well network. As in the overburden groundwater, the bedrock groundwater containing 1,4-dioxane in excess of the risk-based cleanup level extends past the downgradient edge of the monitoring well network on the southern side of the Assabet River to the northern or opposite side of the Assabet River.

Primary Sources and Routes of Migration

The waste streams from the major processes were discharged to or deposited in several locations at the Site. The release mechanisms resulting in contamination include direct discharge, waste disposal, and particulate emissions. Based on the information concerning sources of contamination and migration pathways, the following media are affected by releases from the Site:

- Residual soil/sludge at the bottom of and beneath the Holding Basin;
- Surface and subsurface soil surrounding (and beneath) the Holding Basin;
- Sediment at the bottom of the Cooling Water Recharge Pond;
- Surface water in the Cooling Water Recharge Pond;
- Surface and subsurface soils surrounding the Cooling Water Recharge Pond;
- Overburden and bedrock groundwater beneath and downgradient of the NMI Property;
- Sediment in the Sphagnum Bog;

- Subsurface soil in the vicinity of the Drain Lines, beneath the building floors, and the UST Area (located north of Building B);
- Soil in the vicinity of the Old Landfill, Sweepings and Fill Area, Drum Burial Area, Hazardous Waste Area, Transformer Pads, and the industrial courtyard area;
- Sediment in the Northeast Wetland, south of Route 62; and
- Surface soils that may have received deposition from stack emissions from the Site.

The Assabet River is a receiving medium for overburden groundwater. However, site-related contamination has not accumulated in the river as only low levels of VOCs have been detected in sediment, likely resulting from discharge of shallow overburden groundwater. Sediment contamination in the Assabet River Embayment Area is characterized by metals which have not been found to be site-related and that are found upstream at higher concentrations. It is hypothesized that this contamination has resulted from deposition of sediment associated with historic upstream sources during flooding events.

The details of the fate and transport of constituents present in contaminated media (soil, sediment, and groundwater) for the main constituents detected at the Site is as follows:

Sources

Depleted Uranium

The uranium COC in overburden groundwater is DU, and the uranium COC in bedrock groundwater is uranium with a natural isotopic signature. The following sections on the fate of uranium are equally relevant for depleted and naturally occurring uranium.

The primary demonstrated source of DU at the Site is historical disposal at the Holding Basin. Other potential sources of DU at the Site include particulate emissions from building roof stacks, spills, and discharge of contaminated water or fluids to the Cooling Water Recharge Pond.

Low concentrations of DU have been detected in surface soils at the Site, generally surrounding the buildings, as well as in soil/sediment in parking lot drainage swales and outfalls. This suggests that DU may have been released via stack emissions and settled onto surfaces in close proximity to the buildings. The RI delineated the extent of surface soils containing DU in excess of regional screening levels.

DU has also been detected at elevated concentrations in sediments within the Cooling Water Recharge Pond and the soils surrounding the Cooling Water Recharge Pond. This suggests that DU was released to the Cooling Water Recharge Pond, either by floor drain lines that discharged

to the pond, by historical breaches or overflow of the Holding Basin, or by discharge of cooling water that was contaminated with DU.

The remainder of this subsection specifically describes the source of DU to groundwater at the Holding Basin.

The extent of DU contamination in the Holding Basin area extends from the current base of the Holding Basin into the till, encompassing most of the Holding Basin footprint. In addition, DU is found at up to 100 mg/kg in an area of the saturated zone extending in the downgradient direction from the Holding Basin, between approximately 100 to 125 feet of elevation, or about 50 to 75 feet bgs and contiguous with the DU impacted soils located directly beneath the Holding Basin. The average concentration of unsaturated soils in the Holding Basin is 93.3 mg/kg DU and the saturated soils contain an average concentration of 29.5 mg/kg.

The pre-RI groundwater monitoring data in the area adjacent to and down gradient of the Holding Basin provide evidence of the strength of the Holding Basin DU source over time. The first groundwater monitoring data from the Holding Basin area, collected in 1983, indicate moderate groundwater impacts (up to 1,500 µg/L in groundwater). Decommissioning and covering of the Holding Basin in 1986 was followed by a decrease in groundwater impacts (below 200 µg/L). Excavation and uncovering of the Basin in 1998 with subsequent rainwater infiltration through the bottom of the Holding Basin resulted in a substantial release of DU to groundwater, increasing the concentration of DU near the Holding Basin to as high as 40,000 µg/L. Lining of the Holding Basin in 2002 has since limited the potential for releases to groundwater, and recent measurements indicated that groundwater near the Holding Basin contains up to 3,000 to 5,000 µg/L of DU.

Other potential sources of DU to groundwater exist, but none have shown a discernible impact on groundwater quality. These potential sources include subsurface drain lines located between the facility buildings and the Holding Basin, floor drains, sumps, and other potential release points within the buildings, sediments within the Cooling Water Recharge Pond and Sphagnum Bog, and other contaminated soils throughout the site.

Natural Uranium

Unlike the DU plume in overburden groundwater, there is no clear source of uranium with a natural isotopic signature for the bedrock groundwater. The source of elevated uranium in bedrock groundwater is most likely naturally occurring uranium minerals in bedrock. Uranium may have been released to groundwater from the bedrock matrix due to natural variability in groundwater geochemistry, or as a result of site-related activities that may have altered bedrock groundwater geochemistry.

VOCs

It is likely that incidental releases of VOCs have occurred at the Site in the past. Although there is no documentation of how these releases occurred, investigations at the Site have provided some information on possible VOC sources. According to the Phase II Site Assessment for the Site, TCE was used at the NMI Site for cleaning of machines and machined parts from 1958 to 1974, 1,1,1-TCA was used after 1974, and there may have been discharges from floor drains, which were sealed in the mid-1990s. Low concentrations of chlorinated VOCs have been detected in soils at the Drum Burial Area and Old Landfill (AOIs 2 and 3), suggesting that these areas could have functioned as historical sources of VOCs. Several VOCs were discovered in water pumped from supply well SW-1 in 1981; most of this extracted water was discharged to the Cooling Water Recharge Pond after use. Several VOCs, primarily toluene and acetone, were detected historically in samples collected from the two on-site septic tanks, indicating a potential for releases from the two leach fields at the Site.

Low concentrations and sparse detects of several VOCs, for example, 1,1,1-TCA and cis-1,2-DCE, suggest the possibility of other historical incidental releases of VOCs at the Site.

Groundwater data do not indicate the presence of any ongoing sources of VOCs at the Site.

1,4-dioxane

Used as a stabilizer in TCA and possibly other solvents, 1,4-dioxane may have been present in solvents used at the Site and released as a co-contaminant. 1,4-dioxane was not detected in soil, surface water, or sediment at the Site, suggesting that there are no residual sources of 1,4-dioxane in these media.

PCBs

There are no documented uses of PCBs at the Site. It is hypothesized that PCBs were released to the Cooling Water Recharge Pond, possibly through floor drains that discharged to the pond. Since PCBs adsorb strongly to particulates, PCBs became sorbed to sediments within the pond. It is recognized that pond sediments were occasionally dredged, and the dredging spoils were then used to build up the berm between the Cooling Water Recharge Pond (AOI 4) and the Sphagnum Bog (AOI 6). Dredging spoils were also believed to have been deposited in the Sweeping Piles Area (AOI 8).

Routes of Migration

Depleted Uranium

The primary migration pathway for DU released to overburden groundwater is expected to coincide with the preferred flow zone located in the central part of the Site, aligned southeast-northwest. The eventual fate of DU migrating along this pathway is discharge to the Assabet River located approximately 1,300 feet downgradient, although evidence collected to date

indicates this pathway remains incomplete (i.e., to date DU has migrated at least 350 feet from the downgradient edge of the Holding Basin, as defined by the extent of DU above 30 µg/L).The Cooling Water Recharge Pond sediments were occasionally dredged during historical operations to create more water storage capacity in the pond. DU that accumulated in the Cooling Water Recharge Pond sediments was relocated with the dredge spoils. Generally, the dredge spoils were piled around the east side of the Cooling Water Recharge Pond, creating a berm between the pond and the Sphagnum Bog. Dredge spoils were also believed to have been placed at AOI 8 (Sweepings and Fill Area); the sweepings piles may actually be dredge spoils. Elevated concentrations of DU have been detected in soils around the Cooling Water Recharge Pond and at AOI 8.

DU present in surface soil (from particulate deposition, spills, and Cooling Water Recharge Pond dredge spoils) does not appear to be a leaching source, as evidenced by concentrations that decrease substantially with depth. The primary migration pathway for DU in surface soil is erosion. The principal erosion migration area at the Site appears to have been associated with soils in the berm area between the Cooling Water Recharge Pond and the Sphagnum Bog. Elevated concentrations of DU have been detected in sediments within the bog, particularly in the eastern and southern areas of the bog, nearest the berm area. This suggests that an erosional migration pathway from the contaminated berm soils (which are believed to be dredge spoils from the Cooling Water Recharge Pond) to the bog existed. A minor erosional pathway is evidenced by low concentrations of DU in surface soils on the steep embankment between the parking lot and the Northeast Wetland, and low concentrations in the Northeast Wetland sediments.

DU was also detected in surface water in the Cooling Water Recharge Pond and Sphagnum Bog, suggesting that some partitioning between sediment and surface water has occurred.

Natural Uranium

As shown in **Figure E-15**, the elevated uranium plume in bedrock with a natural isotopic signature extends from the Holding Basin/SW-2A northwestward toward the Assabet River. Concentrations appear to be relatively steady over time with no plume expansion or uranium in excess of the MCL off-site. Migration appears to be confined to a relatively narrow zone encompassing the shallow bedrock around MW-BS15. Shallow bedrock wells to the west (MW-BS31), to the east (MW-BS26), and deeper (MW-BM15) all show less than 1 ppb of uranium.

VOCs

Similar to uranium, VOCs have migrated along the preferred flow zone extending across the Site northwest of the Holding Basin. However, the greater mobility of these constituents and the greater diversity of release points have resulted in historical and current migration pathways throughout the Site. For example, the presence of PCE and other VOCs in groundwater between

the Cooling Water Recharge Pond and SW-1 may reflect historical preferential groundwater flow between these features due to active recharge and pumping. Migration pathways from each of the septic leach fields (AOI 5) are also more important for VOCs than for uranium and have resulted in migration pathways in the western and eastern portions of the Site, outside of the primary migration pathway for uranium.

Migration between the buildings, SW-1, and off-property locations is generally north and northwesterly with TCE extending underneath the Assabet River into the overburden on the northern side of the Assabet River (**see Figure E-13**).

Migration pathways for VOCs in bedrock are expected to be oriented generally north and northwesterly, following the hydraulic gradient in the shallow, highly fractured bedrock.

1,4- dioxane

The fate of 1,4-dioxane in Site groundwater is similar to other chemicals; that is, local discharge to the overburden and shallow bedrock downgradient of Route 62 with eventual discharge to the Assabet River. Recent detections of 1,4-dioxane in deep overburden north of the Assabet River indicate the migration of 1,4-dioxane beneath the river. The current extent of 1,4-dioxane in both overburden and bedrock, respectively, is illustrated on **Figure E-13**. On the upper left of both figures, the locations of two public water supply wells for the Town of Acton, "Assabet IA" and "Assabet I" are shown. There is a clear gradient in 1,4-dioxane concentrations, with a peak concentration on the eastern (NMI side) of the Assabet River of 97.9 ug/L at the bedrock MW-BS15 location, dropping to 33 ug/L at deep overburden PT-11B1, and then to 6.1 ug/L at monitoring well PT-03B1 nearest the Acton water supply wells. The concentration trends in these wells are increasing, although changes in analytical methods over the monitoring period make qualitative trend analysis difficult. Monitoring data at Assabet IA, the well in current use, shows an increasing trend in 1,4-dioxane, with several samples in 2014 greater than 0.3 ug/L. The blended output of the various Acton production wells is currently less than 0.3 ug/L. There is no enforceable federal or Massachusetts maximum contaminant level (MCL) for 1,4-dioxane. In 2011, MassDEP reduced the drinking water guideline for 1,4-dioxane from 3 µg/L to 0.3 µg/L. The MassDEP drinking water guideline is not considered an enforceable standard. Similarly, in 2014, MassDEP reduced the Method 1 GW-1 standard for 1,4-dioxane (used to regulate cleanup of MassDEP sites) from 3.0 µg/L to 0.3 µg/L but this does not apply directly to Superfund sites because the MCP allows for a site specific risk assessment which was used to generate the cleanup number for 1,4-dioxane.

PCBs

The principal migration pathway for PCBs is via migration of the particulates that they are adsorbed to. Particulate migration can occur via erosional transport, and by wind erosion and dispersion. PCBs have been detected in sediments within the Sphagnum Bog. Since the Sphagnum Bog is located at the base of the berm between the Cooling Water Recharge Pond and

the bog where PCB-impacted soils are located, it is possible that erosion of soils at the berm, with subsequent transport to the bog, has occurred. Sampling of soils on the opposite side of the bog, in the predominant down-wind direction of the buildings and Cooling Water Recharge Pond, did not identify PCBs. This suggests that wind erosion and dispersion is not a significant migration pathway for PCBs. PCBs have not been detected in surface water in the Cooling Water Recharge Pond or the Sphagnum Bog, indicating that partitioning between sediment and surface water is not a complete migration pathway for PCBs.

Routes of Exposure

Human Health

The potentially complete human health exposure pathways include:

- direct contact (incidental ingestion and dermal contact) with soil, surface water and sediment;
- external exposure to radiation in soil and unsubmerged sediment;
- inhalation of dust and vapor released from soil;
- potable use of groundwater (ingestion, dermal contact, and inhalation of vapors released from groundwater used as household tap water);
- vapor intrusion; and
- ingestion of radionuclides in home-grown produce.[5]

Presently, the Site is a mix of industrial buildings, adjacent open space areas that are within a fenced portion of the NMI Property, and undeveloped open space areas outside of the fenced portion of the NMI Property. Risks associated with potential exposures to the undeveloped open space areas of the Site under the current land use conditions were characterized using a current abutting resident/passive recreational visitor scenario. This scenario assumed that young children and adults would be exposed to contamination in surface soil within the open space (unfenced) portions of the Site, and surface water and sediment in the Sphagnum Bog, Northeast Wetland, Assabet River and associated Embayment Area, and the floodplain at the Rt. 62 Outfall area. This scenario is protective for other receptor populations that might access the unfenced areas of the Site under current use conditions, e.g., attendee at the adjacent day camp.

Risks associated with potential exposures to fenced (restricted) area of the Site under the current land use conditions were characterized using a current trespasser scenario, which evaluated an

[5] In accordance with USEPA guidance, only radionuclides are typically evaluated for uptake into home-grown produce.

older child/adolescent, assumed to be exposed to contamination in unpaved surface soil (within the fenced areas of the Site), as well as to surface water and sediment in the Sphagnum Bog and Cooling Water Recharge Pond.

The future use of the Site has not been determined. Therefore, health risks were evaluated for a range of possible future site uses, including passive recreational, residential, and commercial/industrial. Passive recreational use refers to land uses that involve passive leisure activities such as walking, hiking, picnicking, or nature study. The passive recreational use scenario evaluated young children and adults who were assumed to be exposed to soil, as well as to surface water and sediment if wading or swimming activities occur. Residential use refers to use of property for the location of a residential dwelling, with the conservative assumption that young children and adults spend the majority of their time each day at their property (i.e., at the Site). Residential land uses are assumed to involve exposure to soil and use of groundwater as a potable water source, as well as ingestion of home-grown produce. Risks associated with exposures to surface water and sediment were also evaluated for residential use. The evaluation of risks associated with commercial and industrial uses of the Site considered risks to full-time adult indoor workers (e.g., office workers) and risks to full-time adult outdoor workers (e.g., workers in a business such as a landscape supply depot), under the assumption that exposures to soil can occur to both types of workers. Although the Site potentially could also be used for active recreational uses in the future (e.g., athletic fields), risks associated with residential land use can be used to conservatively represent the potential risks associated with active recreational land uses. Consequently, active recreational use was not evaluated in the HHRA.

Ecological

The potentially complete ecological exposure pathways are:

- Uptake of contaminants from sediment, surface water, shallow groundwater, and soil through roots (vegetation);
- Ingestion of contaminants bound to soil (terrestrial invertebrates, birds, mammals);
- Ingestion of contaminants bound to sediment (benthic invertebrates, fish, aquatic and wetland birds, mammals)
- Ingestion of dissolved and particulate contaminants in surface water (aquatic invertebrates, fish, semi-aquatic and wetland birds, mammals);
- Ingestion of contaminants through consumption of contaminated plants (herbivores, omnivores); and
- Ingestion of contaminants through consumption of contaminated prey (all predators).

Although inhalation and dermal absorption pathways are possibly complete for some receptors, these pathways are considered to be minor compared to dietary ingestion and are not evaluated. The exposure pathway is considered incomplete for media located below pavement, buildings or other impervious surfaces that are considered inaccessible to ecological receptors. In addition, since groundwater does not directly discharge to the ground surface (e.g., through seeps), there are no direct exposures to groundwater by environmental receptors.

Principal Threat Waste

Principal threat waste includes those source materials considered to be highly toxic or subsurface soil containing high concentrations of contaminants of concern that are (or potentially are) mobile due to sub-surface transport which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. The manner in which principal threats are addressed generally will determine whether the statutory preference for treatment as a principal element is satisfied. Wastes generally considered to be principal threats are liquid, mobile, and/or highly-toxic source material.

There are under a dozen soil samples collected within the unsaturated zone of the Holding Basin with concentrations which exceed a 10^{-3} risk, making them highly toxic and therefore principal threat wastes. The soils within the Holding Basin footprint above and below the water table are identified as source material. The maximum concentration of DU in the Holding Basin soils is approximately 12,000 mg/kg and the average concentration is approximately 93 mg/kg. These materials are located at least 20 feet below ground surface, are covered by a temporary cap, and therefore currently do not allow for direct exposure. The temporary cap has reduced the rate of migration of the source materials located above the water table. However, the high concentrations of DU in the Holding Basin have historically been mobile, migrating or potentially migrating to the ground water. The apatite stabilization treatment and the containment of the holding basin with a barrier wall and cover address the mobility of the principal threat waste.

In addition, at one location in the industrial courtyard near an old transformer, DU exceeds the 10^{-3} risk. The 10^{-3} risk concentration for DU is 2,310 mg/kg, and the concentration in the surface soils in this location is 5,070 mg/kg. This area has been roped off until it is remediated.

Low-level threat wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure. Wastes that are generally considered to be low-level threat wastes include non-mobile contaminated source material of low to moderate toxicity, surface soil containing chemicals of concern that are relatively immobile in air or ground water, or low leachability contaminants. The Holding Basin soils that do not constitute a 10^{-3} risk due to toxicity, do not contain high concentrations of DU that have (or potentially have) mobility due to subsurface transport and are therefore considered to be low-level threat wastes.

F. CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

The current land use at the NMI Property is a mix of former industrial use property, fenced undeveloped property, and unfenced undeveloped property. The industrial portion of the NMI Property is represented by the buildings and associated paved parking lots, paved staging areas, and small landscaped areas (mowed grass). The property is currently zoned as Limited Industrial Park, which among other things, allows accessory use as a residential area. A security fence with locking gates restricts access to the southern and eastern sides of the portion of the property where the buildings are located. The fence extends from that area to the Sphagnum Bog, encompassing the Cooling Water Recharge Pond, Holding Basin, and Old Landfill areas. The NMI Property is bordered by Main Street (Route 62) and several commercial and residential properties to the north, residential properties to the east, town-owned open space and a health club with a children's summer camp to the south and southwest, and residential/woodland and commercial/industrial properties to the west. Although Starmet is the current owner of the NMI Property, Starmet vacated the Site in early November 2011, and the company is now defunct. Therefore, future use of the Site may depend on another party taking ownership of the NMI Property.

EPA is in discussions with the Town of Concord and the community group Citizen's Research and Environmental Watch (CREW) regarding the potential future uses for the Site. The community has indicated that it would like to see a future use other than commercial/industrial for the NMI Property, possibly recreation land or even residential use. In April 2015, the town authorized the Concord Board of Selectmen to acquire the 2229 Main Street property, provided the Site is cleaned up for residential use. The Town has cited commercial enterprise, affordable or other housing, recreation, or solar power generation as possible reuse options for the Site.

EPA evaluated residential use, recreational use, as well as commercial/industrial use as exposure scenarios in the overall Site Human Health Risk Assessment (HHRA). In the evaluation of those exposure scenarios and the level of cleanup necessary to achieve recreational versus residential use, the difference in the volume requiring remediation was negligible (2,500 cubic yards or 3% of total volume) considering the large quantity of soils requiring cleanup. For this reason as well as what the reasonably anticipated future use of the Site will be, EPA has chosen cleanup standards based upon future residential use for this remedy. As a result of discussions with the town, EPA believes the use of the NMI Property will either be some type of housing or other municipal use by the town, possibly a combination of the two. Based upon demographics and property use trends in the Concord area, the surrounding area will likely continue to be used for residential use in the foreseeable future.

Currently the town of Concord is on public water supply from the 2nd division supply well, which is not hydraulically connected to the Site groundwater. However, some of the town of Acton's public water supply wells are downgradient from the Site, and may become impacted by 1,4-dioxane that is migrating away from the Site. To address this issue, pursuant to the Action

Memorandum attached to this ROD in Appendix F, EPA is accelerating a portion of the proposed groundwater remedy as a non-time critical removal action (NTCRA).

Consistent with EPA's 1996 Final Ground Water Use and Value Determination Guidance, and the Commonwealth of Massachusetts' Comprehensive State Groundwater Protection Program (CSGWPP), MassDEP has developed a "Use and Value Determination" of the groundwater relative to the Site. The purpose of the Use and Value Determination is to identify whether the aquifer at the Site should be considered of "High," "Medium," or "Low" use and value. In the development of its Determination, MassDEP applied the criteria for groundwater classification as promulgated in the Massachusetts Contingency Plan (MCP). The classification contained in the MCP considers criteria similar to those recommended in the Use and Value Guidance. MassDEP determined that there is a High use and value for the Site area groundwater. Therefore, EPA is proposing cleanup levels based on federal and state drinking water standards, or Maximum Contamination Levels (MCLs), and risk-based criteria that support this use as a future potential drinking water source.

G. SUMMARY OF SITE RISKS

A baseline risk assessment was performed to estimate the probability and magnitude of potential adverse human health and environmental effects from exposure to contaminants associated with the Site assuming no remedial action was taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. The baseline health risk assessment followed a four step process: 1) hazard identification, which identified those hazardous substances which, given the specifics of the Site, were of significant concern; 2) exposure assessment, which identified actual or potential exposure pathways, characterized the potentially exposed populations, and determined the extent of possible exposure; 3) toxicity assessment, which considered the types and magnitude of adverse health effects associated with exposure to hazardous substances, and 4) risk characterization and uncertainty analysis, which integrated the three earlier steps to summarize the potential and actual risks posed by hazardous substances at the Site, including carcinogenic and non-carcinogenic risks and a discussion of the uncertainty in the risk estimates. A summary of those aspects of the human health risk assessment which support the need for remedial action is provided below followed by a summary of the environmental risk assessment.

1. Human Health Risk Assessment

A baseline human health risk assessment (HHRA), conducted pursuant to EPA Risk Assessment Guidance for Superfund (RAGS), was completed for the NMI Site to evaluate the likelihood and magnitude of potential human health effects associated with the current land use of the Site, as well as three possible future land uses of the Site, which included residential, passive

recreational, and commercial/industrial. The HHRA evaluated baseline risks which assume that current and future land uses occur in the absence of any remedial actions (*de maximus*, 2013).[6]

Section 1: Hazard Identification

Fifty-five of the approximately 130 chemicals detected at the Site were selected for evaluation in the baseline and Supplemental HHRAs as chemicals of potential concern (COPCs). The COPCs were selected to represent potential Site-related hazards based on toxicity, concentration, frequency of detection, and mobility and persistence in the environment and can be found in **Tables 2-1** through **2-16** of Appendix C of the baseline HHRA (*de maximus*, 2013).[7] From this, a subset of the chemicals were identified in the FS as presenting a significant current or future risk in AOIs across the Site and are referred to as the COCs in this ROD and summarized in **Tables G-1** through **G-4**. These tables contain the exposure point concentrations used to evaluate the reasonable maximum exposure (RME) scenario in the baseline HHRA for the chemicals of concern.

Section 2: Exposure Assessment

Current and potential future Site-specific pathways of exposure to COCs were determined. The extent, frequency, and duration of current or future potential exposures were estimated for each pathway. From these exposure parameters, a daily intake level for each Site-related chemical was estimated.

Presently, the Site is a mix of industrial buildings, adjacent open space areas that are within a fenced portion of the NMI Property, and undeveloped open space areas outside of the fenced portion of the NMI Property. Health risks were evaluated for a range of possible future Site uses, including passive recreational, residential, and commercial/industrial. Passive recreational use refers to land uses that involve passive leisure activities such as walking, hiking, picnicking, or nature study. The passive recreational use scenario evaluated young children and adults who were assumed to be exposed to soil, as well as to surface water and sediment, if wading or swimming activities occur. Residential use refers to use of property for the location of a residential dwelling, with the assumption that young children and adults spend the majority of their time each day at their property (i.e., at the Site). Residential land uses are assumed to involve exposure to soil and use of groundwater as a potable water source, as well as ingestion of home-grown produce. Risks associated with exposures to surface water and sediment were also evaluated for residential use. The evaluation of risks associated with commercial and industrial uses of the Site considered risks to full-time adult indoor workers (e.g., office workers) and risks

[6] *de maximis*, 2013. *Baseline Human Health Risk Assessment, Nuclear Metals Inc. Superfund Site*; September 4, 2013.

[7] *Id.*

to full-time adult outdoor workers (e.g., landscape supply depot worker), under the assumption that exposures to soil can occur to both types of workers. Although the Site potentially could also be used for active recreational uses in the future (e.g., athletic fields), risks associated with residential land use can be used to conservatively represent the potential risks associated with active recreational land uses. Consequently, active recreational use was not evaluated in the baseline HHRA. Evaluation of risks were also performed for future construction workers exposed to Site soils. Additional details on current and potential future land use can be found in Section 3.1 of the baseline HHRA (*de maximis*, 2013).[8]

The following is a brief summary of the exposure pathways that were found to present a significant risk (Incremental Lifetime Cancer Risk [ILCR] greater than 10^{-4} or a Hazard Index [HI]>1) at the Site. A more thorough description of all exposure pathways evaluated in the risk assessment, can be found in Section 3.2 and on Tables 4.1 through 4.12 of Appendix E of the baseline HHRA (*de maximis*, 2013).

The following current exposure pathways were found to present a significant risk at the Site:

- Trespasser (older child/adolescent) with exposure to Cooling Pond sediment (by ingestion and dermal contact);[9]

The following future exposure pathways were found to present a significant risk at the Site:

- Resident (adult and young child) with exposure to surface and/or subsurface soil (by ingestion, dermal contact, inhalation of particulates, produce ingestion, and external [radiological] exposure) at the following AOIs: AOI 14 North, AOI 8 Sweepings Area, AOI 7 & 11 Industrial Area East, AOI 2 & 4 Soils Area at Cooling Pond, Rt 62 Outfall and Embayment Area, and AOI 1 Holding Basin;[10]

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[8] *Id.*

[9] For current trespasser sediment exposures, an exposure frequency of 15 days/year was used, along with an exposure duration of 12 years. An ingestion rate of 100 mg/day was used. Dermal contact was assumed with 3,402 cm^2 of surface area and an adherence factor of 0.3 mg/cm^2-event. A body weight of 44 kg was used.

[10] For future residential soil exposures, exposure durations of 24 years and 6 years, respectively, were presumed for an adult and young child. Body weights of 70 kg and 15 kg were used for the adult and young child, respectively. Dermal contact was assumed with 5,700 cm^2 of surface area for the adult and 2,800 cm^2 for the young child, with adherence factors of 0.07 and 0.2 mg/cm^2-event for the adult and child, respectively. An exposure frequency of 161 days/year [see Appendix E.2 and Table 4.8 in Appendix E of baseline HHRA for calculation of exposure frequency] was used for a combined exposure duration of 30 years. For future residential dust exposures, exposure durations of 24 years and 6 years, respectively, were presumed for an adult and young child. Future indoor air exposures were assumed to occur 16.4 hours/day (adult) and 20 hours/day (child) for 350 days/year, while outdoor air exposures were assumed to occur 1.75 hours/day (adult) and 3 hours/day (child) for 161 days/year. Future indoor air inhalation rates were 13.3 m^3/day (adult) and 8.3 m^3/day (child), while outdoor air inhalation rates were 38.4 m^3/day (adult) and 28.8 m^3/day (child). The indoor dust dilution factor used was 0.4. For external radiological exposures, the indoor and outdoor exposure times (hours/day) were the same as for dust exposures, however, the outdoor exposure frequency

- Resident (adult and young child) with exposure to untreated groundwater (by ingestion, inhalation, and dermal contact) used as tap water from the following areas: on-property bedrock groundwater plume, on-property bedrock groundwater, on-property overburden groundwater plume, on-property overburden groundwater, off-property bedrock groundwater, and off-property overburden groundwater;[11]

- Abutting resident/recreational visitor (young child) with exposure to cooling pond sediment (by ingestion and dermal contact);[12]

- Recreational visitor (young child) with exposure to surface and/or subsurface soil (by ingestion, inhalation of particulates, and dermal contact) at the following AOIs: AOI 8 Sweepings Area, AOI 7 & 11 Industrial Area East, AOI 2 & 4 Soils Area at Cooling Pond, and AOI 1 Holding Basin;[13]

- Outdoor worker with exposure to surface soil (by ingestion, inhalation of particulates, dermal contact, and external [radiological] exposure) at AOI 7 & 11 Industrial Area East;[14]

- Construction worker with exposure to surface and/or subsurface soil (by ingestion,

was a site-specific value of 186 days/year [see Appendix E.2 and Table 4.8 in Appendix E of baseline HHRA for calculation of exposure frequency]. An indoor shielding factor of 0.4 was used, while an outdoor shielding factor of 1 was used. In addition, an area correction factor of 0.9 was applied. For produce ingestion, an exposure frequency of 350 days/year was used for a combined exposure duration of 30 years. For both the child and adult, the ingestion rate of vegetables was 10 g/kgBW/day and the ingestion rate of fruit was 12 g/kgBW/day. The fractions of homegrown vegetables and fruits were 0.038 and 0.005, respectively.

[11] For future residential exposures to untreated groundwater, drinking water ingestion rates of 2 L/day and 1.5 L/day for the adult and young child, respectively, were assumed. An exposure frequency of 350 days/year was used for a combined exposure duration of 30 years. Dermal contact was assumed with 18,000 cm^2 of surface area for the adult, and 6,600 cm^2 for the young child. Showers/baths were assumed to occur 350 days/year for 0.58 hr/day for the adult and 1 hr/day for the young child. Inhalation during showers/baths evaluated using the Andelman model with a volatilization factor of 0.5 L/m^3.

[12] For a future young child abutting resident/recreational visitor sediment exposures, an exposure frequency of 26 days/year was used, along with an exposure duration of 6 years. An ingestion rate of 200 mg/day was used. Dermal contact was assumed with 1,560 cm^2 of surface area and an adherence factor of 0.3 mg/cm^2-event. A body weight of 15 kg was used.

[13] For future young child recreational visitor soil exposures, an exposure frequency of 80 days/year was used, along with an exposure duration of 6 years. A body weight of 15 kg was used. An ingestion rate of 200 mg/day was used. Dermal contact was assumed with 2,800 cm^2 of surface area and an adherence factor of 0.2 mg/cm^2-event. For outdoor air exposures, an exposure duration of 6 years was presumed. Future outdoor air exposures were assumed to occur 3 hours/day for 80 days/year.

[14] For future outdoor worker soil exposures, an exposure duration of 25 years was used. A body weight of 70 kg was used, as well as an ingestion rate of 100 mg/day. Dermal contact was assumed with 3,300 cm^2 of surface area and an adherence factor of 0.2 mg/cm^2-event. An exposure frequency of 161 days/year was used. For future outdoor worker dust exposures an exposure duration of 25 years was presumed. Future outdoor air exposures were assumed to occur 8 hours/day for 161 days/year. The future outdoor air inhalation rate used was 38.4 m^3/day. For external radiological exposures, the exposure time (3 hours/day) was the same as for dust exposures, however, the exposure frequency was 225 days/year. An outdoor shielding factor of 1 was used. In addition, an area correction factor of 0.9 was applied.

inhalation of particulates, and dermal contact) at the following AOIs: AOI 1 Holding Basin, AOI 8 Sweepings Area, AOI 7 & 11 Industrial Area East, AOI 2 & 4 Soils Area at Cooling Pond, and, based on updated toxicity values for uranium (see below, as well as Appendix E of this ROD), AOI 1 Holding Basin;[15]

In addition, the vapor intrusion pathway is considered to be potentially complete under future land use conditions if occupied buildings are constructed within 100 feet of overburden soil where VOCs have been detected (at any concentration), and within 100 feet of overburden groundwater in which VOCs have been detected at concentrations greater than vapor intrusion screening levels (VISLs). VOC-impacted soils are generally found within AOI 3 Old Landfill, AOI 2 Former Drum Burial Area and AOI 11 Industrial Drain Lines. The areas of VOC-impacted groundwater (above VISLs) are shown in **Figure E-14**. Refer to Section E for discussion of **Figure E-14** as it relates to the most current VISLs (June 2015).

Note that the baseline HHRA was completed in 2013. In February 2014, EPA finalized a Directive to update standard default exposure factors and frequently asked questions associated with these updates (located online at http://www.epa.gov/oswer/riskassessment/superfund_hh_exposure.htm; items # 22 and #23 of this web link). Applying these updated standard default exposure factors to the risk assessment would possibly result in a slight decrease of the risk estimates; however, it would not change the previous conclusions regarding unacceptable risks at the Site. These updated standard default exposure factors have been utilized during development of risk-based performance standards (see Section L of this ROD).

Section 3: Toxicity Assessment

Carcinogenic Effects

The potential for exposure to a chemical to result in a carcinogenic effect is generally described by two factors: a statement reflecting the degree of confidence that the compound causes cancer in humans and a potency estimate, indicating how potent the chemical may be at causing cancer, with the general assumption that every exposure has some probability of resulting in cancer. The descriptor reflecting the degree of confidence that the compound causes cancer in humans may be either an alpha-numeric value or a narrative. Both are closely tied to the nature and extent of information available from human and animal studies. The cancer potency estimate is a quantitative measure of a compound's ability to cause cancer, and is generally expressed as either a cancer potency factor or an inhalation unit risk value. Cancer potency estimates and unit

[15] For future construction worker soil exposures, an exposure frequency of 250 days/year was used, along with an exposure duration of 1 year. A body weight of 70 kg was used. An ingestion rate of 330 mg/day was used. Dermal contact was assumed with 3,300 cm^2 of surface area and an adherence factor of 0.3 mg/cm^2-event. For outdoor air exposures, an exposure duration of 1 year was presumed. Future outdoor air exposures were assumed to occur 8 hours/day for 250 days/year.

risk values are toxicity estimates developed by EPA based on epidemiological and/or animal studies, and they reflect a conservative "upper bound" of the potency of the carcinogenic compound. That is, the true potency is unlikely to be greater than the potency described by EPA. **Table G-5** presents these cancer toxicity values and cancer classifications for the COCs at the Site.

In some cases, however, EPA may conclude that it is not appropriate to generate a cancer potency estimate or unit risk value given the mode of action of the known or suspect carcinogen (e.g. chloroform). Currently, EPA's default procedure for characterizing cancer risk for compounds which may exhibit a threshold for carcinogenic effects, mirrors the process used to characterize the potential for adverse non-cancer effects, and is described in the section which follows. A summary of the cancer toxicity data relevant to the chemicals of concern at the Site is presented in **Table G-5**. EPA's Cancer Guidelines and Supplemental Guidance (March 2005) has been used as the basis for analysis of carcinogenicity risk assessment.

Non-Carcinogenic Effects and Non-Linear Carcinogenic Effects

For addressing non-carcinogenic effects and effects of carcinogenic compounds which exhibit a threshold, it is EPA's policy to assume that a safe exposure level exists, which is described by the reference dose (RfD) or reference concentration (RfC). RfDs and RfCs have been developed by EPA as estimates of a daily exposure that is likely to be without an appreciable risk of an adverse health effect when exposure occurs over the duration of a lifetime. RfDs and RfCs are derived from epidemiological and/or animal studies and incorporate uncertainty factors to help ensure that adverse health effects will not occur. The RfDs and RfCs relevant to the Site are presented in **Table G-6**.

The toxicity values presented in **Tables G-5** and **G-6** are those used in the baseline HHRA, except for compounds where a toxicity update occurred since the baseline HHRA was completed in 2013. The chronic and subchronic RfCs for uranium (lower) have changed since the time of the baseline HHRA. The subchronic RfD for uranium (lower) has also changed since the time of the baseline HHRA. The results presented in the following section (Risk Characterization) are based on the toxicity values used in the baseline HHRA. A technical memorandum (see Appendix E) has been developed which provides what the approximate changes to hazards would be for the applicable scenarios based on the revised uranium toxicity values. While the lower uranium RfCs would result in higher non-cancer hazards related to dust inhalation, based on a review of the results, the conclusions of the risk assessment presented below would not have changed. The change in the subchronic RfD for uranium would have resulted in uranium being selected as an additional COC for the construction worker for the AOI 7 & 11 Industrial Area East subsurface soil scenario. In addition, uranium would have been selected as a COC for the construction worker for the AOI 1 Holding Basin surface and subsurface soil scenarios. The revised toxicity values have been used during development of risk-based performance standards (see Section L of this ROD).

Additional changes in toxicity values are associated with 1,4-dioxane and 1,1-dichloroethane. In June 2015, EPA classified 1,4-dioxane as volatile (as defined in the Regional Screening Levels June 2015 update found at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm). As 1,4-dioxane is already a COC for groundwater, this change does not impact the conclusions of the risk assessment presented below. However, inhalation toxicity values have now been used for development of risk-based cleanup levels (see Section L of this ROD) and have therefore been included in Tables G-5 and G-6. It should be noted that the inhalation Unit Risk value has changed since the time of the baseline HHRA, and although the chronic RfC value has not changed, the source and primary target organ did change. With respect to 1,1-dichloroethane, the inhalation RfC used in the BHHRA has been withdrawn and is no longer used by EPA during risk calculations. Therefore, development of risk-based cleanup levels (see Section L of this ROD) did not include the non-cancer inhalation pathway.

Section 4: Risk Characterization

The risk characterization combines the exposure estimate with the toxicity information to estimate the probability or potential that adverse health effects may occur if no action were to be taken at a site. A separate characterization is generated depending on the nature of the adverse effect. Cancer risks are generally expressed as a probability whereas the potential for adverse non-cancer effects (and carcinogenic effects resulting from non-linear (i.e., exhibiting a threshold of toxicity) mode of action (MOA) compounds) are described in terms what is thought to be a safe exposure level.

For exposure to most known or potentially carcinogenic substances, EPA believes that as the exposure increases, the cancer risk increases. In characterizing risk to these types of carcinogenic compounds, a chemical- specific exposure level is generally multiplied with the cancer potency factor or inhalation unit risk to estimate excess lifetime cancer risk as a result of exposure to site contaminants. To the extent that EPA has deemed that data are sufficient to apply the provisions of the 2005 Children's Supplemental Cancer Risk Guidelines, special consideration of the increased susceptibility to carcinogenic effects that children may have, was included in the risk characterization. The 2005 Children's Supplemental Cancer Guidelines were used to describe any such heightened susceptibility among potentially exposed children. Typically, the resulting cancer risk estimates are expressed in scientific notation as a probability (e.g., 1×10^{-6} or 1E-06 for 1/1,000,000) and indicate (using this example), that an average individual is not likely to have greater that a one in a million chance of developing cancer over 70 years as a result of site-related exposure (as defined) to the compound at the stated concentration.

All risks estimated represent an excess risk of cancer from exposures to contamination originating from the Site. These are risks above and beyond that which we face from other

causes such as from cigarettes or ultra-violet radiation from the sun. The chance of an individual developing cancer from all other (non-site related) causes has been estimated to be as high as one in three. EPA generally views site related cancer risks in excess of 10^{-4} as unacceptable. Current EPA practice considers carcinogenic risks to be additive when assessing exposure to a mixture of hazardous substances.

In assessing the potential for adverse non-carcinogenic effects (and carcinogenic effects resulting from non-linear MOA compounds), a hazard quotient (HQ) is calculated by expressing the exposure (or the exposure concentration in the case of air exposures) as a ratio of the reference value (RfD or RfC). A HQ $\leq$ 1 indicates that a receptor's exposure to a single contaminant is less than the safe value and that adverse effects are unlikely. Conversely, a HQ > 1 indicates that adverse effects as a result of exposure to the contaminant are possible. To account for additive effects resulting from exposure to more than one compound, a Hazard Index (HI) is generated by adding the HQs for all chemicals of concern that have the same or a similar mechanism or mode of action. As a conservative measure and a common practice, HQs are often added for all COPCs that affect the same organ or system (i.e., liver, nervous system) since the mechanism or mode of action is not always known. A HI < 1 indicates that adverse effects are unlikely whereas a HI > 1 indicates adverse effects are possible. Generally, EPA views HI values based on site-related exposure in excess of unity as unacceptable. It should be noted that the magnitude of the HQ or HI is not proportional to the likelihood that an adverse effect will be observed.

The following is a summary of the media and exposure pathways that were found to present a significant risk exceeding EPA's cancer risk range and non-cancer threshold at the Site. Only those exposure pathways deemed relevant to the remedy being proposed are presented in this ROD. Readers are referred to Section 5.2 and Appendices G, H, I, and M of the baseline HHRA (*de maximus*, 2013)[16] for a more comprehensive risk summary of all exposure pathways evaluated for all COPCs, as well the technical memorandum on impacts to the previously proposed cleanup levels showing results utilizing updated toxicity values for uranium (see Appendix E of this ROD).

Current Trespasser – Sediment

Table G-7 depicts the non-carcinogenic risk summary for the COCs in sediment evaluated to reflect potential future trespasser exposure at the Cooling Pond corresponding to the RME scenario. For the current older child/adolescent, non-carcinogenic risks exceeded the EPA target organ HI of 1. The exceedance is primarily due to PCBs in sediment.

Future Resident – Soil

[16] *Id.*

Tables G-8 and **G-9** depict the carcinogenic and non-carcinogenic risk summaries for the COCs in soil evaluated to reflect potential future residential exposure corresponding to the RME scenario. For the future young child and adult resident, carcinogenic and non-carcinogenic risks exceeded the EPA acceptable risk range of 10^{-4} to 10^{-6} and/or a target organ HI of 1 at multiple AOIs and in both surface and subsurface soil. The exceedances are primarily due to PAHs, PCBs, arsenic, uranium, and/or radionuclides (uranium and/or thorium isotopes/decay products) in soil at:

- AOI 14 North (surface soil) - primarily due to PCBs;
- AOI 8 Sweepings Area (surface soil) - primarily due to PAHs, PCBs, arsenic, and radionuclides (uranium and thorium isotopes/decay products);
- AOI 8 Sweepings Area (subsurface soil) - primarily due to PCBs;
- AOI 7 & 11 Industrial Area East (surface soil) - primarily due to PAHs, PCBs, arsenic, uranium, and radionuclides ;
- AOI 7 & 11 Industrial Area East (subsurface soil) - primarily due to PAHs, PCBs, arsenic, uranium, and radionuclides;
- AOI 2 & 4 Soils Area at Cooling Pond (surface soil) - primarily due to PAHs, PCBs, arsenic, and radionuclides;
- AOI 2 & 4 Soils Area at Cooling Pond (subsurface soil) - primarily due to PAHs, PCBs, arsenic, and radionuclides;
- Rt 62 Outfall and Embayment Area (surface soil) - primarily due to PAHs, arsenic, and radionuclides (thorium isotopes/decay products);
- AOI 1 Holding Basin (surface soil) - primarily due to arsenic, uranium, and radionuclides; and
- AOI 1 Holding Basin (subsurface soil) - primarily due to arsenic, uranium, and radionuclides.

<u>Future Resident--Groundwater</u>

Tables G-10 and **G-11** depict the carcinogenic and non-carcinogenic risk summaries for the COCs in groundwater evaluated to reflect potential future residential potable water exposure corresponding to the RME scenario (under the assumption that groundwater associated with the Site is used as a source of potable water in the future). For the future resident using untreated

groundwater as household water, carcinogenic and non-carcinogenic risks exceeded the EPA acceptable risk of 10^{-4} and/or a target organ HI of 1 for groundwater. The exceedances were due primarily to the presence of 1,1-dichloroethane, tetrachloroethene, trichloroethene, vinyl chloride, 1,4-dioxane, bis(2-ethylhexyl)phthalate, arsenic, barium, chromium, cobalt, copper, iron, manganese, molybdenum, uranium, nitrate, nitrite, and radionuclides in these areas:

- On-Property Bedrock Groundwater Plume – primarily due to 1,1-dichloroethane, trichloroethene, 1,4-dioxane, bis(2-ethylhexyl)phthalate, arsenic, barium, chromium, cobalt, iron, manganese, molybdenum, uranium, nitrate, nitrite, and radionuclides;

- On-Property Bedrock Groundwater – primarily due to trichloroethene, bis (2-ethylhexyl)phthalate, arsenic, iron, manganese, uranium, and radionuclides;

- On-Property Overburden Groundwater Plume – primarily due to tetrachloroethene, trichloroethene, 1,4-dioxane, bis(2-ethylhexyl)phthalate, arsenic, chromium, cobalt, copper, iron, manganese, molybdenum, uranium, nitrate, nitrite, and radionuclides;

- On-Property Overburden Groundwater – primarily due to vinyl chloride, bis (2-ethylhexyl)phthalate, arsenic, cobalt, iron, manganese, and radionuclides;

- Off-Property Bedrock Groundwater – primarily due to trichloroethene, vinyl chloride, 1,4-dioxane, arsenic, cobalt, iron, manganese, uranium, nitrate, and radionuclides; and

- Off-Property Overburden Groundwater – primarily due to trichloroethene, 1,4-dioxane, bis(2-ethylhexyl)phthalate, arsenic, iron, and radionuclides.

Abutting Resident/Recreational Visitor - Sediment

Table G-12 depicts the non-carcinogenic risk summary for the COCs in sediment evaluated to reflect potential future young child abutting resident/recreational visitor exposure at the Cooling Pond corresponding to the RME scenario. For the future young child, non-carcinogenic risks exceeded the EPA target organ HI of 1. The exceedance is primarily due to PCBs in sediment.

Recreational Visitor – Soil

Table G-13 depicts the non-carcinogenic risk summary for the COCs in soil evaluated to reflect potential future young child recreational visitor exposure corresponding to the RME scenario. For the future young child, non-carcinogenic risks exceeded the EPA target organ HI of 1 at multiple AOIs and in both surface and subsurface soil. The exceedances are primarily due to PCBs and uranium in soil at:

- AOI 8 Sweepings Area (surface soil) - primarily due to PCBs;

- AOI 8 Sweepings Area (subsurface soil) - primarily due to PCBs;
- AOI 7 & 11 Industrial Area East (surface soil) - primarily due to uranium;
- AOI 7 & 11 Industrial Area East (subsurface soil) - primarily due to PCBs and uranium;
- AOI 2 & 4 Soils Area at Cooling Pond (surface soil) - primarily due to PCBs;
- AOI 2 & 4 Soils Area at Cooling Pond (subsurface soil) - primarily due to PCBs;
- AOI 1 Holding Basin (surface soil) - primarily due to uranium; and
- AOI 1 Holding Basin (subsurface soil) - primarily due to uranium.

Future Outdoor Worker – Soil

Table G-14 depicts the non-carcinogenic risk summary for the COCs in soil evaluated to reflect potential future outdoor worker exposure corresponding to the RME scenario. For the future adult outdoor worker, non-carcinogenic risks exceeded the EPA target organ HI of 1 at AOI 7 & 11 Industrial Area East in surface soil. The exceedance is primarily due to PAHs, PCBs, arsenic, and radionuclides (uranium and thorium isotopes/decay products) in soil.

Construction Worker – Soil

Table G-15 depicts the non-carcinogenic risk summary for the COCs in soil evaluated to reflect potential future construction worker exposure corresponding to the RME scenario. For the future adult construction worker, non-carcinogenic risks exceeded the EPA target organ HI of 1 at multiple AOIs and in both surface and subsurface soil. The exceedances are primarily due to PCBs and uranium in soil at:

- AOI 8 Sweepings Area (surface soil) - primarily due to PCBs;
- AOI 7 & 11 Industrial Area East (surface soil) - primarily due to uranium;
- AOI 7 & 11 Industrial Area East (subsurface soil) - primarily due to PCBs and, based on toxicity value updates (see above), uranium (not presented in Table G-15);
- AOI 2 & 4 Soils Area at Cooling Pond (surface soil) - primarily due to PCBs;
- AOI 2 & 4 Soils Area at Cooling Pond (subsurface soil) - primarily due to PCBs; and
- AOI 1 Holding Basin (surface and subsurface soil) – primarily due to uranium, based on toxicity value updates (see above; not presented in **Table G-15**).

Section 5: Uncertainties

The baseline HHRA showed that two of the most substantial contributors to cancer risks in soil are arsenic and thorium. However, the baseline HHRA concluded that arsenic and thorium concentrations in soil at the Site are consistent with local background concentrations. Consequently, the risks calculated in the HHRA for arsenic and thorium in soil are a reflection of the risks associated with ambient background conditions, and not a representation of risks associated with site-related contamination.

To further evaluate arsenic and thorium in Site soil, a statistically-based analysis was performed to determine if there was any statistically significant difference between the concentrations of arsenic and thorium in Site soil and background soil. The analysis concluded that the mean/median concentrations of arsenic and thorium in surface and shallow subsurface soils at the Site are equal to or less than the mean/median concentrations or arsenic and thorium in background samples. This evaluation was discussed in Section 5.3 of the baseline HHRA (*de maximis*, 2013).

The HHRA included an incremental risk analysis which identified the differences between risk for exposure to Site soil concentrations and risks for exposure to background levels.

The conclusions of the incremental risk analysis for the residential, passive recreational, and commercial/industrial future land use evaluations are that the majority of exposure areas that had total risks within EPA's cancer risk range have incremental cancer risks that do not exceed 10^{-6}. In addition, incremental cancer risk for future residential land use at the Rt 62 Outfall and Embayment Area and for future commercial/industrial land use at AOI 7 & 11 Industrial Area East are also reduced to be within EPA's cancer risk range. However, this does not change the non-cancer risk criteria exceedances listed in the Risk Characterization section (above) for each area.

Soil samples collected during the RI from the Old Landfill were used in the HHRA; the Old Landfill was included as part of one of the exposure areas evaluated. However, for safety reasons, soil sampling at the Old Landfill avoided metallic anomalies that were identified in ground penetrating radar scans. Therefore, if there is contamination associated with metallic anomalies, it is possible that soil samples collected from the Old Landfill did not characterize the highest levels of contamination. The Old Landfill was included in the FS because the metallic anomalies require removal. Once the metallic anomalies have been removed, soil samples will be collected from the adjacent soils and analyzed for the parameters evaluated in the RI. Soil data will be evaluated to determine if additional soil removal will be required. Therefore, although it is possible that the HHRA underestimates risk for that exposure area if elevated COPC concentrations are present near metallic anomalies in soil at the Old Landfill, the remedy will provide a mechanism to address potential risks if elevated COPC concentrations are

identified in soil during remedial design.

2. Ecological Risk Assessment

A Baseline Ecological Risk Assessment (BERA) was prepared for the Site to evaluate the likelihood and magnitude of potential ecological risks associated with the Site (*de maximis,* 2014a).[17] The technical guidance used to perform the BERA came primarily from "Ecological risk assessment guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments EPA/540/R-97/006." (EPA, 1997)

The Phase 1A and Phase 1B field work performed in 2005 and 2006 focused on field investigations to support a draft Screening Level Ecological Risk Assessment (SLERA) (*de maximis*, 2006).[18] Data gaps identified by the SLERA were addressed in 2006, 2007, and 2008 as part of the Phase 1C field investigations. The BERA (*de maximis*, 2014a) evaluated data collected during the Phase 1A, Phase 1B, and Phase 1C field programs to estimate the risk of ecological harm associated with site-related Chemicals of Potential Concern (COPCs) in surface soil as well as surface water and sediment associated with each of the Site surface water bodies evaluated in the RI.

Section 1: Identification of Chemicals of Potential Ecological Concern (COPCs)

A SLERA prepared for this Site in 2006 (*de maximis*, 2006) identified the COPCs which were further evaluated in the BERA based on pooled Phase 1A, 1B, and 1C datasets (*de maximis* 2014a, Appendix A).

The following ecologically-relevant areas of interest (AOIs) were identified during the Phase 1A, Phase 1B, and Phase 1C investigations:

- Cooling Water Recharge Pond
- Sphagnum Bog
- Northeast Wetland
- Assabet River Main Channel
- Assabet River Embayment Area

[17] *de maximis*, 2014a. *Baseline Ecological Risk Assessment, Nuclear Metals, Inc. Superfund Site*; June 2014.

[18] *de maximis*, 2006. Draft First Interim Deliverable, Screening-Level Ecological Risk Assessment, Nuclear Metals, Inc., Superfund Site, Concord, Massachusetts, June 2006.

- Site-Wide Surface Soil

In order to select COPCs, maximum detected chemical concentrations were compared to media-specific screening benchmarks for surface water, sediment, and soil. An analyte was retained as a COPC if (a) the maximum concentration equaled or exceeded the screening benchmark, or (b) it did not have a screening benchmark. A chemical was eliminated as a COPC if it was detected in less than five percent of the samples in the data set. To simplify the data presentation, only those habitats that showed significant risk in the BERA have been included in this ROD. Those habitats are the Cooling Water Recharge Pond and the Sphagnum Bog (**Tables G-16 to G-20).**

As part of the COPC screening (*de maximis*, 2014a,[19] Appendix A), COPCs were also selected in three other areas of concern: Northeast Wetland, the Assabet River Main Channel, Assabet River Embayment Area, and Site-Wide Surface Soil. Based on the evaluations in the BERA, no significant ecological risk was determined to be associated with media in any of these AOIs.

The Assabet River is a receiving medium for overburden groundwater, but is not a major receiving medium for site-related contamination, as only low levels of VOCs have been detected in sediment. Sediment contamination in the Assabet River Embayment Area is characterized by metals which have not been found to be site-related and that are found upstream at higher concentrations. It is hypothesized that this contamination has resulted from deposition of sediment associated with historical upstream sources during flooding events and the elevated levels of COPCs in the river do not appear to be site-related.

Benchmark comparisons in the BERA characterized possible risk to benthic invertebrates and amphibians at Northeast Wetland as possible in surface water due to copper, lead, and manganese and as unlikely in sediment (*de maximus*, 2014a). Food chain models characterized risk to wetland birds and mammals as unlikely. Based on the weight of evidence and confidence and uncertainties in the data, ecological risk at the Northeast Wetland was determined in the BERA to be unlikely.

In addition, the preliminary screening of COPCs in the SLERA (*de maximis*, 2006)[20] selected COPCs in Site-Wide Surface Soils. Evaluation in the BERA, based on the weight of evidence and confidence and uncertainties in the data, determined that ecological risk in site-wide soils was possible from depleted uranium (DU) (plants and soil invertebrates), PCB Aroclor-1254 (birds), and PCB Aroclor-1260 (birds). However, the BERA conclusions indicated that these possible risks were not ecologically significant and were not addressed further in the FS (*de*

[19] *Id.*

[20] *Id.*

maximis, 2014b).[21]

Furthermore, the preliminary screening of COPCs in the SLERA (*de maximis*, 2006) concluded that risk of adverse radiological effects to ecological receptors is negligible and could be eliminated from further evaluation. Based on the concentrations of PCBs and uranium in the Cooling Water Recharge Pond the need for a remedy was identified. As a result, additional evaluation of ecological risk within the Cooling Water Recharge Pond was not necessary since risk associated with potential exposure to ecological receptors was to be addressed by a presumptive remedy (removal of sediments in the Cooling Water Recharge Pond).

Section 2: Exposure Assessment

The NMI Property is approximately 46 acres; the property is bordered by Main Street (Route 62) and several commercial and residential properties to the north, residential properties to the east, Town-owned open space and a children's summer camp to the south and southwest, and woodland and commercial/industrial properties to the west. The Assabet River is situated approximately 300 feet north of the NMI Property, on the opposite side of Route 62.

There are two wetlands at the Site, the Sphagnum Bog and the Northeast Wetland located north of the Cooling Water Recharge Pond. The Sphagnum Bog is a palustrine, broad-leafed evergreen, scrub-shrub, saturated, acidic wetland. The bog is located approximately 75 feet east of the Cooling Water Recharge Pond and the Holding Basin. The bog covers an area of approximately 3.5 acres. The bog is composed primarily of sphagnum peat. The substrate of the bog varies from growing sphagnum at the surface, to decomposed peat below the surface. The Sphagnum Bog has no inlets or outlets and receives the bulk of its moisture from precipitation and run-off.

The BERA was completed to estimate the risk of ecological harm associated with site-related COPCs in surface soil as well as surface water and sediment associated with each of the site surface water bodies evaluated in the RI (*de maximis*, 2014a).[22] Ecological risks were characterized using a weight-of-evidence approach that evaluated if the growth, survival, or reproduction of aquatic invertebrates, amphibians, wetland birds, and wetland mammals could be significantly affected by site-related contamination in aquatic habitats (Sphagnum Bog), and terrestrial plants, soil invertebrates, songbirds, and mammals terrestrial habitats (Site-Wide Surface Soils).

Complete exposure pathways identified in the BERA included: the uptake of COPCs from sediment, surface water, and soil through roots (vegetation); ingestion of COPCs bound to soil

[21] *de maximis*, 2014b. *Feasibility Study Report, Nuclear Metals, Inc. Superfund Site*; November 2014.

[22] *Id.*

(terrestrial invertebrates, birds, and mammals); ingestion of COPCs bound to sediment (benthic invertebrates, aquatic and wetland birds, and mammals); ingestion of dissolved and particulate COPCs in surface water (aquatic invertebrates, semi-aquatic and wetland birds, and mammals); ingestion of COPCs through consumption of contaminated plants (herbivores and omnivores); and ingestion of COPCs through consumption of contaminated prey (all predators).

Tables G-21 summarizes the receptor groups, lines of evidence, and endpoints evaluated in the BERA for the AOI that was determined to show potential risk, the Sphagnum Bog.

The Massachusetts Natural Heritage and Endangered Species Program (MANHESP; 2009a)[23] and United States Fish and Wildlife Service (USFWS) were consulted regarding the presence of state- and federal-listed rare, threatened, or endangered species and priority habitat at and in the vicinity of the Site during the preparation of the BERA (*de maximus*, 2014a). The USFWS indicated that there are no federally listed species known to occur in the project area (USFWS, 2009).[24] The MANHESP indicated that three species of freshwater mussels including the eastern pondmussel (*Ligumia nasuta*), triangle floater (*Alasmidonta undulata*), and creeper (*Strophitus undulates*) have been historically observed in surface waters in the vicinity of the Site and are listed as species of special concern (MANHESP, 2009b).[25] Responses from both agencies and fact sheets for these three state-listed special concern species are presented in Appendix B of the BERA (*de maximus*, 2014a). Based on the habitat and substrate preferences for these species, it is likely that their potential presence at the Site would be limited to the main channel of the Assabet River. Endpoints in the BERA evaluated the potential risk to these species, and concluded that as risk from surface water and sediment COPCs in the Assabet River Main Channel was characterized as unlikely, the risk to these species of special concern from COPCs is also considered unlikely.

Exposure Point Concentrations (EPCs) for COPCs in surface water, sediment, and prey were calculated in terms of Reasonable Maximum Exposures (RMEs) and Central Tendency Exposures (CTEs). CTE represents the most likely concentration to which a population of receptors would be exposed. CTE EPCs were calculated as the lower of either the maximum concentration or the arithmetic mean. RME EPCs were calculated as the lower of either the 95 percent UCL or the maximum concentration.

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[23] MANHESP, 2009a. Massachusetts Natural Heritage and Endangered Species Program, Letter dated June 22, 2009 from Thomas W. French, PhD, Assistant Director, Division of Fisheries and Wildlife, Field Headquarters, Westborough, MA to Antony Rodolakis, MACTEC.

[24] USFWS, 2009. Letter dated July 14, 2009 from Thomas R. Chapman, Supervisor, New England Field Office, Concord, NH to Sarah Harding and Tony Rodolakis, MACTEC. July 2009.

[25] MANHESP, 2009b. Rare Species Fact Sheets. Available at: http://www.mass.gov/dfwele/dfw/nhesp/species_info/fact_sheets.htm.

Exposure of terrestrial and wetland wildlife (i.e., birds and mammals) to Site COPCs was estimated using food chain models. Biological tissue samples from representative prey species, such as frogs and aquatic invertebrates, were collected from the Site and background bogs to provide site-specific tissue data to be incorporated into the food chain models. Surface water, sediment, soil, and tissue EPCs were entered into the food chain model to calculate an estimated daily intake (EDI) to which the receptor may be exposed. EPCs for prey items were either directly measured in tissue samples, estimated using biota-sediment accumulation factors (BSAFs) or bioaccumulation factors (BAFs) derived from site-specific data, or estimated using literature-based BSAFs; literature-based BSAFs were used only when measured tissue concentrations or site-specific BSAFs were not available.

Food chain modeling was used to calculate COPC-specific EDIs for the piscivorous and omnivorous wildlife receptors foraging in the aquatic and terrestrial habitats at the Site. The food chain models quantified the EDIs by calculating the intake of COPCs via food ingestion, surface water drinking, and incidental soil or sediment ingestion, which were considered the primary exposure routes.

Section 3: Ecological Effects Assessment

In aquatic habitats, effects assessments included comparison of Site surface water concentrations to published chronic surface water benchmarks and to background, and comparison of concentrations of COPCs in solid media (mineral sediment, moss, and peat) to published sediment benchmarks. Effects evaluation for benthic invertebrates also included performing laboratory toxicity tests to measure survival and growth of a freshwater benthic invertebrate (*Chironomus dilutus*) exposed to sediments collected from the Site and from background sediment. Benthic community survey samples were collected from 13 locations in the Sphagnum Bog and from five locations in the background bog. These data were used to evaluate the community structure of benthic invertebrates in Site sediments compared to background.

Endpoints used to evaluate potential effects on amphibians included comparison of Site surface water and sediment concentrations to published chronic benchmarks and to background, and also included performing laboratory FETAX (Frog Embryo teratogenesis assay - using *Xenopus*) toxicity tests to measure survival, malformation, and growth of amphibians exposed to surface water.

Food chain models were also used to compare the EDIs for omnivorous waterfowl (mallard), predatory wading birds (great blue heron), omnivorous small mammals (shrew) and predatory large mammals (raccoon), based on exposure in the Sphagnum Bog, to published wildlife toxicity reference values (TRVs) and to background conditions.

Section 4: Ecological Risk Characterization

The following risk characterization includes a brief summary of the environmental risks

associated with the relevant media, the basis of these risks, how these risks were determined in the BERA. The BERA utilized a weight-of-evidence approach which consisted of evaluating several lines of evidence including comparing Site data (exposure point concentrations) to ecotoxicological benchmark values, food chain modeling, benthic community survey evaluations, and toxicity testing. Each of these lines of evidence is qualitatively weighted in consideration of how uncertain the results of the evaluation may be relative to site-specific attributes. Accordingly, ecotoxicological benchmark evaluations which incorporate little site-specific information are given a low to medium weight, whereas bioassay data which are highly site-specific are given a relatively high weight. The conclusions of the BERA, based on the weight-of-evidence approach, are summarized below for each of the exposure areas where it was determined that ecological risk is likely to be present. Ecological risk was also evaluated in the BERA, and concluded to be unlikely, for the Northeast Wetland, the Assabet River Main Channel, the Assabet River Embayment Area, and Site-Wide Surface Soil.

Hazard Quotients (HQs) were calculated to determine risk to (a) aquatic receptors directly exposed to surface water, mineral sediment, moss and peat, and (b) wildlife species exposed to contaminated media, plus prey items. An HQ shows how much the concentration of a COPC exceeds its benchmark or TRV. HQs were calculated as follows:

HQ = EPC / benchmark or TRV

The EPC can be based on either an RME or CTE scenario.

The risk characterization also includes an evaluation of incremental risks, which take into account the contribution of background concentrations to the overall Site risks:

Incremental Risk HQ (IR) = Site HQ – Background HQ

IRs above 1.0 represented the degree to which the site exposure, adjusted for background, exceeded its toxicity benchmark.

A weight-of-evidence analysis was used to evaluate how well the measurement endpoints represented their assessment endpoints. This analysis integrated all the BERA findings to help determine the potential for risk by: 1) assigning a weight (between “low” and “high”) to all measurement endpoints; 2) evaluating the magnitude of risk with respect to each measurement endpoint; and 3) determining the concurrence among the measurement endpoints used to answer the questions posed by the assessment endpoints.

<u>Sphagnum Bog</u>

The potential for ecological risk to the benthic invertebrate community in the *Sphagnum* bog was identified by all the lines of evidence (**Table G-22**). The benchmark-driven measurement endpoints identified copper (Cu), lead (Pb), silver (Ag), and phenolic compounds as the major

risk drivers. Lesser risk drivers included molybdenum (Mo) and uranium (U). The sediment toxicity tests identified statistically significant effects in six of the 11 sediment samples used in the test. Toxicity in three of those six samples coincided with high levels of PCBs and Cu, whereas the most toxic of these three samples also had high levels of Pb and mercury (Hg). The benthic survey identified mild to moderate effects in four of the 11 sediment samples used in the toxicity test.

The potential for ecological risk to amphibians in the *Sphagnum* Bog was identified by two of the three lines of evidence. The two benchmark-driven measurement endpoints identified Cu, Pb, and Ag as the major risk drivers in surface water and mineral sediment. However, as presented in Appendix A of the FS (*de maximis,* 2014b),[26] the FETAX test performed on five surface water samples collected from the *Sphagnum* bog did not show any adverse effects to survival, malformation, or growth in embryonic *Xenopus*. Two of the five surface water samples used in the FETAX test were co-located with two of the three most toxic sediment samples. It would appear, therefore, that the high contaminant levels in the sediment at these two locations did not affect the quality of the surrounding water column in terms of toxicity to *Xenopus*.

Medium-weighted food chain models characterized risk to mallard duck and raccoon at the Sphagnum Bog as unlikely. Food chain models suggest that risk to great blue heron is possible from beryllium (Be) in mineral, peat, and moss sediment fractions. Food chain models also suggest that in the mineral and peat fractions, risk to shrews is possible from Mo.

The BERA concluded that risk to the benthic community is possible for the mineral sediment within the southwest corner of the Sphagnum Bog. Adverse effects in *C. dilutus* bioassays at two sample locations in the bog appear to be explained by elevated sediment metal and PCB concentrations at those specific locations, which are within the southwest corner of the Sphagnum Bog. Sediment contaminant levels at these locations in the *Sphagnum* bog could be expected to have direct, measurable impacts on the local benthic community based on the results of the site-specific testing. The mineral sediment fraction is the primary medium of concern in the *Sphagnum* bog. The peat and moss fractions are secondary and lesser media of concern to two of the four wildlife receptors groups evaluated in the BERA, namely the great blue heron and the short-tailed shrew. The analysis focused on mineral sediment as the medium of concern because it showed the highest amount of ecological risk to the receptor groups evaluated in the BERA, particularly the benthic invertebrate community. One sample outside of the southwest corner has been identified as exceeding the cleanup level for PCBs, but the benefits of physically removing this one area does not outweigh the damage that would occur to the bog, which has taken thousands of years to become established; so this one location will be left undisturbed to avoid impacting the well-established peat. Leaving one location of elevated PCBs represents a very low risk for receptor populations over the large area of the remaining bog.

[26] *Id.*

The refined list of COCs in the Sphagnum Bog, along with recommended protective levels and the basis for each level, are presented in **Table G-23.**

Cooling Water Recharge Pond

Based on the results of the previously completed SLERA, it was concluded that risks to benthic invertebrates at the Cooling Water Recharge Pond are likely due to Cu and PCBs based on benchmark comparisons. Therefore, the BERA carried forward the conclusion that sediment in the Cooling Water Recharge Pond would pose significant risks, and due to concurrent exceedances of USEPA target human health risk criteria (risk range of 10^{-4} to 10^{-6} and/or a target organ HI of 1), it was presumptively assumed that a response action will be required for this AOI.

Section 5: Uncertainties

There is uncertainty associated with estimates of risk in any BERA because the risk estimates are based on a number of assumptions regarding exposure and toxicity. More specifically, there is inherent variability and uncertainty associated with the data collected to characterize exposure concentrations and assumptions about the bioavialability of the selected COPCs. There are also assumptions and limitations inherent in food chain modeling, including selection of exposure and modeling parameters (e.g., dietary intake, body weight, and age), uptake factors, and toxicological data (e.g., TRVs).

The food chain models assumed that 100% of the metals ingested are absorbed. Beryllium is poorly absorbed by animals (ATSDR, 2002)[27] and molybdenum is not known to biomagnify. Overall, the conservative nature of the food chain models likely overestimate risk associated with beryllium and molybdenum.

Site-specific conditions also contribute to uncertainty. Due to the variability in media within the bog to which ecological receptors could potentially be exposed, sediment, peat, and sphagnum moss were sampled for analysis. There are no specific screening benchmarks available for peat or sphagnum, and therefore these two data sets are treated as sediment-like media in the BERA and are compared to sediment benchmarks. Both peat and sphagnum likely support some type of invertebrate community, and therefore the sediment benchmarks are the most appropriate benchmarks currently available for these media, however the bioavailability in these media is uncertain, and assumed by the analysis to be similar to mineral sediment.

[27] ATSDR, 2002. Toxicological Profile for Beryllium. U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Division of Toxicology/Toxicology Information Branch, Atlanta, Georgia. September 2002.

It is also known that peat bogs bind metals strongly (Novak *et al*., 2003).[28] Bioavailability of copper has also been reported to be low in bogs that have excessive amounts of this metal which, in turn, would explain a decrease in bioavailability (Brewina *et al*., 2007).[29] These observations are important because the Sphagnum Bog may have much lower bioavailability of copper and other COPCs that were identified at a fairly high frequency, even though the pH is acidic. Humic and tannic acids are negatively charged compounds that can sequester metals, which would render the metals "dissolved" but still unavailable for uptake through the gills of aquatic organisms.

Considerable uncertainty exists with respect to the *Xenopus* testing due to overall poor test performance, therefore this test is not used as a major line of evidence for potential risk in the Sphagnum Bog, and is not line of evidence used to select of PRGs for the Bog (Feasibility Study, Appendix A; *de maximis,* 2014b).[30]

Site-specific prey tissue data were available for benthic macroinvertebrates and amphibians at the Sphagnum Bog. Site-specific tissue data reduce uncertainty and result in high confidence in the risk estimation because they are direct measures of potential exposures to receptors.

There is some uncertainty regarding the interpretation of the benthic community survey results in the Sphagnum Bog where the aquatic habitat is poorly suited to standard metrics for benthic community structure. Most benthic sampling also employs a minimum of three replicates because macroinvertebrates typically exhibit a clustered distribution in sediment. For the NMI study, only one sample was obtained per location, which reduces the statistical power when interpreting the results. Therefore, the benthic community survey was given a "low" weight in the interpretation scheme. The toxicity testing, which provides a more direct line of evidence, was given a higher weight in the evaluation of risk to the benthic community.

3. Basis for Response Action

The baseline human health and ecological risk assessments revealed that a future resident or ecological receptors potentially exposed to chemicals of concern in soil, sediment, or groundwater via direct contact, ingestion, inhalation or ionizing radiation may present an unacceptable human health or ecological risk. Actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this

[28] Novak, M., Emmanuel, S., Vile, M.A., Yigal, E., Veron, A., Paces, T., Wieder, R.K., Vanecek, M., Stepanova, M., Birzova, E. and Hovorka, J., 2003. Origin of lead in eight central European peat bogs determined from isotope ratios, strengths, and operation times of regional pollution sources. Environ. Sci. Technol. 37(3), p. 437-445.

[29] Brewina, L.E., Mehraa, A., Lyncha, P.T. and Faragob, M.E., 2007. Bioavailability of copper within Dolfrwynog Bog soils, North Wales, UK. Chemical Speciation and Bioavailability 19(4), p. 149-162.

[30] *Id.*

ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment. Remedial actions are focused on the following media: surface and sub-surface soils and debris throughout the Site, soils contained within the Holding Basin, sediments in the Cooling Water Recharge Pond and Sphagnum Bog, and overburden and bedrock groundwater throughout the Site.

H. REMEDIATION OBJECTIVES

Risk Management Discussion

As noted in section 2.4 of the Feasibility Study, based on incremental risk being less than 10^{-4} due to PAHs, the Route 62 outfall area is not included in areas subject to remediation in the ROD. The exposure area which encompasses the Route 62 outfall area has a cumulative HI value of less than 1 and the incremental cancer risk does not exceed 10^{-4}. Aside from naturally occurring arsenic and thorium, the only contaminants of concern are PAHs, which are likely attributable to storm water runoff from Route 62, and not to activities associated with the Site.

Based on the results of the previously completed SLERA, it was concluded that risks to benthic invertebrates at the Cooling Water Recharge Pond are likely due to Cu and PCBs based on benchmark comparisons. Therefore, the BERA carried forward the conclusion that sediment in the Cooling Water Recharge Pond would pose significant risks, and due to concurrent exceedances of USEPA target human health risk criteria (risk range of 10^{-4} to 10^{-6} and/or a target organ HI of 1), it was presumptively assumed that a response action will be required for this AOI.

The southwest corner of the bog contains sediment exceeding the PRGs that will be removed based on ecological risk to benthic invertebrates. One sample outside of the southwest corner has been identified as exceeding the 1 ppm cleanup level for PCBs at 4.8 mg/kg, but the benefits of physically removing this one area does not outweigh the damage that would occur to the bog, which has taken thousands of years to become established; so this one location will be left undisturbed to avoid impacting the well-established peat. Leaving one location of elevated PCBs represents a very low risk for receptor populations over the large area of the remaining bog.

Remedial Action Objectives

Remedial Action Objectives (RAOs) are medium-specific goals that define the objective of remedial actions to protect human health and the environment. RAOs specify the COCs, potential exposure routes and receptors and provide a general description of what the cleanup will accomplish. The RAOs are based on available information and standards, such as applicable or relevant and appropriate requirements (ARARs) and site-specific risk-based levels. These RAOs were developed to mitigate, restore and/or prevent existing and future potential threats to

human health and the environment.

The RAOs for the selected remedy for the Site are to:

(1) Prevent direct human exposure by a future resident (by dermal contact, ingestion, inhalation, or ionizing radiation) to soils or sediments with contaminants (DU, PCBs, PAHs, and other inorganics) that exceed risk-based standards;

(2) Prevent migration of DU/uranium from soils in the Holding Basin that would result in groundwater concentrations exceeding ARARs;

(3) Prevent potential future exposure to contaminated indoor air by a future resident/commercial worker;

(4) Prevent potential human exposure (ingestion, dermal contact, vapor inhalation) by a future resident to groundwater impacted by the Site that may be used as a domestic water supply with VOC, SVOC, DU, or inorganic contaminant concentrations that exceed ARARs or risk-based standards.

(5) Protect ecological receptors from exposure to contaminants (PCBs, copper) in sediments indicative of adverse effects at the Cooling Water Recharge Pond;

(6) Protect ecological receptors from exposure to contaminants (PCBs, copper, mercury, and lead) in sediments indicative of adverse effects at the Sphagnum Bog while maintaining the physical and ecological integrity of the bog;

(7) Restore groundwater within the contaminant plumes to its beneficial use as a potential drinking water supply by meeting ARARs including federal MCLs, or in their absence, by meeting cleanup levels protective of human health;

(8) Limit migration of VOCs, SVOCs, uranium (depleted and/or naturally occurring), PAHs, and other inorganics in groundwater within the contaminant plumes at concentrations that would exceed ARARs or risk-based standards.

I. DEVELOPMENT AND SCREENING OF ALTERNATIVES

A. Statutory Requirements/Response Objectives

Under its legal authorities, EPA's primary responsibility at Superfund sites is to undertake remedial actions that are protective of human health and the environment. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences, including: 1) a

requirement that EPA's remedial action, when complete, must comply with all federal and more stringent state environmental and facility siting standards, requirements, criteria or limitations, unless a waiver is invoked; 2) a requirement that EPA select a remedial action that is cost-effective, and that utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and 3) a preference for remedies in which treatment that permanently and significantly reduces the volume, toxicity or mobility of the hazardous substances is a principal element over remedies not involving such treatment. Response alternatives were developed to be consistent with these Congressional mandates.

B. Technology and Alternative Development and Screening

CERCLA and the National Contingency Plan (NCP) set forth the process by which remedial actions are evaluated and selected. In accordance with these requirements, a range of alternatives were developed for the Site.

With respect to source control, the RI/FS developed a range of alternatives in which treatment that reduces the toxicity, mobility, or volume of the hazardous substances is a principal element. This range included an alternative that removes or destroys hazardous substances to the maximum extent practicable, eliminating or minimizing to the degree possible the need for long term management. This range also included: alternatives that treat the principal threats posed by the Site, but vary in the degree of treatment employed and the quantities and characteristics of the treatment residuals and untreated waste that must be managed; alternative(s) that involve little or no treatment but provide protection through engineering or institutional controls; and a no action alternative.

With respect to the groundwater response action, the RI/FS developed a limited number of remedial alternatives that attain site specific cleanup levels within different time frames using different technologies, and a no action alternative.

As discussed in Section 3 of the FS, soil and groundwater treatment technology options were identified, assessed, and screened based on implementability, effectiveness, and cost. These technologies were combined into source control and management of migration alternatives. Sections 4 and 6 of the FS presented the remedial alternatives developed for soil and groundwater, respectively, by combining the technologies identified in the previous screening process in the categories identified in Section 300.430(e)(3) of the NCP. Each alternative was then evaluated in detail in these sections.

J. DESCRIPTION OF ALTERNATIVES

This Section provides a narrative summary of each source control and management of migration alternative evaluated. Refer to Section K of this ROD for a breakdown of costs (including

capital and O&M), as well as discussion on the time to construct and meet RAOs, for each alternative.

1. Source Control Alternatives Analyzed

Soil/Sediment Alternatives (Table J-1 in Appendix B provides a soil/sediment alternative matrix showing the general response action and technology type for each alternative)

SS-1: No Action

Under the no action alternative, no additional actions would be taken to address exposure to soils or sediments. Five-year reviews would still be performed as part of the no-action alternative. As required by the Superfund law, the no action alternative will serve as a baseline for comparing the effectiveness of other remedial alternatives to be developed for soils and sediments. Except for the cost of five-year reviews, there is no cost associated with this alternative.

SS-2: Excavation and On-Site Consolidation of Soils (Including Unsaturated Holding Basin Soils) and Sediments with a Cap and Liner System, and In-Situ Stabilization of Holding Basin Saturated Soils Using Apatite or a Comparable Stabilization Agent

Under this alternative, all Site soils, sediments, underground drain lines and debris exceeding cleanup levels (estimated to be 82,500 cubic yards) would be excavated and placed within an on-site lined consolidation area. These excavated areas would then be backfilled with clean soils. Approximately 12,500 cubic yards of Holding Basin soils in the unsaturated zone would be excavated (approximately 35 feet below the ground surface (bgs)) and placed within the on-site consolidation area.

In this alternative, the DU contaminated saturated soils from 35 feet to approximately 85 feet bgs would be stabilized *in-situ* using apatite or a similar stabilization agent. During construction, a temporary downgradient hydraulic containment well with *ex-situ* treatment would be installed to capture and treat DU impacted groundwater. The well would be removed following construction. With approximately 95,000 cubic yards of contaminated soils to be consolidated, the area would cover approximately 2.5 acres of property and would not extend deeper than four feet above the highest groundwater elevation.

This consolidation area would be designed to meet applicable landfill/ARAR requirements, including the construction of a bottom liner and leachate collection system. The estimated average concentration of DU in the soils to be excavated is 11 mg/kg. Soils and sediments containing PCBs greater than 50 mg/kg would be transported off-site for disposal in a TSCA-licensed facility. All disturbed areas would be restored to existing grades (where appropriate), top soiled, mulched and seeded. This alternative also includes operation and maintenance of the consolidation area as well as institutional controls to prevent disturbance of the consolidation area such as notices of activity and use limitations and/or local ordinances to prevent

unacceptable exposures to wastes left in place. The total estimated present value cost of this alternative is approximately $41.9 million.

SS-3: Excavation and Off-Site Disposal of Sediments and Non-Holding Basin Soils, Containment with Partial In-Situ Stabilization of Holding Basin Soils Using Cement and a Low-Permeability Horizontal Sub-Grade Cover

This alternative includes the excavation of approximately 82,500 cubic yards of non-Holding Basin soils, sediments, underground drain lines and debris exceeding cleanup levels and disposal of these materials at an approved off-site disposal facility pursuant to the off-site rule, 40 CFR § 300.440. Excavated areas would then be backfilled with clean soils.

Unsaturated soils within the Holding Basin footprint extend from the ground surface of the pit to the elevation of the water table (approximately 35 feet bgs). The highest concentrations of DU in soils at the Site are in this zone. The unsaturated soil volume within the Holding Basin is approximately 12,500 cubic yards. Saturated soils within the Holding Basin footprint that contain DU extend down to bedrock (from 35 feet to approximately 85 feet bgs). In this alternative, a portion of the DU contaminated unsaturated and saturated soils will be stabilized *in-situ* with cement-based soil mixing/jet grouting. A 20-foot thick wall of stabilized soils, functioning as a vertical containment wall, will circle the Holding Basin soils left untreated (a cement ring).

Approximately 22,700 cubic yards of spoils (left over by-product) are expected to be generated from stabilizing the saturated and unsaturated soils. Approximately 4,200 cubic yards will be used to cap the Holding Basin before installing the sub-grade low-permeability horizontal containment cover. The remaining 18,500 cubic yards of spoils would be disposed off-site instead of within the Holding Basin footprint. This allows space for 10 feet of clean soils to be placed on top of the Holding Basin cover which maximizes reuse options for the Holding Basin area. In total, approximately 101,000 cubic yards of soils and sediments would be disposed off-site.

A low-permeability cover would be installed over the stabilized soils to limit infiltration into the stabilized soils. The cover would be placed at a minimum depth of 10 feet below the surface of the excavation area to increase re-use options, with clean soil fill placed on top of the cover to restore the surface of the Holding Basin footprint to grade level. A temporary downgradient hydraulic containment well with *ex-situ* treatment would be installed to capture and treat DU impacted groundwater during construction.

All disturbed areas will be restored to existing grades (where appropriate), top soiled, mulched and seeded. This alternative also includes institutional controls such as notice of activity and use limitations and/or local ordinances to prevent unacceptable exposures to, and prevent disturbance of, the Holding Basin area, and long-term operation and maintenance of the remedy. The total estimated present value cost of this alternative is approximately $129.2 million.

SS-4: Excavation and Off-Site Disposal of Sediments and Non-Holding Basin Soils, Full In-Situ Stabilization of Holding Basin Soils Using Apatite or a Comparable Stabilization Agent, and Containment with Low-Permeability Vertical Wall and Sub-Grade Horizontal Cover

Alternative SS-4 includes the excavation of approximately 82,500 cubic yards of non-Holding Basin soils, sediments, and underground drain lines and debris exceeding cleanup levels and disposal of these materials at an approved off-site disposal facility. Excavated areas would be backfilled with clean soils. Materials (wastes, debris, etc.) previously disposed within the Old Landfill (AOI 3) will be removed and transported off-site at an appropriate disposal facility.

Soils within the Holding Basin footprint would be stabilized with a stabilization agent such as apatite or a comparable stabilization agent. Apatite works to immobilize the DU in the soils. The stabilized soils will then be contained within a low-permeability vertical containment wall and low-permeability horizontal cover. This alternative is expected to involve injection of apatite through specially-designed flights of a drill auger placed close together for full stabilization of the Holding Basin soils.

A low-permeability vertical containment wall would be constructed to be keyed into the bedrock (approximately 85 feet bgs) and a low-permeability horizontal sub-grade cover placed above the stabilized soils within the Holding Basin footprint. The horizontal cover would be placed at a minimum depth of 10 feet below the surface of the excavation area to increase re-use options. Clean soil fill will be placed on top of the cover to restore the surface of the Holding Basin footprint to grade level. This will minimize water from infiltrating to the stabilized soils within the containment, further minimizing the leaching potential of depleted uranium to the groundwater.

A temporary downgradient hydraulic containment well with *ex-situ* treatment will be installed to capture and treat DU impacted groundwater during construction.

All disturbed areas will be restored to existing grades (where appropriate), top soiled, mulched and seeded. This alternative also includes operation and maintenance of the remedy as well as institutional controls such as notice of activity and use limitations and/or local ordinances to prevent unacceptable exposures to, and to prevent disturbance of, the Holding Basin area. The total estimated present value cost of this alternative is approximately $104.7 million.

SS-5: Excavation and Off-Site Disposal of Sediments and Soils (Including Unsaturated Holding Basin Soils), and Containment with Full In-Situ Stabilization of Holding Basin Saturated Soils Using Cement and a Low-Permeability Horizontal Sub-Grade Cover

Alternative SS-5 includes the excavation of approximately 82,500 cubic yards of non-Holding Basin soils, sediments, underground drain lines and debris) exceeding cleanup levels and disposal of these materials at an approved off-site disposal facility. Excavated areas would be backfilled with clean soils. In addition, this alternative involves the excavation and off-site

disposal of approximately 12,500 cubic yards of unsaturated Holding Basin soils, for a total of 95,000 cubic yards.

The remaining Holding Basin soils, approximately 20,000 cubic yards of DU contaminated saturated soils, will be fully stabilized *in-situ* with cement. Using cement as a stabilization agent would result in approximately 28,750 cubic yards of spoils being generated to stabilize the saturated soils. Of that amount, approximately 16,000 cubic yards can be used to fill the Holding Basin. The remaining 12,750 cubic yards of spoils would be disposed of off-site along with the 95,000 cubic yards of Site soils and sediments exceeding cleanup levels noted above, for a total of 107,500 cubic yards.

A temporary downgradient hydraulic containment well with *ex-situ* treatment would be installed to capture and treat DU impacted groundwater during construction.

A low-permeability sub-grade cover would be installed within the Holding Basin footprint to act as a barrier layer to limit infiltration into the stabilized soils. The cover would be placed at least 10 feet deep within the excavation area to increase re-use options, and clean soil fill would be placed on top of the cover to restore the surface of the Holding Basin footprint.

Disturbed areas would be backfilled to existing grades (where appropriate), covered with top soil and mulch, and seeded to restore natural vegetation. This alternative also includes long-term operation and maintenance of the remedy, and institutional controls such as notice of activity and use limitations and/or local ordinances to prevent unacceptable exposures to and disturbance of the Holding Basin area. The total estimated present value cost of this alternative is approximately $147.9 million.

2. Management of Migration Alternatives Analyzed

Groundwater Alternatives[31] (**Table J-2** provides a groundwater alternative matrix)

GW-1: No Action

Alternative GW-1 is the no action alternative.

[31] The groundwater alternatives described below differ slightly from the alternatives presented in the Proposed Plan. A change to the institutional controls requirement for vapor intrusion mitigation systems was made to require installation of vapor mitigation systems should future structures be built above the VOC plumes unless an evaluation of vapor intrusion risks is performed to show such systems are not required. The groundwater alternatives in the Proposed Plan required evaluation of vapor intrusion risks and if necessary, installation of vapor mitigation systems should future structures be built above the VOC plumes. See Section N below.

This alternative provides no active groundwater treatment. Concentrations of VOCs and 1,4-dioxane in groundwater would be reduced somewhat through natural attenuation via dispersion, dilution, and volatilization. There is no cost estimate for this alternative.

GW-2: Limited Actions / Institutional Controls

Alternative GW-2 includes: (1) implementation of institutional controls to: (a) prohibit future use of impacted groundwater as a drinking water source, and (b) require installation of vapor mitigation systems should future structures be built above the VOC plumes unless an evaluation of vapor intrusion risks is performed to show such systems are not required; and (2) long-term groundwater monitoring for DU, VOCs/1,4-dioxane and natural uranium to monitor the plumes and evaluate concentration decreases due to natural attenuation. The total estimated present value cost of this alternative is approximately $2.9 million.

GW-3: Ex-Situ Treatment

Alternative GW-3 includes: (1) extraction of overburden groundwater downgradient of the Holding Basin (DU source area) with *ex-situ* treatment; (2) extraction of overburden and bedrock groundwater north and downgradient of the property boundary with *ex-situ* treatment for 1,4-dioxane and VOCs; (3) extraction of groundwater from shallow bedrock at the downgradient end of the natural uranium plume with *ex-situ* treatment for uranium removal; (4) implementation of institutional controls to: (a) prohibit future use of impacted groundwater as a drinking water source until cleanup levels are met, and (b) require installation of vapor mitigation systems should future structures be built above the VOC plumes unless an evaluation of vapor intrusion risks is performed to show such systems are not required; and (5) long-term groundwater monitoring for DU, VOCs/1,4-dioxane and natural uranium to monitor the effectiveness of *ex-situ* treatment and to evaluate concentration decreases due to natural attenuation. Methods of *ex-situ* treatment may include ion exchange and advanced oxidation (or other suitable technologies) and will be determined during the design. The total estimated present value cost of this alternative is approximately $29.3 million.

GW-4: Ex-Situ Treatment of VOCs/1,4-Dioxane, and In-Situ Treatment of DU And Natural Uranium

Alternative GW-4 includes: (1) extraction of overburden and bedrock groundwater with *ex-situ* treatment for VOCs and 1,4-dioxane with effluent discharge to surface water or recharge/reinjection into the aquifer; (2) injection of apatite /Zero Valent Iron (ZVI) based media or other comparable amendments in the overburden DU and natural uranium bedrock plumes to take uranium out of solution (remove uranium from groundwater in sorbed and mineral precipitate forms); (3) implementation of institutional controls to: (a) prohibit future use of impacted groundwater as a drinking water source until cleanup levels are met, and (b) require installation of vapor mitigation systems should future structures be built above the VOC plumes

unless an evaluation of vapor intrusion risks is performed to show such systems are not required; (4) long-term groundwater monitoring of the effectiveness of *in*- and *ex-situ* treatment and to evaluate concentration decreases due to natural attenuation. The total estimated present value cost of this alternative is approximately $20.2 million.

Recent sampling of monitoring wells on the northern side of the Assabet River has shown that 1,4-dioxane contamination from the Site appears to be migrating underneath the Assabet River toward the town of Acton public water supply wells. EPA requested public comment in the proposed plan on addressing this portion of the remedy (groundwater extraction and *ex-situ* treatment of 1,4-dioxane and VOCs in overburden and bedrock groundwater) in advance of implementing the full remedy at the Site and received wide acceptance of this proposal from the public (See Part 3: The Responsiveness Summary). Pursuant to the Action Memorandum attached to this ROD, EPA is accelerating this portion of the proposed remedy as a non-time critical removal action (NTCRA). Beginning the groundwater remedy for 1,4-dioxane before the rest of the remedial action could contain this plume from expanding further. If the plume continued to migrate, the time and cost for this component of the cleanup action could increase substantially. The cost of this portion of the remedy is approximately $5.2 million. This includes design, construction and up to four years of operation and maintenance until the full remedial action for the Site is underway. Long-term operation and maintenance and long-term monitoring of this NTCRA will be included as part of the remedial action for the Site.

K. SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

Section 121(b)(1) of CERCLA presents several factors that at a minimum EPA is required to consider in its assessment of alternatives. Building upon these specific statutory mandates, the NCP articulates nine evaluation criteria to be used in assessing the individual remedial alternatives.

A detailed analysis was performed on the alternatives using the nine evaluation criteria in order to select a site remedy. The following is a summary of the comparison of each alternative's strength and weakness with respect to the nine evaluation criteria. These criteria are summarized as follows:

Threshold Criteria

The two threshold criteria described below must be met in order for the alternatives to be eligible for selection in accordance with the NCP:

1. **Overall protection of human health and the environment** addresses whether or not a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced or controlled through treatment, engineering controls, or institutional controls.

2. **Compliance with applicable or relevant and appropriate requirements (ARARs)** addresses whether or not a remedy will meet all Federal environmental and more stringent State environmental and facility siting standards, requirements, criteria or limitations, unless a waiver is invoked.

Primary Balancing Criteria

The following five criteria are utilized to compare and evaluate the elements of one alternative to another that meet the threshold criteria:

3. **Long-term effectiveness and permanence** addresses the criteria that are utilized to assess alternatives for the long-term effectiveness and permanence they afford, along with the degree of certainty that they will prove successful.

4. **Reduction of toxicity, mobility, or volume through treatment** addresses the degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume, including how treatment is used to address the principal threats posed by the site.

5. **Short term effectiveness** addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period, until cleanup goals are achieved.

6. **Implementability** addresses the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

7. **Cost** includes estimated capital and Operation Maintenance (O&M) costs, as well as present-worth costs.

Modifying Criteria

The modifying criteria are used as the final evaluation of remedial alternatives, generally after EPA has received public comment on the RI/FS and Proposed Plan:

8. **State acceptance** addresses the State's position and key concerns related to the preferred alternative and other alternatives, and the State's comments on ARARs or the proposed use of waivers.

9. **Community acceptance** addresses the public's general response to the alternatives described in the Proposed Plan and RI/FS report.

Following the detailed analysis of each individual alternative, a comparative analysis, focusing on the relative performance of each alternative against the nine criteria, was conducted. This

comparative analysis for soil/sediment and groundwater, respectively, are attached to this ROD as **Tables K-1 and K-2** (see Appendix B).

The section below presents the nine criteria and a brief narrative summary of the alternatives and the strengths and weaknesses according to the detailed and comparative analysis. Only those alternatives which satisfied the first two threshold criteria were balanced and modified using the remaining seven criteria.

Soil/Sediment:

Overall Protection of Human Health and the Environment

All alternatives except for the No Action alternative are protective of human health and the environment when combined with a groundwater remedy. All the alternatives other than the No Action alternative provide for some level of *in-situ* stabilization of the unsaturated and/or saturated soils within the Holding Basin footprint. Alternative SS-2 provides for *in-situ* stabilization of the saturated Holding Basin soils, and consolidates all the other excavated Site soils and sediments within one consolidation area. Since the area containing untreated contaminated soils in SS-2 is more than three times larger than alternatives SS-3, 4, and 5, and since the materials are only 4 feet from the surface whereas the other alternatives (other than the no-action alternative) provide at least a 10 foot layer of clean soil on top of at least partially stabilized soils, SS-2 is considered to be less protective than SS-3, 4, and 5.

SS-3 provides for partial *in-situ* stabilization of the unsaturated and saturated soils within the Holding Basin footprint, contained within a cement ring which limits stabilization to just the inside perimeter of the Holding Basin , with a cover above the stabilized soils, and disposes of the other excavated Site soils and sediments off-site. SS-3 does not treat all of the Holding Basin soils, including some soils that are considered to be principal threat waste and therefore is less protective than SS-4 or SS-5. Alternative SS-4 provides for full *in-situ* stabilization of all the saturated and unsaturated soils within the Holding Basin, a vertical containment wall and horizontal cover around/above the stabilized soils, and disposes of the other excavated Site soils and sediments off-site. Alternative SS-5 provides for excavation and off-site disposal of the unsaturated soils within the Holding Basin, *in-situ* stabilization of all of the saturated soils within the Holding Basin, a cover above the stabilized soils, and disposes of the other excavated site soils and sediments off-site. Since SS-4 and SS-5 fully treat or remove contaminated soils from the Site, these two alternatives provide a similar level of protectiveness and are more protective than SS-1, 2, or 3.

Compliance with ARARs

All alternatives except for the No Action alternative have been developed to comply with ARARs. Alternative SS-2's 2.5-acre consolidation area would present more challenges with respect to active maintenance and monitoring due to its cap and liner, which the other

alternatives do not have. Alternative SS-2 would need to meet ARARs for land disposal of radioactive wastes (10 CFR Part 61, Subparts C and D) and Massachusetts' licensing and operational requirements for low-level radioactive waste facilities (105 CMR 120.800).

Alternatives SS-2, 3, and 4 will impact wetlands and in compliance with Section 404 of the Clean Water Act, 40 CFR Part 230 (Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material), 21 M.G.L. §§ 26-53, and 314 CMR 9.06(1-2) (Criteria for the Evaluation of Applications for Discharge of Dredged or Fill Material), EPA has determined that there is no practicable alternative to conducting this work and cleanup activities selected are the least damaging practicable alternatives. Alternatives SS-2, 3, and 4 will comply with the wetland ARARs by minimizing potential harm and avoid adverse impacts on wetland resources, to the extent practicable by using best management practices to minimize harmful impacts on wetlands, wildlife, or habitat. Wetlands will be restored and/or replicated consistent with the requirements of federal and state wetlands protection laws.

Alternatives SS-2, 3, and 4 will comply with 40 CFR § 761.61 of TSCA regarding management of PCB-contaminated soil. Under each of these alternatives sediments and soils at the Site with PCB concentrations greater than or equal to 50 ppm (*PCB remediation waste* as defined under 40 CFR § 761.3) will be excavated and disposed off-site at a TSCA-approved disposal facility or a RCRA hazardous waste landfill in accordance with 40 CFR § 761.61(a)(5)(i)(B)(*2*)(*iii*). PCB-contaminated soils and sediments with concentrations of PCBs above the 1 mg/kg cleanup level but less than 50 ppm will be excavated and disposed of in accordance with state requirements.

Long-Term Effectiveness and Permanence

Each of the alternatives has some degree of residual risk due to contamination that will remain on-site and will require five year reviews to assess the on-going protectiveness of the remedy and institutional controls to prevent exposure to the remaining contamination. The long-term effectiveness and permanence of the non-Holding Basin excavation and the horizontal cover is anticipated to be the same for each alternative. A much larger amount of contaminated soil will be left on-site and will be much closer to the surface in alternative SS-2 than SS-3, -4 or -5. Also, the on-site consolidation area in SS-2 will require more long-term operation and maintenance and institutional controls over a larger area of the Site.

Alternative SS-3 may provide a lesser degree of long-term effectiveness and permanence than SS-4 and SS-5 because the cement stabilization in SS-3 leaves an area of untreated Holding Basin soils which are contained in a 20-foot thick "ring". Alternative SS-4 provides two layers of protection by fully stabilizing all Holding Basin soils and then containing the soils with a vertical containment wall around and a horizontal cover over the stabilized soils. Alternative SS-5 leaves the least amount of contaminated soils on-site because all of the unsaturated Holding Basin soils are excavated and disposed of off-site. The remaining saturated Holding Basin soils are fully stabilized with cement.

Cement is a proven technology; however, it is a technology that does not allow easily for further actions to be easily implemented, and generates spoils in the process equal to approximately 40% of the contaminated soil treated. SS-2 provides for apatite stabilization of saturated soils in the Holding Basin. Alternative SS-4 provides for full *in-situ* stabilization of all the soils within the Holding Basin using apatite and for a containment wall and horizontal cover around the stabilized soils. Through bench-scale studies conducted at the Site, apatite has been shown to be extremely effective in preventing DU from becoming soluble in groundwater. However, if the apatite application technology is lacking in effectiveness in the future, SS-4 provides the added protection of a vertical containment wall, and additional actions are more easily implemented. The cement stabilized Holding Basin soils in SS-3 are providing containment of Holding Basin soils that are left untreated.

Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment

All the alternatives, except the No Action alternative, reduce the mobility of DU and PCBs throughout the Site by providing for their on-site containment or off-site disposal. Alternative SS-2 consolidates all contaminated soils (except for saturated Holding Basin soils) and sediments on-site, SS-3 and SS-4 contain Holding Basin soils on-site and dispose of other contaminated soils and sediments off-site, and SS-5 disposes all contaminated soils and sediments off-site except for saturated Holding Basin soils. Alternatives SS-2, SS-3, SS-4, and SS-5 include treatment. In Alternatives SS-2 and SS-5, only the saturated soils within the Holding Basin footprint are stabilized in place. The unsaturated soils in SS-5 would be disposed off-site, and SS-2 consolidates the unsaturated soils on-site. Therefore, neither of these alternatives addresses the preference for treatment of principal threat waste.

In Alternatives SS-3 and SS-4, both saturated and unsaturated soils are stabilized in place, although SS-3 limits stabilization to just the inside perimeter of the Holding Basin, and therefore does not fully treat the principal threat waste. Stabilization reduces the mobility of DU from these soils. Alternative SS-4 uses apatite for stabilization of the Holding Basin soils and provides for the added containment of the entire footprint of the Holding Basin with a vertical containment wall, which further reduces the mobility of the DU in these soils. Alternatives SS-3 and SS-5 allow for stabilization to be performed with cement. Cement is a proven technology to reduce mobility of DU; however, it is a technology that does not allow easily for further actions to be easily implemented, and increases the volume of contaminated materials that need to be handled by generating spoils equal to 40% of the contaminated soil treated, as compared to apatite.

Short Term Effectiveness

SS-2, SS-3, SS-4 and SS-5 will meet the established Remedial Action Objectives for the soils and sediments in the same timeframe (within 2-3 years of remedial construction). However, in the short-term, there is a greater potential for additional DU to be released into the groundwater in the implementation of SS-2 and SS-5 during excavation of the Holding Basin soils down to

the water table because the interim cover must be removed for a longer period. The Holding Basin currently has an interim cover placed over the soils that when removed will allow infiltration of precipitation for as long as the excavation remains open. A temporary downgradient hydraulic containment groundwater well is planned for all alternatives to capture any DU that may be released during excavation and construction activities. However, the potential for DU release is lower for SS-3 and SS-4 because the current interim cover on the Holding Basin can remain in place for a longer time while remedial activities are conducted. All alternatives require the same amount of time to construct.

The community is protected the most in the short term by alternative SS-2 because no soils or sediments are transported off-site. Alternative SS-4 will require 82,500 cubic yards of DU contaminated soils and sediments to be transported off-site. Alternative SS-3 will require 101,000 cubic yards of materials to be transported off-site (82,500 cubic yards of DU contaminated soils and sediments and 18,500 cubic yards of spoils). Alternative SS-5 will require 107,500 cubic yards of materials to be transported off-site (95,000 cubic yards of DU contaminated non-Holding Basin soils and sediments, 12,500 cubic yards of the most heavily contaminated soil (the Holding Basin unsaturated soils) plus an additional 12,750 cubic yards of spoils). SS-5 requires the most off-site disposal and transportation due to additional spoils being generated through the cement stabilization method. Alternatives SS-2 and SS-5 are the least protective of workers, as these alternatives include the excavation down to 35 feet below the surface of the Holding Basin in soils that may become unstable due to the level of shoring needed for such a deep excavation. SS-3 involves the stabilization of saturated and unsaturated soils, exposing some workers to the soils and drilling muds or displaced soils (spoils). Cement stabilization will increase the exposure of workers to additional spoils, while apatite, projected to be used in SS-2 and SS-4, will not generate additional spoils. Alternative SS-4 is the most protective of workers because it requires the least amount of handling contaminated soils.

Implementability

Alternatives SS-2 and SS-5 are the most difficult to implement due to the difficulty in excavating Holding Basin soils down to 35 feet and then also procuring the equipment and stabilizing the saturated soils down to 85 feet below ground surface. Alternatives SS-3 and SS-5 utilize cement for stabilization/containment in the Holding Basin which is a proven effective and reliable technology but has the disadvantage of creating additional material/spoils which require disposal. Alternatives SS-2 and SS-4 utilize apatite to immobilize DU in Holding Basin soils. Apatite has been proven very effective in bench scale studies but there are some unknowns in using Apatite on a larger scale. An advantage of using apatite is that no additional materials/spoils are created. Future actions are not anticipated for the Holding Basin once the remedial action is complete, but if additional actions are required they will be more difficult to implement for alternatives SS-3 and SS-5 due to the use of cement. For SS-2, 3, 4 and 5, monitoring to determine the effectiveness of the remedy is equally implementable.

Cost

Off-site transport and disposal is an expensive component of the alternatives, making alternative SS-5 the most expensive because it requires the greatest volume of off-site disposal. Alternative SS-5 is more expensive than SS-3 because it is fully treating the saturated Holding Basin soils, whereas SS-3 only partially treats unsaturated and saturated soils. Alternative SS-2 involves on-site containment and disposal and is the least expensive alternative other than no action. For each of the alternatives, capital costs are the largest component, with operation and maintenance costs making up a small fraction of the total costs. See **Table K-1** (alternative comparison table) in Appendix B for the estimated costs for each alternative.

State and Community Acceptance

The State has expressed its support for Alternative SS-4. The State does not believe that Alternative SS-1 provides adequate protection of human health and the environment. The State does not support SS-2 because it does not use treatment as a permanent solution.

During the public comment period, members of the community expressed its support for either Alternatives SS-4 or SS-5. Alternatives SS-1, 2 and 3 were not considered adequately protective, and the on-site containment component of alternative SS-2 was strongly opposed.

Groundwater

Overall Protection of Human Health and the Environment

The GW-2, GW-3, and GW-4 alternatives protect human health by prohibiting use of contaminated groundwater as a drinking water source via institutional controls until cleanup goals are met. The GW-3 and GW-4 alternatives also protect human health by (1) limiting migration of 1,4-dioxane and VOCs to and beyond the Assabet River via hydraulic containment and *ex-situ* treatment, (2) preventing migration of DU in overburden groundwater via hydraulic containment and *ex-situ* treatment (GW-3) or *in-situ* treatment (GW-4), and (3) preventing migration of natural uranium in bedrock groundwater hydraulic containment with *ex-situ* treatment (GW-3), or *in-situ* treatment (GW-4). Therefore, alternatives GW-3 and GW-4 are more protective of human health than GW-2. Alternative GW-1 does not reduce the potential for human exposure to contaminated Site groundwater; therefore, GW-1 is not protective of human health.

Compliance with ARARs

The key ARAR for groundwater is the MCL for uranium, and GW-4 would meet this ARAR sooner than the other alternatives. Alternative GW-4 provides the most robust strategy for meeting chemical-specific ARARs because it provides treatment throughout the overburden DU and bedrock natural uranium plumes via *in-situ* treatment. Implementation of this technology

has the potential to meet chemical-specific ARARs for uranium within a reasonable timeframe (i.e., 15 years).

Alternatives GW-1 and GW-2 are not likely to meet chemical-specific ARARs for DU or natural uranium within 200 years. Also, attainment of chemical-specific ARARs for VOCs is not likely to occur within 50 years for GW-1 and GW-2 alternatives, but may be achieved within 30 years for GW-3 and GW-4. Alternative GW-3 is unlikely be able to meet chemical-specific ARARs for DU and natural uranium via hydraulic containment and *ex-situ* treatment in a reasonable timeframe. Alternative GW-4 is likely to achieve chemical-specific ARARs for DU and natural uranium within 15 years.

Long-Term Effectiveness and Permanence

Alternative GW-3 is expected to have very good long-term effectiveness due to the combination of institutional controls and hydraulic containment with *ex-situ* treatment (along with source control of DU in the Holding Basin implemented as part of the soil remedy). Long-term monitoring will provide a reliable means of evaluating concentrations over time. GW-4 will also have good long-term effectiveness due to the combination of institutional controls, *ex-situ* treatment of VOCs/1,4-dioxane and the anticipated high stability of immobilized DU and natural uranium using *in-situ* treatment. GW-2 will have higher residual risk due to the lack of engineering controls to prevent off-property migration of impacted groundwater. GW-1 will have the highest residual risk due to lack of institutional controls or plume containment.

Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment

Alternative GW-4 has the best potential for reducing the mass, volume and mobility of DU in groundwater because it provides treatment of DU and natural uranium throughout the overburden and bedrock plumes, respectively. This alternative includes injection of apatite and/or ZVI based media to immobilize uranium. Through bench-scale studies conducted at the Site, apatite has been shown to be extremely effective in removing uranium from groundwater, and ZVI is a proven technology for removal of uranium from groundwater. GW-4 will also reduce the mass, volume and mobility of VOCs and 1,4-dioxane through *ex-situ* treatment. *Ex-situ* treatment in GW-3 also has good potential to reduce mass, volume and mobility of contaminants and will provide some treatment of DU in overburden and natural uranium in bedrock. Mass reduction of DU and natural uranium will likely be less significant in GW-3 than for GW-4 because treatment is not distributed throughout the plume. Alternative GW-3 will provide similar performance to GW-4 with respect to VOCs and 1,4-dioxane. The treatment technologies associated with these alternatives are well-proven and irreversible.

GW-1 and GW-2 include no active treatment and would provide less reduction of toxicity, mobility and volume of contaminants than GW-3 and GW-4. Decreasing trends in the concentration and volume of VOCs in groundwater have been observed. These trends indicate that there may be some reduction of volume of those contaminants in GW-1 and 2 which do not

provide for active treatment. DU in overburden, natural uranium in bedrock, and 1,4-dioxane in both overburden and bedrock would persist for the reasonably foreseeable future.

Short Term Effectiveness

GW-2, GW-3, and GW-4 will prevent human exposure to contaminants in groundwater through institutional controls. GW-1 does not prevent human exposure to contaminants in groundwater at the Site. GW-3 and GW-4 limit migration of contaminants (through *ex-situ* or *in-situ* treatment). GW-1 and GW-2 will not limit migration of contaminants. GW-3 includes hydraulic containment and *ex-situ* treatment of the distal end of the DU plume rather than treatment throughout the plume; therefore, plume flushing times are expected to be longer for GW-3 than for GW-4. GW-4 is likely to achieve the MCLs for DU and natural uranium more quickly (15 years) than the other alternatives (greater than 200 years) because it includes *in-situ* treatment throughout the plumes. The estimated time to reach cleanup levels for VOCs/1,4-dioxane for GW-1 and 2 is greater than 50 years. GW-3 and GW-4 will likely meet cleanup levels for VOCs/1,4-dioxane within 30 years. ARARs for DU and natural uranium will not be achieved within a reasonable timeframe for alternatives GW-1 and GW-2 because they provide no treatment. It is relatively easy to monitor the effectiveness of GW-1, GW-2, GW-3 and GW-4 with long-term monitoring and 5-year reviews.

Implementability

Alternative GW-1 (No Action) is the easiest to implement because it does not involve the construction, operation or maintenance of remedial systems or enforcement of institutional controls. GW-2 is easier to implement than GW-3 or GW-4 because it does not require the construction, operation or maintenance of active remedial systems. However, GW-2 may be less reliable for limiting potential human exposure to contaminants in groundwater than GW-3 or GW-4 because it relies only on institutional controls. Of the active remedial alternatives considered for groundwater, GW-3 is easier to implement in the short term than GW-4 as the *in-situ* treatment portion of GW-4 could be impacted by subsurface conditions that affect direct-push injection equipment. The reliability of GW-3 is high because groundwater extraction and *ex-situ* treatment via ion exchange or advanced oxidation and discharge to surface water are relatively routine tasks. The reliability of *in-situ* treatment in alternative GW-4 has been proven at the bench scale for apatite and ZVI is a proven media. *In-situ* treatment technology allows for a passive remedy that does not depend on long-term manipulation of groundwater geochemistry; and if successful, implementation of GW-4 will not have the long-term operating requirements of the active groundwater extraction and *ex-situ* treatment system included in GW-3.

Cost

The range in estimated cost for all four alternatives is from $0 for GW-1 (No Action) to $29.3 million for GW-3. See **Table K-2** (alternative comparison table) in Appendix B for a summary of costs for all alternatives.

State and Community Acceptance

The State has expressed its support for Alternative GW-4. The State does not believe that Alternative GW-1 provides adequate protection of human health and the environment. The State does not support Alternative GW-2 because it does not use treatment as a permanent solution.

During the public comment period, the members of the community expressed its support for Alternative GW-4. Alternatives GW-1 and 2 were not considered adequately protective.

L. THE SELECTED REMEDY

1. Summary of the Rationale for the Selected Remedy

The selected remedy is a comprehensive remedy which utilizes source control and management of migration components to address the principal Site risks in soil, sediment, and groundwater. Source control measures are required to address soil and sediment at the Site that present unacceptable risks to human health or to environmental receptors, and/or exceed ARARs. The management of migration component addresses contaminants in groundwater underlying the Site that exceed ARARs or otherwise pose an unacceptable risk. Of all the alternatives, the selected remedy best satisfies the statutory criteria for remedy selection.

The major components of the remedy are as follows:

- Excavation and off-site disposal of approximately 82,500 cubic yards of contaminated sediments, underground drain lines, debris, and non-Holding Basin soils (contaminated with DU, PCBs and other contaminants of concern) in various areas of the Site (see **Figure L-1** for approximate excavation areas and depths);

- *In-Situ* stabilization of DU contaminated soils in the Holding Basin via injection using a stabilization agent such as apatite, or other comparable stabilization agent, to prevent leaching of contaminants to groundwater, and containment of Holding Basin stabilized soils with a low-permeability vertical wall and horizontal sub-grade cover to isolate the stabilized soils and further limit mobility of contaminants by removing the flow of groundwater (see **Figure L-2**);

- Extraction and *ex-situ* treatment of VOCs and 1,4-dioxane in overburden and bedrock aquifers, and *in-situ* treatment of depleted uranium in overburden aquifer and natural uranium in bedrock aquifer (see **Figure L-3**);

- Long-term monitoring for effectiveness of *in-* and *ex-situ* treatment; and Institutional Controls to: 1) prevent unacceptable exposures to, and to prevent disturbance of, the Holding Basin area; 2) prohibit use of contaminated groundwater until cleanup levels are met; and 3) require installation of vapor mitigation systems should future structures be built above the VOC plumes unless an evaluation of vapor intrusion risks is performed to show such systems are not required.

Excavation of Site soils and sediments will prevent contact and migration of contamination and will be protective of human and ecological health. Stabilization and containment of Holding Basin soils will limit leaching and migration of source materials. Groundwater treatment will limit migration of contaminants.

2. Description of Remedial Components

The selected remedy is consistent with EPA's preferred alternative outlined in the October 2014 Proposed Plan and is consistent with a combination of Alternatives SS-4 and GW-4.

Soil/Sediment Remediation

The selected remedy component for Site soil and sediment, Alternative SS-4, involves the excavation and off-site disposal of sediments and non-Holding Basin soils, *in-situ* stabilization of Holding Basin soils through the use of a stabilization agent such as apatite or other comparable stabilization agent, and containment with a low-permeability vertical wall and sub-grade horizontal cover.

The selected remedy includes the excavation of approximately 82,500 cubic yards of non-Holding Basin soils, sediments, underground drain lines, and debris exceeding cleanup levels and disposal of these materials at an approved off-site disposal facility. Excavated areas will be backfilled with clean fill. Materials (wastes, debris, etc.) previously disposed within the Old Landfill (AOI 3) will be removed and transported off-site at an appropriate disposal facility. Soils underlying the Old Landfill will be tested and excavated if they exceed the soil cleanup levels identified below.

The primary components of the soil/sediment portion of the selected remedy include:

- Developing an excavation plan through the use of topographical surveys and data evaluation tools to define quantities and locations of all soils and sediments to be excavated (currently estimated as 82,500 cy);
- Designing sampling plan to certify clean soils if on-site borrow area is used;
- Designing a low-permeability, sub-grade cover to be placed below grade within the Holding Basin footprint;

- Installing a temporary hydraulic containment well immediately downgradient of the Holding Basin to capture uranium-impacted groundwater generated during remedial construction;
- Further testing application rate for use of selected stabilizing reagent, and designing injection system to stabilize the soils beneath the Holding Basin;
- Excavating contaminated soils and sediments throughout the Site, including underground drain lines and debris;
- Solidification of soils, if needed to meet paint filter test and compaction requirements, for disposal in off-site facility;
- Transporting soils to disposal facility;
- Stabilizing soils beneath the Holding Basin;
- Installing vertical containment wall around perimeter of Holding Basin;
- Installing sub-grade low-permeability cover system;
- Transporting clean soil onto the Site to re-fill excavations;
- Restoring excavated areas to obtain original grades;
- Restoring Sphagnum Bog and the northeast wetland; and
- Implementing Institutional Controls to prevent unacceptable exposure to, and disturbance of the Holding Basin area, such as restricting excavation and construction of buildings.

Soils within the Holding Basin footprint will be stabilized with apatite, or other comparable stabilizing agent. Apatite works to immobilize the DU in the soils. The stabilized soils will then be contained within a low-permeability vertical containment wall and low-permeability horizontal cover. This alternative is expected to involve injection of apatite or other comparable agent, through specially-designed flights of a drill auger placed close together for full stabilization of the Holding Basin soils. Treatment with apatite (a form of calcium phosphate) sequesters uranium in two ways: 1) dissolution of apatite and subsequent precipitation of U(VI)-phosphate minerals, such as autunite (which has very low solubility and dissolution kinetics); and 2) direct sorption of uranium on the apatite mineral itself. The apatite stabilization technique assumes that sorbed uranium on soils that could become solubilized would come in contact with the apatite media or phosphate in the porewater and become sequestered. Bench scale tests performed at the Site on the use of apatite have proven successful in uranium sequestration (Further information on the bench scale study results can be found in Appendix J of the Feasibility Study).

A low-permeability vertical containment wall such as a slurry wall or grout curtain will be constructed to be keyed into the bedrock (approximately 85 feet below the ground surface) and a low-permeability horizontal sub-grade cover placed above the stabilized soils within the Holding Basin footprint (**Figure L-2** provides a conceptual layout). The horizontal cover is expected to be placed approximately 10 feet below the surface of the excavation area to increase re-use

options, with clean soil fill placed on top of the cover to restore the surface of the Holding Basin footprint to grade level. The cover system will minimize water from infiltrating to the stabilized soils within the containment area, further minimizing the leaching potential of the depleted uranium to the groundwater. In accordance with Nuclear Regulatory Commission regulation 10 CFR Part 40, Appendix A, Criterion 6(1), the containment wall and cover will be constructed to be maintained for a minimum of 200 years.

The Holding Basin is currently capped with an interim polyethylene cover which is minimizing current mobilization of DU. A concern during stabilization of the soils within the Holding Basin footprint is the mobilization of DU into the overburden groundwater when the existing interim cover is removed and the Holding Basin is open and receiving rainwater run-on. Historic excavation of the Holding Basin has resulted in pronounced increases of DU to the overburden for a long as the Holding Basin was open. Therefore, a temporary downgradient hydraulic containment well with *ex-situ* treatment will be installed, as needed, to capture and treat uranium impacted groundwater during construction. Every attempt will be made to have the existing interim cover remain in place while the remedy is conducted in order to minimize infiltration of rainwater through the Holding Basin soils while remediation work is on-going.

The appropriate composition of the stabilizing agent and materials of construction for the vertical containment wall and horizontal cover will be evaluated and additional pre-design studies will be conducted, as necessary, as part of Remedial Design.

The contaminated soil and sediments excavated from throughout the Site will be transferred off-site for disposal at a properly licensed facility pursuant to the off-site rule, 40 CFR § 300.440. The excavations will need to be refilled with clean fill that is either borrowed from an area on-site, or brought on-site from clean off-site sources.

Restoration would include filling excavated areas with clean soils to return the area to the pre-existing conditions, and applying seed, mulch and/or soil amendments to restore the disturbed areas. Portions of the bog where sediment is removed to meet cleanup levels will be restored to return wetland areas to pre-remediation conditions, to the maximum extent practicable.

Under TSCA and 40 CFR § 761.61(c), the Region has made a finding that the manner of sampling, storage, cleanup, and disposal of PCB-contaminated sediment and soil as set out in this Record of Decision will not pose an unreasonable risk of injury to health or the environment. See TSCA Determination included as Appendix G to this ROD.

<u>Groundwater Remediation</u>

The selected remedy component for site-wide groundwater, Alternative GW-4, involves *ex-situ* treatment of VOCs/1,4-dioxane, and *in-situ* treatment of DU and natural uranium to meet the groundwater cleanup levels specified in **Table L-1** (see Appendix B).

The selected remedy includes:

- Extraction of overburden and bedrock groundwater with *ex-situ* treatment for VOCs and 1,4-dioxane and operation and maintenance of the treatment system;
- Injection of agents such as apatite and/or ZVI based media in the overburden DU and natural uranium bedrock plumes to remove uranium from groundwater in sorbed and mineral precipitate forms;
- Implementation of institutional controls to:
    - prohibit future use of impacted groundwater as a drinking water source, and
    - require installation of vapor mitigation systems should future structures be built above the VOC plumes unless an evaluation of vapor intrusion risks is performed to show such systems are not required; and
- Long-term groundwater monitoring of *in-* and *ex-situ* treatment effectiveness and evaluation of concentration decreases due to natural attenuation.

In order to ensure a timely response to contamination that may impact the existing public water supply for the town of Acton, concurrent with this Record of Decision, EPA has signed an Action Memorandum authorizing a Non-Time-Critical Removal Action (NTCRA). The NTCRA encompasses construction and startup of systems to capture and treat 1,4-dioxane and VOCs to halt migration of these groundwater contaminants. The components of the NTCRA are described in the Action Memorandum (Appendix F) and are also included in the description outlined below.

Figure L-3 provides a conceptual layout of the groundwater remedy.

VOCs and 1,4-dioxane

The selected remedy for VOCs and 1,4-dioxane in groundwater may include groundwater extraction from one deep overburden extraction well (approximate depth of 100 feet) and two bedrock extraction wells (approximate depth of 120 feet) with *ex-situ* treatment of extracted groundwater. Additional extraction wells could be included, if needed to provide adequate capture. The extraction wells are expected to be located off-property, north of Main Street and/or on the other side of the Assabet River from the Site, to capture deep overburden and bedrock groundwater containing VOCs and 1,4-dioxane before they discharge to the Assabet River or further migrate under the river toward the Assabet Wellfields. The locations of the extraction wells in Figure L-3 are subject to change based on the results of pre-design studies conducted during the NTCRA as outlined above.

A groundwater treatment plant (GWTP) will be constructed on-Site or in close proximity to the NMI property, likely in the vicinity of the extraction well network. Ex-situ treatment technologies such as advanced oxidation using ultra-violet light, hydrogen peroxide or equivalent, and/or other appropriate technologies will be considered during design of the

treatment system. Treated effluent from the GWTP will either be discharged to surface water or recharged/reinjected into the aquifer. GWTP location, processes, and appropriate discharge standards will be determined during the design of the system. As noted above, the construction and initial operation of this component of the selected remedy is expected to be conducted as a NTCRA.

Depleted Uranium

For DU in overburden groundwater, the selected remedy includes *in-situ* treatment (sequestration) of DU using agents such as apatite and ZVI (or other comparable agent) in In Situ Reactive Zones (ISRZs), which are injections of the agents placed close together. The ISRZ technology using apatite is based on an evaluation of existing literature and Site data, a Site specific pilot study discussed in the Feasibility Study, and the applicability of this technology to the hydrogeochemical conditions in the DU plume. The ISRZs used in this alternative will be passive (no mechanical operation required) and will not require *in-situ* redox control of the aerobic groundwater. Pilot testing and pre-design studies will be conducted to identify appropriate injection methods, media, and well spacing for remedial design; however, it is anticipated that this remedy will include either three separate apatite ISRZs or two apatite ISRZs followed by a ZVI ISRZ at the edge of the DU plume.

Natural Uranium

The selected remedy component for uranium in bedrock groundwater includes *in-situ* treatment (sequestration) of uranium by creating ISRZs amended with apatite and/or ZVI (or other comparable amendments).

Prior to designing an injection program for *in-situ* uranium sequestration, additional investigations will be completed in order to delineate the vertical extent of the uranium plume and evaluate hydraulic connectivity between the bedrock wells. To design an effective remedy, additional hydrogeological characterization will be completed during Remedial Design. Characterization activities will likely include bedrock drilling, rock coring, borehole geophysics, monitoring well installations and multi-well pump testing to identify and understand hydraulic connections within the bedrock. Further, each of the proposed ISRZ amendments will likely require bench and pilot testing to understand the degree of uranium sequestration possible given the bedrock mineralogy and groundwater geochemistry.

The ISRZs are intended to be passive remedies, but will likely require some temporary hydraulic manipulation (e.g., groundwater recirculation) to distribute amendments during or immediately following injection periods. Several *in-situ* amendments considered for remediation of overburden groundwater may be used for the bedrock remedy including apatite and ZVI ISRZs. Bench-scale testing can be used to evaluate the efficacy of these media.

A field-scale injection pilot will likely be necessary to assess appropriate well spacing needed for

adequate amendment distribution to provide a continuous treatment zone. A pilot test may be implemented to identify appropriate injection methods and likely include one to two injection wells (depending on results of hydraulic testing) and several observation wells monitored for amendment presence and geochemical changes during injections. It is likely that this alternative could include more injection rounds at a limited number of injection points compared to the ISRZs in overburden. The limited number of injection points in bedrock is due to the more difficult nature of installing deep open bedrock boreholes, the anticipated presence of a limited discrete fracture network in low porosity bedrock, and the likelihood of needing temporary pumping to distribute amendments in bedrock.

Long-Term Monitoring and Five-Year Reviews

Long-term monitoring of groundwater, surface water, and sediments will be conducted, as necessary, to evaluate contaminant status and migration, to determine long-term effectiveness of *in*- and *ex-situ* treatment, and to evaluate progress towards meeting cleanup levels.

The effectiveness of the groundwater remedy will be determined based upon attainment of the cleanup levels outlined in **Table L-1** (see Appendix B), as well as any additional site-related COCs added through subsequent decision documents. A monitoring program will be implemented in order to evaluate remedy performance and progress towards attainment. The details of the monitoring program will be established during the remedial design phase and will include the preparation of a long-term monitoring plan, but initial monitoring is expected to include evaluation of all site-related contaminants such as VOCs, 1,4-dioxane, and uranium (both natural and depleted). Monitoring scope and frequency could change over time based on technical analysis of the remedy, optimization studies, revised conceptual site model, or other information, as determined by EPA. Groundwater elevation, water quality and geochemistry will be monitored to evaluate groundwater remedy performance. Collection of soils from within the plume will be used to evaluate the type and distribution of uranium sequestration (sorbed or precipitated).

The determination that all cleanup levels have been met should consider historical and current monitoring data, contaminant distribution, trend analysis, and the appropriateness of the compliance monitoring program (i.e., locations, frequency of monitoring, sampling parameter). After all groundwater cleanup levels (as shown in **Table L-1** in Appendix B) have been met as determined by EPA consistent with Agency guidance, EPA will perform a risk evaluation which considers additive risk from remaining COCs considering all potential routes of exposure to document the residual risk based on exposure to groundwater at the Site. The residual risk evaluation will document the potential risk associated with the concentrations of the COCs remaining in groundwater at the Site (if detected).

At the conclusion of remedy construction, hazardous substances, pollutants or contaminants will remain at the Site. Therefore, as required by law, EPA will review the Site at least once every five years after the initiation of remedial action at the Site to assure that the remedial action

continues to protect human health and the environment. These Five-Year Reviews will evaluate the components of the remedy for as long as contaminated media above CERCLA risk levels remain in place. The purpose of this Five-Year Review is to evaluate the implementation and performance of the remedy in order to determine if the remedy is or will be protective of human health and the environment. The Five-Year Review will document recommendations and follow-up actions as necessary to ensure long-term protectiveness of the remedy or bring about protectiveness of a remedy that is not protective. These recommendations could include providing additional response actions, improving O&M activities, optimizing the remedy, enforcing access controls and institutional controls, and conducting additional studies and investigations.

Institutional Controls

In order to protect human health by controlling potential exposures to contaminated soils and groundwater, the selected remedy relies on the use of Institutional Controls including limitations on land and groundwater uses and activities. Institutional Controls are also necessary for the protection of the selected remedy including limitations on uses and activities that interfere with or disturb components of the remedy. Institutional Controls will be required to prevent unacceptable exposures to, and to prevent disturbance of, the Holding Basin area, such as restricting excavation and construction of buildings in the Holding Basin footprint. Institutional controls will also be necessary to: (a) prohibit future use of impacted groundwater as a drinking water source and (b) require installation of vapor mitigation systems should future structures be built above the VOC plumes unless an evaluation of vapor intrusion risks is performed to show such systems are not required. Should someone wish to demonstrate that there are no unacceptable risks from vapor intrusion and therefore mitigation systems are not required, an evaluation of vapor intrusion risks (subject to EPA approval) may be performed prior to building of structures above the VOC plume to demonstrate that vapor intrusion risks are within or below USEPA target risk levels (risk range of 10^{-4} to 10^{-6} and/or a target organ HI of 1). The details of the Institutional Controls will be resolved during the pre-design and remedial design phase in coordination with the parties performing the Remedial Action, impacted landowners, local officials, and MassDEP. Institutional Controls may be implemented through measures that include, but are not limited to, a local Town ordinance, a Notice of Activity and Use Limitation (NAUL), or a Grant of Environmental Restriction and Easement (GERE).

Restrictions on land use on the Site, in this case, restrictions on activities that might interfere with or disturb components of the remedy and restrictions to prevent exposure to contamination contained in the Holding Basin area, are expected to be memorialized in a NAUL or a GERE, as set forth in the Massachusetts Contingency Plan (MCP). Risks from exposure to contaminated groundwater (until cleanup levels are met) will also be controlled through the implementation of Institutional Controls. Within the NMI Property, groundwater use restrictions will be required to prohibit the extraction of groundwater for drinking water. Such restrictions will likely be incorporated into the NAUL to restrict land uses. In addition, for properties outside of the NMI

Property where groundwater exceeds cleanup levels, groundwater extraction may be restricted by a NAUL, GERE, a local Town ordinance, or other appropriate measure, as necessary. In addition, a buffer zone may be required to restrict the installation of wells within close proximity of the edge of the area exceeding groundwater cleanup levels that could impact performance of the groundwater cleanup or otherwise contribute to an unacceptable risk.

The selected remedy may change somewhat as a result of the remedial design and construction processes. Changes to the remedy described in this Record of Decision will be documented in a technical memorandum in the Administrative Record for the Site, an Explanation of Significant Differences (ESD) or a Record of Decision (ROD) Amendment, as appropriate.

3. Summary of the Estimated Remedy Costs

Tables L-5 and **L-6** in Appendix B list a summary of the major capital and O&M cost elements for the selected remedy. These tables present the major construction and O&M activities required to implement each remedy component along with their associated unit and total costs.

The information in the cost estimate summary tables is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

The total estimated cost of the Selected Remedy is $125 million. This cost includes approximately $5.2 million for the construction and initial operation of the groundwater remedy to address 1,4-dioxane contamination which will be conducted as a NTCRA pursuant the Action Memorandum signed concurrent with this ROD.

4. Expected Outcomes of the Selected Remedy

The primary expected outcome of the selected remedy is that the soils underlying the Site will no longer present an unacceptable risk to human health via direct contact and will be suitable for residential use. Contamination in the Holding Basin will not pose a risk to human health via direct contact and will no longer act as a source of groundwater contamination after the remedy is put into place. Sediments in the Bog Area will no longer present risks to human health or the environment following completion of remedial construction. Groundwater contamination underlying the Site will be treated and not allowed to spread further once the extraction/treatment system is put into place. The groundwater is expected to be restored to its permissible, beneficial use as a future potential drinking water source within approximately 30 years and will no longer present an unacceptable risk to human health. It is anticipated that the selected remedy will also provide socio-economic and community revitalization impacts by allowing the currently

abandoned NMI Property to be used in the future. The effectiveness of the groundwater remedy will be determined based upon attainment of the cleanup levels outlined in **Table L-1** as well as any additional site-related COCs added through subsequent decision documents. A monitoring program will be implemented in order to evaluate remedy performance and progress towards attainment. The details of the monitoring program will be established during the remedial design phase and will include the preparation of a long-term monitoring plan, but initial monitoring is expected to include evaluation of all site-related contaminants such as VOCs, SVOCs, metals, PAHs. Monitoring scope and frequency could change over time based on technical analysis of the remedy, optimization studies, revised conceptual site model, or other information, as determined by EPA.

The determination that all cleanup levels have been met should consider historical and current monitoring data, contaminant distribution, trend analysis, and the appropriateness of the compliance monitoring program (i.e., locations, frequency of monitoring, sampling parameter). After all groundwater, soil, and sediment cleanup levels (as shown in **Tables L-1** to **L-3**) have been met as determined by EPA consistent with Agency guidance, EPA will perform a risk evaluation which considers additive risk from remaining COCs considering all potential routes of exposure to document the residual risk based on exposure to soil, sediment, and/or groundwater at the Site. The residual risk evaluation will document the potential risk associated with the concentrations of the COCs remaining in soil, sediment, and/or groundwater at the Site (if detected).

a. **Cleanup Levels**

Cleanup levels were developed for the COCs identified in the human health and ecological risk assessments. COCs are the chemicals found at the Site that, based on the results of the risk assessment, were determined to pose an excess lifetime cancer risk greater than 1 in 1 million (10^{-6}) or an HI greater than 1. COCs were identified for exposure areas that posed A) a cancer risk in excess of an ELCR of 10^{-4}, B) an HI greater than 1, or C) a significant ecological risk.

1. Ground Water Cleanup Levels

The cleanup levels for most Chemicals of Concern (COCs) in groundwater were selected based on federal Maximum Contaminant Levels (MCLs), or risk-based cleanup goals. For those COCs that do not have a federal or state ARAR at the time this ROD was developed, a site-specific, risk-based cleanup level was calculated. If a value described by any of the methods described above was not capable of being detected with good precision and accuracy, or was below what was deemed to be the background value, then the practical quantification limit or background value was selected as the cleanup level. The selected cleanup levels are shown in **Table L-1** (see Appendix B of this ROD, as well as Appendix E, which contains cleanup level development). Many of these cleanup levels represent federal MCLs, but some are based on a cancer risk level of 1×10^{-6} or an HQ of 1 (risk-based cleanup level).

The cleanup levels are based on a residential scenario with potential future cumulative cancer risks greater than 10^{-4} or target organ HIs greater than 1 considering the ingestion, dermal contact, and inhalation exposure pathways. Risk-based PRG development was required for each chemical with an individual cancer risk above 10^{-6} or with an HQ above 1 (see Appendix B of the FS). Based on USEPA revisions to default exposure parameters and toxicity values since the release of the FS, Appendix E of this ROD contains updated cleanup level development.

The human health risk-based PRGs provided in Appendix E of this ROD correspond to target cancer risk levels of 10^{-6}, 10^{-5}, and 10^{-4} and a target non-cancer HQ of 1. For each of the contaminants, risk-based PRGs were calculated using equations and exposure assumptions initially presented in Appendix B of the FS, which were the same as those used in the baseline HHRA except as noted in the following paragraphs. Note that the baseline HHRA conservatively used 1.5 L/day (typical EPA assumption at the time of the risk assessment) as the ingestion rate for a child. However, EPA's default value of 1 L/day has been used in development of the PRGs to be consistent with recommended national default standard values. In addition, for national consistency, an assumption was used that receptors are exposed to volatiles released during use of tap water 24 hours per day (as opposed to only during periods of bathing, as used in the baseline HHRA). Toxicity values used in the calculation of the risk-based PRGs are presented in Section G of this ROD.

As noted in Section G of this ROD, the baseline HHRA was completed in 2013. In February 2014, EPA finalized a Directive to update standard default exposure factors and frequently asked questions associated with these updates. These updated standard default exposure factors have been utilized to develop the risk-based cleanup levels for groundwater (see Appendix E of this ROD).

The human health risk-based PRG selection process for each contaminant is summarized in Appendix B of the FS and Appendix E of this ROD. It should be noted that due to the presence of contaminated groundwater in the vicinity of the site that is not attributable to releases from the site, the groundwater remediation at this Site addresses contaminants related to the Site only.

Consistent with EPA's 1996 Final Ground Water Use and Value Determination Guidance, and the Commonwealth of Massachusetts' Comprehensive State Groundwater Protection Program (CSGWPP), MassDEP has developed a "Use and Value Determination" of the groundwater relative to the Site. The purpose of the Use and Value Determination is to identify whether the aquifer at the Site should be considered of "High," "Medium," or "Low" use and value. In the development of its Determination, MassDEP applied the criteria for groundwater classification as promulgated in the Massachusetts Contingency Plan (MCP). The classification contained in the MCP considers criteria similar to those recommended in the Use and Value Guidance. MassDEP determined that there is a High use and value for the Site area groundwater. Therefore, EPA is proposing cleanup levels based on federal and state drinking water standards,

or Maximum Contamination Levels (MCLs), and risk-based criteria that support this use as a future potential drinking water source.[32]

2. Soil Cleanup Levels

Human health-based soil cleanup levels were developed in the FS (*de maximus*, 2014b)[33] for multiple exposure scenarios, based on risks presented earlier in Section G of this ROD. EPA has determined, based on input from the town on future use, that cleanup levels will be established which allow for unrestricted (e.g., residential) use over much of the Site.

Cleanup levels for chemicals of concern (COCs) in surface or subsurface soil exhibiting an unacceptable cancer or non-cancer risk have been established such that they are protective of human health. Risk-based Preliminary Remediation Goals (PRGs) were developed for soil associated with potential future cumulative cancer risks greater than 10^{-4} or target organ HIs greater than 1 considering the ingestion, dermal contact, and inhalation exposure pathways in a residential exposure scenario. For those soils, risk-based PRG development was required for each chemical with an individual cancer risk above 10^{-6} or with an HQ above 1 (see Appendix B of the FS). These contaminants include benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, PCBs, arsenic, uranium, and thorium. The baseline HHRA showed that two of the most substantial contributors to cancer risks in soil are arsenic and thorium. However, the baseline HHRA concluded that arsenic and thorium concentrations in soil at the Site are consistent with local background concentrations. Consequently, the risks calculated in the HHRA for arsenic and thorium in soil are a reflection of the risks associated with ambient background conditions, and not a representation of risks associated with site-related contamination.

The human health risk-based PRGs provided in Appendix E of this ROD correspond to target cancer risk levels of 10^{-6}, 10^{-5}, and 10^{-4} and a target non-cancer HQ of 1. For each of the contaminants, risk-based PRGs were calculated using equations and exposure assumptions presented in Appendix E of this ROD. Toxicity values used in the calculation of the risk-based PRGs are presented in Section G of this ROD, while Appendix E of this ROD presents the dermal absorption and plant uptake factors used during PRG development. In addition, Appendix E of this ROD includes the site-specific conversion of radionuclide COCs from activity-based concentrations to mass-based concentrations. An oral relative bioavailability factor of 0.6 is now recommended by EPA for evaluation of risks and calculation of PRGs for arsenic in soil. The bioavailability factor was not used in the baseline HHRA, but has been applied during PRG development.

[32] The risk associated with the MCLs for arsenic and vinyl chloride fall outside (above) the Superfund risk range; however, EPA has determined that MCLs are protective values for drinking water.

[33] *Id.*

As noted in Section G of this ROD, the baseline HHRA was completed in 2013. In February 2014, EPA finalized a Directive to update standard default exposure factors and frequently asked questions associated with these updates. These updated standard default exposure factors have been utilized to develop the risk-based cleanup levels for soil (see Appendix E of this ROD), along with the revised toxicity values for uranium, as discussed in Section G of this ROD.

The human health risk-based soil cleanup levels for each contaminant are summarized in **Table L-2** in Appendix B of this ROD. The cleanup levels are selected by considering the ARARs, risk-based PRGs, quantitation limits, and reference/background data.

Cleanup levels for soil correspond to a cancer risk level of 1 x 10^{-6} for benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, and uranium. Per CERCLA and the NCP, EPA does not require cleanup to below background or reference levels. Therefore, cleanup levels for arsenic and thorium are set at background levels. The cleanup level for PCBs is based on CERCLA policy.

These cleanup levels must be met at the completion of the remedial action in surface and sub-surface soils at the NMI Property. These soil cleanup levels attain EPA's risk management goal for remedial actions and have been determined by EPA to be protective.

3. Sediment Cleanup Levels

Human Health

Sediment cleanup levels were initially developed in the FS (*de maximus*, 2014b)[34] for an abutting resident/recreational visitor exposed to PCBs at the Cooling Water Pond. While there was also unacceptable risk calculated for a trespasser due to PCBs, the recreational visitor scenario is the more conservative scenario which results in a lower cleanup level. Similar to groundwater and soil, Appendix E of this ROD presents revised cleanup level development information.

The cleanup level for PCBs in sediment has been established such that it is protective of human health. Risk-based PRGs were developed for sediment associated with a potential future target organ HI greater than 1 considering the ingestion and dermal contact exposure pathways in a recreational visitor exposure scenario.

The human health risk-based PRGs provided in Appendix E of this ROD correspond to target cancer risk levels of 10^{-6}, 10^{-5}, and 10^{-4} and a target non-cancer HQ of 1. Risk-based PRGs were calculated using equations and exposure assumptions presented in Appendix E of this ROD. Toxicity values used in the calculation of the risk-based PRGs are presented in Section G of this ROD, along with the dermal absorption factors used during PRG development.

[34] *Id.*

As noted in Section G of this ROD, the baseline HHRA was completed in 2013. In February 2014, EPA finalized a Directive to update standard default exposure factors and frequently asked questions associated with these updates. These updated standard default exposure factors have been utilized to develop the risk-based cleanup levels for sediment (see Appendix E of this ROD).

The human health risk-based sediment cleanup level for PCBs is summarized in **Table L-3** in Appendix B of this ROD. The cleanup level is selected by considering the ARARs, risk-based PRGs, quantitation limits, and reference/background data.

The human health-based cleanup level for PCBs in sediment corresponds to a cancer risk level of 1×10^{-5}. See also the TSCA determination in Appendix G of this ROD and EPA policy (Guidance on Remedial Actions for Superfund Sites with PCB Contamination, OSWER Directive #9355.4-01, EPA/540/G-90/007, August 1990) for further information.

This cleanup level must be met at the completion of the remedial action in sediment in the Cooling Water Pond at the NMI Property. This sediment cleanup level attains EPA's risk management goal for remedial actions and has been determined by EPA to be protective.

<u>Ecological</u>

The results of the ecological risk assessment indicated that there are potential risks to the benthic community in the Sphagnum Bog, as determined by a weight-of-evidence evaluation which concluded that the hazard index for effects to the benthic community is greater than 1. Risks were determined to be primarily associated with sediment in the southwestern portion of the bog, as this area of the bog has higher concentrations of several Site-related COPCs.

An analysis of toxicity test data with sediment chemistry data indicated that risks to the benthic community were likely to be associated with two COPCs: PCBs; and copper. Lead and mercury were also identified as potential contributors to risk in the samples that contained elevated concentrations of PCBs and copper. Consequently, these four constituents were identified as COCs in Sphagnum Bog sediment.

PRGs for sediment in the Sphagnum Bog were derived by identifying "no effect" COC concentrations and 'effect' COC concentrations. The "no effect" concentrations were identified as the highest COC concentrations measured in sediment samples which exhibited no toxicity, as determined by the sediment toxicity tests performed in support of the BERA. The 'effect' concentrations were identified as the lowest COC concentrations measured in sediment samples which exhibited statistically significant toxicity, as determined by the sediment toxicity tests performed in support of the BERA. The selected cleanup levels were then calculated as the geometric mean of the "no effect" and "effect" values. Ecological cleanup levels for sediment are presented in **Table L-4** in Appendix B of this ROD. Documentation of the ecological PRGs is provided in Appendix A of the FS (*de maximus*, 2014b). Note that the ecological cleanup

levels for sediment were developed for the Sphagnum Bog, but will also be applied to the sediment in the Cooling Water Pond.

These cleanup levels must be met at the completion of the remedial action in sediment in the Sphagnum Bog and Cooling Water Pond at the NMI Property. These sediment cleanup levels attain EPA's risk management goal for remedial actions and have been determined by EPA to be protective.

M. STATUTORY DETERMINATIONS

The remedial action selected for implementation at the Site is consistent with CERCLA and, to the extent practicable, the NCP. The selected remedy is protective of human health and the environment, will comply with ARARs, and is cost effective. In addition, the selected remedy utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable, and satisfies the statutory preference for treatment that permanently and significantly reduces the mobility, toxicity, or volume of hazardous substances as a principal element.

1. The Selected Remedy is Protective of Human Health and the Environment

The Holding Basin soil component of the remedy will adequately protect human health and the environment by eliminating, reducing, or controlling exposures to human and environmental receptors through treatment, engineering controls, and institutional controls. More specifically, treatment and containment of principal threat waste material in the Holding Basin will be protective of human health and the environment through prevention of precipitation infiltration into the groundwater and prevention of direct contact with soils. The soil component of this remedy will prevent potential human health risks from direct contact with or leaching from contaminated soil that contain contaminants at concentrations that exceed ARARs and/or risk-based standards. Excavation and off-site disposal of non-Holding Basin soils that generally cannot be reliably contained will prevent direct contact with soils, prevent erosion, and runoff of hazardous waste/contaminated soils, and prevent precipitation infiltration into the groundwater. Excavation and off-site disposal of areas where PCB-contaminated soil exists over the cleanup level will meet TSCA requirements for disposal of PCB remediation waste. Institutional controls to prevent unacceptable exposures to, and disturbance of, the Holding Basin area are required.

The groundwater component of the selected remedy will adequately protect human health and the environment by eliminating, reducing and/or controlling exposures to human and environmental receptors through the treatment and containment of Holding Basin soils, removal of site-wide contaminated soil and sediments, and treatment of groundwater to reduce COC concentrations in groundwater to levels that meet ARARs. Institutional controls are required to prohibit use of contaminated groundwater until cleanup levels are met; and also require

installation of vapor mitigation systems should future structures be built above the VOC plumes unless an evaluation of vapor intrusion risks is performed to show such systems are not required.

Permanent removal of all contaminated sediment from the Cooling Water Recharge Pond will reduce the threat of human exposure to contaminants via direct contact. Removal of targeted areas of sediment contamination will also reduce risks to ecological receptors from sediment contact in the Sphagnum Bog to levels protective of the benthic invertebrate population. The excavation and removal of sediments will provide overall protection to human health and the environment by quickly reducing human health and ecological risks to acceptable levels. Institutional controls are not required for the sediment component of this remedy.

No unacceptable short-term risks to human health or cross media impacts are expected from construction of the selected remedy.

2. The Selected Remedy Complies With ARARs

The selected remedy will comply with all federal and any more stringent state ARARs that pertain to the Site. A detailed list of ARARs/To Be Considered requirements for the selected remedy is included in Appendix D of this ROD. A discussion of the more significant ARAR issues is included below.

Wetlands Impacts

The cleanup plan selected by EPA includes activities that impact wetlands. Before EPA can select a cleanup plan that will impact wetlands, EPA must make a determination that there is no practicable alternative to conducting this work. Pursuant to Section 404 of the Clean Water Act, 40 CFR Part 230 (Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material), 21 M.G.L. §§ 26-53, and 314 CMR 9.06(1-2) (Criteria for the Evaluation of Applications for Discharge of Dredged or Fill Material), EPA has determined that because significant levels of contamination exist in wetlands within the Site's cleanup areas, there is no practicable alternative to conducting work in these wetlands.

For those wetland areas that will be impacted by cleanup activities, including the northeast wetland and sphagnum bog (see **Figure L-1**), EPA is also required to make a determination that the cleanup activities that will be conducted are the least damaging practicable alternatives. EPA has determined that the cleanup activities selected are the least damaging practicable alternatives.

EPA will minimize potential harm and avoid adverse impacts on wetland resources, to the extent practicable by using best management practices to minimize harmful impacts on wetlands, wildlife, or habitat. Wetlands will be restored and/or replicated consistent with the requirements of federal and state wetlands protection laws.

TSCA Requirements

Management of PCB-contaminated soil at the Site must comply with 40 CFR § 761.61 of TSCA. EPA has determined that PCB-contaminated sediments and soils with PCB concentrations greater than or equal to 50 ppm at the Site meet the definition of a *PCB remediation waste* as defined under 40 CFR § 761.3. Therefore, cleanup and disposal of these PCB-contaminated sediments and soils is regulated under 40 CFR Part 761 which requires, among other things, excavation and disposal off-site at a TSCA-approved disposal facility or a RCRA hazardous waste landfill. PCB-contaminated soils and sediments with concentrations of PCBs above the 1 ppm cleanup level but less than 50 ppm will be excavated and disposed of in accordance with state requirements.

3. The Selected Remedy is Cost-Effective

In EPA's judgment, the selected remedy is cost-effective because the remedy's costs are proportional to its overall effectiveness (see 40 CFR § 300.430(f)(1)(ii)(D)). This determination was made by evaluating the overall effectiveness of those alternatives that satisfied the threshold criteria (*i.e.*, that are protective of human health and the environment and comply with all federal and any more stringent state ARARs, or as appropriate, waive ARARs). Overall effectiveness was evaluated by assessing three of the five balancing criteria—long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness, in combination. The overall effectiveness of each alternative then was compared to the alternative's costs to determine cost-effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence represents a reasonable value for the money to be spent.

The selected remedy is more cost-effective than the other active alternatives considered. The active combined soil/sediment and groundwater alternatives range in cost from $0 to $177.2 million. The range in estimated cost for the five soil/sediment alternatives is $0 (SS-1: No-Action) to $147.9 million (SS-5) and the range for the four groundwater alternatives is from $0.0 (GW-1: No Action) to $29.3 million (GW-3).

Off-site transport and disposal is an expensive component of the alternatives, making alternative SS-5 the most expensive because it requires the greatest volume of off-site disposal. Alternative SS-5 is $43 million more than the selected remedy SS-4 because it involves the excavation and off-site disposal of an additional 24,000 cubic yards of unsaturated Holding Basin soil and cement stabilized spoils. Also, SS-5 would be extremely difficult to implement due to the need to excavate down to 40 feet below ground surface, and may not be more protective of human health.

SS-3 is $25 million more expensive than SS-4, in part, because it requires an additional 18,500 cubic yards of cement stabilized spoils to be shipped off-site. Alternative SS-3 does not meet the preference for treatment of principal threat waste as well as alternative SS-4, as it only partially treats unsaturated and saturated soils in the Holding Basin. Furthermore, based on bench-scale studies conducted at the Site, EPA believes that the apatite injection process in SS-4 will be as

effective as the cement grouting in SS-3 and SS-5. Since apatite is a phosphate mineral derived primarily from fish bones, a waste product of the commercial fishing industry, it is also highly cost-effective.

Alternative SS-2 involves on-site containment and disposal and is the least expensive alternative other than no action; however, this alternative requires that all contaminated soil remains on-site, and will be much closer to the surface than SS-4, and SS-2 will require long-term operation and maintenance and institutional controls over a larger area of the site than SS-4.

Table K-1 helps demonstrate the cost-effectiveness of the selected soil/sediment remedy.

For groundwater, the selected remedy, GW-4, costs $20.2 million. GW-3 and GW-4 are more expensive than GW-2 (institutional controls and long-term monitoring) because in addition to institutional controls and monitoring, they include active remedial measures. GW-3 includes groundwater extraction and *ex-situ* treatment for all plumes and is the most expensive by $9 million because it includes the most active remedial measures over 30 years. Even though the GW-4 alternative includes extensive bench and pilot scale testing for the DU remedy, the estimated cost is 69% of GW-3 because it includes a passive remedy for DU in overburden and for the uranium plume in bedrock (which is not migrating).

For each of the alternatives, capital costs are the largest component, with operation and maintenance costs making up a small fraction of the total costs[35]. See **Table K-2** (alternative comparison table) for the estimated costs for each groundwater alternative.

4. The Selected Remedy Utilizes Permanent Solutions and Alternative Treatment or Resource Recovery Technologies to the Maximum Extent Practicable

Once the Agency identified those alternatives that attain or, as appropriate, waive ARARs and that are protective of human health and the environment, EPA identified which alternative utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. This determination was made by deciding which one of the identified alternatives provides the best balance of trade-offs among alternatives in terms of: 1) long-term effectiveness and permanence; 2) reduction of toxicity, mobility, or volume through treatment; 3) short-term effectiveness; 4) implementability; and 5) cost. The balancing test <u>emphasized</u> long-term effectiveness and permanence and the reduction of toxicity, mobility, and volume through treatment; and <u>considered</u> the preference for treatment as a principal element, the bias against off-site land disposal of untreated waste, and community and state acceptance. The selected remedy provides the best balance of trade-offs among the

[35] While the NPV analysis of alternatives for comparative analysis purpose used a 7% discount rate in accordance with EPA guidance, however; the future discount rate may vary from this number.

alternatives.

The selected remedy is protective of human health and the environment, uses proven cleanup technologies such as excavation, treatment and disposal, and is cost effective, while achieving the site-specific cleanup objectives in a reasonable timeframe. This cleanup approach provides both short and long-term protection of human health and the environment; attains all applicable or relevant and appropriate federal and state environmental laws and regulations; reduces the toxicity, mobility, and volume of contaminated soil, sediment, and groundwater through treatment, to the maximum extent practicable; utilizes permanent solutions and uses land use restrictions to prevent unacceptable exposures in the future to the remaining site-related wastes that will be contained on-site.

SS-4 would best meet all of the RAOs. This alternative also meets ARARs. The threats of release and direct exposure would be best eliminated by removing contaminated soils at the surface for off-site disposal. Soils in the Holding Basin are more than 20 feet deep and extend to more than 85 feet deep from the ground surface, therefore it is only a source of groundwater contamination and does not have any other exposure routes. For this reason EPA has decided that stabilization and containment of the Holding Basin soils to prevent further groundwater contamination is the best alternative. The time to achieve RAOs is estimated to be within 2-3 years of remedial construction, which is the same for all the soil alternatives.

The use of both *in-situ* and *ex-situ* treatment in GW-4 is the only alternative that is expected to meet ARARs in a reasonable timeframe. *Ex-situ* and *in-situ* treatment limits migration and further spreading of the plumes. *Ex-situ* treatment will be used to meet risk-based cleanup goals for 1,4-dioxane, and chemical-specific ARARs for VOCs. ARARs pertaining to DU in overburden and natural uranium in bedrock groundwater will be met through the use of on-site ISRZs which will also limit off-property migration.

Tables K-1 and K-2 demonstrate how the respective selected remedies provide the best balance of trade-offs when compared against the evaluation criteria.

5. The Selected Remedy Satisfies the Preference for Treatment Which Permanently and Significantly Reduces the Toxicity, Mobility or Volume of the Hazardous Substances as a Principal Element

The principal elements of the selected remedy are source control and management of migration. These elements address the primary threats at the Site, contamination of the Holding Basin soils that contain DU principal threat waste at levels that represent a greater than 10^{-3} risk, and present a source for contamination of groundwater. The selected remedy satisfies the statutory preference for treatment as a principal element through stabilization and containment of the Holding Basin soils and treatment of the contaminated groundwater**.** The selected remedy also excavates and disposes off-site contaminated Site soils and sediment. Because of the large volume of Site soils and sediments (approximately 82,500 cubic yards), full scale

implementation of treatment is impracticable.

6. Five-Year Reviews of the Selected Remedy are Required

Because this remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure, a review will be conducted within five years after initiation of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. EPA will continue to review the Site at least once every five years after the initiation of remedial action for as long as contaminated media above CERCLA risk levels remain in place.

N. DOCUMENTATION OF SIGNIFICANT CHANGES

EPA presented a Proposed Plan for remediation of the Site on October 31, 2014. The components of the preferred alternative included:

- Excavation and off-site disposal of approximately 82,500 cubic yards of contaminated sediments, underground drain lines, debris, and non-Holding Basin soils (contaminated with DU, PCBs and other contaminants of concern) in various areas of the Site;
- *In-Situ* stabilization of DU contaminated soils in the Holding Basin via injection using a stabilization agent such as apatite, or other comparable stabilization agent, to prevent leaching of contaminants to groundwater, and containment of Holding Basin stabilized soils with a low-permeability vertical wall and horizontal sub-grade cover to isolate the stabilized soils and further limit mobility of contaminants by removing the flow of groundwater;
- Extraction and *ex-situ* treatment of VOCs and 1,4-dioxane in overburden and bedrock aquifers, and *in-situ* treatment of depleted uranium in overburden aquifer and natural uranium in bedrock aquifer; and
- Long-term monitoring to monitor effectiveness of *in-* and *ex-situ* treatment; and Institutional Controls to: 1) prevent unacceptable exposures to, and to prevent disturbance of, the Holding Basin area; 2) prohibit use of contaminated groundwater until cleanup levels are met; and 3) to require evaluation of vapor intrusion risks and if necessary, installation of vapor mitigation systems should future structures be built above the VOC plumes.

EPA reviewed all written and verbal comments submitted during the public comment period. It was determined that no significant changes to the remedy, as originally identified in the proposed plan, were necessary. EPA made some changes to the proposed plan that were not significant in nature. These changes included:

- A change to the institutional controls requirement for vapor intrusion mitigation systems

as follows: EPA is now requiring installation of vapor mitigation systems should future structures be built above the VOC plumes unless an evaluation of vapor intrusion risks is performed to show such systems are not required. Should someone wish to demonstrate that there are no unacceptable risks from vapor intrusion and therefore mitigation systems are not required, an evaluation of vapor intrusion risks (subject to EPA approval) may be performed prior to building of structures above the VOC plume to demonstrate that vapor intrusion risks are within or below USEPA target risk levels (risk range of 10^{-4} to 10^{-6} and/or a target organ HI of 1).

- Based on changes made by EPA to default exposure parameters and toxicity values since release of the FS and Proposed Plan (see Sections G and L of this ROD for further discussion), cleanup levels were revised in this ROD. Following the revised calculations, groundwater cleanup levels for 1,1-dichloroethane, 1,4-dioxane, cobalt, iron, molybdenum, and thorium were changed from that presented in the Proposed Plan. With respect to soil, cleanup levels associated with benzo(a)anthracene, benzo(b)fluoranthene, indeno(l,2,3-cd)pyrene, and uranium were changed from that presented in the Proposed Plan.

O. STATE ROLE

The Massachusetts Department of Environmental Protection has reviewed the various alternatives and has indicated its support for the selected remedy. The Commonwealth has also reviewed the Remedial Investigation, Risk Assessments, and Feasibility Study to determine if the selected remedy is in compliance with applicable or relevant and appropriate state environmental and facility siting laws and regulations. The Commonwealth of Massachusetts concurs with the selected remedy for the NMI Superfund Site. A copy of the declaration of concurrence is attached as Appendix A.

STAKEHOLDER COMMENTS AND EPA RESPONSES

EPA published notices of availability of the Proposed Plan and Administrative Record in the Concord Journal on October 31, 2014 and released the Proposed Plan to the public on November 3, 2014. EPA also held a public information session on November 12, 2014 at the Concord Town House in Concord, MA. A Public Hearing was held on December 10, 2014, also at the Concord Town House. A transcript was created for the December 10, 2014 hearing and has been made part of the Administrative Record for this Record of Decision. Based upon a request by the Citizens Research and Environmental Watch (CREW), the Public Comment Period was extended until January 14, 2015. In addition to oral comments at the Public Hearing, a number of written comments were provided on the Proposed Plan. Outlined below is a summary of comments received from the public and other interested parties during the public comment period and EPA's response to those comments. Similar comments have been summarized and grouped together. The full text of all written and oral comments received during the comment period has been included in the Administrative Record.

Comment #1:
Several commenters expressed general support of key aspects EPA's proposed remedy, including the Commonwealth of Massachusetts, the Town of Concord, and Citizens Research and Environmental Watch (CREW), the Technical Assistance Grant (TAG) grantee for the Site. These comments supported the general approach to remediation, the disposal of excavated materials off-site, and the selection of residential future use and future groundwater use as the basis for cleanup levels.

EPA Response:
EPA appreciates the commenters' support for EPA's proposed remedy.

Comment #2:
Numerous comments were received in support of EPA's proposal to accelerate one aspect of the remedy, the extraction and treatment of groundwater contaminated with 1,4-dioxane and volatile organic compounds (VOCs), as a Non-Time Critical Removal Action (NTCRA). No comments were received that opposed this proposal. A number of commenters also noted concerns with the overall remedy implementation timeline and implored EPA not to delay the overall Site cleanup any further.

EPA Response:
EPA has decided to issue an Action Memorandum for a Non-Time Critical Removal Action to address the 1,4-dioxane and VOC contaminated groundwater (GW NTCRA). The Action Memorandum is attached to the ROD as Appendix F. In addition, EPA has requested that the potentially responsible parties begin investigations to determine the full extent of the 1,4-dioxane plume. The investigation work will include installing additional wells and performing additional sampling. Upon issuance of the Action Memorandum, EPA anticipates it will negotiate an agreement for the potentially responsible parties to perform the GW NTCRA at the Site.

The issuance of the ROD also begins a timeline to begin negotiations with potentially responsible parties for completion of the remedial design and remedial action (RD/RA). The GW NTCRA and RD/RA negotiations may proceed at the same time, if necessary.

Comment #3:
A number of commenters concurred with EPA's assessment that there is no less damaging practicable alternative than the proposed remedy in terms of wetlands impacts. Several commenters noted the need to properly restore and/or mitigate wetlands disturbed as part of the remedy.

EPA Response:
EPA will minimize potential harm and avoid adverse impacts on wetland resources, to the extent practical by using best management practices to minimize harmful impacts on the wetlands, wildlife or habitat. Wetlands will be restored and/or replicated consistent with the requirements of federal and state wetlands protection laws.

Comment #4:
Several commenters, including the Massachusetts Department of Environmental Protection (MassDEP) and Massachusetts Department of Public Health (MassDPH), wrote in support of EPA's proposed finding under the Toxic Substances Control Act (40 CFR Part 761) regarding the proposed PCB cleanup level for contaminated soil and sediments. Other commenters asked EPA to confirm that this proposed cleanup level (1 mg/kg PCBs) would also be protective of groundwater, while also citing lower PCB soil cleanup levels selected at other sites in the country.

EPA Response:
PCBs are primarily insoluble in water and adsorb strongly to organic carbon. As such, PCBs do not readily leach from soil or partition from sediment. This is evidenced by the finding that PCBs are primarily associated with surface soils at the Site, and the only locations where PCBs have been detected in subsurface soils are in areas with subsurface drain lines. In these areas, it is hypothesized that PCBs were released from leaks in the drain lines. PCBs are not present in saturated soils. This suggests that PCB migration to groundwater is an incomplete pathway. In addition, the OSWER directive "Guidance on Remedial Actions for Superfund Sites with PCB Contamination" August 1990, indicates that for a 20 ppm PCB source the corresponding concentration in groundwater would be under 0.5 ppm. As noted the soil cleanup level for PCBs is 1 ppm which corresponds to a 1 in 1 million excess cancer risk, and is therefore protective.

Comment #5:
Several comments were received that requested that the Record of Decision provide more detailed information regarding certain aspects of the remedy, including dust suppression techniques (citing numerous concerns regarding risks from air emissions during construction and suggestions for monitoring); measures to ensure the suitability of clean fill imported from off-site; methods of construction; off-site transportation plans; confirmation sampling; long-term monitoring programs; operation and maintenance plans; etc.

EPA Response:
Detailed information on the methods of construction, dust suppression techniques, and determination of suitable clean fill from off-site locations will be provided in the remedial design. The remedial design will be reviewed by and discussed with members of the Nuclear Metals, Inc. Technical Advisory Group, which consists of members from CREW and the town-appointed 2229 Main Street Committee, to ensure the concerns from community members are addressed. Long-term monitoring plans and operation and maintenance plans will be electronically filed in EPA's records center to ensure longevity of the plans, and will also be available for viewing at the Concord Public Library Repository.

Comment #6:
A number of questions were received regarding the extent of required excavation in soil, areas under existing buildings, the former landfill area, and wetland areas. Commenters requested extensive additional characterization of soils under building slabs and under the former landfill. Comments were also received requesting that EPA mandate the cleanup of all soils within the top 15 feet to be consistent with the Massachusetts Contingency Plan (MCP), which some commenters asserted should be considered an ARAR. Questions were also raised regarding the required depth of excavation beneath former building slabs.

EPA Response:
Subsurface soil is usually considered up to 10 feet deep based on the general depth of frost penetration in New England soil. Typically, soil is excavated to the depth of frost penetration when constructing a foundation for a house. Mixing of subsurface soil occurs due to frost heaving and also due to excavation. EPA assumes that the excavated soil will be used as fill; hence, exposures to soil composited from 1 to 10 feet are assessed under the future land use scenario. The approximate extent of excavation for Site soils and sediments, based on data collected to date, can be found in Figure L-1, however they generally consist of approximately 1-3 feet in depth.

Comment #7:
Some commenters suggested that EPA select Alternative SS-5 rather than SS-4 based on concerns about the long-term effectiveness of stabilization techniques as well as the desire to remove all contamination from the Site.

EPA Response:
Alternative SS-4 provides for full *in-situ* stabilization of all the soils within the Holding Basin using Apatite II, and for a containment wall and horizontal cover around the stabilized soils. Through bench-scale studies conducted at the Site, Apatite II has been shown to be extremely effective in preventing DU from becoming soluble in groundwater. However, if the Apatite II application technology is lacking in effectiveness in the future, SS-4 provides the added protection of a vertical containment wall, and additional actions are more easily implemented. In Alternative SS-5, only the saturated soils within the Holding Basin footprint are stabilized in place. The unsaturated soils in SS-5 would be disposed off-site. EPA considers treatment to be a preferential element for principal threat wastes, and SS-4 treats all principal threat wastes whereas Alternative SS-5 does not. Alternative SS-5 is $43 million more than SS-4, would be

extremely difficult to implement, and may not be more protective of human health. The excavation in the Holding Basin would start at a depth of 20 feet below ground surface and require an excavation of close to 20 feet in depth which would result in an excavation of approximately 40 feet from the ground surface. It would also require an extra 25,000 cubic yards of soil to be transported off-site compared to SS-4.

Comment #8:
Several commenters questioned EPA's proposal to use Apatite and ZVI as part of the groundwater remedy as well as the use of Apatite to stabilize residual contamination in the Holding Basin, based on concerns about the innovative nature of these methods and the need for certainty regarding long-term performance. Comparisons were made between this Site and the Hanford site regarding the use and injection of Apatite. Several commenters suggested additional testing and evaluation to determine the most appropriate construction and injection methods, ensure that the additive to be used is free of contamination, and to determine the long-term viability of Apatite and ZVI. Other comments suggested that EPA specify the use of concrete stabilization for contamination remaining in the Holding Basin either instead of Apatite or as a contingency should Apatite be deemed unacceptable in the future.

EPA Response:

Although EPA believes that the use of Apatite and ZVI as part of the In-Situ Reactive Zones (also known as Permeable Reactive Barriers) groundwater remedy as well as the use of Apatite for soil stabilization in the Holding Basin will prove effective, further treatment studies will be conducted during the remedial design to confirm the appropriate material to be used for both the Holding Basin soils and the groundwater. Should those studies confirm that the use of Apatite and/or ZVI is not the appropriate material for treatment of soils or remediation of groundwater, another suitable material will be chosen to ensure a permanent remedy at the Site. Any significant changes to the selected remedy as described in the ROD will be documented in an Explanation of Significant Differences or ROD Amendment.

Comment #9:
Some commenters questioned EPA's proposal to construct the slurry wall around the holding basin area using bentonite, suggesting the use of concrete instead. One commenter also provided additional suggestions on the methods of construction of the slurry wall to ensure long-term performance, including suggestions to construct the wall in a series of "panels" and "keying" the wall into the underlying bedrock.

EPA Response:

During the Remedial Design process, design studies will be conducted to determine the appropriate material and construction method for the containment wall around the Holding Basin. Although the proposed plan indicated the use of bentonite, other material such as concrete will be considered. EPA appreciates the attention to detail regarding the construction of the containment system and will take the information provided under advisement.

Comment #10:
The owner of the Valley Sports Arena expressed concern regarding plans for a groundwater treatment facility and the potential use of his property or adjacent properties for that purpose. This commenter, as well as the town's 2229 Main Street Oversight Committee, also expressed concern that the implementation of the groundwater remedy could impact operations at Valley Sports, either by use of a portion of the property or by impacts to the quality or quantity of water currently used by Valley Sports for their ice rink operations. The Valley Sports Arena owner pledged his willingness to work with those implementing the remedy but requested formal written assurance from EPA that his property would not be taken by eminent domain in order to carry out the remedy. Also, as an alternative to constructing a treatment plant at Valley Sports, several suggestions were made regarding the location of the proposed groundwater treatment plant, including suggestions to locate the plant on the Starmet property, directing extracted groundwater to the existing groundwater treatment facility at the W.R. Grace Superfund Site in Acton, or utilizing land acquired by the Acton Water District for that purpose. Comments were also submitted noting that such a treatment facility should be located outside of wetland buffer zones. A number of comments were also provided regarding a preference for recharge of treated groundwater to the ground rather than discharge to surface water as well as concerns that EPA set an appropriate discharge standard should surface water discharge be allowed.

EPA Response:
EPA is exploring options for locating the groundwater treatment system other than the Valley Sports Arena property. Investigations and design studies that will be conducted as part of the Groundwater Non-Time Critical Removal Action (GW NTCRA) will determine the most appropriate location of the treatment system. Should EPA need to consider the use of the Valley Sports Arena property for the groundwater treatment system, EPA will work with the property owner to the extent practicable to reach an amicable solution. Although EPA is considering all of the noted locations for the construction of the groundwater treatment system, the Acton Water District location looks to be the most promising and will be explored first. The exact location of the groundwater treatment system will depend on investigations currently being performed as well as design studies conducted during the NTCRA. Injection of treated groundwater into the aquifer as well as surface water discharge will be considered during the design phase.

Comment #11:
The Town of Concord's Natural Resources Commission requested that EPA conduct closer coordination with the Town's Natural Resources Division staff in order to substantially comply with the Massachusetts Wetlands Protection Act and the Town of Concord Wetlands Bylaw. In their comments, the Commission outlined their request for further wetlands delineation, review of wetland excavation and restoration/mitigation plans, and notification prior to starting any work in wetlands or buffer zones.

EPA Response: Though no permits are required for Superfund actions such as this, EPA has been and will continue to work with the town-appointed 2229 Main Street Committee, and through that committee information can be provided to the town's Natural Resources Commission with a reasonable opportunity to review and comment on various work plans associated with cleanup activities in the wetland and bog. The Massachusetts Wetlands

Protection Act is an ARAR and all work to be performed within wetlands and the 100 foot buffer zone will be in accordance with the substantive requirements of these regulations.

Comment #12:
The Town of Concord requested that the ROD specify a plan and cost estimate for addressing risks from vapor intrusion. The town's 2229 Main Street Oversight Committee suggested that the ROD identify specific areas for investigation, the responsibility for such investigations, the requirements for such investigations, and the responsibility and cost for implementation of any vapor intrusion mitigation. This comment suggested that an escrow account for future vapor mitigation be established and EPA outline processes for property owners to access these funds for vapor intrusion monitoring as well as design and installation of mitigation systems.

EPA Response:
The selected remedy for groundwater includes institutional controls to address risks from vapor intrusion. EPA is requiring installation of vapor mitigation systems should future structures be built above the VOC plumes unless an evaluation of vapor intrusion risks is performed to show such systems are not required. Should someone wish to demonstrate that there are no unacceptable risks from vapor intrusion and therefore mitigation systems are not required, an evaluation of vapor intrusion risks (subject to EPA approval) may be performed prior to building of structures above the VOC plume to demonstrate that vapor intrusion risks are within or below USEPA target risk levels (risk range of 10^{-4} to 10^{-6} and/or a target organ HI of 1).

Comment #13:
The Acton Water District (AWD) requested that EPA change its proposed groundwater cleanup level for 1,4-dioxane to match the MassDEP Drinking Water Guidance value (and MCP Method 1 GW-1 standard) of 0.3 ug/l. These comments also stated that, since groundwater on the Acton side of the Assabet River exceeded this guidance value, the remedy should include extraction and treatment of groundwater from that location as well. The District also requested that they be included during future planning for remedy implementation and monitoring.

EPA Response:
EPA used a site-specific risk assessment in calculating an acceptable risk-based cleanup number for 1,4-dioxane in groundwater, arriving at 0.46 which represents a 10-6 risk for drinking water. The MassDEP Drinking Water Guideline/MCP Method 1 GW-1 standard of 0.3 ug/l does not apply at the Site pursuant to Section 40.011 of the MCP which limits the applicability of the MCP to response actions at disposal sites that are deemed adequately regulated. The Nuclear Metals, Inc. Superfund Site is considered adequately regulated because MassDEP has concurred with this ROD (see 310 CMR 40.0111). EPA will coordinate with the AWD during design and construction of the remedy, as appropriate.

Comment #14:
The Acton Water District and the Acton Citizens for Environmental Safety (ACES) requested in their comments that additional groundwater characterization be conducted to ensure that the full extent of groundwater contamination is known, and the impacts of pumping on the Acton water supply's yield and the interaction between groundwater and surface water is adequately

understood. The District also questioned the usability of historic 1,4-Dioxane monitoring data due to changes in detection limits over time.

EPA Response:
Additional groundwater investigation work is being performed prior to the initiation of the GW NTCRA. This investigation work will fully characterize groundwater where 1,4-dioxane impacts are known or suspected. Further treatability studies to determine the most effective method of treatment and best location of the treatment system will be conducted during the GW NTCRA.

Comment #15:
The Acton Water District asked whether Institutional Controls included as part of Alternative GW-4 restricting use of groundwater for drinking water purposes will impact the current use of the aquifer by the District.

EPA Response:
The groundwater restrictions are intended to restrict use of contaminated groundwater that would pose an unacceptable risk until the cleanup levels in the ROD are met. At the time of the ROD's issuance, contamination levels in the Acton Water District wells do not exceeded the cleanup levels for 1,4-dioxane or other contaminants in this Record of Decision. Thus, EPA does not expect to restrict the use of the groundwater at the Acton Water District's wells. EPA will continue to coordinate closely with AWD regarding implementation of the groundwater remedy and continued monitoring to ensure that there are no unacceptable risks posed by Acton's drinking water.

Comment #16:
The Town of Concord and CREW noted their desire to maximize the ability to use the property in the future and limit the need for institutional controls and also requested clarification that any institutional controls on the Holding Basin area would not be an outright prohibition on use but would allow for certain uses (parking lot, playing field, park area, etc.).

EPA Response:
Institutional controls will be limited to the extent required to protect human health and the environment. Specifically, restrictions on the land above the Holding Basin footprint will allow for various uses as long as they do not allow for unacceptable exposures to, or disturbance of, the Holding Basin area.

Comment #17:
Two commenters, responding to information outlined at the public informational meeting regarding recently discovered depleted uranium debris on the Starmet property, requested additional investigation outside of the property at a reasonable distance to ensure that no additional debris exists outside of the Site fence line.

EPA Response:
Areas where DU fragments were discovered near the property line were located in areas where

historical waste processing activities were conducted; all other areas where DU fragments were found were well within Site boundaries. In locations where fragments were found at the fence line, the area outside the fence line was scanned for DU and no additional metal fragments were found. As a precaution, the fence was moved back in this area approximately 40 feet. During the design phase, contamination in areas where DU fragments were found will be fully delineated.

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PUBLIC HEARING ON THE PROPOSED REMEDIAL ACTION PLAN

FOR THE NUCLEAR METALS, INC. SUPERFUND SITE

LOCATED AT 2229 MAIN STREET, CONCORD, MASSACHUSETTS

Wednesday, December 10, 2014, 6:30 p.m.
Concord Town Hall
22 Monument Square
Concord, Massachusetts16

-------Reporter: Joan M. Cassidy, RPR, CRR-------
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PRESENT:

Robert G. Cianciarulo, Hearing officer,
EPA Region 1 -- New England,
Chief, Massachusetts Superfund Section

Melissa Taylor, EPA Project Manager,
USEPA New England

Kelsey O'Neil, Congressional Liaison and
Community Involvement Coordinator,
USEPA

Bruce Thompson, Project Coordinator,
de maximis, inc.

P R O C E E D I N G S

(Presentation by Melissa Taylor.)

MR. CIANCIARULO: We do have a court reporter here, so I'm going to read a statement into the record, which will be us kicking off the hearing, and then I will turn the microphone over to...

Good evening. My name is Bob Cianciarulo. I'm the chief of the Massachusetts Superfund Section in EPA's Boston office. I'll be the hearing officer for tonight's hearing on the proposed cleanup plan for the Nuclear Metals Superfund site in Concord, Massachusetts.

The purpose of this hearing is to formally accept oral comments on the proposed plan which was released to the public on October 31, 2014.

As a reminder, the public comment period has recently been extended and now runs until January 14, 2015. We will not be responding to comments tonight but will respond to them in writing after the close of the comment period.

A public information meeting on EPA's proposal was held on November 12, 2014, in this room

in Concord. At that meeting information concerning the proposed cleanup plan was presented, and EPA responded to questions about the site. The proposed plan and the rest of the administrative record was delivered to the site information repositories in Concord and Boston, and the official comment period began on November 13. There was also an informal session tonight where EPA project manager Melissa Taylor reviewed EPA's proposal.

For the record, the proposed plan includes excavation and off-site disposal of approximately 82,500 cubic yards of contaminated materials, in-situ stabilization of depleted-uranium contaminated soils in the holding basin using Apatite II injection, extraction and ex-situ treatment of groundwater for volatile organic compounds and 1,4-dioxane, in-situ treatment of depleted uranium and natural uranium in groundwater, long-term monitoring to monitor the effectiveness of the treatment, and institutional controls to prevent disturbance of the holding basin area, prevent the use of site groundwater, and address potential vapor intrusion risks.

EPA is also proposing to accelerate the

cleanup of 1,4-dioxane in groundwater by initially addressing this contaminant under the non-time-critical removal authority as outlined in the proposal plan.

The total estimated cost of this proposed remedy is approximately $125 million.

Copies of the proposed plan were available outside of this room when you came in. They're also available online. So those of you wishing to make a comment should come to the front of the room and state your name and address and your affiliation. We would ask that we allow your elected officials to testify first, and then we can move on to those in the general public.

Please limit your oral comments to ten minutes. If the extent of your comments will run longer than ten minutes, I'm going to ask that you summarize your major points and provide EPA with a copy of the full text of your comments. The text in its entirety will become part of the record.

After all the comments have been heard, I will close the formal hearing. As Melissa outlined earlier, if you do wish to submit written comments, you can hand them to us tonight or mail,

fax or email them to Melissa as instructed in the plan.

At the conclusion of the hearing, please see any of the EPA representatives if you have any questions on how to submit comments. All oral comments that we receive tonight and written comments that we receive during the comment period will be addressed in a responsiveness summary and become a part of the administrative record for the site and will be included in the EPA's final decision on the cleanup plan.

Thank you for coming. Your input into this process is important, and it helps us in our decision-making process.

I'm going to begin the formal process. I'm just going to go back and sit down so I can take my own notes on your comments. And we ask that those who wish to make comments just approach the microphone. Thank you.

SENATOR ELDRIDGE: Hi. Good evening. I'm Senator Jamie Eldridge, and this is Representative Jennifer Benson, and I'm speaking on behalf of both of us as legislators who represent the town of Acton.

We wanted to be here because, of course, environmental cleanups and environmentally contaminated sites like the Nuclear Metals site don't stop at the town border. So I want to be here to say I had a staff member at the presentation in November here in Concord, and I wanted to express my strong support for the EPA's comprehensive proposal for the cleanup of the Nuclear Metals site.

Specifically, I wanted to express my strong support that the residential standard be the standard that this site is cleaned up to. From just a quick view at this map over here, you can see residences very close to the outer edges of this site.

And actually, just recently, the two of us were at the Minute Man Arc for Human Services nonprofit, which actually is in a similar area near to this site, so it's an area where a lot of people are coming through, living, working, and so we think the residential standard is important, especially given there are a lot of industrial sites in Massachusetts that eventually homes are built there. So I want to express my support for that.

I also wanted to express my support to

make sure that the 82,000-plus cubic yards of soil sediment is shipped and removed from the site. So I want to express my support for that. And I do support the accelerated cleanup of the VOC dioxane.

Just listening to the presentation that Bruce Thompson explained to me about the plumes that are -- look like they could be headed towards the Assabet River and therefore crossing over into the Town of Acton, I think it's extremely important that EPA take accelerated action through the wells and through the bedrock to make sure that we don't have some of these sediments cross over the river into Acton.

So I just wanted to express my strong support for the EPA's proposed cleanup. As a resident of Acton, I'm grateful for the work that the EPA's done to clean up the W.R. Grace site in Acton, and I want to express my equal appreciation for your proposed cleanup of this site in Concord.

Thank you very much.

REPRESENTATIVE BENSON: Thank you.

MR. CIANCIARULO: Are there any other officials? I'm not sure if -- okay. So however everybody wants to do this. I don't know who's

going to go first, but if others want to step up and comment for the record.

(Pause.)

MR. CIANCIARULO: Or this could be the fastest hearing we've ever seen.

(Laughter.)

MR. GRAY: Could I have you put the map up of the site, the one that shows the wells that you wanted to --

(Map displayed.)

MR. GRAY: I'm Carl Gray, owner of Valley Sports, Inc., the building on the left where those two loops are and then the overburden well behind the property.

I asked the question at the other hearing. I would like a formal letter saying that you would not take the land by eminent domain. I'd like it in a registered letter if that's going to be the case.

I don't mind working with the people that are over here on the left, John Hunt and his superior; they've been quite helpful.

I don't want to put a 30-foot building in the middle of my second parking lot and have to

close the business down. I don't mind working with the developers of the remediation to put those monitoring wells in, but I strongly recommend, which I did to them informally tonight, that we pump the fluid from the two baserock wells up onto the site, existing site that you have, and from the overburden one, the third one, up onto the site, process it up there without having to take land from the doctor next door or from Valley Sports.

And we have to work through a plan to be able to do it. We're talking about 10,000 gallons of water a day from each of those wells for forty years. That's a lot of water, a lot there. It has to be done.

I had to close -- you can see where Route 62 or Main Street is there and the Assabet River. I had to shut down on March 19 the well that I had there because it's being contaminated by -- and I'll use it for right now -- road salt coming down the Assabet River. I understand what that -- the water. I use 10 -- between 5,000 and 10,000 gallons of water a day to make ice for the ice skating facility. I don't want to have to close the business.

But this is a serious solution to this, but you're going to have to take it back up onto the site -- I don't mind wells being put in there, but you're going to have to take it back up onto the site, process it and then discharge it appropriately either back into the ground up there or directly into the Assabet River, where you see it at the top of the picture here.

I don't mind working with 'em. There's no specific plan in place right now, but I don't want to put a building right in the middle of our second parking lot, right in the flood plain. I can't put any -- another rink in there. I've got enough land to put a second, third rink in there, but I can't do it because of the Federal Rivers Act, a hundred-foot set back and a hundred-foot buffer zone.

But you're going to ask me to bear the burden of the solution. I don't mind working with you, but I don't want to -- you're telling me that I have to give up a business that I've taken forty years to develop. I'll leave it at that for today.

MR. CIANCIARULO: Thank you.

MS. CERASO: Hello. My name is Jane

Ceraso. I live at 39 Ethan Allen Drive in Acton, and I am a long-term member of Acton Citizens for Environmental Safety, which is an organization that was formed back in the 1980s to provide a forum for Acton residents to ensure the health and safety of its population during the cleanup of the W.R. Grace site in Acton.

Currently, Acton ACES is merging with a group in Acton called Green Acton. They have similar missions, and we are -- I am going to be submitting these comments on behalf of, I will call it ACES/Green Acton because we have not formalized the merger yet.

Acton's population relies almost entirely upon groundwater for its drinking water supply. The most productive wells are located in the Assabet aquifer just across the Assabet River from the Nuclear Metals Superfund site in Concord.

ACES/Green Acton is very concerned about the potential for depleted and natural uranium and chemicals such as volatile organic chemicals, VOCs, and 1,4-dioxane to migrate through the overburden and bedrock groundwater to the Assabet wells.

Although Acton monitors the current

1 treatment online for VOCs and the Assabet wells,
2 this current treatment plan was not engineered to
3 remove radiological contaminants nor 1,4-dioxane
4 from the water.
5 We are particularly concerned about
6 1,4-dioxane reaching Acton's drinking water. The
7 chemical is a suspected human carcinogen known to
8 affect lymphatic, ocular and renal systems, and
9 removal of this compound is difficult and expensive.
10 To further complicate the issue,
11 1,4-dioxane is currently in regulatory limbo between
12 Massachusetts and federal health advisory levels.
13 We urge the EPA to ensure the
14 remediation efforts fully -- that all remediation
15 efforts fully address the treatment and removal of
16 these chemicals and halt their migration toward the
17 Assabet well field.
18 We remind EPA that it is critically
19 important at this stage to ensure that the nature
20 and extent of contaminant plumes are clearly
21 understood and delineated. Without good knowledge
22 of the extent of the plume, a situation similar to
23 what happened during the design of the W.R. Grace
24 remediation system could occur.

Hydrogeologists now suspect that the incomplete delineation of the extent of the VOC plume around the industrial landfill at the Acton W.R. Grace site led to installation of a treatment system that did not fully capture the northeastern migrating portion of the plume.

This section of the plume, uncaptured, continued to migrate along groundwater gradients toward the School Street well field in Acton. Chemicals from the plume were eventually detected in the School Street well field, necessitating a separate remediation effort decades after the original remediation was installed at the industrial landfill.

We strongly encourage EPA to require an efficient and thorough characterization of the plume migrating from the Nuclear Metals site and a full remediation of the harmful chemicals in these plumes. This is Acton's most important groundwater resource on which thousands rely. Please help us protect it. Thank you.

MR. CIANCIARULO: Thank you.

MR. ROSE: May I use the podium?

MR. CIANCIARULO: Yes, okay.

MR. ROSE: Thank you.

Good evening. My name is Tim Rose. I reside at 97 Bartlett Hill Road in Concord. I'm a professional chemist and most recently taught environmental chemistry at Brandeis University.

My involvement with Nuclear Metals began in 1988, when I was on the Concord Board of Health, and has continued to the present as a member of the technical advisory group of Citizens Research & Environmental Watch, more commonly known as CREW.

Tonight I am presenting comments on behalf of CREW. CREW is an all-volunteer organization citizens group that has been working since 1989 to address issues of environmental contamination and human health associated with the NMI site.

Over the past 25 years, CREW has interacted with numerous local and state interested parties to advance the cause of a complete cleanup of contaminated soil and groundwater at the NMI site.

In addition to local advocacy, CREW members have brought significant technical capability to the oversight process, including

1 expertise in chemistry, toxicology, hydrogeology,
2 nuclear physics, statistics and environmental law.
3 As part of its activity, CREW has used
4 grants obtained from private foundations, the state
5 and EPA to hire technical consultants to help
6 evaluate technical and regulatory submittals.
7 CREW has participated in the EPA
8 Technical Assistance Grant program since 2001.
9 During this period CREW retained GeoInsight, an
10 environmental consulting firm with significant
11 Superfund experience, to assist in reviewing and
12 commenting on Superfund issues and reports. CREW
13 and GeoInsight are thus extremely knowledgeable
14 about NMI-related issues, and the process has led to
15 the current proposed plan.
16 From its founding CREW has maintained a
17 focus on the following two objectives: A complete
18 cleanup of uranium and other constituents of concern
19 to levels that are safe for residential use of the
20 whole 46-acre NMI site and areas impacted by the NMI
21 site, and, secondly, the cleanup of groundwater to
22 safe drinking water standards.
23 To date, CREW has expended significant
24 time, effort, energy into following, understanding

and commenting on the Superfund process at the NMI site. Technical advisory committee members have regularly attended EPA-sponsored meetings with representatives from EPA, de maximis and the state.

At the technical advisory committee meetings, which have been conducted approximately bimonthly over the last ten years, we have discussed and resolved many of CREW's issues associated with the remedial investigation (RI) and the feasibility study (FS).

We've also provided EPA with our perspective on NMI site conditions and CREW's ultimate desire for cleanup and reuse of the site. CREW is preparing detailed written comments on the proposed plan. The following summarizes the major points in CREW's response:

CREW wants to acknowledge and thank EPA for including CREW in the RI/FS process. This involvement has provided CREW with a detailed understanding of the agency's rationale and approach for the selection of the proposed remedy.

Throughout the process we have been impressed with the thoroughness of the technical review and the attention that EPA has brought to

bear on the NMI site. Unlike the period when Starmet/NMI was responsible for conducting characterization activities, CREW can attest that the NMI site received a thorough, rigorous investigation by EPA. We are also confident that the site-specific information and data are reliable and were collected using appropriate methods.

CREW supports the general components and the overall remedial approach that EPA selected in the proposed plan. Thus, we are not proposing an alternative remedial approach.

We understand that remedial actions at the NMI site will be an intrusive and lengthy process. We expect that the remedial actions will be implemented safely and in a manner that recognizes the proximity of the NMI site to residential neighborhoods.

CREW is pleased with the careful and controlled manner that Superfund activities have been completed to date. However, with this comment, CREW underscores the importance that future cleanup activities be conducted in a similarly careful and controlled manner.

Since its founding CREW has consistently

voiced concern regarding the use and handling of depleted uranium and other radioactive materials in Concord. We repeatedly pointed out that the site is located near many environmentally sensitive areas.

Unlike common environmental contaminants such as petroleum or solvents, depleted uranium is both a toxic heavy metal and radioactive with a very long half-life. As a chemical element, it cannot be destroyed and will be present at the site well into the distant future.

CREW has consistently supported removing as much of the depleted uranium from the NMI site as is feasible and practicable. While EPA's proposed plan is generally consistent with this objective, CREW supports and encourages EPA to modify the proposed plan to include excavation and off-site disposal of all highly to moderately impacted soil regardless of depth and location beneath the water table.

CREW supports EPA's plan to accelerate the installation of a groundwater system to treat 1,4-dioxane and VOCs as a non-time-critical removal action prior to implementing the full proposed remedy for the site. With adequate monitoring to

ensure that the treated water introduced to the Assabet River is not polluted, we believe the action is protective of the Assabet River and an aquifer that the Town of Acton relies upon for drinking water.

Based upon information obtained while completing the RI, EPA determined that significant levels of contamination exist in the northeast wetland and southwest portion of the sphagnum bog and that there was no practical alternative to conducting work in the wetland areas.

CREW agrees with EPA's determination that the cleanup activities proposed for these areas are the least damaging practical alternatives. CREW expects that EPA will employ best management practices to minimize harmful impacts to the area and that the wetlands will be restored or replicated where feasible.

During the RI it was assumed that the final remedy for the site would include complete removal and off-site disposal of material in the old landfill; therefore, the old landfill was not characterized with the same level of detail as the rest of the site.

The proposed plan currently includes excavating four to six feet of material from the old landfill. CREW's preference is that the landfill area and associated debris and soil be completely excavated and removed from the property and placed into the landfill that was specifically sited and engineered to handle this type of material.

CREW expects that all landfill and associated soil/material will be removed vertically and additional characterization of the remaining soil/material will be conducted on a scale similar to the RI to show that any remaining material meets cleanup goals.

Available information suggests that it is very likely that impacted soil and utilities are present beneath the site building. CREW recognizes that it was not practical to investigate conditions beneath the buildings while the RI was being completed.

The proposed plan currently includes the investigation and off-site removal of four to six feet of material from beneath each building. CREW expects that all soils impacted by elevated concentrations of site contaminants that are

encountered beneath the site buildings will be excavated and disposed of off-site.

Although not specifically addressed in the proposed plan, it is CREW's understanding that miscellaneous depleted uranium billets were recently found at unexpected locations on the site. CREW expects that prior to the start of on-site remedial actions, additional surveys will be completed to evaluate further the possible presence of miscellaneous depleted uranium billets around the property.

Finally, CREW conditionally accepts the in-situ treatment of DU-impacted groundwater that is included in the proposed plan because the DU plume movement in groundwater is slow. Since the apatite injection in-situ treatment method selected for the site has not received widespread application to date, however, we expect that the proposed plan will include a robust monitoring program to demonstrate that the remedy is effective.

In addition, we recommend that the USEPA amend the proposed plan to include a contingent remedy for DU in groundwater that could be designed and readily available if the selected remedy fails.

In conclusion, we appreciate USEPA's continuing efforts to provide CREW and the local community with opportunities to participate in the Superfund process at the NMI site. We look forward to continuing our work with EPA at the site and facilitating the successful implementation of the proposed plan. Thank you.

MR. CIANCIARULO: Thank you.

MR. MOSTOLLER: Good evening. My name is Matthew Mostoller. I'm the environmental manager for the Acton water District, 693 Massachusetts Avenue, Acton, Massachusetts.

First of all, I'd like to thank EPA for giving us the opportunity to speak this evening. We obviously have come late to the game relative to this site, but we do feel like we have been given quite a bit of information, and we appreciate being pulled into the cleanup process here.

Tonight I'm just going to briefly go through some of our concerns. We're working with our environmental consultant to come up with a more comprehensive review of the proposed remedial actions, but conceptually we do support the timely cleanup of the 1,4-dioxane and the VOC plume that

you can see here.

Admittedly, we have not given much consideration to the on-site cleanup actions as we don't see those being as prominent of a concern to the water supply.

The reason that we conceptually support the timely cleanup is we do have some concerns that actually Jane Ceraso from ACES laid out pretty well about our experience with the W.R. Grace cleanup. There was some inadequate characterization that occurred that created an ongoing contamination issue that created greater risk to our customers and ultimately cost more money both to the district and to the cleanup efforts, and we would like to avoid that.

So one of the things that we're looking for is a better characterization of the aquifer in this area. We believe, based on the data that we've seen, that both the water quality data and some of the subsurface investigation data has gaps in it.

Specifically, we have concerns about the ongoing contribution of bedrock to the overburden aquifer. We would like to understand the river area better. Through a number of years working on the

W.R. Grace site, that cleanup process always said, "Well, what's on the other side of the river isn't our issue, and that can get dealt with in other remedial cleanup actions." And, well, we view this as that cleanup action coming due, so we would like to understand what's going on relative to the river interface better.

Additionally, there currently are concentrations of 1,4-dioxane that are above the proposed remediation goal on the northwestern side of the river, and we believe that that should be part of the cleanup in addition to the parts of the plume on the southeast side of the river.

Furthermore, for 30 years there have been certain assumptions made about the hydrogeology in this area. In the past ten years, we have seen some of those assumptions aren't necessarily true as we once believed. In fact, we're starting to review the Zone 2 delineations for our Assabet well field, and we believe that during the course of that redelineation, a better understanding of what's happening in this area will be brought forth.

We do request participation in the design of this remediation system. Additionally, we

1 would like a seat at the table relative to the
2 ongoing monitoring that's been discussed as part of
3 this remedial alternative.
4 And we would also like to understand the
5 impacts of the ongoing withdrawal of water from
6 these aquifers relative to the flow in the Assabet
7 River, the potential impacts to the yield of our
8 wells and also to the ultimate discharge of that
9 treated water.
10 Finally, we would like to thank EPA for
11 extending the comment deadline. We certainly
12 appreciate that. Again, coming into the process
13 late, getting our environmental consultant and other
14 interested parties up to speed is greatly
15 appreciated. And again, we will be submitting
16 formal written comments before the deadline. Thank
17 you.
18 MR. CIANCIARULO: Thank you.
19 MR. SCOTNICKI: Hi. My name is Jack
20 Scotnicki. I've been a long-term supporter and
21 member of CREW, although tonight I'm speaking as an
22 individual; I'm not representing CREW. I live at 52
23 Prairie Street in Concord, Mass.
24 The EPA under -- is recommending under

Soil Sediment Plan No. 4 -- asking us to approve it to be used at the Starmet/NMI site.

This plan does not provide for any removal of the 12,500 cubic yards of the depleted uranium contaminated unsaturated soil that is currently in the holding basin. Nor does Sediment Plan No. 4 provide for any removal of the 20,000 cubic yards of the depleted uranium contaminated saturated soil that also resides in the holding basin.

The EPA wants to keep over 32,500 cubic yards of depleted uranium contaminated soil inside the holding basin forever. I find this totally unacceptable.

Secondly, the EPA wants to treat contaminated soils outside the holding basin with a process called Apatite II injections. This technology was used in Hanford, Washington, but some of the results are disturbing.

When these injections are performed, there can be a reaction of the soil's organic matter with the fishbone-based Apatite II material. This reaction can result in a reduction of the soil's biomass. When this reduction occurs, the previously

bound depleted uranium could in fact return to the soil.

Clearly, more work needs to be done before we jump into the use of Apatite II injection technology at the NMI/Starmet site.

MR. GIFFORD: Good evening. My name is Douglas Gifford. I live at 562 Harrington Avenue in Concord. I am an engineer by training, 42 years, give or take another year, practicing underground construction throughout Boston and the U.S.

I've read through the summary report and some of the feasibility report; and as a result, I have some concerns. Number one, though, I do support the concept of containing the DU on-site with a permanent retaining wall and also the in-situ treatment of the DU, and thirdly, the use of recovery wells to treat the 1,4-dioxane and other VOCs. I think that's a reasonable plan.

I do have some concerns about some of the details of what is proposed, and I do think there is a solution; and I am going to present that. And I have a written comment to present tonight, and I'd like to review a few of those recommendations.

Number one, I would recommend using a,

what is called a concrete slurry wall to enclose the radioactive DU around the old holding basin or sludge pit.

Number two, I would recommend using an installation method that excavates the wall in individual panels and includes both what's called a hydromill and clamshell to excavate the soil and rock in order to create a keyway into the rock.

I would not recommend that we use a soil/cement/bentonite wall as the underground containment wall.

I think the proposed solutions, at least a part of them, should be implemented as soon as possible; for example, the wall is a good concept, and we should go forward with that, and that is not an impossible thing to activate quickly.

Likewise, the wells; they also are a conventional procedure, and they should be implemented quickly. I think at the last meeting a date of 2016 was proposed for some remedial response activities. In my mind that is very slow. Some of our development work in Boston where we put slurry walls around buildings would never tolerate a schedule such as that.

So a little more detail on some of the recommendations. I don't recommend that we select the soil/bentonite wall as a permanent solution. I have concerns about the vertical settlement of the wall and about the homogeneity of the wall when it, with time, becomes irregularly permeable, and I don't believe that we can create a sound key at the bottom of the wall.

The wall is proposed to be something like 90 feet deep, and the soil is placed by end-dumping in a manner that lets the soil travel down the slope so at the bottom of the slope you collect all the coarse, large-sized particles, and this is just where you want the best conditions and the finest soils. And there's no way to check the conditions under construction since it's at the bottom of the 90-foot slope. I don't recommend this method.

We should use a concrete slurry wall which is keyed into rock, and it should be excavated conventional equipment, clamshell or hydromill, which will allow us to clearly cut a slot in the underlying bedrock.

And by excavating the wall in panels and

using proper techniques, we can create a watertight enclosure that is both concrete and solid; and we should provide additives such as bentonite to further reduce the permeability of the wall so for longevity that wall is solid, it's going to be there for that 200-year lifetime which was proposed.

I think we should confirm the use of apatite as a stabilizing agent. From learning and reading some of the Hanford work, I'm puzzled about how it was used. At one point it appeared that the way it was proposed to be used was to inject the components of apatite, calcium, phosphorus and hydroxide, into the ground and let the chemicals react and precipitate in the site to form an apatite crystal.

I think it was intended at that point that the crystal would absorb in that case Strontium 90, which was the chemical of concern out there, into the apatite and fix it in place. I'm not sure if that procedure is supposed to be used in our case, which is below the groundwater table; so I don't know how apatite is going to be used, and I don't know its effectiveness.

So I will concur that we need to monitor

the soil and VOCs for any long-term release of the DU from any soil layers that are not stabilized by the apatite, and that we should provide for a minimum of secondary and tertiary routing of the soil and rock layers as needed to further contain the release of DU.

We should also consider installation of a safety net downstream, reactive -- either a reactive wall or a cement grout barrier wall to further trap any DU that may escape from untreated layers in the soil.

Remember, this soil deposit contains sand, silty sand, clay, so when something is injected into the ground, it's a natural thing that the chemical will be injected into the coarsest layers first, and the silty layers will not accept any injection.

So it's going to be a random process. The only way to beat that is to use second- and third-level graveling and try and make that a more uniform distribution of chemicals. But I suspect in the end there's still going to be a certain percentage that's free to migrate, so we must be prepared to trap that.

Finally, I think we have to clearly prepare both a written and electronic design summary and operation manual for use by future generations. I know it sounds a little silly to talk about, but I've looked at a lot of dams throughout New England and looked at operation manuals that tell people what to do.

We're talking about turning this project over to generations in the future, and really, those operation manuals usually reside on shelves somewhere, and no one can remember what to do. So it needs to be clearly and simply prepared, making it simple and obvious for our future operators to manage this project.

That summarizes some high points of my concerns. I have additional, more detailed recommendations contained in the report, which I will be glad to submit; and if you're interested in this, I can certainly make a copy available by email. Thank you.

MR. CIANCIARULO: Others wishing to make comments?

MR. KILCOYNE: I'm Brian Kilcoyne. I live at 284 Central Street in Concord. I'm here

tonight as a representative of OARS. OARS is a nonprofit organization, advocacy group for the Assabet, Concord and Sudbury Rivers, so my comments will be specifically focused on the potential impacts of the project to the Assabet River.

We are greatly gratified with the results which have been completed to date that indicate that the Nuclear Metals site has not adversely impacted the Assabet, and we want to ensure going forward that the selected remedy does not change that.

To that effect, the -- we support the groundwater treatment system to contain the 1,4-dioxane and VOC plume. It would be our preference that any treated effluent from this system is discharged to groundwater rather than being discharged directly to the Assabet to the extent that that is feasible.

If the review process ends up in there being groundwater -- excuse me, surface water discharge, we trust that the permitting review process will ensure that the discharge limit set will be entirely protective of the Assabet, that there will be no adverse effects from any future

discharges. Thank you.

MR. CIANCIARULO: Thank you.

REPRESENTATIVE ATKINS: Good evening. I am Cory Atkins. I live at 93 Pilgrim Road, Concord, Mass. I am also the state representative for the Fourteenth Middlesex District, and I am here to reinforce the views of my colleagues, who I understand have testified this evening, that the cleanup should be done to residential standards, and that the dirt and material be shipped off-site, and that an accelerated program be put in place so that the plume does not reach the Assabet River.

I also would like to take this opportunity for the few seconds that I've had to gaze around the room; there are people here who have worked on this issue for more than two decades, and I just want to applaud them for their efforts and just their persistence, and the Town of Concord owes them a great deal. So thank you.

MR. CIANCIARULO: Others wishing to comment before we close the hearing?

(No response.)

MR. CIANCIARULO: Hearing none, you have until I walk up to that podium.

(Laughter.)

MR. CIANCIARULO: Okay. If there's no one else wishing to make a comment, we're going to formally close the hearing. I appreciate your input and your involvement in the process. As a reminder, the public comment period will close on January 14, 2014. The hearing is now officially closed.

(Concluded at 7:35 p.m.)

C E R T I F I C A T E

I, Joan M. Cassidy, Registered Professional Reporter, do hereby certify that the foregoing transcript is a true and accurate transcription of my stenographic notes taken on December 10, 2014.

_____ _____

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APPENDIX A

MASSDEP CONCURRENCE LETTER

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

One Winter Street Boston, MA 02108 • 617-292-5500

Charles D. Baker
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Secretary

Martin Suuberg
Commissioner

September 25, 2015

Mr. Robert Cianciarulo.
Office of Site Remediation and Restoration
U.S. Environmental Protection Agency, Region 1
5 Post Office Square
Boston, MA 02109

Re: State Concurrence Determination
Record of Decision – Nuclear Metals Superfund Site
Concord, Massachusetts

Dear Mr. Cianciarulo:

The Department of Environmental Protection (MassDEP) has reviewed the Record of Decision (ROD) and the selected remedy recommended by the U.S. Environmental Protection Agency (EPA) for the Nuclear Metals Superfund Site date September 2015. For the reasons described below, MassDEP concurs with the recommended remedy for the Site.

The remedy set forth in the ROD addresses threats due to soils exposure and releases of contaminants from soils to other media such as groundwater and sediment. The components to the remedy are:

1. Excavation and off-site disposal of approximately 82,500 cubic yards of contaminated sediments, underground drain lines and debris, and non-Holding Basin soils (contaminated with depleted uranium (DU), polychlorinated biphenyls (PCBs) and other contaminants of concern) in various areas of the Site;

2. *In-Situ* stabilization of DU contaminated soils in the Holding Basin via injection of a stabilization agent such as Apatite II or other comparable stabilization agent to prevent leaching of contaminants to groundwater, and containment of Holding Basin stabilized soils with a low-permeability vertical wall and horizontal sub-grade cover to isolate the

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stabilized soils and further limit mobility of contaminants by removing the flow of groundwater;

3. Extraction and *ex-situ* treatment of volatile organic compounds (VOCs) and 1,4-dioxane in overburden and bedrock aquifers, and *in-situ* treatment of depleted uranium in overburden aquifer and natural uranium in bedrock aquifer;

4. Long-term monitoring to monitor effectiveness of *in*- and *ex-situ* treatment; and

5. Institutional Controls to: 1) prevent unacceptable exposures to, and to prevent disturbance of, the Holding Basin area; 2) prohibit use of contaminated groundwater until cleanup levels are met; and 3) require installation of vapor mitigation systems should future structures be built above the VOC plume before groundwater cleanup levels are met, unless an evaluation of vapor intrusion risks is performed to show such systems are not required.

The selected remedy addresses principal and low-level threat wastes at the site by: 1) the stabilization and containment of source soils in the Holding Basin to eliminate exposure to and leaching from the Holding Basin soils; 2) the excavation and off-site disposal of remaining contaminated soils and sediments to eliminate exposure to these soils and sediments; 3) *ex-situ* and *in-situ* treatment of contaminated groundwater to restore groundwater to levels protective of human health and the environment.

The selected remedy is a comprehensive approach for this site that addresses all current and potential future risks caused by soil sediment, and groundwater contamination. The plan is based on the maximum reuse of the site.

The Department agrees with the conclusions in the ROD, and therefore, DEP concurs with the EPA's selection of the remedy.

If you have any questions regarding this letter, please contact Mr. Garry Waldeck, Project Manager at (617) 348-4017 or Mr. Jay Naparstek, Deputy Division Director at (617) 292-5697.

Very truly yours,

Paul W. Locke
Acting Assistant Commissioner
Bureau of Waste Site Cleanup
Department of Environmental Protection

Copies to:

Jay Naparstek, MADEP Boston
Garry Waldeck, MADEP
Mellissa Taylor, USEPA

APPENDIX B

TABLES

Table G-1

Summary of Chemical of Concern and Medium-Specific Exposure Point Concentration

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Minimum	Maximum					(1)
Cooling Pond								
	Aroclor-1254	0.436	366	mg/kg	6 / 6	366	mg/kg	Max

Key

(1) Statistics: Maximum Detected Value (Max); 95% UCL (95% UCL); Arithmetic Mean (Mean)

The table represents the current/future chemicals of concern (COCs) and exposure point concentrations (EPCs) for the COCs detected in sediment (i.e., the concentrations that will be used to estimate the exposure and risk for each COC in sediment). The table includes the range of concentrations detected for each COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the site), the EPC, and how the EPC was derived. This table indicates that Aroclor-1254 is the only COC in the Cooling Pond sediment. The maximum detected concentration was used as the EPC.

Source: A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents (U.S. EPA, 1999)

Table G-2

Summary of Chemical of Concern and Medium-Specific Exposure Point Concentration

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

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Minimum	Maximum					(1)
AOI 14 North								
	Aroclor-1254	0.0077	4.91	mg/kg	6 / 8	3.5	mg/kg	95% UCL
	Aroclor-1260	0.0266	1.67	mg/kg	5 / 8	0.85	mg/kg	95% UCL
AOI 8 Sweepings Area								
	Benzo(a)pyrene	0.0187	0.307	mg/kg	13 / 26	0.12	mg/kg	95% UCL
	Aroclor-1254	0.0031	23.5	mg/kg	24 / 24	16.2	mg/kg	95% UCL
	Aroclor-1260	0.0058	3	mg/kg	19 / 24	2.37	mg/kg	95% UCL
	Arsenic	2.8	14.1	mg/kg	28 / 29	8.7	mg/kg	95% UCL
	Uranium (3)	1.1	311	mg/kg	29 / 29	82	mg/kg	95% UCL
	Uranium-238+D	- -	- -	pCi/g	- -	27	pCi/g	(2)
	Uranium-235+D	- -	- -	pCi/g	- -	0.36	pCi/g	(2)
	Uranium-234	- -	- -	pCi/g	- -	4.6	pCi/g	(2)
	Thorium (3)	2.4	7.85	mg/kg	29 / 29	5.1	mg/kg	95% UCL
	Thorium-232	- -	- -	pCi/g	- -	0.56	pCi/g	(2)
	Radium-228+D	- -	- -	pCi/g	- -	0.56	pCi/g	(2)
	Thorium-228+D	- -	- -	pCi/g	- -	0.56	pCi/g	(2)
AOI 7 & 11 Industrial Area East								
	Benzo(a)pyrene	0.0186	1.85	mg/kg	17 / 32	0.368	mg/kg	95% UCL
	Benzo(b)fluoranthene	0.0177	3.04	mg/kg	18 / 32	0.925	mg/kg	95% UCL
	Aroclor-1254	0.0012	9.07	mg/kg	20 / 22	2.6	mg/kg	95% UCL
	Arsenic	2	18	mg/kg	36 / 36	7.13	mg/kg	95% UCL
	Uranium	1.4	5070	mg/kg	36 / 36	793	mg/kg	95% UCL
	Uranium-238+D	- -	- -	pCi/g	- -	265	pCi/g	(2)
	Uranium-235+D	- -	- -	pCi/g	- -	3.4	pCi/g	(2)
	Uranium-234	- -	- -	pCi/g	- -	45	pCi/g	(2)
	Thorium (3)	3.4	9.3	mg/kg	36 / 36	5.5	mg/kg	95% UCL
	Thorium-232	- -	- -	pCi/g	- -	0.61	pCi/g	(2)
	Radium-228+D	- -	- -	pCi/g	- -	0.61	pCi/g	(2)
	Thorium-228+D	- -	- -	pCi/g	- -	0.61	pCi/g	(2)
AOI 2 & 4 Soils Area at Cooling Pond								
	Benzo(a)pyrene	0.0282	0.261	mg/kg	7 / 8	0.261	mg/kg	Max
	Aroclor-1254	0.0535	12.2	mg/kg	17 / 20	6.9	mg/kg	95% UCL
	Aroclor-1260	0.0187	38.1	mg/kg	19 / 20	28	mg/kg	95% UCL
	Arsenic	5.4	31.8	mg/kg	13 / 13	16.4	mg/kg	95% UCL
	Uranium (3)	4.5	46.1	mg/kg	14 / 14	31	mg/kg	95% UCL
	Uranium-238+D	- -	- -	pCi/g	- -	10	pCi/g	(2)
	Uranium-235+D	- -	- -	pCi/g	- -	0.14	pCi/g	(2)
	Uranium-234	- -	- -	pCi/g	- -	1.8	pCi/g	(2)
	Thorium (3)	3.4	6.9	mg/kg	13 / 13	5.3	mg/kg	95% UCL
	Thorium-232	- -	- -	pCi/g	- -	0.58	pCi/g	(2)
	Radium-228+D	- -	- -	pCi/g	- -	0.58	pCi/g	(2)
	Thorium-228+D	- -	- -	pCi/g	- -	0.58	pCi/g	(2)

Table G-2

Summary of Chemical of Concern and Medium-Specific Exposure Point Concentration

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

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Minimum	Maximum					(1)
Rt 62 Outfall and Embayment Area								
	Benzo(a)anthracene	0.849	4.12	mg/kg	4 / 9	2.1	mg/kg	95% UCL
	Benzo(a)pyrene	0.336	4.41	mg/kg	9 / 9	2.2	mg/kg	95% UCL
	Benzo(b)fluoranthene	0.221	6.82	mg/kg	9 / 9	3.5	mg/kg	95% UCL
	Indeno(1,2,3-cd)pyrene	0.222	2.19	mg/kg	8 / 9	1.0	mg/kg	95% UCL
	Arsenic	3	10.2	mg/kg	9 / 9	7.5	mg/kg	95% UCL
	Thorium (3)	2.9	7.8	mg/kg	9 / 9	5.3	mg/kg	95% UCL
	Thorium-232	- -	- -	pCi/g	- -	0.58	pCi/g	(2)
	Radium-228+D	- -	- -	pCi/g	- -	0.58	pCi/g	(2)
	Thorium-228+D	- -	- -	pCi/g	- -	0.58	pCi/g	(2)
AOI 1 Holding Basin								
	Arsenic	2.9	15.8	mg/kg	26 / 26	8.29	mg/kg	95% UCL
	Uranium	1.2	1502	mg/kg	98 / 98	301	mg/kg	95% UCL
	Uranium-238+D	- -	- -	pCi/g	- -	101	pCi/g	(2)
	Uranium-235+D	- -	- -	pCi/g	- -	1.3	pCi/g	(2)
	Uranium-234	- -	- -	pCi/g	- -	17	pCi/g	(2)
	Thorium (3)	0.84	24.7	mg/kg	24 / 26	7.35	mg/kg	95% UCL
	Thorium-232	- -	- -	pCi/g	- -	0.81	pCi/g	(2)
	Radium-228+D	- -	- -	pCi/g	- -	0.81	pCi/g	(2)
	Thorium-228+D	- -	- -	pCi/g	- -	0.81	pCi/g	(2)

Key

(1) Statistics: Maximum Detected Value (Max); 95% UCL (95% UCL); Arithmetic Mean (Mean)

(2) Isotopes/decay products calculated from total concentrations (see Appendix D-2 in Baseline HHRA)

(3) Not a chemical of concern (COC), however isotopes/decay product concentrations calculated from total concentrations (see Appendix D-2 in Baseline HHRA), so basis information presented.

The table represents the future chemicals of concern (COCs) and exposure point concentrations (EPCs) for each of the COCs detected in surface soil at the following Areas of Interest: AOI 14 North, AOI 8 Sweepings Area, AOI 7 & 11 Industrial Area East, AOI 2 & 4 Soils Area at Cooling Pond, Rt 62 Outfall and Embayment Area, and AOI 1 Holding Basin (i.e., the concentrations that will be used to estimate the exposure and risk for each COC in surface soil). The table includes the range of concentrations detected for each COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the site), the EPC, and how the EPC was derived. This table indicates that: Aroclor-1254 and Aroclor-1260 are the only COCs in surface soil at AOI 14 North; benzo(a)pyrene, Aroclor-1254, Aroclor-1260, arsenic, uranium isotopes/decay products, and thorium isotopes/decay products are the only COCs in surface soil at the AOI 8 Sweepings Area; benzo(a)pyrene, benzo(b)fluoranthene, Aroclor-1254, arsenic, uranium (and its isotopes/decay products), and thorium isotopes/decay products are the only COCs in surface soil at the AOI 7 & 11 Industrial Area East; benzo(a)pyrene, Aroclor-1254, Aroclor-1260, arsenic, uranium isotopes/decay products, and thorium isotopes/decay products are the only COCs in surface soil at the AOI 2 & 4 Soils Area at Cooling Pond; benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, arsenic, and thorium isotopes/decay products are the only COCs in surface soil at the Rt 62 Outfall and Embayment Area; and arsenic, uranium (and its isotopes/decay products), and thorium isotopes/decay products are the only COCs in surface soil at the AOI 1 Holding Basin. The 95% UCL on the arithmetic mean was used as the EPC for all COCs. Isotope/decay product EPCs were calculated from the total uranium and thorium 95% UCL on the arithmetic mean.

Source: A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents (U.S. EPA, 1999)

Table G-3

Summary of Chemical of Concern and Medium-Specific Exposure Point Concentration

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

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Minimum	Maximum					(1)
AOI 8 Sweepings Area								
	Aroclor-1254	0.0011	16.6	mg/kg	25 / 40	9.4	mg/kg	95% UCL
	Aroclor-1260	0.0016	2.24	mg/kg	20 / 40	1.3	mg/kg	95% UCL
AOI 7 & 11 Industrial Area East								
	Benzo(a)pyrene	0.0431	1.7	mg/kg	13 / 54	0.22	mg/kg	95% UCL
	Aroclor-1254	0.0012	44.1	mg/kg	16 / 27	18.2	mg/kg	95% UCL
	Aroclor-1260	0.0053	6.36	mg/kg	7 / 28	2.6	mg/kg	95% UCL
	Arsenic	1.3	13.3	mg/kg	67 / 67	5.2	mg/kg	95% UCL
	Uranium	0.9	3360	mg/kg	67 / 67	337	mg/kg	95% UCL
	Uranium-238+D	- -	- -	pCi/g	- -	113	pCi/g	(2)
	Uranium-235+D	- -	- -	pCi/g	- -	1.5	pCi/g	(2)
	Uranium-234	- -	- -	pCi/g	- -	19	pCi/g	(2)
	Thorium (3)	3.5	34.5	mg/kg	67 / 67	7.3	mg/kg	95% UCL
	Thorium-232	- -	- -	pCi/g	- -	0.80	pCi/g	(2)
	Radium-228+D	- -	- -	pCi/g	- -	0.80	pCi/g	(2)
	Thorium-228+D	- -	- -	pCi/g	- -	0.80	pCi/g	(2)
AOI 2 & 4 Soils Area at Cooling Pond								
	Benzo(a)pyrene	0.075	0.144	mg/kg	3 / 17	0.088	mg/kg	95% UCL
	Aroclor-1254	0.002	9.83	mg/kg	14 / 16	3.7	mg/kg	95% UCL
	Aroclor-1260	0.0096	22.9	mg/kg	10 / 16	16	mg/kg	95% UCL
	Arsenic	2.9	41	mg/kg	21 / 21	18	mg/kg	95% UCL
	Uranium (3)	1.4	51.7	mg/kg	21 / 21	29.3	mg/kg	95% UCL
	Uranium-238+D	- -	- -	pCi/g	- -	9.8	pCi/g	(2)
	Uranium-235+D	- -	- -	pCi/g	- -	0.13	pCi/g	(2)
	Uranium-234	- -	- -	pCi/g	- -	1.6	pCi/g	(2)
	Thorium (3)	2.8	7.8	mg/kg	21 / 21	5.9	mg/kg	95% UCL
	Thorium-232	- -	- -	pCi/g	- -	0.65	pCi/g	(2)
	Radium-228+D	- -	- -	pCi/g	- -	0.65	pCi/g	(2)
	Thorium-228+D	- -	- -	pCi/g	- -	0.65	pCi/g	(2)

Table G-3

Summary of Chemical of Concern and Medium-Specific Exposure Point Concentration

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

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Minimum	Maximum					(1)
AOI 1 Holding Basin								
	Arsenic	2.3	18.7	mg/kg	37 / 37	6.3	mg/kg	95% UCL
	Uranium	0.82	3400	mg/kg	152 / 152	359	mg/kg	95% UCL
	Uranium-238+D	- -	- -	pCi/g	- -	120	pCi/g	(2)
	Uranium-235+D	- -	- -	pCi/g	- -	1.6	pCi/g	(2)
	Uranium-234	- -	- -	pCi/g	- -	20	pCi/g	(2)
	Thorium (3)	1.4	9	mg/kg	33 / 37	4.97	mg/kg	95% UCL
	Thorium-232	- -	- -	pCi/g	- -	0.55	pCi/g	(2)
	Radium-228+D	- -	- -	pCi/g	- -	0.55	pCi/g	(2)
	Thorium-228+D	- -	- -	pCi/g	- -	0.55	pCi/g	(2)

Key

(1) Statistics: Maximum Detected Value (Max); 95% UCL (95% UCL); Arithmetic Mean (Mean)

(2) Isotopes/decay products calculated from total concentrations (see Appendix D-2 in Baseline HHRA)

(3) Not a chemical of concern (COC), however isotopes/decay product concentrations calculated from total concentrations (see Appendix D-2 in Baseline HHRA), so basis information presented.

The table represents the future chemicals of concern (COCs) and exposure point concentrations (EPCs) for each of the COCs detected in subsurface soil at the following Areas of Interest: AOI 8 Sweepings Area, AOI 7 & 11 Industrial Area East, AOI 2 & 4 Soils Area at Cooling Pond, and AOI 1 Holding Basin (i.e., the concentrations that will be used to estimate the exposure and risk for each COC in subsurface soil). The table includes the range of concentrations detected for each COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the site), the EPC, and how the EPC was derived. This table indicates that: Aroclor-1254 and Aroclor-1260 are the only COCs in subsurface soil at the AOI 8 Sweepings Area; benzo(a)pyrene, Aroclor-1254, Aroclor-1260, arsenic, uranium (and its isotopes/decay products), and thorium isotopes/decay products are the only COCs in subsurface soil at the AOI 7 & 11 Industrial Area East; benzo(a)pyrene, Aroclor-1254, Aroclor-1260, arsenic, uranium isotopes/decay products, and thorium isotopes/decay products are the only COCs in subsurface soil at the AOI 2 & 4 Soils Area at Cooling Pond; and arsenic, uranium (and its isotopes/decay products), and thorium isotopes/decay products are the only COCs in subsurface soil at the AOI 1 Holding Basin. The 95% UCL on the arithmetic mean was used as the EPC for all COCs. Isotope/decay product EPCs were calculated from the total uranium and thorium 95% UCL on the arithmetic mean.

Source: A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents (U.S. EPA, 1999)

Table G-4

Summary of Chemical of Concern and Medium-Specific Exposure Point Concentration

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Minimum (4)	Maximum		(4)			(1)
On-Property Bedrock Groundwater Plume Used As Tap Water								
	1,4-Dioxane	0.506	35.4	µg/L	22 / 49	35.4	µg/L	Max
	bis(2-Ethylhexyl)phthalate	2.49	13.3	µg/L	11 / 45	13.3	µg/L	Max
	1,1-Dichloroethane	0.184	15.7	µg/L	39 / 54	15.7	µg/L	Max
	Trichloroethene	0.277	10.8	µg/L	41 / 54	10.8	µg/L	Max
	Arsenic	0.96	59.5	µg/L	17 / 45	59.5	µg/L	Max
	Barium	5.6	4650	µg/L	45 / 45	4650	µg/L	Max
	Chromium	0.53	76.4	µg/L	23 / 45	76.4	µg/L	Max
	Cobalt	0.15	11.8	µg/L	44 / 45	11.8	µg/L	Max
	Iron	93	40500	µg/L	54 / 57	40500	µg/L	Max
	Manganese	1.6	1230	µg/L	52 / 55	1230	µg/L	Max
	Molybdenum	0.85	116	µg/L	42 / 45	116	µg/L	Max
	Nitrate as N	62	113000	µg/L	43 / 60	113000	µg/L	Max
	Nitrite as N	66	10600	µg/L	15 / 32	10600	µg/L	Max
	Uranium	0.001	217	µg/L	71 / 76	217	µg/L	Max
	Uranium-238+D	- -	- -	pCi/L	- -	72	pCi/L	(2)
	Uranium-235+D	- -	- -	pCi/L	- -	3.4	pCi/L	(2)
	Uranium-234	- -	- -	pCi/L	- -	77	pCi/L	(2)
	Actinium-227+D	- -	- -	pCi/L	- -	3.4	pCi/L	(2)
	Thorium-230	- -	- -	pCi/L	- -	77	pCi/L	(2)
	Radium-226+D	- -	- -	pCi/L	- -	77	pCi/L	(2)
	Lead-210	- -	- -	pCi/L	- -	77	pCi/L	(2)
	Bismuth-210	- -	- -	pCi/L	- -	77	pCi/L	(2)
	Polonium-210	- -	- -	pCi/L	- -	77	pCi/L	(2)
	Thorium (3)	0.19	6.7	µg/L	17 / 45	6.7	µg/L	Max
	Thorium-232	- -	- -	pCi/L	- -	0.74	pCi/L	(2)
	Radium-228+D	- -	- -	pCi/L	- -	0.74	pCi/L	(2)
	Thorium-228+D	- -	- -	pCi/L	- -	0.74	pCi/L	(2)
On-Property Bedrock Groundwater Used As Tap Water								
	bis(2-Ethylhexyl)phthalate	2.49	4.4	µg/L	11 / 45	4.4	µg/L	Max
	Trichloroethene	0.277	3.6	µg/L	41 / 54	3.6	µg/L	Max
	Arsenic	0.96	7.2	µg/L	17 / 45	7.2	µg/L	Max
	Iron	93	13500	µg/L	54 / 57	13500	µg/L	Max
	Manganese	1.6	352	µg/L	52 / 55	352	µg/L	Max
	Uranium	0.001	23.8	µg/L	71 / 76	23.8	µg/L	Max
	Uranium-238+D	- -	- -	pCi/L	- -	7.9	pCi/L	(2)
	Uranium-235+D	- -	- -	pCi/L	- -	0.37	pCi/L	(2)
	Uranium-234	- -	- -	pCi/L	- -	8.5	pCi/L	(2)
	Actinium-227+D	- -	- -	pCi/L	- -	0.37	pCi/L	(2)
	Thorium-230	- -	- -	pCi/L	- -	8.5	pCi/L	(2)
	Radium-226+D	- -	- -	pCi/L	- -	8.5	pCi/L	(2)
	Lead-210	- -	- -	pCi/L	- -	8.5	pCi/L	(2)
	Bismuth-210	- -	- -	pCi/L	- -	8.5	pCi/L	(2)
	Polonium-210	- -	- -	pCi/L	- -	8.5	pCi/L	(2)
	Thorium (3)	0.19	0.98	µg/L	17 / 45	0.98	µg/L	Max
	Thorium-232	- -	- -	pCi/L	- -	0.11	pCi/L	(2)
	Radium-228+D	- -	- -	pCi/L	- -	0.11	pCi/L	(2)
	Thorium-228+D	- -	- -	pCi/L	- -	0.11	pCi/L	(2)

Table G-4

Summary of Chemical of Concern and Medium-Specific Exposure Point Concentration

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Minimum (4)	Maximum		(4)			(1)
On-Property Overburden Groundwater Plume Used As Tap Water								
	1,4-Dioxane	0.992	13	µg/L	14 / 147	13	µg/L	Max
	bis(2-Ethylhexyl)phthalate	2	9.18	µg/L	18 / 140	9.18	µg/L	Max
	Tetrachloroethene	0.11	60	µg/L	75 / 158	60	µg/L	Max
	Trichloroethene	0.258	13.5	µg/L	93 / 158	13.5	µg/L	Max
	Arsenic	0.84	12.8	µg/L	17 / 141	12.8	µg/L	Max
	Chromium	0.52	89	µg/L	53 / 141	89	µg/L	Max
	Cobalt	0.046	39.8	µg/L	128 / 141	39.8	µg/L	Max
	Copper	0.45	1590	µg/L	22 / 141	1590	µg/L	Max
	Iron	43.3	40400	µg/L	116 / 177	40400	µg/L	Max
	Manganese	0.51	884	µg/L	153 / 171	884	µg/L	Max
	Molybdenum	0.2	925	µg/L	66 / 141	925	µg/L	Max
	Nitrate as N	90	113000	µg/L	143 / 158	113000	µg/L	Max
	Nitrite as N	61	2130	µg/L	7 / 67	2130	µg/L	Max
	Uranium	0.01	5480	µg/L	132 / 188	5480	µg/L	Max
	Uranium-238+D	- -	- -	pCi/L	- -	1833	pCi/L	(2)
	Uranium-235+D	- -	- -	pCi/L	- -	24	pCi/L	(2)
	Uranium-234	- -	- -	pCi/L	- -	308	pCi/L	(2)
	Thorium (3)	0.094	2.9	µg/L	30 / 141	2.9	µg/L	Max
	Thorium-232	- -	- -	pCi/L	- -	0.32	pCi/L	(2)
	Radium-228+D	- -	- -	pCi/L	- -	0.32	pCi/L	(2)
	Thorium-228+D	- -	- -	pCi/L	- -	0.32	pCi/L	(2)
On-Property Overburden Groundwater Used As Tap Water								
	bis(2-Ethylhexyl)phthalate	2	4.1	µg/L	18 / 140	4.1	µg/L	Max
	Vinyl chloride	0.33	0.46	µg/L	2 / 158	0.46	µg/L	Max
	Arsenic	0.84	16.2	µg/L	17 / 141	16.2	µg/L	Max
	Cobalt	0.046	15.2	µg/L	128 / 141	15.2	µg/L	Max
	Iron	43.3	18200	µg/L	116 / 177	18200	µg/L	Max
	Manganese	0.51	1270	µg/L	153 / 171	1270	µg/L	Max
	Uranium (3)	0.01	4.5	µg/L	132 / 188	4.5	µg/L	Max
	Uranium-238+D	- -	- -	pCi/L	- -	1.5	pCi/L	(2)
	Uranium-234	- -	- -	pCi/L	- -	1.6	pCi/L	(2)
	Thorium-230	- -	- -	pCi/L	- -	1.6	pCi/L	(2)
	Radium-226+D	- -	- -	pCi/L	- -	1.6	pCi/L	(2)
	Lead-210	- -	- -	pCi/L	- -	1.6	pCi/L	(2)
	Polonium-210	- -	- -	pCi/L	- -	1.6	pCi/L	(2)
	Thorium (3)	0.094	2.3	µg/L	30 / 141	2.3	µg/L	Max
	Thorium-232	- -	- -	pCi/L	- -	0.25	pCi/L	(2)
	Radium-228+D	- -	- -	pCi/L	- -	0.25	pCi/L	(2)
	Thorium-228+D	- -	- -	pCi/L	- -	0.25	pCi/L	(2)

Table G-4

Summary of Chemical of Concern and Medium-Specific Exposure Point Concentration

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
		Minimum (4)	Maximum		(4)			(1)
Off-Property Bedrock Groundwater Used As Tap Water								
	1,4-Dioxane	0.506	81.8	µg/L	22 / 49	81.8	µg/L	Max
	Trichloroethene	0.277	19.6	µg/L	41 / 54	19.6	µg/L	Max
	Vinyl chloride	0.375	0.375	µg/L	1 / 54	0.375	µg/L	Max
	Arsenic	0.96	6.1	µg/L	17 / 45	6.1	µg/L	Max
	Cobalt	0.15	28.4	µg/L	44 / 45	28.4	µg/L	Max
	Iron	93	31500	µg/L	54 / 57	31500	µg/L	Max
	Manganese	1.6	4130	µg/L	52 / 55	4130	µg/L	Max
	Nitrate as N	62	277000	µg/L	43 / 60	277000	µg/L	Max
	Uranium	0.001	19.9	µg/L	71 / 76	19.9	µg/L	Max
	Uranium-238+D	- -	- -	pCi/L	- -	6.6	pCi/L	(2)
	Uranium-234	- -	- -	pCi/L	- -	7.1	pCi/L	(2)
	Actinium-227+D	- -	- -	pCi/L	- -	0.31	pCi/L	(2)
	Thorium-230	- -	- -	pCi/L	- -	7.1	pCi/L	(2)
	Radium-226+D	- -	- -	pCi/L	- -	7.1	pCi/L	(2)
	Lead-210	- -	- -	pCi/L	- -	7.1	pCi/L	(2)
	Bismuth-210	- -	- -	pCi/L	- -	7.1	pCi/L	(2)
	Polonium-210	- -	- -	pCi/L	- -	7.1	pCi/L	(2)
	Thorium (3)	0.19	1.6	µg/L	17 / 45	1.6	µg/L	Max
	Thorium-232	- -	- -	pCi/L	- -	0.18	pCi/L	(2)
	Radium-228+D	- -	- -	pCi/L	- -	0.18	pCi/L	(2)
	Thorium-228+D	- -	- -	pCi/L	- -	0.18	pCi/L	(2)
Off-Property Overburden Groundwater Used As Tap Water								
	1,4-Dioxane	0.992	42.2	µg/L	14 / 147	42.2	µg/L	Max
	bis(2-Ethylhexyl)phthalate	2	23.9	µg/L	18 / 140	23.9	µg/L	Max
	Trichloroethene	0.258	52.7	µg/L	93 / 158	52.7	µg/L	Max
	Arsenic	0.84	3.3	µg/L	17 / 141	3.3	µg/L	Max
	Iron	43.3	32800	µg/L	116 / 177	32800	µg/L	Max
	Uranium (3)	0.01	0.46	µg/L	132 / 188	0.46	µg/L	Max
	Lead-210	- -	- -	pCi/L	- -	0.16	pCi/L	(2)
	Polonium-210	- -	- -	pCi/L	- -	0.16	pCi/L	(2)
	Thorium (3)	0.094	1.6	µg/L	30 / 141	1.6	µg/L	Max
	Thorium-232	- -	- -	pCi/L	- -	0.18	pCi/L	(2)
	Radium-228+D	- -	- -	pCi/L	- -	0.18	pCi/L	(2)
	Thorium-228+D	- -	- -	pCi/L	- -	0.18	pCi/L	(2)

Key

(1) Statistics: Maximum Detected Value (Max); 95% UCL (95% UCL); Arithmetic Mean (Mean)

(2) Isotopes/decay products calculated from total concentrations (see Appendix D-2 in Baseline HHRA)

(3) Not a chemical of concern (COC), however isotopes/decay product concentrations calculated from total concentrations (see Appendix D-2 in Baseline HHRA), so basis information presented.

(4) Minimum detected values and frequencies of detection were taken from Tables 3-4 and 3-5 in the Baseline HHRA and apply to the entire overburden and bedrock data sets, respectively.

Multiple results from each on-site monitoring well were treated as discrete samples.

The table represents the future chemicals of concern (COCs) and exposure point concentrations (EPCs) for each of the COCs detected in on- and off-property overburden and bedrock groundwater (i.e., the concentrations that will be used to estimate the exposure and risk for each COC in on- and off-property overburden and bedrock groundwater). The table includes the range of concentrations detected for each COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the site), the EPC, and how the EPC was derived. This table indicates that the inorganic chemicals, arsenic, barium, chromium, cobalt, copper, iron, manganese, molybdenum, nitrate, nitrite, uranium (and its isotopes/decay products), and thorium (and its isotopes/decay products), and the organic chemicals, 1,4-dioxane, bis(2-ethylhexyl)phthalate, 1,1-dichloroethane, tetrachloroethene, trichloroethane, and vinyl chloride are the most frequently detected COCs in on- and off-property groundwater. The maximum detected concentration, identified assuming multiple results from each on- and off-property monitoring well were treated as discrete samples, was used as the EPC for each of the COCs detected in groundwater. Isotope/decay product EPCs were calculated from the total uranium and thorium maximum detection.

Source: A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents (U.S. EPA, 1999)

Table G-5

Cancer Toxicity Data Summary

Pathway: Ingestion, Dermal

Chemical of Concern	Oral Cancer Slope Factor	Dermal Cancer Slope Factor	Slope Factor Units	Weight of Evidence/Cancer Guideline Description	Source	Date [1] (MM/DD/YYYY)
1,4-Dioxane	1.0E-01	1.0E-01	$(mg/kg\text{-}day)^{-1}$	Likely to be carcinogenic to humans	IRIS	03/03/15
Benzo(a)anthracene	7.3E-01	7.3E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	03/03/15
Benzo(a)pyrene	7.3E+00	7.3E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	03/03/15
Benzo(b)fluoranthene	7.3E-01	7.3E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	03/03/15
bis(2-Ethylhexyl)phthalate	1.4E-02	1.4E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	03/03/15
Indeno(1,2,3-cd)pyrene	7.3E-01	7.3E-01	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	03/03/15
1,1-Dichloroethane	5.7E-03	5.7E-03	$(mg/kg\text{-}day)^{-1}$	C	CalEPA	03/03/15
Tetrachloroethene	2.1E-03	2.1E-03	$(mg/kg\text{-}day)^{-1}$	Likely to be carcinogenic to humans	IRIS	03/03/15
Trichloroethene	4.6E-02	4.6E-02	$(mg/kg\text{-}day)^{-1}$	Carcinogenic to humans	IRIS	03/03/15
Vinyl Chloride	7.2E-01	7.2E-01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	03/03/15
Aroclor-1254	2.0E+00	2.0E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	03/03/15
Aroclor-1260	2.0E+00	2.0E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	03/03/15
Arsenic	1.5E+00	1.5E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	03/03/15
Barium	N/A	N/A	N/A	D	IRIS	03/03/15
Chromium	5.0E-01	1.3E-02	$(mg/kg\text{-}day)^{-1}$	Likely to be carcinogenic to humans	NJDEP	03/03/15
Cobalt	N/A	N/A	N/A	N/A	N/A	N/A
Copper	N/A	N/A	N/A	D	IRIS	03/03/15
Iron	N/A	N/A	N/A	N/A	N/A	N/A
Manganese	N/A	N/A	N/A	D	IRIS	03/03/15
Molybdenum	N/A	N/A	N/A	N/A	N/A	N/A
Uranium	N/A	N/A	N/A	N/A	N/A	N/A
Nitrate as N	N/A	N/A	N/A	N/A	N/A	N/A
Nitrite as N	N/A	N/A	N/A	N/A	N/A	N/A

Pathway: Inhalation

Chemical of Concern	Unit Risk	Units	Inhalation Cancer Slope Factor	Units	Weight of Evidence/Cancer Guideline Description	Source	Date [1] (MM/DD/YYYY)
1,4-Dioxane (used in BHHRA	7.7E-06	$(\mu g/m^3)^{-1}$	N/A	$(mg/kg\text{-}day)^{-1}$	NA	CalEPA	July 2009
1,4-Dioxane (updated) [2]	5.0E-06	$(\mu g/m^3)^{-1}$	N/A	$(mg/kg\text{-}day)^{-1}$	Likely to be carcinogenic to humans	IRIS	06/25/15
Benzo(a)anthracene	1.1E-04	$(ug/m^3)^{-1}$	N/A	$(mg/kg\text{-}day)^{-1}$	B2	CalEPA	03/03/15
Benzo(a)pyrene	1.1E-03	$(ug/m^3)^{-1}$	N/A	$(mg/kg\text{-}day)^{-1}$	B2	CalEPA	03/03/15
Benzo(b)fluoranthene	1.1E-04	$(ug/m^3)^{-1}$	N/A	$(mg/kg\text{-}day)^{-1}$	B2	CalEPA	03/03/15
Indeno(1,2,3-cd)pyrene	1.1E-04	$(ug/m^3)^{-1}$	N/A	$(mg/kg\text{-}day)^{-1}$	B2	CalEPA	03/03/15
1,1-Dichloroethane	1.6E-06	$(\mu g/m^3)^{-1}$	N/A	$(mg/kg\text{-}day)^{-1}$	C	CalEPA	03/03/15
Tetrachloroethene	2.6E-07	$(\mu g/m^3)^{-1}$	N/A	$(mg/kg\text{-}day)^{-1}$	Likely to be carcinogenic to humans	IRIS	03/03/15
Trichloroethene	4.1E-06	$(\mu g/m^3)^{-1}$	N/A	$(mg/kg\text{-}day)^{-1}$	Carcinogenic to humans	IRIS	03/03/15
Vinyl Chloride	4.4E-06	$(\mu g/m^3)^{-1}$	N/A	$(mg/kg\text{-}day)^{-1}$	A	IRIS	03/03/15
Aroclor-1254	5.7E-04	$(ug/m^3)^{-1}$	N/A	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	03/03/15
Aroclor-1260	5.7E-04	$(ug/m^3)^{-1}$	N/A	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	03/03/15
Arsenic	4.3E-03	$(ug/m^3)^{-1}$	N/A	$(mg/kg\text{-}day)^{-1}$	A	IRIS	03/03/15
Uranium	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table G-5

Cancer Toxicity Data Summary

Pathway: External (Radiation)

Chemical of Concern	Cancer Slope or Conversion Factor	Exposure Route	Units	Weight of Evidence/Cancer Guideline Description	Source	Date (MM/DD/YYYY)
Ra-228+D	4.53E-06	External Exposure	Risk/year per pCi/g soil	A	HEAST	03/03/15
Th-228+D	7.76E-06	External Exposure	Risk/year per pCi/g soil	A	HEAST	03/03/15
Th-232	5.43E-07	External Exposure	Risk/year per pCi/g soil	A	HEAST	03/03/15
U-234	2.52E-10	External Exposure	Risk/year per pCi/g soil	A	HEAST	03/03/15
U-235+D	5.43E-07	External Exposure	Risk/year per pCi/g soil	A	HEAST	03/03/15
U-238+D	1.14E-07	External Exposure	Risk/year per pCi/g soil	A	HEAST	03/03/15
Ra-228+D	2.29E-09	Soil Ingestion	Risk/pCi soil	A	HEAST	03/03/15
Th-228+D	8.09E-10	Soil Ingestion	Risk/pCi soil	A	HEAST	03/03/15
Th-232	2.31E-10	Soil Ingestion	Risk/pCi soil	A	HEAST	03/03/15
U-234	1.58E-10	Soil Ingestion	Risk/pCi soil	A	HEAST	03/03/15
U-235+D	1.63E-10	Soil Ingestion	Risk/pCi soil	A	HEAST	03/03/15
U-238+D	2.10E-10	Soil Ingestion	Risk/pCi soil	A	HEAST	03/03/15
Ra-228+D	5.23E-09	Soil Inhalation	Risk/pCi soil	A	HEAST	03/03/15
Th-228+D	1.43E-07	Soil Inhalation	Risk/pCi soil	A	HEAST	03/03/15
Th-232	4.33E-08	Soil Inhalation	Risk/pCi soil	A	HEAST	03/03/15
U-234	1.14E-08	Soil Inhalation	Risk/pCi soil	A	HEAST	03/03/15
U-235+D	1.01E-08	Soil Inhalation	Risk/pCi soil	A	HEAST	03/03/15
U-238+D	9.35E-09	Soil Inhalation	Risk/pCi soil	A	HEAST	03/03/15
Ra-228+D	1.43E-09	Food Ingestion	Risk/pCi soil	A	HEAST	03/03/15
Th-228+D	4.22E-10	Food Ingestion	Risk/pCi soil	A	HEAST	03/03/15
Th-232	1.33E-10	Food Ingestion	Risk/pCi soil	A	HEAST	03/03/15
U-234	9.55E-11	Food Ingestion	Risk/pCi soil	A	HEAST	03/03/15
U-235+D	9.76E-11	Food Ingestion	Risk/pCi soil	A	HEAST	03/03/15
U-238+D	1.21E-10	Food Ingestion	Risk/pCi soil	A	HEAST	03/03/15
Ac-227+D	4.86E-10	Water Ingestion	Risk/pCi water	A	HEAST	03/03/15
Bi-210	8.92E-12	Water Ingestion	Risk/pCi water	A	HEAST	03/03/15
Pb-210	8.81E-10	Water Ingestion	Risk/pCi water	A	HEAST	03/03/15
Po-210	3.77E-10	Water Ingestion	Risk/pCi water	A	HEAST	03/03/15
Ra-226+D	3.86E-10	Water Ingestion	Risk/pCi water	A	HEAST	03/03/15
Ra-228+D	1.04E-09	Water Ingestion	Risk/pCi water	A	HEAST	03/03/15
Th-228+D	3.00E-10	Water Ingestion	Risk/pCi water	A	HEAST	03/03/15
Th-230	9.10E-11	Water Ingestion	Risk/pCi water	A	HEAST	03/03/15
Th-232	1.01E-10	Water Ingestion	Risk/pCi water	A	HEAST	03/03/15
U-234	7.07E-11	Water Ingestion	Risk/pCi water	A	HEAST	03/03/15
U-235+D	7.18E-11	Water Ingestion	Risk/pCi water	A	HEAST	03/03/15
U-238+D	8.71E-11	Water Ingestion	Risk/pCi water	A	HEAST	03/03/15

Table G-5

Cancer Toxicity Data Summary

Key

N/A: Not applicable

IRIS: Integrated Risk Information System, U.S. EPA

HEAST = Health Effects Assessment Summary Tables

NJDEP = New Jersey Department of Environmental Protection

CalEPA = California Environmental Protection Agency, Office of Environmental Health Hazard Assessment

EPA Group

A - Human carcinogen

B1 - Probable human carcinogen - Indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

(1) Date indicates when source was last reviewed.

(2) 1,4-Dioxane was not classified as volatile at the time of the BHHRA, but has since been re-classified as volatile (USEPA, 2015). The Unit Risk has been utilized during development of cleanup levels.

For PCBs, the RME slope factor presented represents the upper-bound slope factor for high risk and persistence situations.

The slope factor for benzo(a)pyrene, along with the appropriate relative potency factor (USEPA, 1993), used for the other carcinogenic PAHs.

The slope factor presented for trichloroethene is the adult-based value. For early-life exposures, tumor-specific slope factor values of 9.3E-03 $(mg/kg\text{-}day)^{-1}$ for kidney tumors and 3.7E-02 $(mg/kg\text{-}day)^{-1}$ for combined liver tumors and non-Hodgkins lymphoma (NHL) are used in conjuction with age-dependent adjustment factors, as appropriate.

The unit risk presented for trichloroethene is the adult-based value. For early-life exposures, tumor-specific unit risk values of 1E-06 $(\mu g/m^3)^{-1}$ for kidney tumors and 3.1E-06 $(\mu g/m^3)^{-1}$ for combined liver tumors and non-Hodgkins lymphoma (NHL) are used in conjuction with age-dependent adjustment factors, as appropriate.

The slope factor for hexavalent chromium used for chromium, based on lack of speciation data.

Age-dependent adjustment factors are used in conjunction with toxicity values, as appropriate, for carcinogenic PAHs, chromium (evaluated as hexavalent chromium), trichloroethene, and vinyl chloride.

Soil ingestion cancer slope factors for the external (radiation) pathway are for whole population. Refer to the Table 10 in Appendix B of the FS for adult values.

This table provides the carcinogenic risk information which is relevant to the contaminants of concern in soil, sediment, indoor air, and groundwater. At this time, slope factors are not available for the dermal route of exposure. Thus, the dermal slope factors used in this assessment have been extrapolated from oral values. An adjustment factor is sometimes applied, and is dependent upon how well the chemical is absorbed via the oral route. Adjustments are particularly important for chemicals with less than 50% absorption via the ingestion route. However, adjustment is not necessary for the chemicals evaluated at this site, except for chromium (evaluated as hexavalent chromium) which has an adjustment factor of 0.025. For the remaining chemicals, the same oral slope factors as presented above were used as the dermal carcinogenic slope factors for these contaminants. Eleven of the COCs considered carcinogenic via the inhalation route were determined to be primary risk drivers for at least one exposure pathway evaluated at the site.

Source: A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents (U.S. EPA, 1999)

Table G-6

Non-Cancer Toxicity Data Summary

Pathway: Ingestion, Dermal

Chemical of Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Dermal RfD	Dermal RfD Units	Primary Target Organ	Combined Uncertainty / Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ [1] (MM/DD/YYYY)
1,4-Dioxane	Chronic	3.0E-02	mg/kg-day	3.0E-02	mg/kg-day	Liver / Kidney	300	IRIS	03/03/15
Benzo(a)anthracene	Chronic	3.0E-02	mg/kg-day	3.0E-02	mg/kg-day	Kidney	3000	Surrogate	03/03/15
Benzo(a)pyrene	Chronic	3.0E-02	mg/kg-day	3.0E-02	mg/kg-day	Kidney	3000	Surrogate	03/03/15
Benzo(b)fluoranthene	Chronic	3.0E-02	mg/kg-day	3.0E-02	mg/kg-day	Kidney	3000	Surrogate	03/03/15
bis(2-Ethylhexyl)phthalate	Chronic	2.0E-02	mg/kg-day	2.0E-02	mg/kg-day	Liver	1000	IRIS	03/03/15
Indeno(1,2,3-cd)pyrene	Chronic	3.0E-02	mg/kg-day	3.0E-02	mg/kg-day	Kidney	3000	Surrogate	03/03/15
1,1-Dichloroethane	Chronic	2.0E-01	mg/kg-day	2.0E-01	mg/kg-day	Kidney	3000	PPRTV	03/03/15
Tetrachloroethene	Chronic	6.0E-03	mg/kg-day	6.0E-03	mg/kg-day	CNS	1000	IRIS	03/03/15
Trichloroethene	Chronic	5.0E-04	mg/kg-day	5.0E-04	mg/kg-day	Developmental / Immune System	10 to 1000	IRIS	03/03/15
Vinyl Chloride	Chronic	3.0E-03	mg/kg-day	3.0E-03	mg/kg-day	Liver	30	IRIS	03/03/15
Aroclor-1254	Chronic	2.0E-05	mg/kg-day	2.0E-05	mg/kg-day	Immune System	300	IRIS	03/03/15
Aroclor-1254	Subchronic	5.0E-05	mg/kg-day	5.0E-05	mg/kg-day	Immune System	300	IRIS	03/03/15
Aroclor-1260	Chronic	2.0E-05	mg/kg-day	2.0E-05	mg/kg-day	Immune System	300	IRIS	03/03/15
Aroclor-1260	Subchronic	5.0E-05	mg/kg-day	5.0E-05	mg/kg-day	Immune System	300	IRIS	03/03/15
Arsenic	Chronic	3.0E-04	mg/kg-day	3.0E-04	mg/kg-day	Skin	3	IRIS	03/03/15
Barium	Chronic	2.0E-01	mg/kg-day	1.4E-02	mg/kg-day	Kidney	300	IRIS	03/03/15
Chromium	Chronic	3.0E-03	mg/kg-day	7.5E-05	mg/kg-day	GI System	900	IRIS	03/03/15
Cobalt	Chronic	3.0E-04	mg/kg-day	3.0E-04	mg/kg-day	Thyroid	3000	PPRTV	03/03/15
Copper	Chronic	4.0E-02	mg/kg-day	4.0E-02	mg/kg-day	GI System	N/A	HEAST	FY 1997
Iron	Chronic	7.0E-01	mg/kg-day	7.0E-01	mg/kg-day	GI System	1.5	PPRTV	03/03/15
Manganese	Chronic	2.4E-02	mg/kg-day	9.6E-04	mg/kg-day	CNS	3	IRIS	03/03/15
Molybdenum	Chronic	5.0E-03	mg/kg-day	5.0E-03	mg/kg-day	Kidney	30	IRIS	03/03/15
Nitrate as N	Chronic	1.6E+00	mg/kg-day	1.6E+00	mg/kg-day	Hematological	1	IRIS	03/03/15
Nitrite as N	Chronic	1.0E-01	mg/kg-day	1.0E-01	mg/kg-day	Hematological	10	IRIS	03/03/15
Uranium	Chronic	6.0E-04	mg/kg-day	6.0E-04	mg/kg-day	Kidney	100	EPA Office of Water	03/03/15
Uranium (used in BHHRA)	Subchronic	2.0E-03	mg/kg-day	2.0E-03	mg/kg-day	Kidney	30	ATSDR	Feb 2012
Uranium (updated)	Subchronic	2.0E-04	mg/kg-day	2.0E-04	mg/kg-day	Kidney	300	ATSDR	03/03/15

Table G-6

Non-Cancer Toxicity Data Summary

Pathway: Inhalation

Chemical of Concern	Chronic/ Subchronic	Inhalation RfC	Inhalation RfC Units	Inhalation RfD	Inhalation RfD Units	Primary Target Organ	Combined Uncertainty / Modifying Factors	Sources of RfC: RfD: Target Organ	Dates (MM/DD/YYYY)
1,4-Dioxane (used in BHHRA	Chronic	30	$\mu g/m^3$	N/A	N/A	Liver	30	CalEPA	December 2008
1,4-Dioxane (updated) (3)	Chronic	30	$\mu g/m^3$	N/A	N/A	Respiratory System	1000	IRIS	06/25/15
Benzo(a)anthracene	Chronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(a)pyrene	Chronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene	Chronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Indeno(1,2,3-cd)pyrene	Chronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1,1-Dichloroethane (2)	Chronic	5000	$\mu g/m^3$	N/A	N/A	Kidney	100	HEAST	FY 1997
Tetrachloroethene	Chronic	40	$\mu g/m^3$	N/A	N/A	CNS	1000	IRIS	03/03/15
Trichloroethene	Chronic	2	$\mu g/m^3$	N/A	N/A	Developmental / Immune System	10 to 100	IRIS	03/03/15
Vinyl Chloride	Chronic	100	$\mu g/m^3$	N/A	N/A	Liver	30	IRIS	03/03/15
Aroclor-1254	Chronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Aroclor-1260	Chronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic	Chronic	0.015	ug/m^3	N/A	N/A	Developmental	30	CalEPA	03/03/15
Uranium (used in BHHRA)	Chronic	0.3	ug/m^3	N/A	N/A	Kidney	90	ATSDR	Feb 2012
Uranium (updated)	Chronic	0.04	ug/m^3	N/A	N/A	Kidney	100	ATSDR	03/03/15
Uranium (used in BHHRA)	Subchronic	0.4	ug/m^3	N/A	N/A	Kidney	30	ATSDR	Feb 2012
Uranium (updated)	Subchronic	0.1	ug/m^3	N/A	N/A	Kidney	300	ATSDR	03/03/15

Key

N/A - No information available

IRIS: Integrated Risk Information System, U.S. EPA

PPRTV = Provisional Peer Reviewed Toxicity Value developed by STSC

HEAST = Health Effects Assessment Summary Tables

CalEPA = California Environmental Protection Agency, Office of Environmental Health Hazard Assessment

ATSDR = Agency for Toxic Substances and Disease Registry

(1) Date indicates when source was last reviewed.

(2) The RfC for 1,1-dichloroethane was used in the BHHRA, but has since been withdrawn from HEAST and therefore, has not been utilized for development of cleanup levels.

(3) 1,4-Dioxane was not classified as volatile at the time of the BHHRA, but has since been re-classified as volatile (USEPA, 2015). The RfC has been utilized during development of cleanup levels.

The RfD for Aroclor 1254 was used as a surrogate for Aroclor 1260 (High risk and persistence; upper-bound slope factor).

The RfD for pyrene was used as a surrogate for benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene.

The subchronic RfD and RfC for uranium and the chronic RfC for uranium have been updated since the baseline HHRA. Results presented on Risk Summary tables use the toxicity values and site-specific exposure parameters from the baseline HHRA. Refer to AECOM, 2015 technical memorandum for results adjusted based on updated toxicity values.

This table provides non-carcinogenic risk information which is relevant to the contaminants of concern in soil, sediment, indoor air, and groundwater. Twenty-three of the COCs have oral toxicity data (or surrogate toxicity data) indicating their potential for adverse non-carcinogenic health effects in humans. Chronic toxicity data available for the twenty-three COCs for oral exposures have been used to develop chronic oral reference doses (RfDs), provided in this table. The available chronic toxicty data indicate that trichloroethene and PCBs affect the immune system, 1,4-dioxane, bis(2-ethylhexyl)phthalate, and vinyl chloride affect the liver, 1,4-dioxane, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, 1,1-dichloroethane, barium, molybdenum, and uranium affect the kidney, tetrachloroethene and manganese affect the central nervous system, trichloroethene and arsenic are developmental toxicants, cobalt affects the thyroid, chromium, copper, and iron affect the gastrointestinal system, nitrate and nitrite affect the hematological system, and arsenic affects the skin. Dermal RfDs are not available for any of the COCs. As was the case for the carcinogenic data, dermal RfDs can be extrapolated from oral RfDs by applying an adjustment factor as appropriate. Oral RfDs were adjusted for COCs with less than 50% absorption via the ingestion route (barium, chromium, and manganese) to derive dermal RfDs for these COCs. Inhalation reference concentrations (RfCs) are available for six COCs evaluated for the inhalation pathway.

Source: A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents (U.S. EPA, 1999)

Table G-7

Risk Characterization Summary - Non-Carcinogens

Scenario Timeframe: Current
Receptor Population: Trespasser
Receptor Age: Older Child/Adolescent

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Cooling Pond	Aroclor-1254	Immune System	1.7E+00	--	2.4E+00	4.1E+00
							Sediment Hazard Index Total =	4E+00
							Immune System Hazard Index =	4E+00

Key

N/A - Toxicity criteria are not available to quantitatively address this route of exposure.

-- Route of exposure is not applicable to this medium.

This table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of the hazard quotients) for all routes of exposure for a current older child/adolescent trespasser exposed to sediment in the Cooling Pond. The Risk Assessment Guidance for Superfund (RAGS) states that, generally, a hazard index (HI) of greater than 1 indicates the potential for adverse noncancer effects. The estimated target organ HI of 4 indicates that the potential for adverse effects could occur from exposure to contaminated sediment containing PCBs. Results presented use current toxicity values along with site-specific exposure parameters from the baseline HHRA.

Source: A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents (U.S. EPA, 1999)

Table G-8

Risk Characterization Summary - Carcinogens

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk					
				Ingestion	Inhalation	Dermal	External (Radiation)	Produce Ingestion	Exposure Routes Total
Soil	Surface Soil	AOI 8 Sweepings Area							
			Benzo(a)pyrene	2.7E-06	1.7E-12	1.0E-06	- -	- -	3.7E-06
			Aroclor-1254	2.3E-05	4.1E-11	1.0E-05	- -	- -	3.4E-05
			Aroclor-1260	3.4E-06	6.0E-12	1.5E-06	- -	- -	4.9E-06
			Arsenic	9.4E-06	1.7E-10	8.9E-07	- -	- -	1.0E-05
			Uranium-238+D	3.3E-06	3.6E-09	- -	2.6E-05	2.4E-06	3.2E-05
			Uranium-235+D	3.3E-08	5.3E-11	- -	1.7E-06	2.6E-08	1.8E-06
			Uranium-234	4.2E-07	7.5E-10	- -	9.9E-09	3.2E-07	7.5E-07
			Thorium-232	7.5E-08	3.4E-10	- -	1.6E-09	2.2E-08	9.9E-08
			Radium-228+D	7.4E-07	4.2E-11	- -	2.2E-05	9.4E-06	3.2E-05
			Thorium-228+D	2.6E-07	1.1E-09	- -	3.7E-05	7.0E-08	3.7E-05
								Surface Soil Risk Total =	2E-04
								Total Risk =	2E-04
Soil	Surface Soil	AOI 7 & 11 Industrial Area East							
			Benzo(a)pyrene	8.2E-06	5.1E-12	3.2E-06	- -	- -	1.1E-05
			Benzo(b)fluoranthene	2.1E-06	1.3E-12	8.0E-07	- -	- -	2.9E-06
			Aroclor-1254	3.7E-06	6.6E-12	1.7E-06	- -	- -	5.4E-06
			Arsenic	7.7E-06	1.4E-10	7.3E-07	- -	- -	8.4E-06
			Uranium-238+D	3.2E-05	3.6E-08	- -	2.6E-04	2.4E-05	3.1E-04
			Uranium-235+D	3.2E-07	4.9E-10	- -	1.6E-05	2.4E-07	1.6E-05
			Uranium-234	4.1E-06	7.4E-09	- -	9.7E-08	3.2E-06	7.4E-06
			Thorium-232	8.1E-08	3.8E-10	- -	1.7E-09	2.4E-08	1.1E-07
			Radium-228+D	8.1E-07	4.6E-11	- -	2.4E-05	1.0E-05	3.5E-05
			Thorium-228+D	2.9E-07	1.3E-09	- -	4.0E-05	7.6E-08	4.1E-05
								Surface Soil Risk Total =	4E-04
								Total Risk =	4E-04

Table G-8

Risk Characterization Summary - Carcinogens

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk					
				Ingestion	Inhalation	Dermal	External (Radiation)	Produce Ingestion	Exposure Routes Total
Soil	Subsurface Soil	AOI 7 & 11 Industrial Area East							
			Benzo(a)pyrene	4.9E-06	3.1E-12	1.9E-06	- -	- -	6.8E-06
			Aroclor-1254	2.6E-05	4.6E-11	1.2E-05	- -	- -	3.8E-05
			Aroclor-1260	3.7E-06	6.6E-12	1.7E-06	- -	- -	5.4E-06
			Arsenic	5.6E-06	1.0E-10	5.3E-07	- -	- -	6.1E-06
			Uranium-238+D	1.4E-05	1.5E-08	- -	1.1E-04	1.0E-05	1.3E-04
			Uranium-235+D	1.4E-07	2.2E-10	- -	7.0E-06	1.1E-07	7.2E-06
			Uranium-234	1.7E-06	3.1E-09	- -	3.2E-08	1.3E-06	3.1E-06
			Thorium-232	1.1E-07	5.0E-10	- -	2.4E-09	3.1E-08	1.4E-07
			Radium-228+D	1.1E-06	6.0E-11	- -	3.1E-05	1.3E-05	4.5E-05
			Thorium-228+D	3.8E-07	1.6E-09	- -	5.3E-05	9.9E-08	5.3E-05
								Subsurface Soil Risk Total =	3E-04
								Total Risk =	3E-04
Soil	Surface Soil	AOI 2 & 4 Soils Area at Cooling Pond							
			Benzo(a)pyrene	5.8E-06	3.6E-12	2.6E-06	- -	- -	8.5E-06
			Aroclor-1254	9.9E-06	1.8E-11	4.4E-06	- -	- -	1.4E-05
			Aroclor-1260	4.0E-05	7.1E-11	1.8E-05	- -	- -	5.8E-05
			Arsenic	1.8E-05	3.1E-10	1.7E-06	- -	- -	1.9E-05
			Uranium-238+D	1.2E-06	1.3E-09	- -	9.7E-06	8.9E-07	1.2E-05
			Uranium-235+D	1.3E-08	2.1E-11	- -	6.5E-07	1.0E-08	6.7E-07
			Uranium-234	1.7E-07	2.9E-10	- -	3.8E-09	1.2E-07	2.9E-07
			Thorium-232	7.8E-08	3.6E-10	- -	1.7E-09	2.3E-08	1.0E-07
			Radium-228+D	7.7E-07	4.4E-11	- -	2.2E-05	9.8E-06	3.3E-05
			Thorium-228+D	2.7E-07	1.2E-09	- -	3.8E-05	7.2E-08	3.9E-05
								Surface Soil Risk Total =	2E-04
								Total Risk =	2E-04

Table G-8

Risk Characterization Summary - Carcinogens

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk					
				Ingestion	Inhalation	Dermal	External (Radiation)	Produce Ingestion	Exposure Routes Total
Soil	Subsurface Soil	AOI 2 & 4 Soils Area at Cooling Pond							
			Benzo(a)pyrene	2.0E-06	1.2E-12	7.5E-07	- -	- -	2.7E-06
			Aroclor-1254	5.3E-06	9.4E-12	2.4E-06	- -	- -	7.7E-06
			Aroclor-1260	2.3E-05	4.1E-11	1.0E-05	- -	- -	3.3E-05
			Arsenic	1.9E-05	3.5E-10	1.8E-06	- -	- -	2.1E-05
			Uranium-238+D	1.2E-06	1.3E-09	- -	9.5E-06	8.7E-07	1.2E-05
			Uranium-235+D	1.2E-08	1.9E-11	- -	6.1E-07	9.4E-09	6.3E-07
			Uranium-234	1.5E-07	2.6E-10	- -	3.4E-09	1.1E-07	2.6E-07
			Thorium-232	3.5E-07	4.0E-10	- -	1.9E-09	2.5E-08	3.8E-07
			Radium-228+D	8.6E-07	4.9E-11	- -	2.5E-05	1.1E-05	3.7E-05
			Thorium-228+D	3.0E-07	1.3E-09	- -	4.3E-05	8.1E-08	4.3E-05
								Subsurface Soil Risk Total =	2E-04
								Total Risk =	2E-04
Soil	Surface Soil	Rt 62 Outfall and Embayment Area							
			Benzo(a)anthracene	4.7E-06	4.0E-12	1.8E-06	- -	- -	6.5E-06
			Benzo(a)pyrene	4.9E-05	3.1E-11	1.9E-05	- -	- -	6.8E-05
			Benzo(b)fluoranthene	7.8E-06	5.4E-12	3.0E-06	- -	- -	1.1E-05
			Indeno(1,2,3-cd)pyrene	2.3E-06	1.4E-12	8.6E-07	- -	- -	3.1E-06
			Arsenic	8.1E-06	1.4E-12	7.7E-07	- -	- -	8.9E-06
			Thorium-232	7.8E-08	3.6E-10	- -	1.7E-09	2.3E-08	1.0E-07
			Radium-228+D	7.7E-07	4.4E-11	- -	2.2E-05	9.8E-06	3.3E-05
			Thorium-228+D	2.7E-07	1.2E-09	- -	3.8E-05	7.2E-08	3.9E-05
								Surface Soil Risk Total =	2E-04
								Total Risk =	2E-04

Table G-8

Risk Characterization Summary - Carcinogens

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk					
				Ingestion	Inhalation	Dermal	External (Radiation)	Produce Ingestion	Exposure Routes Total
Soil	Surface Soil	AOI 1 Holding Basin							
			Arsenic	9.0E-06	1.6E-10	8.5E-07	- -	- -	9.8E-06
			Uranium-238+D	1.2E-05	1.4E-08	- -	9.8E-05	9.0E-06	1.2E-04
			Uranium-235+D	1.2E-07	1.9E-10	- -	6.0E-06	9.3E-08	6.2E-06
			Uranium-234	1.6E-06	2.8E-09	- -	3.7E-08	1.2E-06	2.8E-06
			Thorium-232	1.1E-07	5.0E-10	- -	2.4E-09	3.2E-08	1.4E-07
			Radium-228+D	1.1E-06	6.1E-11	- -	3.1E-05	1.4E-05	4.6E-05
			Thorium-228+D	3.8E-07	1.7E-09	- -	5.4E-05	1.0E-07	5.4E-05
								Surface Soil Risk Total =	2E-04
								Total Risk =	2E-04
Soil	Subsurface Soil	AOI 1 Holding Basin							
			Arsenic	6.8E-06	1.2E-10	6.4E-07	- -	- -	7.5E-06
			Uranium-238+D	1.5E-05	1.6E-08	- -	1.2E-04	1.1E-05	1.4E-04
			Uranium-235+D	1.5E-07	2.3E-10	- -	7.4E-06	1.1E-07	7.7E-06
			Uranium-234	1.8E-06	3.3E-09	- -	4.3E-08	1.4E-06	3.3E-06
			Thorium-232	7.4E-08	3.4E-10	- -	1.6E-09	2.2E-08	9.8E-08
			Radium-228+D	7.3E-07	4.1E-11	- -	2.1E-05	9.3E-06	3.1E-05
			Thorium-228+D	2.6E-07	1.1E-09	- -	3.6E-05	6.8E-08	3.7E-05
								Subsurface Soil Risk Total =	2E-04
								Total Risk =	2E-04

Key

N/A - Toxicity criteria are not available to quantitatively address this route of exposure.

-- Route of exposure is not applicable to this medium.

This table provides risk estimates for the significant routes of exposure for future young child and adult residents exposed to surface and subsurface soil at the following Areas of Interest: AOI 8 Sweepings Area, AOI 7 & 11 Industrial Area East, AOI 2 & 4 Soils Area at Cooling Pond, Rt 62 Outfall and Embayment Area, and AOI 1 Holding Basin. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about exposure to surface and subsurface soil by a young child and adult resident, as well as the toxicity of the COCs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, PCBs, arsenic, uranium isotopes, and thorium isotopes). The total risk from exposure to soil for a future resident is estimated to be 2 x 10^{-4} (AOI 8 Sweepings Area surface soil), 4 x 10^{-4} (AOI 7 & 11 Industrial Area East surface soil), 3 x 10^{-4} (AOI 7 & 11 Industrial Area East subsurface soil), 2 x 10^{-4} (AOI 2 & 4 Soils Area at Cooling Pond surface soil), 2 x 10^{-4} (AOI 2 & 4 Soils Area at Cooling Pond subsurface soil), 2 x 10^{-4} (Rt 62 Outfall and Embayment Area surface soil), 2 x 10^{-4} (AOI 1 Holding Basin surface soil), and 2 x 10^{-4} (AOI 1 Holding Basin subsurface soil). The COCs contributing most to this risk level are PCBs, arsenic, uranium isotopes, and thorium isotopes. This risk level indicates that if no clean-up action is taken, a young child and adult resident would have an increased probability of 2 in 10,000 (AOI 8 Sweepings Area surface soil, AOI 2 & 4 Soils Area at Cooling Pond surface and subsurface soil, Rt 62 Outfall and Embayment Area surface soil, and AOI 1 Holding Basin surface and subsurface soil), 3 in 10,000 (AOI 7 & 11 Industrial Area East subsurface soil), or 4 in 10,000 (AOI 7 & 11 Industrial Area East surface soil) of developing cancer as a result of site-related exposure to the COCs in soil. Results presented use current toxicity values along with site-specific exposure parameters from the baseline HHRA.

Source: A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents (U.S. EPA, 1999)

Table G-9

Risk Characterization Summary - Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Surface Soil	AOI 14 North	Aroclor-1254	Immune System	1.0E+00	N/A	4.0E-01	1.4E+00
			Aroclor-1260	Immune System	2.5E-01	N/A	9.8E-02	3.5E-01
							Sediment Hazard Index Total =	2E+00
							Immune System Hazard Index =	2E+00
Soil	Surface Soil	AOI 8 Sweepings Area	Aroclor-1254	Immune System	4.8E+00	N/A	1.9E+00	6.7E+00
							Surface Soil Hazard Index Total =	7E+00
							Immune System Hazard Index =	7E+00
Soil	Subsurface Soil	AOI 8 Sweepings Area	Aroclor-1254	Immune System	2.8E+00	N/A	1.1E+00	4E+00
			Aroclor-1260	Immune System	3.8E-01	N/A	1.5E-01	5E-01
							Subsurface Soil Hazard Index Total =	4E+00
							Immune System Hazard Index =	4E+00
Soil	Surface Soil	AOI 7 & 11 Industrial Area East	Uranium	Kidney	7.8E+00	4.1E-05	N/A	7.8E+00
							Surface Soil Hazard Index Total =	8E+00
							Kidney Hazard Index =	8E+00
Soil	Subsurface Soil	AOI 7 & 11 Industrial Area East	Aroclor-1254	Immune System	5.4E+00	N/A	2.1E+00	7.4E+00
			Uranium	Kidney	3.3E+00	1.8E-05	N/A	3.3E+00
							Subsurface Soil Hazard Index Total =	1E+01
							Kidney Hazard Index =	3E+00
							Immune System Hazard Index =	7E+00
Soil	Surface Soil	AOI 2 & 4 Soils Area at Cooling Pond	Aroclor-1254	Immune System	2.0E+00	N/A	8.0E-01	2.8E+00
			Aroclor-1260	Immune System	8.2E+00	N/A	3.2E+00	1.1E+01
							Surface Soil Hazard Index Total =	1E+01
							Immune System Hazard Index =	1E+01

Table G-9

Risk Characterization Summary - Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Subsurface Soil	AOI 2 & 4 Soils Area at Cooling Pond	Aroclor-1254	Immune System	1.1E+00	N/A	4.3E-01	1.5E+00
			Aroclor-1260	Immune System	4.7E+00	N/A	1.8E+00	6.5E+00
							Subsurface Soil Hazard Index Total =	8E+00
							Immune System Hazard Index =	8E+00
Soil	Surface Soil	AOI 1 Holding Basin	Uranium	Kidney	3.0E+00	1.6E-05	N/A	3.0E+00
							Surface Soil Hazard Index Total =	3E+00
							Kidney Hazard Index =	3E+00
Soil	Subsurface Soil	AOI 1 Holding Basin	Uranium	Kidney	3.5E+00	1.9E-05	N/A	3.5E+00
							Subsurface Soil Hazard Index Total =	4E+00
							Kidney Hazard Index =	4E+00

Key

N/A - Toxicity criteria are not available to quantitatively address this route of exposure.

-- Route of exposure is not applicable to this medium.

This table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of the hazard quotients) for all routes of exposure for future young child and adult residents exposed to surface and subsurface soil at the following Areas of Interest: AOI 14 North, AOI 8 Sweepings Area, AOI 7 & 11 Industrial Area East, AOI 2 & 4 Soils Area at Cooling Pond, and AOI 1 Holding Basin. The Risk Assessment Guidance for Superfund (RAGS) states that, generally, a hazard index (HI) of greater than 1 indicates the potential for adverse noncancer effects. The estimated target organ HIs between 2 and 10 indicate that the potential for adverse effects could occur from exposure to contaminated soil containing PCBs and uranium. Results presented use current toxicity values along with site-specific exposure parameters from the baseline HHRA.

Source: A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents (U.S. EPA, 1999)

Table G-10

Risk Characterization Summary - Carcinogens

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total
Groundwater	Groundwater	On-Property Bedrock Groundwater Plume Used As Tap Water						
			1,1-Dichloroethane	1.6E-06	1.4E-07	1.0E-07	- -	1.8E-06
			Trichloroethene	1.3E-05	3.5E-07	1.7E-06	- -	1.5E-05
			1,4-Dioxane	6.2E-05	N/A	1.6E-06	- -	6.4E-05
			Bis(2-Ethylhexyl)phthalate	3.3E-06	N/A	4.2E-06	- -	7.5E-06
			Arsenic	1.6E-03	N/A	7.6E-06	- -	1.6E-03
			Uranium-238+D	1.3E-04	- -	- -	- -	1.3E-04
			Uranium-235+D	4.9E-06	- -	- -	- -	4.9E-06
			Uranium-234	1.1E-04	- -	- -	- -	1.1E-04
			Actinium-227+D	3.3E-05	- -	- -	- -	3.3E-05
			Thorium-230	1.4E-04	- -	- -	- -	1.4E-04
			Radium-226+D	7.9E-04	- -	- -	- -	7.9E-04
			Lead-210	1.8E-03	- -	- -	- -	1.8E-03
			Bismuth-210	2.0E-05	- -	- -	- -	2.0E-05
			Polonium-210	3.5E-03	- -	- -	- -	3.5E-03
			Thorium-232	1.5E-06	- -	- -	- -	1.5E-06
			Radium-228+D	1.5E-05	- -	- -	- -	1.5E-05
			Thorium-228+D	4.4E-06	- -	- -	- -	4.4E-06
							Groundwater Risk Total =	8E-03
							Total Risk =	8E-03
Groundwater	Groundwater	On-Property Bedrock Groundwater Used As Tap Water						
			Trichloroethene	4.1E-06	1.1E-07	5.3E-07	- -	4.8E-06
			Bis(2-Ethylhexyl)phthalate	1.1E-06	N/A	1.4E-06	- -	2.5E-06
			Arsenic	1.9E-04	N/A	9.2E-07	- -	1.9E-04
			Uranium-238+D	1.4E-05	- -	- -	- -	1.4E-05
			Uranium-235+D	5.3E-07	- -	- -	- -	5.3E-07
			Uranium-234	1.2E-05	- -	- -	- -	1.2E-05
			Actinium-227+D	3.6E-06	- -	- -	- -	3.6E-06
			Thorium-230	1.5E-05	- -	- -	- -	1.5E-05
			Radium-226+D	8.7E-05	- -	- -	- -	8.7E-05
			Lead-210	2.0E-04	- -	- -	- -	2.0E-04
			Bismuth-210	2.2E-06	- -	- -	- -	2.2E-06
			Polonium-210	3.8E-04	- -	- -	- -	3.8E-04
			Thorium-232	2.2E-07	- -	- -	- -	2.2E-07
			Radium-228+D	2.3E-06	- -	- -	- -	2.3E-06
			Thorium-228+D	6.6E-07	- -	- -	- -	6.6E-07
							Groundwater Risk Total =	9E-04
							Total Risk =	9E-04

Table G-10

Risk Characterization Summary - Carcinogens

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total
Groundwater	Groundwater	On-Property Overburden Groundwater Plume Used As Tap Water						
			Tetrachloroethene	2.1E-06	1.0E-07	1.1E-06	- -	3.3E-06
			Trichloroethene	1.6E-05	3.0E-07	2.1E-06	- -	1.9E-05
			1,4-Dioxane	2.3E-05	N/A	7.0E-08	- -	2.3E-05
			Bis(2-Ethylhexyl)phthalate	2.3E-06	N/A	2.9E-06	- -	5.2E-06
			Arsenic	3.4E-04	N/A	1.6E-06	- -	3.4E-04
			Uranium-238+D	3.2E-03	- -	- -	- -	3.2E-03
			Uranium-235+D	3.4E-05	- -	- -	- -	3.4E-05
			Uranium-234	4.3E-04	- -	- -	- -	4.3E-04
			Thorium-232	6.4E-07	- -	- -	- -	6.4E-07
			Radium-228+D	6.6E-06	- -	- -	- -	6.6E-06
			Thorium-228+D	1.9E-06	- -	- -	- -	1.9E-06
							Groundwater Risk Total =	4E-03
							Total Risk =	4E-03
Groundwater	Groundwater	On-Property Overburden Groundwater Used As Tap Water						
			Vinyl chloride	3.7E-05	5.0E-08	1.3E-06	- -	3.8E-05
			Bis(2-Ethylhexyl)phthalate	1.0E-06	N/A	1.3E-06	- -	2.3E-06
			Arsenic	4.3E-04	N/A	2.1E-06	- -	4.3E-04
			Uranium-238+D	2.6E-06	- -	- -	- -	2.6E-06
			Uranium-234	2.3E-06	- -	- -	- -	2.3E-06
			Thorium-230	2.9E-06	- -	- -	- -	2.9E-06
			Radium-226+D	1.6E-05	- -	- -	- -	1.6E-05
			Lead-210	3.8E-05	- -	- -	- -	3.8E-05
			Polonium-210	7.2E-05	- -	- -	- -	7.2E-05
			Thorium-232	5.0E-07	- -	- -	- -	5.0E-07
			Radium-228+D	5.2E-06	- -	- -	- -	5.2E-06
			Thorium-228+D	1.5E-06	- -	- -	- -	1.5E-06
							Groundwater Risk Total =	6E-04
							Total Risk =	6E-04

Table G-10

Risk Characterization Summary - Carcinogens

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total
Groundwater	Groundwater	Off-Property Bedrock Groundwater Used As Tap Water						
			Trichloroethene	2.3E-05	6.6E-07	3.2E-06	- -	2.7E-05
			Vinyl chloride	3.2E-05	4.5E-08	1.1E-06	- -	3.4E-05
			1,4-Dioxane	1.4E-04	N/A	4.4E-07	- -	1.4E-04
			Arsenic	1.6E-04	N/A	7.8E-07	- -	1.6E-04
			Uranium-238+D	1.1E-05	- -	- -	- -	1.1E-05
			Uranium-234	1.0E-05	- -	- -	- -	1.0E-05
			Actinium-227+D	3.0E-06	- -	- -	- -	3.0E-06
			Thorium-230	1.3E-05	- -	- -	- -	1.3E-05
			Radium-226+D	7.3E-05	- -	- -	- -	7.3E-05
			Lead-210	1.7E-04	- -	- -	- -	1.7E-04
			Bismuth-210	1.8E-06	- -	- -	- -	1.8E-06
			Polonium-210	3.2E-04	- -	- -	- -	3.2E-04
			Thorium-232	3.6E-07	- -	- -	- -	3.6E-07
			Radium-228+D	3.7E-06	- -	- -	- -	3.7E-06
			Thorium-228+D	1.1E-06	- -	- -	- -	1.1E-06
							Groundwater Risk Total =	1E-03
							Total Risk =	1E-03
Groundwater	Groundwater	Off-Property Overburden Groundwater Used As Tap Water						
			Trichloroethene	6.3E-05	2.1E-06	8.4E-06	- -	7.3E-05
			1,4-Dioxane	7.4E-05	N/A	2.3E-07	- -	7.5E-05
			Bis(2-Ethylhexyl)phthalate	5.9E-06	N/A	7.6E-06	- -	1.3E-05
			Arsenic	8.7E-05	N/A	4.2E-07	- -	8.8E-05
			Lead-210	3.8E-06	- -	- -	- -	3.8E-06
			Polonium-210	7.2E-06	- -	- -	- -	7.2E-06
			Thorium-232	3.6E-07	- -	- -	- -	3.6E-07
			Radium-228+D	3.7E-06	- -	- -	- -	3.7E-06
			Thorium-228+D	1.1E-06	- -	- -	- -	1.1E-06
							Groundwater Risk Total =	3E-04
							Total Risk =	3E-04

Key

-- Route of exposure is not applicable to this medium.

N/A - Toxicity criteria are not available to quantitatively address this route of exposure.

This table provides risk estimates for the significant routes of exposure for the future young child and adult resident exposed to groundwater used as household water. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of a young child's and adult's exposure to groundwater, as well as the toxicity of the COCs (1,1-dichloroethane, tetrachloroethane, trichloroethane, vinyl chloride, 1,4-dioxane, bis(2-ethylhexyl)phthalate, indeno(1,2,3-cd)pyrene, naphthalene, arsenic, uranium isotopes, and thorium isotopes). The total risk from direct exposure to contaminated groundwater to a future resident, in the event that groundwater is used as a potable source, is estimated to be 8 x 10^{-3} (On-Property Bedrock Plume), 9 x 10^{-4} (On-Property Bedrock), 4 x 10^{-3} (On-Property Overburden Plume), 6 x 10^{-4} (On-Property Overburden), 1 x 10^{-3} (Off-Property Bedrock), and 3 x 10^{-4} (Off-Property Overburden). The COCs contributing most to these risk levels are 1,4-dioxane, trichloroethene, arsenic, and uranium isotopes in groundwater. This risk level indicates that if no clean-up action is taken, a future child/adult resident would have an increased probability of 8 in 1,000 (On-Property Bedrock Plume), 9 in 10,000 (On-Property Bedrock), 4 in 1,000 (On-Property Overburden Plume), 6 in 10,000 (On-Property Overburden), 1 in 1,000 (Off-Property Bedrock), and 3 in 10,000 (Off-Property Overburden) of developing cancer as a result of site-related exposure to the COCs in groundwater. Results presented use current toxicity values along with site-specific exposure parameters from the baseline HHRA.

Source: A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents (U.S. EPA, 1999)

Table G-11

Risk Characterization Summary - Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	On-Property Bedrock Groundwater Plume Used As Tap Water	Trichloroethene	Developmental / Immune System	2.1E+00	1.1E-01	1.3E-01	2.3E+00
			Arsenic	Skin	1.9E+01	N/A	8.4E-02	1.9E+01
			Barium	Kidney	2.2E+00	N/A	1.4E-01	2.4E+00
			Chromium	GI System	2.4E+00	N/A	8.6E-01	3.3E+00
			Cobalt	Thyroid	3.8E+00	N/A	1.7E-02	3.8E+00
			Iron	GI System	5.5E+00	N/A	N/A	5.5E+00
			Manganese	CNS	4.9E+00	N/A	5.4E-01	5.5E+00
			Molybdenum	Kidney	2.2E+00	N/A	9.8E-03	2.2E+00
			Uranium	Kidney	3.5E+01	N/A	1.5E-01	3.5E+01
			Nitrate as N	Hematological	6.8E+00	N/A	N/A	6.8E+00
			Nitrite as N	Hematological	1.0E+01	N/A	N/A	1.0E+01
							Groundwater Hazard Index Total =	1E+02
							Skin Hazard Index =	2E+01
							Immune System Hazard Index =	2E+00
							Developmental Hazard Index =	2E+00
							Kidney Hazard Index =	4E+01
							Thyroid Hazard Index =	4E+00
							GI System Hazard Index =	9E+00
							CNS Hazard Index =	6E+00
							Hematological Hazard Index =	2E+01
Groundwater	Groundwater	On-Property Bedrock Groundwater Used As Tap Water	Arsenic	Skin	2.3E+00	N/A	1.0E-02	2.3E+00
			Iron	GI System	1.8E+00	N/A	N/A	1.8E+00
			Manganese	CNS	1.4E+00	N/A	1.5E-01	1.6E+00
			Uranium	Kidney	3.8E+00	N/A	1.7E-02	3.8E+00
							Groundwater Hazard Index Total =	9E+00
							Skin Hazard Index =	2E+00
							Kidney Hazard Index =	4E+00
							GI System Hazard Index =	2E+00
							CNS Hazard Index =	2E+00

Table G-11

Risk Characterization Summary - Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	On-Property Overburden Groundwater Plume Used As Tap Water						
			Tetrachloroethene	CNS	9.6E-01	3.0E-02	3.7E-01	1.3E+00
			Trichloroethene	Developmental / Immune System	2.6E+00	1.3E-01	1.6E-01	2.7E+00
			Arsenic	Skin	4.1E+00	N/A	1.8E-02	4.1E+00
			Chromium	GI System	2.8E+00	N/A	1.0E+00	3.8E+00
			Cobalt	Thyroid	1.3E+01	N/A	5.6E-02	1.3E+01
			Copper	GI System	3.8E+00	N/A	1.7E-02	3.8E+00
			Iron	GI System	5.5E+00	N/A	N/A	5.5E+00
			Manganese	CNS	3.5E+00	N/A	3.9E-01	3.9E+00
			Molybdenum	Kidney	1.8E+01	N/A	7.8E-02	1.8E+01
			Uranium	Kidney	8.8E+02	N/A	3.9E+00	8.8E+02
			Nitrate as N	Hematological	6.8E+00	N/A	N/A	6.8E+00
			Nitrite as N	Hematological	2.0E+00	N/A	N/A	2.0E+00
							Groundwater Hazard Index Total =	9E+02
							Skin Hazard Index =	4E+00
							Immune System Hazard Index =	3E+00
							Kidney Hazard Index =	9E+02
							Developmental Hazard Index =	3E+00
							Thyroid Hazard Index =	1E+01
							GI System Hazard Index =	1E+01
							CNS Hazard Index =	5E+00
							Hematological Hazard Index =	9E+00
Groundwater	Groundwater	On-Property Overburden Groundwater Used As Tap Water						
			Arsenic	Skin	5.2E+00	N/A	2.3E-02	5.2E+00
			Cobalt	Thyroid	4.9E+00	N/A	2.1E-02	4.9E+00
			Iron	GI System	2.5E+00	N/A	N/A	2.5E+00
			Manganese	CNS	5.1E+00	N/A	5.6E-01	5.6E+00
							Groundwater Hazard Index Total =	2E+01
							Skin Hazard Index =	5E+00
							Thyroid Hazard Index =	5E+00
							GI System Hazard Index =	3E+00
							CNS Hazard Index =	6E+00
Groundwater	Groundwater	Off-Property Bedrock Groundwater Used As Tap Water						

Table G-11

Risk Characterization Summary - Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
			Trichloroethene	Developmental / Immune System	3.8E+00	2.0E-01	2.3E-01	4.0E+00
			Arsenic	Skin	1.9E+00	N/A	8.6E-03	2.0E+00
			Cobalt	Thyroid	9.1E+00	N/A	4.0E-02	9.1E+00
			Iron	GI System	4.3E+00	N/A	N/A	4.3E+00
			Manganese	CNS	1.7E+01	N/A	1.8E+00	1.8E+01
			Uranium	Kidney	3.2E+00	N/A	1.4E-02	3.2E+00
			Nitrate as N	Hematological	1.7E+01	N/A	N/A	1.7E+01
							Groundwater Hazard Index Total =	6E+01
							Skin Hazard Index =	2E+00
							Immune System Hazard Index =	4E+00
							Kidney Hazard Index =	3E+00
							Developmental Hazard Index =	4E+00
							Thyroid Hazard Index =	9E+00
							GI System Hazard Index =	4E+00
							CNS Hazard Index =	2E+01
							Hematological Hazard Index =	2E+01
Groundwater	Groundwater	Off-Property Overburden Groundwater Used As Tap Water	Trichloroethene	Developmental / Immune System	1.0E+01	5.3E-01	6.1E-01	1.1E+01
			Iron	GI System	4.5E+00	N/A	N/A	4.5E+00
							Groundwater Hazard Index Total =	2E+01
							Immune System Hazard Index =	1E+01
							Developmental Hazard Index =	1E+01
							GI System Hazard Index =	5E+00

Key

N/A - Toxicity criteria are not available to quantitatively address this route of exposure.

-- Route of exposure is not applicable to this medium.

This table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of the hazard quotients) for all routes of exposure for the future young child and adult resident exposed to groundwater used as household water. The Risk Assessment Guidance for Superfund (RAGS) states that, generally, a hazard index (HI) of greater than 1 indicates the potential for adverse noncancer effects. The estimated target organ HIs between 2 and 900 indicate that the potential for adverse effects could occur from exposure to contaminated groundwater containing tetrachloroethene, trichloroethene, arsenic, barium, chromium, cobalt, copper, iron, manganese, molybdenum, uranium, nitrate, and nitrite. Results presented use current toxicity values along with site-specific exposure parameters from the baseline HHRA.

Source: A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents (U.S. EPA, 1999)

Table G-12

Risk Characterization Summary - Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Abutting Resident/Recreational Visitor
Receptor Age: Young Child

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Cooling Pond	Aroclor-1254	Immune System	1.7E+01	--	5.7E+00	2.3E+01
							Sediment Hazard Index Total =	2E+01
							Immune System Hazard Index =	2E+01

Key

N/A - Toxicity criteria are not available to quantitatively address this route of exposure.

-- Route of exposure is not applicable to this medium.

This table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of the hazard quotients) for all routes of exposure for a future child abutting resident/recreational visitor exposed to sediment in the Cooling Pond. The Risk Assessment Guidance for Superfund (RAGS) states that, generally, a hazard index (HI) of greater than 1 indicates the potential for adverse noncancer effects. The estimated target organ HI of 20 indicates that the potential for adverse effects could occur from exposure to contaminated sediment containing PCBs. Results presented use current toxicity values along with site-specific exposure parameters from the baseline HHRA.

Source: A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents (U.S. EPA, 1999)

Table G-13

Risk Characterization Summary - Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Child Recreational Visitor
Receptor Age: Young Child

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Surface Soil	Area	Aroclor-1254	Immune System	2.4E+00	N/A	9.3E-01	3.3E+00
							Surface Soil Hazard Index Total =	3E+00
							Immune System Hazard Index =	3E+00
Soil	Subsurface Soil	Area	Aroclor-1254	Immune System	1.4E+00	N/A	5.4E-01	1.9E+00
							Subsurface Soil Hazard Index Total =	2E+00
							Immune System Hazard Index =	2E+00
Soil	Surface Soil	AOI 7 & 11 Industrial Area East	Uranium	Kidney	3.9E+00	2.1E-05	N/A	3.9E+00
							Surface Soil Hazard Index Total =	4E+00
							Kidney Hazard Index =	4E+00
Soil	Subsurface Soil	AOI 7 & 11 Industrial Area East	Aroclor-1254	Immune System	2.7E+00	N/A	1.0E+00	3.7E+00
			Uranium	Kidney	1.6E+00	8.7E-06	N/A	1.6E+00
							Subsurface Soil Hazard Index Total =	5E+00
							Kidney Hazard Index =	2E+00
							Immune System Hazard Index =	4E+00
Soil	Surface Soil	AOI 2 & 4 Soils Area at Cooling Pond	Aroclor-1260	Immune System	4.1E+00	N/A	1.6E+00	5.7E+00
							Surface Soil Hazard Index Total =	6E+00
							Immune System Hazard Index =	6E+00

Table G-13

Risk Characterization Summary - Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Child Recreational Visitor
Receptor Age: Young Child

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Subsurface Soil	AOI 2 & 4 Soils Area at Cooling Pond	Aroclor-1260	Immune System	2.3E+00	N/A	9.2E-01	3.3E+00
							Subsurface Soil Hazard Index Total =	3E+00
							Immune System Hazard Index =	3E+00
Soil	Surface Soil	AOI 1 Holding Basin	Uranium	Kidney	1.5E+00	7.8E-06	N/A	1.5E+00
							Surface Soil Hazard Index Total =	2E+00
							Kidney Hazard Index =	2E+00
Soil	Subsurface Soil	AOI 1 Holding Basin	Uranium	Kidney	1.7E+00	9.3E-06	N/A	1.7E+00
							Subsurface Soil Hazard Index Total =	2E+00
							Kidney Hazard Index =	2E+00

Key

N/A - Toxicity criteria are not available to quantitatively address this route of exposure.

-- Route of exposure is not applicable to this medium.

This table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of the hazard quotients) for all routes of exposure for a future child recreational visitor exposed to surface and subsurface soil at the following Areas of Interest: AOI 8 Sweepings Area, AOI 7 & 11 Industrial Area East, AOI 2 & 4 Soils Area at Cooling Pond, and AOI 1 Holding Basin. The Risk Assessment Guidance for Superfund (RAGS) states that, generally, a hazard index (HI) of greater than 1 indicates the potential for adverse noncancer effects. The estimated target organ HIs between 2 and 6 indicates that the potential for adverse effects could occur from exposure to contaminated sediment containing PCBs and uranium. Results presented use current toxicity values along with site-specific exposure parameters from the baseline HHRA.

Source: A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents (U.S. EPA, 1999)

Table G-14

Risk Characterization Summary - Carcinogens

Scenario Timeframe: Future
Receptor Population: Outdoor Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Carcinogenic Risk				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total
Soil	Surface Soil	AOI 7 & 11 Industrial Area East						
			Benzo(a)pyrene	6.0E-07	6.0E-12	5.2E-07	- -	1.1E-06
			Aroclor-1254	1.2E-06	2.2E-11	1.1E-06	- -	2.3E-06
			Arsenic	2.4E-06	4.6E-10	2.9E-06	- -	5.3E-06
			Uranium-238+D	6.9E-06	3.6E-08	- -	1.4E-04	1.5E-04
			Uranium-235+D	6.9E-08	5.0E-10	- -	8.5E-06	8.6E-06
			Uranium-234	9.3E-07	7.5E-09	- -	5.2E-08	9.9E-07
			Thorium-232	2.1E-08	3.9E-10	- -	9.6E-10	2.2E-08
			Radium-228+D	1.6E-07	4.7E-11	- -	1.3E-05	1.3E-05
			Thorium-228+D	4.0E-08	1.3E-09	- -	2.2E-05	2.2E-05
							Surface Soil Risk Total =	2E-04
							Total Risk =	2E-04

Key

N/A - Toxicity criteria are not available to quantitatively address this route of exposure.

-- Route of exposure is not applicable to this medium.

This table provides risk estimates for the significant routes of exposure for a future adult outdoor worker exposed to surface soil at AOI 7 & 11 Industrial Area East. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the exposure to soil by an adult outdoor worker, as well as the toxicity of the COCs (benzo(a)pyrene, PCBs, arsenic, uranium isotopes, and thorium isotopes). The total risk from surface soil exposure to a future adult outdoor worker is estimated to be 2×10^{-4}. The COCs contributing most to this risk level are uranium isotopes. This risk level indicates that if no clean-up action is taken, an individual would have an increased probability of 2 in 10,000 of developing cancer as a result of site-related exposure to the COCs in surface soil. Results presented use current toxicity values along with site-specific exposure parameters from the baseline HHRA.

Source: A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents (U.S. EPA, 1999)

Table G-15

Risk Characterization Summary - Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Surface Soil	AOI 8 Sweepings Area	Aroclor-1254	Immune System	1.0E+00	N/A	4.4E-01	1.4E+00
			Aroclor-1260	Immune System	1.5E-01	N/A	6.4E-02	2.1E-01
							Surface Soil Hazard Index Total =	2E+00
							Immune System Hazard Index =	2E+00
Soil	Surface Soil	AOI 7 & 11 Industrial Area East	Uranium	Kidney	1.3E+00	5.7E-02	N/A	1.4E+00
							Surface Soil Hazard Index Total =	1E+00
							Kidney Hazard Index =	1E+00
Soil	Subsurface Soil	AOI 7 & 11 Industrial Area East	Aroclor-1254	Immune System	1.2E+00	N/A	4.9E-01	1.7E+00
							Subsurface Soil Hazard Index Total =	2E+00
							Immune System Hazard Index =	2E+00
Soil	Surface Soil	AOI 2 & 4 Soils Area at Cooling Pond	Aroclor-1260	Immune System	1.8E+00	N/A	7.6E-01	2.6E+00
							Surface Soil Hazard Index Total =	3E+00
							Immune System Hazard Index =	3E+00
Soil	Subsurface Soil	AOI 2 & 4 Soils Area at Cooling Pond	Aroclor-1254	Immune System	2.4E-01	N/A	1.0E-01	3.4E-01
			Aroclor-1260	Immune System	1.0E+00	N/A	4.3E-01	1.4E+00
							Subsurface Soil Hazard Index Total =	2E+00
							Immune System Hazard Index =	2E+00

Key

N/A - Toxicity criteria are not available to quantitatively address this route of exposure.

-- Route of exposure is not applicable to this medium.

This table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of the hazard quotients) for all routes of exposure for a future adult construction worker exposed to surface and subsurface soil at the following Areas of Interest: AOI 8 Sweepings Area, AOI 7 & 11 Industrial Area East, and AOI 2 & 4 Soils Area at Cooling Pond. The Risk Assessment Guidance for Superfund (RAGS) states that, generally, a hazard index (HI) of greater than 1 indicates the potential for adverse noncancer effects. The estimated target organ HIs between 1.4 and 3 indicate that the potential for adverse effects could occur from exposure to contaminated soil containing PCBs and uranium. Results presented use current toxicity values along with site-specific exposure parameters from the baseline HHRA.

Source: A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents (U.S. EPA, 1999)

Table G-16

Occurrence, Distribution, and Selection of Chemicals of Potential Concern (COPCs)
Cooling Water Pond

Nuclear Metals Superfund Site, Concord, Massachusetts
Medium: Surface Water

Analyte	Frequency of Detection	Range of Detected Concentrations	Average (arithmetic mean) [a]	Final Selected Benchmark [b]	COPC? [c]	Rationale [c]	Maximum HQ [d]	Average HQ [e]
Semivolatile Organics (mg/L)								
Benzo(a)anthracene	1 / 7	0.000261 - 0.000261	0.000060	0.000027	Yes	ASL	9.7	2.2
Benzo(a)pyrene	1 / 7	0.000295 - 0.000295	0.000065	0.000014	Yes	ASL	21	4.6
Benzo(k)fluoranthene	1 / 7	0.000191 - 0.000191	0.000038	0.00014	Yes	ASL	1.4	0.3
Chrysene	1 / 7	0.000288 - 0.000288	0.000064	0.000070	Yes	ASL	4.1	0.9
Pyrene	2 / 7	0.000023 - 0.000521	0.000096	0.00040	Yes	ASL	1.3	0.2
Metals, Total (mg/L)								
Aluminum	7 / 7	0.0763 - 0.615	0.29	0.087	Yes	ASL	7.1	3.3
Barium	7 / 7	0.0087 - 0.011	0.010	0.0039	Yes	ASL	2.8	2.6
Copper	2 / 7	0.202 - 0.252	0.090	0.0049	Yes	ASL	51	18.5
Lead	3 / 7	0.0052 - 0.0099	0.0040	0.0012	Yes	ASL	8.3	3.3
Titanium	4 / 7	0.005300 - 0.0124	0.0078		Yes	NSL	NA	NA
Uranium	7 / 7	0.0049 - 0.0133	0.0080		Yes	NSL	NA	NA
Zinc	3 / 7	0.0555 - 0.0872	0.042	0.064	Yes	ASL	1.4	0.6
Metals, Dissolved (mg/L)								
Barium	7 / 7	0.0083 - 0.0099	0.0089	0.0040	Yes	ASL	2.5	2.2
Copper	7 / 7	0.0263 - 0.0338	0.029	0.0047	Yes	ASL	7.2	6.2
Manganese	5 / 7	0.0028 - 0.004	0.0028		Yes	NSL	NA	NA
Tungsten	4 / 7	0.00023 - 0.00032	0.00021		Yes	NSL	NA	NA
Uranium	7 / 7	0.0044 - 0.0055	0.0049	0.0026	Yes	ASL	2.1	1.9
Zirconium	1 / 7	0.0485 - 0.0485	0.0070	0.017	Yes	ASL	2.9	0.4
EPH (mg/L)								
C11-C22 Aromatics	1 / 7	0.137 - 0.137	0.081		Yes	NSL	NA	NA
C19-C36 Aliphatics	2 / 7	0.0876 - 0.132	0.059		Yes	NSL	NA	NA
C9-C18 Aliphatics	1 / 7	0.0232 - 0.0232	0.028		Yes	NSL	NA	NA

Notes:
[a] Average (arithmetic mean) was calculated using one-half the detection limit for non detects.
[b] Screening benchmarks were selected in BERA Table 3-9. Where applicable, benchmarks were adjusted based on measured hardness of 47.4 mg/L as $CaCO_3$.
[c] Chemical is selected as a chemical of potential concern (COPC) if the maximum detected concentration is greater than the screening benchmark or a screening benchmark is unavailable, unless the frequency of detection (FOD) is less than 5%.
ASL - Above Screening Level
NSL - No Screening Level
[d] Hazard quotient (HQ) is the maximum detected concentration divided by the screening benchmark. HQs are only calculated for COPCs.
[e] Average HQ is the average detected concentration divided by the screening benchmark.

NA - Hazard quotient not calculated because benchmark not available.
mg/L - milligrams per liter

Table G-17

Occurrence, Distribution, and Selection of Chemicals of Potential Concern (COPCs)
Cooling Water Pond

Nuclear Metals Superfund Site, Concord, Massachusetts
Medium: Sediment

Analyte	Frequency of Detection	Range of Detected Concentrations	Average (arithmetic mean) [a]	Final Selected Benchmark [b]	COPC? [c]	Rationale [c]	Maximum HQ [d]	Average HQ [e]
Volatile Organics (mg/Kg)								
Carbon disulfide	8 / 12	0.0011 - 0.0106	0.0042	0.00075	Yes	ASL	14	5.6
Semivolatile Organics (mg/Kg)								
2,4,6-Trichlorophenol	1 / 12	0.0972 - 0.0972	0.24		Yes	NSL	NA	NA
2-Methylnaphthalene	4 / 12	0.0163 - 0.0744	0.031	0.070	Yes	ASL	1.1	0.45
Acenaphthene	6 / 13	0.0227 - 0.101	0.039	0.016	Yes	ASL	6.3	2.4
Acenaphthylene	4 / 13	0.0212 - 0.148	0.034	0.044	Yes	ASL	3.4	0.78
Anthracene	10 / 13	0.014 - 0.317	0.072	0.057	Yes	ASL	5.6	1.3
Benzo(a)anthracene	13 / 13	0.0299 - 1.79	0.33	0.11	Yes	ASL	16	3.0
Benzo(a)pyrene	12 / 13	0.0165 - 1.71	0.33	0.15	Yes	ASL	11	2.2
Benzo(b)fluoranthene	13 / 13	0.0678 - 3.58	0.59	0.21	Yes	ASL	17	2.8
Benzo(ghi)perylene	10 / 13	0.0226 - 0.82	0.16	0.15	Yes	ASL	5.5	1.1
Benzo(k)fluoranthene	8 / 13	0.0306 - 0.439	0.085	0.21	Yes	ASL	2.1	0.41
Chrysene	13 / 13	0.0231 - 2.3	0.40	0.17	Yes	ASL	14	2.3
Dibenz(a,h)anthracene	1 / 13	0.195 - 0.195	0.038	0.033	Yes	ASL	5.9	1.1
Fluoranthene	13 / 13	0.047 - 4.09	0.78	0.42	Yes	ASL	9.7	1.9
Fluorene	7 / 13	0.0147 - 0.243	0.060	0.019	Yes	ASL	13	3.2
Indeno(1,2,3-cd)pyrene	13 / 13	0.0187 - 0.872	0.25	0.18	Yes	ASL	4.8	1.4
Phenanthrene	13 / 13	0.0265 - 2.44	0.47	0.20	Yes	ASL	12	2.3
Pyrene	13 / 13	0.0511 - 3.77	0.70	0.20	Yes	ASL	19	3.5
PCBs (mg/Kg)								
Aroclor-1254	6 / 6	0.436 - 366	67	0.053	Yes	ASL	6,906	1,261
Aroclor-1260	1 / 6	0.0697 - 0.0697	6.1	0.0044	Yes	ASL	16	1,387
Inorganics (mg/Kg)								
Aluminum	13 / 13	5080 - 11500	7,976		Yes	NSL	NA	NA
Antimony	1 / 13	2.7 - 2.7	0.49	2.0	Yes	ASL	1.4	0.24
Arsenic	13 / 13	6.6 - 19.5	12.5	6.0	Yes	ASL	3.3	2.1
Barium	13 / 13	19.5 - 158	43		Yes	NSL	NA	NA
Beryllium	13 / 13	0.71 - 2.9	1.6		Yes	NSL	NA	NA
Copper	13 / 13	256 - 1040	529	16	Yes	ASL	65	33
Lead	13 / 13	22.2 - 139	55	31	Yes	ASL	4.5	1.8
Mercury	13 / 13	0.023 - 0.22	0.085	0.15	Yes	ASL	1.5	0.57
Nickel	13 / 13	9.9 - 20	15	16	Yes	ASL	1.3	0.94
Thallium	12 / 13	0.07 - 0.15	0.10		Yes	NSL	NA	NA
Thorium	13 / 13	2.1 - 5.9	4.0		Yes	NSL	NA	NA
Titanium	13 / 13	131 - 532	398		Yes	NSL	NA	NA
Tungsten	10 / 13	0.45 - 1.3	0.61		Yes	NSL	NA	NA
Uranium	13 / 13	6.9 - 129	31	32	Yes	ASL	4.0	0.98
Vanadium	13 / 13	9 - 32.2	17.0	27	Yes	ASL	1.2	0.63
Zinc	13 / 13	51.9 - 153	82	120	Yes	ASL	1.3	0.68
Zirconium	13 / 13	1.3 - 4.6	3.0		Yes	NSL	NA	NA
EPH (mg/Kg)								
C11-C22 Aromatics	3 / 12	65.8 - 288	124		Yes	NSL	NA	NA
C19-C36 Aliphatics	12 / 12	14.7 - 610	119		Yes	NSL	NA	NA

Table G-17

Occurrence, Distribution, and Selection of Chemicals of Potential Concern (COPCs)
Cooling Water Pond

Nuclear Metals Superfund Site, Concord, Massachusetts
Medium: Sediment

Analyte	Frequency of Detection	Range of Detected Concentrations	Average (arithmetic mean) [a]	Final Selected Benchmark [b]	COPC? [c]	Rationale [c]	Maximum HQ [d]	Average HQ [e]
C9-C18 Aliphatics	3 / 12	3.92 - 13	30		Yes	NSL	NA	NA

Notes:
[a] Average (arithmetic mean) was calculated using one-half the detection limit for non-detects.
[b] Screening benchmarks were selected in BERA Table 3-11. Where applicable, benchmarks were adjusted based on site-wide average of 0.88% TOC.
[c] Chemical is selected as a chemical of potential concern (COPC) if the maximum detected concentration is greater than the screening benchmark or a screening benchmark is unavailable, unless the frequency of detection (FOD) is less than 5%.
ASL - Above Screening Level
NSL - No Screening Level
[d] Hazard quotient (HQ) is the maximum detected concentration divided by the screening benchmark. HQs are only calculated for COPCs.
[e] Average HQ is the average detected concentration divided by the screening benchmark.

NA - Hazard quotient not calculated because benchmark not available.
mg/Kg - milligram per kilogram
TOC - total organic carbon

Table G-18

Occurrence, Distribution, and Selection of Chemicals of Potential Concern (COPCs)
Sphagnum Bog

Nuclear Metals Superfund Site, Concord, Massachusetts
Medium: Surface Water

Analyte	Frequency of Detection	Range of Detected Concentrations	Average (arithmetic mean) [a]	Final Selected Benchmark [b]	COPC? [c]	Rationale [c]	Maximum HQ [d]	Average HQ [e]
Semivolatile Organics (mg/L)								
4-Methylphenol	1 / 3	0.0028 - 0.0028	0.0043	0.000027	Yes	ASL	103.7	158.0
Chrysene	2 / 20	0.000143 - 0.000203	0.0000	0.00007	Yes	ASL	2.9	0.6
Pyrene	5 / 20	0.0000558 - 0.000511	0.0001	0.0004	Yes	ASL	1.3	0.2
Metals, Total (mg/L)								
Aluminum	25 / 25	0.0799 - 2.29	0.3215	0.087	Yes	ASL	26.3	3.7
Barium	25 / 25	0.0025 - 0.142	0.0209	0.0039	Yes	ASL	36.4	5.4
Beryllium	21 / 25	0.00008 - 0.0173	0.0023	0.0051	Yes	ASL	3.4	0.4
Cadmium	8 / 25	0.000046 - 0.0011	0.0001	0.00025	Yes	ASL	4.4	0.5
Copper	8 / 25	0.0182 - 0.738	0.0506	0.0018	Yes	ASL	410.0	28.1
Iron	25 / 25	0.119 - 2.22	0.6380	1	Yes	ASL	2.2	0.6
Lead	14 / 25	0.0013 - 0.0948	0.0079	0.00028	Yes	ASL	338.6	28.2
Manganese	25 / 25	0.0189 - 0.488	0.0946	0.08	Yes	ASL	6.1	1.2
Mercury	12 / 25	0.000025 - 0.0021	0.0002	0.00091	Yes	ASL	2.3	0.2
Nickel	25 / 25	0.00057 - 0.0351	0.0058	0.01	Yes	ASL	3.5	0.6
Silver	9 / 25	0.00013 - 0.0055	0.0005	0.000012	Yes	ASL	458.3	39.5
Titanium	20 / 25	0.0054 - 0.0857	0.0119		Yes	NSL	NA	NA
Tungsten	9 / 25	0.00011 - 0.0092	0.0015		Yes	NSL	NA	NA
Uranium	25 / 25	0.00067 - 0.078	0.0112		Yes	NSL	NA	NA
Uranium-235 as Mass	25 / 25	0.000001 - 0.0003	0.0000		Yes	NSL	NA	NA
Uranium-238 as Mass	25 / 25	0.00067 - 0.0777	0.0112		Yes	NSL	NA	NA
Zinc	12 / 25	0.0113 - 0.233	0.0393	0.024	Yes	ASL	9.7	1.6
Zirconium	5 / 25	0.0007 - 0.0037	0.0007		Yes	NSL	NA	NA
Metals, Dissolved (mg/L)								
Aluminum	25 / 25	0.0431 - 2.51	0.1967	0.087	Yes	ASL	28.9	2.3
Barium	25 / 25	0.0018 - 0.0887	0.0111	0.004	Yes	ASL	22.2	2.8
Beryllium	20 / 25	0.00002 - 0.0255	0.0021	0.00066	Yes	ASL	38.6	3.2
Cadmium	6 / 25	0.000033 - 0.0179	0.0007	0.00025	Yes	ASL	71.6	3.0
Chromium	2 / 25	0.0061 - 0.0222	0.0015	0.016	Yes	ASL	1.4	0.1
Copper	25 / 25	0.0024 - 0.567	0.0359	0.0018	Yes	ASL	315.0	19.9
Iron	24 / 25	0.0437 - 2.32	0.4491	1	Yes	ASL	2.3	0.4
Lead	8 / 25	0.00082 - 0.153	0.0075	0.0003	Yes	ASL	510.0	24.9
Manganese	25 / 25	0.0115 - 0.199	0.0592		Yes	NSL	NA	NA
Mercury	3 / 25	0.000043 - 0.0015	0.0001	0.00077	Yes	ASL	1.9	0.1
Nickel	25 / 25	0.0008 - 0.0407	0.0053	0.01	Yes	ASL	4.1	0.5
Selenium	2 / 25	0.0025 - 0.0089	0.0012	0.005	Yes	ASL	1.8	0.2
Silver	13 / 25	0.000046 - 0.0066	0.0003	0.00036	Yes	ASL	18.3	0.9
Titanium	23 / 25	0.001 - 0.0635	0.0065		Yes	NSL	NA	NA
Tungsten	8 / 25	0.0016 - 0.0074	0.0013		Yes	NSL	NA	NA
Uranium	25 / 25	0.00035 - 0.147	0.0104	0.0026	Yes	ASL	56.5	4.0
Vanadium	7 / 25	0.0011 - 0.0271	0.0020	0.02	Yes	ASL	1.4	0.1
Zinc	25 / 25	0.0076 - 0.226	0.0436	0.023	Yes	ASL	9.8	1.9
EPH (mg/L)								
C11-C22 Aromatics	14 / 20	0.0573 - 1.01	0.2556		Yes	NSL	NA	NA

Table G-18

Occurrence, Distribution, and Selection of Chemicals of Potential Concern (COPCs)
Sphagnum Bog

Nuclear Metals Superfund Site, Concord, Massachusetts
Medium: Surface Water

Analyte	Frequency of Detection	Range of Detected Concentrations	Average (arithmetic mean) [a]	Final Selected Benchmark [b]	COPC? [c]	Rationale [c]	Maximum HQ [d]	Average HQ [e]
C19-C36 Aliphatics	12 / 20	0.025 - 0.224	0.0566		Yes	NSL	NA	NA
C9-C18 Aliphatics	5 / 20	0.0155 - 0.0591	0.0276		Yes	NSL	NA	NA

Notes:
[a] Average (arithmetic mean) was calculated using one-half the detection limit for non detects.
[b] Screening benchmarks were selected in BERA Table 3-9. Where applicable, benchmarks were adjusted based on measured hardness of 14.9 mg/L as $CaCO_3$.
[c] Chemical is selected as a chemical of potential concern (COPC) if the maximum detected concentration is greater than the screening benchmark or a screening benchmark is unavailable, unless the frequency of detection (FOD) is less than 5%.
ASL - Above Screening Level
NSL - No Screening Level
[d] Hazard quotient (HQ) is the maximum detected concentration divided by the screening benchmark. HQs are only calculated for COPCs.
[e] Average HQ is the average detected concentration divided by the screening benchmark.

NA - Hazard quotient not calculated because benchmark not available.
mg/L - milligrams per liter

Table G-19

Occurrence, Distribution, and Selection of Chemicals of Potential Concern (COPCs)
Sphagnum Bog

Nuclear Metals Superfund Site, Concord, Massachusetts
Medium: Sediment

Analyte	Frequency of Detection	Range of Detected Concentrations	Average (arithmetic mean) [a]	Final Selected Benchmark [b]	COPC? [c]	Rationale [c]	Maximum HQ [d]	Average HQ [e]
Volatile Organics (mg/Kg)								
Acetone	5 / 10	0.0889 - 0.79	0.24	0.13	Yes	ASL	6.1	1.9
Semivolatile Organics (mg/Kg)								
2,4-Dinitrophenol	1 / 19	0.436 - 0.436	1.4	0.0027	Yes	ASL	161	510
4-Methylphenol	1 / 3	0.163 - 0.163	0.50	0.11	Yes	ASL	1.5	4.5
Acenaphthylene	2 / 28	0.0212 - 0.0732	0.057	0.044	Yes	ASL	1.7	1.29
Anthracene	6 / 28	0.00598 - 0.176	0.059	0.057	Yes	ASL	3.1	1.0
Benzo(a)anthracene	4 / 28	0.0238 - 0.111	0.050	0.11	Yes	ASL	1.0	0.5
Fluorene	2 / 28	0.0198 - 0.0232	0.055	0.019	Yes	ASL	1.2	2.9
m+p-Methylphenol	3 / 16	0.494 - 1.1	0.77		Yes	NSL	NA	NA
Phenol	3 / 19	0.093 - 0.116	0.67	0.048	Yes	ASL	2.4	14
Pyrene	21 / 28	0.0329 - 0.301	0.10	0.20	Yes	ASL	1.5	0.5
PCBs (mg/Kg)								
Aroclor-1254	26 / 28	0.0125 - 27.8	2.1	0.88	Yes	ASL	32	2.4
Aroclor-1260	9 / 29	0.0037 - 0.271	0.15	0.073	Yes	ASL	3.7	2.1
Inorganics (mg/Kg)								
Aluminum	29 / 29	1210 - 11,600	3,882		Yes	NSL	NA	NA
Antimony	11 / 28	0.55 - 2.5	0.43	2.0	Yes	ASL	1.3	0.2
Arsenic	23 / 28	0.49 - 9.2	2.8	6.0	Yes	ASL	1.5	0.5
Barium	28 / 28	10.1 - 98.1	34		Yes	NSL	NA	NA
Beryllium	28 / 28	1.3 - 140	17		Yes	NSL	NA	NA
Cadmium	28 / 28	0.036 - 2	0.52	0.60	Yes	ASL	4.0	0.9
Chromium	28 / 28	3.1 - 96.8	15	26	Yes	ASL	3.7	0.6
Copper	28 / 28	14.4 - 1,590	208	16	Yes	ASL	99	13
Lead	28 / 28	6.8 - 200	41	31	Yes	ASL	6.5	1.3
Mercury	26 / 26	0.0094 - 5.8	0.42	0.15	Yes	ASL	39	2.8
Molybdenum	23 / 23	6.5 - 183	49	8.3	Yes	ASL	22	5.9
Nickel	28 / 28	6.9 - 66	20	16	Yes	ASL	4.1	1.2
Silver	20 / 28	0.28 - 32.4	2.7	1.0	Yes	ASL	32	2.7
Thallium	9 / 28	0.13 - 1.3	0.16		Yes	NSL	NA	NA
Thorium	23 / 23	0.12 - 10.7	2.1		Yes	NSL	NA	NA
Titanium	23 / 23	38.2 - 532	209		Yes	NSL	NA	NA
Tungsten	21 / 23	0.58 - 35	5.5		Yes	NSL	NA	NA
Uranium	30 / 30	2.8 - 327	51	32	Yes	ASL	10	1.6
Zinc	28 / 28	7.8 - 466	82	120	Yes	ASL	3.9	0.7
Zirconium	22 / 22	0.3 - 69	8.28		Yes	NSL	NA	NA
EPH (mg/Kg)								
C11-C22 Aromatics	16 / 19	59 - 801	250		Yes	NSL	NA	NA
C19-C36 Aliphatics	14 / 19	39.6 - 752	147		Yes	NSL	NA	NA
C9-C18 Aliphatics	13 / 19	1.8 - 12.2	4.6		Yes	NSL	NA	NA

Table G-19

Occurrence, Distribution, and Selection of Chemicals of Potential Concern (COPCs)
Sphagnum Bog

Nuclear Metals Superfund Site, Concord, Massachusetts
Medium: Sediment

Analyte	Frequency of Detection	Range of Detected Concentrations	Average (arithmetic mean) [a]	Final Selected Benchmark [b]	COPC? [c]	Rationale [c]	Maximum HQ [d]	Average HQ [e]

Notes:
[a] Average (arithmetic mean) was calculated using one-half the detection limit for non-detects.
[b] Screening benchmarks were selected in BERA Table 3-11. Where applicable, benchmarks were adjusted based AOI 6 average of 14.6% TOC.
[c] Chemical is selected as a chemical of potential concern (COPC) if the maximum detected concentration is greater than the screening benchmark or a screening benchmark is unavailable, unless the frequency of detection (FOD) is less than 5%.
ASL - Above Screening Level
NSL - No Screening Level
[d] Hazard quotient (HQ) is the maximum detected concentration divided by the screening benchmark. HQs are only calculated for COPCs.
[e] Average HQ is the average detected concentration divided by the screening benchmark.

NA - Hazard quotient not calculated because benchmark not available.
mg/Kg - milligram per kilogram
TOC - total organic carbon

Table G-20

Occurrence, Distribution, and Selection of Chemicals of Potential Concern (COPCs)
Sphagnum Bog

Nuclear Metals Superfund Site, Concord, Massachusetts
Medium: Peat

Analyte	Frequency of Detection	Range of Detected Concentrations	Average (arithmetic mean) [a]	Final Selected Benchmark [b]	COPC? [c]	Rationale [c]	Maximum HQ [d]	Average HQ [e]
Semivolatile Organics (mg/Kg)								
2-Methylnaphthalene	1 / 17	0.092 - 0.092	0.082	0.070	Yes	ASL	1.3	1.2
Acenaphthylene	2 / 18	0.09 - 0.738	0.12	0.044	Yes	ASL	16.8	2.7
Anthracene	2 / 18	0.0469 - 0.097	0.092	0.057	Yes	ASL	1.7	1.6
Benzo(a)pyrene	5 / 18	0.0363 - 0.234	0.091	0.15	Yes	ASL	1.6	0.61
Benzoic Acid	13 / 17	0.49 - 9.2	3.1	8.9	Yes	ASL	1.0	0.35
Chrysene	12 / 18	0.0448 - 0.256	0.12	0.17	Yes	ASL	1.5	0.69
Fluoranthene	16 / 18	0.0266 - 0.597	0.17	0.42	Yes	ASL	1.4	0.41
Fluorene	2 / 18	0.036 - 0.105	0.092	0.019	Yes	ASL	5.5	4.8
Phenanthrene	15 / 18	0.0343 - 0.259	0.12	0.20	Yes	ASL	1.3	0.59
Phenol	3 / 17	0.28 - 0.554	0.78	0.048	Yes	ASL	11.5	16.2
Pyrene	16 / 18	0.0737 - 0.391	0.19	0.20	Yes	ASL	2.0	0.95
PCBs (mg/Kg)								
Aroclor-1254	8 / 15	0.0058 - 4.82	0.36	2.1	Yes	ASL	2.3	0.17
Aroclor-1260	4 / 15	0.006 - 0.636	0.065	0.18	Yes	ASL	3.5	0.36
Inorganics (mg/Kg)								
Aluminum	18 / 18	900 - 5,450	1,745		Yes	NSL	NA	NA
Antimony	16 / 18	0.39 - 2.5	0.97	2.0	Yes	ASL	1.3	0.49
Arsenic	10 / 18	2.2 - 14	3.1	6.0	Yes	ASL	2.3	0.51
Barium	18 / 18	6.4 - 105	35		Yes	NSL	NA	NA
Beryllium	18 / 18	0.14 - 143	15.4		Yes	NSL	NA	NA
Cadmium	18 / 18	0.24 - 2	0.87	0.60	Yes	ASL	3.5	1.4
Chromium	17 / 18	3 - 104	12.2	26	Yes	ASL	4.0	0.47
Copper	14 / 18	19.3 - 837	135	16	Yes	ASL	52	8.4
Iron	18 / 18	1070 - 27200	5,025	20,000	Yes	ASL	1.4	0.3
Lead	18 / 18	20.4 - 211	62	31	Yes	ASL	6.8	2.0
Mercury	17 / 18	0.021 - 1.4	0.23	0.15	Yes	ASL	9.3	1.5
Molybdenum	18 / 18	0.7 - 213	43	8.3	Yes	ASL	26	5.2
Nickel	18 / 18	4.3 - 33	11.3	16	Yes	ASL	2.0	0.71
Silver	7 / 18	0.75 - 36	3.1	1.0	Yes	ASL	36	3.1
Thallium	8 / 18	0.11 - 0.67	0.15		Yes	NSL	NA	NA
Thorium	14 / 18	0.069 - 3.2	0.54		Yes	NSL	NA	NA
Titanium	18 / 18	33.2 - 180	65		Yes	NSL	NA	NA
Tungsten	18 / 18	0.59 - 34	5.7		Yes	NSL	NA	NA
Uranium	18 / 18	3.5 - 268	34	32	Yes	ASL	8.4	1.1
Vanadium	18 / 18	7.5 - 30.7	14.0	27	Yes	ASL	1.1	0.52
Zinc	18 / 18	24.6 - 648	156	120	Yes	ASL	5.4	1.3
Zirconium	13 / 13	0.22 - 24.2	3.2		Yes	NSL	NA	NA
EPH (mg/Kg)								
C11-C22 Aromatics	14 / 14	102 - 778	297		Yes	NSL	NA	NA
C19-C36 Aliphatics	14 / 14	25.4 - 1140	144		Yes	NSL	NA	NA
C9-C18 Aliphatics	9 / 14	2.15 - 20.9	5.1		Yes	NSL	NA	NA

Table G-20

Occurrence, Distribution, and Selection of Chemicals of Potential Concern (COPCs)
Sphagnum Bog

Nuclear Metals Superfund Site, Concord, Massachusetts
Medium: Peat

Analyte	Frequency of Detection	Range of Detected Concentrations	Average (arithmetic mean) [a]	Final Selected Benchmark [b]	COPC? [c]	Rationale [c]	Maximum HQ [d]	Average HQ [e]

Notes:
[a] Average (arithmetic mean) was calculated using one-half the detection limit for non-detects.
[b] Screening benchmarks were selected in BERA Table 3-11. Where applicable, benchmarks were adjusted based on AOI 6 peat average of 35.6% TOC.
[c] Chemical is selected as a chemical of potential concern (COPC) if the maximum detected concentration is greater than the screening benchmark or a screening benchmark is unavailable, unless the frequency of detection (FOD) is less than 5%.
ASL - Above Screening Level
NSL - No Screening Level
[d] Hazard quotient (HQ) is the maximum detected concentration divided by the screening benchmark. HQs are only calculated for COPCs.
[e] Average HQ is the average detected concentration divided by the screening benchmark.

NA - Hazard quotient not calculated because benchmark not available.
mg/Kg - milligram per kilogram
TOC - total organic carbon

Table G-21

Ecological Exposure Pathways of Concern - Aquatic Habitats

Exposure Media	Sensitive Environment Flag Y or N	Receptor	Endangered/ Threatened Species Flag Y or N	Exposure Routes	Assessment Endpoints	Measurement Endpoints
AOI 6 - SPHAGNUM BOG						
Surface water	Y	Aquatic Invertebrates	N	Ingestion and direct contact with chemicals in surface water	Aquatic benthic invertebrate community structure.	1A. Compare COPC levels in surface water samples to published surface water benchmarks and to background.
Sediment	Y	Aquatic Invertebrates	N	Ingestion and direct contact with chemicals in sediment	Aquatic benthic invertebrate community structure.	1B1. Compare COPC levels in mineral sediment samples to published sediment benchmarks and to background.
Moss	Y	Aquatic Invertebrates	N	Ingestion and direct contact with chemicals in moss	Aquatic benthic invertebrate community structure.	1B2. Compare COPC levels in moss samples to published mineral sediment benchmarks and to background.
Peat	Y	Aquatic Invertebrates	N	Ingestion and direct contact with chemicals in peat	Aquatic benthic invertebrate community structure.	1B3. Compare COPC levels in peat samples to published mineral sediment benchmarks and to background.
Sediment	Y	Aquatic Invertebrates	N	Ingestion and direct contact with chemicals in sediment	Aquatic benthic invertebrate community structure.	1C. Perform lab toxicity tests to measure survival and growth of a freshwater benthic invertebrate (*Chironomus dilutus*) exposed to mineral sediment and compare results to those measured in background samples.
Sediment	Y	Aquatic Invertebrates	N	Ingestion and direct contact with chemicals in sediment	Aquatic benthic invertebrate community structure.	1D. Assess the health of the benthic community in mineral sediment samples and compare the results to background conditions.
Surface water	Y	Amphibians	N	Ingestion and direct contact with chemicals in surface water	Growth, survival, and reproduction of amphibian populations	2A. Compare surface water concentrations to published surface water benchmarks and to background.
Sediment	Y	Amphibians	N	Ingestion and direct contact with chemicals in sediment	Growth, survival, and reproduction of amphibian populations	2B. Compare site sediment concentrations to published sediment benchmarks and to background
Surface water	Y	Amphibians	N	Ingestion and direct contact with chemicals in surface water	Growth, survival, and reproduction of amphibian populations	2C. Perform laboratory FETAX tests to measure survival, malformation, and growth of amphibians exposed to surface water collected from the site and compare to background.
Sediment, prey	Y	Wetland Birds	N	Dietary exposures of soil COPCs	Growth, survival, and reproduction of semi-aquatic bird populations	3A. Compare the EDDs for omnivorous waterfowl (mallard) based on ingesting prey from the Sphagnum Bog to published avian TRVs and to background conditions.
Sediment, prey	Y	Wetland Birds	N	Dietary exposures of soil COPCs	Growth, survival, and reproduction of semi-aquatic bird populations	3B. Compare the EDDs for predatory wading birds (great blue heron) based on ingesting prey fromthe SphagnumBog to published mammal TRVs and to background conditions.
Sediment, prey	Y	Wetland Mammals	N	Dietary exposures of soil COPCs	Growth, survival, and reproduction of semi-aquatic mammal populations	4A. Compare the EDDs for omnivorous small mammals (shrew) based on ingesting prey from the Sphagnum Bog to published mammal TRVs and to background conditions.
Sediment, prey	Y	Wetland Mammals	N	Dietary exposures of soil COPCs	Growth, survival, and reproduction of semi-aquatic mammal populations	4B. Compare the EDDs for predatory large mammals (raccoon) based on ingesting prey from the *Sphagnum* Bog to published mammal TRVs and to background conditions.

Notes:

COPC - Chemical of Potential Concern
EDD - Estimated Daily Dose
FETAX - Frog Embryo teratogenesis assay - Xenopus
TRV - Toxicity Reference Value

TABLE G-22

SUMMARY OF RISK BY ASSESSMENT ENDPOINT

Receptor Group	Assessment Endpoint	Measurement Endpoint	Weight	Risk summary
Aquatic Invertebrates	Aquatic benthic invertebrate community structure.	1A. Compare COPC levels in surface water samples to published surface water benchmarks and to background.	low-medium	Adverse impacts are possible based on CTE IRs > 1.0 derived from chronic toxicity surface water benchmarks. The three major risk drivers for metals are Cu, Pb, and Ag .
		1B1. Compare COPC levels in mineral sediment samples to published sediment benchmarks and to background.	low-medium	Adverse impacts in mineral sediment are possible based on CTE IRs > 1.0 derived from no-effect sediment benchmarks. The three main risk drivers are 2,4-dinitrophenol, Cu, and Mo.
		1B2. Compare COPC levels in moss samples to published mineral sediment benchmarks and to background.	low-medium	Adverse impacts in moss are possible based on CTE IRs > 1.0 derived from no-effect sediment benchmarks. The three main risk drivers are Cu, Mo, and U.
		1B3. Compare COPC levels in peat samples to published mineral sediment benchmarks and to background.	low-medium	Adverse impacts in peat are possible based on CTE IRs derived from no-effect sediment benchmarks. The three main risk drivers are phenol, Cu and Mo.
		1C. Perform lab toxicity tests to measure survival and growth of a freshwater benthic invertebrate (*Chironomus dilutus*) exposed to mineral sediment and compare results to those measured in background samples.	medium-high	Adverse impacts are possible at several locations in the bog. *C. dilutus* showed statistically significant effects in six of the 11 mineral sediment samples tested for toxicity. Highest impacts were measured only at two locations which corresponded with the highest and second highest PCB and metal levels in mineral sediments.
		1D. Assess the health of the benthic community in mineral sediment samples and compare the results to background conditions.	medium	Five of 13 benthic community samples were characterized as either slightly or moderately impaired. No relationship was found between the responses measured in the laboratory toxicity test and benthic community impairment.
Amphibians		2A. Compare surface water concentrations to published surface water benchmarks and to background.	low-medium	Adverse impacts are possible based on CTE IRs > 1.0 derived from chronic toxicity surface water benchmarks. The three major risk drivers for metals are Cu, Pb, and Ag .
		2B. Compare site sediment concentrations to published sediment benchmarks and to background.	low-medium	Adverse impacts in moss are possible based on CTE IRs > 1.0 derived from no-effect sediment benchmarks. The three main risk drivers are Cu, Mo, and U.
Wetland Birds	Growth, survival, and reproduction of semi-aquatic bird populations	3B. Compare the EDDs for predatory wading birds (great blue heron) based on ingesting prey from the *Sphagnum* Bog to published avian TRVs and to background conditions.	medium	Adverse population effects to great blue heron are possible from Be in the mineral fraction, peat fraction, and moss fraction
Wetland Mammals	Growth, survival, and reproduction of semi-aquatic mammal populations	4A. Compare the EDDs for omnivorous small mammals (shrew) based on ingesting prey from the Sphagnum Bog to published mammal TRVs and to background conditions.	medium	Adverse population effects to the shrew are possible from Mo in the peat fraction but not in the mineral or moss fractions

Notes:

COPC = contaminant of potential concern

CTE = central tendency exposure

IR = incremental risk

EDD = estimated daily dose

TRV = toxicity reference value

Table G-23

COC Concentrations Expected to Provide Adequate Protection of Ecological Receptors

Habitat Type/Name	Exposure Medium	COC	Protective Level	Units	Basis	Assessment Endpoint
BENTHIC INVERTEBRATE COMMUNITY						
Sphagnum Bog	Sediment	mean PEC-Q[1]	0.64		Site-specific MATC [2]	Survival and growth of benthic invertebrates communities
		Total PCBs	1.08	mg/kg	Site-specific MATC	
		Copper	176	mg/kg	Site-specific MATC	
		Lead	97.3	mg/kg	Site-specific MATC	
		Mercury	1.3	mg/kg	Site-specific MATC	

Notes:

[1] See Appendix A of the Feasibility Study (*de maximus*, 2014b) for discussion of development of PEC-Q values based on the results of the sediment toxicity tests.

[2] The site-specific MATC (set as the geometric mean between the NOEC and LOEC values) has been selected as the protective level for each COC.

COC - Chemical of Concern

NOEC - No observed effect concentration. The NOEC was set as the higher of the concentrations observed at locations with no observed effects.

LOEC - Lowest observed effect concentration. The LOEC was set as the lower of the concentrations observed at locations with observed toxicity to benthic invertebrates.

MATC - Maximum Acceptable Toxic Concentration

PEC-Q - Probable Effect Concentration - Quotients for mixtures consisting of metals, PAHs, and PCBs (unitless)

Table J1 - SOIL REMEDIAL ALTERNATIVE MATRIX

		General Response Action/Technology Type							
								In-Situ Stabilization of Holding Basin	
Alternative	Description	No Action	Excavation and **On-Site Consolidation** of Soils and Sediments	Excavation and **Off-Site Consolidation** of Soils and Sediments	Cap and Liner System at Grade	Vertical Barrier Jet Grouted	Horizontal Barrier (Sub-Grade Cover)	Apatite Injection (Note 2)	Cement Stabilization
SS-1	**N**o Action	√							
SS-2	**E**xcavation and On-Site Consolidation of Soils (including Unsaturated Holding Basin Soils) and Sediments. **C**ap and Liner System, **I**n-Situ Stabilization of Holding Basin Saturated Soils Using Apatite Injection[2]		95,000 cy (Note 1)		√			√	
SS-3	**E**xcavation and Off-Site Disposal Of Sediments And Non-Holding Basin Soils, **C**ontainment with Partial In-Situ Solidification/Stabilization of Holding Basin Soils Using Cement Grouting, and **L**ow-Permeability Sub-Grade Cover			82,500 cy of soils/ sediment, plus another 18,500 cy of spoils from solidification/ stabilization		Deep Soil Mixing Cement Ring	√		Cement Ring
SS-4	**E**xcavation and Off-Site Disposal Of Sediments and Non-Holding Basin Soils, **C**ontainment with Vertical Containment Wall **L**ow-Permeability Sub-Grade Cover **I**n-Situ Stabilization of Holding Basin Soils Using Apatite Injection[2]			82,500 cy		Jet Grouted Bentonite	√	√	
SS-5	**E**xcavation and Off-Site Disposal of Sediments and Soils (including Unsaturated Holding Basin Soils), and **C**ontainment with Full In-Situ Solidification/Stabilization of Holding Basin Saturated Soils Using Deep Soil Mixing **L**ow-Permeability Sub-Grade Cover			95,000 cy, plus another 12,750 cy of spoils from solidification/ stabilization (Note 1)		Cement Monolith	√		Cement Monolith

Notes:
Note 1 - The volumes for alternatives SS-2 and SS-5 are inclusive of 12,500 cubic yards of unsaturated holding basin soils that will be excavated and either consolidated on-site (SS-2) or disposed off-site (SS-5)
Note 2 - Apatite used for costing purposes; other comparable stabilization agents may be used.

Key:
bgs - below ground surface
cy - cubic yard
ft - feet

Table J2 - GROUNDWATER REMEDIAL ALTERNATIVE MATRIX

Alternative	Description	Long Term Monitoring			Pump and Treat (*Ex-Situ)*			*In-Situ* Treatment
		DU/ Natural U	VOCs	1,4-dioxane	DU/ Natural U	VOCs	1,4-dioxane	DU/ Natural U
GW-1	No-Action							
GW-2	Long-Term Monitoring	X	X	X				
GW-3	Ex-situ Treatment; Long-Term Monitoring	X			X	X	X	
GW-4	Ex-situ and In-situ Treatment; Long-Term Monitoring	X				X	X	X

Table K-1: Soil/Sediment Comparative Analysis of Alternatives

Evaluation Criteria	SS-1	SS-2	SS-3	SS-4	SS-5
	No Action	**Excavation and On-Site Consolidation of Soils (including Unsaturated Holding Basin Soils) and Sediments, Cap and Liner System, In-Situ Stabilization of Holding Basin Saturated Soils Using Apatite Injection**	**Excavation and Off-Site Disposal Of Sediments And Non-Holding Basin Soils, Containment with Partial In-Situ Solidification/Stabilization of Holding Basin Soils Using Cement Grouting, and Low-Permeability Sub-Grade Cover**	**Excavation and Off-Site Disposal Of Sediments and Non-Holding Basin Soils, Containment with Vertical Containment Wall Low-Permeability Sub-Grade Cover In-Situ Stabilization of Holding Basin Soils Using Apatite (or equivalent) Injection**	**Excavation and Off-Site Disposal of Sediments and Soils (including Unsaturated Holding Basin Soils), and Containment with Full In-Situ Solidification/Stabilization of Holding Basin Saturated Soils Using Deep Soil Mixing Low-Permeability Sub-Grade Cover**
Overall Protection of Human Health and the Environment	**No Protection**	**Significant Protection ♦♦♦** - Effective when combined with groundwater remedy - Southwest corner of bog will be adversely affected but extent of impact will be minimized to remove highest concentrations of COCs	**Significant Protection ♦♦♦** - Effective when combined with groundwater remedy - Southwest corner of bog will be adversely affected but extent of impact will be minimized to remove highest concentrations of COCs	**Significant Protection ♦♦♦** - Effective when combined with groundwater remedy - Southwest corner of bog will be adversely affected but extent of impact will be minimized to remove highest concentrations of COCs	**Significant Protection ♦♦♦** - Effective when combined with groundwater remedy - Southwest corner of bog will be adversely affected but extent of impact will be minimized to remove highest concentrations of COCs
Compliance with ARARs	**Will Not Meet ARARs**	**Will Meet Soil and Sediment ARARs ♦♦♦** - PRGs in soil and sediment can be achieved - Cap can be designed to meet requirements of 105CMR120.245	**Will Meet Soil and Sediment ARARs ♦♦♦** - PRGs in soil and sediment can be achieved - Cap can be designed to meet requirements of 105CMR120.245	**Will Meet Soil and Sediment ARARs ♦♦♦** - PRGs in soil and sediment can be achieved - Cap can be designed to meet requirements of 105CMR120.245	**Will Meet Soil and Sediment ARARs ♦♦♦** - PRGs in soil and sediment can be achieved - Cap can be designed to meet requirements of 105CMR120.245
Long-Term Effectiveness and Permanence	**Not Effective** - Concentrations of Uranium and PCBs in soils and sediments will not be addressed	**Effective for Excavated Soils ♦♦** A larger amount of soil will be left on site untreated, which reduces the long-term effectiveness and permanence of this alternative - Containment is an approved Presumptive Remedy for metals in soils - Groundwater is a stable environment for stabilization technology Sequestration using apatite will treat principal threats that may exist in saturated soils in the Holding Basin footprint. Other principal threat soil within the Holding Basin will be excavated and placed in the consolidation area without treatment.	**Very Effective for Excavated Soils ♦♦♦** - Containment is an approved Presumptive Remedy for metals in soils - All soils are contained or disposed off site Principal threats will either be excavated for off-site disposal or treated with in-situ solidification / stabilization.	**Very Effective for Excavated Soils ♦♦♦** - Containment is an approved Presumptive Remedy for metals in soils - All soils are contained or disposed off-site Principal threats will either be excavated for off-site disposal or treated with in-situ sequestration using apatite.	**Very Effective for Excavated Soils ♦♦♦** - Containment is an approved Presumptive Remedy for metals in soils - All soils are contained or disposed off-site. This alternative is the most permanant as the most soils are disposed off site. Principal threats will either be excavated for off-site disposal or treated with in-situ solidification / stabilization.

Table K-1: Soil/Sediment Comparative Analysis of Alternatives

Evaluation Criteria	SS-1	SS-2	SS-3	SS-4	SS-5
	No Action	**Excavation and On-Site Consolidation of Soils (including Unsaturated Holding Basin Soils) and Sediments, Cap and Liner System, In-Situ Stabilization of Holding Basin Saturated Soils Using Apatite Injection**	**Excavation and Off-Site Disposal Of Sediments And Non-Holding Basin Soils, Containment with Partial In-Situ** Solidification/Stabilization of Holding Basin Soils Using Cement Grouting, and **Low-Permeability Sub-Grade Cover**	**Excavation and Off-Site Disposal Of Sediments and Non-Holding Basin Soils, Containment with Vertical Containment Wall Low-Permeability Sub-Grade Cover In-Situ Stabilization of Holding Basin Soils Using Apatite (or equivalent) Injection**	**Excavation and Off-Site Disposal of Sediments and Soils (including Unsaturated Holding Basin Soils), and Containment with Full In-Situ Solidification/Stabilization of Holding Basin Saturated Soils Using Deep Soil Mixing Low-Permeability Sub-Grade Cover**
Reduction of Toxicity, Mobility and Volume through Treatment	**No Treatment**	**No Treatment for Excavated Soils Reduction of Toxicity and Mobility for Saturated Soils ♦♦** - Excavated soils will experience reduction in mobility through consolidation facility - Long-term stability of stabilization is promising; least amount of material treated, including principal threat waste	**No Treatment for Excavated Soils Reduction of Toxicity and Mobility for Contained Soils ♦♦** - Excavated soils will experience reduction in mobility through containment- -Long-term stability of cement stabilization is proven, however increases volume or material requiring disposal	**No Treatment for Excavated Soils Reduction of Toxicity and Mobility for Contained Soils ♦♦♦** - Excavated soils will experience reduction in mobility through containment and stabilization, least volume generated; DU in saturated soils will be sequestered using apatite.	**No Treatment for Excavated Soils Reduction of Toxicity and Mobility for Contained Soils ♦♦** - Excavated soils will experience reduction in mobility through containment - Long-term stability of cement stabilization is proven, however increases volume of material requiring disposal
Short-Term Effectiveness	**RAOs are not met Workers and Community are not affected ♦♦♦**	**RAOs are met ♦♦♦** - GW impact from removing existing cover over Holding Basin is minimized by downgradient groundwater hydraulic containment. **Community is Protected ♦♦♦** - No contaminated soils transferred off-site	**RAOs are met ♦♦♦** - GW impact from removing existing cover over Holding Basin is minimized by downgradient groundwater hydraulic containment. **Community is Protected ♦** - Approximately 101,000 cy of contaminated soils and spoils from stabilization process will be transported off-site - Transport and disposal of soils will require working with community to minimize impact	**RAOs are met ♦♦♦** - GW impact from removing existing cover over Holding Basin is minimized by downgradient groundwater hydraulic containment. **Community is Protected ♦♦** - Approximately 82,500 cy of contaminated soils will be transported off-site - Transport and disposal of soils will require working with community to minimize impact	**RAOs are met ♦♦** - GW impact from removing existing cover over Holding Basin is minimized by downgradient groundwater hydraulic containment. **Community is Protected ♦♦** - Approximately 107,750 cy of contaminated soils and spoils from stabilization process will be transported off-site. - Transport and disposal of soils will require working with community to minimize impact
Short-Term Effectiveness (Continued)		**Worker Protections will be Critical ♦** - Dangers exist in excavating to 35 feet and bringing drill rig into excavation to stabilize saturated soils - Some exposure to drilling muds and displaced soils in stabilization processes	**Workers are Protected ♦** - This Alternative has the most exposure to approximately 40,000 cy drilling muds and displaced soils in stabilization processes	**Workers are Protected ♦♦♦** - Most protective of workers	**Worker Protections will be Critical ♦** - Dangers exist in excavating to 35 feet and bringing drill rig into excavation to stabilize saturated soils - Some exposure to drilling muds and displaced soils in stabilization processes.

Table K-1: Soil/Sediment Comparative Analysis of Alternatives

Evaluation Criteria	SS-1	SS-2	SS-3	SS-4	SS-5
	No Action	**Excavation and On-Site Consolidation of Soils (including Unsaturated Holding Basin Soils) and Sediments, Cap and Liner System, In-Situ Stabilization of Holding Basin Saturated Soils Using Apatite Injection**	**Excavation and Off-Site Disposal Of Sediments And Non-Holding Basin Soils, Containment with Partial In-Situ** Solidification/Stabilization of Holding Basin Soils Using Cement Grouting, and **Low-Permeability Sub-Grade Cover**	**Excavation and Off-Site Disposal Of Sediments and Non-Holding Basin Soils, Containment with Vertical Containment Wall Low-Permeability Sub-Grade Cover In-Situ Stabilization of Holding Basin Soils Using Apatite (or equivalent) Injection**	**Excavation and Off-Site Disposal of Sediments and Soils (including Unsaturated Holding Basin Soils), and Containment with Full In-Situ Solidification/Stabilization of Holding Basin Saturated Soils Using Deep Soil Mixing Low-Permeability Sub-Grade Cover**
Implementability	**Not Applicable**	**Difficult to Implement ♦♦** - Stabilization of saturated soils from 35 to 90 feet will be difficult - Additional future actions will be difficult with consolidation facility built above stabilized soils - Stabilization contractors are not readily available - Pilot testing and extensive construction QA/QC will be required - Shoring of excavation will be necessary to excavate the unsaturated soils	**Difficult to Implement ♦♦** - Most difficult task to stabilize from 20 to 90 feet - Additional future actions will be difficult if cement is used - Stabilization contractors are not readily available - Pilot testing and extensive construction QA/QC will be required	**Implementable ♦♦♦** - Construction of vertical barrier wall and stabilization to 90 feet will be difficult - Stabilization contractors are not readily available - Pilot testing and extensive construction QA/QC will be required	**Very Difficult to Implement ♦** - Stabilization of saturated soils from 35 to 90 feet will be difficult - Additional future actions will be difficult if cement is used - Stabilization contractors are not readily available - Pilot testing and extensive construction QA/QC will be required - Shoring of excavation will be necessary to excavate the unsaturated soils
Costs	**$0 ♦♦♦**	**$ 37,953 K Capital Cost $ 7,305 K O&M (NPV at 7% for 200 years) $ 44,891 K Total Cost ♦♦♦**	**$127,682 K Capital Cost $ 1,566 K O&M (NPV at 7% for 200 years) $ 129,248 K Total Cost ♦**	**$ 103,188 K Capital Cost $ 1,566 K O&M (NPV at 7% for 200 years) $ 104,754 K Total Cost ♦♦**	**$ 146,358 K Capital Cost $ 1,566 K O&M (NPV at 7% for 200 years) $ 147,924 K Total Cost ♦**
♦ Diamonds represent how the evaluation criteria for each alternative compares to other alternatives, with more meaning "better"					

Table K-2: Comparative Analysis of Groundwater Alternatives

Evaluation Criteria		GW-1 No Action	GW-2 Limited Action/Institutional Controls and Long- Term Monitoring	GW-3 Ex-Situ Treatment (DU, UROCK, 1,4-dioxane), Institutional Controls,and Long-Term Monitoring	GW-4 Ex-Situ Treatment (VOCs and 1,4-Dioxane), In-situ Treatment (DU/Natural Uranium), Institutional Controls, and Long-Term Monitoring
Overall Protection of Human Health and the Environment	**Human Health Protection**	**No Additional Protection ♦** -There is no current exposure that poses risk to human health. -This alternative does not reduce the potential for on- or off-property human exposure to impacted groundwater.	**Moderate Protection ♦♦** -There is no current exposure that poses risk to human health. -Deed restrictions prevent potential human exposure to on- and off-property overburden or bedrock groundwater (used as a hypothetical future domestic water supply) with uranium, VOCs, or 1,4-dioxane that exceed ARARs or target risk limits. -The plume of isotopically natural uranium in bedrock is at steady-state, and no off-property migration is expected in the future. -Although Holding Basin Source Control is included, this alternative does not specifically address potential human exposure to DU-impacted overburden groundwater which may migrate off-property in the future.	**Significant Protection ♦♦♦** -There is no current exposure that poses risk to human health. -Deed restrictions prevent potential human exposure to on and off-property overburden or bedrock groundwater (used as a hypothetical future domestic water supply) with uranium, VOCs, or 1,4-dioxane that exceeds ARARs or target risk limits. -The plume of isotopically natural uranium in bedrock is at steady-state, and no off-property migration is expected in the future. -Holding Basin source isolation and hydraulic containment would limit off-property migration of DU- impacted overburden groundwater. -Active pumping for the 1,4-dioxane hydraulic containment system will limit migration to and beyond the Assabet River and flush 1,4-dioxane from the aquifer over time.	**Significant Protection ♦♦♦** -There is no current exposure that poses risk to human health. -Deed restrictions prevent potential human exposure to on and off- property overburden or bedrock groundwater (used as a hypothetical future domestic water supply) with uranium, VOCs, or 1,4-dioxane that exceeds ARARs or target risk limits. -The plume of isotopically natural uranium in bedrock is at steady- state, and no off-property migration is expected in the future. -Active pumping for the 1,4-dioxane hydraulic containment system will limit migration to and beyond the Assabet River and flush 1,4- dioxane from the aquifer over time. --Holding Basin source isolation and the In-situ reactive zones would limit off-property migration of DU-impacted overburden groundwater and would likely occur in a shorter timeframe than hydraulic containment alone.
	Ecological Protection	**Not needed to satisfy RAOs**	**Not needed to satisfy RAOs**	**Not needed to satisfy RAOs**	**Not needed to satisfy RAOs**
Compliance with ARARs	**Chemical-Specific**	**May Partially Meet ARARs ♦♦** -May meet ARARs for VOCs in groundwater off-property within a reasonable timeframe (i.e., ≤ 30 years) due to natural attenuation. -May not meet ARARs for VOCs on- property due to slow natural attenuation rates. -ARARs are currently met off-property for isotopically natural uranium in bedrock but not on-property, although the plume is at steady-state. ARARs are not likely to be met on-property. -Not likely to meet ARARs for isotopically natural uranium in bedrock or DU in overburden groundwater on- property.	**May Partially Meet ARARs ♦♦** -May meet ARARs for VOCs in groundwater off- property within a reasonable timeframe (i.e., ≤ 30 years) due to natural attenuation. -May not meet ARARs for VOCs on-property due to slow natural attenuation rates. -ARARs are currently met off-property for isotopically natural uranium in bedrock but not on-property, although the plume is at steady-state. ARARs are not likely to be met on-property. -Not likely to meet ARARs for DU in overburden groundwater on-property or off-property.	**May Partially Meet ARARs ♦♦** -May meet ARARs for VOCs in groundwater within a reasonable timeframe(i.e., ≤ 30 years) due to natural attenuation. Active pumping of the VOC hydraulic containment system will flush VOCs from the aquifer over time; therefore, this alternative is more likely to achieve ARARs for VOCs than GW-1 or GW-2. -ARARs are currently met off-property for isotopically natural uranium in bedrock but not on-property, although the plume is at steady-state. ARARs are not likely to be met on-property. -May meet ARARs for DU in overburden groundwater off-property due to Holding Basin source control and hydraulic containment, but not likely to meet ARARs for DU on-property.	**Will Meet ARARs ♦♦♦** -May meet ARARs for VOCs in groundwater within a reasonable timeframe (i.e., ≤ 30 years) due to natural attenuation. Active pumping of the VOC hydraulic containment system VOCs from the aquifer over time; therefore, this alternative is more likely to achieve ARARs for VOCs than GW-1 or GW-2. -ARARs are currently met off-property for isotopically natural uranium in bedrock but not on-property, although the plume is at steady-state. ARARs are expected to be met in a reasonable timeframe with in-situ treatment. -Will meet ARARs for DU in overburden groundwater on- and off- property due to Holding Basin Source control and the In-Situ Reactive Zone remedy.
	Location-Specific	**Not Applicable**	**Not Applicable**	**Not Applicable**	**Not Applicable**
	Action-Specific	**Not Applicable**	**Will Comply with ARARs**	**Will Comply with ARARs**	**Will Comply with ARARs**

Table K-2: Comparative Analysis of Groundwater Alternatives

Evaluation Criteria		GW-1 No Action	GW-2 Limited Action/Institutional Controls and Long- Term Monitoring	GW-3 Ex-Situ Treatment (DU, UROCK, 1,4-dioxane), Institutional Controls,and Long-Term Monitoring	GW-4 Ex-Situ Treatment (VOCs and 1,4-Dioxane), In-situ Treatment (DU/Natural Uranium), Institutional Controls, and Long-Term Monitoring
Long-Term Effectiveness and Performance	**Magnitude of Residual Risk**	**Higher Relative Risk ♦** -Potential future human exposure to uranium, VOCs, and 1,4-dioxane in groundwater from a hypothetical supply well would pose a higher level of risk compared to other alternatives.	**Moderate Residual Risk ♦♦** -Risks related to human exposure to uranium, VOCs, and 1,4-dioxane in groundwater on-property are mitigated through institutional controls to limit groundwater use. -Potential future human exposure to uranium, VOCs, and 1,4-dioxane in groundwater from a hypothetical supply well off-property pose a higher level of risk compared to GW-3 and GW-4, if institutional controls are not feasible off-property.	**Residual Risk ♦♦** -Risks related to human exposure to uranium, VOCs, and 1,4-dioxane in groundwater are mitigated through institutional controls to limit groundwater use. -Risks related to potential future human exposure to uranium, VOCs, and 1,4-dioxane in groundwater are mitigated through hydraulic containment, alhtough this alternative will take longer to achieve acceptable risk for uranium than GW-4.	**Lower Residual Risk ♦♦♦** -Risks related to human exposure to uranium, VOCs, and 1,4- dioxane in groundwater are mitigated through institutional controls to limit groundwater use. -Risks related to potential future human exposure to depleted uranium, VOCs, and 1,4-dioxane in groundwater are mitigated through in-situ treatmentof uranium and and hydraulic containment of 1,4 dioxane and VOCs.
Long-Term Effectiveness and Performance (Continued)	**Adequacy and Reliability of Controls**	**Not Applicable**	**Adequate & Reliable ♦♦** -Institutional controls are reliable for limiting groundwater use. -Long-term monitoring provides a reliable means of evaluating concentrations over time.	**Highly Adequate & Reliable ♦♦♦** -Institutional controls are reliable for limiting groundwater use. -Hydraulic containment is a reliable and well-proven technology. -Long-term monitoring provides a reliable means of evaluating concentrations over time.	**Adequate & Reliable ♦♦** -Institutional controls are reliable for limiting groundwater use. -Hydraulic containment is a reliable and well-proven technology. -The reliability of ISRZs to sequester uranium will need to be evaluated during the remedial design phase. -Long-term monitoring provides a reliable means of evaluating concentrations over time.
Reduction of Toxicity, Mobility and Volume through Treatment	**Treatment Process Used and Materials Treated**	**Not Applicable**	**Not Applicable**	**Well Proven Treatment ♦♦♦** -Groundwater extraction and ex-situ treatment of extracted groundwater by advanced oxidation for 1,4- dioxane and uranium-specific ion exchange resin for uranium removal are well-proven treatment technologies.	**Combination of Well Proven and Experimental Treatment** **♦♦** -Groundwater extraction and ex-situ treatment of extracted groundwater by advanced oxidation for 1,4-dioxane are well- proven treatment technologies. -In-situ immobilization of DU using ISRZs downgradient of the Holding Basin is an experimental technology, but site-specific testing results to date have been favorable.
	Amount Destroyed or Treated	**Some Destroyed, None Treated ♦** **-Mass reduction of VOCs due to natural attenuation will occur although no active remediation will be implemented.** -No treatment or destruction of uranium in bedrock or overburden groundwater will occur.	**Some Destroyed, None Treated ♦** -Mass reduction of VOCs due to natural attenuation will occur although no active remediation will be implemented. -Due to Holding Basin source control, some reduction in the total mass of DU in overburden groundwater will occur. -No treatment or destruction of uranium in bedrock or overburden groundwater will occur.	**Some Destroyed, Moderate Treatment ♦♦** -Mass reduction of VOCs due to natural attenuation will occur and there will be some destruction of 1,4-dioxane through advanced oxidation of extracted groundwater. -Due to Holding Basin source control, some reduction in the total mass of DU in overburden groundwater will occur. -There will be treatment of DU and isotopically natural uranium using uranium-specific ion exchange resins to remove uranium from extracted groundwater. The amount of uranium treated will depend on design extraction rates and influent concentrations.	**Some Destroyed, Moderate to Good Treatment ♦♦♦** -Mass reduction of VOCs due to natural attenuation will occur and there will be some destruction of 1,4-dioxane through advanced oxidation of extracted groundwater. -Due to Holding Basin source control, some reduction in the total mass of DU in overburden groundwater will occur. Significant treatment of DU in groundwater via sequestration will occur in the ISRZs. -No treatment or destruction of uranium in bedrock groundwater will occur.

Table K-2: Comparative Analysis of Groundwater Alternatives

Evaluation Criteria		GW-1 No Action	GW-2 Limited Action/Institutional Controls and Long- Term Monitoring	GW-3 Ex-Situ Treatment (DU, UROCK, 1,4-dioxane), Institutional Controls,and Long-Term Monitoring	GW-4 Ex-Situ Treatment (VOCs and 1,4-Dioxane), In-situ Treatment (DU/Natural Uranium), Institutional Controls, and Long-Term Monitoring
	Degree of Expected Reductions in Toxicity, Mobility, or Volume through Treatment	**Not Applicable**	**Little to Moderate Reduction ♦** -There will be some reduction in the volume of aquifer impacted by VOCs and 1,4-dioxane over time through natural attenuation. -There will be moderate reduction in DU mobility due to Holding Basin source control.	**Moderate to Significant Reductions ♦♦** -There will be some reduction in the volume of aquifer impacted by VOCs over time through natural attenuation. - There will be a significant reduction in the mobility of 1,4-dioxane and VOCs through hydraulic containment. -There will be a significant reduction in the mobility of DU via Holding Basin source control and hydraulic containment, and slight to moderate reductions in the uranium mass in bedrock groundwater via groundwater extraction and treatment.	**Significant Reductions ♦♦♦** --There will be some reduction in the volume of aquifer impacted by VOCs over time through natural attenuation. - There will be a significant reduction in the mobility of 1,4-dioxane and VOCs through hydraulic containment. -There will be a significant reduction in the mobility of DU and natural uranium via Holding Basin source control and in-situ treatment.
Reduction of Toxicity, Mobility and Volume through Treatment (Continued)	**Degree to which Treatment is Irreversible**	**Not Applicable**	**No Active Treatment ♦** -Natural attenuation of VOCs is irreversible.	**Not Reversible ♦♦♦** -Natural attenuation of VOCs is irreversible. -Ex-situ treatment of DU, uranium and 1,4-dioxane in extracted groundwater is irreversible.	**Possibly Reversible ♦♦** -Natural attenuation of VOCs is irreversible. -Ex-situ treatment of 1,4-dioxane in extracted groundwater is irreversible. -DU sequestration via adsorption on apatite and incorporation into low solubility mineral forms is expected to be very stable. The degree of irreversibility would be evaluated during pilot testing in the remedial design phase.
	Type and Quantity of Residuals Remaining after Treatment	**Not Applicable**	**Not Applicable**	**Low to Mobile Residuals Remain ♦♦** -There will be low residual concentrations of 1,4-dioxane and VOCs in overburden and bedrock groundwater, DU in overburden groundwater, and uranium in bedrock groundwater after treatment. -Residuals from groundwater treatment would include spent ion exchange resins containing uranium.	**Low to Moderate Residuals Remain ♦♦** -There will be low residual concentrations of 1,4-dioxane and VOCs in overburden and bedrock groundwater, and uranium in bedrock groundwater after treatment. -Residual DU within the plume sequestered to the in-situ reactive media will remain after treatment.
	Degree to which Treatment Reduces Principal Threats	There are no principal threats associated with subsurface conditions at the site.	There are no principal threats associated with subsurface conditions at the site.	There are no principal threats associated with subsurface conditions at the site.	There are no principal threats associated with subsurface conditions at the site.

Table K-2: Comparative Analysis of Groundwater Alternatives

Evaluation Criteria		GW-1 No Action	GW-2 Limited Action/Institutional Controls and Long- Term Monitoring	GW-3 Ex-Situ Treatment (DU, UROCK, 1,4-dioxane), Institutional Controls,and Long-Term Monitoring	GW-4 Ex-Situ Treatment (VOCs and 1,4-Dioxane), In-situ Treatment (DU/Natural Uranium), Institutional Controls, and Long-Term Monitoring
Short-Term Effectiveness	**Protection of Community During Remedial Action**	**Not Applicable**	**Significant Protection ♦♦♦** -There is no increased incremental risk to the community as a result of remedial action.	**Significant Protection ♦♦♦** -There is no increased incremental risk to the community as a result of remedial action. -Extracted groundwater will be treated prior to discharge to surface water.	**Significant Protection ♦♦♦** -There is no increased incremental risk to community as a result of remedial action. -Extracted groundwater treated prior to discharge to surface water. -In-situ treatment reduces potential future exposure to DU in off- site groundwater.
	Environmental Impacts	**Not Applicable**	**Minimal ♦♦♦** -There are no short-term changes in environmental impact for this alternative relative to existing condition.	**Limited ♦♦** -Compliance with a NPDES permit would limit the potential for adverse environmental impacts from discharge of treated groundwater. -Compliance with appropriate location and action specific ARARs would limit potential environmental impacts.	**Limited ♦♦** -Compliance with a NPDES permit would limit the potential for adverse environmental impacts from discharge of treated groundwater. -Compliance with appropriate location and action specific ARARs would limit potential environmental impacts.
Short-Term Effectiveness (Continued)	**Time Until Remedial Action Objectives are Achieved**	**Very Long ♦** Chemical Specific ARARS: VOCs,1,4-dioxane (on-prop): > 50 Yrs VOCs,1,4-dioxane (off-prop): < 30 Yrs DU: Likely > 100 years Uranium: Likely > 100 years -No prevention of human exposure to uranium, VOCs, and 1,4-dioxane in groundwater on-property or off-property -No limiting of off-property migration of COCs in groundwater	**Very Long ♦** Chemical Specific ARARS: VOCs,1,4-dioxane (on-prop): > 50 Yrs VOCs,1,4-dioxane (off-prop): < 30 Yrs DU: Likely > 100 years Uranium: Likely > 100 years -Immediate prevention of human exposure to DU, uranium, VOCs, and 1,4-dioxane in groundwater on and off-property through institutional controls -No limiting of off-property migration of COCs in groundwater -No restoration of groundwater to chemical-specific ARARs for uranium within 100 years	**Long to Very Long ♦** Chemical Specific ARARS: VOCs,1,4-dioxane (on-prop): > 50 Yrs VOCs,1,4-dioxane (off-prop): < 30 Yrs DU: Likely > 100 years Uranium: Likely > 100 years -Immediate prevention of human exposure to DU, uranium, VOCs, and 1,4-dioxane in groundwater on-and off-property through institutional controls -Rapid limiting of off-property migration of COCs in groundwater through hydraulic containment -No restoration of groundwater to chemical-specific ARARs for uranium within 100 years	**Long to Very Long ♦♦** Chemical Specific ARARS VOCs,1,4-dioxane (on-prop): > 50 Yrs VOCs,1,4-dioxane (off-prop): < 30 Yrs DU: Likely <15 years Uranium in Bedrock: Likely < 15 years -Immediate prevention of human exposure to DU, uranium, VOCs, and 1,4-dioxane in groundwater on and off-property through institutional controls -Rapid limiting of off-property migration of COCs in groundwater through hydraulic containment and in-situ treatment -Possible restoration of overburden groundwater to meet chemical- specific ARARs for DU and natural uranium within 15 years through source controls and in-situ treatment
	Protection of Workers During Remedial Action	**Not Applicable**	**Good Protection ♦♦♦** -Site-specific health and safety plans would be used to ensure worker safety. -Work would be conducted in accordance with OSHA standards.	**Good Protection ♦♦♦** -Site-specific health and safety plans would be used to ensure worker safety. -Work would be conducted in accordance with OSHA standards.	**Good Protection ♦♦♦** -Site-specific health and safety plans would be used to ensure worker safety. -Work would be conducted in accordance with OSHA standards.

Table K-2: Comparative Analysis of Groundwater Alternatives

Evaluation Criteria		GW-1 No Action	GW-2 Limited Action/Institutional Controls and Long- Term Monitoring	GW-3 Ex-Situ Treatment (DU, UROCK, 1,4-dioxane), Institutional Controls,and Long-Term Monitoring	GW-4 Ex-Situ Treatment (VOCs and 1,4-Dioxane), In-situ Treatment (DU/Natural Uranium), Institutional Controls, and Long-Term Monitoring
Implementability	**Ability to Construct and Operate the Technology**	**Not Applicable**	**Readily Implementable ♦♦♦** -Installation of monitoring wells and periodic groundwater monitoring are routine activities.	**Implementable ♦♦** -Installation of extraction wells, supplemental monitoring wells, construction of treatment systems, and associated O&M tasks are readily implementable. -Negotiation of access rights for installation of extraction wells at off-property locations and obtaining surface water discharge permits pose potential difficulties.	**Implementable ♦** -Installation of extraction wells, supplemental monitoring wells, construction of treatment systems, and associated O&M tasks are readily implementable. -Negotiation of access rights for installation of extraction wells at off-property locations and obtaining surface water discharge permits pose potential difficulties. -Installation of in-situ reactive zones by injection from approximately 40-80 ft bgs is implementable but would need pilot testing and detailed design of injection procedures.
	Reliability of the Technology	**Not Applicable**	**Very Reliable ♦♦♦** -Deed restrictions are reliable if properly enforced. -Long-term monitoring is reliable for assessing groundwater concentrations relative to applicable RAOs.	**Very Reliable ♦♦♦** -Deed restrictions are reliable if properly enforced. -Long-term monitoring is reliable for assessing groundwater concentrations relative to applicable RAOs. -Hydraulic containment with ex-situ treatment is a reliable and well-proven technology.	**Reliable ♦♦** -Deed restrictions are reliable if properly enforced. -Long-term monitoring is reliable for assessing groundwater concentrations relative to applicable RAOs. -Hydraulic containment with ex-situ treatment is a reliable and well- proven technology. -The reliability of the in-situ reactive zone technology for the DU plume has been proven at the field scale level but not over a long period. However, the unique combination of allowing for a passive remedy that does not require manipulation of geochemical conditions, combined with favorable testing to date at other sites, indicates that an apatite/ZVI ISRZ remedy is likely to be reliable.
Implementability (Continued)	**Ease of Undertaking Additional Remedial Actions, if Necessary**	**No Significant Interference ♦♦♦**	**No Significant Interference ♦♦♦**	**No Significant Interference ♦♦♦**	**No Significant Interference ♦♦♦**
	Ability to Monitor Effectiveness of Remedy	**Not Applicable**	**Easily Monitored ♦♦♦** -Monitoring through groundwater sampling and analysis can readily be used to assess the progress of natural attenuation and changes in the DU and uranium plumes.	**Somewhat Easily Monitored ♦♦** -Capture zones of hydraulic containment systems can be monitored using monitoring wells and water level measurements. -Monitoring capture associated with extraction wells for the 1,4-dioxane plume in bedrock may be challenging due to low hydraulic conductivity and the likely need to batch pump these wells.	**Somewhat Easily Monitored ♦♦** -Capture zones of hydraulic containment systems can be monitored using monitoring wells and water level measurements. -Monitoring capture associated with extraction wells for the 1,4- dioxane plume in bedrock may be challenging due to low hydraulic conductivity and the likely need to batch pump these wells. -Monitoring of ISRZs using monitoring wells and water level measurements up and downgradient is routine, but solid phase sampling in ISRZs is less routine.

Table K-2: Comparative Analysis of Groundwater Alternatives

Evaluation Criteria		GW-1 No Action	GW-2 Limited Action/Institutional Controls and Long- Term Monitoring	GW-3 Ex-Situ Treatment (DU, UROCK, 1,4-dioxane), Institutional Controls,and Long-Term Monitoring	GW-4 Ex-Situ Treatment (VOCs and 1,4-Dioxane), In-situ Treatment (DU/Natural Uranium), Institutional Controls, and Long-Term Monitoring
	Availability of Off-site Treatment, Storage and Disposal Services and Capacity	**Not Applicable**	**Readily Available** ♦♦♦ -Disposal facilities for investigation-derived waste generated during sampling are readily available.	**Readily Available** ♦♦♦ -Disposal facilities for soils generated during construction and for spent groundwater treatment media (i.e., ion exchange resins used for uranium removal) are available. -Discharge of treated groundwater would be conducted in comply with ARARs (e.g., a NPDES permit).	**Readily Available** ♦♦♦ -Disposal facilities for soils generated during construction are available. -Discharge of treated groundwater would be conducted in comply with ARARs (e.g., a NPDES permit).
	Availability of Necessary Equipment and Specialists	**Not Applicable**	**Readily Available** ♦♦♦	**Readily Available** ♦♦♦	**Readily Available** ♦♦♦
	Ability to Obtain Approvals and Coordinate with Other Agencies	**Not Applicable**	**Possible to Obtain** ♦♦♦ -Monitoring under this alternative would be conducted in coordination with the USEPA, MassDEP and other appropriate agencies.	**Possible to Obtain** ♦♦♦ -Remedial actions under this alternative would be designed, constructed and operated under coordination with the USEPA, MassDEP and other appropriate agencies.	**Possible to Obtain** ♦♦♦ -Remedial actions under this alternative would be designed, constructed and operated under coordination with the USEPA, MassDEP and other appropriate agencies.
Capital Costs		None	$1,185,000	$6,510,000	$9,669,000
Annual Operation, Maintenance and Monitoring - net present value (7%) 30 - 200 years (monitoring is 200 years, active treatment 30 years)		None	$1,724,000	$22,755,000	$10,573,000
TOTAL		None	$2,909,000	$29,265,000	$20,242,000

Key:
1,1-DCE = 1,1 -Dichloroethene
ARARs = Applicable or Relevant and Appropriate Requirements ISRZ = In-Situ Reactive Zone
MCL = Maximum Contaminant Level MNA = Monitored Natural Attenuation PCE = Tetrachloroethene
PRG = Preliminary Remediation Goal RAO = Remedial Action Objective
RI/FS = Remedial Investigation and Feasibility Study TBC = To Be Considered
TCE = Trichloroethene VI = Vapor Intrusion
VOC = Volatile Organic Compound

Table L-1: Groundwater Cleanup Levels

Carcinogenic Chemical of Concern	Cancer Classification	Overburden Cleanup Level		Bedrock Cleanup Level	
		µg/L	Basis	µg/L	Basis
1,1-Dichloroethane	C	NA	NA	2.7	ILCR = 10^{-6} (Residential)
Tetrachloroethene	Likely to be carcinogenic to humans	5	MCL	5	MCL
Trichloroethene	Carcinogenic to humans	5	MCL	5	MCL
Vinyl chloride	A	2	MCL	2	MCL
1,4-Dioxane	Likely to be carcinogenic to humans	0.46	ILCR = 10^{-6} (Residential)	0.46	ILCR = 10^{-6} (Residential)
bis(2-Ethylhexyl)phthalate	B2	6	MCL	6	MCL
Arsenic	A	10	MCL	10	MCL
Chromium	Likely to be carcinogenic to humans	100	MCL	100	MCL
Thorium	A	0.33	ILCR = 10^{-6} (Residential)	0.33	ILCR = 10^{-6} (Residential)
Non-Carcinogenic Chemical of Concern	**Target Endpoint**	**Overburden Cleanup Level**		**Bedrock Cleanup Level**	
		µg/L	Basis	µg/L	Basis
1,1-Dichloroethane	Kidney	NA	NA	2.7	ILCR = 10^{-6} (Residential)
Tetrachloroethene	CNS	5	MCL	5	MCL
Trichloroethene	Developmental / Immune System	5	MCL	5	MCL
Vinyl chloride	Liver	2	MCL	2	MCL
1,4-Dioxane	Liver / Kidney / Respiratory	0.46	ILCR = 10^{-6} (Residential)	0.46	ILCR = 10^{-6} (Residential)
bis(2-Ethylhexyl)phthalate	Liver	6	MCL	6	MCL
Arsenic	Skin	10	MCL	10	MCL
Barium	Kidney	NA	NA	2,000	MCL
Chromium	GI System	100	MCL	100	MCL
Cobalt	Thyroid	6.0	HI = 1 (Residential)	6.0	HI = 1 (Residential)
Copper	GI System	1,300	Action Level	NA	NA
Iron	GI System	14,000	HI = 1 (Residential)	14,000	HI = 1 (Residential)
Manganese	CNS	300	Health Advisory	300	Health Advisory
Molybdenum	Kidney	100	HI = 1 (Residential)	100	HI = 1 (Residential)
Depleted Uranium	Kidney	30	MCL	30	MCL
Natural Uranium	Kidney	30	MCL	30	MCL
Nitrate-N	Hematological	10,000	MCL	10,000	MCL
Nitrite-N	Hematological	1,000	MCL	1,000	MCL

Key

1. See Appendix E of this ROD for cleanup level development and basis:

Health Advisory - Health Advisory on Manganese (EPA-822-R-04-003; January 2004)

HI - Hazard Index

MCL - Maximum Contaminant Level

ILCR - Incremental Lifetime Cancer Risk; 10^{-6} = 1 in 1,000,000

NA - Not applicable

Cancer Classification

A - Human carcinogen

B1 - Probable human carcinogen - Indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

Table L-2: Soil Cleanup Levels for the Protection of Human Health

Carcinogenic Chemical of Concern	Cancer Classification	Cleanup Level[1]		Basis[1]
		mg/kg	pCi/g	
Benzo(a)anthracene	B2	0.34	NA	ILCR = 10^{-6} (Residential)
Benzo(a)pyrene	B2	0.22	NA	ILCR = 10^{-6} (Residential)
Benzo(b)fluoranthene	B2	0.34	NA	ILCR = 10^{-6} (Residential)
Indeno(1,2,3-cd)pyrene	B2	0.34	NA	ILCR = 10^{-6} (Residential)
PCBs	B2	1	NA	Policy
Arsenic	A	13.7	NA	Background
Uranium	A	2.7	1.1	ILCR = 10^{-6} (Residential)
U-238	A	NA	0.90	ILCR = 10^{-6} (Residential)
U-235	A	NA	0.01	ILCR = 10^{-6} (Residential)
U-234	A	NA	0.15	ILCR = 10^{-6} (Residential)
Thorium	A	7.4	0.81	Background
Th-232	A	NA	0.81	Background

Non-Carcinogenic Chemical of Concern	Target Endpoint	Cleanup Level[1]		Basis[1]
		mg/kg	pCi/g	
PCBs	Immune System	1	NA	Policy
Arsenic	Skin	13.7	NA	ILCR = 10^{-6} (Residential)
Uranium	Kidney	2.7	1.1	ILCR = 10^{-6} (Residential)

Key

NA - Not applicable

1. See Appendix E of this ROD for cleanup level development and basis:

Policy - Cleanup level for PCBs based on CERCLA Policy (Guidance on Remedial Actions for Superfund Sites with PCB Contamination, OSWER Directive #9355.4-01, EPA/540/G-90/007, August 1990

Background - If risk-based cleanup levels were below background concentrations for the site, the background concentration was selected.

ILCR - Incremental Lifetime Cancer Risk; 10^{-6} = 1 in 1,000,000

Cancer Classification

A - Human carcinogen

B1 - Probable human carcinogen - Indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

Table L-3: Sediment Cleanup Levels for the Protection of Human Health

Carcinogenic Chemical of Concern	Cancer Classification	Cleanup Level[1] mg/kg	Basis[1]
PCBs	B2	2.7	ILCR = 10^{-6} (Abutting Resident/Recreational Visitor)

Non-Carcinogenic Chemical of Concern	Target Endpoint	Cleanup Level[1] mg/kg	Basis[1]
PCBs	Immune System	1	Policy

Key

NA - Not applicable

1. See Appendix B of FS for cleanup level development and basis:

Policy - Cleanup level for PCBs based on CERCLA Policy (Guidance on Remedial Actions for Superfund Sites with PCB Contamination, OSWER Directive #9355.4-01, EPA/540/G-90/007, August 1990

Cancer Classification

A - Human carcinogen

B1 - Probable human carcinogen - Indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

Table L-4: Sediment Cleanup Levels for the Protection of Ecological Receptors

Habitat Type/Name	Exposure Medium	COC	Protective Level	Units	Basis	Assessment Endpoint
BENTHIC INVERTEBRATE COMMUNITY						
Sphagnum Bog	Sediment	mean PEC-Q[1]	0.64		Site-specific MATC [2]	Survival and growth of benthic invertebrate community
		Total PCBs	1.08	mg/kg	Site-specific MATC	
		Copper	176	mg/kg	Site-specific MATC	
		Lead	97.3	mg/kg	Site-specific MATC	
		Mercury	1.3	mg/kg	Site-specific MATC	

Notes:

[1] See Appendix A of the Feasibility Study (*de maximus* , 2014b) for discussion of development of PEC-Q values based on the results of the sediment toxicity tests.

[2] The site-specific MATC (set as the geometric mean between the NOEC and LOEC values) has been selected as the protective level for each COC.

COC - Chemical of Concern

NOEC - No observed effect concentration. The NOEC was set as the higher of the concentrations observed at locations with no observed effects.

LOEC - Lowest observed effect concentration. The LOEC was set as the lower of the concentrations observed at locations with observed toxicity to benthic invertebrates.

MATC - Maximum Acceptable Toxic Concentration

PEC-Q - Probable Effect Concentration - Quotients for mixtures consisting of metals, PAHs, and PCBs (unitless)

Table L-5: Cost Estimate Summary for Remedial Alternative GW-4

REMEDIAL ALTERNATIVE GW-4

Ex-Situ Treatment (VOCs and 1,4-Dioxane), In-situ Treatment (DU/Natural Uranium), Institutional Controls, and Long-Term Monitoring

COST ESTIMATE SUMMARY

Feasibility Study
Nuclear Metals, Inc. Superfund Site

Discount Rate: 7.00%

Item	Year	Unit Cost	Total Cost
CAPITAL EXPENDITURES			
Pre-Design Investigation			
Pilot Test for DU In-Situ Injection Design	1	$ 340,000	$ 340,000
Pump Test for 1,4-dioxane Containment System	1	$ 350,000	$ 350,000
Investigation for In-Situ UROCK Treatment	1	$ 460,700	$ 460,700
Pre-design Investigation Subtotal			$ 1,150,700
Remedial Design			
Remedial Design	1	$ 646,700	$ 646,700
Remedial Action			
Institutional Controls	1	$ 975,000	$ 975,000
Hydraulic Containment	2	$ 299,700	$ 261,800
Ex-Situ Treatment	2	$ 1,701,800	$ 1,486,400
In-Situ Treatment - DU	2	$ 1,760,000	$ 1,537,300
In-Situ Treatment - U in Rock	2	$ 313,600	$ 273,900
Groundwater Monitoring Wells	2	$ 207,900	$ 181,600
Professional Labor and Management	2	$ 1,058,300	$ 924,400
Remedial Action Subtotal			***$ 5,640,400***
Capital Expenditures - Subtotal			***$ 7,437,800***
Contingency (Capital Expenditures)	30%		$ 2,231,300
CAPITAL EXPENDITURES - TOTAL COST			**$ 9,669,000**
OPERATION, MAINTENANCE, MONITORING & REPORTING (OMM&R) COSTS			
Operation and Maintenance (O&M)			
General Operations	2-30	$ 250,000	$ 2,868,600
Advanced Oxidation System	2-30	$ 129,900	$ 1,490,500
Electricity Usage	2-30	$ 33,000	$ 378,700
O&M Subtotal			***$ 4,737,800***
Solid Phase Sampling (Proof of Attenuation)			
Semi-Annual Solid Phase Sampling	3	$ 250,000	$ 204,100
Annual Solid Phase Sampling	4-5	$ 125,000	$ 184,500
Solid Phase Sampling Subtotal			***$ 388,600***
Long-Term Monitoring			
Quarterly Monitoring Program (Years 2-3)	2-3	$ 299,400	$ 505,900
Semi-Annual Monitoring Program (Years 4-8)	4-8	$ 143,100	$ 479,000
Annual Monitoring Program (Years 9-30)	9-30	$ 86,400	$ 556,200
Five-Year Monitoring Program (Years 1-30)	1-30, Every 5 yrs	$ 25,400	$ 54,800
Five-Year Monitoring Program (Years 31-200)	31-200, Every 5 yrs	$ 52,900	$ 17,300
Long-Term Monitoring Subtotal			***$ 1,613,200***
Five-Year Review (CERCLA)			
Document Review, Interviews, Inspection, Report	1-200, Every 5 yrs	$ 81,300	$ 202,000
Project Management			
Project Management	2-30	$ 100,000	$ 1,147,446
Project Management	31-200	$ 25,000	$ 43,847
Site Closeout			
Closeout Report, Public Meetings, Notice of Completion	200	$ 116,100	$ 0.15
Well Decomissioning	1-30, Every 5 yrs	$ 11,200	$ 24,200
OMM&R Subtotal			***$ 8,132,893***
Contingency (OMM&R)	30%		$ 2,439,900
OMM&R - TOTAL COST			**$ 10,573,000**
TOTAL PROJECT COST - NET PRESENT VALUE	**7.0%**		**$ 20,242,000**

Table L-5: Cost Estimate Summary for Remedial Alternative GW-4

REMEDIAL ALTERNATIVE GW-4

Ex-Situ Treatment (VOCs and 1,4-Dioxane), In-situ Treatment (DU/Natural Uranium), Institutional Controls, and Long-Term Monitoring

COST ESTIMATE SUMMARY

Feasibility Study
Nuclear Metals, Inc. Superfund Site

Discount Rate: 7.00%

Notes:

A. Total costs are rounded to the nearest $100.

B. Future capital costs beyond Year 1 are subject to NPV calculation.

Assumptions:

1. Costs assume deed restrictions prohibiting groundwater use will be executed for the Site.
2. Hydraulic containment for the 1,4-dioxane plumes will consist of one (1) overburden extraction well with a depth of 100 ft and pumping rate of 2 gpm and two (2) bedrock wells with depths of 120 ft and pumping rates of approximately 1 gpm each.
3. Ex-situ treatment will include advanced oxidation using ultra-violet light and hyrdogen peroxide or equivalent. Treated water will discharge to surface water.
4. Nine (9) monitoring wells will be installed in the vicinity of the extraction wells to demonstrate capture of the 1,4-dioxane plumes, three (3) in the overburden and six (6) in the bedrock. Thirteen (13) monitoring wells will be installed in the vicinity of
5. The in-situ remedy for depleted uranium in overburden will include a pilot test to evaluate injection design, injection of apatite in two separate areas and nZVI in a downgradient location. Additional monitoring wells will be installed to monitor effectiveness, and borings will be drilled to collect aquifer materials for remedy evaluation.
6. Costs for DU in-situ treatment assume two (2) apatite and one (1) zero-valent iron (ZVI) in-situ reactive zones (ISRZs) installed by direct push injection. These ISRs installations will be repeated once.
7. The in-situ remedy for uranium in bedrock will include five (5) monitoring well locations with two (2) screened intervals in bedrock to delineate the depth of uranium >MCL. The remedy will include injection and recirculation of nZVI, apatite or bioremediation amendments via six (6) open bedrock boreholes.
8. Drill cuttings will be disposed on-site.
9. Well development water will be stored on-site and the treatment is represented and costed under the soils section of the Feasibility Study Report.
10. Long-term monitoring is assumed for costing purposes to consist of quarterly sampling for Years 2-3, semi-annual sampling for Years 4-8, annual sampling for Years 9-30 with an augmented program every fifth year, and five-year sampling for Years 31-200. The five-year monitoring for Years 1-30 is an incremental cost associated with the annual monitoring every fifth year. Solid phase sampling will be performed for Years 3-5. Five year monitoring for DU and UROCK will continue from year 31 to 200.
11. Well decomissioning will occur evey fifth year for Years 1-30, each for five (5) wells.

Table L-6: Cost Estimate Summary for Remedial Alternative SS-4

REMEDIAL ALTERNATIVE SS-4

Excavation and Off-Site Disposal Of Sediments and Non-Holding Basin Soils,
Containment with Vertical Containment Wall
Low-Permeability Sub-Grade Cover
In-Situ Stabilization of Holding Basin Soils Using Apatite Injection

COST ESTIMATE SUMMARY
Feasibility Study
Nuclear Metals Inc. Superfund Site

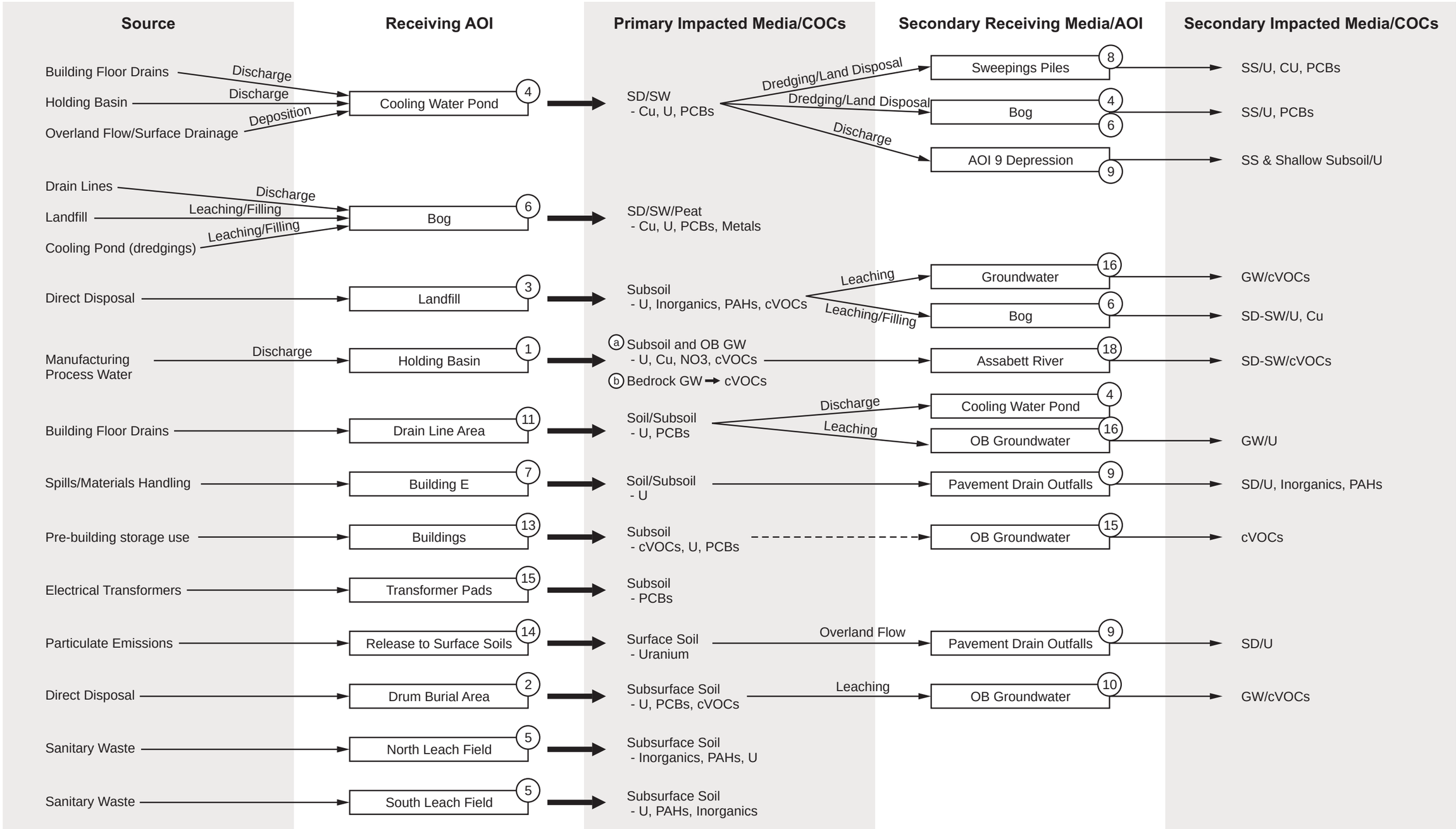
Item	Year	Unit Cost	Total Cost
CAPITAL EXPENDITURES			
Remedial Design			
Pilot Test Work Plan and Implementation	1	$ 440,000	$ 440,000
Remedial Design Work Plan and Project Planning	1	$ 120,000	$ 120,000
Remedial Design, including Design Specifications	1	$ 390,000	$ 390,000
Bid Document Preparation and Subcontractor Selection	1	$ 120,000	$ 120,000
Remedial Design Subtotal			$ 1,070,000
Remedial Action			
Project and Construction Management and Support	1 & 2	$ 10,513,040	$ 10,513,040
Mobilization	1	$ 1,545,800	$ 1,545,800
Monitoring, Surveying and Sampling	1 & 2	$ 788,042	$ 788,042
Excavation	1 & 2	$ 4,218,917	$ 4,218,917
Disposal	1 & 2	$ 57,296,250	$ 57,296,250
Stabilization of Soils beneath Holding Basin	1 & 2	$ 5,300,000	$ 5,300,000
Construction of Containment Wall and Cap	1 & 2	$ 2,753,607	$ 2,753,607
Site Restoration & Demobilization	2	$ 2,114,316	$ 2,114,316
Construction Completion Report	3	$ 300,000	$ 300,000
O&M Work Plans	3	$ 90,000	$ 90,000
Remedial Action Subtotal			$ 84,919,972
Capital Expenditures - Subtotal			***$ 85,989,972***
Contingency (Capital Expenditures)	20%		$ 17,197,994
CAPITAL EXPENDITURES - TOTAL COST			**$ 103,188,000**
OPERATION, MAINTENANCE, MONITORING & REPORTING (OMM&R) COSTS			
Operation and Maintenance (O&M)			
Project Management	2-200	$ 24,488	$ 326,935
Site Management and Inspections	2-200	$ 73,250	$ 977,969
O&M Subtotal			$ 1,304,905
Site Closeout Documentation			
Closeout Report, Public Meeting, Notice of Completion	200	$ 50,000	$ 0.07
OMM&R Subtotal			***$ 1,304,905***
Contingency (OMM&R)	20%		$ 260,981
OMM&R - TOTAL COST			**$ 1,566,000**
TOTAL COST - NET PRESENT VALUE (NPV)	**7%**		**$ 104,754,000**

Notes:

1. Total Capital Expenditures and Total OMM&R Costs are rounded to the nearest $1,000.
2. Future Capital Cost, beyond Year 1; subject to NPV calculation
3. Long-term groundwater monitoring, institutional controls, and 5-Year Review Reports are accounted for within the groundwater alternative evaluation and cost estimates.

APPENDIX C

FIGURES



Prepared/Date: JPH 7/10/13
Checked/Date: JDP 7/10/13

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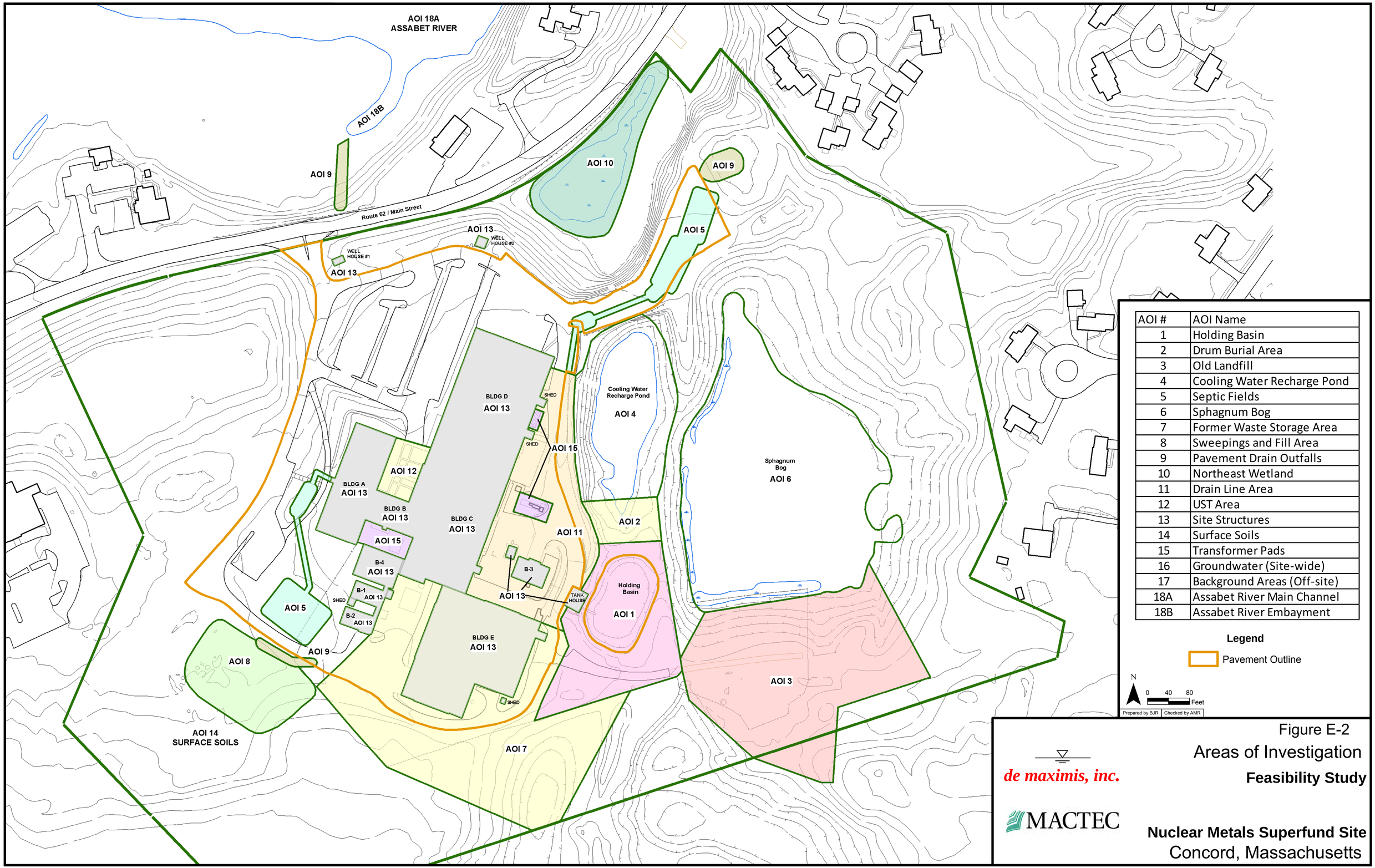
Figure E-1
Feasibility Study
Nuclear Metals Superfund Site
Concord, Massachusetts

PORT2013028a.cdr



AOI #	AOI Name
1	Holding Basin
2	Drum Burial Area
3	Old Landfill
4	Cooling Water Recharge Pond
5	Septic Fields
6	Sphagnum Bog
7	Former Waste Storage Area
8	Sweepings and Fill Area
9	Pavement Drain Outfalls
10	Northeast Wetland
11	Drain Line Area
12	UST Area
13	Site Structures
14	Surface Soils
15	Transformer Pads
16	Groundwater (Site-wide)
17	Background Areas (Off-site)
18A	Assabet River Main Channel
18B	Assabet River Embayment

Legend

Pavement Outline

de maximis, inc.

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Figure E-2

Areas of Investigation

Feasibility Study

Nuclear Metals Superfund Site

Concord, Massachusetts

Document: P:\Nuclear Metals\GIS\Mapdocuments\nmi_22x34.mxd PDF: P:\Nuclear Metals\Nuclear Metals RI FS EECA\Ecological Risk Assessment\BERA\Figures\Figure 1-2 - Areas of Investigation.pdf 12/17/2009 2:35 PM bjroden

Assabet Well Field
Floodplain
Assabet River
AOI 18
Assabet River Embayment Area
2250 Main St.
AOI 9
2220 Main St.
Main Street (Route 62)
Northeast Wetland
AOI 10
AOI 9
AOI 5
Residential Properties
AOI 14
BLDG D
Cooling Water Recharge Pond
AOI 4
Sphagnum Bog
AOI 6
AOI 14
AOI 15
BLDG A
BLDG B
AOI 11
BLDG C
Commercial Properties
AOI 15
B-4
B-3
AOI 2
AOI 1
Holding Basin
AOI 5
B-1
B-2
BLDG E
AOI 8
AOI 9
AOI 3
Residential Properties
AOI 7
Town-owned Property
AOI 14
Day Camp
Day Camp

Legend

- Fence
- Approximate Site Boundary
- AOI Boundary
- Structure
- Road
- Paved Area
- Sidewalks/Steps
- Unpaved Area
- Guard Rail

N

0 110 220 Feet

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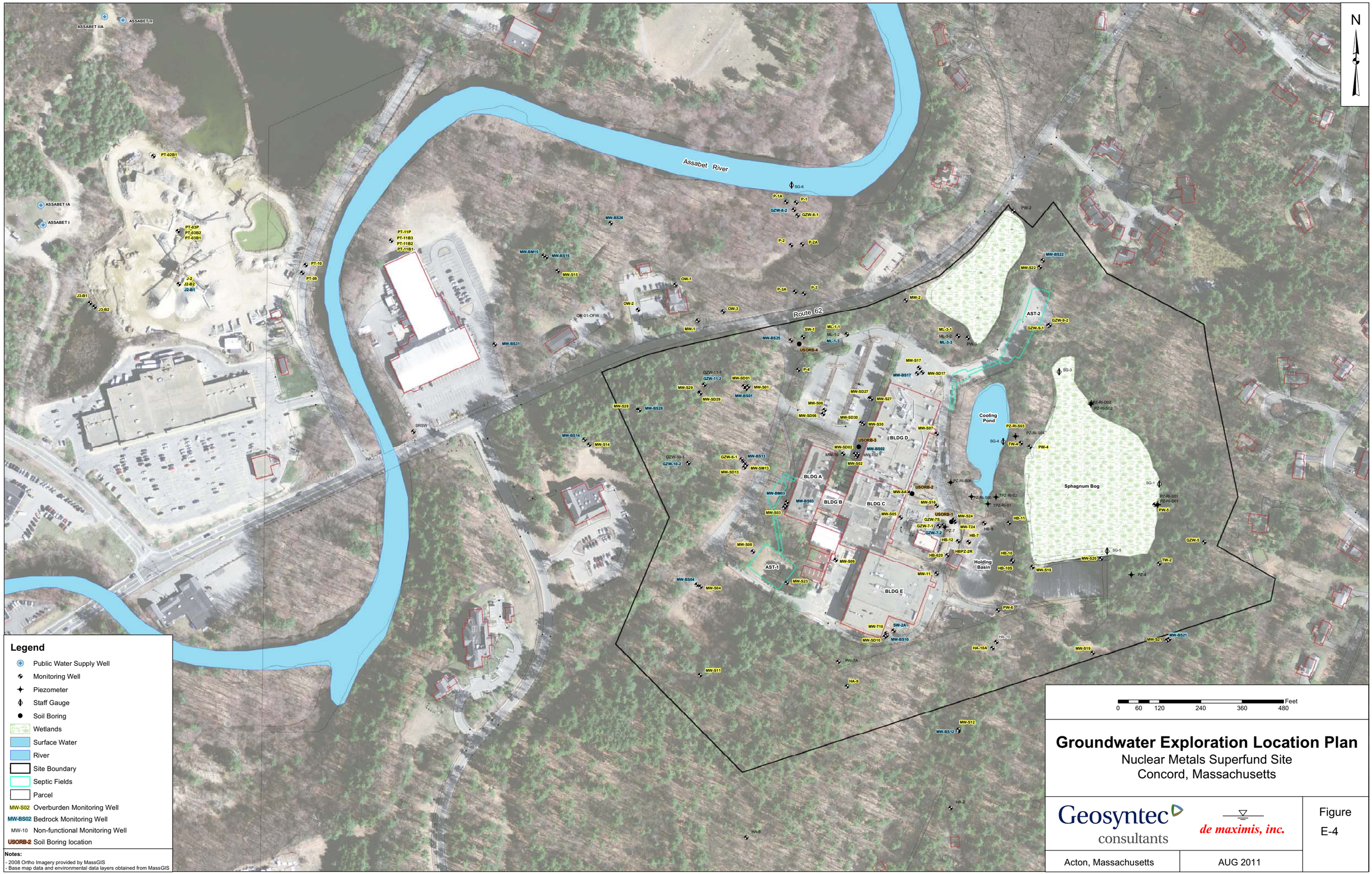
MACTEC

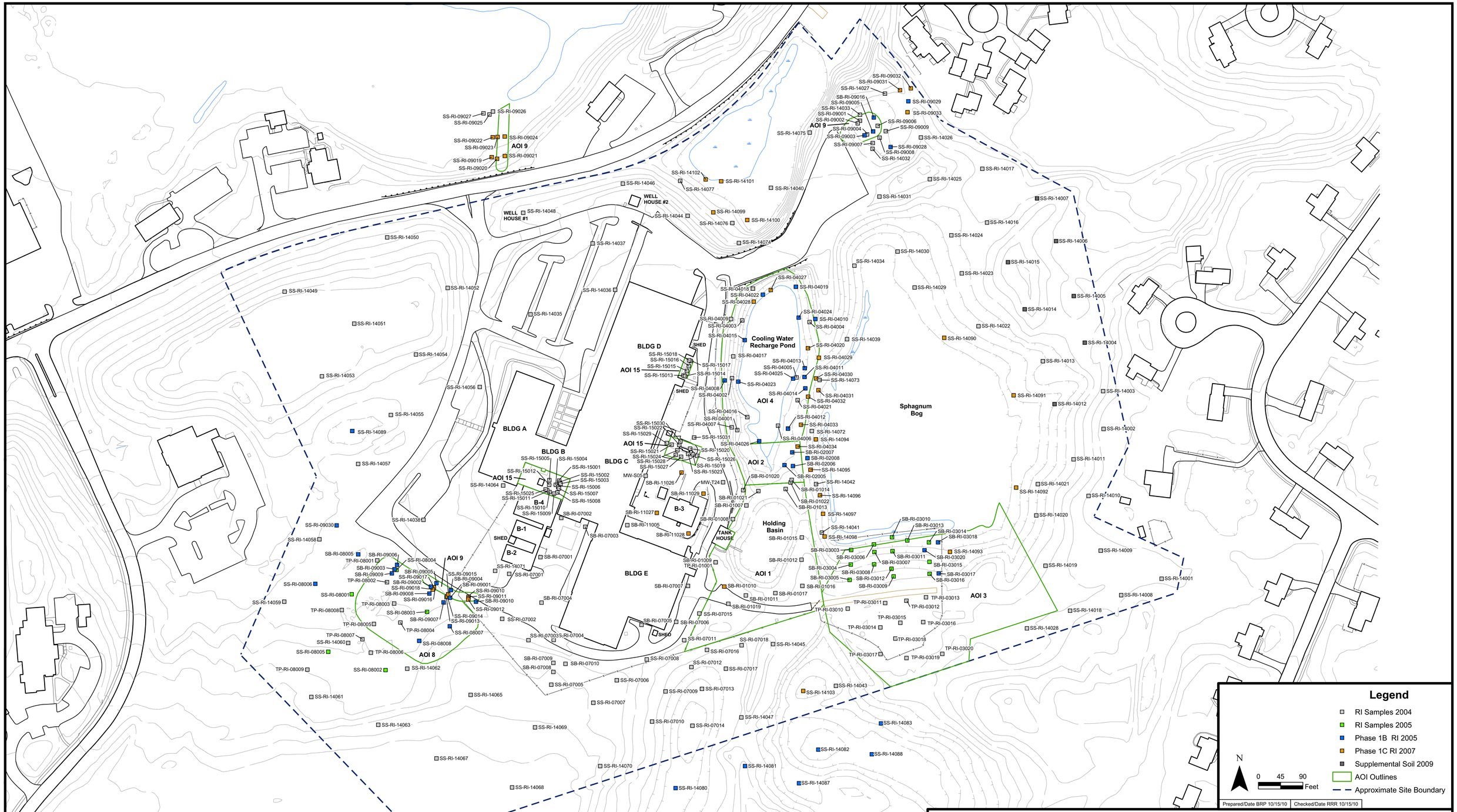
Prepared by BJR | Checked by JHP

Figure E-3
Site and Surrounding Properties

Feasibility Study
Nuclear Metals Superfund Site
Concord, Massachusetts

Document: P:\Nuclear Metals\GIS\Mapdocuments\HHRA_11x17L.mxd PDF: P:\Nuclear Metals\GIS\Figures\HHRA 2010\Figure 1-1 - Site and Surrounding Properties.pdf 10/29/2010 12:01 PM bjroden


N
Assabet River
Route 62
ASSABET IIA
ASSABET II
ASSABET IA
ASSABET I
PT-02B1
PT-03P
PT-03B2
PT-03B1
PT-11P
PT-11B3
PT-11B2
PT-11B1
PT-10
PT-09
J-2
J2-B2
J2-B1
J3-B1
J3-B2
SRSW
MW-BS26
MW-BM15
MW-BS15
MW-S15
OW-1
OW-2
OW-3
OR-01-OFW
MW-BS31
MW-1
SG-6
P-1A
P-1
GZW-8-2
GZW-8-1
P-2
P-2A
P-3A
P-3
MW-2
PW-2
MW-BS22
MW-S22
AST-2
GZW-9-2
GZW-9-1
ML-3-1
ML-3-2
ML-3-3
PW-3
SW-1
ML-1-1
ML-1-2
ML-1-3
MW-BS25
USORB-4
P-4
MW-S17
MW-BS17
MW-SD17
SG-3
GZW-11-1
GZW-11-2
MW-SD01
MW-S01
MW-BS01
MW-S29
MW-SD29
MW-S28
MW-BS28
MW-SD27
MW-S27
MW-S06
MW-SD06
MW-SD30
MW-S30
MW-S07
BLDG D
USORB-3
MW-SD02
MW-BS02
MW-10
MW-T02
MW-S02
MW-BS14
MW-S14
GZW-10-1
GZW-10-2
GZW-6-1
MW-BS13
MW-SM13
MW-SD13
BLDG A
MW-BM03
MW-BS03
BLDG B
BLDG C
MW-S03
MW-SA1
USORB-2
MW-S16
MW-S05
USORB-1
MW-S24
GZW-7S
GZW-7-1
GZW-7-2
PZ-7
MW-T24
HB-12
HB-7
HB-9
HB-11
HB-820
HBPZ-2R
HB-10
HB-10S
Holding Basin
MW-S08
MW-S09
AST-1
MW-S23
MW-BS04
MW-S04
MW-11
BLDG E
PW-6
MW-T10
SW-2A
MW-SD10
MW-BS10
HA-10
HA-10A
PW-7A
HA-9
MW-S11
HA-2
HA-8
MW-S12
MW-BS12
Cooling Pond
PZ-RI-D02
PZ-RI-S02
PZ-RI-S03
PZ-RI-S04
SG-4
TW-4
PW-4
Sphagnum Bog
SG-1
PZ-RI-S01
PZ-RI-D01
PW-5
PZ-RI-S06
PZ-RI-S05
TPZ-RI-02
TPZ-RI-01
GZW-5
SG-5
MW-S20
TW-2
MW-S18
PZ-4
MW-S19
MW-S21
MW-BS21
Legend
Public Water Supply Well
Monitoring Well
Piezometer
Staff Gauge
Soil Boring
Wetlands
Surface Water
River
Site Boundary
Septic Fields
Parcel
MW-S02 Overburden Monitoring Well
MW-BS02 Bedrock Monitoring Well
MW-10 Non-functional Monitoring Well
USORB-2 Soil Boring location
Notes:
- 2008 Ortho Imagery provided by MassGIS
- Base map data and environmental data layers obtained from MassGIS
0 60 120 240 360 480 Feet
Groundwater Exploration Location Plan
Nuclear Metals Superfund Site
Concord, Massachusetts
Geosyntec consultants
de maximis, inc.
Figure
E-4
Acton, Massachusetts
AUG 2011
G:\GISProjects\BR0090-NMI\Site\Projects\NMI_Exploration_Location_Master.mxd



de maximis, inc.

MACTEC

Figure E-5
Remedial Investigation Surface Soil Sample Locations

Remedial Investigation Report
Nuclear Metals Superfund Site
Concord, Massachusetts

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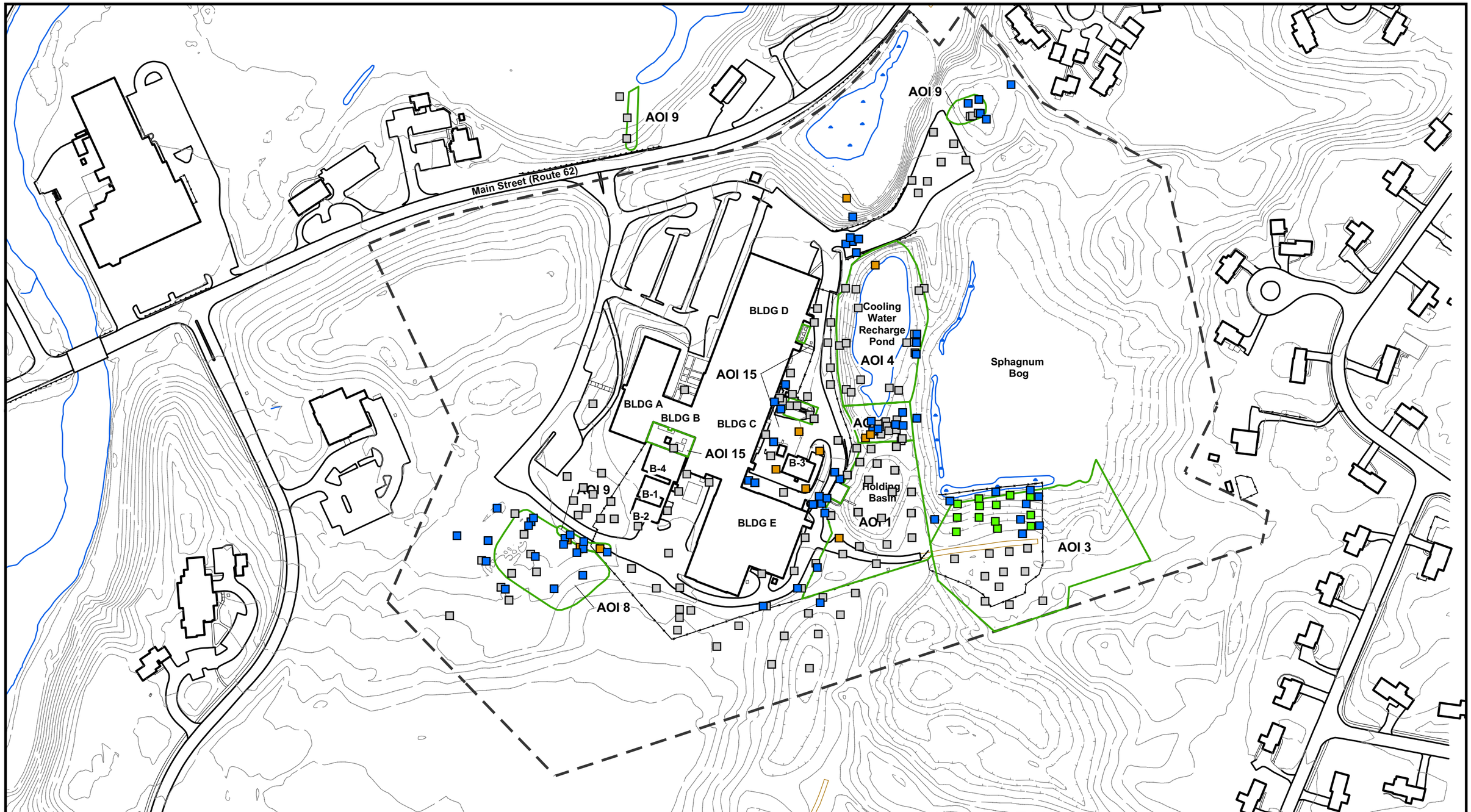

de maximis, inc.

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N

0 100 200 Feet

Prepared/Date BJS 10/15/10 | Checked/Date SCF 10/15/10

Legend

- RI Samples 2004
- RI Samples 2005
- Phase 1B 2005 RI
- Phase 1C 2007 RI
- AOI Outlines
- Approximate Site Boundary
- Water Body

Figure E-6
Remedial Investigation Subsurface Soil Sample Locations

Remedial Investigation Report
Nuclear Metals Superfund Site
Concord, Massachusetts

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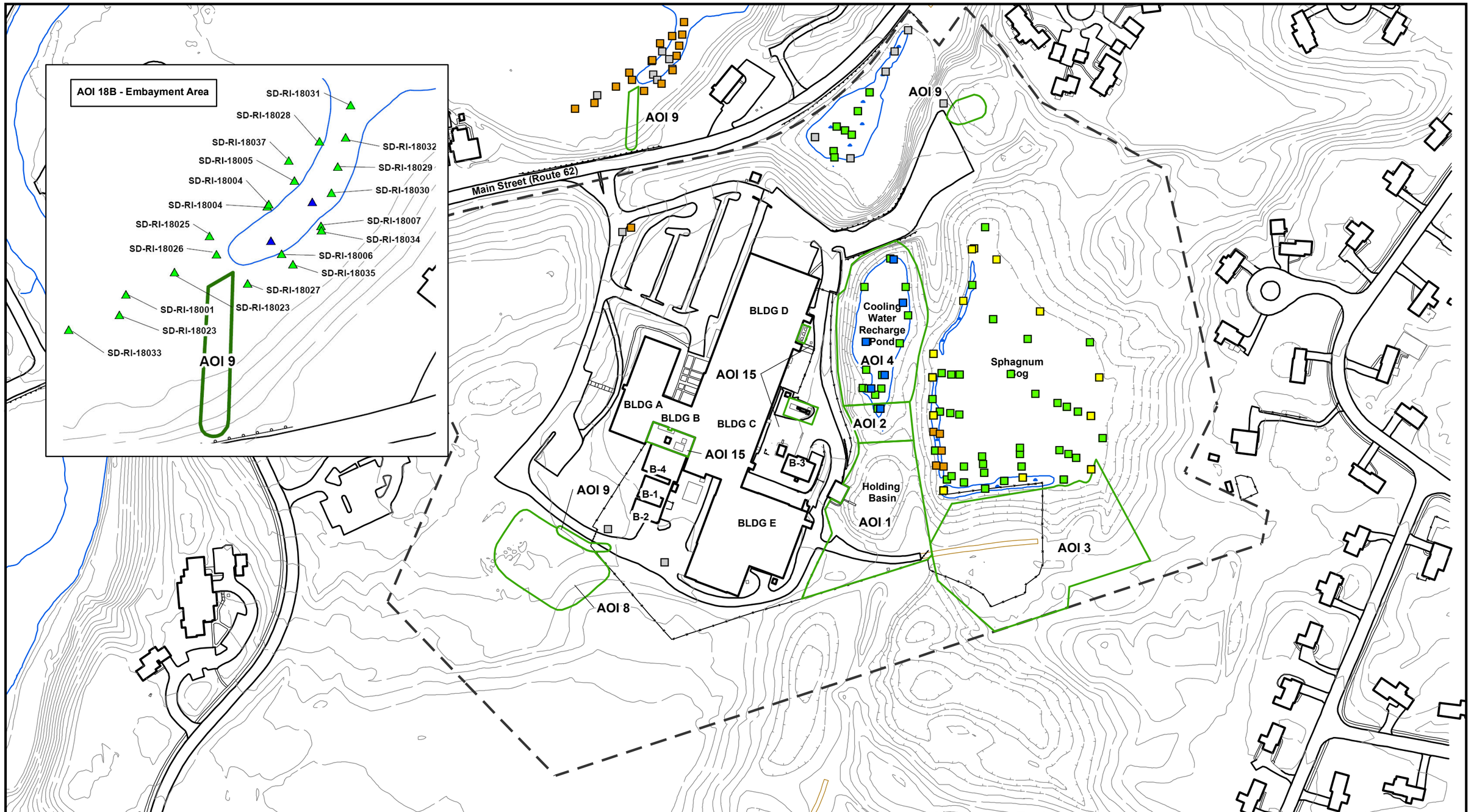

de maximis, inc.

MACTEC

N

0 100 200 Feet

Prepared/Date BJS 08/26/11 | Checked/Date DRP 08/26/11

Legend

- RI Samples 2004
- RI Samples 2005
- Phase 1B 2005 RI
- Phase 1C 2007 RI
- Ecological 2007
- AOI Outlines
- Approximate Site Boundary
- Water Body

Figure E-7
Remedial Investigation Sediment Sample Locations

Remedial Investigation Report
Nuclear Metals Superfund Site
Concord, Massachusetts

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de maximis, inc.

MACTEC

N

0 125 250 Feet

Legend

- RI Samples 2004
- Phase 1C 2007 RI
- AOI Outlines

Prepared/Date BJS 10/15/10 | Checked/Date SCF 10/15/10

Figure E-8
Remedial Investigation Sediment Sample Locations - Off Site

Remedial Investigation Report
Nuclear Metals Superfund Site
Concord, Massachusetts

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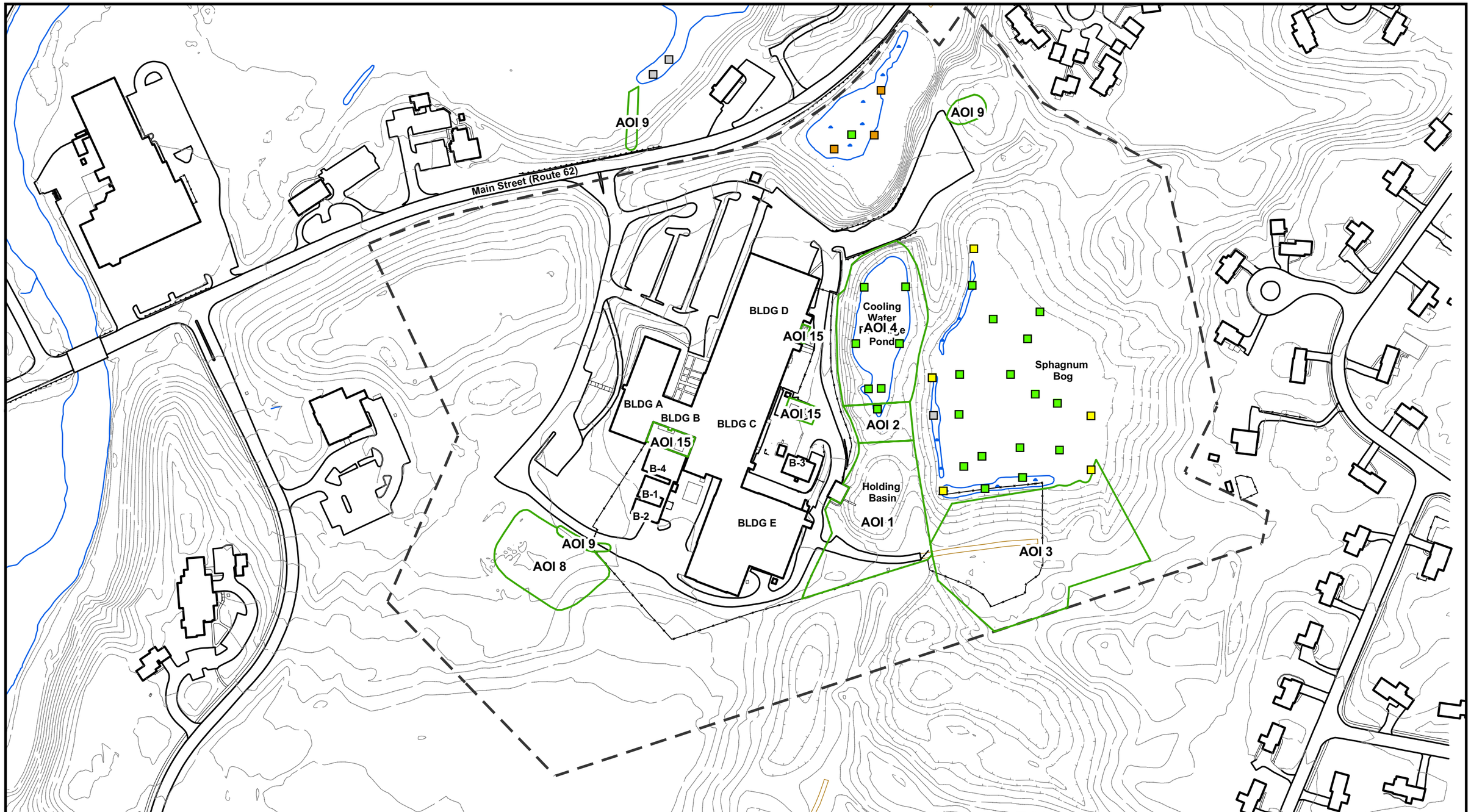

de maximis, inc.

MACTEC

N

0 100 200 Feet

Legend

- RI Samples 2004
- RI Samples 2005
- Phase 1C 2007 RI
- Ecological 2007
- AOI Outlines
- Approximate Site Boundary
- Water Body

Figure E-9
Remedial Investigation Surface Water Sample Locations

Remedial Investigation Report
Nuclear Metals Superfund Site
Concord, Massachusetts

Prepared/Date BJS 10/15/10	Checked/Date SCF 10/15/10

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de maximis, inc.

MACTEC

N

0 125 250 Feet

Legend

RI Samples 2004

AOI Outlines

Prepared/Date BJS 10/15/10 | Checked/Date SCF 10/15/10

Figure E-10
Remedial Investigation Surface Water Sample Locations - Off Site

Remedial Investigation Report
Nuclear Metals Superfund Site
Concord, Massachusetts

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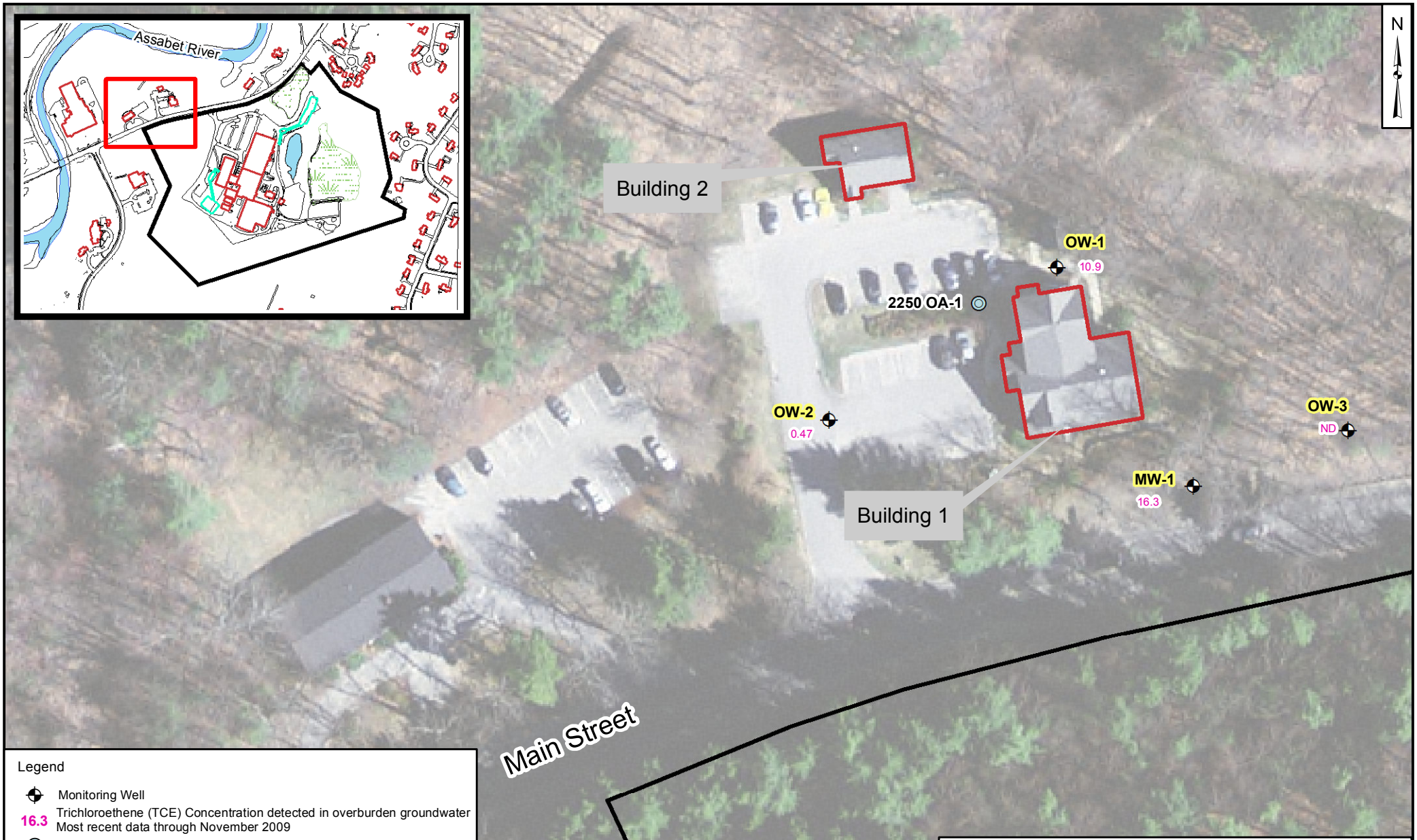


Legend

- Monitoring Well
- 16.3 Trichloroethene (TCE) Concentration detected in overburden groundwater Most recent data through November 2009
- Outdoor Air Sampling Location
- Buildings
- Wetlands
- Site Boundary
- Parcel

Note:
- Overburden locations indicated with yellow labels
- Concentrations reported in microgram per liter (µg/L)
- ND = Non detect above the method detection limit
- Locations without results were not included on the figure.
- 2008 Ortho Imagery provided by MassGIS
- Base map data and environmental data layers obtained from MassGIS

Prepared by: CS Reviewed by: TC/DA

Feet
20 10 0 20 40 60 80 100

Soil Vapor Investigation Location

Nuclear Metals, Inc. Site
Concord, Massachusetts

Geosyntec consultants

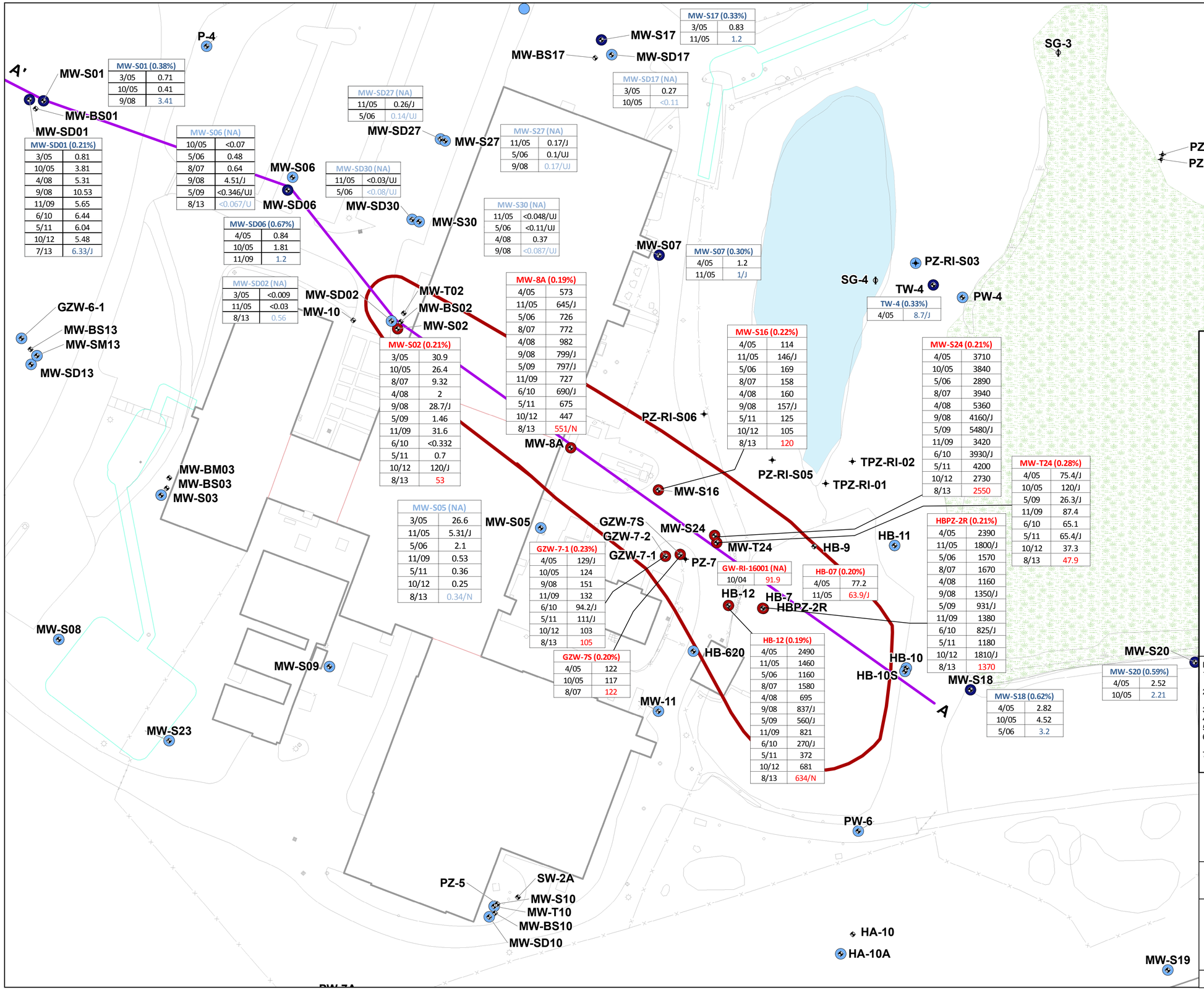
de maximis, inc.

ACTON, MASSACHUSETTS

17-SEP-2015

Figure E-11

Document Path: Q:\GISProjects\BR0090-NMISite\Projects\NMI_SiteMap_Most_Recent - with Inset.mxd



Legend

- Monitoring Well
- Piezometer
- Staff Gauge
- Groundwater Profiling location
- Septic Fields
- Wetlands
- Surface Water
- Uranium MCL Exceedance (>30 µg/L)
- Cross Section A-A"

Most Recent Total Uranium

- < 1 µg/L
- 1.01 - 10 µg/L
- 10.01 - 20 µg/L
- 20.01 - 30 µg/L
- > 30.01 µg/L MCL Exceedance in Overburden

Historical Total Uranium (µg/L)

HBPZ-2R (0.21%)	
Date	Total Uranium (µg/L)
5/11	10.0
10/12	20.0
8/13	95.0

(0.21%) Represents the U-235% in the most recent sample data through August 2013

Notes:
1. Although concentrations shown are for total uranium, results shown are primarily depleted uranium (U-235% <0.6%).
2. Tabular summaries at wells downgradient of elevated total uranium are displayed for illustrative purposes only.
3. µg/L = micrograms per liter.
4. U = Not detected at or above the method detection limit shown.
5. J = Estimated value.
6. N = Indicates presumptive evidence of a compound. This flag is usually used for a tentatively identified compound, where the identification is based on a mass spectral library search.
7. Most Recent concentration text color within tabular summaries on figure coded by concentration ranges listed above.

Total Uranium Concentrations in Overburden Groundwater

Nuclear Metals Superfund Site
Concord, Massachusetts

0 20 40 80 120 160 Feet

Geosyntec consultants

de maximis, inc.

Figure E-12

Acton, Massachusetts | SEPTEMBER-2015

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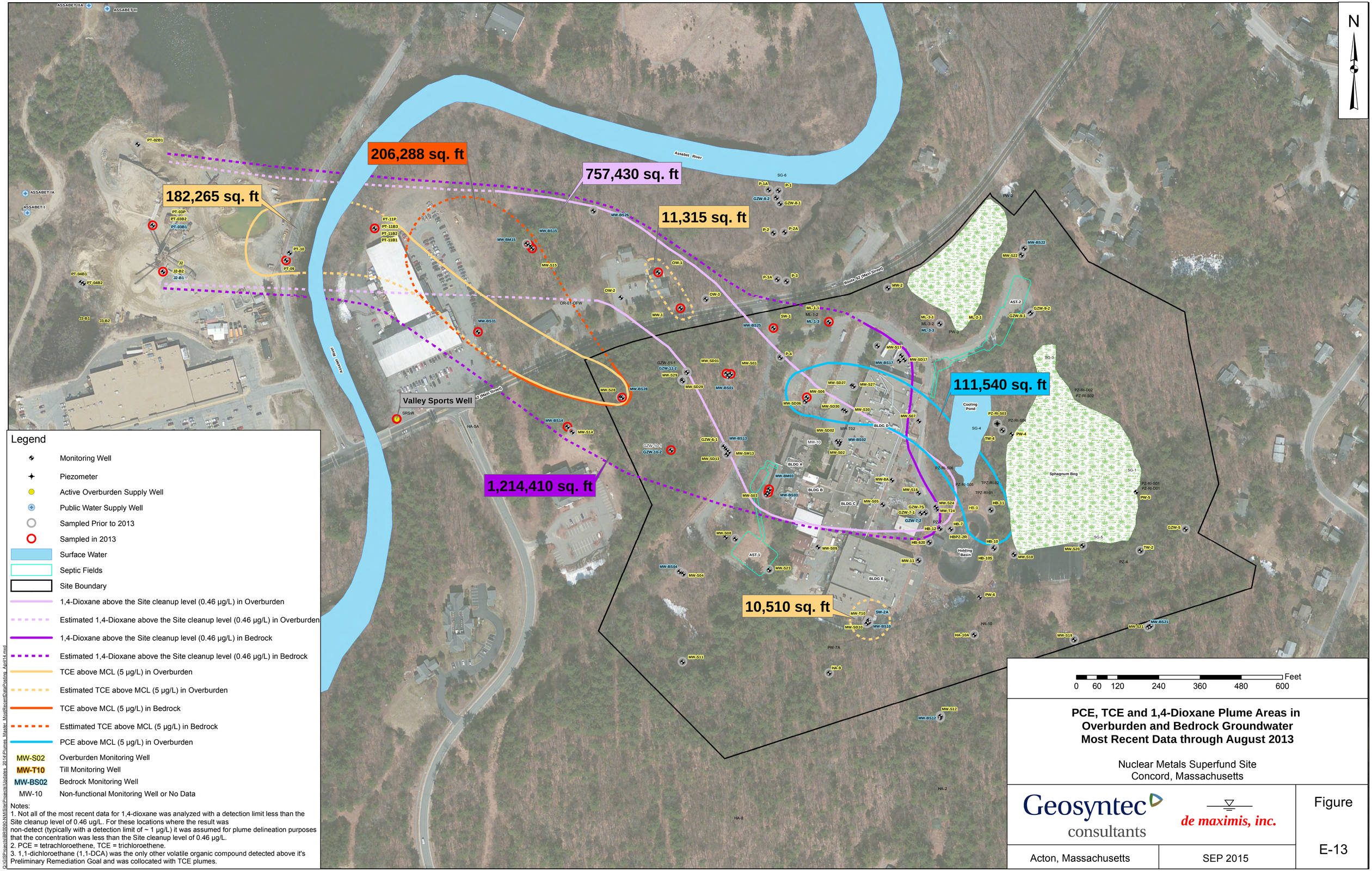
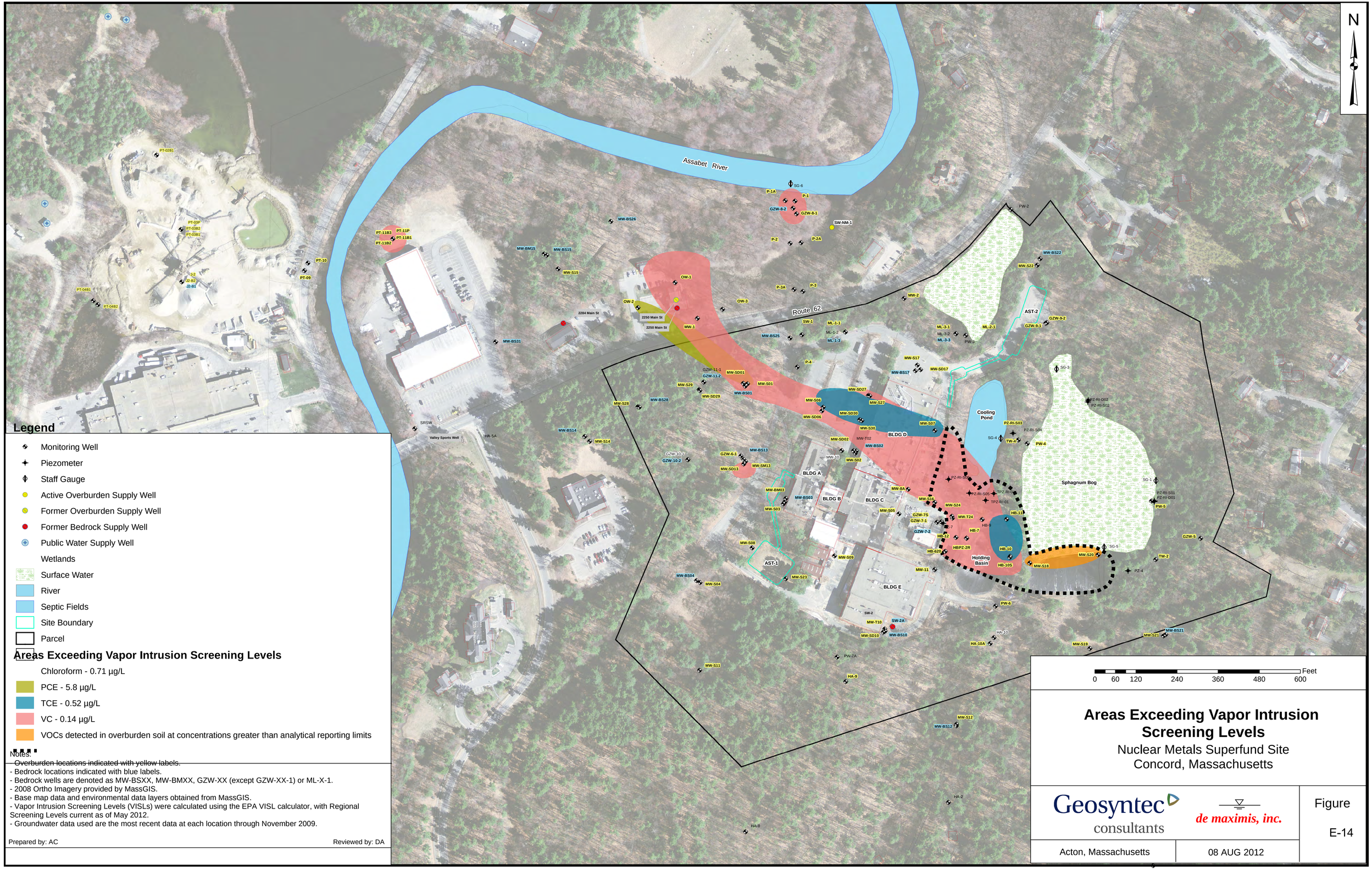
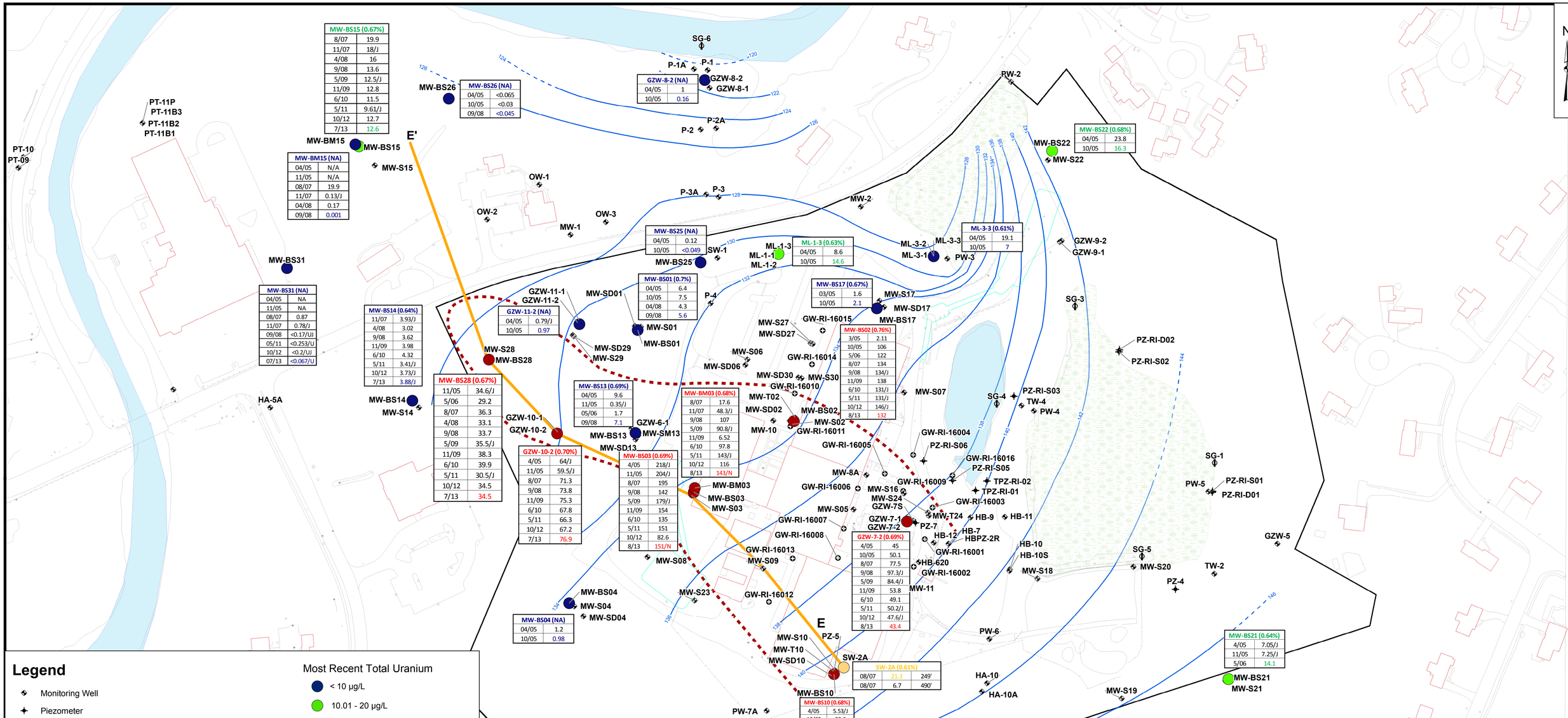

N
206,288 sq. ft
757,430 sq. ft
182,265 sq. ft
11,315 sq. ft
111,540 sq. ft
1,214,410 sq. ft
10,510 sq. ft
Valley Sports Well
Assabet River
Route 62 (Main Street)
Sphagnum Bog
Cooling Pond
Holding Basin
BLDG A
BLDG B
BLDG C
BLDG D
BLDG E
Legend
Monitoring Well
Piezometer
Active Overburden Supply Well
Public Water Supply Well
Sampled Prior to 2013
Sampled in 2013
Surface Water
Septic Fields
Site Boundary
1,4-Dioxane above the Site cleanup level (0.46 µg/L) in Overburden
Estimated 1,4-Dioxane above the Site cleanup level (0.46 µg/L) in Overburden
1,4-Dioxane above the Site cleanup level (0.46 µg/L) in Bedrock
Estimated 1,4-Dioxane above the Site cleanup level (0.46 µg/L) in Bedrock
TCE above MCL (5 µg/L) in Overburden
Estimated TCE above MCL (5 µg/L) in Overburden
TCE above MCL (5 µg/L) in Bedrock
Esttimated TCE above MCL (5 µg/L) in Bedrock
PCE above MCL (5 µg/L) in Overburden
MW-S02 Overburden Monitoring Well
MW-T10 Till Monitoring Well
MW-BS02 Bedrock Monitoring Well
MW-10 Non-functional Monitoring Well or No Data
Notes:
1. Not all of the most recent data for 1,4-dioxane was analyzed with a detection limit less than the Site cleanup level of 0.46 ug/L. For these locations where the result was non-detect (typically with a detection limit of ~ 1 µg/L) it was assumed for plume delineation purposes that the concentration was less than the Site cleanup level of 0.46 µg/L.
2. PCE = tetrachloroethene, TCE = trichloroethene.
3. 1,1-dichloroethane (1,1-DCA) was the only other volatile organic compound detected above it's Preliminary Remediation Goal and was collocated with TCE plumes.
Feet
0 60 120 240 360 480 600
PCE, TCE and 1,4-Dioxane Plume Areas in Overburden and Bedrock Groundwater Most Recent Data through August 2013
Nuclear Metals Superfund Site
Concord, Massachusetts
Geosyntec consultants
de maximis, inc.
Figure
E-13
Acton, Massachusetts
SEP 2015


N
Assabet River
Route 62
BLDG A
BLDG B
BLDG C
BLDG D
BLDG E
Cooling Pond
Sphagnum Bog
Holding Basin
AST-1
AST-2
2250 Main St
2284 Main St
Valley Sports Well
Legend
Monitoring Well
Piezometer
Staff Gauge
Active Overburden Supply Well
Former Overburden Supply Well
Former Bedrock Supply Well
Public Water Supply Well
Wetlands
Surface Water
River
Septic Fields
Site Boundary
Parcel
Areas Exceeding Vapor Intrusion Screening Levels
Chloroform - 0.71 µg/L
PCE - 5.8 µg/L
TCE - 0.52 µg/L
VC - 0.14 µg/L
VOCs detected in overburden soil at concentrations greater than analytical reporting limits
Notes:
- Overburden locations indicated with yellow labels.
- Bedrock locations indicated with blue labels.
- Bedrock wells are denoted as MW-BSXX, MW-BMXX, GZW-XX (except GZW-XX-1) or ML-X-1.
- 2008 Ortho Imagery provided by MassGIS.
- Base map data and environmental data layers obtained from MassGIS.
- Vapor Intrusion Screening Levels (VISLs) were calculated using the EPA VISL calculator, with Regional Screening Levels current as of May 2012.
- Groundwater data used are the most recent data at each location through November 2009.
Prepared by: AC
Reviewed by: DA
0 60 120 240 360 480 600 Feet
Areas Exceeding Vapor Intrusion Screening Levels
Nuclear Metals Superfund Site
Concord, Massachusetts
Geosyntec consultants
de maximis, inc.
Figure
E-14
Acton, Massachusetts
08 AUG 2012



Legend

- Monitoring Well
- Piezometer
- Staff Gauge
- Wetlands
- Surface Water
- Site Boundary
- Septic Fields
- Uranium MCL Exceedance (>30 µg/L)
- E-E' Cross-Section
- 123 April 2008 Groundwater Elevation Contour (ft NGVD)
- 123 April 2008 Estimated Groundwater Elevation Contour (ft NGVD)

Most Recent Total Uranium

- < 10 µg/L
- 10.01 - 20 µg/L
- 20.01 - 30 µg/L
- > 30.01 µg/L MCL Exceedance in Bedrock

Historical Total Uranium (µg/L)

Date	Total Uranium (µg/L)
5/11	10.0
10/12	20.0
8/13	95.0

Most Recent concentration text color coded by concentration ranges listed above.
(0.25%) Represents the U-235% in the most recent sample data through August 2013

Notes:
Results for SW-2A include sample collection depth.
µg/L = microgram per liter
U = Not detected above the method detection limit shown
J = Estimated value
NGVD = National Geodetic Vertical Datum of 1929
N = Indicates presumptive evidence of a compound. This flag is usually used for a tentatively identified compound, where the identification is based on a mass spectral library search.

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Total Uranium Concentrations in Bedrock Groundwater Historical Data through August 2013

Nuclear Metals Superfund Site
Concord, Massachusetts

Geosyntec consultants

de maximis, inc.

Acton, Massachusetts

APRIL-2014

Figure E-15

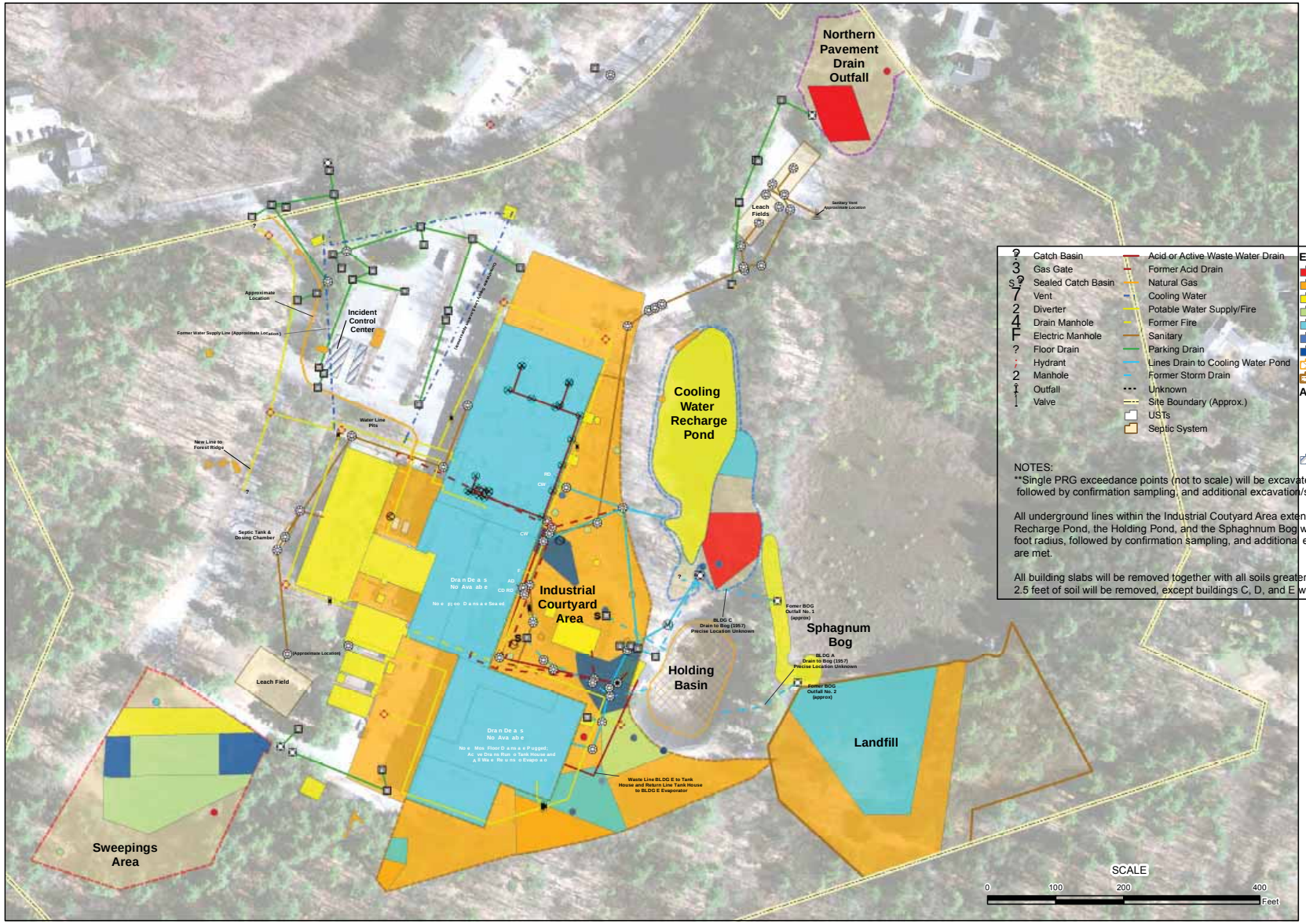

Figure L-1
Soil/Sediment Excavation Areas including Building Foundations and Utilities
In Surface and Sub Surface Soil

Nuclear Metals Inc. (NTCRA)
Concord, Massachusetts

Source:
RI/FS database and
Site MACTEC Utility layers
from Site Engineering Drawings

Map Legend:

- Catch Basin
- Gas Gate
- Sealed Catch Basin
- Vent
- Diverter
- Drain Manhole
- Electric Manhole
- Floor Drain
- Hydrant
- Manhole
- Outfall
- Valve
- Acid or Active Waste Water Drain
- Former Acid Drain
- Natural Gas
- Cooling Water
- Potable Water Supply/Fire
- Former Fire
- Sanitary
- Parking Drain
- Lines Drain to Cooling Water Pond
- Former Storm Drain
- Unknown
- Site Boundary (Approx.)
- USTs
- Septic System

Excavation Depth (ft) **
- 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 6.00
- 6.01 - 8.00
- 8.01 - 10.00
- T.B.D. by remedy selection
- Remove all metal & soil to PRGs

AreaName
- Cooling Water Recharge Pond
- Industrial Courtyard Area
- Sweepings Area
- Northern Pavement Drain Outfall
- Trailer

NOTES:
**Single PRG exceedance points (not to scale) will be excavated in an initial 2.5 foot radius, followed by confirmation sampling, and additional excavation/sampling until PRGs are met.

All underground lines within the Industrial Coutyard Area extending to the Cooling Water Recharge Pond, the Holding Pond, and the Sphaghnum Bog will be excavated in an initial 2.5 foot radius, followed by confirmation sampling, and additional excavation/sampling until PRGs are met.

All building slabs will be removed together with all soils greater than PRGs. For cost estimating, 2.5 feet of soil will be removed, except buildings C, D, and E where 5 feet will be removed.

Spatial Projection:

Coordinate System:
MA State Plane Mainland
FIPS Zone: 2001
Units: US Survey Feet
Datum: NAD83

Plot Info:

File: Fig2.5.2_ExcAreaswUtils
Project No.:3167c
Plot Date: 5 August, 2014
Arc Operator: HG
Reviewed by: VR/BT

ddms

de maximis, inc.

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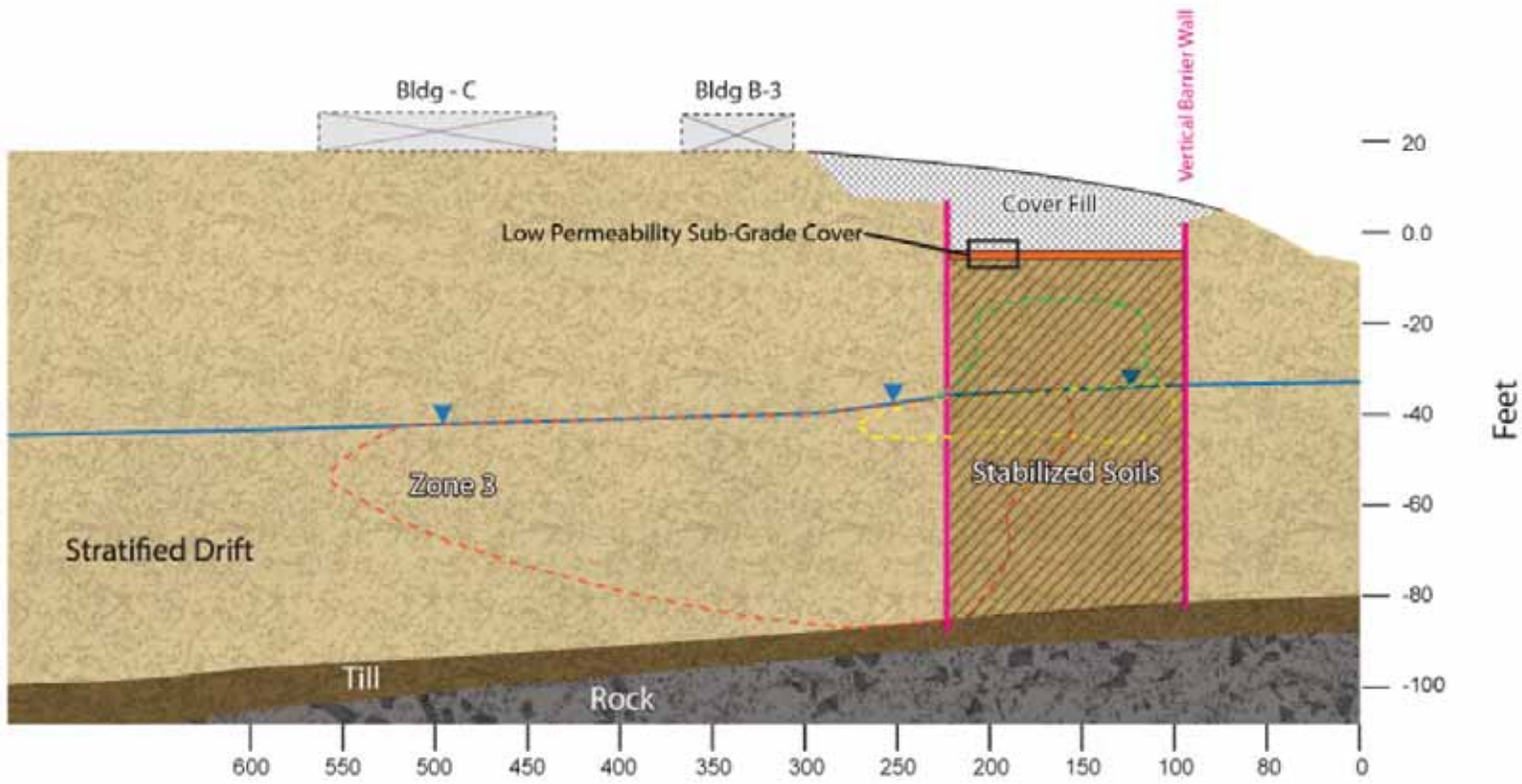

LEGEND

- Zone 1 - Uranium > 30 mg/kg in Vadose Zone Soils
- Zone 2 - Uranium > 30 mg/kg in Saturated Zone Soils
- Zone 3 - Uranium > 30 ug/l in Groundwater
- Building to be demolished
- Groundwater

Units depicted are feet (ft)

Holding Basin Soil Stabilization and Containment

Nuclear Metals Inc., Concord, MA

Name: Fig4.3.5_VBW_profile
Date: 8/7/2014
Author: RKoehnen
Project No.: 3215
Reviewed by: VR

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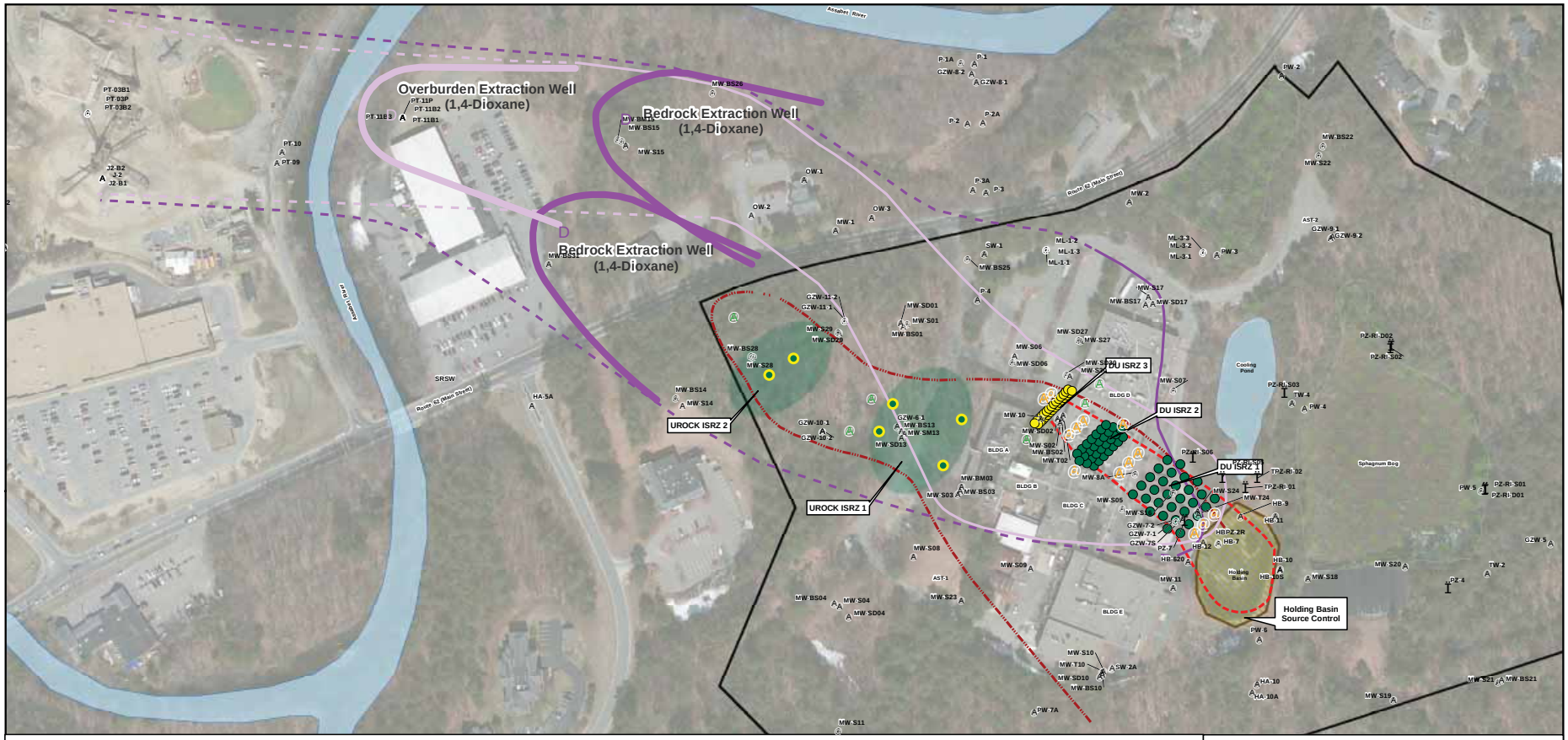
ddms

1217 Bandana Blvd N
St. Paul, MN 55108

DDMS Map Document: (R:\Projects\DEF\demax-1547\3167c-NMI\DataAnalysis\GISData\Projects\RA Design)



Legend

- D Proposed Extraction Well in Bedrock
- D Proposed Extraction Well in Overburden
- A Monitoring Well
- Piezometer
- Wetlands
- Surface Water
- Site Boundary
- A Proposed ISRZ Reactive Zone Monitoring Well
- Proposed Media Injection Point (Apatite)
- Proposed Media Injection Point (Zero Valent Iron (ZVI))
- Proposed Media Injection Point in Bedrock (Apatite or ZVI)
- A Proposed Monitoring Well
- Estimated Hydraulic Capture Zone in Overburden (1,4-Dioxane)
- Estimated Hydraulic Capture Zone in Bedrock (1,4-Dioxane)
- 1,4-Dioxane above the Site PRG (0.67 µg/L) in Overburden
- Estimated 1,4-Dioxane above the Site PRG (0.67 µg/L) in Overburden
- 1,4-Dioxane above the Site PRG (0.67 µg/L) in Bedrock
- Estimated 1,4-Dioxane above the Site PRG (0.67 µg/L) in Bedrock
- Uranium above the MCL (>30 µg/L)
- Depleted Uranium above the MCL (>30 µg/L)
- Holding Basin Source Control Area
- ISRZ in Bedrock

Notes:
1. The illustrated capture zone for the 1,4-Dioxane overburden well assumes an extraction rate of approximately 6.0 gpm, based on a hydraulic gradient of 0.011, a hydraulic conductivity of 4.3 ft/day, a plume width of 200 ft and a plume thickness of 50 ft.
2. The illustrated capture zone for the two 1,4-Dioxane bedrock wells assumes an extraction rate of approximately <0.5 gpm, based on a hydraulic gradient of 0.004, hydraulic conductivity of 0.22 ft/day, a plume width of 430 ft and a plume thickness of 25 ft.
3. The locations of conveyance lines, treatment building, and discharge line would be selected during remedial design.
4. The upgradient portions of the 1,4-Dioxane plumes have been cut off for figure clarity.
5. ISRZ = In-situ Reactive Zone, DU = depleted uranium, UROCK = Isotopically natural Uranium in Bedrock.

Ex-situ Treatment of VOCs/1,4 dioxane ,
In-situ Treatment of DU and Natural Uranium

Nuclear Metals Superfund Site
Concord, Massachusetts

Feet
200 100 0 200

Geosyntec consultants

de maximis, inc.

Figure
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19-SEP-2007

APPENDIX D

ARARs TABLES

Action-Specific ARARs for SS-4 and GW-4
Record of Decision
Nuclear Metals Superfund Site
Concord, Massachusetts

Regulatory Authority	Action/Trigger	Requirement	Status	Requirement Synopsis	Action To Be Taken To Attain ARAR
Soil and Sediment (Alternative SS-4)					
Federal	Management of PCB-contaminated soil	TSCA PCB Remediation Waste (40 CFR 761.61(c))	Applicable	This section of the TSCA regulations provides risk-based cleanup and disposal options for PCB remediation waste based on the risks posed by the concentrations at which the PCBs are found. Written approval for the proposed risk-based cleanup must be obtained from the Director, Office of Site Remediation and Restoration, USEPA Region 1.	The cleanup and disposal of PCB contaminated soil and sediment will be performed in a manner to comply with TSCA. EPA has determined that the method of excavation and disposal of the ≥ 50 ppm PCB-contaminated sediment and soil as described in the TSCA determination will not pose an unreasonable risk of injury to health and the environment.. (See TSCA Determination in Appendix G)
Federal	Management of waste radioactive material	Nuclear Regulatory Commission, Licensing of Radioactive Material (10 CFR Part 40, Appendix A, Criterion 6)	Relevant and Appropriate	10 CFR Part 40 Appendix A, Criterion 6(1) requires the disposal of waste byproduct radioactive material to be closed with a design which provides reasonable assurance of control of radiological hazards to be effective for 1,000 years, to the extent reasonably achievable, and in any case, for at least 200 years.	These requirements will be incorporated in the design of the vertical containment wall and horizontal cover for the solidified/stabilized soils remaining on-site in the Holding Basin.
State	Radiation containment design requirements	Massachusetts Regulations for the Control of Radiation, Standards for Protection Against Radiation, Vacating Premises (105 CMR 120.245)	Relevant and Appropriate	These regulations specify that the annual total effective dose equivalent (TEDE) from any specific environmental source during decommissioning activities should not exceed ten millirem above background and that the annual TEDE to any individual after the Site is released for unrestricted use should not exceed ten millirem above background.	The 10 mRem above background criteria was used during the development of cleanup goals and will be used in the design of the containment wall and cover.
Soil, Sediment, and Groundwater (Alternatives SS-4 and GW-4)					
Federal	Radiation protection program	Nuclear Regulatory Commission, Radiation Protection Programs (10 CFR Part 20 - Appendix B)	Relevant and Appropriate	Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage.	ALIs and DACs will be determined for protection of workers during remedial activities.
Federal	Control of surface water runoff, Direct discharge to surface water	Clean Water Act NPDES Permit Program (40 CFR Part 122,125)	Applicable	The NPDES permit program specifies the permissible concentration or level of contaminants in the discharge from any point source, including surface runoff, to waters of the United States.	Any discharges to surface waters will meet the substantive discharge standards.

Action-Specific ARARs for SS-4 and GW-4
Record of Decision
Nuclear Metals Superfund Site
Concord, Massachusetts

Regulatory Authority	Action/Trigger	Requirement	Status	Requirement Synopsis	Action To Be Taken To Attain ARAR
Federal	Discharge to publicly owned treatment works	CWA, General Pretreatment Program (40 CFR Part 403)	Applicable	Discharge of nondomestic wastewater to POTW must comply with the general prohibitions of this regulation, as well as categorical standards, and local pretreatment standards.	Discharge to POTW will be sampled to evaluate compliance with pre-treatment standards.
Federal	Storage and treatment of low-level mixed waste (hazardous waste containing low-level radioactive waste)	RCRA Conditional Exemption for Low-Level Mixed Waste Storage, Treatment, Transportation, and Disposal (40 CFR Part 266 Subpart N)	Applicable	Low-level mixed waste (LLMW) (hazardous waste containing low-level radioactive waste) is exempted from RCRA storage, treatment, transportation and disposal requirements.. LLMW must still be managed as radioactive waste according to Nuclear Regulatory Commission (NRC) regulations (Title 10, Chapter I, of the Code of Federal Regulations).	LLMW will be managed as radioactive waste according to NRC regulations.
Federal	Use of a treatment, storage or disposal facility for hazardous waste	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (40 CFR Part 264)	Applicable	Establishes minimum national standards for the management of hazardous waste, including closure and post-closure requirements. Applies to owners and operators of all facilities which treat, store, or dispose of hazardous waste. Such facilities include landfills, containers, tank systems, waste piles, and miscellaneous units.	The use of treatment, storage or disposal facilities for hazardous waste that does not contain low-level radioactive waste will be done in accordance with these requirements.
Federal	Identification of hazardous waste	RCRA Identification and Listing of Hazardous Waste (40 CFR 261.3 and 40 CFR 264.13)	Applicable	These regulations include rules to identify hazardous waste. If waste exhibits the characteristics of a hazardous waste and does not contain low-level radioactive waste, RCRA waste regulations are applicable.	Any waste generated as part of the remedial activities will be tested for hazardous waste characteristics as well as low-level radioactive waste to determine whether it should be managed as hazardous waste.
Federal	Storage and disposal of hazardous wastes	RCRA Standards Applicable to Generators of Hazardous Waste (40 CFR Part 262)	Applicable	These standards govern storage, labeling, accumulation times, and disposal of hazardous waste. These regulations establish standards for generators of hazardous waste. RCRA Subtitle C established standards applicable to treatment, storage, and disposal of hazardous waste and closure of hazardous waste facilities.	Any hazardous waste generated during remedial action activities that does not contain low-level radioactive waste will be managed in accordance with these standards.
State	Receipt, ownership, possession, use, transfer, or disposal of any radiation source	Massachusetts Regulations for the Control of Radiation (105 CMR 120)	Applicable	Massachusetts regulates all sources of radiation including naturally occurring radioactive material, byproduct material and special nuclear material. These regulations pertain to source material, byproduct material, and special nuclear materials in quantities not sufficient to form a critical mass and apply to the protection of workers and individuals against radiation, termination of licenses, decommissioning of facilities, and transportation of radioactive material.	The substantive requirements of this regulation will be followed during the cleanup of the Site.

Action-Specific ARARs for SS-4 and GW-4
Record of Decision
Nuclear Metals Superfund Site
Concord, Massachusetts

Regulatory Authority	Action/Trigger	Requirement	Status	Requirement Synopsis	Action To Be Taken To Attain ARAR
State	Identification and management of hazardous waste	Massachusetts Hazardous Waste Management Rules (310 CMR 30.000)	Applicable	These regulations outline requirements and procedures for handling, storage, treatment, disposal, and record keeping at hazardous waste facilities.	Any waste generated as part of the remedial activities will be tested for hazardous waste characteristics as well as low-level radioactive waste to determine whether it should be managed as hazardous waste in accordance with these standards.
State	Discharges to surface water	Massachusetts Surface Water Discharge Permit Program (314 CMR 3.00)	Applicable	These regulations establish a permit program to regulate pollutant discharges to surface waters of the Commonwealth and to confer sufficient authority to the Massachusetts Department of Environmental Protection to assume the delegated administration of the NPDES permit program within the Commonwealth.	Any discharge to surface water of extracted groundwater, monitor well purge water, and investigation derived waste water will be treated and controlled to meet the requirements of these regulations. Construction activities will be controlled to meet surface water discharge requirements.
State	Discharges to surface water	Massachusetts Surface Water Quality Standards (314 CMR 4.00)	Applicable	Through these regulations MassDEP will limit or prohibit discharges of pollutants to surface waters to assure that surface water quality standards of the receiving waters are protected and maintained or attained. The level of treatment for an individual discharger will be established by the discharge permit in accordance with 314 CMR 3.00 (Massachusetts Surface Water Discharge Permit Program).	Any discharge to surface water of extracted groundwater, monitor well purge water, and investigation derived waste water will be treated and controlled to meet the requirements of these regulations. Construction activities will be controlled to meet surface water quality standards.
State	Activities that affect ambient air quality	Massachusetts Air Pollution Control Regulations (310 CMR 7.00)	Applicable	These regulations set emission limits necessary to attain ambient air quality standards, including standards for Visible Emissions (310 CMR 7.06); Dust, Odor, Construction and Demolition (310 CMR 7.09); Noise (310 CMR 7.10); and Volatile Organic Compounds (310 CMR 7.18).	Remedial activities will be conducted to meet these air quality standards, including standards for Visible Emissions (310 CMR 7.06); Dust, Odor, Construction and Demolition (310 CMR 7.09); Noise (310 CMR 7.10); and Volatile Organic Compounds (310 CMR 7.18).
Groundwater (Alternative GW-4)					
Federal	Use of air stripping	Clean Air Act National Emissions Standards for Hazardous Air Pollutants (NESHAPs), (40 CFR Part 61)	Applicable	These regulations set standards for emissions of 189 Hazardous Air Pollutants that are listed in Section 112(b)(1) of the Clean Air Act.	If air stripping is selected during remedial design as a component of the groundwater remedy and any of the 189 hazardous air pollutants will be emitted, engineering and other controls will be implemented to comply with these standards.
Federal	Underground injections	SDWA Underground Injection Control Program (40 CFR Part 144, 146, and 147 Subpart W)	Relevant and Appropriate	These regulations outline the minimum program and performance standards for underground injection programs. Technical criteria and standards for siting, operation and maintenance, closure, and reporting and recordkeeping as required for permitting are set forth in Part 146.	If treated groundwater is re-injected into the aquifer, these standards would be met since the treated groundwater would meet MCLs and would not be considered hazardous waste.

Action-Specific ARARs for SS-4 and GW-4
Record of Decision
Nuclear Metals Superfund Site
Concord, Massachusetts

Regulatory Authority	Action/Trigger	Requirement	Status	Requirement Synopsis	Action To Be Taken To Attain ARAR
State	Activities that affect ambient air quality	Massachusetts Ambient Air Quality Standards (310 CMR 6.00)	Applicable	These regulations set primary and secondary standards for emissions of sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead.	If air stripping is selected during remedial design as a component of the groundwater remedy, it will be designed, constructed, and operated in accordance with these requirements.
State	Discharge of treated groundwater to groundwater	Massachusetts Groundwater Discharge Permit Program [3.14 CMR 5.10 (Permit Conditions) and 5.11 (Groundwater Standards)]	Relevant and Appropriate	These regulations require MassDEP to control the discharge of pollutants to the ground waters of the Commonwealth through the issuance of permits to assure that groundwaters are protected for their actual and potential use as a source of potable water and surface waters are protected for their existing and designated uses.	If treated groundwater is re-injected into the aquifer, the discharge of any pollutant to groundwater will controlled so that groundwaters are protected for their actual and potential use as a source of potable water and surface waters are protected for their existing and designated uses.

Key:

ARAR = Applicable or Relevant and Appropriate Requirement
BACT = best available control technology
CAA = Clean Air Act
CERCLA = Comprehensive Environmental Response, Compensation and Liability Act
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
CWA = Clean Water Act
DCLG = Derived Concentration Guideline Level
LDRs = Land Disposal Restrictions
NCP = National Contingency Plan
NESHAP = National Emission Standards for Hazardous Air Pollutants
NPDES = National Pollutant Discharge Elimination System
PCBs = polychlorinated biphenyls
POTW = publicly owned treatment works
ppm = parts per million
RCRA = Resource Conservation and Recovery Act
SDWA = Safe Drinking Water Act
TSCA = Toxic Substances Control Act
UIC = Underground Injection Control
USEPA = U.S. Environmental Protection Agency
USC = United States Code

Chemical-Specific ARARs for Groundwater (Alternative GW-4)
Record of Decision
Nuclear Metals Superfund Site
Concord, Massachusetts

Regulatory Authority	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARAR
Federal	Safe Drinking Water Act, National Primary Drinking Water Regulations, MCLs and MCLGs [40 CFR Parts 141.60 - 141.63 and 141.50 - 141.52]	Relevant and Appropriate	The National Primary Drinking Water Regulations establish Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) for several common organic and inorganic contaminants. MCLs specify the maximum permissible concentrations of contaminants in public drinking water supplies. MCLs are federally enforceable standards based in part on the availability and cost of treatment techniques. MCLGs specify the maximum concentration at which no known or anticipated adverse effect on humans will occur. MCLGs are non-enforceable health based goals set equal to or lower than MCLs.	MCLs and nonzero MCLGs were used during the development of cleanup goals. Cleanup actions will be designed and implemented to attain the concentration limits of these regulations.
Federal	USEPA Risk Reference Doses	To Be Considered	Risk reference doses (RfDs) are estimates of daily exposure levels that are unlikely to cause significant adverse non-carcinogenic health effects over a lifetime.	RfDs were considered during the development of cleanup goals.
Federal	USEPA Carcinogen Assessment Group, Cancer Slope Factors (CSFs)	To Be Considered	CSFs are used to compute the incremental cancer risk from exposure to site contaminants and represent the most up-to-date information on cancer risk from USEPA's Carcinogen Assessment Group.	CSFs were considered during the development of cleanup goals.
Federal	Guidelines for Carcinogen Risk Assessment (EPA/630/P-03/001F, March 2005)	To Be Considered	Guidance values are to be used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	These guidelines were considered during the development of cleanup goals.
Federal	Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens (EPA/630/R-03/003F, March 2005)	To Be Considered	Guidance values are to be used to evaluate the potential carcinogenic hazard to children caused by exposure to contaminants.	This guidance was considered during the development of cleanup goals.
Federal	EPA Office of Water, Drinking Water Health Advisories (EPA 822-R-06-013)	To Be Considered	Health Advisories (HAs) are estimates of acceptable drinking water levels for chemical substances based on health effects information; an HA is not a legally enforceable federal standard, but serves as technical guidance to assist federal, state and local officials.	HAs were considered during the development of cleanup goals. In particular, HAs were used if a constituent does not have a promulgated MCL or MCP GW-1 [or MA MCL] standard.
State	Massachusetts Regulations for the Control of Radiation, Standards for Protection Against Radiation, Vacating Premises (105 CMR 120.245)	Relevant and Appropriate	These regulations specify that the annual TEDE dose from any specific environmental source during decommissioning activities should not exceed ten millirem above background and that the annual TEDE to any individual after the Site is released for unrestricted use should not exceed ten millirem above background.	The 10 mRem above background criterion was used during the development of cleanup goals.

Chemical-Specific ARARs for Groundwater (Alternative GW-4)
Record of Decision
Nuclear Metals Superfund Site
Concord, Massachusetts

Regulatory Authority	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARAR
State	Massachusetts Contingency Plan (MCP) [310 CMR 40.0000], Method 1 GW-1 Standards	To Be Considered	The MCP Method 1 groundwater standards assume exposure to concentrations of hazardous material in groundwater under current or foreseeable future conditions. These standards contain a list of numerical, risk-based limitations on particular contaminants in groundwater based on the groundwater classification.	These standards were considered during development of cleanup goals.
State	Massachusetts Drinking Water Regulations [310 CMR 22.00]	Relevant and Appropriate	These standards establish Massachusetts Maximum Contaminant Levels (MA MCLs) for organic and inorganic contaminants that have been determined to adversely affect human health in public drinking water supply systems.	MA MCLs were used during development of cleanup goals.

Key:

ARAR = Applicable or Relevant and Appropriate Requirement
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
CSF = cancer slope factor
DCGL = Derived Concentration Guideline Level
MCLs = Maximum Contaminant Levels
MCLGs = Maximum Contaminant Level Goals
MA MCLs = Massachusetts Maximum Contaminant Levels
RfD = reference dose
TEDE = total effective dose equivalent
TSCA = Toxic Substances Control Act
USEPA = United States Environmental Protection Agency

Chemical-Specific ARARs for Soil and Sediment (Alternative SS-4)
Record of Decision
Nuclear Metals Superfund Site
Concord, Massachusetts

Regulatory Authority	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	ACTION TO BE TAKEN TO ATTAIN ARAR
Federal	USEPA Risk Reference Doses	To Be Considered	Risk reference doses (RfDs) are estimates of daily exposure levels that are unlikely to cause significant adverse non-carcinogenic health effects over a lifetime.	RfDs were considered during the development of cleanup goals.
Federal	USEPA Carcinogen Assessment Group, Cancer Slope Factors (CSFs)	To Be Considered	CSFs are used to compute the incremental cancer risk from exposure to site contaminants and represent the most up-to-date information on cancer risk from USEPA's Carcinogen Assessment Group.	CSFs were considered during the development of cleanup goals.
Federal	Guidelines for Carcinogen Risk Assessment (EPA/630/P-03/001F, March 2005)	To Be Considered	Guidance values are to be used to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	These guidelines were considered during the development of cleanup goals.
Federal	Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens (EPA/630/R-03/003F, March 2005)	To Be Considered	Guidance values are to be used to evaluate the potential carcinogenic hazard to children caused by exposure to contaminants.	This guidance were considered during the development of cleanup goals.
Federal	A Guide on Remedial Actions at Superfund Sites with PCB Contamination, OSWER Directive #9355.4-01FS, August 1990	To Be Considered	Establishes a policy that a cleanup level of 1 mg/kg PCBs in residential area soil reflects a protective quantifiable concentration.	This policy was considered during the development of cleanup levels for soils and sediments.
Federal	Prediction of sediment toxicity using consensus-based freshwater sediment quality guidelines. EPA 905/R-00/007. June 2000	To Be Considered	The methodology presented in this document represent USEPA's best recommendation as to the concentration of a substance that may be present in sediment while still protecting benthic organisms from the effects of that substance.	These guidelines were considered during the development of cleanup goals for sediments.
State	Massachusetts Regulations for the Control of Radiation, Standards for Protection Against Radiation, Vacating Premises; 105 CMR 120.245; Standards for Protection Against Radiation	Relevant and Appropriate	These regulations specify that the annual total effective dose equivalent (TEDE) from any specific environmental source during decommissioning activities should not exceed ten millirem above background and that the annual TEDE to any individual after the Site is released for unrestricted use should not exceed ten millirem above background.	The 10 mRem above background criterion was used during the development of cleanup goals

Key:

ARAR = Applicable or Relevant and Appropriate Requirement
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
CSF = cancer slope factor
mRem = millirem
RfD = reference dose
TEDE = total effective dose equivalent
TSCA = Toxic Substances Control Act
NUREG = NRC Regulation
USEPA = United States Environmental Protection Agency

Location-Specific ARARs for SS-4 and GW-4
Record of Decision
Nuclear Metals Superfund Site
Concord, Massachusetts

Regulatory Authority	Location Characteristic	Requirement	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
Soil and Sediment (Alternative SS-4)					
Federal	Surface Waters, Endangered Species, Migratory Species	Fish and Wildlife Coordination Act [16 USC 661 et seq.] 40 CFR Part 6	Applicable	Actions that affect species/habitat require consultation with USDOI, USFWS, NMFS, and/or state agencies, as appropriate, to ensure that proposed actions do not jeopardize the continued existence of the species or adversely modify or destroy critical habitat. The effects of water-related projects on fish and wildlife resources must be considered. Action must be taken to prevent, mitigate, or compensate for project-related damages or losses to fish and wildlife resources.	To the extent necessary, actions will be taken to develop measures to prevent, mitigate, or compensate for project related impacts to habitat and wildlife. The USFWS, acting as a review agency for the USEPA, will be kept informed of proposed remedial activities.
Federal	Wetlands, Aquatic Ecosystem	Clean Water Act, Dredge or Fill Requirements Section 404 [40 CFR Part 230, 33 CFR 320-323]	Applicable	Section 404 of the CWA regulates the discharge of dredged or fill materials to U.S. waters, including wetlands. Filling wetlands would be considered a discharge of fill materials. Guidelines for Specification of Disposal Sites for Dredged or Fill material at 40 CFR Part 230, promulgated under CWA Section 404(b)(1), maintain that no discharge of dredged or fill material will be permitted if there is a practical alternative that would have less effect on the aquatic ecosystem. If adverse impacts are unavoidable, action must be taken to restore, or create alternative wetlands.	SS-4's effects on surface waters and wetlands will be evaluated and avoided and/or minimized. Compensatory wetlands mitigation will need to be performed as necessary to comply with this ARAR. The selected remedy is the least environmentally damaging practicable alternative that meets the remedial action objectives. Any wetland or surface water areas that require removal of soil/sediment will be designated for eventual restoration.
Federal	Endangered Species	Endangered Species Act [50 CFR Parts 17.11-17.12; 50 CFR 402]	Applicable, if such species are encountered	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat.	Protection of endangered species and their habitat will be considered as part of the design and excavation activities.
State	Floodplains, Wetlands, Surface Waters	Massachusetts Wetland Protection Regulations [310 CMR 10.00]	Applicable	These regulations include standards on dredging, filling, altering, or polluting inland wetlands and protected areas (defined as areas within the 100-year floodplain). Under this requirement, available alternatives must be considered that minimize the extent of adverse impacts, and mitigation including restoration and/or replication is required.	All work to be performed within wetlands and the 100 foot buffer zone will be in accordance with the substantive requirements of these regulations. The Sphagnum Bog is within 100 feet of the Holding Basin and Cooling Water Recharge Pond.

Location-Specific ARARs for SS-4 and GW-4
Record of Decision
Nuclear Metals Superfund Site
Concord, Massachusetts

Regulatory Authority	Location Characteristic	Requirement	Status	Requirement Synopsis	Action To Be Taken To Attain Requirement
State	Aquatic Ecosystem	Massachusetts Clean Waters Act, 21 M.G.L. §§ 26-53 Massachusetts Water Quality Certification for Discharge of Dredged or Fill Material, Dredging, and Dredging Material Disposal in Waters of the U.S. within the Commonwealth [314 CMR 9.00]	Applicable	For discharges of dredged or fill material, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; appropriate and practicable steps must be taken to avoid and minimize potential adverse impacts to wetlands and land under water; stormwater discharges must be controlled with BMPs; and there must not be substantial adverse impacts to the physical, chemical or biological integrity of surface waters. For dredging and dredged material management, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; and if avoidance is not possible, then minimize, or if neither avoidance nor minimization are possible, then mitigate potential adverse impacts.	Excavation and filling activities to be performed impacting the aquatic ecosystem will be in accordance with the substantive requirements of these regulations. The selected remedy is the least environmentally damaging practicable alternative that meets the remedial action objectives. Any wetland or surface water areas that require removal of soil/sediment will be designated for eventual restoration.
State	Endangered Species	Massachusetts Endangered Species Regulations [321 CMR 10.00]	Applicable, if such species are encountered	Actions must be conducted in a manner that minimizes the impact to Massachusetts-listed rare, threatened, or endangered species, and species listed by the Massachusetts Natural Heritage Program.	The protection of state listed endangered species will be considered during the design and implementation of remedial activities.
Groundwater (Alternative GW-4)					
Federal	Wetlands and Floodplains	Floodplain Management [44 CFR Part 9]	Relevant and Appropriate	These FEMA regulations set forth the policy, procedure and responsibilities to implement and enforce Executive Order 11988, Floodplain Management.	There is no practicable alternative to monitoring groundwater wells and installing new groundwater wells that may be within the floodplain. EPA will avoid or minimize potential harmful impacts on floodplain resources to the extent practicable.

Key:

ARAR = Applicable or Relevant and Appropriate Requirement
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
CWA = Clean Water Act
NCP = National Contingency Plan
NMFS = National Marine Fisheries Service
USDOI = U.S. Department of the Interior
USEPA = U.S. Environmental Protection Agency
USFWS = U.S. Fish and Wildlife Service
USC = United States Code

Location-Specific ARARs for SS-4 and GW-4
Record of Decision
Nuclear Metals Superfund Site
Concord, Massachusetts

APPENDIX E

HUMAN HEALTH RISK-RELATED UPDATES AND REVISED CLEANUP LEVEL DEVELOPMENT

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Technical Memorandum

April 20, 2015

UPDATES ON TOXICITY VALUES AND THEIR IMPLICATION ON THE BASELINE HUMAN HEALTH RISK ASSESSMENT

Nuclear Metals Inc. Superfund Site
Concord, Massachusetts

Since the production of the 2013 Baseline Human Health Risk Assessment (BHHRA; *de maximus*, 2013) for the Nuclear Metals Inc. Superfund Site (the Site), the chronic and subchronic reference concentrations (RfCs) for uranium, as well as the subchronic reference dose (RfD) for uranium have changed. Therefore, the purpose of this memorandum is to identify the changes in toxicity values used and present resulting risks/hazards and impacts to the Nuclear Metals project based on these changes.

In 2003, the EPA Office of Solid Waste and Emergency Response (OSWER) developed a recommended hierarchy (EPA, 2003) for the selection of toxicity values to be used in risk assessments. As discussed in the 2003 memorandum, the preferred tier of toxicological information is as follows:

- Tier 1 – EPA's Integrated Risk Information System (IRIS), developed by EPA's Office of Research and Development National Center for Environmental Assessment (ORD NCEA);
- Tier 2 – EPA's Provisional Peer Reviewed Toxicity Values (PPRTVs), developed by NCEA; and
- Tier 3 – Other toxicity values, including additional EPA and non-EPA sources of toxicity information.

Toxicity values were selected for the 2013 BHHRA following the EPA recommended hierarchy. The uranium RfD and RfCs used in the BHHRA which have since changed were Tier 3 values (Minimal Risk Levels; MRLs) from the Agency for Toxic Substances and Disease Registry (ATSDR), current as of February 2012. In February 2013, ATSDR updated the MRLs for uranium. For non-cancer effects, currently there are neither Tier 1 nor Tier 2 toxicity values for uranium. Upon reviewing the available non-cancer toxicity values, the subchronic oral RfD MRL value of 2.0E-04 mg/kg-day developed by ATSDR (ATSDR, 2013) has been determined to be the most appropriate Tier 3 value for risk assessment of uranium exposure. This value is well documented and peer reviewed. The chronic and subchronic inhalation RfC MRL values of 4E-05 mg/m^3 and 1E-04 mg/m^3, respectively, developed by ATSDR (ATSDR, 2013) have been determined to be the most appropriate Tier 3 values for risk assessment of uranium inhalation exposure.

Table 1 shows different uranium toxicity values used in the 2013 BHHRA and the toxicity values in the current approach on evaluating uranium. Applying the recommended toxicity values to the same Reasonable Maximum Exposure (RME) scenarios and exposure parameters as used in the 2013 BHHRA and using the toxicity values for the current approach from Table 1, non-cancer hazards would be approximately revised as shown in Table 2. Note that the only exposure scenarios presented are those that involved the changed toxicity values.

As shown in Table 2, the changes due to lower RfCs are minimal and do not change the overall hazards. However, the changes due to the lower uranium subchronic RfD would result in the inclusion of uranium as a chemical of concern (COC) for the construction worker at AOI 7 & 11 Industrial Area East (subsurface soil scenario). While uranium is already a COC for the subsurface soil scenario at this area for other receptors, a cleanup level should also be developed for the construction worker using the updated subchronic RfD. In addition, the lower subchronic RfD results in an exceedance of the

acceptable hazard index level of 1 for the construction worker at AOI 1 Holding Basin (both surface and subsurface soil scenarios). Similar to AOI 7 & 11 Industrial Area East, uranium is already a COC for the surface and subsurface soil scenarios at the AOI 1 Holding Basin, but for other receptors. A cleanup level should also be developed for the construction worker using the updated RfD.

Table 1

Non-cancer toxicity data for uranium – oral/dermal and inhalation

Source	Oral/Dermal RfD(1)	Unit	Source	Inhalation RfC	Unit	Source
2013 BHHRA						
Chronic	6.0E-04	mg/kg-day	EPA Office of Water	0.3	$\mu g/m^3$	ATSDR
Subchronic	2.0E-03	mg/kg-day	ATSDR	0.4	$\mu g/m^3$	ATSDR
Current approach						
chronic	6.0E-04	mg/kg-day	EPA Office of Water	0.04	$\mu g/m^3$	ATSDR
subchronic	2.0E-04	mg/kg-day	ATSDR	0.1	$\mu g/m^3$	ATSDR

Note:
(1) There are no dermal toxicity values for uranium. Since the oral absorption efficiency to dermal for uranium exceeds 50%, no adjustment of the oral toxicity values is necessary.

Table 2

Summary of uranium non-cancer hazards (for RME scenario)

Exposure Point	Exposure Media	Scenario/ Receptor	Exposure Route	Non-cancer Hazards	
				2013 BHHRA	Revised Hazards
Current 1 – Open Space Area	Surface soil	Child Abutting Resident	Inhalation (U)	1E-07	8E-07
			Total	*3E-01*	*3E-01*
		Adult Abutting Resident	Inhalation (U)	1E-07	8E-07
			Total	*3E-02*	*3E-02*
Current 2 – Open Space Area North	Surface soil	Child Abutting Resident	Inhalation (U)	3E-07	2E-06
			Total	*1E+00*	*1E+00*
		Adult Abutting Resident	Inhalation (U)	3E-07	2E-06
			Total	*1E-01*	*1E-01*
Current 6 – Fenced Area (Sphagnum Bog)	Surface soil	Adolescent Trespasser	Inhalation (U)	2E-07	2E-06
			Total	*3E-01*	*3E-01*
Current 6 – Fenced Area (Cooling Pond)	Surface soil	Adolescent Trespasser	Inhalation (U)	2E-07	2E-06
			Total	*3E-01*	*3E-01*
Current 4/Future B4 – Rt. 62 Outfall and Embayment Area (Surface)	Surface soil	Child Abutting Resident/Rec. Visitor	Inhalation (U)	8E-08	6E-07
			Total	*3E-01*	*3E-01*
		Adult Abutting Resident/Rec. Visitor	Inhalation (U)	8E-08	6E-07
			Total	*3E-02*	*3E-02*

Exposure Point	Exposure Media	Scenario/ Receptor	Exposure Route	Non-cancer Hazards	
				2013 BHHRA	Revised Hazards
Current 4/Future B4 – Rt. 62 Outfall and Embayment Area (Subsurface)	Subsurface soil	Child Abutting Resident/Rec. Visitor	Inhalation (U)	5E-07	4E-06
			Total	*4E-01*	*4E-01*
		Adult Abutting Resident/Rec. Visitor	Inhalation (U)	5E-07	4E-06
			Total	*4E-02*	*4E-02*
Future A1 – AOI 14 West	Surface soil	Child Resident	Inhalation (U)	1E-07	8E-07
			Total	*5E-01*	*5E-01*
		Adult Resident	Inhalation (U)	6E-08	5E-07
			Total	*5E-02*	*5E-02*
Future A2 – AOI 14 South	Surface soil	Child Resident	Inhalation (U)	6E-07	5E-06
			Total	*7E-01*	*7E-01*
		Adult Resident	Inhalation (U)	4E-07	3E-06
			Total	*8E-02*	*8E-02*
Future A3 – AOI 14 East	Surface soil	Child Resident	Inhalation (U)	1E-07	8E-07
			Total	*7E-01*	*7E-01*
		Adult Resident	Inhalation (U)	8E-08	6E-07
			Total	*7E-02*	*7E-02*
Future A4 – AOI 14 North	Surface soil	Child Resident	Inhalation (U)	9E-07	7E-06
			Total	*3E+00*	*3E+00*
		Adult Resident	Inhalation (U)	5E-07	4E-06
			Total	*3E-01*	*3E-01*
	Subsurface soil	Child Resident	Inhalation (U)	3E-07	2E-06
			Total	*6E-01*	*6E-01*
		Adult Resident	Inhalation (U)	2E-07	2E-06
			Total	*6E-02*	*6E-02*
Future A5 – AOI 8 Sweepings Area	Surface soil	Child Resident	Inhalation (U)	4E-06	3E-05
			Total	*9E+00*	*9E+00*
		Adult Resident	Inhalation (U)	2E-06	2E-05
			Total	*1E+00*	*1E+00*
	Subsurface soil	Child Resident	Inhalation (U)	1E-06	8E-06
			Total	*5E+00*	*5E+00*
		Adult Resident	Inhalation (U)	8E-07	6E-06
			Total	*6E-01*	*6E-01*
Future A6 – AOI 7 & 11 Industrial Area East	Surface soil	Child Resident	Inhalation (U)	4E-05	3E-04
			Total	*1E+01*	*1E+01*
		Adult Resident	Inhalation (U)	2E-05	2E-04
			Total	*1E+00*	*1E+00*
	Subsurface soil	Child Resident	Inhalation (U)	2E-05	2E-04
			Total	*1E+01*	*1E+01*
		Adult Resident	Inhalation (U)	1E-05	8E-05
			Total	*1E+00*	*1E+00*
Future A7 – AOI 5 Industrial Area West	Surface soil	Child Resident	Inhalation (U)	1E-06	8E-05
			Total	*9E-01*	*9E-01*
		Adult Resident	Inhalation (U)	7E-07	5E-06
			Total	*1E-01*	*1E-01*
	Subsurface soil	Child Resident	Inhalation (U)	1E-06	8E-05
			Total	*7E-01*	*7E-01*
		Adult Resident	Inhalation (U)	6E-07	5E-06
			Total	*7E-02*	*7E-02*

Exposure Point	Exposure Media	Scenario/ Receptor	Exposure Route	Non-cancer Hazards	
				2013 BHHRA	Revised Hazards
Future A8 – AOI 14 Off-Property	Surface soil	Child Resident	Inhalation (U)	1E-07	8E-07
			Total	*6E-01*	*6E-01*
		Adult Resident	Inhalation (U)	7E-08	5E-07
			Total	*6E-02*	*6E-02*
Future B1 – Area Around Cooling Pond	Surface soil	Child Resident	Inhalation (U)	2E-06	2E-05
			Total	*2E+00*	*2E+00*
		Adult Resident	Inhalation (U)	1E-06	8E-06
			Total	*2E-01*	*2E-01*
	Subsurface soil	Child Resident	Inhalation (U)	5E-07	4E-06
			Total	*1E+00*	*1E+00*
		Adult Resident	Inhalation (U)	3E-07	2E-06
			Total	*1E-01*	*1E-01*
Future B2 – AOI 2 & 4 Soils Area At Cooling Pond	Surface soil	Child Resident	Inhalation (U)	2E-06	2E-05
			Total	*2E+01*	*2E+01*
		Adult Resident	Inhalation (U)	9E-07	7E-06
			Total	*2E+00*	*2E+00*
	Subsurface soil	Child Resident	Inhalation (U)	2E-06	2E-05
			Total	*9E+00*	*9E+00*
		Adult Resident	Inhalation (U)	9E-07	7E-06
			Total	*1E+00*	*1E+00*
Future B3 – AOI 10 NE Wetland Soils Area	Surface soil	Child Resident	Inhalation (U)	1E-06	8E-06
			Total	*7E-01*	*7E-01*
		Adult Resident	Inhalation (U)	6E-07	5E-06
			Total	*7E-02*	*7E-02*
	Subsurface soil	Child Resident	Inhalation (U)	2E-06	2E-05
			Total	*1E+00*	*1E+00*
		Adult Resident	Inhalation (U)	1E-06	8E-06
			Total	*1E-01*	*1E-01*
Future B4 – Rt. 62 Outfall and Embayment Area	Surface soil	Child Resident	Inhalation (U)	2E-07	2E-06
			Total	*6E-01*	*6E-01*
		Adult Resident	Inhalation (U)	9E-08	7E-07
			Total	*6E-02*	*6E-02*
	Subsurface soil	Child Resident	Inhalation (U)	1E-06	8E-06
			Total	*8E-01*	*8E-01*
		Adult Resident	Inhalation (U)	6E-07	5E-06
			Total	*8E-02*	*8E-02*
Future B1 – Area Around Cooling Pond	Surface soil	Child Abutting Resident	Inhalation (U)	1E-06	8E-06
			Total	*2E+00*	*2E+00*
		Adult Abutting Resident	Inhalation (U)	1E-06	8E-06
			Total	*2E-01*	*2E-01*
	Subsurface soil	Child Abutting Resident	Inhalation (U)	3E-07	2E-06
			Total	*1E+00*	*1E+00*
		Adult Abutting Resident	Inhalation (U)	3E-07	2E-06
			Total	*1E-01*	*1E-01*

Exposure Point	Exposure Media	Scenario/ Receptor	Exposure Route	Non-cancer Hazards	
				2013 BHHRA	Revised Hazards
Future B2 – AOI 2 & 4 Soils Area At Cooling Pond	Surface soil	Child Abutting Resident	Inhalation (U)	9E-07	7E-06
			Total	*2E+01*	*2E+01*
		Adult Abutting Resident	Inhalation (U)	9E-07	7E-06
			Total	*2E+00*	*2E+00*
	Subsurface soil	Child Abutting Resident	Inhalation (U)	9E-07	7E-06
			Total	*9E+00*	*9E+00*
		Adult Abutting Resident	Inhalation (U)	9E-07	7E-06
			Total	*1E+00*	*1E+00*
Future B3 – AOI 10 NE Wetland Soils Area	Surface soil	Child Abutting Resident	Inhalation (U)	6E-07	5E-06
			Total	*7E-01*	*7E-01*
		Adult Abutting Resident	Inhalation (U)	6E-07	5E-06
			Total	*7E-02*	*7E-02*
	Subsurface soil	Child Abutting Resident	Inhalation (U)	1E-06	8E-06
			Total	*1E+00*	*1E+00*
		Adult Abutting Resident	Inhalation (U)	1E-06	8E-06
			Total	*1E-01*	*1E-01*
Future A1 – AOI 14 West	Surface soil	Child Recreational Visitor	Inhalation (U)	5E-08	4E-07
			Total	*2E-01*	*2E-01*
		Adult Recreational Visitor	Inhalation (U)	5E-08	4E-07
			Total	*3E-02*	*3E-02*
Future A2 – AOI 14 South	Surface soil	Child Recreational Visitor	Inhalation (U)	3E-07	2E-06
			Total	*4E-01*	*4E-01*
		Adult Recreational Visitor	Inhalation (U)	3E-07	2E-06
			Total	*4E-02*	*4E-02*
Future A3 – AOI 14 East	Surface soil	Child Recreational Visitor	Inhalation (U)	7E-08	5E-07
			Total	*3E-01*	*3E-01*
		Adult Recreational Visitor	Inhalation (U)	7E-08	5E-07
			Total	*4E-02*	*4E-02*
Future A4 – AOI 14 North	Surface soil	Child Recreational Visitor	Inhalation (U)	5E-07	4E-06
			Total	*1E+00*	*1E+00*
		Adult Recreational Visitor	Inhalation (U)	5E-07	4E-06
			Total	*1E-01*	*1E-01*
	Subsurface soil	Child Recreational Visitor	Inhalation (U)	2E-07	2E-06
			Total	*3E-01*	*3E-01*
		Adult Recreational Visitor	Inhalation (U)	2E-07	2E-06
			Total	*3E-02*	*3E-02*
Future A5 – AOI 8 Sweepings Area	Surface soil	Child Recreational Visitor	Inhalation (U)	2E-06	2E-05
			Total	*4E+00*	*4E+00*
		Adult Recreational Visitor	Inhalation (U)	2E-06	2E-05
			Total	*5E-01*	*5E-01*
	Subsurface soil	Child Recreational Visitor	Inhalation (U)	7E-07	5E-06
			Total	*3E+00*	*3E+00*
		Adult Recreational Visitor	Inhalation (U)	7E-07	5E-06
			Total	*3E-01*	*3E-01*

Exposure Point	Exposure Media	Scenario/ Receptor	Exposure Route	Non-cancer Hazards	
				2013 BHHRA	Revised Hazards
Future A6 – AOI 7 & 11 Industrial Area East	Surface soil	Child Recreational Visitor	Inhalation (U)	2E-05	2E-04
			Total	*5E+00*	*5E+00*
		Adult Recreational Visitor	Inhalation (U)	2E-05	2E-04
			Total	*5E-01*	*5E-01*
	Subsurface soil	Child Recreational Visitor	Inhalation (U)	9E-06	7E-05
			Total	*6E+00*	*6E+00*
		Adult Recreational Visitor	Inhalation (U)	9E-06	7E-05
			Total	*7E-01*	*7E-01*
Future A7 – AOI 5 Industrial Area West	Surface soil	Child Recreational Visitor	Inhalation (U)	6E-07	5E-06
			Total	*5E-01*	*5E-01*
		Adult Recreational Visitor	Inhalation (U)	6E-07	5E-06
			Total	*5E-02*	*5E-02*
	Subsurface soil	Child Recreational Visitor	Inhalation (U)	5E-07	4E-06
			Total	*3E-01*	*3E-01*
		Adult Recreational Visitor	Inhalation (U)	5E-07	4E-06
			Total	*4E-02*	*4E-02*
Future A8 – AOI 14 Off-Property	Surface soil	Child Recreational Visitor	Inhalation (U)	6E-08	5E-07
			Total	*3E-01*	*3E-01*
		Adult Recreational Visitor	Inhalation (U)	6E-08	5E-07
			Total	*3E-02*	*3E-02*
Future B1 – Area Around Cooling Pond	Surface soil	Child Recreational Visitor	Inhalation (U)	9E-07	7E-06
			Total	*8E-01*	*8E-01*
		Adult Recreational Visitor	Inhalation (U)	9E-07	7E-06
			Total	*9E-02*	*9E-02*
	Subsurface soil	Child Recreational Visitor	Inhalation (U)	3E-07	2E-06
			Total	*6E-01*	*6E-01*
		Adult Recreational Visitor	Inhalation (U)	3E-07	2E-06
			Total	*7E-02*	*7E-02*
Future B2 – AOI 2 & 4 Soils Area At Cooling Pond	Surface soil	Child Recreational Visitor	Inhalation (U)	8E-07	6E-06
			Total	*8E+00*	*8E+00*
		Adult Recreational Visitor	Inhalation (U)	8E-07	6E-06
			Total	*9E-01*	*9E-01*
	Subsurface soil	Child Recreational Visitor	Inhalation (U)	8E-07	6E-06
			Total	*5E+00*	*5E+00*
		Adult Recreational Visitor	Inhalation (U)	8E-07	6E-06
			Total	*5E-01*	*5E-01*
Future B3 – AOI 10 NE Wetland Soils Area	Surface soil	Child Recreational Visitor	Inhalation (U)	5E-07	4E-06
			Total	*3E-01*	*3E-01*
		Adult Recreational Visitor	Inhalation (U)	5E-07	4E-06
			Total	*4E-02*	*4E-02*
	Subsurface soil	Child Recreational Visitor	Inhalation (U)	1E-06	8E-06
			Total	*5E-01*	*5E-01*
		Adult Recreational Visitor	Inhalation (U)	1E-06	8E-06
			Total	*5E-02*	*5E-02*
Future A1 – AOI 14 West	Surface soil	Indoor Commercial/ Industrial Worker	Inhalation (U)	3E-08	2E-07
			Total	*3E-02*	*3E-02*
Future A2 – AOI 14 South	Surface soil	Indoor Commercial/ Industrial Worker	Inhalation (U)	2E-07	2E-06
			Total	*4E-02*	*4E-02*
Future A3 – AOI 14 East	Surface soil	Indoor Commercial/ Industrial Worker	Inhalation (U)	5E-08	4E-07
			Total	*3E-02*	*3E-02*

Exposure Point	Exposure Media	Scenario/ Receptor	Exposure Route	Non-cancer Hazards	
				2013 BHHRA	Revised Hazards
Future A4 – AOI 14 North	Surface soil	Indoor Commercial/ Industrial Worker	Inhalation (U)	3E-07	2E-06
			Total	*1E-01*	*1E-01*
	Subsurface soil	Indoor Commercial/ Industrial Worker	Inhalation (U)	1E-07	8E-07
			Total	*3E-02*	*3E-02*
Future A5 – AOI 8 Sweepings Area	Surface soil	Indoor Commercial/ Industrial Worker	Inhalation (U)	1E-06	8E-06
			Total	*4E-01*	*4E-01*
	Subsurface soil	Indoor Commercial/ Industrial Worker	Inhalation (U)	5E-07	4E-06
			Total	*2E-01*	*2E-01*
Future A6 – AOI 7 & 11 Industrial Area East	Surface soil	Indoor Commercial/ Industrial Worker	Inhalation (U)	1E-05	8E-05
			Total	*5E-01*	*5E-01*
	Subsurface soil	Indoor Commercial/ Industrial Worker	Inhalation (U)	6E-06	5E-05
			Total	*6E-01*	*6E-01*
Future A7 – AOI 5 Industrial Area West	Surface soil	Indoor Commercial/ Industrial Worker	Inhalation (U)	4E-07	3E-06
			Total	*5E-02*	*5E-02*
	Subsurface soil	Indoor Commercial/ Industrial Worker	Inhalation (U)	3E-07	2E-06
			Total	*4E-02*	*4E-02*
Future A8 – AOI 14 Off-Property	Surface soil	Indoor Commercial/ Industrial Worker	Inhalation (U)	4E-08	3E-07
			Total	*3E-02*	*3E-02*
Future B1 – Area Around Cooling Pond	Surface soil	Indoor/Outdoor Commercial/ Industrial Worker	Inhalation (U)	6E-07	5E-06
			Total	*8E-02*	*8E-02*
	Subsurface soil	Indoor/Outdoor Commercial/ Industrial Worker	Inhalation (U)	2E-07	2E-06
			Total	*6E-02*	*6E-02*
Future B2 – AOI 2 & 4 Soils Area At Cooling Pond	Surface soil	Indoor/Outdoor Commercial/ Industrial Worker	Inhalation (U)	5E-07	4E-06
			Total	*7E-01*	*7E-01*
	Subsurface soil	Indoor/Outdoor Commercial/ Industrial Worker	Inhalation (U)	5E-07	4E-06
			Total	*4E-01*	*4E-01*
Future A1 – AOI 14 West	Surface soil	Outdoor Commercial/ Industrial Worker	Inhalation (U)	3E-07	2E-06
			Total	*5E-02*	*5E-02*
Future A2 – AOI 14 South	Surface soil	Outdoor Commercial/ Industrial Worker	Inhalation (U)	2E-06	2E-05
			Total	*8E-02*	*8E-02*
Future A3 – AOI 14 East	Surface soil	Outdoor Commercial/ Industrial Worker	Inhalation (U)	4E-07	3E-06
			Total	*7E-02*	*7E-02*
Future A4 – AOI 14 North	Surface soil	Outdoor Commercial/ Industrial Worker	Inhalation (U)	2E-06	2E-05
			Total	*4E-01*	*4E-01*
	Subsurface soil	Outdoor Commercial/ Industrial Worker	Inhalation (U)	9E-07	7E-06
			Total	*7E-02*	*7E-02*
Future A5 – AOI 8 Sweepings Area	Surface soil	Outdoor Commercial/ Industrial Worker	Inhalation (U)	1E-05	8E-05
			Total	*1E+00*	*1E+00*
	Subsurface soil	Outdoor Commercial/ Industrial Worker	Inhalation (U)	4E-06	3E-05
			Total	*7E-01*	*7E-01*
Future A6 – AOI 7 & 11 Industrial Area East	Surface soil	Outdoor Commercial/ Industrial Worker	Inhalation (U)	1E-04	8E-04
			Total	*1E+00*	*1E+00*
	Subsurface soil	Outdoor Commercial/ Industrial Worker	Inhalation (U)	5E-05	4E-04
			Total	*2E+00*	*2E+00*

Exposure Point	Exposure Media	Scenario/ Receptor	Exposure Route	Non-cancer Hazards	
				2013 BHHRA	Revised Hazards
Future A7 – AOI 5 Industrial Area West	Surface soil	Outdoor Commercial/ Industrial Worker	Inhalation (U)	3E-06	2E-05
			Total	*1E-01*	*1E-01*
	Subsurface soil	Outdoor Commercial/ Industrial Worker	Inhalation (U)	3E-06	2E-05
			Total	*7E-02*	*7E-02*
Future A8 – AOI 14 Off-Property	Surface soil	Outdoor Commercial/ Industrial Worker	Inhalation (U)	3E-07	2E-06
			Total	*6E-02*	*6E-02*
Future B4 – Rt. 62 Outfall and Embayment Area	Surface soil	Construction Worker	Ingestion (U)	5E-03	5E-02
			Inhalation (U)	2E-04	8E-04
			Total	*4E-01*	*4E-01*
	Subsurface soil	Construction Worker	Ingestion (U)	3E-02	3E-01
			Inhalation (U)	1E-03	4E-03
			Total	*5E-01*	*8E-01*
Future A1 – AOI 14 West	Surface soil	Construction Worker	Ingestion (U)	3E-03	3E-02
			Inhalation (U)	1E-04	4E-04
			Total	*4E-01*	*4E-01*
Future A2 – AOI 14 South	Surface soil	Construction Worker	Ingestion (U)	2E-02	2E-01
			Inhalation (U)	9E-04	4E-03
			Total	*5E-01*	*7E-01*
Future A3 – AOI 14 East	Surface soil	Construction Worker	Ingestion (U)	4E-03	4E-02
			Inhalation (U)	2E-04	8E-04
			Total	*5E-01*	*5E-01*
Future A4 – AOI 14 North	Surface soil	Construction Worker	Ingestion (U)	3E-02	3E-01
			Inhalation (U)	1E-03	4E-03
			Total	*9E-01*	*1E+00*
	Subsurface soil	Construction Worker	Ingestion (U)	1E-02	1E-01
			Inhalation (U)	5E-04	2E-03
			Total	*4E-01*	*5E-01*
Future A5 – AOI 8 Sweepings Area	Surface soil	Construction Worker	Ingestion (U)	1E-01	1E+00
			Inhalation (U)	6E-03	2E-02
			Total	*2E+00*	*3E+00*
	Subsurface soil	Construction Worker	Ingestion (U)	4E-02	4E-01
			Inhalation (U)	2E-03	8E-03
			Total	*1E+00*	*2E+00*
Future A6 – AOI 7 & 11 Industrial Area East	Surface soil	Construction Worker	Ingestion (U)	1E+00	1E+01
			Inhalation (U)	6E-02	2.4E-01
			Total	*2E+00*	*1E+01*
	Subsurface soil	Construction Worker	Ingestion (U)	5E-01	5E+00
			Inhalation (U)	2E-02	8E-01
			Total	*3E+00*	*8E+00*
Future A7 – AOI 5 Industrial Area West	Surface soil	Construction Worker	Ingestion (U)	4E-02	4E-01
			Inhalation (U)	2E-03	8E-03
			Total	*5E-01*	*9E-01*
	Subsurface soil	Construction Worker	Ingestion (U)	3E-02	3E-01
			Inhalation (U)	1E-03	4E-03
			Total	*4E-01*	*7E-01*
Future A8 – AOI 14 Off-Property	Surface soil	Construction Worker	Ingestion (U)	4E-03	4E-02
			Inhalation (U)	2E-04	8E-04
			Total	*1E+00*	*1E+00*

Exposure Point	Exposure Media	Scenario/ Receptor	Exposure Route	Non-cancer Hazards	
				2013 BHHRA	Revised Hazards
Future B1 – Area Around Cooling Pond	Surface soil	Construction Worker	Ingestion (U)	6E-02	6E-01
			Inhalation (U)	3E-03	1E-02
			Total	*6E-01*	*1E+00*
	Subsurface soil	Construction Worker	Ingestion (U)	2E-02	2E-01
			Inhalation (U)	8E-04	3E-03
			Total	*5E-01*	*7E-01*
Future B2 – AOI 2 & 4 Soils Area At Cooling Pond	Surface soil	Construction Worker	Ingestion (U)	5E-02	5E-01
			Inhalation (U)	2E-03	8E-03
			Total	*4E+00*	*5E+00*
	Subsurface soil	Construction Worker	Ingestion (U)	5E-02	5E-01
			Inhalation (U)	2E-03	8E-03
			Total	*2E+00*	*3E+00*
Future B3 – AOI 10 NE Wetland Soils Area	Surface soil	Construction Worker	Ingestion (U)	3E-02	3E-01
			Inhalation (U)	1E-03	4E-03
			Total	*4E-01*	*7E-01*
	Subsurface soil	Construction Worker	Ingestion (U)	7E-02	7E-01
			Inhalation (U)	3E-03	1E-02
			Total	*6E-01*	*1E+00*
Future B5 – AOI 1 Holding Basin	Surface soil	Child Resident	Inhalation (U)	2E-05	2E-04
			Total	*4E+00*	*4E+00*
		Adult Resident	Inhalation (U)	9E-06	7E-05
			Total	*4E-01*	*4E-01*
	Subsurface soil	Child Resident	Inhalation (U)	2E-05	2E-04
			Total	*4E+00*	*4E+00*
		Adult Resident	Inhalation (U)	1E-05	8E-05
			Total	*4E-01*	*4E-01*
Future B5 – AOI 1 Holding Basin	Surface soil	Child Recreational Visitor	Inhalation (U)	8E-06	6E-05
			Total	*2E+00*	*2E+00*
		Adult Recreational Visitor	Inhalation (U)	8E-06	6E-05
			Total	*2E-01*	*2E-01*
	Subsurface soil	Child Recreational Visitor	Inhalation (U)	9E-06	7E-05
			Total	*2E+00*	*2E+00*
		Adult Recreational Visitor	Inhalation (U)	9E-06	7E-05
			Total	*2E-01*	*2E-01*
Future B5 – AOI 1 Holding Basin	Surface soil	Construction Worker	Ingestion (U)	5E-01	5E+00
			Inhalation (U)	2E-02	8E-02
			Total	*1E+00*	*6E+00*
	Subsurface soil	Construction Worker	Ingestion (U)	6E-01	6E+00
			Inhalation (U)	3E-02	1E-01
			Total	*1E+00*	*7E+00*

(U) - Uranium

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Technical Memorandum

September 18, 2015

IMPACTS TO THE PREVIOUSLY PROPOSED CLEANUP LEVELS BASED ON CHANGES TO DEFAULT EXPOSURE PARAMETERS AND TOXICITY VALUES SINCE THE RELEASE OF THE 2013 BASELINE HUMAN HEALTH RISK ASSESSMENT

Nuclear Metals Inc. Superfund Site
Concord, Massachusetts

Since the production of the 2013 Baseline Human Health Risk Assessment (BHHRA; *de maximus*, 2013) for the Nuclear Metals Inc. Superfund Site (the Site), the chronic and subchronic reference concentrations (RfCs) for uranium, as well as the subchronic reference dose (RfD) for uranium have changed. In addition, in February 2014, EPA finalized a Directive to update standard default exposure factors and frequently asked questions associated with these updates (USEPA, 2014; located online at http://www.epa.gov/oswer/riskassessment/superfund_hh_exposure.htm; items # 22 and #23 [as updated in February 2015] of this web link). Furthermore, as part of the June 2015 periodic updates to EPA's Regional Screening Levels (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm), changes were made regarding the definition of volatile compounds. Risk-based Preliminary Remediation Goals (PRGs) were initially calculated in the Feasibility Study (FS; *de maximus*, 2014). EPA has requested this technical memorandum to identify the changes in toxicity values and exposure parameters used during the initial PRG development and present resulting cleanup levels when applying the changes.

Toxicity Value Changes

Refer to AECOM's April 20, 2015 technical memorandum entitled "Updates on Toxicity Values and Their Implication on the Baseline Human Health Risk Assessment" for the basis of the changes presented below. The April 20, 2015 memorandum presents impacts of toxicity value changes to risk assessment conclusions, while this memorandum provides resulting changes to proposed cleanup levels previously generated in the FS (*de maximus*, 2014).

Table 1 below shows different uranium toxicity values used in the 2013 BHHRA/2014 FS and the toxicity values in the current approach on evaluating uranium:

Table 1

Non-cancer toxicity data for uranium – oral/dermal and inhalation

Source	Oral/Dermal RfD(1)	Unit	Source	Inhalation RfC	Unit	Source
2013 BHHRA/2014 FS						
Chronic	6.0E-04	mg/kg-day	EPA Office of Water	0.3	$\mu g/m^3$	ATSDR
Subchronic	2.0E-03	mg/kg-day	ATSDR	0.4	$\mu g/m^3$	ATSDR
Current approach						
chronic	6.0E-04	mg/kg-day	EPA Office of Water	0.04	$\mu g/m^3$	ATSDR
subchronic	2.0E-04	mg/kg-day	ATSDR	0.1	$\mu g/m^3$	ATSDR

Note:
(1) There are no dermal toxicity values for uranium. Since the oral absorption efficiency for uranium exceeds 50%, no adjustment of the oral toxicity values is necessary.

Exposure Parameter Changes

As noted above, the 2014 EPA directive, as updated in 2015 (included in Attachment A), resulted in a change to default exposure parameters utilized in human health risk evaluation. Table 2 below shows the changes which impact cleanup levels initially developed in the 2014 FS (*de maximus*, 2014).

Table 2
Summary of Exposure Parameter Changes

Definition (units)	Value previously used in 2014 FS	Current value[1]
Resident Drinking Water Ingestion Rate – Child (L/day)	1	0.78
Resident Drinking Water Ingestion Rate – Adult (L/day)	2	2.5
Resident Skin Surface Area – Child (cm^2)	2,800	2,373
Resident Skin Surface Area – Adult (cm^2)	5,700	6,032
Resident Water Surface Area – Child (cm^2)	6,600	6,378
Resident Water Surface Area – Adult (cm^2)	18,000	20,900
Adult Body Weight (kg)	70	80
Resident/Rec. User Exposure Duration (yr)	30	26
Resident/Rec. User Exposure Duration - Adult (yr)	24	20
Resident Water Exposure Time – Child (hrs/event)	1	0.54
Resident Water Exposure Time – Adult (hrs/event)	0.58	0.71
Worker Skin Surface Area (cm^2)	3,300	3,527
Worker Soil Adherence Factor (mg/cm^2)	0.2	0.12
Rec. Visitor Sediment Surface Area – Child (cm^2)	1,560	1,364
Rec. Visitor Sediment Surface Area – Adult (cm^2)	2,970	2,275
Rec. Visitor Sediment Adherence Factor – Child (mg/cm^2)	0.3	0.4
Rec. Visitor Sediment Adherence Factor – Child (mg/cm^2)	0.3	0.6

Notes:

1 – Refer to 2014 EPA Directive for all current values except related to sediment. Sediment values were developed in Attachment A (Table 1 for age-weighted mean surface areas; Table 2 for adherence factors) based on the Directive guidance.

Revised Cleanup Levels

Utilizing the changes to toxicity values and exposure parameters presented above, the PRG calculations presented in Appendix C of the FS were revised by AECOM for all receptors to assist with future evaluations which may be performed during future five-year reviews. Attachment B includes the revised calculations, with highlighting showing the parameters that were updated. The FS tables which summarized the PRGs for soil, sediment, and groundwater (Tables 2.3.2, 2.3.3, and 2.3.4, respectively) have been included as Attachment B.8. It should be noted that, even though radiological exposure parameters did not change for the worker scenarios, the uranium cancer PRG for the indoor and outdoor commercial/industrial workers (soil) changed due to rounding differences. Similarly, the arsenic non-cancer PRG for the recreational visitor (soil) and the thorium and depleted uranium cancer PRGs for the resident (groundwater) did not appear to change due to rounding. Finally, as noted in the introductory paragraph, as part of the June 2015 periodic updates to EPA's Regional Screening Levels (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm), changes were made regarding the definition of volatile compounds. This change resulted in the addition/inclusion of inhalation calculations related to 1,4-dioxane in groundwater.

Applying these toxicity value and exposure parameter changes to the most conservative potential exposure scenarios results in the following proposed human health cleanup levels for soil (Table 3) and groundwater (Table 4). The resulting proposed human health proposed cleanup level for PCBs in sediment (2.7 mg/kg), based on an Incremental Lifetime Cancer Risk (ILCR) of 10^{-6} (Recreational Visitor), did not change.

Table 3
Human Health Proposed Cleanup Levels (PCLs) for Soil

Contaminant	Previously Proposed PCL		Selected PCL		Basis
	mg/kg	pCi/g	mg/kg	pCi/g	
Benzo(a)anthracene	0.32	NA	0.34	NA	ILCR = 10^{-6} (Residential)
Benzo(a)pyrene	0.22	NA	0.22	NA	Background
Benzo(b)fluoranthene	0.32	NA	0.34	NA	ILCR = 10^{-6} (Residential)
Indeno(1,2,3-cd)pyrene	0.32	NA	0.34	NA	ILCR = 10^{-6} (Residential)
PCBs	1	NA	1	NA	Policy
Arsenic	13.7	NA	13.7	NA	Background
Uranium	2.3	0.92	2.7	1.1	ILCR = 10^{-6} (Residential)
U-238	NA	0.78	NA	0.90	ILCR = 10^{-6} (Residential)
U-235	NA	0.01	NA	0.01	ILCR = 10^{-6} (Residential)
U-234	NA	0.13	NA	0.15	ILCR = 10^{-6} (Residential)
Thorium	7.4	0.81	7.4	0.81	Background
Th-232	NA	0.81	NA	0.81	Background

Notes:

mg/kg - milligram per kilogram

pCi/g - picocuries per gram

ILCR - Incremental Lifetime Cancer Risk; 10^{-6} = 1 in 1,000,000

NA - Not Applicable

Table 4
Human Health Proposed Cleanup Levels (PCLs) for Groundwater

Contaminant	Overburden		Bedrock	
	Selected PCL (µg/L)	Basis	Selected PCL (µg/L)	Basis
1,1-Dichloroethane	NA	NA	2.7 (prev. 2.4)	ILCR = 10^{-6} (Residential)
Tetrachloroethene	5	MCL	5	MCL
Trichloroethene	5	MCL	5	MCL
Vinyl chloride	2	MCL	2	MCL
1,4-Dioxane	0.46 (prev. 0.67)	ILCR = 10^{-6} (Residential)	0.46 (prev. 0.67)	ILCR = 10^{-6} (Residential)
bis(2-Ethylhexyl)phthalate	6	MCL	6	MCL
Arsenic	10	MCL	10	MCL
Barium	NA	NA	2000	MCL
Chromium	100	MCL	100	MCL
Cobalt	6.0 (prev. 4.7)	HI = 1 (Residential)	6.0 (prev. 4.7)	HI = 1 (Residential)
Copper	1,300	Action Level	NA	
Iron	14,000 (prev. 11,000)	HI = 1 (Residential)	14,000 (prev. 11,000)	HI = 1 (Residential)
Manganese	300	Health Advisory	300	Health Advisory
Molybdenum	100 (prev. 78)	HI = 1 (Residential)	100 (prev. 78)	HI = 1 (Residential)
Thorium	0.33 (prev. 0.32)	ILCR = 10^{-6} (Residential)	0.33 (prev. 0.32)	ILCR = 10^{-6} (Residential)
Depleted Uranium	30	MCL	30	MCL
Natural Uranium	30	MCL	30	MCL
Nitrate-N	10,000	MCL	10,000	MCL
Nitrite-N	1,000	MCL	1,000	MCL

Notes:

µg/L - micrograms per liter

MCL - Maximum Contaminant Level

ILCR - Incremental Lifetime Cancer Risk; 10^{-6} = 1 in 1,000,000

HI - Hazard Index

NA - Not Applicable – not a primary risk driver in this flow zone and/or maximum detection does not exceed MCL

prev. – previously proposed value

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ATTACHMENT A – EXPOSURE PARAMETERS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

FEB - 6 2014

OFFICE OF
SOLID WASTE AND
EMERGENCY RESPONSE

OSWER Directive 9200.1-120

MEMORANDUM

SUBJECT: Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors

FROM: Dana Stalcup, Acting Director
Assessment and Remediation Division
Office of Superfund Remediation and Technology Innovation

TO: Superfund National Policy Managers, Regions 1 - 10

Purpose

The mission of the Superfund program is to protect human health and the environment consistent with the Comprehensive Environmental Response, Compensation and Liability Act, as amended, (CERCLA) and as implemented by the National Oil and Hazardous Substances Pollution Contingency Plan. The purpose of this directive is to update the Interim Final Standard Exposure Factors Guidance (1991), which is reflected in the attached table and is to be used:

- in the CERCLA remedial investigation and feasibility study process (e.g., assessing baseline health risks, developing preliminary remediation goals, evaluating risks of remedial alternatives),
- to evaluate health risks in the CERCLA removal program, and
- in the process of five-year reviews of selected remedies.

This guidance update supplements the *Risk Assessment Guidance for Superfund: Human Health Evaluation Manual, Part A* (RAGS, Part A) that was issued October 13, 1989. This guidance supersedes and replaces certain portions of OSWER Directive 9285.6-03, issued March 25, 1991 and updates the *Risk Assessment Guidance for Superfund, Part E,* issued July 2004 (RAGS, Part E). Other cleanup programs in the Office of Solid Waste and Emergency Response (OSWER) are welcome and encouraged to adopt the recommended exposure factors, much as they have historically adopted other aspects of the *Risk Assessment Guidance for Superfund* (RAGS).

Background

In September 2011, EPA's National Center for Environmental Assessment, Office of Research and Development (ORD/NCEA) issued a substantive update to its exposure assessment recommendations. *Exposure Factors Handbook – 2011 Edition*, referred to as EFH 2011 herein, provides information and recommendations on various physiological and behavioral factors commonly used in assessing exposure of adults and children to environmental chemicals. ORD/NCEA's recommended values for exposure factors are based on the results of studies deemed to be the most up-to-date and scientifically sound, based upon data available up to July 2011, and incorporates revisions made to the *Child-Specific Exposure Factors Handbook*, which was last updated and published in 2008. EFH 2011 is not a Superfund-specific document; rather, it provides a summary of the latest developments in exposure science and provides recommendations for a broad range of EPA programs.

Following the publication of EFH 2011, regional risk assessors received inquiries from other EPA program offices, states, the regulated community, and other interested parties regarding the applicability of the ORD/NCEA's recommendations for use in human health risk assessments. During the October 2011 to August 2012 period, the OSWER Human Health Regional Risk Assessors Forum (OHHRRAF) reviewed the recommendations in EFH 2011 in the context of the default exposure factors used in the Superfund program and to derive Regional screening levels. As a result of a consensus-driven process, the OHHRRAF identified several Superfund-specific default exposure factors that warranted updating, based upon recommendations from ORD/NCEA in EFH 2011. This guidance incorporates and adopts the updates recommended by the OHHRRAF.

Objective

This guidance has been developed to reduce variability and uncertainty in the exposure assumptions used by Regional Superfund staff to characterize exposures to human populations for human health risk assessments.

Implementation

This guidance supplements the *Risk Assessment Guidance for Superfund: Human Health Evaluation Manual* (RAGS), Part A through E. Where numerical values differ from those presented in Part A or E, the factors presented in this guidance should be considered updates to the older values. As new data become available, this Directive may be modified accordingly.

This report can be found at www.epa.gov/oswer/riskassessment/superfund_hh_exposure.htm
Please contact Richard Kapuscinski at (703) 305-7411 if you have questions or concerns.

Attachment

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CITATIONS

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Attachment 1. Recommended Default Exposure Factors (2014)

Symbol	Definition (units)	Previous Default Value	Currently Recommended Value	Source of current recommendation	Source of previous recommendation
Ingestion and Dermal Contact Rates					
IRW_c	Resident Drinking Water Ingestion Rate - Child (L/day)	1	0.78	U.S. EPA 2011a, Tables 3-15 and 3-33; weighted average of 90th percentile consumer-only ingestion of drinking water (birth to <6 years)	U.S. EPA 1989 (Exhibit 6-11)
IRW_a	Resident Drinking Water Ingestion Rate - Adult (L/day)	2	2.5	U.S. EPA 2011a, Table 3-33; 90th percentile of consumer-only ingestion of drinking water (≥ 21 years)	U.S. EPA 1989 (Exhibit 6-11)
IRS_c	Resident Soil Ingestion Rate - Child (mg/day)	200	200	U.S. EPA 2011a (Table 5-1); "upper-bound values" accounting for both soil and dust ingestion	U.S. EPA 1991a (pg. 15)
IRS_a	Resident Soil Ingestion Rate - Adult (mg/day)	100	100	U.S. EPA 1991a (pp. 6 and 15); EFH 2011 only provides a central tendency value	U.S. EPA 1991a (pg. 15)
IR_{iw}	Indoor Worker Soil Ingestion Rate (mg/day)	50	50	U.S. EPA 1991a (pp. 9-10, 15); EFH 2011 values not provided	U.S. EPA 1991a (pg. 15)
IR_{ow}	Outdoor Worker Soil Ingestion Rate (mg/day)	100	100	U.S. EPA 1991a (pg. 15), same as adult resident; EFH 2011 value not provided	U.S. EPA 1991a (pg. 15)
SA_c	Resident skin surface area - child (cm^2)	2,800	2,373	U.S. EPA 2011a, Tables 7-2 and 7-8; weighted average of mean values for head, hands, forearms, lower legs, and feet (male and female, birth to < 6 years)(forearm and lower leg-specific data used when available, ratios for nearest available age group used elsewhere (per EPA 2011b))	U.S. EPA 2002 (Exhibit 1-2)
SA_a	Resident skin surface area - adult (cm^2)	5,700	6,032	U.S. EPA 2011a, Tables 7-2 and 7-12; weighted average of mean values for head, hands, forearms, and lower legs (male and female, 21+ years)(forearm and lower leg-specific data used for males and female lower leg; ratio of male forearm to arm applied to female arm data)	U.S. EPA 2002 (Exhibit 1-2)
SA_{ow}	Worker skin surface area - adult (cm^2)	3,300	3,527	US EPA 2011a, Table 7-2; weighted average of mean values for head, hands, and forearms (male and female, 21+years) (similar assumptions for forearms as used in EPA 2011b)	U.S. EPA 2002 (Exhibit 1-2)
SA_c	Resident Water Surface area - child (cm^2)	6,600	6,378	U.S. EPA 2011a, Table 7.10; weighted average of mean values for children <6 years.	U.S. EPA 2004 (Exhibit 3-2)
SA_a	Resident Water Surface area - adult (cm^2)	18,000	20,900	U.S. EPA 2011a, Table 7.10; weighted average of mean values for adults, male and female 21+.	U.S. EPA 2004 (Exhibit 3-2)
AF_c	Resident soil adherence factor - child (mg/cm^2)	0.2	0.2	U.S. EPA 2004 (Exhibit 3-5), RAGS Part E	U.S. EPA 2002 (Exhibit 1-2)
AF_a	Resident soil adherence factor - adult (mg/cm^2)	0.07	0.07	U.S. EPA 2004 (Exhibit 3-5), RAGS Part E	U.S. EPA 2002 (Exhibit 1-2)
AF_{ow}	Worker soil adherence factor - adult (mg/cm^2)	0.2	0.12	U.S. EPA 2011a, Table 7-20 and Section 7.2.2; arithmetic mean of weighted average of body part-specific (hands, forearms, and face) mean adherence factors for adult commercial/industrial activities	U.S. EPA 2002 (Exhibit 1-2)
BW_c	Resident Body Weight - child (kg)	15	15	U.S. EPA 2011a, Table 8-1; weighted average of mean body weights (birth to <6 years)	U.S. EPA 1991a (pg. 15)

Attachment 1. Recommended Default Exposure Factors (2014)

Symbol	Definition (units)	Previous Default Value	Currently Recommended Value	Source of current recommendation	Source of previous recommendation
BW_a	Resident Body Weight - adult (kg)	70	80	U.S. EPA 2011a, Table 8-3; weighted mean values for adults 21 – 78	U.S. EPA 1991a (pg. 15)
Bw_w	Worker Body Weight (kg)	70	80	U.S. EPA 2011a, Table 8-3; weighted mean values for adults 21 – 78	U.S. EPA 1991a (pg. 15)
Exposure Frequency, Exposure Duration, and Exposure Time Variables					
EF_r	Resident Exposure Frequency (days/yr)	350	350	U.S. EPA 1991a (pg. 15); value not provided in EFH 2011	U.S. EPA 1991a (pg. 15)
EF_w	Worker Exposure Frequency (days/yr)	250	250	U.S. EPA 1991a (pg. 15); value not provided in EFH 2011	U.S. EPA 1991a (pg. 15)
EF_{iw}	Indoor Worker Exposure Frequency (days/yr)	250	250	U.S. EPA 1991a (pg. 15); value not provided in EFH 2011	U.S. EPA 1991a (pg. 15)
EF_{ow}	Outdoor Worker Exposure Frequency (days/yr)	225	225	U.S. EPA 2002; value not provided in EFH 2011	U.S. EPA 1991a (pg. 15)
ED_r	Resident Exposure Duration (yr)	30	26	EPA 2011a, Table 16-108; 90th percentile for current residence time.	U.S. EPA 1991a (pg. 15)
ED_c	Resident Exposure Duration - child (yr)	6	6	U.S. EPA 1991a, Pages 6 and 15	U.S. EPA 1991a (pg. 15)
ED_a	Resident Exposure Duration - adult (yr)	24	20	EDr (26 years) - EDc (6 years)	U.S. EPA 1991a (pg. 15)
ED_w	Worker Exposure Duration - (yr)	25	25	U.S. EPA 1991a (pg. 15); EFH 2011 only provides a central tendency value	U.S. EPA 1991a (pg. 15)
ED_{iw}	Indoor Worker Exposure Duration - (yr)	25	25	U.S. EPA 1991a (pg. 15); EFH 2011 only provides a central tendency value	U.S. EPA 1991a (pg. 15)
ED_{ow}	Outdoor Worker Exposure Duration (yr)	25	25	U.S. EPA 1991a (pg. 15); EFH 2011 only provides a central tendency value	U.S. EPA 1991a (pg. 15)
ET_{ra}	Resident Air Exposure Time (hours/day)	24	24	The whole day	The whole day
ET_{rs}	Resident Soil Exposure Time (hours/day)	24	24	The whole day	The whole day
ET_w	Worker Air Exposure Time (hr/hr)	8	8	The work day	The work day
ET_{ws}	Worker Soil Exposure Time (hours/day)	8	8	The work day	The work day
ET_{rw}	Resident Water Exposure Time (hours/day)	24	24	The whole day	The whole day
ET_{rwc}	Resident Water Exposure Time - child (hours/event)	1	0.54	U.S. EPA 2011a, Table 16-28; weighted average of 90th percentile time spent bathing (birth to <6 years)	U.S. EPA 2004
ET_{rwa}	Resident Water Exposure Time - adult (hours/event)	0.58	0.71	U.S. EPA 2011a, Tables 16-30 and 16-31; weighted average of adult (21 to 78) 90th percentile of time spent bathing/ showering in a day, divided by mean number of baths/showers taken in a day.	U.S. EPA 2004
Miscellaneous Variables; values not provided in EFH 2011					

Attachment 1. Recommended Default Exposure Factors (2014)

Symbol	Definition (units)	Previous Default Value	Currently Recommended Value	Source of current recommendation	Source of previous recommendation
AT_r	Averaging time - resident (days/year)	365	365	U.S. EPA 1989 (pg. 6-23)	U.S. EPA 1989 (pg. 6-23)
AT_w	Averaging time - composite worker (days/year)	365	365	U.S. EPA 1989 (pg. 6-23)	U.S. EPA 1989 (pg. 6-23)
AT_{iw}	Averaging time - indoor worker (days/year)	365	365	U.S. EPA 1989 (pg. 6-23)	U.S. EPA 1989 (pg. 6-23)
AT_{ow}	Averaging time - outdoor worker (days/year)	365	365	U.S. EPA 1989 (pg. 6-23)	U.S. EPA 1989 (pg. 6-23)
LT	Lifetime (years)	70	70	U.S. EPA 1989 (pg. 6-22), pending additional input from NCEA	U.S. EPA 1989 (pg. 6-22)
IR_{fish}	Fish Ingestion Rate (mg/day)	5.4×10^4	**	Recommend using site-specific values	U.S. EPA 1991a (pg. 15)
$IR_{produce}$	Consumption of homegrown produce (g/day)	42 (fruit); 80 (veg)	**	Recommend using site-specific values	U.S. EPA 1990

References for Cited Sources:

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U.S. EPA, 2005. Guidance on Selecting Age Groupsfor Monitoring and Assessing Childhood Exposures to Environmental Contaminants. EPA/630/P-03/003F, November, 2005.

U.S. EPA 2009. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment) Final. OSWER 9285.7-82.2009.

U.S. EPA 2011a. Exposure Factors Handbook: 2011 Edition. EPA/ 600/ R-090/052F, September 2011.

EPA. 2011b. "Regional Screening Levels (Formerly PRGs), User's Guide." November. On-Line Address: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

Footnote: Users are directed to the *Exposure Factors Handbook* (2011) as a source for specific age-group exposure factors as described in EPA, 2005.

ATTACHMENT A TABLE 1
CALCULTION OF AGE-WEIGHTED MEAN SURFACE AREAS FOR SEDIMENT

	Mean Surface Area by Body Part (m^2)										Number of months within age-range
				hands	legs	feet		lower leg			
Age				(a)	(a)	(a)					
children (boy/girl)											
Birth to <1 month				0.015	0.06	0.019		0.0252			1
1 to <3 months				0.017	0.068	0.021		0.02856			2
3 to <6 months				0.02	0.078	0.025		0.03276	(c)		3
6 to <12 months				0.024	0.093	0.029		0.03906			6
1 to <2 years				0.03	0.122	0.033		0.05124			12
2 to <3 years				0.028	0.154	0.038		0.06468			12
3 to <6 years				0.037	0.195	0.049		0.078	(d)		36
adult male 21+ years				0.107	0.682	0.137		0.268	(b)		NA
adult female 21+ years				0.089	0.598	0.122		0.233	(e)		NA
adult 21+ years (average of male and female)				0.098	0.64	0.1295		0.2505			NA

	Calculated Age-Weighted Mean Surface Areas by Body Part (cm^2) (f)									Number of months within receptor's age-range
Receptor				hands	legs	feet		lower leg		
child - 0 to <6 years				317	1572	406		641		72
adult 21+ years				980	6400	1295		2505		684

ATTACHMENT A TABLE 1
CALCULTION OF AGE-WEIGHTED MEAN SURFACE AREAS FOR SEDIMENT

Receptor	Calculated Age-Weighted Mean Surface Areas (cm^2)	Note
Child (0 to <6 years)		
Sediment - hands, lower legs, feet	1364	USEPA, 2011. Table 7-2. Represents weighted mean surface area for males and females, including hands, lower legs and feet. These body parts were selected based on best professional judgment assuming contact with sediment may occur as part of a wading scenario.
Adult (21+ years)		
Sediment - hands, feet	2275	USEPA, 2011. Table 7-2. Represents weighted mean surface area for males and females, including hands and feet. These body parts were selected based on best professional judgment assuming contact with sediment may occur as part of a wading scenario.

Notes:
cm^2 - square centimeter.
EFH, 2011; USEPA, 2011 - USEPA Exposure Factors Handbook: 2011 Edition. September 2011.
m^2 - square meter.
NA - Not applicable.
USEPA - United States Environmental Protection Agency.
USEPA, 2014 - USEPA Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. February 6, 2014 (as updated in February 2015).
(a) EFH, 2011. Table 7-2. Recommended Values for Surface Area of Body Parts; Mean Surface Area by Body Part.
(b) Table 7-12.
(c) Surface area for the leg x ratio of the lower leg to the leg for the 2-year old, average of male and female (0.42) (Table 7-8).
(d) Surface area for the leg x ratio of the lower leg to the leg for the 4-year old, average of male and female (0.4) (Table 7-8).
(e) Table 7-13.
(f) The surface areas assocated with each receptor listed in this table are age-weighted as follows:

[(Mean surface area x number of months within age-range (from above table))$_{\text{age range 1}}$ + (Mean surface area x number of months within age-range (from above table))$_{\text{age range 2}}$ ….] / number of months within receptor's age-range. A factor of 1000 is applied to convert m^2 to cm^2.

ATTACHMENT A TABLE 2
SEDIMENT ADHERENCE FACTORS

	Adult Recreational Visitor - Sediment RME		
Body Part	Surface Area Weighted Mean (a) (cm^2)	Sediment Loading Reed Gatherer (mg/cm^2) (b)	Total Sediment Mass (mg)
Hands	980	0.658	645
Feet	1,295	0.633	820
Total	2,275	--	1465
Area-Weighted Sediment Adherence factor (mg/cm^2) = Sediment mass/Surface area =			0.6

Notes:
RME - Reasonable Maximum Exposure.
USEPA, 2011. Exposure Factors Handbook. September 2011.
USEPA, 2004. Risk Assessment Guidance for Superfund, Supplemental Guidance for Dermal Risk Assessment. July 2004.
(a) Data from USEPA (2011). Table 7-2. Weighted mean values (average of men and women).

(b) Data from USEPA (2004) Exhibit C-2. Geometric mean of reed gatherers. Since a high-end activity (i.e., reasonable but higher exposure) is being used to represent contact with sediment, the geometric mean adherence factor is selected for use to represent the RME exposure scenario, in accordance with USEPA guidance (page 3-14). USEPA (2004) states that it is not recommended that a high-end soil contact activity be used with a high-end weighted adherence factor for that activity, as this use would not be consistent with the use of a RME scenario.

	Child Recreational Visitor - Sediment RME		
Body Part	Surface Area Weighted Mean (a) (cm^2)	Sediment Loading Children Playing in Wet Soil (mg/cm^2) (b)	Total Sediment Mass (mg)
Hands	317	0.656	208
Lower legs	641	0.026	17
Feet (c)	406	0.656	266
Total	1,364	--	491
Area-Weighted Sediment Adherence factor (mg/cm^2) = Sediment mass/Surface area =			0.4

Notes:
RME - Reasonable Maximum Exposure.
USEPA, 2011. Exposure Factors Handbook. September 2011.
USEPA, 2004. Risk Assessment Guidance for Superfund, Supplemental Guidance for Dermal Risk Assessment. July 2004.
(a) Data from USEPA (2011). Table 7-2. Represents weighted mean surface area for males and females. Surface area of the lower legs is assumed to be 40% of the legs.
(b) Data from USEPA (2004) Exhibit C-2. Geometric mean of children playing in wet soil. Since a high-end activity (i.e., reasonable but higher exposure) is being used to represent contact with sediment, the geometric mean adherence factor is selected for use to represent both the RME and CTE exposure scenario, in accordance with USEPA guidance (page 3-14). USEPA (2004) states that it is not recommended that a high-end soil contact activity be used with a high-end weighted adherence factor for that activity, as this use would not be consistent with the use of a RME scenario.
(c) Soil loading data not available for feet. Data for hands used as a proxy.

ATTACHMENT B – REVISED PRG CALCULATIONS

B.1 – SEDIMENT – RECREATIONAL VISITOR

TABLE 1

VALUES USED FOR DAILY INTAKE CALCULATIONS - RECREATIONAL VISITOR

REASONABLE MAXIMUM EXPOSURE

NUCLEAR METALS SUPERFUND SITE

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Route	Receptor Population	Receptor Age	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion/Dermal	Recreational Visitor	Young Child/Adult					See FS Appendix C	
							Except where noted	See attached
			THQ	Target Hazard Quotient	1	- -		
			$AT\text{-}N_C$	Averaging Time (Non-Cancer) - child	2,190	days		
			ED_C	Exposure Duration - child	6	years		
			BW_C	Body Weight - child	15	kg		
			EF_C	Exposure Frequency - child	26	days/year		
			IR_C	Ingestion Rate of Sediment - child	200	mg/day		
			CF	Conversion Factor	0.000001	kg/mg		
			SA_C	Surface Area - child	1,364	cm^2	See Attachment A	
			AF_C	Adherence Factor - child	0.40	mg/cm^2-day	See Attachment A	
			ABS	Dermal Absorption Fraction	see FS Appendix C	- -		
			$AT\text{-}N_A$	Averaging Time (Non-Cancer) - adult	7,300	days	See Attachment A	
			ED_A	Exposure Duration - adult	20	years	See Attachment A	
			BW_A	Body Weight - adult	80	kg	See Attachment A	
			EF_A	Exposure Frequency - adult	26	days/year		
			IR_A	Ingestion Rate of Sediment - adult	100	mg/day		
			SA_A	Surface Area - adult	2,275	cm^2	See Attachment A	
			AF_A	Adherence Factor - adult	0.60	mg/cm^2-day	See Attachment A	
			RBA	Relative Bioavailability	0.6 for Arsenic/1 for all other analytes	- -		
			TR	Target ILCR	10^{-6} to 10^{-4}	- -		
			AT-C	Averaging Time (Cancer)	25,550	days		
			RfD_O	Oral Reference Dose	see ROD Table G-6	mg/kg-day		
			RfD_D	Dermal Reference Dose	see ROD Table G-6	mg/kg-day		
			SF_O	Oral Slope Factor	see ROD Table G-5	$(mg/kg\text{-}day)^{-1}$		
			SF_D	Dermal Slope Factor	see ROD Table G-5	$(mg/kg\text{-}day)^{-1}$		
			$ED_{0\text{-}2}$	Exposure Duration - 0-2 yrs	2	years		
			$ED_{2\text{-}6}$	Exposure Duration - 2-6 yrs	4	years		
			$ED_{6\text{-}16}$	Exposure Duration - 6-16 yrs	10	years		
			$ED_{16\text{-}26}$	Exposure Duration - 16-26 yrs+	10	years	See Attachment A	

Intake Equation/
Model Name

Preliminary Remediation Goal (PRG) non-cancer:

Ingestion - child

$$PRG_{nc\text{-}ing}\ (mg/kg) = \frac{THQ \times AT\text{-}N_C \times RfD_o \times BW_C}{EF_C \times ED_C \times IR_C \times CF \times RBA}$$

Dermal - child

$$PRG_{nc\text{-}derm}\ (mg/kg) = \frac{THQ \times AT\text{-}N_C \times RfD_D \times BW_C}{EF_C \times ED_C \times SA_C \times AF_C \times ABS \times CF}$$

Total - child

$$PRG_{nc\text{-}tot}\ (mg/kg) = \frac{1}{1/PRG_{nc\text{-}ing} + 1/PRG_{nc\text{-}derm}}$$

Ingestion - adult

$$PRG_{nc\text{-}ing}\ (mg/kg) = \frac{THQ \times AT\text{-}N_A \times RfD_o \times BW_A}{EF_A \times ED_A \times IR_A \times CF \times RBA}$$

Dermal - adult

$$PRG_{nc\text{-}derm}\ (mg/kg) = \frac{THQ \times AT\text{-}N_A \times RfD_D \times BW_A}{EF_A \times ED_A \times SA_A \times AF_A \times ABS \times CF}$$

Total - adult

$$PRG_{nc\text{-}tot}\ (mg/kg) = \frac{1}{1/PRG_{nc\text{-}ing} + 1/PRG_{nc\text{-}derm}}$$

Preliminary Remediation Goal (PRG) cancer:

Ingestion

$$PRG_{ca\text{-}ing}\ (mg/kg) = \frac{TR \times AT\text{-}C}{SF_o \times IFS_{adj} \times CF \times RBA}$$

$$IFS_{adj}\ (mg/kg) = \frac{ED_C \times EF_C \times IR_C}{BW_C} + \frac{ED_A \times EF_A \times IR_A}{BW_A}$$

Dermal

$$PRG_{ca\text{-}derm}\ (mg/kg) = \frac{TR \times AT\text{-}C}{SF_D \times DFS_{adj} \times ABS \times CF}$$

$$DFS_{adj}\ (mg/kg) = \frac{ED_C \times EF_C \times SA_C \times AF_C}{BW_C} + \frac{ED_A \times EF_A \times SA_A \times AF_A}{BW_A}$$

Total

$$PRG_{ca\text{-}tot}\ (mg/kg) = \frac{1}{1/PRG_{ca\text{-}ing} + 1/PRG_{ca\text{-}derm}}$$

Notes

IFS_{adj} - age-adjusted soil ingestion factor

DFS_{adj} - age-adjusted soil dermal factor

TABLE 2. INTERMEDIATE RECREATIONAL VISITOR SEDIMENT PRG CALCULATIONS - INGESTION

Chemical	Mutagenic?	THQ	$AT\text{-}N_C$ days	$AT\text{-}N_A$ days	RfD_o mg/kg-day	BW_C kg	BW_A kg	EF_C days/yr	EF_A days/yr	ED_C yrs	ED_A yrs	IR_C mg/day	IR_A mg/day	CF kg/mg	RBA	TR	AT-C days	SF_o $(mg/kg\text{-}day)^{-1}$	IFS_{adj} mg/kg	$PRG_{ca\text{-}ing}$ mg/kg	$PRG_{nc\text{-}ing\text{-}child}$ mg/kg	$PRG_{nc\text{-}ing\text{-}adult}$ mg/kg
Aroclor-1254		1	2190	7300	2E-05	15	80	26	26	6	20	200	100	0.000001	1	1E-06	25550	2.0E+00	2730	**4.7E+00**	**2.1E+01**	**2.2E+02**

Notes

See Table 1 for input parameters and equations

TABLE 3. INTERMEDIATE RECREATIONAL VISITOR SEDIMENT PRG CALCULATIONS - DERMAL

Chemical	Mutagenic?	THQ	$AT\text{-}N_C$ days	$AT\text{-}N_A$ days	RfD_D mg/kg-day	BW_C kg	BW_A kg	EF_C days/yr	EF_A days/yr	ED_C yrs	ED_A yrs	SA_C cm^2	SA_A cm^2	AF_C mg/cm^2-day	AF_A mg/cm^2-day	ABS	CF kg/mg	TR	AT-C days	SF_D $(mg/kg\text{-}day)^{-1}$	DFS_{adj} mg/kg	$PRG_{ca\text{-}derm}$ mg/kg	$PRG_{nc\text{-}derm\text{-}child}$ mg/kg	$PRG_{nc\text{-}derm\text{-}adult}$ mg/kg
Aroclor-1254		1	2190	7300	2E-05	15	80	26	26	6	20	1364	2275	0.4	0.6	0.14	0.000001	1E-06	25550	2.0E+00	14547	**6.3E+00**	**5.5E+01**	**1.2E+02**

Notes

See Table 1 for input parameters and equations

TABLE 4. INTERMEDIATE RECREATIONAL VISITOR SEDIMENT PRG CALCULATIONS - RESULTS

	Carcinogenic Risk Level = 1E-06			Non-Cancer HQ = 1 - Child			Non-Cancer HQ = 1 - Adult		
Chemical	$PRG_{ca\text{-}ing}$ mg/kg	$PRG_{ca\text{-}derm}$ mg/kg	Result mg/kg	$PRG_{nc\text{-}ing}$ mg/kg	$PRG_{nc\text{-}derm}$ mg/kg	Result mg/kg	$PRG_{nc\text{-}ing}$ mg/kg	$PRG_{nc\text{-}derm}$ mg/kg	Result mg/kg
Aroclor-1254	4.7E+00	6.3E+00	**2.7E+00**	2.1E+01	5.5E+01	**1.5E+01**	2.2E+02	1.2E+02	**7.7E+01**

Notes

See Table 1 for equations

HQ = Hazard Quotient

The lowest non-cancer PRG between the child and adult is used as the non-cancer PRG.

B.2 – GROUNDWATER – RESIDENT

TABLE 1

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

NUCLEAR METALS SUPERFUND SITE

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion/Dermal/ Inhalation	Resident	Adult/Young Child					See FS Appendix C except where noted	
			IR_A	Ingestion Rate of Water - adult	2.5	liters/day	See Attachment A	See attached
			EF	Exposure Frequency	350	days/year		
			ED_A	Exposure Duration - adult	20	years	See Attachment A	
			BW_A	Body Weight - adult	80	kg	See Attachment A	
			AT-C	Averaging Time (Cancer)	25550	days		
			AT-N	Averaging Time (Non-Cancer)	2190	days		
			CF1	Conversion Factor 1	0.001	mg/ug		
			BW_C	Body Weight - child	15	kg		
			IR_C	Ingestion Rate of Water - child	0.78	liters/day	See Attachment A	
			RfD_o	Oral Reference Dose	see ROD Table G-6	mg/kg-day		
			RfD_d	Dermal Reference Dose	see ROD Table G-6	mg/kg-day		
			RfC	Inhalation Reference Concentration	see ROD Table G-6	ug/m^3		
			CF2	Conversion Factor 2	0.001	cm^3/mg		
			CF3	Conversion Factor 3	0.001	$liters/cm^3$		
			K	Volatilization Factor	0.5	L/m^3		
			EV	Event Frequency	1	events/day		
			THQ	Target Hazard Quotient	1	- -		
			ED_C	Exposure Duration - child	6	years		
			SF_o	Oral Slope Factor	see ROD Table G-5	$(mg/kg\text{-}day)^{-1}$		
			TR	Target ILCR	10^{-6} to 10^{-4}	- -		
			SF_d	Dermal Slope Factor	see ROD Table G-5	$(mg/kg\text{-}day)^{-1}$		
			UR	Unit Risk	see ROD Table G-5	$(ug/m^3)^{-1}$		
			DA_{event}	Dose Absorbed per Unit Area per Event	see Table 3	mg/cm^2-event		
			ET_C	Exposure Time - child	0.54	hr/event	See Attachment A	
			ET_A	Exposure Time - adult	0.71	hr/event	See Attachment A	
			GIABS	Gastrointestinal absorption	see Table 3	- -		
			FA	Fraction Absorbed Water	see Table 3	- -		
			MW	Molecular Weight	see Table 3	g/mol		
			SA_A	Skin Surface Area Available for Contact - adult	20900	cm^2	See Attachment A	
			SA_C	Skin Surface Area Available for Contact - child	6378	cm^2	See Attachment A	

Intake Equation/
Model Name

Preliminary Remediation Goal (PRG) non-cancer:

Ingestion

$$PRG_{nc\text{-}ing}\ (ug/L) = \frac{THQ \times AT\text{-}N \times RfD_o \times BW_C}{EF \times CF1 \times ED_C \times IR_C}$$

Dermal - inorganics

$$PRG_{nc\text{-}derm}\ (ug/L) = \frac{DA_{event}}{Kp \times ET_C \times CF3}$$

where

$$DA_{event}\ (ug/cm2\text{-}event) = \frac{THQ \times AT\text{-}N \times RfD_o \times GIABS \times BW_C}{EV \times CF1 \times ED_C \times EF \times SA_C}$$

Dermal - organics

if ET_C <= t*

$$PRG_{nc\text{-}derm}\ (ug/L) = \frac{DA_{event}}{2 \times FA \times Kp \times [6 \times tau \times ET_C / \pi]^{0.5} \times CF3}$$

if ET_C > t*

$$PRG_{nc\text{-}derm}\ (ug/L) = \frac{DA_{event}}{FA \times Kp \times [ET_C / (1 + B) + 2 \times tau \times (1 + 3B + 3B^2)/(1 + B)^2] \times CF3}$$

where

$$DA_{event}\ (ug/cm2\text{-}event) = \frac{THQ \times AT\text{-}N \times RfD_o \times GIABS \times BW_C}{EV \times CF1 \times ED_C \times EF \times SA_C}$$

$$B = \frac{Kp \times MW^{0.5}}{2.6}$$

$$tau = \frac{I_{SC}^2}{6 \times D_{SC}}$$

I_{SC} = Skin Thickness (cm; assumed)

1.00E-03

D_{SC} = I_{SC} x 10^(-2.8 - 0.0056 x MW)

t* = If B <= 0.6

2.4 x tau

If B > 0.6

$$6 \times tau \times (b - (b^2 - c^2)^{0.5})$$

$$b = \frac{2 \times (1 + B)^2}{\pi} - c$$

$$c = \frac{1 + 3 \times B + 3 \times B^2}{3 \times (1 + B)}$$

Inhalation

$$PRG_{nc\text{-}inh}\ (ug/L) = \frac{THQ \times AT\text{-}N \times RfC}{EF \times ED_C \times K}$$

Total

$$PRG_{nc\text{-}tot}\ (ug/L) = \frac{1}{1/PRG_{nc\text{-}ing} + 1/PRG_{nc\text{-}derm} + 1/PRG_{nc\text{-}inh}}$$

Preliminary Remediation Goal (PRG) cancer:

Ingestion

$$PRG_{ca\text{-}ing}\ (ug/L) = \frac{TR \times AT\text{-}C}{EF \times CF1 \times SF_o \times IFW_{adj}}$$

$$IFW_{adj} = \frac{ED_C \times IR_C}{BW_C} + \frac{ED_A \times IR_A}{BW_A}$$

Dermal - inorganics

$$PRG_{ca\text{-}derm}\ (ug/L) = \frac{DA_{event}}{Kp \times ET_{adj} \times CF3}$$

where

$$ET_{adj} = ET_C \times ED_C/30 + ET_A \times ED_A/30$$

$$DA_{event}\ (ug/cm2\text{-}event) = \frac{TR \times AT\text{-}C \times GIABS}{SF_o \times CF1 \times EF \times DFW_{adj}}$$

$$DFW_{adj} = \frac{EV \times ED_C \times SA_C}{BW_C} + \frac{EV \times ED_A \times SA_A}{BW_A}$$

Dermal - organics

if ET_{adj} <= t*

$$PRG_{ca\text{-}derm}\ (ug/L) = \frac{DA_{event}}{2 \times FA \times Kp \times [6 \times tau \times ET_{adj} / \pi]^{0.5} \times CF3}$$

if ET_{adj} > t*

$$PRG_{ca\text{-}derm}\ (ug/L) = \frac{DA_{event}}{FA \times Kp \times [ET_{adj} / (1 + B) + 2 \times tau \times (1 + 3B + 3B^2)/(1 + B)^2] \times CF3}$$

where

$$DA_{event}\ (ug/cm2\text{-}event) = \frac{TR \times AT\text{-}C \times GIABS}{SF_o \times CF1 \times EF \times DFW_{adj}}$$

$$B = \frac{Kp \times MW^{0.5}}{2.6}$$

$$tau = \frac{I_{SC}^2}{6 \times D_{SC}}$$

I_{SC} = Skin Thickness (cm; assumed)

1.00E-03

$$D_{SC} = I_{SC} \times 10\text{^}(-2.8 - 0.0056 \times MW)$$

t* = If B <= 0.6

$$2.4 \times tau$$

If B > 0.6

$$6 \times tau \times (b - (b^2 - c^2)^{0.5})$$

$$b = \frac{2 \times (1 + B)^2}{\pi} - c$$

$$c = \frac{1 + 3 \times B + 3 \times B^2}{3 \times (1 + B)}$$

Inhalation

$$PRG_{ca\text{-}inh}\ (ug/L) = \frac{TR \times AT\text{-}C}{EF \times (ED_C + ED_{A)} \times UR \times K}$$

Total

$$PRG_{ca\text{-}tot}\ (ug/L) = \frac{1}{1/PRG_{ca\text{-}ing} + 1/PRG_{ca\text{-}derm} + 1/PRG_{ca\text{-}inh}}$$

Preliminary Remediation Goal (PRG) mutagenic:

Ingestion

$$PRG_{mu\text{-}ing}\ (ug/L) = \frac{TR \times AT\text{-}C}{EF \times CF1 \times SF_o \times IFWM_{adj}}$$

$$IFWM_{adj} = \frac{ED_{0\text{-}2} \times IR_C \times 10}{BW_C} + \frac{ED_{2\text{-}6} \times IR_C \times 3}{BW_C} + \frac{ED_{6\text{-}16} \times IR_A \times 3}{BW_A} + \frac{ED_{16\text{-}30} \times IR_A}{BW_A}$$

Dermal - inorganics

$$PRG_{mu\text{-}derm}\ (ug/L) = \frac{DA_{event}}{Kp \times ET_{madj} \times CF3}$$

where

$$ET_{madj} = \frac{ET_C \times ED_{0\text{-}2} + ET_C \times ED_{2\text{-}6} + ET_A \times ED_{6\text{-}16} + ET_A \times ED_{16\text{-}30}}{ED_{0\text{-}2} + ED_{2\text{-}6} + ED_{6\text{-}16} + ED_{16\text{-}30}}$$

$$DA_{event}\ (ug/cm2\text{-}event) = \frac{TR \times AT\text{-}C \times GIABS}{SF_o \times CF1 \times EF \times DFWM_{adj}}$$

$$DFWM_{adj} = \frac{ED_{0\text{-}2} \times SA_C \times 10}{BW_C} + \frac{ED_{2\text{-}6} \times SA_C \times 3}{BW_C} + \frac{ED_{6\text{-}16} \times SA_A \times 3}{BW_A} + \frac{ED_{16\text{-}30} \times SA_A}{BW_A}$$

Dermal - organics

if ET_{madj} <= t*

$$PRG_{mu\text{-}derm}\ (ug/L) = \frac{DA_{event}}{2 \times FA \times Kp \times [6 \times tau \times ET_{madj} / \pi]^{0.5} \times CF3}$$

if ET_{madj} > t*

$$PRG_{mu\text{-}derm}\ (ug/L) = \frac{DA_{event}}{FA \times Kp \times [ET_{madj} / (1 + B) + 2 \times tau \times (1 + 3B + 3B^2)/(1 + B)^2] \times CF3}$$

where

$$DA_{event}\ (ug/cm2\text{-}event) = \frac{TR \times AT\text{-}C \times GIABS}{SF_o \times CF1 \times EF \times DFWM_{adj}}$$

$$B = \frac{Kp \times MW^{0.5}}{2.6}$$

$$tau = \frac{I_{SC}^2}{6 \times D_{SC}}$$

I_{SC} = Skin Thickness (cm; assumed)

1.00E-03

D_{SC} = I_{SC} x 10^(-2.8 - 0.0056 x MW)

t* = If B <= 0.6

2.4 x tau

If B > 0.6

$$6 \times tau \times (b - (b^2 - c^2)^{0.5})$$

$$b = \frac{2 \times (1 + B)^2}{\pi} - c$$

$$c = \frac{1 + 3 \times B + 3 \times B^2}{3 \times (1 + B)}$$

Inhalation

$$PRG_{mu\text{-}inh}\ (ug/L) = \frac{TR \times AT\text{-}C}{EF \times K \times INFM_{adj}}$$

$$INFM_{adj} = ED_{0\text{-}2} \times UR \times 10 + ED_{2\text{-}6} \times UR \times 3 + ED_{6\text{-}16} \times UR \times 3 + ED_{16\text{-}30} \times UR$$

Total

$$PRG_{mu\text{-}tot}\ (ug/L) = \frac{1}{1/PRG_{mu\text{-}ing} + 1/PRG_{mu\text{-}derm} + 1/PRG_{mu\text{-}inh}}$$

Preliminary Remediation Goal (PRG) vinyl chloride:

Ingestion

$$PRG_{vc\text{-}ing}\ (ug/L) = \frac{TR}{CF1 \times SF_o \times ((EF \times IFW_{adj}) / AT\text{-}C + (IR_C / BW_C))}$$

$$IFW_{adj} = \frac{ED_C \times IR_C}{BW_C} + \frac{ED_A \times IR_A}{BW_A}$$

Dermal - organics

$$ET_{adj} = ET_C \times ED_C/30 + ET_A \times ED_A/30$$

$$DFW_{adj} = \frac{EV \times ED_C \times SA_C}{BW_C} + \frac{EV \times ED_A \times SA_A}{BW_A}$$

if ET_{adj} <= t*

$$PRG_{vc\text{-}derm}\ (ug/L) = \frac{DA_{event}}{2 \times FA \times Kp \times [6 \times tau \times ET_{madj} / \pi]^{0.5} \times CF3}$$

if ET_{adj} > t*

$$PRG_{vc\text{-}derm}\ (ug/L) = \frac{DA_{event}}{FA \times Kp \times [ET_{adj} / (1 + B) + 2 \times tau \times (1 + 3B + 3B^2)/(1 + B)^2] \times CF3}$$

where

$$DA_{event}\ (ug/cm2\text{-}event) = \frac{TR \times GIABS}{SF_o \times CF1 \times ((EF \times DFW_{adj}) / AT\text{-}C + SA_C / BW_C)}$$

$$B = \frac{Kp \times MW^{0.5}}{2.6}$$

$$tau = \frac{l_{SC}^2}{6 \times D_{SC}}$$

l_{SC} = Skin Thickness (cm; assumed)

1.00E-03

D_{SC} = l_{SC} x 10^(-2.8 - 0.0056 x MW)

t* = If B <= 0.6

2.4 x tau

If B > 0.6

$$6 \times tau \times (b - (b^2 - c^2)^{0.5})$$

$$b = \frac{2 \times (1 + B)^2}{\pi} - c$$

$$c = \frac{1 + 3 \times B + 3 \times B^2}{3 \times (1 + B)}$$

Inhalation

$$PRG_{vc\text{-}inh}\ (ug/L) = \frac{TR}{UR \times K \times (EF \times (ED_C + ED_A))/AT\text{-}C + 1)}$$

Total

$$PRG_{vc\text{-}tot}\ (ug/L) = \frac{1}{1/PRG_{vc\text{-}ing} + 1/PRG_{vc\text{-}derm} + 1/PRG_{vc\text{-}inh}}$$

Notes

IFW_{adj} - age-adjusted water ingestion factor

DFW_{adj} - age-adjusted water dermal factor

$IFWM_{adj}$ - mutagenic age-adjusted water ingestion factor

$DFWM_{adj}$ - mutagenic age-adjusted water dermal factor

$INFM_{adj}$ - mutagenic age-adjusted inhalation factor

TABLE 2. INTERMEDIATE GROUNDWATER PRG CALCULATIONS - INGESTION

Chemical	Mutagenic?	EF days	ED_C yrs	ED_A yrs	BW_C kg	BW_A kg	IR_C L/day	IR_A L/day	AT-N days	AT-C days	CF1 mg/ug	SF_o $(mg/kg\text{-}day)^{-1}$	RfD_o mg/kg-day	THQ	TR	IFW_{adj} (L-yr/kg-day)	$IFWM_{adj}$ (L-yr/kg-day)	$PRG_{ca\text{-}ing}$ ug/L	$PRG_{nc\text{-}ing}$ ug/L
1,4-Dioxane		350	6	20	15	80	0.78	2.5	2190	25550	0.001	1.0E-01	3E-02	1	1E-06	0.937	2.914	**7.8E-01**	**6.0E+02**
bis(2-Ethylhexyl)phthalate		350	6	20	15	80	0.78	2.5	2190	25550	0.001	1.4E-02	2E-02	1	1E-06	0.937	2.914	**5.6E+00**	**4.0E+02**
1,1-dichloroethane		350	6	20	15	80	0.78	2.5	2190	25550	0.001	5.7E-03	2E-01	1	1E-06	0.937	2.914	**1.4E+01**	**4.0E+03**
tetrachloroethene		350	6	20	15	80	0.78	2.5	2190	25550	0.001	2.1E-03	6E-03	1	1E-06	0.937	2.914	**3.7E+01**	**1.2E+02**
Trichloroethene	Y	350	6	20	15	80	0.78	2.5	2190	25550	0.001	4.6E-02	5E-04	1	1E-06	0.937	2.914	**1.2E+00**	**1.0E+01**
kidney	Y	350	6	20	15	80	0.78	2.5	2190	25550	0.001	9.3E-03	N/A	1	1E-06	0.937	2.914	**2.7E+00**	
non-kidney		350	6	20	15	80	0.78	2.5	2190	25550	0.001	3.7E-02	N/A	1	1E-06	0.937	2.914	**2.1E+00**	
Vinyl Chloride	Y	350	6	20	15	80	0.78	2.5	2190	25550	0.001	7.2E-01	3E-03	1	1E-06	0.937	2.914	**2.1E-02**	**6.0E+01**
Nitrate		350	6	20	15	80	0.78	2.5	2190	25550	0.001	N/A	2E+00	1	1E-06	0.937	2.914	**N/A**	**3.2E+04**
Nitrite		350	6	20	15	80	0.78	2.5	2190	25550	0.001	N/A	1E-01	1	1E-06	0.937	2.914	**N/A**	**2.0E+03**
Uranium		350	6	20	15	80	0.78	2.5	2190	25550	0.001	N/A	6E-04	1	1E-06	0.937	2.914	**N/A**	**1.2E+01**
Barium		350	6	20	15	80	0.78	2.5	2190	25550	0.001	N/A	2E-01	1	1E-06	0.937	2.914	**N/A**	**4.0E+03**
Arsenic		350	6	20	15	80	0.78	2.5	2190	25550	0.001	1.5E+00	3E-04	1	1E-06	0.937	2.914	**5.2E-02**	**6.0E+00**
Chromium	Y	350	6	20	15	80	0.78	2.5	2190	25550	0.001	5.0E-01	3E-03	1	1E-06	0.937	2.914	**5.0E-02**	**6.0E+01**
Cobalt		350	6	20	15	80	0.78	2.5	2190	25550	0.001	N/A	3E-04	1	1E-06	0.937	2.914	**N/A**	**6.0E+00**
Iron		350	6	20	15	80	0.78	2.5	2190	25550	0.001	N/A	7E-01	1	1E-06	0.937	2.914	**N/A**	**1.4E+04**
Manganese (drinking water)		350	6	20	15	80	0.78	2.5	2190	25550	0.001	N/A	2.4E-02	1	1E-06	0.937	2.914	**N/A**	**4.8E+02**
Molybdenum		350	6	20	15	80	0.78	2.5	2190	25550	0.001	N/A	5.0E-03	1	1E-06	0.937	2.914	**N/A**	**1.0E+02**
Copper		350	6	20	15	80	0.78	2.5	2190	25550	0.001	N/A	4E-02	1	1E-06	0.937	2.914	**N/A**	**8.0E+02**

Notes

See Table 1 for input parameters and equations N/A - Not applicable or not available.

Trichloroethene calculated to account for mutagenic contributions during early life. Slope factors for kidney and non-kidney (liver and non-Hodgkin lymphoma) presented above.

(source - http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/faq.htm#FAQ19)

Final TCE cancer PRG shown calculated by 1/(1/kidney conc + 1/non-kidney conc)

Chromium evaluated as hexavalent chromium

TABLE 3. INTERMEDIATE GROUNDWATER PRG CALCULATIONS - DERMAL

Chemical	MWT g/mol	logKow	Kp (cm/hr) predicted	B	Isc cm	Dsc cm^2/hr	tau (hr)	c	b	t_star1 B>0.6	t_star3 B<=0.6	t_star (hr)	GIABS	Mutagenic?	FA for tau>3	ET_C hr/event	ET_A hr/event	ET_{adj} hr/event	ET_{madj} hr/event	EV event/day	EF days	ED_C yrs	ED_A yrs	BW_C kg	BW_A kg	SA_C cm^2	SA_A cm^2	AT-N days	AT-C days	CF1 mg/ug	CF3 L/cm^3	SF_o $(mg/kg\text{-}day)^{-1}$	RfD_o mg/kg-day	THQ	TR	DFW_{adj} cm^2-evt-day/kg	$DFWM_{adj}$ evt-cm^2/kg	DA_{event} - ca ug/cm^2-evt	DA_{event} - nc ug/cm^2-evt	$PRG_{ca\text{-}derm}$ ug/L	$PRG_{nc\text{-}derm}$ ug/L
1,4-Dioxane	88.1	-0.27	3.3E-04	0.001	1.0E-03	5.09E-07	0.33	3.3E-01	3.0E-01	N/A	0.79	0.79	1		1	1	0.71	0.671	0.671	1	350	6	20	15	80	6378	20900	2190	25550	0.001	0.001	1.0E-01	3E-02	1	1E-06	7776	24056	9.4E-05	7.4E-02	**2.2E+02**	**1.9E+05**
bis(2-Ethylhexyl)phthalate	391.0	7.60	NA	N/A	1.0E-03	1.02E-08	16.27	N/A	N/A	N/A	39.05	N/A	1		0.8	1	0.71	0.671	0.671	1	350	6	20	15	80	6378	20900	2190	25550	0.001	0.001	1.4E-02	2E-02	1	1E-06	7776	24056	N/A	N/A	**N/A**	**N/A**
1,1-dichloroethane	99.0	1.79	6.7E-03	0.026	1.0E-03	4.42E-07	0.38	3.5E-01	3.2E-01	N/A	0.90	0.90	1		1	1	0.71	0.671	0.671	1	350	6	20	15	80	6378	20900	2190	25550	0.001	0.001	5.7E-03	2E-01	1	1E-06	7776	24056	1.6E-03	4.9E-01	**1.8E+02**	**5.8E+04**
tetrachloroethene	165.8	3.40	3.3E-02	0.166	1.0E-03	1.87E-07	0.89	4.5E-01	4.1E-01	N/A	2.14	2.14	1		1	1	0.71	0.671	0.671	1	350	6	20	15	80	6378	20900	2190	25550	0.001	0.001	2.1E-03	6E-03	1	1E-06	7776	24056	4.5E-03	1.5E-02	**6.3E+01**	**2.3E+02**
Trichloroethene	131.4	2.42	1.2E-02	0.051	1.0E-03	2.91E-07	0.57	3.7E-01	3.4E-01	N/A	1.37	1.37	1	Y	1	1	0.71	0.671	0.671	1	350	6	20	15	80	6378	20900	2190	25550	0.001	0.001	4.6E-02	5E-04	1	1E-06	7776	24056	6.6E-05	1.2E-03	**7.2E+00**	**6.9E+01**
kidney	131.4	2.42	1.2E-02	0.051	1.0E-03	2.91E-07	0.57	3.7E-01	3.4E-01	N/A	1.37	1.37	1	Y	1	1	0.71	0.671	0.671	1	350	6	20	15	80	6378	20900	2190	25550	0.001	0.001	9.3E-03	N/A	1	1E-06	7776	24056	3.3E-04	N/A	**1.6E+01**	**N/A**
non-kidney	131.4	2.42	1.2E-02	0.051	1.0E-03	2.91E-07	0.57	3.7E-01	3.4E-01	N/A	1.37	1.37	1		1	1	0.71	0.671	0.671	1	350	6	20	15	80	6378	20900	2190	25550	0.001	0.001	3.7E-02	N/A	1	1E-06	7776	24056	2.5E-04	N/A	**1.3E+01**	**N/A**
Vinyl Chloride	62.5	1.62	8.4E-03	0.025	1.0E-03	7.08E-07	0.24	3.5E-01	3.2E-01	N/A	0.57	0.57	1	Y	1	1	0.71	0.671	0.671	1	350	6	20	15	80	6378	20900	2190	25550	0.001	0.001	7.2E-01	3E-03	1	1E-06	7776	24056	2.6E-06	7.4E-03	**2.7E-01**	**8.9E+02**
Nitrate	--	--	1.0E-03	--	1.0E-03	--	--	--	--	--	--	--	1	--	1	1	0.71	0.671	0.671	1	350	6	20	15	80	6378	20900	2190	25550	0.001	0.001	N/A	2E+00	1	1E-06	7776	24056	N/A	3.9E+00	**N/A**	**7.3E+06**
Nitrite	--	--	1.0E-03	--	1.0E-03	--	--	--	--	--	--	--	1	--	1	1	0.71	0.671	0.671	1	350	6	20	15	80	6378	20900	2190	25550	0.001	0.001	N/A	1E-01	1	1E-06	7776	24056	N/A	2.5E-01	**N/A**	**4.5E+05**
Uranium	--	--	1.0E-03	--	1.0E-03	--	--	--	--	--	--	--	1	--	1	1	0.71	0.671	0.671	1	350	6	20	15	80	6378	20900	2190	25550	0.001	0.001	N/A	6E-04	1	1E-06	7776	24056	N/A	1.5E-03	**N/A**	**2.7E+03**
Barium	--	--	1.0E-03	--	1.0E-03	--	--	--	--	--	--	--	0.07	--	1	1	0.71	0.671	0.671	1	350	6	20	15	80	6378	20900	2190	25550	0.001	0.001	N/A	2E-01	1	1E-06	7776	24056	N/A	3.4E-02	**N/A**	**6.4E+04**
Arsenic	--	--	1.0E-03	--	1.0E-03	--	--	--	--	--	--	--	1	--	1	1	0.71	0.671	0.671	1	350	6	20	15	80	6378	20900	2190	25550	0.001	0.001	1.5E+00	3E-04	1	1E-06	7776	24056	6.3E-06	7.4E-04	**9.3E+00**	**1.4E+03**
Chromium	--	--	2.0E-03	--	1.0E-03	--	--	--	--	--	--	--	0.025	Y	1	1	0.71	0.671	0.671	1	350	6	20	15	80	6378	20900	2190	25550	0.001	0.001	5.0E-01	3E-03	1	1E-06	7776	24056	1.5E-07	1.8E-04	**1.1E-01**	**1.7E+02**
Cobalt	--	--	4.0E-04	--	1.0E-03	--	--	--	--	--	--	--	1	--	1	1	0.71	0.671	0.671	1	350	6	20	15	80	6378	20900	2190	25550	0.001	0.001	N/A	3E-04	1	1E-06	7776	24056	N/A	7.4E-04	**N/A**	**3.4E+03**
Iron	--	--	1.0E-03	--	1.0E-03	--	--	--	--	--	--	--	1	--	1	1	0.71	0.671	0.671	1	350	6	20	15	80	6378	20900	2190	25550	0.001	0.001	N/A	7E-01	1	1E-06	7776	24056	N/A	1.7E+00	**N/A**	**3.2E+06**
Manganese (drinking water)	--	--	1.0E-03	--	1.0E-03	--	--	--	--	--	--	--	0.04	--	1	1	0.71	0.671	0.671	1	350	6	20	15	80	6378	20900	2190	25550	0.001	0.001	N/A	2.4E-02	1	1E-06	7776	24056	N/A	2.4E-03	**N/A**	**4.4E+03**
Molybdenum	--	--	1.0E-03	--	1.0E-03	--	--	--	--	--	--	--	1	--	1	1	0.71	0.671	0.671	1	350	6	20	15	80	6378	20900	2190	25550	0.001	0.001	N/A	5.0E-03	1	1E-06	7776	24056	N/A	1.2E-02	**N/A**	**2.3E+04**
Copper	--	--	1.0E-03	--	1.0E-03	--	--	--	--	--	--	--	1	--	1	1	0.71	0.671	0.671	1	350	6	20	15	80	6378	20900	2190	25550	0.001	0.001	N/A	4E-02	1	1E-06	7776	24056	N/A	9.8E-02	**N/A**	**1.8E+05**

Notes

See Table 1 for input parameters and equations N/A - Not applicable or not available.

log Kow, GIABS, and FA - From Regional Screening Level (January 2015) tables

Kp - predicted values utilize formula from RAGs part E Eq. 3.8: log Kp = -2.805603 + 0.6645865 log Kow - 0.0056118 MW (Equation more accurate in spreadsheet than in report) (Final - EPA/540/R/99/005, July 2004)

NA: Outside of Effective Predictive Domain (EPD). Calculated based on RAGS Part E criteria for MW and log Kow.

Inorganics: Rags Part E, Exhibit 3-1; Final - EPA/540/R/99/005, July 2004

Trichloroethene calculated to account for mutagenic contributions during early life. Slope factors for kidney and non-kidney (liver and non-Hodgkin lymphoma) presented above.

(source - http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/faq.htm#FAQ19)

Final TCE cancer PRG shown calculated by 1/(1/kidney conc + 1/non-kidney conc)

Chromium evaluated as hexavalent chromium

TABLE 4. INTERMEDIATE GROUNDWATER PRG CALCULATIONS - INHALATION

Chemical	Mutagenic?	EF days	ED_C yrs	ED_A yrs	K L/m^3	AT-N days	AT-C days	UR $(ug/m^3)^{-1}$	RfC ug/m^3	THQ	TR	$INFM_{adj}$ $yr\text{-}ug/m^3$	$PRG_{ca\text{-}inh}$ ug/L	$PRG_{nc\text{-}inh}$ ug/L
1,4-Dioxane		350	6	20	0.5	2190	25550	5.0E-06	3E+01	1	1E-06	3.6E-04	**1.1E+00**	**6.3E+01**
bis(2-Ethylhexyl)phthalate		350	6	20	0.5	2190	25550	N/A	N/A	1	1E-06	N/A	**N/A**	**N/A**
1,1-dichloroethane		350	6	20	0.5	2190	25550	1.6E-06	N/A	1	1E-06	1.2E-04	**3.5E+00**	**N/A**
tetrachloroethene		350	6	20	0.5	2190	25550	2.6E-07	4E+01	1	1E-06	1.9E-05	**2.2E+01**	**8.3E+01**
Trichloroethene	Y	350	6	20	0.5	2190	25550	4.1E-06	2E+00	1	1E-06	3.0E-04	**9.6E-01**	**4.2E+00**
kidney	Y	350	6	20	0.5	2190	25550	1.0E-06	N/A	1	1E-06	7.2E-05	**2.0E+00**	
non-kidney		350	6	20	0.5	2190	25550	3.1E-06	N/A	1	1E-06	2.2E-04	**1.8E+00**	
Vinyl Chloride	Y	350	6	20	0.5	2190	25550	4.4E-06	1E+02	1	1E-06	3.2E-04	**3.4E-01**	**2.1E+02**
Nitrate		350	6	20	0.5	2190	25550	N/A	N/A	1	1E-06	N/A	**N/A**	**N/A**
Nitrite		350	6	20	0.5	2190	25550	N/A	N/A	1	1E-06	N/A	**N/A**	**N/A**
Uranium		350	6	20	0.5	2190	25550	N/A	N/A	1	1E-06	N/A	**N/A**	**N/A**
Barium		350	6	20	0.5	2190	25550	N/A	N/A	1	1E-06	N/A	**N/A**	**N/A**
Arsenic		350	6	20	0.5	2190	25550	4.3E-03	1.5E-03	1	1E-06	3.1E-01	**N/A**	**N/A**
Chromium	Y	350	6	20	0.5	2190	25550	N/A	N/A	1	1E-06	N/A	**N/A**	**N/A**
Cobalt		350	6	20	0.5	2190	25550	9.0E-03	6E-03	1	1E-06	6.5E-01	**N/A**	**N/A**
Iron		350	6	20	0.5	2190	25550	N/A	N/A	1	1E-06	N/A	**N/A**	**N/A**
Manganese (drinking water)		350	6	20	0.5	2190	25550	N/A	5E-02	1	1E-06	N/A	**N/A**	**N/A**
Molybdenum		350	6	20	0.5	2190	25550	N/A	N/A	1	1E-06	N/A	**N/A**	**N/A**
Copper		350	6	20	0.5	2190	25550	N/A	N/A	1	1E-06	N/A	**N/A**	**N/A**

Notes

See Table 1 for input parameters and equations N/A - Not applicable or not available.

PRGs shown as "N/A" are due to either lack of inhalation toxicity values or because the analyte is non-volatile.

Trichloroethene calculated to account for mutagenic contributions during early life. Slope factors for kidney and non-kidney (liver and non-Hodgkin lymphoma) presented in spreadsheet.

(source - http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/faq.htm#FAQ19)

Final TCE cancer PRG shown calculated by 1/(1/kidney conc + 1/non-kidney conc)

Chromium evaluated as hexavalent chromium

TABLE 5. INTERMEDIATE GROUNDWATER PRG CALCULATIONS - RESULTS

	Carcinogenic Risk Level = 1E-06				Non-Cancer Hazard Quotient = 1			
Chemical	$PRG_{ca\text{-}ing}$ ug/L	$PRG_{ca\text{-}derm}$ ug/L	$PRG_{ca\text{-}inh}$ ug/L	Result ug/L	$PRG_{nc\text{-}ing}$ ug/L	$PRG_{nc\text{-}derm}$ ug/L	$PRG_{nc\text{-}inh}$ ug/L	Result ug/L
1,4-Dioxane	7.8E-01	2.2E+02	1.1E+00	**4.6E-01**	6.0E+02	1.9E+05	6.3E+01	**5.7E+01**
bis(2-Ethylhexyl)phthalate	5.6E+00	N/A	N/A	**5.6E+00**	4.0E+02	N/A	N/A	**4.0E+02**
1,1-Dichloroethane	1.4E+01	1.8E+02	3.5E+00	**2.7E+00**	4.0E+03	5.8E+04	N/A	**3.8E+03**
Tetrachloroethene	3.7E+01	6.3E+01	2.2E+01	**1.1E+01**	1.2E+02	2.3E+02	8.3E+01	**4.1E+01**
Trichloroethene	1.2E+00	7.2E+00	9.6E-01	**4.9E-01**	1.0E+01	6.9E+01	4.2E+00	**2.8E+00**
Vinyl Chloride	2.1E-02	2.7E-01	3.4E-01	**1.9E-02**	6.0E+01	8.9E+02	2.1E+02	**4.4E+01**
Nitrate	N/A	N/A	N/A	**N/A**	3.2E+04	7.3E+06	N/A	**3.2E+04**
Nitrite	N/A	N/A	N/A	**N/A**	2.0E+03	4.5E+05	N/A	**2.0E+03**
Uranium	N/A	N/A	N/A	**N/A**	1.2E+01	2.7E+03	N/A	**1.2E+01**
Barium	N/A	N/A	N/A	**N/A**	4.0E+03	6.4E+04	N/A	**3.8E+03**
Arsenic	5.2E-02	9.3E+00	N/A	**5.2E-02**	6.0E+00	1.4E+03	N/A	**6.0E+00**
Chromium	5.0E-02	1.1E-01	N/A	**3.5E-02**	6.0E+01	1.7E+02	N/A	**4.4E+01**
Cobalt	N/A	N/A	N/A	**N/A**	6.0E+00	3.4E+03	N/A	**6.0E+00**
Iron	N/A	N/A	N/A	**N/A**	1.4E+04	3.2E+06	N/A	**1.4E+04**
Manganese (drinking water)	N/A	N/A	N/A	**N/A**	4.8E+02	4.4E+03	N/A	**4.3E+02**
Molybdenum	N/A	N/A	N/A	**N/A**	1.0E+02	2.3E+04	N/A	**1.0E+02**
Copper	N/A	N/A	N/A	**N/A**	8.0E+02	1.8E+05	N/A	**8.0E+02**

Notes

See Table 1 for equations

Chromium evaluated as hexavalent chromium

N/A - Not applicable or not available.

TABLE 6. RADIOLOGICAL PRG DEVELOPMENT - INTERMEDIATE CALCULATIONS - RESIDENT - GROUNDWATER

PRG (cancer) - Radionuclide COC (pCi/L) = $\frac{TR}{IR\text{-}W \times FI \times EF \times ED \times CSFw}$

Exposure Parameters[1]

TR	Target Risk	1.00E-06	Risk
IR-Wa	Ingestion Rate of Water-adult	2.5	L/day
IR-Wc	Ingestion Rate of Water-child	0.78	L/day
FI	Fraction Ingested	1	unitless
EF	Exposure Frequency	350	day/yr
EDa	Exposure Duration-adult	20	yr
EDc	Exposure Duration-child	6	yr
CSFw	Cancer Slope Factor - Water	See ROD Table G-5	Risk/pCi

Notes

1 - See FS Appendix C except for highlighted values (see Attachment A)

	Ra-228+D	Th-228+D	Th-232	U-234	U-235+D	U-238+D	Ac-227+D	Th-230	Ra-226+D	Pb-210	Bi-210	Po-210
Cancer Slope Factor - Water Ingestion CSFw:	1.04E-09	3.00E-10	1.01E-10	7.07E-11	7.18E-11	8.71E-11	4.86E-10	9.10E-11	3.86E-10	8.81E-10	8.92E-12	3.77E-10
adult - IR-Wa x FI x EF x EDa x CSFw:	1.82E-05	5.25E-06	1.77E-06	1.24E-06	1.26E-06	1.52E-06	8.51E-06	1.59E-06	6.76E-06	1.54E-05	1.56E-07	6.60E-06
child - IR-Wc x FI x EF x EDc x CSFw:	1.70E-06	4.91E-07	1.65E-07	1.16E-07	1.18E-07	1.43E-07	7.96E-07	1.49E-07	6.32E-07	1.44E-06	1.46E-08	6.18E-07
Activity-Based PRG (pCi/L) = TR / (adult+child):	5.02E-02	1.74E-01	5.17E-01	7.39E-01	7.28E-01	6.00E-01	1.08E-01	5.74E-01	1.35E-01	5.93E-02	5.86E+00	1.39E-01

Table 7 - Derivation of Site-Specific Human Health Preliminary Remediation Goals for Radionucildes - Groundwater
Nuclear Metals Superfund Site

Depleted Uranium				
Isotope	Specific Activity (pCi/ml)	Receptor Scenario:	Resident	
			PRG - Activity (pCi/L)	PRG - Mass (ug/L)
		Total Depleted Uranium PRG - Mass:		1.6E+00
		Mass Abundance		
U-238+D	3.35E+05	99.7982%	6.00E-01	1.8E+00
U-235+D	2.16E+06	0.2009%	7.28E-01	1.7E+02
U-234	6.24E+09	0.0009%	7.39E-01	1.3E+01

Natural Uranium				
Isotope	Specific Activity (pCi/ml)	Receptor Scenario:	Resident	
			PRG - Activity (pCi/L)	PRG - Mass (ug/L)
		Total Natural Uranium PRG - Mass:		7.6E-02
		Mass Abundance		
U-238+D	3.35E+05	99.2739%	6.00E-01	1.80E+00
U-235+D	2.16E+06	0.7204%	7.28E-01	4.67E+01
U-234	6.24E+09	0.0057%	7.39E-01	2.08E+00
Ac-227+D	activity equals U-235 activity		1.08E-01	6.90E+00
Th-230	activity equals U-234 activity		5.74E-01	1.61E+00
Ra-226+D	activity equals U-234 activity		1.35E-01	3.80E-01
Pb-210	activity equals U-234 activity		5.93E-02	1.67E-01
Bi-210	activity equals U-234 activity		5.86E+00	1.65E+01
Po-210	activity equals U-234 activity		1.39E-01	3.89E-01

Total Thorium (as Th-232)				
Isotope	Specific Activity (pCi/ml)	Receptor Scenario:	Resident	
			PRG - Activity (pCi/L)	PRG - Mass (ug/L)
		Total Thorium PRG - Mass:		3.3E-01
		Mass Abundance		
Th-232	1.10E+05	100%	5.17E-01	4.70E+00
Ra-228+D	activity equals Th-232 activity		5.02E-02	4.57E-01
Th-228+D	activity equals Th-232 activity		1.74E-01	1.58E+00

PRG - Activity calculated using equations provided in Table 6.
PRG - Mass calculated for each isotope as PRG-Activity x 1E+06 /specific activity / mass abundance
PRG - Mass for total uranium and total throium calculated as: 1 / [(1/PRG-Mass for isotope) + (1/PRG-Mass for isotope) + (1/PRG-Mass for isotope) … *n*]
ug/L = microgram per liter
pCi/L = picoCurie per liter

B.3 – SOIL – RESIDENT

TABLE 1

VALUES USED FOR DAILY INTAKE CALCULATIONS - RESIDENT

REASONABLE MAXIMUM EXPOSURE

NUCLEAR METALS SUPERFUND SITE

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

Exposure Route	Receptor Population	Receptor Age	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion/Dermal	Resident	Young Child/Adult					See FS Appendix C, except where noted	
								See attached
			THQ	Target Hazard Quotient	1	- -		
			$AT\text{-}N_C$	Averaging Time (Non-Cancer) - child	2,190	days		
			ED_C	Exposure Duration - child	6	years		
			BW_C	Body Weight - child	15	kg		
			EF_C	Exposure Frequency - child	161	days/year		
			IR_C	Ingestion Rate of Soil - child	200	mg/day		
			CF	Conversion Factor	0.000001	kg/mg		
			SA_C	Surface Area - child	2,373	cm^2	See Attachment A	
			AF_C	Adherence Factor - child	0.20	mg/cm^2-day		
			ABS	Dermal Absorption Fraction	see FS Appendix C	- -		
			$AT\text{-}N_A$	Averaging Time (Non-Cancer) - adult	7,300	days	See Attachment A	
			ED_A	Exposure Duration - adult	20	years	See Attachment A	
			BW_A	Body Weight - adult	80	kg	See Attachment A	
			EF_A	Exposure Frequency - adult	161	days/year		
			IR_A	Ingestion Rate of Soil - adult	100	mg/day		
			SA_A	Surface Area - adult	6,032	cm^2	See Attachment A	
			AF_A	Adherence Factor - adult	0.07	mg/cm^2-day		
			RBA	Relative Bioavailability	0.6 for Arsenic/1 for all other analytes	- -		
			TR	Target ILCR	10^{-6} to 10^{-4}	- -		
			AT-C	Averaging Time (Cancer)	25,550	days		
			RfD_O	Oral Reference Dose	see ROD Table G-6	mg/kg-day		
			RfD_D	Dermal Reference Dose	see ROD Table G-6	mg/kg-day		
			SF_O	Oral Slope Factor	see ROD Table G-5	$(mg/kg\text{-}day)^{-1}$		
			SF_D	Dermal Slope Factor	see ROD Table G-5	$(mg/kg\text{-}day)^{-1}$		
			$ED_{0\text{-}2}$	Exposure Duration - 0-2 yrs	2	years		
			$ED_{2\text{-}6}$	Exposure Duration - 2-6 yrs	4	years		
			$ED_{6\text{-}16}$	Exposure Duration - 6-16 yrs	10	years		
			$ED_{16\text{-}26}$	Exposure Duration - 16-26 yrs+	10	years	See Attachment A	

Intake Equation/
Model Name

Preliminary Remediation Goal (PRG) non-cancer:

Ingestion - child

$$PRG_{nc\text{-}ing}\ (mg/kg) = \frac{THQ \times AT\text{-}N_C \times RfD_o \times BW_C}{EF_C \times ED_C \times IR_C \times CF \times RBA}$$

Dermal - child

$$PRG_{nc\text{-}derm}\ (mg/kg) = \frac{THQ \times AT\text{-}N_C \times RfD_D \times BW_C}{EF_C \times ED_C \times SA_C \times AF_C \times ABS \times CF}$$

Total - child

$$PRG_{nc\text{-}tot}\ (mg/kg) = \frac{1}{1/PRG_{nc\text{-}ing} + 1/PRG_{nc\text{-}derm}}$$

Ingestion - adult

$$PRG_{nc\text{-}ing}\ (mg/kg) = \frac{THQ \times AT\text{-}N_A \times RfD_o \times BW_A}{EF_A \times ED_A \times IR_A \times CF \times RBA}$$

Dermal - adult

$$PRG_{nc\text{-}derm}\ (mg/kg) = \frac{THQ \times AT\text{-}N_A \times RfD_D \times BW_A}{EF_A \times ED_A \times SA_A \times AF_A \times ABS \times CF}$$

Total - adult

$$PRG_{nc\text{-}tot}\ (mg/kg) = \frac{1}{1/PRG_{nc\text{-}ing} + 1/PRG_{nc\text{-}derm}}$$

Preliminary Remediation Goal (PRG) cancer:

Ingestion

$$PRG_{ca\text{-}ing}\ (mg/kg) = \frac{TR \times AT\text{-}C}{SF_o \times IFS_{adj} \times CF \times RBA}$$

$$IFS_{adj}\ (mg/kg) = \frac{ED_C \times EF_C \times IR_C}{BW_C} + \frac{ED_A \times EF_A \times IR_A}{BW_A}$$

Dermal

$$PRG_{ca\text{-}derm}\ (mg/kg) = \frac{TR \times AT\text{-}C}{SF_D \times DFS_{adj} \times ABS \times CF}$$

$$DFS_{adj}\ (mg/kg) = \frac{ED_C \times EF_C \times SA_C \times AF_C}{BW_C} + \frac{ED_A \times EF_A \times SA_A \times AF_A}{BW_A}$$

Total

$$PRG_{ca\text{-}tot}\ (mg/kg) = \frac{1}{1/PRG_{ca\text{-}ing} + 1/PRG_{ca\text{-}derm}}$$

Preliminary Remediation Goal (PRG) mutagenic:

Ingestion

$$PRG_{mu\text{-}ing}\ (mg/kg) = \frac{TR \times AT\text{-}C}{SF_o \times IFSM_{adj} \times CF \times RBA}$$

$$IFSM_{adj}\ (mg/kg) = \frac{ED_{0\text{-}2} \times EF_C \times IR_C \times 10}{BW_C} + \frac{ED_{2\text{-}6} \times EF_C \times IR_C \times 3}{BW_C} + \frac{ED_{6\text{-}16} \times EF_A \times IR_A \times 3}{BW_A} + \frac{ED_{16\text{-}26} \times EF_A \times IR_A}{BW_A}$$

Dermal

$$PRG_{mu\text{-}derm}\ (mg/kg) = \frac{TR \times AT\text{-}C}{SF_D \times DFSM_{adj} \times ABS \times CF}$$

$$DFSM_{adj}\ (mg/kg) = \frac{ED_{0\text{-}2} \times EF_C \times AF_C \times SA_C \times 10}{BW_C} + \frac{ED_{2\text{-}6} \times EF_C \times AF_C \times SA_C \times 3}{BW_C} + \frac{ED_{6\text{-}16} \times EF_A \times AF_A \times SA_A \times 3}{BW_A} + \frac{ED_{16\text{-}26} \times EF_A \times AF_A \times SA_A}{BW_A}$$

Total

$$PRG_{mu\text{-}tot}\ (mg/kg) = \frac{1}{1/PRG_{mu\text{-}ing} + 1/PRG_{mu\text{-}derm}}$$

Notes

IFS_{adj} - age-adjusted soil ingestion factor

DFS_{adj} - age-adjusted soil dermal factor

$IFSM_{adj}$ - mutagenic age-adjusted soil ingestion factor

$DFSM_{adj}$ - mutagenic age-adjusted soil dermal factor

TABLE 2. INTERMEDIATE RESIDENT SOIL PRG CALCULATIONS - INGESTION

Chemical	Mutagenic?	THQ	$AT\text{-}N_C$ days	$AT\text{-}N_A$ days	RfD_o mg/kg-day	BW_C kg	BW_A kg	EF_C days/yr	EF_A days/yr	ED_C yrs	ED_A yrs	IR_C mg/day	IR_A mg/day	CF kg/mg	RBA	TR	AT-C days	SF_o $(mg/kg\text{-}day)^{-1}$	IFS_{adj} mg/kg	$IFSM_{adj}$ mg/kg	$PRG_{ca\text{-}ing}$ mg/kg	$PRG_{nc\text{-}ing\text{-}child}$ mg/kg	$PRG_{nc\text{-}ing\text{-}adult}$ mg/kg
Benzo(a)anthracene	Y	1	2190	7300	3E-02	15	80	161	161	6	20	200	100	0.000001	1	1E-06	25550	7.3E-01	16905	76743.3333	**4.6E-01**	**5.1E+03**	**5.4E+04**
Benzo(a)pyrene	Y	1	2190	7300	3E-02	15	80	161	161	6	20	200	100	0.000001	1	1E-06	25550	7.3E+00	16905	76743.3333	**4.6E-02**	**5.1E+03**	**5.4E+04**
Benzo(b)fluoranthene	Y	1	2190	7300	3E-02	15	80	161	161	6	20	200	100	0.000001	1	1E-06	25550	7.3E-01	16905	76743.3333	**4.6E-01**	**5.1E+03**	**5.4E+04**
Indeno(1,2,3-cd)pyrene	Y	1	2190	7300	3E-02	15	80	161	161	6	20	200	100	0.000001	1	1E-06	25550	7.3E-01	16905	76743.3333	**4.6E-01**	**5.1E+03**	**5.4E+04**
Aroclor-1254		1	2190	7300	2E-05	15	80	161	161	6	20	200	100	0.000001	1	1E-06	25550	2.0E+00	16905	76743.3333	**7.6E-01**	**3.4E+00**	**3.6E+01**
Arsenic		1	2190	7300	3E-04	15	80	161	161	6	20	200	100	0.000001	0.6	1E-06	25550	1.5E+00	16905	76743.3333	**1.7E+00**	**8.5E+01**	**9.1E+02**
Thorium		1	2190	7300	N/A	15	80	161	161	6	20	200	100	0.000001	1	1E-06	25550	NA	16905	76743.3333	**N/A**	**N/A**	**N/A**
Uranium		1	2190	7300	6E-04	15	80	161	161	6	20	200	100	0.000001	1	1E-06	25550	NA	16905	76743.3333	**N/A**	**1.0E+02**	**1.1E+03**

Notes

See Table 1 for input parameters and equations

N/A - Not applicable or not available.

TABLE 3. INTERMEDIATE RESIDENT SOIL PRG CALCULATIONS - DERMAL

Chemical	Mutagenic?	THQ	$AT\text{-}N_C$ days	$AT\text{-}N_A$ days	RfD_D mg/kg-day	BW_C kg	BW_A kg	EF_C days/yr	EF_A days/yr	ED_C yrs	ED_A yrs	SA_C cm^2	SA_A cm^2	AF_C mg/cm^2-day	AF_A mg/cm^2-day	ABS	CF kg/mg	TR	AT-C days	SF_D $(mg/kg\text{-}day)^{-1}$	DFS_{adj} mg/kg	$DFSM_{adj}$ mg/kg	$PRG_{ca\text{-}derm}$ mg/kg	$PRG_{nc\text{-}derm\text{-}child}$ mg/kg	$PRG_{nc\text{-}derm\text{-}adult}$ mg/kg
Benzo(a)anthracene	Y	1	2190	7300	3E-02	15	80	161	161	6	20	2373	6032	0.2	0.07	0.13	0.000001	1E-06	25550	7.3E-01	47559	197000	**1.4E+00**	**1.7E+04**	**9.9E+04**
Benzo(a)pyrene	Y	1	2190	7300	3E-02	15	80	161	161	6	20	2373	6032	0.2	0.07	0.13	0.000001	1E-06	25550	7.3E+00	47559	197000	**1.4E-01**	**1.7E+04**	**9.9E+04**
Benzo(b)fluoranthene	Y	1	2190	7300	3E-02	15	80	161	161	6	20	2373	6032	0.2	0.07	0.13	0.000001	1E-06	25550	7.3E-01	47559	197000	**1.4E+00**	**1.7E+04**	**9.9E+04**
Indeno(1,2,3-cd)pyrene	Y	1	2190	7300	3E-02	15	80	161	161	6	20	2373	6032	0.2	0.07	0.13	0.000001	1E-06	25550	7.3E-01	47559	197000	**1.4E+00**	**1.7E+04**	**9.9E+04**
Aroclor-1254		1	2190	7300	2E-05	15	80	161	161	6	20	2373	6032	0.2	0.07	0.14	0.000001	1E-06	25550	2.0E+00	47559	197000	**1.9E+00**	**1.0E+01**	**6.1E+01**
Arsenic		1	2190	7300	3E-04	15	80	161	161	6	20	2373	6032	0.2	0.07	0.03	0.000001	1E-06	25550	1.5E+00	47559	197000	**1.2E+01**	**7.2E+02**	**4.3E+03**
Thorium		1	2190	7300	N/A	15	80	161	161	6	20	2373	6032	0.2	0.07	NA	0.000001	1E-06	25550	NA	47559	197000	**N/A**	**N/A**	**N/A**
Uranium		1	2190	7300	6E-04	15	80	161	161	6	20	2373	6032	0.2	0.07	NA	0.000001	1E-06	25550	NA	47559	197000	**N/A**	**N/A**	**N/A**

Notes

See Table 1 for input parameters and equations

N/A - Not applicable or not available.

TABLE 4. INTERMEDIATE RESIDENT SOIL PRG CALCULATIONS - RESULTS

	Carcinogenic Risk Level = 1E-06			Non-Cancer HQ = 1 - Child			Non-Cancer HQ = 1 - Adult		
Chemical	$PRG_{ca\text{-}ing}$ mg/kg	$PRG_{ca\text{-}derm}$ mg/kg	Result mg/kg	$PRG_{nc\text{-}ing}$ mg/kg	$PRG_{nc\text{-}derm}$ mg/kg	Result mg/kg	$PRG_{nc\text{-}ing}$ mg/kg	$PRG_{nc\text{-}derm}$ mg/kg	Result mg/kg
Benzo(a)anthracene	4.6E-01	1.4E+00	**3.4E-01**	5.1E+03	1.7E+04	**3.9E+03**	5.4E+04	9.9E+04	**3.5E+04**
Benzo(a)pyrene	4.6E-02	1.4E-01	**3.4E-02**	5.1E+03	1.7E+04	**3.9E+03**	5.4E+04	9.9E+04	**3.5E+04**
Benzo(b)fluoranthene	4.6E-01	1.4E+00	**3.4E-01**	5.1E+03	1.7E+04	**3.9E+03**	5.4E+04	9.9E+04	**3.5E+04**
Indeno(1,2,3-cd)pyrene	4.6E-01	1.4E+00	**3.4E-01**	5.1E+03	1.7E+04	**3.9E+03**	5.4E+04	9.9E+04	**3.5E+04**
Aroclor-1254	7.6E-01	1.9E+00	**5.4E-01**	3.4E+00	1.0E+01	**2.6E+00**	3.6E+01	6.1E+01	**2.3E+01**
Arsenic	1.7E+00	1.2E+01	**1.5E+00**	8.5E+01	7.2E+02	**7.6E+01**	9.1E+02	4.3E+03	**7.5E+02**
Thorium	N/A	N/A	**N/A**	N/A	N/A	**N/A**	N/A	N/A	**N/A**
Uranium	N/A	N/A	**N/A**	1.0E+02	N/A	**1.0E+02**	1.1E+03	N/A	**1.1E+03**

Notes

See Table 1 for equations

HQ = Hazard Quotient

The lowest non-cancer PRG between the child and adult is used as the non-cancer PRG.

N/A - Not applicable or not available.

TABLE 5. RADIOLOGICAL PRG DEVELOPMENT - INTERMEDIATE CALCULATIONS - RESIDENT - SOIL

PRG (cancer) - Radionuclide COC (pCi/g) =

$$\frac{TR}{\{ED \times IR\text{-}S \times FI \times EF \times 1E\text{-}03\ g/mg \times CSFo\} + \{ED \times ACF \times CSFe \times [(ETi \times (EFi / 365\ d/y) \times SHFi) + (ETo \times (EFo / 365\ d/y) \times SHFo)]\} + \{[(IR\text{-}V \times FI\text{-}V) + (IR\text{-}F \times FI\text{-}F)] \times UPF \times EF \times ED \times CSFf\}}$$

PRG (cancer) -
Combined adult and child populations =

$$\frac{1}{(1 / \text{Adult PRG}) + (1 / \text{Child PRG})}$$

Exposure Parameters[1]

						Ra-228+D	Th-228+D	Th-232	U-234	U-235+D	U-238+D
TR	Target Risk	1.00E-06	Risk		Plant Uptake Factor (UPF) basis:	Radium	Thorium	Thorium	Uranium	Uranium	Uranium
IR-Sa	Ingestion Rate of Soil-adult	100	mg/day		UPF (see FS Appendix C):	0.04	0.001	0.001	0.0025	0.0025	0.0025
FI	Fraction Ingested	1	unitless	Cancer Slope Factor - Soil Ingestion-Whole Pop.	CSFo (Risk/pCi) - see ROD Table G-5:	2.29E-09	8.09E-10	2.31E-10	1.58E-10	1.63E-10	2.10E-10
EF	Exposure Frequency	161	day/yr	Cancer Slope Factor - External Exposure	CSFe (Risk/pCi) - see ROD Table G-5:	4.53E-06	7.76E-06	3.42E-10	2.52E-10	5.43E-07	1.14E-07
EDa	Exposure Duration-adult	20	yr	Cancer Slope Factor - Food Ingestion	CSFf (Risk/pCi) - see ROD Table G-5:	1.43E-09	4.22E-10	1.33E-10	9.55E-11	9.76E-11	1.21E-10
ACF	Area Correction Factor	0.9	unitless								
ETia	Exposure Time - Indoors-adult	0.683	hr/hr		$adult_{ing}$ - EDa x IR-Sa x FI x EF x 1E-03 g/mg x CSFo:	7.37E-07	2.60E-07	7.44E-08	5.09E-08	5.25E-08	6.76E-08
EFia	Exposure Frequency - Indoor-adult	350	day/yr		$adult_{ext}$ - EDa x ACF x CSFe x [(ETia x (EFia / 365 d/y) x SHFi) + (EToa x (EFoa / 365 d/y) x SHFo)]:	2.44E-05	4.18E-05	1.84E-09	1.36E-09	2.92E-06	6.14E-07
Conv. Fact		365	day/yr		$adult_{food}$ - [(IR-Va x FI-Va) + (IR-Fa x FI-Fa)] x UPF x EFf x EDa x CSFf:	1.41E-05	1.04E-07	3.28E-08	5.88E-08	6.01E-08	7.45E-08
SHFi	Shielding Factor - Indoor	0.4	unitless		Adult Sum:	3.92E-05	4.22E-05	1.09E-07	1.11E-07	3.04E-06	7.56E-07
EToa	Exposure Time - Outdoors-adult	0.073	hr/hr								
EFoa	Exposure Frequency - Outdoor-adult	186	day/yr								
SHFo	Shielding Factor - Outdoor	1	unitless								
IR-Va	Ingestion Rate of Vegetables-adult	800	g/day	10 g/kg BW/day x 80 kg BW							
FI-Va	Fraction Vegetables Homegrown-adult	0.038	unitless								
IR-Fa	Ingestion Rate of Fruit-adult	960	g/day	12 g/kg BW/day x 80 kg BW							
FI-Fa	Fraction Fruits Homegrown-adult	0.005	unitless								
EFf	Exposure Frequency fruits/vegetables	350	day/yr								
TR	Target Risk	1.00E-06	Risk								
IR-Sc	Ingestion Rate of Soil-child	200	mg/day								
FI	Fraction Ingested	1	unitless								
EF	Exposure Frequency	161	day/yr								
EDc	Exposure Duration-child	6	yr								
ACF	Area Correction Factor	0.9	unitless								
ETic	Exposure Time - Indoors-child	0.833	hr/hr		$child_{ing}$ - EDc x IR-Sc x FI x EF x 1E-03 g/mg x CSFo:	4.42E-07	1.56E-07	4.46E-08	3.05E-08	3.15E-08	4.06E-08
EFic	Exposure Frequency - Indoor-child	350	day/yr		$child_{ext}$ - EDc x ACF x CSFe x [(ETic x (EFic / 365 d/y) x SHFi) + (EToc x (EFoc / 365 d/y) x SHFo)]:	9.37E-06	1.61E-05	7.08E-10	5.21E-10	1.12E-06	2.36E-07
Conv. Fact		365	day/yr		$child_{food}$ - [(IR-Vc x FI-Vc) + (IR-Fc x FI-Fc)] x UPF x EFf x EDc x CSFf:	7.93E-07	5.85E-09	1.84E-09	3.31E-09	3.38E-09	4.19E-09
SHFi	Shielding Factor - Indoor	0.4	unitless		Child Sum:	1.06E-05	1.62E-05	4.72E-08	3.44E-08	1.16E-06	2.81E-07
EToc	Exposure Time - Outdoors-child	0.125	hr/hr								
EFoc	Exposure Frequency - Outdoor-child	186	day/yr								
SHFo	Shielding Factor - Outdoor	1	unitless								
IR-Vc	Ingestion Rate of Vegetables-child	150	g/day	10 g/kg BW/day x 15 kg BW							
FI-Vc	Fraction Vegetables Homegrown-child	0.038	unitless								
IR-Fc	Ingestion Rate of Fruit-child	180	g/day	12 g/kg BW/day x 15 kg BW							
FI-Fc	Fraction Fruits Homegrown-child	0.005	unitless								
EFf	Exposure Frequency fruits/vegetables	350	day/yr								
					Activity-Based PRG (pCi/g) = TR/(Adult Sum+Child Sum):	2.0E-02	1.7E-02	6.4E+00	6.9E+00	2.4E-01	9.6E-01

Notes

1 - See FS Appendix C except for highlighted values (see Attachment A)

Table 6 - Derivation of Site-Specific Human Health Preliminary Remediation Goals for Radionucildes - Soil - Resident
Nuclear Metals Superfund Site

Depleted Uranium					
Isotope	Specific Activity (pCi/g)	Receptor Scenario:	Resident		
			PRG - Activity (pCi/g)	PRG - Mass (mg/kg)	Activity-Based PRG based on PRG - Mass and Mass Abundance (pCi/g)
		Total Uranium PRG:		**2.7E+00**	
		Mass Abundance			
U-238+D	3.35E+05	99.7982%	9.6E-01	2.9E+00	9.0E-01
U-235+D	2.16E+06	0.2009%	2.4E-01	5.5E+01	1.2E-02
U-234	6.24E+09	0.0009%	6.9E+00	1.2E+02	1.5E-01
				U-Total:	1.1E+00

Thorium (as Th-232)				
Isotope	Specific Activity (pCi/g)	Receptor Scenario:	Resident	
			PRG - Activity (pCi/g)	PRG - Mass (mg/kg)
		Total Thorium PRG:	**9.2E-03**	**8.4E-02**
		Mass Abundance		
Th-232	1.10E+05	100%	6.4E+00	5.8E+01
Ra-228+D	PRG is for Th-232 mass		2.0E-02	1.8E-01
Th-228+D	PRG is for Th-232 mass		1.7E-02	1.6E-01

PRG - Activity: PRGs for each isotope, expressed as actibivity, are calculated using equations provided in Table 5.

PRG - Mass: Calculated for each isotope as PRG-Activity x 1E+06 /specific activity / mass abundance

PRG - Mass (total): For total uranium and total throium calculated as: 1 / [(1/PRG-Mass for isotope) + (1/PRG-Mass for isotope) + (1/PRG-Mass for isotope)]

PRG - Activity (total): For thorium is calculated as: Activity PRG for Th-232 x Th mass PRG / Th-232 mass PRG. This results in a mass to activity conversion factor of 9.1 mg/kg per pCi/g

mg/Kg = milligram per kilogram

pCi/g = picoCurie per gram

B.4 – SOIL – RECREATIONAL VISITOR

TABLE 1

VALUES USED FOR DAILY INTAKE CALCULATIONS - RECREATIONAL VISITOR

REASONABLE MAXIMUM EXPOSURE

NUCLEAR METALS SUPERFUND SITE

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

Exposure Route	Receptor Population	Receptor Age	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion/Dermal	Recreational Visitor	Young Child/Adult					See FS Appendix C, except where noted	
								See attached
			THQ	Target Hazard Quotient	1	- -		
			$AT\text{-}N_C$	Averaging Time (Non-Cancer) - child	2,190	days		
			ED_C	Exposure Duration - child	6	years		
			BW_C	Body Weight - child	15	kg		
			EF_C	Exposure Frequency - child	80	days/year		
			IR_C	Ingestion Rate of Soil - child	200	mg/day		
			CF	Conversion Factor	0.000001	kg/mg		
			SA_C	Surface Area - child	2,373	cm^2	See Attachment A	
			AF_C	Adherence Factor - child	0.20	mg/cm^2-day		
			ABS	Dermal Absorption Fraction	see FS Appendix C	- -		
			$AT\text{-}N_A$	Averaging Time (Non-Cancer) - adult	7,300	days	See Attachment A	
			ED_A	Exposure Duration - adult	20	years	See Attachment A	
			BW_A	Body Weight - adult	80	kg	See Attachment A	
			EF_A	Exposure Frequency - adult	80	days/year		
			IR_A	Ingestion Rate of Soil - adult	100	mg/day		
			SA_A	Surface Area - adult	6,032	cm^2	See Attachment A	
			AF_A	Adherence Factor - adult	0.07	mg/cm^2-day		
			RBA	Relative Bioavailability	0.6 for Arsenic/1 for all other analytes	- -		
			TR	Target ILCR	10^{-6} to 10^{-4}	- -		
			AT-C	Averaging Time (Cancer)	25,550	days		
			RfD_O	Oral Reference Dose	see ROD Table G-6	mg/kg-day		
			RfD_D	Dermal Reference Dose	see ROD Table G-6	mg/kg-day		
			SF_O	Oral Slope Factor	see ROD Table G-5	$(mg/kg\text{-}day)^{-1}$		
			SF_D	Dermal Slope Factor	see ROD Table G-5	$(mg/kg\text{-}day)^{-1}$		
			$ED_{0\text{-}2}$	Exposure Duration - 0-2 yrs	2	years		
			$ED_{2\text{-}6}$	Exposure Duration - 2-6 yrs	4	years		
			$ED_{6\text{-}16}$	Exposure Duration - 6-16 yrs	10	years		
			$ED_{16\text{-}26}$	Exposure Duration - 16-26 yrs+	10	years	See Attachment A	

Intake Equation/
Model Name

Preliminary Remediation Goal (PRG) non-cancer:

Ingestion - child

$$PRG_{nc\text{-}ing}\ (mg/kg) = \frac{THQ \times AT\text{-}N_C \times RfD_o \times BW_C}{EF_C \times ED_C \times IR_C \times CF \times RBA}$$

Dermal - child

$$PRG_{nc\text{-}derm}\ (mg/kg) = \frac{THQ \times AT\text{-}N_C \times RfD_D \times BW_C}{EF_C \times ED_C \times SA_C \times AF_C \times ABS \times CF}$$

Total - child

$$PRG_{nc\text{-}tot}\ (mg/kg) = \frac{1}{1/PRG_{nc\text{-}ing} + 1/PRG_{nc\text{-}derm}}$$

Ingestion - adult

$$PRG_{nc\text{-}ing}\ (mg/kg) = \frac{THQ \times AT\text{-}N_A \times RfD_o \times BW_A}{EF_A \times ED_A \times IR_A \times CF \times RBA}$$

Dermal - adult

$$PRG_{nc\text{-}derm}\ (mg/kg) = \frac{THQ \times AT\text{-}N_A \times RfD_D \times BW_A}{EF_A \times ED_A \times SA_A \times AF_A \times ABS \times CF}$$

Total - adult

$$PRG_{nc\text{-}tot}\ (mg/kg) = \frac{1}{1/PRG_{nc\text{-}ing} + 1/PRG_{nc\text{-}derm}}$$

Preliminary Remediation Goal (PRG) cancer:

Ingestion

$$PRG_{ca\text{-}ing}\ (mg/kg) = \frac{TR \times AT\text{-}C}{SF_o \times IFS_{adj} \times CF \times RBA}$$

$$IFS_{adj}\ (mg/kg) = \frac{ED_C \times EF_C \times IR_C}{BW_C} + \frac{ED_A \times EF_A \times IR_A}{BW_A}$$

Dermal

$$PRG_{ca\text{-}derm}\ (mg/kg) = \frac{TR \times AT\text{-}C}{SF_D \times DFS_{adj} \times ABS \times CF}$$

$$DFS_{adj}\ (mg/kg) = \frac{ED_C \times EF_C \times SA_C \times AF_C}{BW_C} + \frac{ED_A \times EF_A \times SA_A \times AF_A}{BW_A}$$

Total

$$PRG_{ca\text{-}tot}\ (mg/kg) = \frac{1}{1/PRG_{ca\text{-}ing} + 1/PRG_{ca\text{-}derm}}$$

Preliminary Remediation Goal (PRG) mutagenic:

Ingestion

$$PRG_{mu\text{-}ing}\ (mg/kg) = \frac{TR \times AT\text{-}C}{SF_o \times IFSM_{adj} \times CF \times RBA}$$

$$IFSM_{adj}\ (mg/kg) = \frac{ED_{0\text{-}2} \times EF_C \times IR_C \times 10}{BW_C} + \frac{ED_{2\text{-}6} \times EF_C \times IR_C \times 3}{BW_C} + \frac{ED_{6\text{-}16} \times EF_A \times IR_A \times 3}{BW_A} + \frac{ED_{16\text{-}26} \times EF_A \times IR_A}{BW_A}$$

Dermal

$$PRG_{mu\text{-}derm}\ (mg/kg) = \frac{TR \times AT\text{-}C}{SF_D \times DFSM_{adj} \times ABS \times CF}$$

$$DFSM_{adj}\ (mg/kg) = \frac{ED_{0\text{-}2} \times EF_C \times AF_C \times SA_C \times 10}{BW_C} + \frac{ED_{2\text{-}6} \times EF_C \times AF_C \times SA_C \times 3}{BW_C} + \frac{ED_{6\text{-}16} \times EF_A \times AF_A \times SA_A \times 3}{BW_A} + \frac{ED_{16\text{-}26} \times EF_A \times AF_A \times SA_A}{BW_A}$$

Total

$$PRG_{mu\text{-}tot}\ (mg/kg) = \frac{1}{1/PRG_{mu\text{-}ing} + 1/PRG_{mu\text{-}derm}}$$

Notes

IFS_{adj} - age-adjusted soil ingestion factor

DFS_{adj} - age-adjusted soil dermal factor

$IFSM_{adj}$ - mutagenic age-adjusted soil ingestion factor

$DFSM_{adj}$ - mutagenic age-adjusted soil dermal factor

TABLE 2. INTERMEDIATE RECREATIONAL VISITOR SOIL PRG CALCULATIONS - INGESTION

Chemical	Mutagenic?	THQ	$AT\text{-}N_C$ days	$AT\text{-}N_A$ days	RfD_o mg/kg-day	BW_C kg	BW_A kg	EF_C days/yr	EF_A days/yr	ED_C yrs	ED_A yrs	IR_C mg/day	IR_A mg/day	CF kg/mg	RBA	TR	AT-C days	SF_o $(mg/kg\text{-}day)^{-1}$	IFS_{adj} mg/kg	$IFSM_{adj}$ mg/kg	$PRG_{ca\text{-}ing}$ mg/kg	$PRG_{nc\text{-}ing\text{-}child}$ mg/kg	$PRG_{nc\text{-}ing\text{-}adult}$ mg/kg
Benzo(a)anthracene	Y	1	2190	7300	3E-02	15	80	80	80	6	20	200	100	0.000001	1	1E-06	25550	7.3E-01	8400	38133.3333	**9.2E-01**	**1.0E+04**	**1.1E+05**
Benzo(a)pyrene	Y	1	2190	7300	3E-02	15	80	80	80	6	20	200	100	0.000001	1	1E-06	25550	7.3E+00	8400	38133.3333	**9.2E-02**	**1.0E+04**	**1.1E+05**
Benzo(b)fluoranthene	Y	1	2190	7300	3E-02	15	80	80	80	6	20	200	100	0.000001	1	1E-06	25550	7.3E-01	8400	38133.3333	**9.2E-01**	**1.0E+04**	**1.1E+05**
Indeno(1,2,3-cd)pyrene	Y	1	2190	7300	3E-02	15	80	80	80	6	20	200	100	0.000001	1	1E-06	25550	7.3E-01	8400	38133.3333	**9.2E-01**	**1.0E+04**	**1.1E+05**
Aroclor-1254		1	2190	7300	2E-05	15	80	80	80	6	20	200	100	0.000001	1	1E-06	25550	2.0E+00	8400	38133.3333	**1.5E+00**	**6.8E+00**	**7.3E+01**
Arsenic		1	2190	7300	3E-04	15	80	80	80	6	20	200	100	0.000001	0.6	1E-06	25550	1.5E+00	8400	38133.3333	**3.4E+00**	**1.7E+02**	**1.8E+03**
Thorium		1	2190	7300	N/A	15	80	80	80	6	20	200	100	0.000001	1	1E-06	25550	NA	8400	38133.3333	**N/A**	**N/A**	**N/A**
Uranium		1	2190	7300	6E-04	15	80	80	80	6	20	200	100	0.000001	1	1E-06	25550	NA	8400	38133.3333	**N/A**	**2.1E+02**	**2.2E+03**

Notes

See Table 1 for input parameters and equations

N/A - Not applicable or not available.

TABLE 3. INTERMEDIATE RECREATIONAL VISITOR SOIL PRG CALCULATIONS - DERMAL

Chemical	Mutagenic?	THQ	$AT\text{-}N_C$ days	$AT\text{-}N_A$ days	RfD_D mg/kg-day	BW_C kg	BW_A kg	EF_C days/yr	EF_A days/yr	ED_C yrs	ED_A yrs	SA_C cm^2	SA_A cm^2	AF_C mg/cm^2-day	AF_A mg/cm^2-day	ABS	CF kg/mg	TR	AT-C days	SF_D $(mg/kg\text{-}day)^{-1}$	DFS_{adj} mg/kg	$DFSM_{adj}$ mg/kg	$PRG_{ca\text{-}derm}$ mg/kg	$PRG_{nc\text{-}derm\text{-}child}$ mg/kg	$PRG_{nc\text{-}derm\text{-}adult}$ mg/kg
Benzo(a)anthracene	Y	1	2190	7300	3E-02	15	80	80	80	6	20	2373	6032	0.2	0.07	0.13	0.000001	1E-06	25550	7.3E-01	23632	97888	**2.8E+00**	**3.3E+04**	**2.0E+05**
Benzo(a)pyrene	Y	1	2190	7300	3E-02	15	80	80	80	6	20	2373	6032	0.2	0.07	0.13	0.000001	1E-06	25550	7.3E+00	23632	97888	**2.8E-01**	**3.3E+04**	**2.0E+05**
Benzo(b)fluoranthene	Y	1	2190	7300	3E-02	15	80	80	80	6	20	2373	6032	0.2	0.07	0.13	0.000001	1E-06	25550	7.3E-01	23632	97888	**2.8E+00**	**3.3E+04**	**2.0E+05**
Indeno(1,2,3-cd)pyrene	Y	1	2190	7300	3E-02	15	80	80	80	6	20	2373	6032	0.2	0.07	0.13	0.000001	1E-06	25550	7.3E-01	23632	97888	**2.8E+00**	**3.3E+04**	**2.0E+05**
Aroclor-1254		1	2190	7300	2E-05	15	80	80	80	6	20	2373	6032	0.2	0.07	0.14	0.000001	1E-06	25550	2.0E+00	23632	97888	**3.9E+00**	**2.1E+01**	**1.2E+02**
Arsenic		1	2190	7300	3E-04	15	80	80	80	6	20	2373	6032	0.2	0.07	0.03	0.000001	1E-06	25550	1.5E+00	23632	97888	**2.4E+01**	**1.4E+03**	**8.6E+03**
Thorium		1	2190	7300	N/A	15	80	80	80	6	20	2373	6032	0.2	0.07	NA	0.000001	1E-06	25550	NA	23632	97888	**N/A**	**N/A**	**N/A**
Uranium		1	2190	7300	6E-04	15	80	80	80	6	20	2373	6032	0.2	0.07	NA	0.000001	1E-06	25550	NA	23632	97888	**N/A**	**N/A**	**N/A**

Notes

See Table 1 for input parameters and equations

N/A - Not applicable or not available.

TABLE 4. INTERMEDIATE RECREATIONAL VISITOR SOIL PRG CALCULATIONS - RESULTS

	Carcinogenic Risk Level = 1E-06			Non-Cancer HQ = 1 - Child			Non-Cancer HQ = 1 - Adult		
Chemical	$PRG_{ca\text{-}ing}$ mg/kg	$PRG_{ca\text{-}derm}$ mg/kg	Result mg/kg	$PRG_{nc\text{-}ing}$ mg/kg	$PRG_{nc\text{-}derm}$ mg/kg	Result mg/kg	$PRG_{nc\text{-}ing}$ mg/kg	$PRG_{nc\text{-}derm}$ mg/kg	Result mg/kg
Benzo(a)anthracene	9.2E-01	2.8E+00	**6.9E-01**	1.0E+04	3.3E+04	**7.8E+03**	1.1E+05	2.0E+05	**7.1E+04**
Benzo(a)pyrene	9.2E-02	2.8E-01	**6.9E-02**	1.0E+04	3.3E+04	**7.8E+03**	1.1E+05	2.0E+05	**7.1E+04**
Benzo(b)fluoranthene	9.2E-01	2.8E+00	**6.9E-01**	1.0E+04	3.3E+04	**7.8E+03**	1.1E+05	2.0E+05	**7.1E+04**
Indeno(1,2,3-cd)pyrene	9.2E-01	2.8E+00	**6.9E-01**	1.0E+04	3.3E+04	**7.8E+03**	1.1E+05	2.0E+05	**7.1E+04**
Aroclor-1254	1.5E+00	3.9E+00	**1.1E+00**	6.8E+00	2.1E+01	**5.1E+00**	7.3E+01	1.2E+02	**4.6E+01**
Arsenic	3.4E+00	2.4E+01	**3.0E+00**	1.7E+02	1.4E+03	**1.5E+02**	1.8E+03	8.6E+03	**1.5E+03**
Thorium	N/A	N/A	**N/A**	N/A	N/A	**N/A**	N/A	N/A	**N/A**
Uranium	N/A	N/A	**N/A**	2.1E+02	N/A	**2.1E+02**	2.2E+03	N/A	**2.2E+03**

Notes

See Table 1 for equations

HQ = Hazard Quotient

The lowest non-cancer PRG between the child and adult is used as the non-cancer PRG.

N/A - Not applicable or not available.

TABLE 5. RADIOLOGICAL PRG DEVELOPMENT - INTERMEDIATE CALCULATIONS - RECREATIONAL VISITOR - SOIL

PRG (cancer) - Radionuclide COC (pCi/g) =

$$\frac{TR}{\{ED \times IR\text{-}S \times FI \times EF \times 1E\text{-}03\ g/mg \times CSFo\} + \{ED \times ACF \times CSFe \times [(ETi \times (EFi / 365\ d/y) \times SHFi) + (ETo \times (EFo / 365\ d/y) \times SHFo)]\} + \{[(IR\text{-}V \times FI\text{-}V) + (IR\text{-}F \times FI\text{-}F)] \times UPF \times EF \times ED \times CSFf\}}$$

PRG (cancer) -
Combined adult and child populations =

$$\frac{1}{(1 / \text{Adult PRG}) + (1 / \text{Child PRG})}$$

Exposure Parameters[1]

					Ra-228+D	Th-228+D	Th-232	U-234	U-235+D	U-238+D
TR	Target Risk	1.00E-06	Risk							
IR-Sa	Ingestion Rate of Soil-adult	100	mg/day							
FI	Fraction Ingested	1	unitless	Cancer Slope Factor - Soil Ingestion-Whole Pop. CSFo (Risk/pCi) - see ROD Table G-5:	2.29E-09	8.09E-10	2.31E-10	1.58E-10	1.63E-10	2.10E-10
EF	Exposure Frequency	80	day/yr	Cancer Slope Factor - External Exposure CSFe (Risk/pCi) - see ROD Table G-5:	4.53E-06	7.76E-06	3.42E-10	2.52E-10	5.43E-07	1.14E-07
EDa	Exposure Duration-adult	20	yr							
ACF	Area Correction Factor	0.9	unitless							
ETia	Exposure Time - Indoors-adult	0	hr/hr	$adult_{ing}$ - EDa x IR-Sa x FI x EF x 1E-03 g/mg x CSFo:	3.66E-07	1.29E-07	3.70E-08	2.53E-08	2.61E-08	3.36E-08
EFia	Exposure Frequency - Indoor-adult	0	day/yr	$adult_{ext}$ - EDa x ACF x CSFe x [(ETia x (EFia / 365 d/y) x SHFi) + (EToa x (EFoa / 365 d/y) x SHFo)]:	2.23E-06	3.83E-06	1.69E-10	1.24E-10	2.68E-07	5.62E-08
Conv. Fact		365	day/yr							
SHFi	Shielding Factor - Indoor	0	unitless	Adult Sum:	2.60E-06	3.96E-06	3.71E-08	2.54E-08	2.94E-07	8.98E-08
EToa	Exposure Time - Outdoors-adult	0.125	hr/hr							
EFoa	Exposure Frequency - Outdoor-adult	80	day/yr							
SHFo	Shielding Factor - Outdoor	1	unitless							

TR	Target Risk	1.00E-06	Risk							
IR-Sc	Ingestion Rate of Soil-child	200	mg/day							
FI	Fraction Ingested	1	unitless							
EF	Exposure Frequency	80	day/yr							
EDc	Exposure Duration-child	6	yr							
ACF	Area Correction Factor	0.9	unitless							
ETic	Exposure Time - Indoors-child	0	hr/hr	$child_{ing}$ - EDc x IR-Sc x FI x EF x 1E-03 g/mg x CSFo:	2.20E-07	7.77E-08	2.22E-08	1.52E-08	1.56E-08	2.02E-08
EFic	Exposure Frequency - Indoor-child	0	day/yr	$child_{ext}$ - EDc x ACF x CSFe x [(ETic x (EFic / 365 d/y) x SHFi) + (EToc x (EFoc / 365 d/y) x SHFo)]:	6.70E-07	1.15E-06	5.06E-11	3.73E-11	8.03E-08	1.69E-08
Conv. Fact		365	day/yr							
SHFi	Shielding Factor - Indoor	0	unitless	Child Sum:	8.90E-07	1.23E-06	2.22E-08	1.52E-08	9.60E-08	3.70E-08
EToc	Exposure Time - Outdoors-child	0.125	hr/hr							
EFoc	Exposure Frequency - Outdoor-child	80	day/yr							
SHFo	Shielding Factor - Outdoor	1	unitless							

Activity-Based PRG (pCi/g) = TR/(Adult Sum+Child Sum):	2.9E-01	1.9E-01	1.7E+01	2.5E+01	2.6E+00	7.9E+00

Notes

1 - See FS Appendix C except for highlighted values (see Attachment A)

Table 6 - Derivation of Site-Specific Human Health Preliminary Remediation Goals for Radionucildes - Soil - Recreational Visitor
Nuclear Metals Superfund Site

			Depleted Uranium		
Isotope	Specific Activity (pCi/g)	Receptor Scenario:	Recreational Visitor		
			PRG - Activity (pCi/g)	PRG - Mass (mg/kg)	Activity-Based PRG based on PRG - Mass and Mass Abundance (pCi/g)
		Total Uranium PRG:		**2.2E+01**	
		Mass Abundance			
U-238+D	3.35E+05	99.7982%	7.9E+00	2.4E+01	7.2E+00
U-235+D	2.16E+06	0.2009%	2.6E+00	5.9E+02	9.4E-02
U-234	6.24E+09	0.0009%	2.5E+01	4.4E+02	1.2E+00
				U-Total:	8.5E+00

			Thorium (as Th-232)	
Isotope	Specific Activity (pCi/g)	Receptor Scenario:	Recreational Visitor	
			PRG - Activity (pCi/g)	PRG - Mass (mg/kg)
		Total Thorium PRG:	**1.1E-01**	**1.0E+00**
		Mass Abundance		
Th-232	1.10E+05	100%	1.7E+01	1.5E+02
Ra-228+D	PRG is for Th-232 mass		2.9E-01	2.6E+00
Th-228+D	PRG is for Th-232 mass		1.9E-01	1.8E+00

PRG - Activity: PRGs for each isotope, expressed as actibivity, are calculated using equations provided in Table 5.

PRG - Mass: Calculated for each isotope as PRG-Activity x 1E+06 /specific activity / mass abundance

PRG - Mass (total): For total uranium and total throium calculated as: 1 / [(1/PRG-Mass for isotope) + (1/PRG-Mass for isotope) + (1/PRG-Mass for isotope)]

PRG - Activity (total): For thorium is calculated as: Activity PRG for Th-232 x Th mass PRG / Th-232 mass PRG. This results in a mass to activity conversion factor of 9.1 mg/kg per pCi/g

mg/Kg = milligram per kilogram

pCi/g = picoCurie per gram

B.5 – SOIL – INDOOR COMMERCIAL/INDUSTRIAL WORKER

TABLE 1

VALUES USED FOR DAILY INTAKE CALCULATIONS - COMMERCIAL/INDUSTRIAL WORKER - INDOOR

REASONABLE MAXIMUM EXPOSURE

NUCLEAR METALS SUPERFUND SITE

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

Exposure Route	Receptor Population	Receptor Age	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion/Dermal	Comm. Worker	Adult					See FS Appendix C, except where noted	See attached
			THQ	Target Hazard Quotient	1	- -		
			CF	Conversion Factor	0.000001	kg/mg		
			ABS	Dermal Absorption Fraction	see FS Appendix C	- -		
			$AT\text{-}N_A$	Averaging Time (Non-Cancer) - adult	9,125	days		
			ED_A	Exposure Duration - adult	25	years		
			BW_A	Body Weight - adult	80	kg	See Attachment A	
			EF_A	Exposure Frequency - adult	161	days/year		
			IR_A	Ingestion Rate of Soil - adult	50	mg/day		
			SA_A	Surface Area - adult	3,527	cm^2	See Attachment A	
			AF_A	Adherence Factor - adult	0.02	mg/cm^2-day	(site specific)	
			RBA	Relative Bioavailability	0.6 for Arsenic/1 for all other analytes	- -		
			TR	Target ILCR	10^{-6} to 10^{-4}	- -		
			AT-C	Averaging Time (Cancer)	25,550	days		
			RfD_O	Oral Reference Dose	see ROD Table G-6	mg/kg-day		
			RfD_D	Dermal Reference Dose	see ROD Table G-6	mg/kg-day		
			SF_O	Oral Slope Factor	see ROD Table G-5	$(mg/kg\text{-}day)^{-1}$		
			SF_D	Dermal Slope Factor	see ROD Table G-5	$(mg/kg\text{-}day)^{-1}$		

Intake Equation/
Model Name

Preliminary Remediation Goal (PRG) non-cancer:

Ingestion - adult

$$PRG_{nc\text{-}ing}\ (mg/kg) = \frac{THQ \times AT\text{-}N_A \times RfD_o \times BW_A}{EF_A \times ED_A \times IR_A \times CF \times RBA}$$

Dermal - adult

$$PRG_{nc\text{-}derm}\ (mg/kg) = \frac{THQ \times AT\text{-}N_A \times RfD_D \times BW_A}{EF_A \times ED_A \times SA_A \times AF_A \times ABS \times CF}$$

Total - adult

$$PRG_{nc\text{-}tot}\ (mg/kg) = \frac{1}{1/PRG_{nc\text{-}ing} + 1/PRG_{nc\text{-}derm}}$$

Preliminary Remediation Goal (PRG) cancer:

Ingestion

$$PRG_{ca\text{-}ing}\ (mg/kg) = \frac{TR \times AT\text{-}C}{SF_o \times IFS_{adj} \times CF \times RBA}$$

$$IFS_{adj}\ (mg/kg) = \frac{ED_A \times EF_A \times IR_A}{BW_A}$$

Dermal

$$PRG_{ca\text{-}derm}\ (mg/kg) = \frac{TR \times AT\text{-}C}{SF_D \times DFS_{adj} \times ABS \times CF}$$

$$DFS_{adj}\ (mg/kg) = \frac{ED_A \times EF_A \times SA_A \times AF_A}{BW_A}$$

Total

$$PRG_{ca\text{-}tot}\ (mg/kg) = \frac{1}{1/PRG_{ca\text{-}ing} + 1/PRG_{ca\text{-}derm}}$$

Notes

IFS_{adj} - age-adjusted soil ingestion factor

DFS_{adj} - age-adjusted soil dermal factor

TABLE 2. INTERMEDIATE COMMERCIAL/INDUSTRIAL WORKER (INDOOR) SOIL PRG CALCULATIONS - INGESTION

Chemical	Mutagenic?	THQ	$AT\text{-}N_A$ days	RfD_o mg/kg-day	BW_A kg	EF_A days/yr	ED_A yrs	IR_A mg/day	CF kg/mg	RBA	TR	AT-C days	SF_o $(mg/kg\text{-}day)^{-1}$	IFS_{adj} mg/kg	$PRG_{ca\text{-}ing}$ mg/kg	$PRG_{nc\text{-}ing\text{-}adult}$ mg/kg
Benzo(a)anthracene	Y	1	9125	3E-02	80	161	25	50	0.000001	1	1E-06	25550	7.3E-01	2515.625	**1.4E+01**	**1.1E+05**
Benzo(a)pyrene	Y	1	9125	3E-02	80	161	25	50	0.000001	1	1E-06	25550	7.3E+00	2515.625	**1.4E+00**	**1.1E+05**
Benzo(b)fluoranthene	Y	1	9125	3E-02	80	161	25	50	0.000001	1	1E-06	25550	7.3E-01	2515.625	**1.4E+01**	**1.1E+05**
Indeno(1,2,3-cd)pyrene	Y	1	9125	3E-02	80	161	25	50	0.000001	1	1E-06	25550	7.3E-01	2515.625	**1.4E+01**	**1.1E+05**
Aroclor-1254		1	9125	2E-05	80	161	25	50	0.000001	1	1E-06	25550	2.0E+00	2515.625	**5.1E+00**	**7.3E+01**
Arsenic		1	9125	3E-04	80	161	25	50	0.000001	0.6	1E-06	25550	1.5E+00	2515.625	**1.1E+01**	**1.8E+03**
Thorium		1	9125	N/A	80	161	25	50	0.000001	1	1E-06	25550	NA	2515.625	**N/A**	**N/A**
Uranium		1	9125	6E-04	80	161	25	50	0.000001	1	1E-06	25550	NA	2515.625	**N/A**	**2.2E+03**

Notes

See Table 1 for input parameters and equations

N/A - Not applicable or not available.

TABLE 3. INTERMEDIATE COMMERCIAL/INDUSTRIAL WORKER (INDOOR) SOIL PRG CALCULATIONS - DERMAL

Chemical	Mutagenic?	THQ	$AT\text{-}N_A$ days	RfD_D mg/kg-day	BW_A kg	EF_A days/yr	ED_A yrs	SA_A cm^2	AF_A mg/cm^2-day	ABS	CF kg/mg	TR	AT-C days	SF_D $(mg/kg\text{-}day)^{-1}$	DFS_{adj} mg/kg	$PRG_{ca\text{-}derm}$ mg/kg	$PRG_{nc\text{-}derm\text{-}adult}$ mg/kg
Benzo(a)anthracene	Y	1	9125	3E-02	80	161	25	3527	0.02	0.13	0.000001	1E-06	25550	7.3E-01	3549	**7.6E+01**	**5.9E+05**
Benzo(a)pyrene	Y	1	9125	3E-02	80	161	25	3527	0.02	0.13	0.000001	1E-06	25550	7.3E+00	3549	**7.6E+00**	**5.9E+05**
Benzo(b)fluoranthene	Y	1	9125	3E-02	80	161	25	3527	0.02	0.13	0.000001	1E-06	25550	7.3E-01	3549	**7.6E+01**	**5.9E+05**
Indeno(1,2,3-cd)pyrene	Y	1	9125	3E-02	80	161	25	3527	0.02	0.13	0.000001	1E-06	25550	7.3E-01	3549	**7.6E+01**	**5.9E+05**
Aroclor-1254		1	9125	2E-05	80	161	25	3527	0.02	0.14	0.000001	1E-06	25550	2.0E+00	3549	**2.6E+01**	**3.7E+02**
Arsenic		1	9125	3E-04	80	161	25	3527	0.02	0.03	0.000001	1E-06	25550	1.5E+00	3549	**1.6E+02**	**2.6E+04**
Thorium		1	9125	N/A	80	161	25	3527	0.02	NA	0.000001	1E-06	25550	NA	3549	**N/A**	**N/A**
Uranium		1	9125	6E-04	80	161	25	3527	0.02	NA	0.000001	1E-06	25550	NA	3549	**N/A**	**N/A**

Notes

See Table 1 for input parameters and equations

N/A - Not applicable or not available.

TABLE 4. INTERMEDIATE COMMERCIAL/INDUSTRIAL WORKER (INDOOR) SOIL PRG CALCULATIONS - RESULTS

	Carcinogenic Risk Level = 1E-06			Non-Cancer HQ = 1 - Adult		
Chemical	$PRG_{ca\text{-}ing}$ mg/kg	$PRG_{ca\text{-}derm}$ mg/kg	Result mg/kg	$PRG_{nc\text{-}ing}$ mg/kg	$PRG_{nc\text{-}derm}$ mg/kg	Result mg/kg
Benzo(a)anthracene	1.4E+01	7.6E+01	**1.2E+01**	1.1E+05	5.9E+05	**9.2E+04**
Benzo(a)pyrene	1.4E+00	7.6E+00	**1.2E+00**	1.1E+05	5.9E+05	**9.2E+04**
Benzo(b)fluoranthene	1.4E+01	7.6E+01	**1.2E+01**	1.1E+05	5.9E+05	**9.2E+04**
Indeno(1,2,3-cd)pyrene	1.4E+01	7.6E+01	**1.2E+01**	1.1E+05	5.9E+05	**9.2E+04**
Aroclor-1254	5.1E+00	2.6E+01	**4.2E+00**	7.3E+01	3.7E+02	**6.1E+01**
Arsenic	1.1E+01	1.6E+02	**1.1E+01**	1.8E+03	2.6E+04	**1.7E+03**
Thorium	N/A	N/A	**N/A**	N/A	N/A	**N/A**
Uranium	N/A	N/A	**N/A**	2.2E+03	N/A	**2.2E+03**

Notes

See Table 1 for equations

HQ = Hazard Quotient

N/A - Not applicable or not available.

TABLE 5. RADIOLOGICAL PRG DEVELOPMENT - INTERMEDIATE CALCULATIONS - INDOOR COMMERCIAL/INDUSTRIAL WORKER - SOIL

PRG (cancer) - Radionuclide COC (pCi/g) =

$$\frac{TR}{\{ED \times IR\text{-}S \times FI \times EF \times 1E\text{-}03\ g/mg \times CSFo\} + \{ED \times ACF \times CSFe \times [(ETi \times (EFi / 365\ d/y) \times SHFi) + (ETo \times (EFo / 365\ d/y) \times SHFo)]\} + \{[(IR\text{-}V \times FI\text{-}V) + (IR\text{-}F \times FI\text{-}F)] \times UPF \times EF \times ED \times CSFf\}}$$

Exposure Parameters[1]

TR	Target Risk	1.00E-06	Risk
IR-Sa	Ingestion Rate of Soil-adult	50	mg/day
FI	Fraction Ingested	1	unitless
EF	Exposure Frequency	161	day/yr
EDa	Exposure Duration-adult	25	yr
ACF	Area Correction Factor	0.9	unitless
ETia	Exposure Time - Indoors-adult	0.33	hr/hr
EFia	Exposure Frequency - Indoor-adult	250	day/yr
Conv. Fact		365	day/yr
SHFi	Shielding Factor - Indoor	0.4	unitless
EToa	Exposure Time - Outdoors-adult	0.042	hr/hr
EFoa	Exposure Frequency - Outdoor-adult	186	day/yr
SHFo	Shielding Factor - Outdoor	1	unitless

		Ra-228+D	Th-228+D	Th-232	U-234	U-235+D	U-238+D
Cancer Slope Factor - Soil Ingestion-Whole Pop.	CSFo (Risk/pCi) - see ROD Table G-5:	6.70E-10	1.62E-10	8.47E-11	5.11E-11	5.03E-11	5.62E-11
Cancer Slope Factor - External Exposure	CSFe (Risk/pCi) - see ROD Table G-5:	4.53E-06	7.76E-06	3.42E-10	2.52E-10	5.43E-07	1.14E-07
	$adult_{ing}$ - EDa x IR-Sa x FI x EF x 1E-03 g/mg x CSFo:	1.35E-07	3.26E-08	1.70E-08	1.03E-08	1.01E-08	1.13E-08
	$adult_{ext}$ - EDa x ACF x CSFe x [(ETia x (EFia / 365 d/y) x SHFi) + (EToa x (EFoa / 365 d/y) x SHFo)]:	1.14E-05	1.95E-05	8.60E-10	6.34E-10	1.37E-06	2.87E-07
	Adult Sum:	1.15E-05	1.96E-05	1.79E-08	1.09E-08	1.38E-06	2.98E-07
	Activity-Based PRG (pCi/g) = TR/Sum:	8.7E-02	5.1E-02	5.6E+01	9.2E+01	7.3E-01	3.4E+00

Notes

1 - See FS Appendix C except for highlighted values (see Attachment A)

Table 6 - Derivation of Site-Specific Human Health Preliminary Remediation Goals for Radionucildes - Soil - Commercial/Industrial Worker - Indoor
Nuclear Metals Superfund Site

			Depleted Uranium		
Isotope	Specific Activity (pCi/g)	Receptor Scenario:	C/I Worker - Indoor		Activity-Based PRG based on PRG - Mass and Mass Abundance (pCi/g)
			PRG - Activity (pCi/g)	PRG - Mass (mg/kg)	
		Total Uranium PRG:		**9.4E+00**	
		Mass Abundance			
U-238+D	3.35E+05	99.7982%	3.4E+00	1.0E+01	3.1E+00
U-235+D	2.16E+06	0.2009%	7.3E-01	1.7E+02	4.1E-02
U-234	6.24E+09	0.0009%	9.2E+01	1.6E+03	5.3E-01
				U-Total:	3.7E+00

			Thorium (as Th-232)	
Isotope	Specific Activity (pCi/g)	Receptor Scenario:	C/I Worker - Indoor	
			PRG - Activity (pCi/g)	PRG - Mass (mg/kg)
		Total Thorium PRG:	**3.2E-02**	**2.9E-01**
		Mass Abundance		
Th-232	1.10E+05	100%	5.6E+01	5.1E+02
Ra-228+D	PRG is for Th-232 mass		8.7E-02	7.9E-01
Th-228+D	PRG is for Th-232 mass		5.1E-02	4.6E-01

PRG - Activity: PRGs for each isotope, expressed as actibivity, are calculated using equations provided in Table 5.

PRG - Mass: Calculated for each isotope as PRG-Activity x 1E+06 /specific activity / mass abundance

PRG - Mass (total): For total uranium and total throium calculated as: 1 / [(1/PRG-Mass for isotope) + (1/PRG-Mass for isotope) + (1/PRG-Mass for isotope)]

PRG - Activity (total): For thorium is calculated as: Activity PRG for Th-232 x Th mass PRG / Th-232 mass PRG. This results in a mass to activity conversion factor of 9.1 mg/kg per pCi/g

mg/Kg = milligram per kilogram

pCi/g = picoCurie per gram

B.6 – SOIL – OUTDOOR COMMERCIAL/INDUSTRIAL WORKER

TABLE 1

VALUES USED FOR DAILY INTAKE CALCULATIONS - COMMERCIAL/INDUSTRIAL WORKER - OUTDOOR

REASONABLE MAXIMUM EXPOSURE

NUCLEAR METALS SUPERFUND SITE

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

Exposure Route	Receptor Population	Receptor Age	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion/Dermal	Comm. Worker	Adult					See FS Appendix C, except where noted	See attached
			THQ	Target Hazard Quotient	1	- -		
			CF	Conversion Factor	0.000001	kg/mg		
			ABS	Dermal Absorption Fraction	see FS Appendix C	- -		
			$AT\text{-}N_A$	Averaging Time (Non-Cancer) - adult	9,125	days		
			ED_A	Exposure Duration - adult	25	years		
			BW_A	Body Weight - adult	80	kg	See Attachment A	
			EF_A	Exposure Frequency - adult	161	days/year		
			IR_A	Ingestion Rate of Soil - adult	100	mg/day		
			SA_A	Surface Area - adult	3,527	cm^2	See Attachment A	
			AF_A	Adherence Factor - adult	0.12	mg/cm^2-day	See Attachment A	
			RBA	Relative Bioavailability	0.6 for Arsenic/1 for all other analytes	- -		
			TR	Target ILCR	10^{-6} to 10^{-4}	- -		
			AT-C	Averaging Time (Cancer)	25,550	days		
			RfD_O	Oral Reference Dose	see ROD Table G-6	mg/kg-day		
			RfD_D	Dermal Reference Dose	see ROD Table G-6	mg/kg-day		
			SF_O	Oral Slope Factor	see ROD Table G-5	$(mg/kg\text{-}day)^{-1}$		
			SF_D	Dermal Slope Factor	see ROD Table G-5	$(mg/kg\text{-}day)^{-1}$		

Intake Equation/
Model Name

Preliminary Remediation Goal (PRG) non-cancer:

Ingestion - adult

$$PRG_{nc\text{-}ing}\ (mg/kg) = \frac{THQ \times AT\text{-}N_A \times RfD_o \times BW_A}{EF_A \times ED_A \times IR_A \times CF \times RBA}$$

Dermal - adult

$$PRG_{nc\text{-}derm}\ (mg/kg) = \frac{THQ \times AT\text{-}N_A \times RfD_D \times BW_A}{EF_A \times ED_A \times SA_A \times AF_A \times ABS \times CF}$$

Total - adult

$$PRG_{nc\text{-}tot}\ (mg/kg) = \frac{1}{1/PRG_{nc\text{-}ing} + 1/PRG_{nc\text{-}derm}}$$

Preliminary Remediation Goal (PRG) cancer:

Ingestion

$$PRG_{ca\text{-}ing}\ (mg/kg) = \frac{TR \times AT\text{-}C}{SF_o \times IFS_{adj} \times CF \times RBA}$$

$$IFS_{adj}\ (mg/kg) = \frac{ED_A \times EF_A \times IR_A}{BW_A}$$

Dermal

$$PRG_{ca\text{-}derm}\ (mg/kg) = \frac{TR \times AT\text{-}C}{SF_D \times DFS_{adj} \times ABS \times CF}$$

$$DFS_{adj}\ (mg/kg) = \frac{ED_A \times EF_A \times SA_A \times AF_A}{BW_A}$$

Total

$$PRG_{ca\text{-}tot}\ (mg/kg) = \frac{1}{1/PRG_{ca\text{-}ing} + 1/PRG_{ca\text{-}derm}}$$

Notes

IFS_{adj} - age-adjusted soil ingestion factor

DFS_{adj} - age-adjusted soil dermal factor

TABLE 2. INTERMEDIATE COMMERCIAL/INDUSTRIAL WORKER (OUTDOOR) SOIL PRG CALCULATIONS - INGESTION

Chemical	Mutagenic?	THQ	$AT\text{-}N_A$ days	RfD_o mg/kg-day	BW_A kg	EF_A days/yr	ED_A yrs	IR_A mg/day	CF kg/mg	RBA	TR	AT-C days	SF_o $(mg/kg\text{-}day)^{-1}$	IFS_{adj} mg/kg	$PRG_{ca\text{-}ing}$ mg/kg	$PRG_{nc\text{-}ing\text{-}adult}$ mg/kg
Benzo(a)anthracene	Y	1	9125	3E-02	80	161	25	100	0.000001	1	1E-06	25550	7.3E-01	5031.25	**7.0E+00**	**5.4E+04**
Benzo(a)pyrene	Y	1	9125	3E-02	80	161	25	100	0.000001	1	1E-06	25550	7.3E+00	5031.25	**7.0E-01**	**5.4E+04**
Benzo(b)fluoranthene	Y	1	9125	3E-02	80	161	25	100	0.000001	1	1E-06	25550	7.3E-01	5031.25	**7.0E+00**	**5.4E+04**
Indeno(1,2,3-cd)pyrene	Y	1	9125	3E-02	80	161	25	100	0.000001	1	1E-06	25550	7.3E-01	5031.25	**7.0E+00**	**5.4E+04**
Aroclor-1254		1	9125	2E-05	80	161	25	100	0.000001	1	1E-06	25550	2.0E+00	5031.25	**2.5E+00**	**3.6E+01**
Arsenic		1	9125	3E-04	80	161	25	100	0.000001	0.6	1E-06	25550	1.5E+00	5031.25	**5.6E+00**	**9.1E+02**
Thorium		1	9125	N/A	80	161	25	100	0.000001	1	1E-06	25550	NA	5031.25	**N/A**	**N/A**
Uranium		1	9125	6E-04	80	161	25	100	0.000001	1	1E-06	25550	NA	5031.25	**N/A**	**1.1E+03**

Notes

See Table 1 for input parameters and equations

N/A - Not applicable or not available.

TABLE 3. INTERMEDIATE COMMERCIAL/INDUSTRIAL WORKER (OUTDOOR) SOIL PRG CALCULATIONS - DERMAL

Chemical	Mutagenic?	THQ	$AT\text{-}N_A$ days	RfD_D mg/kg-day	BW_A kg	EF_A days/yr	ED_A yrs	SA_A cm^2	AF_A mg/cm^2-day	ABS	CF kg/mg	TR	AT-C days	SF_D $(mg/kg\text{-}day)^{-1}$	DFS_{adj} mg/kg	$PRG_{ca\text{-}derm}$ mg/kg	$PRG_{nc\text{-}derm\text{-}adult}$ mg/kg
Benzo(a)anthracene	Y	1	9125	3E-02	80	161	25	3527	0.12	0.13	0.000001	1E-06	25550	7.3E-01	21294	**1.3E+01**	**9.9E+04**
Benzo(a)pyrene	Y	1	9125	3E-02	80	161	25	3527	0.12	0.13	0.000001	1E-06	25550	7.3E+00	21294	**1.3E+00**	**9.9E+04**
Benzo(b)fluoranthene	Y	1	9125	3E-02	80	161	25	3527	0.12	0.13	0.000001	1E-06	25550	7.3E-01	21294	**1.3E+01**	**9.9E+04**
Indeno(1,2,3-cd)pyrene	Y	1	9125	3E-02	80	161	25	3527	0.12	0.13	0.000001	1E-06	25550	7.3E-01	21294	**1.3E+01**	**9.9E+04**
Aroclor-1254		1	9125	2E-05	80	161	25	3527	0.12	0.14	0.000001	1E-06	25550	2.0E+00	21294	**4.3E+00**	**6.1E+01**
Arsenic		1	9125	3E-04	80	161	25	3527	0.12	0.03	0.000001	1E-06	25550	1.5E+00	21294	**2.7E+01**	**4.3E+03**
Thorium		1	9125	N/A	80	161	25	3527	0.12	NA	0.000001	1E-06	25550	NA	21294	**N/A**	**N/A**
Uranium		1	9125	6E-04	80	161	25	3527	0.12	NA	0.000001	1E-06	25550	NA	21294	**N/A**	**N/A**

Notes

See Table 1 for input parameters and equations

N/A - Not applicable or not available.

TABLE 4. INTERMEDIATE COMMERCIAL/INDUSTRIAL WORKER (OUTDOOR) SOIL PRG CALCULATIONS - RESULTS

	Carcinogenic Risk Level = 1E-06			Non-Cancer HQ = 1 - Adult		
Chemical	$PRG_{ca\text{-}ing}$ mg/kg	$PRG_{ca\text{-}derm}$ mg/kg	Result mg/kg	$PRG_{nc\text{-}ing}$ mg/kg	$PRG_{nc\text{-}derm}$ mg/kg	Result mg/kg
Benzo(a)anthracene	7.0E+00	1.3E+01	**4.5E+00**	5.4E+04	9.9E+04	**3.5E+04**
Benzo(a)pyrene	7.0E-01	1.3E+00	**4.5E-01**	5.4E+04	9.9E+04	**3.5E+04**
Benzo(b)fluoranthene	7.0E+00	1.3E+01	**4.5E+00**	5.4E+04	9.9E+04	**3.5E+04**
Indeno(1,2,3-cd)pyrene	7.0E+00	1.3E+01	**4.5E+00**	5.4E+04	9.9E+04	**3.5E+04**
Aroclor-1254	2.5E+00	4.3E+00	**1.6E+00**	3.6E+01	6.1E+01	**2.3E+01**
Arsenic	5.6E+00	2.7E+01	**4.7E+00**	9.1E+02	4.3E+03	**7.5E+02**
Thorium	N/A	N/A	**N/A**	N/A	N/A	**N/A**
Uranium	N/A	N/A	**N/A**	1.1E+03	N/A	**1.1E+03**

Notes

See Table 1 for equations

HQ = Hazard Quotient

N/A - Not applicable or not available.

TABLE 5. RADIOLOGICAL PRG DEVELOPMENT - INTERMEDIATE CALCULATIONS - OUTDOOR COMMERCIAL/INDUSTRIAL WORKER - SOIL

PRG (cancer) - Radionuclide COC (pCi/g) =

$$\frac{TR}{\{ED \times IR\text{-}S \times FI \times EF \times 1E\text{-}03\ g/mg \times CSFo\} + \{ED \times ACF \times CSFe \times [(ETi \times (EFi / 365\ d/y) \times SHFi) + (ETo \times (EFo / 365\ d/y) \times SHFo)]\} + \{[(IR\text{-}V \times FI\text{-}V) + (IR\text{-}F \times FI\text{-}F)] \times UPF \times EF \times ED \times CSFf\}}$$

Exposure Parameters[1]

						Ra-228+D	Th-228+D	Th-232	U-234	U-235+D	U-238+D
TR	Target Risk	1.00E-06	Risk								
IR-Sa	Ingestion Rate of Soil-adult	100	mg/day								
FI	Fraction Ingested	1	unitless	Cancer Slope Factor - Soil Ingestion-Whole Pop.	CSFo (Risk/pCi) - see ROD Table G-5:	6.70E-10	1.62E-10	8.47E-11	5.11E-11	5.03E-11	5.62E-11
EF	Exposure Frequency	161	day/yr	Cancer Slope Factor - External Exposure	CSFe (Risk/pCi) - see ROD Table G-5:	4.53E-06	7.76E-06	3.42E-10	2.52E-10	5.43E-07	1.14E-07
EDa	Exposure Duration-adult	25	yr								
ACF	Area Correction Factor	0.9	unitless								
ETia	Exposure Time - Indoors-adult	0	hr/hr		$adult_{ing}$ - EDa x IR-Sa x FI x EF x 1E-03 g/mg x CSFo:	2.70E-07	6.52E-08	3.41E-08	2.06E-08	2.02E-08	2.26E-08
EFia	Exposure Frequency - Indoor-adult	0	day/yr		$adult_{ext}$ - EDa x ACF x CSFe x [(ETia x (EFia / 365 d/y) x SHFi) + (EToa x (EFoa / 365 d/y) x SHFo)]:	2.07E-05	3.55E-05	1.57E-09	1.15E-09	2.49E-06	5.22E-07
Conv. Fact		365	day/yr								
SHFi	Shielding Factor - Indoor	0	unitless		Adult Sum:	2.10E-05	3.56E-05	3.57E-08	2.17E-08	2.51E-06	5.44E-07
EToa	Exposure Time - Outdoors-adult	0.33	hr/hr		Activity-Based PRG (pCi/g) = TR/Sum:	4.8E-02	2.8E-02	2.8E+01	4.6E+01	4.0E-01	1.8E+00
EFoa	Exposure Frequency - Outdoor-adult	225	day/yr								
SHFo	Shielding Factor - Outdoor	1	unitless								

Notes

1 - See FS Appendix C except for highlighted values (see Attachment A)

Table 6 - Derivation of Site-Specific Human Health Preliminary Remediation Goals for Radionucildes - Soil - Commercial/Industrial Worker - Outdoor
Nuclear Metals Superfund Site

			Depleted Uranium		
Isotope	Specific Activity (pCi/g)	Receptor Scenario:	C/I Worker - Outdoor		Activity-Based PRG based on PRG - Mass and Mass Abundance (pCi/g)
			PRG - Activity (pCi/g)	PRG - Mass (mg/kg)	
		Total Uranium PRG:		**5.1E+00**	
		Mass Abundance			
U-238+D	3.35E+05	99.7982%	1.8E+00	5.5E+00	1.7E+00
U-235+D	2.16E+06	0.2009%	4.0E-01	9.2E+01	2.2E-02
U-234	6.24E+09	0.0009%	4.6E+01	8.2E+02	2.9E-01
				U-Total:	2.0E+00

			Thorium (as Th-232)	
Isotope	Specific Activity (pCi/g)	Receptor Scenario:	C/I Worker - Outdoor	
			PRG - Activity (pCi/g)	PRG - Mass (mg/kg)
		Total Thorium PRG:	**1.8E-02**	**1.6E-01**
		Mass Abundance		
Th-232	1.10E+05	100%	2.8E+01	2.5E+02
Ra-228+D	PRG is for Th-232 mass		4.8E-02	4.3E-01
Th-228+D	PRG is for Th-232 mass		2.8E-02	2.6E-01

PRG - Activity: PRGs for each isotope, expressed as actibivity, are calculated using equations provided in Table 5.

PRG - Mass: Calculated for each isotope as PRG-Activity x 1E+06 /specific activity / mass abundance

PRG - Mass (total): For total uranium and total throium calculated as: 1 / [(1/PRG-Mass for isotope) + (1/PRG-Mass for isotope) + (1/PRG-Mass for isotope)]

PRG - Activity (total): For thorium is calculated as: Activity PRG for Th-232 x Th mass PRG / Th-232 mass PRG. This results in a mass to activity conversion factor of 9.1 mg/kg per pCi/g

mg/Kg = milligram per kilogram

pCi/g = picoCurie per gram

B.7 – SOIL – CONSTRUCTION WORKER

TABLE 1

VALUES USED FOR DAILY INTAKE CALCULATIONS - CONSTRUCTION WORKER

REASONABLE MAXIMUM EXPOSURE

NUCLEAR METALS SUPERFUND SITE

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

Exposure Route	Receptor Population	Receptor Age	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion/Dermal	Const. Worker	Adult					See FS Appendix C, except where noted	See attached
			THQ	Target Hazard Quotient	1	- -		
			CF	Conversion Factor	0.000001	kg/mg		
			ABS	Dermal Absorption Fraction	see FS Appendix C	- -		
			$AT\text{-}N_A$	Averaging Time (Non-Cancer) - adult	365	days		
			ED_A	Exposure Duration - adult	1	years		
			BW_A	Body Weight - adult	80	kg	See Attachment A	
			EF_A	Exposure Frequency - adult	250	days/year		
			IR_A	Ingestion Rate of Soil - adult	330	mg/day		
			SA_A	Surface Area - adult	3,527	cm^2	See Attachment A	
			AF_A	Adherence Factor - adult	0.30	mg/cm^2-day	(site specific)	
			RBA	Relative Bioavailability	0.6 for Arsenic/1 for all other analytes	- -		
			TR	Target ILCR	10^{-6} to 10^{-4}	- -		
			AT-C	Averaging Time (Cancer)	25,550	days		
			RfD_O	Oral Reference Dose	see ROD Table G-6	mg/kg-day		
			RfD_D	Dermal Reference Dose	see ROD Table G-6	mg/kg-day		
			SF_O	Oral Slope Factor	see ROD Table G-5	$(mg/kg\text{-}day)^{-1}$		
			SF_D	Dermal Slope Factor	see ROD Table G-5	$(mg/kg\text{-}day)^{-1}$		

Intake Equation/
Model Name

Preliminary Remediation Goal (PRG) non-cancer:

Ingestion - adult

$$PRG_{nc\text{-}ing}\ (mg/kg) = \frac{THQ \times AT\text{-}N_A \times RfD_o \times BW_A}{EF_A \times ED_A \times IR_A \times CF \times RBA}$$

Dermal - adult

$$PRG_{nc\text{-}derm}\ (mg/kg) = \frac{THQ \times AT\text{-}N_A \times RfD_D \times BW_A}{EF_A \times ED_A \times SA_A \times AF_A \times ABS \times CF}$$

Total - adult

$$PRG_{nc\text{-}tot}\ (mg/kg) = \frac{1}{1/PRG_{nc\text{-}ing} + 1/PRG_{nc\text{-}derm}}$$

Preliminary Remediation Goal (PRG) cancer:

Ingestion

$$PRG_{ca\text{-}ing}\ (mg/kg) = \frac{TR \times AT\text{-}C}{SF_o \times IFS_{adj} \times CF \times RBA}$$

$$IFS_{adj}\ (mg/kg) = \frac{ED_A \times EF_A \times IR_A}{BW_A}$$

Dermal

$$PRG_{ca\text{-}derm}\ (mg/kg) = \frac{TR \times AT\text{-}C}{SF_D \times DFS_{adj} \times ABS \times CF}$$

$$DFS_{adj}\ (mg/kg) = \frac{ED_A \times EF_A \times SA_A \times AF_A}{BW_A}$$

Total

$$PRG_{ca\text{-}tot}\ (mg/kg) = \frac{1}{1/PRG_{ca\text{-}ing} + 1/PRG_{ca\text{-}derm}}$$

Notes

IFS_{adj} - age-adjusted soil ingestion factor

DFS_{adj} - age-adjusted soil dermal factor

TABLE 2. INTERMEDIATE CONSTRUCTION WORKER SOIL PRG CALCULATIONS - INGESTION

Chemical	Mutagenic?	THQ	$AT\text{-}N_A$ days	RfD_o mg/kg-day	BW_A kg	EF_A days/yr	ED_A yrs	IR_A mg/day	CF kg/mg	RBA	TR	AT-C days	SF_o $(mg/kg\text{-}day)^{-1}$	IFS_{adj} mg/kg	$PRG_{ca\text{-}ing}$ mg/kg	$PRG_{nc\text{-}ing\text{-}adult}$ mg/kg
Benzo(a)anthracene	Y	1	365	3E-01	80	250	1	330	0.000001	1	1E-06	25550	7.3E-01	1031.25	**3.4E+01**	**1.1E+05**
Benzo(a)pyrene	Y	1	365	3E-01	80	250	1	330	0.000001	1	1E-06	25550	7.3E+00	1031.25	**3.4E+00**	**1.1E+05**
Benzo(b)fluoranthene	Y	1	365	3E-01	80	250	1	330	0.000001	1	1E-06	25550	7.3E-01	1031.25	**3.4E+01**	**1.1E+05**
Indeno(1,2,3-cd)pyrene	Y	1	365	3E-01	80	250	1	330	0.000001	1	1E-06	25550	7.3E-01	1031.25	**3.4E+01**	**1.1E+05**
Aroclor-1254		1	365	5E-05	80	250	1	330	0.000001	1	1E-06	25550	2.0E+00	1031.25	**1.2E+01**	**1.8E+01**
Arsenic		1	365	3E-04	80	250	1	330	0.000001	0.6	1E-06	25550	1.5E+00	1031.25	**2.8E+01**	**1.8E+02**
Thorium		1	365	N/A	80	250	1	330	0.000001	1	1E-06	25550	NA	1031.25	**N/A**	**N/A**
Uranium		1	365	2E-04	80	250	1	330	0.000001	1	1E-06	25550	NA	1031.25	**N/A**	**7.1E+01**

Notes

See Table 1 for input parameters and equations

N/A - Not applicable or not available.

TABLE 3. INTERMEDIATE CONSTRUCTION WORKER SOIL PRG CALCULATIONS - DERMAL

Chemical	Mutagenic?	THQ	$AT\text{-}N_A$ days	RfD_D mg/kg-day	BW_A kg	EF_A days/yr	ED_A yrs	SA_A cm^2	AF_A mg/cm^2-day	ABS	CF kg/mg	TR	AT-C days	SF_D $(mg/kg\text{-}day)^{-1}$	DFS_{adj} mg/kg	$PRG_{ca\text{-}derm}$ mg/kg	$PRG_{nc\text{-}derm\text{-}adult}$ mg/kg
Benzo(a)anthracene	Y	1	365	3E-01	80	250	1	3527	0.3	0.13	0.000001	1E-06	25550	7.3E-01	3307	**8.1E+01**	**2.6E+05**
Benzo(a)pyrene	Y	1	365	3E-01	80	250	1	3527	0.3	0.13	0.000001	1E-06	25550	7.3E+00	3307	**8.1E+00**	**2.6E+05**
Benzo(b)fluoranthene	Y	1	365	3E-01	80	250	1	3527	0.3	0.13	0.000001	1E-06	25550	7.3E-01	3307	**8.1E+01**	**2.6E+05**
Indeno(1,2,3-cd)pyrene	Y	1	365	3E-01	80	250	1	3527	0.3	0.13	0.000001	1E-06	25550	7.3E-01	3307	**8.1E+01**	**2.6E+05**
Aroclor-1254		1	365	5E-05	80	250	1	3527	0.3	0.14	0.000001	1E-06	25550	2.0E+00	3307	**2.8E+01**	**3.9E+01**
Arsenic		1	365	3E-04	80	250	1	3527	0.3	0.03	0.000001	1E-06	25550	1.5E+00	3307	**1.7E+02**	**1.1E+03**
Thorium		1	365	N/A	80	250	1	3527	0.3	NA	0.000001	1E-06	25550	NA	3307	**N/A**	**N/A**
Uranium		1	365	2E-04	80	250	1	3527	0.3	NA	0.000001	1E-06	25550	NA	3307	**N/A**	**N/A**

Notes

See Table 1 for input parameters and equations

N/A - Not applicable or not available.

TABLE 4. INTERMEDIATE CONSTRUCTION WORKER SOIL PRG CALCULATIONS - RESULTS

	Carcinogenic Risk Level = 1E-06			Non-Cancer HQ = 1 - Adult		
Chemical	$PRG_{ca\text{-}ing}$ mg/kg	$PRG_{ca\text{-}derm}$ mg/kg	Result mg/kg	$PRG_{nc\text{-}ing}$ mg/kg	$PRG_{nc\text{-}derm}$ mg/kg	Result mg/kg
Benzo(a)anthracene	3.4E+01	8.1E+01	**2.4E+01**	1.1E+05	2.6E+05	**7.7E+04**
Benzo(a)pyrene	3.4E+00	8.1E+00	**2.4E+00**	1.1E+05	2.6E+05	**7.7E+04**
Benzo(b)fluoranthene	3.4E+01	8.1E+01	**2.4E+01**	1.1E+05	2.6E+05	**7.7E+04**
Indeno(1,2,3-cd)pyrene	3.4E+01	8.1E+01	**2.4E+01**	1.1E+05	2.6E+05	**7.7E+04**
Aroclor-1254	1.2E+01	2.8E+01	**8.5E+00**	1.8E+01	3.9E+01	**1.2E+01**
Arsenic	2.8E+01	1.7E+02	**2.4E+01**	1.8E+02	1.1E+03	**1.5E+02**
Thorium	N/A	N/A	**N/A**	N/A	N/A	**N/A**
Uranium	N/A	N/A	**N/A**	7.1E+01	N/A	**7.1E+01**

Notes

See Table 1 for equations

HQ = Hazard Quotient

N/A - Not applicable or not available.

TABLE 5. RADIOLOGICAL PRG DEVELOPMENT - INTERMEDIATE CALCULATIONS - CONSTRUCTION WORKER - SOIL

$$\text{PRG (cancer) - Radionuclide COC (pCi/g)} = \frac{TR}{\{ED \times IR\text{-}S \times FI \times EF \times 1E\text{-}03\ g/mg \times CSFo\} + \{ED \times ACF \times CSFe \times [(ETi \times (EFi / 365\ d/y) \times SHFi) + (ETo \times (EFo / 365\ d/y) \times SHFo)]\} + \{[(IR\text{-}V \times FI\text{-}V) + (IR\text{-}F \times FI\text{-}F)] \times UPF \times EF \times ED \times CSFf\}}$$

Exposure Parameters[1]

TR	Target Risk	1.00E-06	Risk
IR-Sa	Ingestion Rate of Soil-adult	300	mg/day
FI	Fraction Ingested	1	unitless
EF	Exposure Frequency	250	day/yr
EDa	Exposure Duration-adult	1	yr
ACF	Area Correction Factor	0.9	unitless
ETia	Exposure Time - Indoors-adult	0	hr/hr
EFia	Exposure Frequency - Indoor-adult	0	day/yr
Conv. Fact		365	day/yr
SHFi	Shielding Factor - Indoor	0	unitless
EToa	Exposure Time - Outdoors-adult	0.33	hr/hr
EFoa	Exposure Frequency - Outdoor-adult	250	day/yr
SHFo	Shielding Factor - Outdoor	1	unitless

		Ra-228+D	Th-228+D	Th-232	U-234	U-235+D	U-238+D
Cancer Slope Factor - Soil Ingestion-Whole Pop.	CSFo (Risk/pCi) - see ROD Table G-5:	6.70E-10	1.62E-10	8.47E-11	5.11E-11	5.03E-11	5.62E-11
Cancer Slope Factor - External Exposure	CSFe (Risk/pCi) - see ROD Table G-5:	4.53E-06	7.76E-06	3.42E-10	2.52E-10	5.43E-07	1.14E-07
	$adult_{ing}$ - EDa x IR-Sa x FI x EF x 1E-03 g/mg x CSFo:	5.03E-08	1.22E-08	6.35E-09	3.83E-09	3.77E-09	4.22E-09
	$adult_{ext}$ - EDa x ACF x CSFe x [(ETia x (EFia / 365 d/y) x SHFi) + (EToa x (EFoa / 365 d/y) x SHFo)]:	9.22E-07	1.58E-06	6.96E-11	5.13E-11	1.10E-07	2.32E-08
	Adult Sum:	9.72E-07	1.59E-06	6.42E-09	3.88E-09	1.14E-07	2.74E-08
	Activity-Based PRG (pCi/g) = TR/Sum:	1.0E+00	6.3E-01	1.6E+02	2.6E+02	8.8E+00	3.6E+01

Notes

1 - See FS Appendix C except for highlighted values (see Attachment A)

Table 6 - Derivation of Site-Specific Human Health Preliminary Remediation Goals for Radionucildes - Soil - Construction Worker
Nuclear Metals Superfund Site

			Depleted Uranium		
Isotope	Specific Activity (pCi/g)	Receptor Scenario:	Construction Worker		Activity-Based PRG based on PRG - Mass and Mass Abundance (pCi/g)[1]
			PRG - Activity (pCi/g)	PRG - Mass (mg/kg)	
		Total Uranium PRG:		**1.0E+02**	
		Mass Abundance			
U-238+D	3.35E+05	99.7982%	3.6E+01	1.1E+02	2.4E+01
U-235+D	2.16E+06	0.2009%	8.8E+00	2.0E+03	3.1E-01
U-234	6.24E+09	0.0009%	2.6E+02	4.6E+03	4.0E+00
				U-Total:	2.8E+01

			Thorium (as Th-232)	
Isotope	Specific Activity (pCi/g)	Receptor Scenario:	Construction Worker	
			PRG - Activity (pCi/g)	PRG - Mass (mg/kg)
		Total Thorium PRG:	**3.9E-01**	**3.5E+00**
		Mass Abundance		
Th-232	1.10E+05	100%	1.6E+02	1.4E+03
Ra-228+D	PRG is for Th-232 mass		1.0E+00	9.4E+00
Th-228+D	PRG is for Th-232 mass		6.3E-01	5.7E+00

PRG - Activity: PRGs for each isotope, expressed as actibivity, are calculated using equations provided in Table 5.

PRG - Mass: Calculated for each isotope as PRG-Activity x 1E+06 /specific activity / mass abundance

PRG - Mass (total): For total uranium and total throium calculated as: 1 / [(1/PRG-Mass for isotope) + (1/PRG-Mass for isotope) + (1/PRG-Mass for isotope)]

PRG - Activity (total): For thorium is calculated as: Activity PRG for Th-232 x Th mass PRG / Th-232 mass PRG. This results in a mass to activity conversion factor of 9.1 mg/kg per pCi/g

mg/Kg = milligram per kilogram

pCi/g = picoCurie per gram

1 - The non-cancer risk-based PRG (71 mg/kg) is lower than the cancer PRG (100 mg/kg) presented here (see Attachment B.8). The calculations developing the activity-based PRGs based on the mass-based PRG and mass abundance are for the non-cancer PRG of 71 mg/kg.

B.8 – FS PRG SUMMARY TABLES

Table 2.3.2 - Summary of Site-Specific Preliminary Remediation Goals and Residual Risks - Soil
Nuclear Metals Superfund Site

Chemical of Concern	Receptor Scenario	Preliminary Remedition Goals (mg/kg)						Detection Limits [1] (mg/kg)	Background [2] (mg/kg)	ARAR/Policy (mg/kg)	Selected PRG (mg/kg)		Selected PRG (pCi/g)	Residual Risk at PRG [4]	
		Based on Excess Liftime Cancer Risk			Based on Hazard Index									Excess Lifetime Cancer Risk	Hazard Index
		$1x10^{-6}$	$1x10^{-5}$	$1x10^{-4}$	0.1	1	10								
Benzo(a)anthracene	Resident	0.34	3.4	34	390	3,900	39,000	0.034 - 0.52	0.033	Not Applicable	0.34	c	--	1E-06	0.00009
	Recreational Visitor	0.69	6.9	69	780	7,800	78,000				0.69	c	--	1E-06	0.00009
	C/I Worker - Indoor	12	120	1,200	9,200	92,000	920,000				12	c	--	1E-06	0.0001
	C/I Worker - Outdoor	4.5	45	450	3,500	35,000	350,000				4.5	c	--	1E-06	0.0001
	Construction Worker	24	240	2,400	7,700	77,000	770,000				24	c	--	1E-06	0.0003
Benzo(a)pyrene	Resident	0.034	0.34	3.4	390	3,900	39,000	0.034 - 0.52	0.22	Not Applicable	0.22	b	--	6E-06	0.00006
	Recreational Visitor	0.069	0.69	6.9	780	7,800	78,000				0.22	b	--	3E-06	0.00003
	C/I Worker - Indoor	1.2	12	120	9,200	92,000	920,000				1.2	c	--	1E-06	0.00001
	C/I Worker - Outdoor	0.45	4.5	45	3,500	35,000	350,000				0.45	c	--	1E-06	0.00001
	Construction Worker	2.4	24	240	7,700	77,000	770,000				2.4	c	--	1E-06	0.00003
Benzo(b)fluoranthene	Resident	0.34	3.4	34	390	3,900	39,000	0.034 - 0.52	0.066	Not Applicable	0.34	c	--	1E-06	0.00009
	Recreational Visitor	0.69	6.9	69	780	7,800	78,000				0.69	c	--	1E-06	0.00009
	C/I Worker - Indoor	12	120	1,200	9,200	92,000	920,000				12	c	--	1E-06	0.0001
	C/I Worker - Outdoor	4.5	45	450	3,500	35,000	350,000				4.5	c	--	1E-06	0.0001
	Construction Worker	24	240	2,400	7,700	77,000	770,000				24	c	--	1E-06	0.0003
Indeno(1,2,3-cd)pyrene	Resident	0.34	3.4	34	390	3,900	39,000	0.034 - 0.52	Not Detected	Not Applicable	0.34	c	--	1E-06	0.00009
	Recreational Visitor	0.69	6.9	69	780	7,800	78,000				0.69	c	--	1E-06	0.00009
	C/I Worker - Indoor	12	120	1,200	9,200	92,000	920,000				12	c	--	1E-06	0.0001
	C/I Worker - Outdoor	4.5	45	450	3,500	35,000	350,000				4.5	c	--	1E-06	0.0001
	Construction Worker	24	240	2,400	7,700	77,000	770,000				24	c	--	1E-06	0.0003
PCBs	Resident	0.54	5.4	54	0.26	2.6	26	0.0034 - 0.7	Not Applicable	1 [3]	1	a	--	2E-06	0.4
	Recreational Visitor	1.1	11	110	0.51	5.1	51				1.1	c	--	1E-06	0.2
	C/I Worker - Indoor	4.2	42	420	6.1	61	610			10 - 25 [3]	4.2	c	--	1E-06	0.07
	C/I Worker - Outdoor	1.6	16	160	2.3	23	230			10 - 25 [3]	1.6	c	--	1E-06	0.07
	Construction Worker	8.5	85	850	1.2	12	120			10 - 25 [3]	8.5	c	--	1E-06	0.7
Arsenic	Resident	1.5	15	150	7.6	76	760	0.21 - 6.2	13.7	Not Applicable	13.7	b	--	9E-06	0.2
	Recreational Visitor	3.0	30	300	15	150	1,500				13.7	b	--	5E-06	0.1
	C/I Worker - Indoor	11	110	1100	170	1,700	17,000				13.7	b	--	1E-06	0.01
	C/I Worker - Outdoor	4.7	47	470	75	750	7,500				13.7	b	--	3E-06	0.02
	Construction Worker	24	240	2400	15.0	150	1,500				24.0	c	--	1E-06	0.2

Table 2.3.2 - Summary of Site-Specific Preliminary Remediation Goals and Residual Risks - Soil
Nuclear Metals Superfund Site

Chemical of Concern	Receptor Scenario	Preliminary Remedition Goals (mg/kg)						Detection Limits [1] (mg/kg)	Background [2] (mg/kg)	ARAR/Policy (mg/kg)	Selected PRG (mg/kg)		Selected PRG (pCi/g)		Residual Risk at PRG [4]	
		Based on Excess Liftime Cancer Risk			Based on Hazard Index										Excess Lifetime Cancer Risk	Hazard Index
		$1x10^{-6}$	$1x10^{-5}$	$1x10^{-4}$	0.1	1	10									
Uranium	Resident	2.7	27	270	10	100	1,000				2.7	c	U-238: 0.90	d	1E-06	0.03
													U-235: 0.01	d		
													U-234: 0.15	d		
													U-total: 1.1	d		
	Recreational Visitor	22	220	2,200	21	210	2,100				22	c	U-238: 7.2	d	1E-06	0.10
													U-235: 0.094	d		
													U-234: 1.2	d		
													U-total: 8.5	d		
	C/I Worker - Indoor	9.4	94	940	220	2,200	22,000	0.0064 - 0.0064	1.3	Not Applicable	9.4	c	U-238: 3.1	d	1E-06	0.004
													U-235: 0.041	d		
													U-234: 0.53	d		
													U-total: 3.7	d		
	C/I Worker - Outdoor	5.1	51	510	110	1,100	11,000				5.1	c	U-238: 1.7	d	1E-06	0.005
													U-235: 0.022	d		
													U-234: 0.29	d		
													U-total: 2.0	d		
	Construction Worker	100	1,000	10,000	7	71	710				71	nc	U-238: 24	d	7E-07	1.0
													U-235: 0.31	d		
													U-234: 4.0	d		
													U-total: 28	d		
Thorium	Resident	0.084	0.84	8.4	Not Applicable			0.021 - 0.026	7.35	Not Applicable	7.35	b	0.81	e	9E-05	Not Applicable
	Recreational Visitor	1.0	10.0	100							7.35	b	0.81	e	7E-06	
	C/I Worker - Indoor	0.29	2.9	29							7.35	b	0.81	e	3E-05	
	C/I Worker - Outdoor	0.16	1.6	16							7.35	b	0.81	e	5E-05	
	Construction Worker	3.5	35	348							7.35	b	0.81	e	2E-06	

Highlighted values are those generated in Attachments B.3 through B.7 which are different than what was presented in the FS.
1 - Range of reporting limits for non-detects in surface soil, as reported in data set for the Remedial Investigation.
2 - Background values for soils, where applicable, were established using upper limit concentrations for the Stowe Town Forest dataset (Baseline Human Health Risk Assessment, Appendices C and N) .
3 - PRG for Total PCBs based on CERCLA Policy (A Guide on Remedial Actions at Superfund Sites with PCB Contamination, OSWER Directive #9355.4-01FS, August 1990).
4 - Residual risk represents the excess lifetime cancer risk and hazard index associated with exposure to COC concentrations equal to the PRG. Calculated as:
Cancer risk = Final PRG x 1E-06 / PRG derived for 1E-06 target risk
Hazard Index = Final PRG / PRG derived for a target hazard index of 1
ARAR - Applicable, Relevant, or Appropriate Requirement
mg/kg - milligram per kilogram
a - Final PRG is based on an ARAR
b - Final PRG is based on the background value
c - Final PRG is based on an excess lifetime cancer risk of $1x10^{-6}$
d - PRG as activity (pCi/g) is calculated from PRG as mass (mg/kg) based the isotopic profile for depleted uranium (0.2% U-235) as determined through analysis of soil samples collected in the Remedial Investigation.
e - PRG as activity (pCi/g) calculated as PRG (mg/kg) divided by a mass to activity conversion factor of 9.1 (mg/kg per pCi/g). The conversion factor is based on thorium measured as Th-232 as determined through analysis of soil samples collected in the Remedial Investigation and accounting for in-growth of Ra-228+D and Th-228+D.
nc - Final PRG is based on a non-cancer hazard index of 1
-- - Not Applicable

Table 2.3.3 - Summary of Site-Specific Preliminary Remediation Goals and Residual Risks - Sediment
Nuclear Metals Superfund Site

Chemical of Concern	Receptor Scenario	Preliminary Remedition Goals (mg/kg)							Detection Limits (1) (mg/kg)	Background (2) (mg/kg)	ARAR/Policy (mg/kg)	Selected PRG (mg/kg)		Residual Risk at PRG (4)	
		Human Health - Based on Excess Liftime Cancer Risk			Human Health - Based on Hazard Index			Ecological						Excess Lifetime Cancer Risk	Hazard Index
		$1x10^{-6}$	$1x10^{-5}$	$1x10^{-4}$	0.1	1	10	Based on Benthic Community							
PCBs	Recreational Visitor	2.7	27	269	1.5	15	150	1.08	0.45	Not Detected	1 (3)	1	a	4E-07	0.07
Copper		Not a COC			Not a COC			176	0.21 - 1.1	9.1	Not Applicable	176	e		
Lead		Not a COC			Not a COC			97.3	0.21 - 1.1	33.7	Not Applicable	97	e		
Mercury		Not a COC			Not a COC			1.3	0.21 - 1.1	0.041	Not Applicable	1.3	e		

Highlighted values are those generated in Attachment B.1 which are different than what was presented in the FS.
1 - Range of reporting limits for non-detects in sediment, as reported in data set for the Remedial Investigation.
2 - Background values for sediments, where applicable, were established using upper limit concentrations for the Maynard Pond dataset (Baseline Human Health Risk Assessment, Appendices C and N).
3 - PRG for Total PCBs based on CERCLA Policy (A Guide on Remedial Actions at Superfund Sites with PCB Contamination, OSWER Directive #9355.4-01FS, August 1990).
4 - Residual risk represents the excess lifetime cancer risk and hazard index associated with exposure to COC concentrations equal to the PRG. Calculated as:
Cancer risk = Final PRG x 1E-06 / PRG derived for 1E-06 target risk
Hazard Index = Final PRG / PRG derived for a target hazard index of 1
ARAR - Applicable, Relevant, or Appropriate Requirement
mg/kg - milligram per kilogram
a - Final PRG is based on an ARAR
b - Final PRG is based on the background value
c - Final PRG is based on an excess lifetime cancer risk of $1x10^{-6}$
nc - Final PRG is based on a non-cancer hazard index of 1
e - Final PRG is based on ecological risk (protection of benthic community)

Table 2.3.4 - Summary of Site-Specific Preliminary Remediation Goals - Groundwater
Nuclear Metals Superfund Site

Chemical of Concern	Receptor Scenario	Preliminary Remedition Goals (ug/l)						Detection Limits [1] (ug/L)	Background (ug/L)		ARARs and TBC (ug/L)			Selected PRG (ug/L)	
		Based on Excess Liftime Cancer Risk			Based on Hazard Index				Overuburden [7]	Bedrock [7]	Federal MCL [2]	MA MCL [3]	TBC		
		$1x10^{-6}$	$1x10^{-5}$	$1x10^{-4}$	0.1	1	10							Overburden	Bedrock
1,1-Dichloroethane	Resident	2.7	27	270	380	3,800	38,000	0.5	Not Applicable	Not Applicable	Not Available	Not Available		Not a COC	2.7 c
Tetrachloroethene	Resident	11	110	1100	4.1	41	410	0.5	Not Applicable	Not Applicable	5	5		5 a	5 a
Trichloroethene	Resident	0.49	4.9	49	0.28	2.8	28	0.5	Not Applicable	Not Applicable	5	5		5 a	5 a
Vinyl chloride	Resident	0.019	0.19	1.9	4.4	44	440	0.5	Not Applicable	Not Applicable	2	2		2 a	2 a
1,4-Dioxane	Resident	0.46	4.6	46	5.7	57	570	0.15 [5] - 4.0 [6]	Not Applicable	Not Applicable	Not Available	Not Available	0.3 (G)	0.46 c	0.46 c
bis(2-Ethylhexyl)phthalate	Resident	5.6	56	560	40	400	4,000	4.3 - 11	3.2	4.6	6	6		6 a	6 a
Arsenic	Resident	0.052	0.52	5.2	0.60	6.0	60	0.8 - 16	1.2	26.8	10	10		10 a	10 a
Barium	Resident	Not Applicable			380	3,800	38,000	NA	19.5	44	2000	2000		Not a COC	2000 a
Chromium	Resident	0.035	0.35	3.5	4.4	44	440	0.27 - 13	1.7	9.6	100	100		100 a	100 a
Cobalt	Resident	Not Applicable			0.60	6.0	60	0.045 - 0.47	0.64	1.1	Not Available	Not Available		6.0 nc	6.0 nc
Copper	Resident	Not Applicable			80	800	8,000	0.29 - 24	0.78	6.8	1,300	1,300		1300 a	Not a COC
Iron	Resident	Not Applicable			1,400	14,000	140,000	32 - 280	596	4000	Not Available	Not Available	300 (S)	14,000 nc	14,000 nc
Manganese	Resident	Not Applicable			43	430	4,300	0.2 - 4.8	25.6	200	Not Available	Not Available	300 (HA)	300 a	300 a
Molybdenum	Resident	Not Applicable			10	100	1000	0.022 - 1.4	Not Detected	8.7	Not Available	Not Available		100 nc	100 nc
Thorium	Resident	0.33	3.3	33	Not Applicable			0.05 - 0.38	0.15	Not Detected	Not Available	Not Available		0.33 c	0.33 c
Depleted Uranium	Resident	1.6	16	160	1.2	12	120	0.038 - 0.048	0.47 [4]	14.1 [4]	30	30		30 a	30 a
Natural Uranium	Resident	0.076	0.76	7.6	1.2	12	120	0.03 - 0.17	0.47	14.1	30	30		30 a	30 a
Nitrate-N	Resident	Not Applicable			3,200	32,000	320,000	20 - 310	522	253	10,000	10,000		10000 a	10000 a
Nitrite-N	Resident	Not Applicable			200	2,000	20,000	30 - 100	Not Detected	70	1,000	1,000		1000 a	1000 a

Highlighted values are those generated in Attachment B.2 which are different than what was presented in the FS.
1 - Range of reporting limits for non-detects in groundwater, as reported in data set for the Remedial Investigation.
2 - National Primary Drinking Water Regulations (EPA 816-F-09-0004, May 2009) (http://water.epa.gov/drink/contaminants/index.cfm#List)
3 - 2012 Standards and Guidelines for Contaminants in Massachusetts Drinking Water (http://www.mass.gov/dep/water/drinking/standards/dwstand.htm)
4 - Values are for natural uranium
5 - Reporting limit for 8270 SIM
6 - Reporting limit for 8260 SIM
7 - Background values for groundwater, where applicable, were established using upper limit concentrations for background wells at the Site (Baseline Human Health Risk Assessment, Appendix C) .
(G) - Value is a Massachusetts Drinking Water Guideline
(S) - Value is a Federal and Massachusetts Secondary MCL
(HA) - Value is a USEPA Health Advisory
MCL - Maximum Contaminant Level
ARAR - Applicable, Relevant, or Appropriate Requirement
TBC - To Be Considered
ug/L - microgram per liter
a - Final PRG is based on an ARAR
b - Final PRG is based on the background value
c - Final PRG is based on an excess lifetime cancer risk of $1x10^{-6}$
nc - Final PRG is based on a non-cancer hazard index of 1
Not a COC - Not a primary risk driver in this flow zone and/or maximum detection does not exceed MCL

APPENDIX F

ACTION MEMORANDUM FOR A

NON-TIME CRITICAL REMOVAL ACTION

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
5 POST OFFICE SQUARE, BOSTON, MA 02109

<u>Enforcement Confidential Materials Attached</u>

MEMORANDUM

DATE:

SUBJ: Request for a Non-Time Critical Removal Action at the Nuclear Metals, Inc. Superfund Site, Concord, Massachusetts -- **ACTION MEMORANDUM**

FROM: Melissa Taylor, Remedial Project Manager
MA Superfund Section

THRU: Bob Cianciarulo, Chief
MA Superfund Section

Bryan Olson, Chief
Remediation and Restoration Branch

TO: Nancy Barmakian, Acting Director
Office of Site Remediation & Restoration

I. PURPOSE

The purpose of this Action Memorandum is to request and document approval of a non-time critical removal action (NTCRA) for the Nuclear Metals, Inc. Superfund Site (the "Site"), located at 2229 Main Street, Concord, Massachusetts. This NTCRA is expected to be completed within one to five years of mobilization at a cost of approximately $5.2 million (up to one year of construction and up to four years of monitoring, operation, and maintenance). This NTCRA is necessary to prevent, minimize, stabilize, and mitigate potential threats to human health and the environment posed by a release of hazardous substances to the environment.

In particular, this NTCRA will address migration of contaminated groundwater. The location and layout of the Site is shown in Figure E-3 of the Record of Decision (ROD). The Site includes a 46-acre Nuclear Metals, Inc. property (the "NMI Property") and surrounding areas where contamination has come to be located. In the fall of 2014, EPA completed a Remedial Investigation and Feasibility Study for the Site, which determined that groundwater contaminated with 1,4–dioxane was migrating away from the NMI Property under the Assabet River. The Assabet wellfield, one of the public water supply wellfields for the town of Acton, Massachusetts, could be impacted if the groundwater plume continues to migrate. This NTCRA is consistent with the long-term remedial strategy for this Site to minimize exposure to and migration of contaminants.

This NTCRA will ensure that EPA can provide a timely response to effectively minimize threats to public health or welfare or the environment which may result from the continuing release and/or threat of release of hazardous substances from the site.

While this NTCRA will accelerate the overall Site cleanup by reducing site contamination, it does not constitute the complete cleanup plan for the Site. EPA has issued a Record of Decision (ROD) concurrent with this Action Memorandum. The ROD selects a remedy to address the full nature and extent of contamination at the Site not addressed by this NTCRA or the on-going building NTCRA, prior time-critical removal actions, or the prior removal action by the Massachusetts Department of Environmental Protection (MassDEP).

II. SITE CONDITIONS AND BACKGROUND

CERCLIS Identifier: MAD062166335
Site Identifier: 017D
Removal Category: Non-Time Critical
NPL status: Listed on NPL on June 14, 2001

A. Site Description

1. Removal site evaluation

The portion of the Site addressed by this action is groundwater contaminated with 1,4-dioxane and VOCs that has migrated off the NMI property and is headed towards a public water supply. Other areas of the Site not addressed by this removal action are the 46-acre NMI property, which includes: a five-section interconnected building and several other storage buildings (which altogether have a current footprint of approximately 185,000 square feet); a holding basin and a small landfill (which have both been covered with a temporary cap by EPA as part of a 2002 time-critical removal action); site soils; a sphagnum bog; a cooling water recharge pond; a "sweepings" pile, and DU and uranium groundwater contamination. These areas are being addressed under the ROD that is being issued concurrently with this Action Memorandum.

Currently, a NTCRA is on-going which requires the removal of all contents of the facility buildings and demolition of the buildings themselves. Most of the facility contents have been removed and the buildings are scheduled for demolition in fall 2015/spring 2016.

Anecdotal information indicates that volatile organic compounds (VOCs) used as solvents and degreasers were discharged through floor drains of the facility buildings to an on-site cooling water pond, resulting in contamination of an on-site supply well. The VOCs likely contained 1,4-dioxane as a stabilizer. The Remedial Investigation and Feasibility Study that was completed in the fall of 2014 determined that a groundwater plume of 1,4-dioxane was migrating away from the NMI Property towards the one of the public water supply wellfields for the town of Acton. Due to the rate at which the 1,4-dioxane plume is moving, EPA is requesting Non-Time Critical

Removal Authority to address the contaminated groundwater migrating off the Starmet property. EPA signed an approval memorandum for performance of an Engineering Evaluation and Cost Analysis (EE/CA) equivalent in September 2015. The completed Feasibility Study is serving as the EE/CA equivalent as it evaluates the necessary groundwater remedial alternatives. The RI/FS was performed by potentially responsible parties (PRPs) pursuant to an Administrative Order by Consent for RI/FS (RI/FS AOC), signed on June 13, 2003.[1] The RI/FS reports can be found in the administrative record for the ROD and on the Nuclear Metals EPA website: http://www.epa.gov/region1/superfund/sites/nmi. EPA anticipates that performance of this NTCRA would be performed on a PRP-lead basis. A more detailed description of the Site history can be found in Section B of the ROD and Section 1 of the Feasibility Study.

As this NTCRA is not anticipated to cost more than $6 million, consultation with the Office of Superfund Remediation and Technology Innovation (OSRTI) and the Office of Emergency Management (OEM) in accordance with the national guidance document "Use of Non-Time Critical Removal Authority in Superfund Response Actions", dated February 14, 2000, is not required.

In October 2014, EPA issued a Proposed Plan outlining the cleanup plan at the Site to local communities. In addition to seeking comments on the proposed overall cleanup plan, the Proposed Plan also asked for comments on the proposal to accelerate a portion of the groundwater cleanup of 1,4-dioxane and VOCs as a NTCRA. On December 10, 2014, EPA held a public hearing to discuss the cleanup alternatives in the Proposed Plan and Feasibility Study, and EPA's preferred alternative for the cleanup plan and accelerated groundwater cleanup for 1,4-dioxane and VOCs. From November 13, 2014 to January 14, 2015, EPA held a public comment period. Responses to significant comments related to this NTCRA proposal are provided in Part 3 of the ROD along with responses to other comments received on EPA's proposed cleanup plan. Additional supporting documentation can be found in the Administrative Record.

2. Physical location

The Site is located at 2229 Main Street, in Concord, Massachusetts. The NMI Property consists of approximately 46 acres, including five interconnected buildings, a tank house, a hydrogen peroxide tank house, four "Butler" buildings, and two gas cylinder storage huts. The property is bordered by residential properties to the east and northeast, a commercial property to the west, Main Street (Route 62) to the north and to the south and southwest by conservation land/woodlands and the Thoreau Hills Summer Camp (a children's day camp).

The closest residence is located within 200-300 feet of the Site**.** The Assabet River is approximately 300 feet north from the northern perimeter of the property. Both the town of Concord and the adjacent town of Acton are on public water supplies that have not been impacted by site-contaminated groundwater; however, 1,4-dioxane has been found in monitoring wells approximately 300 feet from the town of Acton's Assabet wellfield.

[1] The RI/FS AOC was amended on February 13, 2008 and again on October 2, 2012.

3. Site characteristics

From 1958 to the present, the Site was used by various operators as a specialized research and metal manufacturing facility, which was licensed to possess radioactive substances. At various times, Site operators used depleted uranium, beryllium, titanium, zirconium, copper, acids, solvents, and other substances. Although the source of the DU is known, sources of other contaminants at the Site can only be hypothesized. It is thought that the PCBs were used at the Site within the machinery, and VOCs were used as solvents at the Site and those VOCs likely contained 1,4-dioxane as a stabilizer. Other areas of the Site investigated as part of the RI/FS include: site soils, site groundwater, a cooling water recharge pond, a sphagnum bog, the northeast wetland, the former waste holding basin, a small landfill, and a waste pile referred to as the "sweepings" pile that contains dredged material from the cooling water recharge pond.

Since 1972, Starmet Corp. (Starmet), formerly known as Nuclear Metals, Inc., or one of its wholly-owned subsidiaries, owned and/or operated the Site. Starmet previously manufactured penetrator bullets from depleted uranium as a defense contractor for the U.S. Army under a license to possess radioactive materials by the MADPH-RCP[2]. Starmet vacated the Site in early November 2011 (in accordance with the terms of a Consent Decree with the MADPH-RCP), Starmet's radioactive materials licenses were terminated by MADPH-RCP on November 8, 2011, and the company is now defunct.

The Site lies within the Assabet River basin. No natural streams are present on-site. The only apparent surface water body that pre-dates development of the Site is a Sphagnum Bog located in the eastern-central portion of the Site. The Assabet River flows in an easterly direction and merges with the Sudbury River to form the Concord River approximately 3.5 miles downstream of the Site. A surface water divide is located in the upland to the south of the Site. Surface water runoff from areas north of this divide flow north to the Assabet River. Surface water runoff from areas south of this divide flow south to Second Division Brook, which flows in an easterly direction, and then north to join with the Assabet River. Groundwater is found both in the unconsolidated and bedrock formations and migrates north/northwest, towards the Assabet River.

Groundwater data suggest that DU migrated to the overburden groundwater, natural uranium migrated to the bedrock groundwater, and chlorinated VOCs, and 1,4-dioxane migrated to the overburden and bedrock groundwater. The groundwater flow is toward the north and northwest, resulting in overburden and bedrock plumes of VOCs and 1,4-dioxane that extend off the facility property toward and beneath the Assabet River. The 1,4-dioxane plume associated with the Site extends to deeper overburden as evidenced by monitoring results from wells located just south and northwest of the Assabet River.

[2] The Commonwealth of Massachusetts became a Nuclear Regulatory Commission (NRC) "agreement state" licensee in 1997.

4. Release or threatened release into the environment of a hazardous substance or pollutant or contaminant

The last round of groundwater sampling results shows that the 1,4-dioxane plume is migrating away from the NMI property under the Assabet River. Previous sampling results had shown that the 1,4-dioxane plume was contained with no signs of migration. Addressing 1,4-dioxane (which will address VOCs simultaneously) in groundwater as a non-time critical removal action (NTCRA) in advance of implementing the full remedy for the Site could contain this plume from expanding further, thereby protecting human health and avoiding the increase in time and cost for this component of the cleanup action. There is a release or threatened release of hazardous substances into the environment posed by the contamination of groundwater with 1,4-dioxane in the near vicinity of public supply wells. Recent sampling of monitoring wells in the vicinity of the public supply wells has shown concentrations of 1,4-dioxane between 2 and 14 ug/l, which is in exceedance of the ROD groundwater cleanup level of 0.46 ug/l for 1,4-dioxane.

5. NPL status

This Site is listed on the National Priorities List (NPL). The Site was proposed for listing on the NPL on July 27, 2000, and was listed on the NPL on June 14, 2001 with the concurrence of the Governor of Massachusetts.

B. <u>Other Actions to Date</u>

1. EPA Region 1 Emergency Planning and Response Branch (EPRB) Actions

EPA's EPRB has been involved at the Site since mid-2000. Through investigations of past activities and EPRB's subsequent Preliminary Assessment/Site Investigations (PA/SIs), two discrete buried drum areas were identified: one was located between the holding basin and the water cooling recharge pond, and one is located within the old landfill area immediately south of the sphagnum bog. (See Figure E-3 in the ROD showing the locations of the cooling water recharge pond, holding basin, and sphagnum bog.)

From April 23, 2002 to April 30, 2003, the EPRB conducted a time-critical removal action that included the installation of a cap over the old landfill area, and the installation of a liner over the holding basin. In addition, a fence was erected around the old landfill area. A small buried drum area located within a fenced area near the holding basin was not addressed as part of this removal action because trespasser access to the buried materials was limited and the materials were not at or near the surface. As explained below, the buried materials were removed from the Site in December 2004. The 2002 removal action prevented the direct contact threat with the contaminated surface soils located in the landfill area, eliminated contaminated dust migration from the holding basin, and prevented precipitation from infiltrating the soils within the holding basin.

Due to a fire that occurred at the Site in June 2007, EPA's EPRB conducted a second time-critical removal action in early 2008 to remove hazardous and flammable materials from within the facility buildings at the request of the Concord Fire Department.

2. Remedial Branch Actions

In 2003, EPA entered into an Administrative Order by Consent to perform a Remedial Investigation/Feasibility Study (RI/FS AOC) with several potentially responsible parties (PRPs) for the Site. In 2014, the Respondents under the RI/FS AOC completed the RI/FS at the Site. The drums discovered during the 2002 time-critical removal action were removed in December 2004 as part of the activities performed under the RI/FS AOC. In addition, as another activity performed under the RI/FS AOC, the Respondents completed an EE/CA which evaluated alternatives for addressing contamination related to buildings on the Site. An Action Memorandum for a NTCRA to remove of all contents of the facility buildings and demolish the buildings themselves (the "Building NTCRA") was signed on September 23, 2008. Subsequently, an Administrative Settlement Agreement and Order on Consent for NTCRA was signed in August 2011 which requires several PRPs to perform the Building NTCRA. Most of the facility contents have been removed and the buildings are scheduled for demolition beginning in fall 2015/spring 2016. A comprehensive remedy for the Site is being selected concurrent with this Action Memorandum, as outlined in the ROD.

C. State and Local Authorities' Roles

1. State and local actions to date

From about the late 1980s to 2000, Starmet, performed certain Site investigations and a partial cleanup under the oversight of MADEP. In 1997, Starmet, with the financial support of the U.S. Army, and oversight by MADEP and MADPH-RCP, excavated approximately 8,000 cubic yards of soil contaminated with depleted uranium and copper from the on-site holding basin and disposed of these soils at an off-site, low-level radioactive waste disposal facility. The cleanup halted in late 1998 when Starmet determined that the cleanup level required by MADEP could not be met without excavating significantly more material.

In the spring of 2006, MADEP conducted a removal action, with proceeds obtained by the State through a settlement with the U.S. Army, which consisted of the removal of more than 3,800 drums and containers containing depleted uranium from within the facility.

On May 22, 2007, MADPH-RCP and Starmet entered into a Consent Decree in which Starmet agreed to vacate the Site by October 31, 2007. Starmet's related companies (i.e., the Starmet Parties), also operating at the Site, were required to vacate the Site on the same date.

On June 26, 2007, the Concord Fire Department, MADPH-RCP, MADEP, and EPA responded to a fire at the Starmet facility. Subsequently, the Concord Fire Department issued two orders to Starmet to correct various violations of the state fire code at the Site. In November 2007, after Starmet failed to comply with the orders, the Concord Fire Department sent a letter to EPA requesting assistance with removing these materials from the Starmet facility, concluding that the continued existence of these materials within the facility constitutes an imminent threat to public health and safety. EPA completed a time-critical removal action in early 2008 which removed hazardous and flammable materials from within the facility buildings.

Starmet and its related companies vacated the Site on November 1, 2011 and Starmet's radioactive materials licenses were terminated by MADPH-RCP on November 8, 2011. Starmet is now defunct but remains the current owner of the NMI Property.

2. Potential for continued State/local response

MassDEP is the lead agency for the Commonwealth of Massachusetts. MassDEP has limited funds available to address the Site. There is no state response mechanism available with sufficient funds to perform this NTCRA.

III. THREATS TO PUBLIC HEALTH OR WELFARE OR THE ENVIRONMENT, AND STATUTORY AND REGULATORY AUTHORITIES

Based on Site conditions and information available on the hazardous substances present, the Site poses the following threats to public health, welfare, or the environment:

A. <u>Threats to Public Health or Welfare or the Environment</u>

"Actual or potential exposure to nearby human populations, animals or the food chain from hazardous substances or pollutants or contaminants" [40 CFR 300.415(b)(2)(i)];

The NMI Property is bordered by residential properties to the east, a commercial property to the west, Main Street (Route 62) to the north and to the south and southwest by conservation land/woodlands and the Thoreau Hills Summer Camp. The 1,4-dioxane plume extends off the NMI Property, across Main Street to the northern side of the Assabet River. This groundwater plume has elevated concentrations of 1,4-dioxane in exceedance of EPA's risk-based cleanup level of 0.46 ug/l.

"Actual or potential contamination of drinking water supplies or sensitive ecosystems" [40 CFR 300.415(b)(2)(ii)];

As stated above, Site groundwater is contaminated at levels exceeding risk-based cleanup levels, as well as MCLs. Concentrations approaching EPA's risk based cleanup level of 0.46 ug/l for 1,4-dioxane have been detected in the vicinity of the Acton Water District supply wells.

"The availability of other appropriate federal or state response mechanisms to respond to the release" [40 CFR 300.415(b)(2)(vii)];

EPA is the lead agency at the Site. The Site was listed on the NPL on June 14, 2001. MassDEP has limited funds available to address the Site and there are no state response mechanisms available with sufficient funding to respond to the release.

IV. ENDANGERMENT DETERMINATION

Actual or threatened releases of hazardous substances at or from the Site, if not addressed by implementing the response action selected in this Action Memorandum, may present an imminent and substantial endangerment to public health and welfare.

V. EXEMPTION FROM STATUTORY LIMITS

It is expected that this removal action will be performed with PRP funds. However, if it were to be performed as a Fund-lead response, it would require funding above $2 million and more than one year to implement, thereby exceeding the statutory money and time limits on Fund-financed removal actions established under Section 104(c) of the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended (CERCLA), and Section 300.415(b)(5) of the National Oil and Hazardous Substances Pollution Contingency Plan, as amended (NCP). The proposed NTCRA is projected to cost approximately $5.2 million and take one to five years to complete. In the event that the removal action were to be performed as a Fund-lead response, a "consistency" exemption is invoked through this Action Memorandum to allow for the proposed removal action to exceed the $2 million ceiling and 12-month time limit for Fund-financed removal actions.

Section 104(c) of CERCLA, 42 U.S.C. § 9604(c), states that removal actions can exceed the $2 million and 12 month statutory limits if conditions meet either the "emergency exemption" criteria or the "consistency exemption" criteria. The consistency exemption requires that the proposed removal be appropriate and consistent with the remedial action to be taken. As described below conditions and proposed actions at the Site meet the criteria for a consistency exemption.

A. <u>Appropriateness</u>

EPA OSWER Directive 9360.0-12A, "Final Guidance on Implementation of the 'Consistency' Exemption to the Statutory Limits on Removal Actions," June 12, 1989, states that an action is appropriate if the activity is necessary for any *one* of the following reasons:

1. To avoid a foreseeable threat;
2. To prevent further migration of contaminants;
3. To use alternatives to land disposal, or,

4. To comply with the off-site policy.

The NTCRA described in Section VI below meets criteria one and two identified above. The proposed removal action abates the foreseeable threat posed by the migrating 1,4-dioxane groundwater plume. In addition, by addressing the off-property contaminated groundwater in advance of the full Remedial Design/Remedial Action, the removal action will minimize the scope and cost of the final remedial action and the potential for migration of contaminants to a public water supply.

The proposed removal action is therefore appropriate and necessary.

B. Consistent With the Remedial Action

The proposed NTCRA is also consistent with anticipated remedial actions to minimize exposure to and migration of contaminants. As indicated in EPA's 1989 guidance (p. 3), "the 'remedial action to be taken' is the remedial action that, prior to the start of the removal action, was planned or could reasonably have been expected to be taken."

The proposed NTCRA is one part of a phased approach to address concerns at the Nuclear Metals, Inc. Superfund Site. The other past and future components are (1) a time-critical removal action conducted in 2002 including: installation of a permanent fence around an area containing buried drums where local residents and a summer camp had direct access; capping of beryllium-contaminated soils overlying the same buried drum area; and lining of the holding basin with a temporary cover; (2) a MassDEP removal action that has addressed the 3,800 stored drums and containers of depleted uranium in the facility through an agreement reached with the U.S. Army; (3) a time-critical removal action conducted in 2008 to remove containers of flammable and other hazardous substances from the Site that constitute a threat of fire and/or explosion; (4) an on-going NTCRA to address contaminated buildings on the NMI Property; (5) the RI/FS completed in 2014 which characterized the Site contaminants; and (6) the ROD for the Site, issued concurrently with this Action Memorandum, which will address site-wide contamination not addressed in prior actions.

Because the proposed NTCRA is both appropriate and consistent with the remedial action to be taken, EPA finds that the requirements of the consistency exemption under Section 104(c) of CERCLA have been met.

VI. PROPOSED ACTIONS AND ESTIMATED COSTS

A. Proposed Action

EPA issued a Feasibility Study Report in November 2014 which found that groundwater at the Site is contaminated with 1,4-dioxane and VOCs most likely from the use of VOCs as solvents at the Site. The VOCs used likely contained 1,4-dioxane as a stabilizer. The Feasibility Study Report, also functioning as the Engineering Evaluation and Cost Analysis ("EE/CA") equivalent

for this NTCRA, evaluated several alternatives for addressing VOCs and 1,4-dioxane in groundwater. EPA issued a proposed cleanup plan ("Proposed Plan") for public comment on October 31, 2014 which outlined EPA's proposed cleanup approach for the Site and summarized the alternative cleanup approaches considered. The proposed plan recommended hydraulic containment (by pumping from overburden and bedrock extraction wells) and ex-situ treatment to address 1,4-dioxane and VOCs in groundwater. An estimate of the total pumping rate needed to hydraulically contain and cut off further migration of 1,4-dioxane is ~12 gallon per minute (gpm). Treatment at this relatively low flow rate, while not inexpensive, is feasible and this alternative is readily implemented. The Proposed Plan was based on findings from the Remedial Investigation (April 2014) and Feasibility Study Reports issued by EPA.

The Proposed Plan also sought comment on accelerating the 1,4-dioxane and VOC groundwater extraction and *ex-situ* treatment portion of the proposed remedy as a NTCRA. This accelerated action was proposed because recent sampling has shown that the 1,4-dioxane plume at the Site may be migrating away from the NMI Property under the Assabet River, and taking early action to contain the plume could prevent the further migration. Previous sampling results had shown that the 1,4-dioxane plume was contained with no signs of migration.

The ROD selected the remedy proposed in the Proposed Plan and EPA has elected to issue this Action Memorandum to accelerate a portion of the groundwater remedy. This NTCRA includes extraction of overburden and bedrock groundwater with *ex-situ* treatment for VOCs and 1,4-dioxane and discharge to surface water or underground injection. The estimated cost of this portion of the groundwater remedy is $5.2 million. This includes design, construction and up to four years of monitoring, operation, and maintenance. Long-term operation and maintenance and long-term monitoring of this portion of the groundwater remedy is included as part of the remedial action for the Site.

1. Removal Action Objectives

Prevent Release to the Environment

Prevent the further migration of contaminated groundwater.

Prevent Direct Exposure to Contaminants

Prevent direct contact with, ingestion of, contaminated groundwater that present an unacceptable risk to human health and the environment. This NTCRA is designed to address the cleanup of contaminated groundwater in exceedance of the ROD cleanup levels for 1,4-dioxane (0.46ug/l), 1,1-dichloroethane (2.7ug/l), Tetrachloroethene (5ug/l), Tricholorethene (5ug/l), and Vinyl Chloride (2ug/l).

Contribute to the Efficient Performance of Remedial Activities

To the extent practicable, contribute to the efficient performance of the anticipated long-term remedial action with respect to the release concerned, as outlined in the ROD.

2. Proposed action description

The alternatives that were subject to detailed analysis in the FS as the EE/CA equivalent are summarized below. As noted below, only certain portions of these alternatives are the subject of this NTCRA.

Removal Action Alternatives:

GW-1: No Action

Alternative GW-1 is the no action alternative. This alternative provides no active groundwater treatment. Concentrations of VOCs and 1,4-dioxane in groundwater would be reduced somewhat through natural attenuation via dispersion, dilution, and volatilization. There is no cost estimated as part of this alternative.

GW-2: Limited Actions / Institutional Controls

Alternative GW-2 includes: (1) implementation of institutional controls to and (2) long-term groundwater monitoring for DU, VOCs/1,4-dioxane and natural uranium to monitor the plumes and evaluate concentration decreases due to natural attenuation. The total estimated present value cost of this alternative is approximately $2.9 million. Since there is no provision for active treatment in this alternative, there would be no cost for this NTCRA action under this alternative.

GW-3: *Ex-Situ* Treatment

Alternative GW-3 includes: (1) extraction of overburden groundwater downgradient of the Holding Basin (DU source area) with *ex-situ* treatment and discharge to surface water; (2) extraction of overburden and bedrock groundwater in the off-property area between Main Street and the Assabet River with *ex-situ* treatment for 1,4-dioxane and VOCs and discharge to surface water; (3) extraction of groundwater from shallow bedrock at the downgradient end of the natural uranium plume with *ex-situ* treatment for uranium removal and discharge to surface water; (4) implementation of institutional controls; and (5) long-term groundwater monitoring for DU, VOCs/1,4-dioxane and natural uranium to monitor the effectiveness of *in-situ* and *ex-situ* treatment and to evaluate concentration decreases due to natural attenuation. The total estimated present value cost of this alternative is approximately $29.3 million. The portion of this alternative that would be completed as a NTCRA is similar in scope and cost ($5.2 million) to alternative GW-4 below.

GW-4: Ex-Situ Treatment of VOCs/1,4-Dioxane, and *In-Situ* Treatment of DU And Natural Uranium (EPA's Preferred Alternative)

Alternative GW-4 includes: (1) extraction of overburden and bedrock groundwater with *ex-situ* treatment for VOCs and 1,4-dioxane and discharge to surface water or recharge/reinjection into the aquifer; (2) injection of apatite and/or Zero Valent Iron (ZVI) based media in the overburden DU and natural uranium bedrock plumes to remove uranium from groundwater in sorbed and

mineral precipitate forms; (3) long-term groundwater monitoring to monitor effectiveness of *in-* and *ex-situ* treatment and to evaluate concentration decreases due to natural attenuation; (4) implementation of institutional controls. The total estimated present value cost of this alternative is approximately $20.2 million. The portion of this alternative to be completed as a NTCRA, the initial construction and up to 4 years of operation, maintenance and monitoring of the system to capture the 1,4-dioxane and VOC plume, is estimated to cost $5.2 million.

As required under CERCLA and the NCP, during the FS process, all of the alternatives were evaluated independently based upon cost, effectiveness, and implementability. Cost was used to assess options of similar effectiveness and implementability. Effectiveness was based upon the ability of the alternative to meet the removal action objectives. The effectiveness evaluation also involved the assessment of federal and state applicable or relevant and appropriate requirements (ARARs). Implementability involved the assessment of technical feasibility, availability, and administrative feasibility. After comparing these alternatives and weighing the strengths and weaknesses, EPA has selected Alternative GW-4 as presented below as the best balance of human health and environmental protection considering cost, effectiveness, and implementability of each of the alternatives. Immediately below is a comparison of the five alternatives based on effectiveness, implementability, and cost. See the FS Section 6.5 (as the EE/CA equivalent) for a more detailed presentation of the cost and components of each alternative.

Effectiveness
GW-2, GW-3 and GW-4 will prevent human exposure to contaminants in groundwater through institutional controls. GW-1 does not prevent human exposure to contaminants in groundwater at the Site. GW-3 and GW-4 limit migration of contaminants (through *ex-situ* or *in-situ* treatment). GW-1 and GW-2 will not limit migration of contaminants. GW-3 includes hydraulic containment and *ex-situ* treatment of the distal end of the DU plume rather than treatment throughout the plume; therefore, plume flushing times are expected to be longer for GW-3 than for GW-4. GW-4 is likely to achieve the MCLs for DU and natural uranium more quickly (15 years) than the other alternatives (greater than 200 years) because it includes *in-situ* treatment throughout the plumes. The estimated time to reach cleanup levels for VOCs/1,4-dioxane for GW-1 and 2 is greater than 50 years. GW-3 and GW-4 will likely meet cleanup levels for VOCs/1,4-dioxane within 30 years. ARARs for DU and natural uranium will not be achieved within a reasonable timeframe for alternatives GW-1 and GW-2 because they provide no treatment. It is relatively easy to monitor the effectiveness of GW-1, GW-2, GW-3 and GW-4 with long-term monitoring and 5-year reviews.

Implementability
Alternative GW-1 (No Action) is the easiest to implement because it does not involve the construction, operation or maintenance of remedial systems or enforcement of institutional controls. GW-2 is easier to implement than GW-3 or GW-4 because it does not require the construction, operation or maintenance of active remedial systems. However, GW-2 may be less reliable for limiting potential human exposure to contaminants in groundwater than GW-3 or GW-4 because it relies only on institutional controls. Of the active remedial alternatives

considered for groundwater, GW-3 is easier to implement in the short term than GW-4 as the ability to construct the *in-situ* treatment portion of GW-4 depends on subsurface conditions that affect direct-push injection equipment (which would be evaluated during pilot testing in the remedial design phase). The reliability of GW-3 is high because groundwater extraction and *ex-situ* treatment via ion exchange or advanced oxidation and discharge to surface water are relatively routine tasks. The reliability of *in-situ* treatment in alternative GW-4 has been proven at the bench scale for apatite, and ZVI is a proven media. *In-situ* treatment technology allows for a passive remedy that does not depend on long-term manipulation of groundwater geochemistry; and if successful, implementation of GW-4 will not have the long-term operating requirements of the active groundwater extraction and *ex-situ* treatment system included in GW-3.

Cost

The range in estimated cost for all four alternatives is from $0 for GW-1 (No Action) to $29.3 million for GW-3. A summary of costs for each alternative is provided below:

ALTERNATIVE	**TOTAL COST (IN MILLIONS)**	**NTCRA COST (IN MILLIONS)**
Alternative GW-1 – No Action	$0	$0
Alternative GW-2 – Limited Action – Monitoring and Access Controls	$2.9	$0
Alternative GW-3 – Ex-Situ Treatment	$29.3	$5.2
Alternative GW-4 – Ex-Situ Treatment of VOCs/1,4 Dioxane, and *In-Situ* Treatment of DU And Natural Uranium	$20.2	$5.2

Alternative GW-4 is EPA's selected groundwater remedy in the ROD: Ex-Situ Treatment of VOCs/1,4-Dioxane, and *In-Situ* Treatment of DU And Natural Uranium

Technical Description

The work to be conducted under Alternative GW-4 is discussed in detail in Section 6.4 of the FS. This NTCRA includes extraction of overburden and bedrock groundwater with *ex-situ* treatment for VOCs and 1,4-dioxane and discharge to surface water or underground injection. Extraction and *ex-situ* treatment are proven technologies for reducing 1,4-dioxane and VOCs in groundwater. There are no technical difficulties associated with this technology, and it can be implemented without major obstacles. Groundwater monitoring can easily be undertaken to determine the effectiveness of the treatment. The cost of this portion of the groundwater remedy

is $5.2 million. This includes design, construction and up to four years of operation and maintenance. Long-term operation and maintenance and long-term monitoring of this portion of the groundwater remedy is included as part of the remedial action for the Site.

Since this NCTRA includes only a portion of the GW-4 remedy, the following components of the GW-4 remedy do not apply to this NTCRA but will be completed pursuant to the ROD:

- injection of apatite and/or ZVI based media in the overburden DU and natural uranium bedrock plumes to remove uranium from groundwater in sorbed and mineral precipitate forms;
- long-term groundwater monitoring to monitor effectiveness of *in*- and *ex-situ* treatment and to evaluate concentration decreases due to natural attenuation; and
- implementation of institutional controls.

3. Community relations

In advance of and during performance of this NTCRA, EPA's Community Involvement Office will disseminate information regarding the project to the impacted residents and local citizen groups. There are two very active community groups that EPA meets with bi-monthly to discuss technical issues at the Site, the town-appointed 2229 Main Street Advisory Committee and the Technical Assistance Grant recipient group CREW (Citizens Research and Environmental Watch). EPA will continue to work closely with the town of Concord, CREW, and state officials as the NTCRA progresses.

The town of Concord, CREW, and the Commonwealth of Massachusetts fully support EPA's decision to accelerate the cleanup of 1,4-dioxane in groundwater under this NTCRA. MassDEP concurred with the selected remedy outlined in the ROD, including this NTCRA (attached as Appendix F to the ROD).

4. Contribution to remedial performance

Contribution to the Efficient Performance of Remedial Activities

Under Section 104(a)(2) of CERCLA and Section 300.415(d) of the NCP, removal activities shall, to the extent practicable, contribute to the efficient performance of any anticipated long-term remedial action with respect to the release concerned. See EPA's OSWER Directive 9360.0-13, "Guidance on Implementation of the 'Contribute to Remedial Performance' Provision." This provision was meant to avoid repetitive removal actions that do not take into account their impact on the performance of subsequent remedial actions and to allow for more permanent tasks to be completed under removal authorities. (See NCP Preamble, 53 Federal Register 51409-51410, December 21, 1988). Together, CERCLA Sections 104(a)(2) and 104(c) ("consistency" exemption) are intended to promote and enhance efficiency and continuity.

Section 104(a)(2) of CERCLA and Section 300.415(d) of the NCP require that any removal action should, to the extent deemed practicable, contribute to the efficient performance of any long term remedial action with respect to the release or threatened release concerned. This removal action will contribute to the efficient performance of the long term remedial action by eliminating the potential for further migration of hazardous substances in off-property groundwater near the Acton drinking water public supply wells. Because the performance of this NTCRA portion of groundwater cleanup is part of the selected remedial action, this NTCRA contributes to the efficient performance of the long term remedial action.

5. Description of alternative technologies considered

A detailed description of alternative groundwater treatment technologies is located in Section 3.2.1.3 of the FS (as the EE/CA equivalent). The FS stated that although there are numerous technologies available for treatment of VOCs/1,4-dioxane, groundwater extraction and ex-situ treatment with advanced oxidation or synthetic media adsorption (or similar treatment technologies) are the most effective for removal of 1,4-dioxane from groundwater. Although other technologies are effective for VOC removal (such as air stripping and carbon adsorption), they were less effective for 1,4-dioxane removal, and therefore, were not chosen. A summary of the effectiveness, technical implementability, and cost screening of the technologies for VOCs and 1,4-dioxane in overburden and bedrock groundwater are presented in Table 3.2.2 of the FS.

6. Applicable or relevant and appropriate regulations (ARARs)

The ARARs tables can be found in Appendix D of the ROD.

7. Project schedule

Duration of the removal action shall be one to five years from the day of its commencement.

B. Estimated Costs

The estimated costs associated with this alternative are $5.2 million. A more detailed breakdown of costs associated with this alternative can be found in the attached Table 1.

VII. EXPECTED CHANGE IN THE SITUATION SHOULD ACTION BE DELAYED OR NOT TAKEN

In the absence of the removal action described herein, conditions at the Site can be expected to remain unaddressed until implementation of the remedial action, and threats associated with the presence of contaminated groundwater migrating to public supply wells will continue to pose a threat of release.

VIII. OUTSTANDING POLICY ISSUES

There have been no outstanding policy issues identified to date.

IX. ENFORCEMENT

See attached Enforcement Strategy (for internal distribution only).

X. RECOMMENDATION

This decision document represents the selected removal action for the Nuclear Metals, Inc. Superfund Site in Concord, MA, developed in accordance with CERCLA, as amended, and is not inconsistent with the NCP. The decision is based on documents contained in the Administrative Record for the Site.

Conditions at the Site meet the criteria set out in the NCP Section 300.415(b)(2) due to:

"Actual or potential exposure to nearby human populations, animals or the food chain from hazardous substances or pollutants or contaminants" [§ 300.415(b)(2)(i)];

"Actual or potential contamination of drinking water supplies or sensitive ecosystems" [§ 300.415(b)(2)(ii)]; and

"The availability of other appropriate federal or state response mechanisms to respond to the release" [§ 300.415(b)(2)(vii)].

I recommend that you approve the proposed removal action. Your signature will also reflect that an exemption pursuant to Section 104(c) of CERCLA and Section 300.415(b)(5)(ii) of the NCP has been granted.

APPROVAL: Nancy Barmakian DATE: 09/28/15

DISAPPROVAL: _____ DATE: _____

Table 1: GROUNDWATER NTCRA
COST ESTIMATE SUMMARY

Feasibility Study
Nuclear Metals, Inc. Superfund Site

:Discount Rate **7.00%**

Item	Year	Unit Cost	Total Cost
CAPITAL EXPENDITURES			
Pre-Design Investigation			
Pump Test for 1,4-dioxane Containment System	1	$ 500,000	$ 500,000
Pre-design Investigation Subtotal			$ 500,000
Remedial Design			
Remedial Design	1	$ 165,200	$ 165,200
Remedial Action			
Hydraulic Containment	2	$ 299,700	$ 261,800
Ex-Situ Treatment	2	$ 1,701,800	$ 1,486,400
Groundwater Monitoring Wells	2	$ 81,600	$ 71,300
Professional Labor and Management	2	$ 412,200	$ 360,000
Remedial Action Subtotal			***$ 2,179,500***
Capital Expenditures - Subtotal			***$ 2,844,700***
Contingency (Capital Expenditures)	30%		$ 853,400
CAPITAL EXPENDITURES - TOTAL COST			**$ 3,698,000**
OPERATION, MAINTENANCE, MONITORING & REPORTING (OMM&R) COSTS			
Operation and Maintenance (O&M)			
General Operations	2-5	$ 250,000	$ 573,000
Advanced Oxidation System	2-5	$ 129,900	$ 297,800
Electricity Usage	2-5	$ 33,000	$ 75,600
O&M Subtotal			***$ 946,400***
Project Management			
Project Management	2-5	$ 100,000	$ 229,218
OMM&R Subtotal			***$ 1,175,618***
Contingency (OMM&R)	30%		$ 352,700
OMM&R - TOTAL COST			**$ 1,528,000**
TOTAL PROJECT COST - NET PRESENT VALUE	**7.0%**		**$ 5,226,000**

Notes:

A. Total costs are rounded to the nearest $100.

B. Future capital costs beyond Year 1 are subject to NPV calculation. Future discount rate is subject to change.

Assumptions:

1. Costs assume deed restrictions prohibiting groundwater use will be executed for the Site.
2. Hydraulic containment for the 1,4-dioxane plumes will consist of one (1) overburden extraction well with a depth of 100 ft and pumping rate of 2 gpm and two (2) bedrock wells with depths of 120 ft and pumping rates of approximately 1 gpm each.
3. Nine (9) monitoring wells will be installed in the vicinity of the extraction wells to demonstrate capture of the 1,4-dioxane plumes, three (3) in the overburden and six (6) in the bedrock.
4. Drill cuttings will be disposed on-site.
5. Well development water will be stored on-site and treated in the final system
12. This alternative is illustrated on Figure 3

APPENDIX G

TSCA 40 CFR SECTION 761.61(c) DETERMINATION

APPENDIX G

TSCA 40 CFR SECTION 761.61(c) DETERMINATION

This Determination is included in EPA's Record of Decision to address cleanup of soil, sediment, and groundwater contamination at the Nuclear Metals, Inc. Superfund Site located in Concord, Massachusetts. In general, PCB-contaminated soils and sediments with greater than ("$>$") 1 part per million ("ppm") will be excavated and disposed off-site.

EPA's Superfund program has determined that PCB-contaminated sediments and soils with PCB concentrations greater than or equal to ("$\geq$") 50 ppm located at the Nuclear Metals, Inc. Superfund Site meet the definition of a *PCB remediation waste* as defined under 40 CFR § 761.3. Therefore, these PCB-contaminated sediments and soils are regulated for cleanup and disposal under 40 CFR Part 761. PCB-contaminated sediments and soils with less than ("$<$") 50 ppm will be excavated and disposed of in accordance with state requirements.

EPA's Administrative Record, available for public review, includes extensive information on the nature of the contamination, location and extent of the contamination, the procedures used relative to sampling, Human Health and Ecological Risk Assessments, and the Proposed Plan for the Nuclear Metals, Inc. Superfund Site.

Consistent with 40 CFR 761.61(c) of the Toxic Substances Control Act ("TSCA"), I have determined that the method of excavation and disposal of the $\geq$ 50 ppm PCB-contaminated sediments and soils as described will not pose an unreasonable risk of injury to health or the environment as long as the following conditions are met:

1. The selected contractor for the PCB remediation work shall submit a contractor work plan describing the containment and air monitoring that will be employed during PCB remedial activities, including but not limited to site control, excavation, handling, storage, and disposal activities. This work plan should also include information on how and where all PCB-contaminated wastes (both less than ("$<$") 50 ppm and $\geq$ 50 ppm) will be stored and disposed of, how stormwater controls and runoff will be managed, how dust levels will be controlled and monitored, and on how field equipment will be decontaminated.

2. Two PCB-contaminated sediment and soil samples with $\geq$ 50 ppm PCBs are located in Areas of Investigation (AOIs) 4 and 8, as shown in **Attachment 1.** Identified PCB-contaminated soils and sediments with $\geq$ 50 ppm shall be excavated and disposed off-site at a TSCA-approved disposal facility or a RCRA hazardous waste landfill in accordance with 40 CFR § 761.61(a)(5)(i)(B)(*2*)(*iii*). Confirmatory sampling shall be conducted in accordance with 40 CFR Part 761, Subpart O to document that all PCBs with $\geq$ 50 ppm have been removed. The locations of these PCB-contaminated soil and sediment areas are identified in **Attachment 1.**

3. Compliance with the PCB regulations at 40 CFR Part 761 is maintained during all phases of work involving ≥ 50 ppm PCB-contaminated soils and/or sediments, including but not limited to:

   a. 40 CFR Part 761 Subpart C – Marking of PCBs and PCB Items
   b. 40 CFR § 761.50(b)(7) – PCB/Radioactive waste
   c. 40 CFR § 761.65 – Storage for Disposal
   d. 40 CFR § 761.79 – Decontamination Standards and Procedures
   e. 40 CFR Part 761 Subpart K – PCB Waste Disposal Records and Reports

This Determination is based on the information contained in the Administrative Record. In the event that PCBs are identified in other areas located on the Nuclear Metals Superfund Site that meet the definition of a *PCB remediation waste* and that are not addressed under this TSCA Determination, compliance with 40 CFR § 761.61 for cleanup and disposal of these PCBs shall be required.

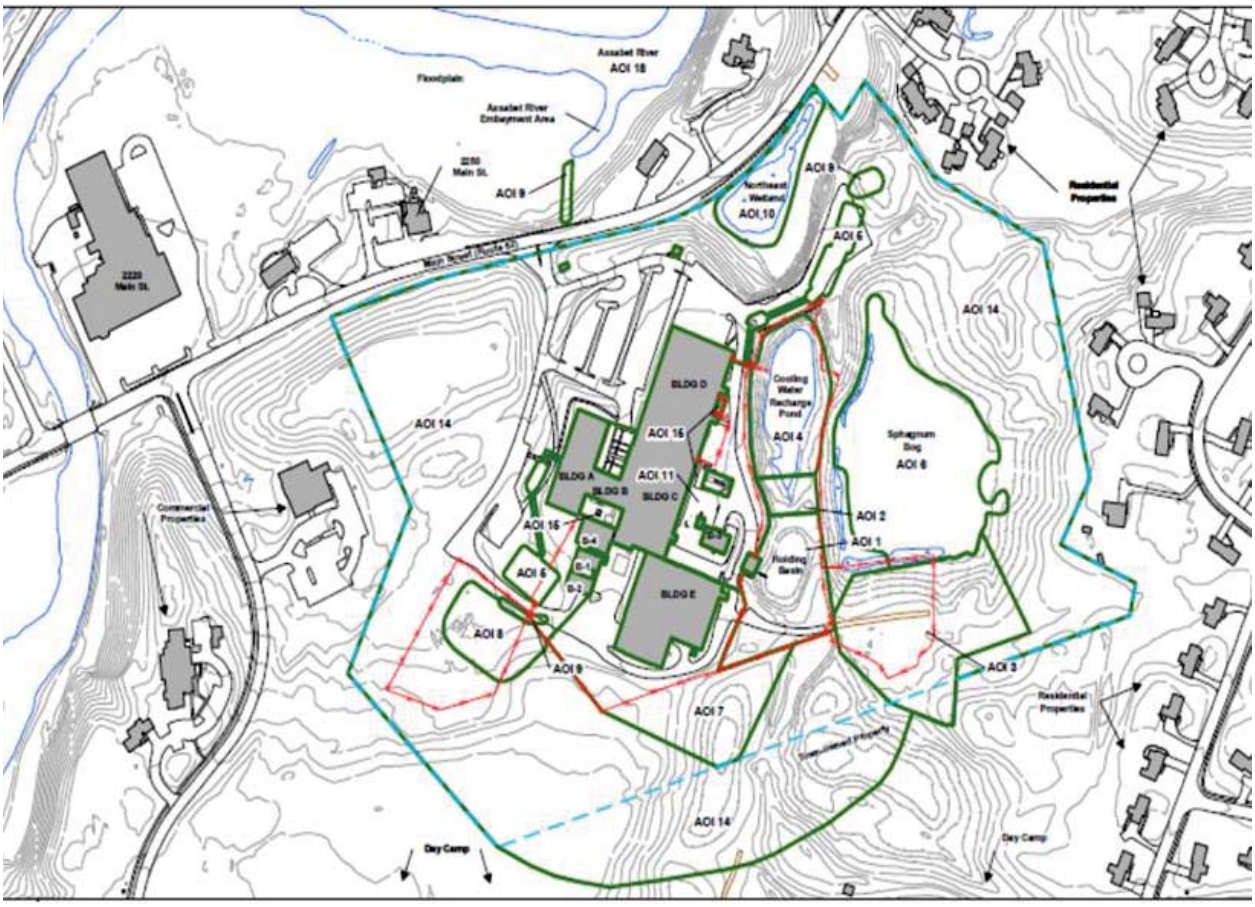
Nancy Barmakian 09/28/15

Nancy Barmakian, Acting Director — Date

Office of Site Remediation & Restoration

Attachment 1: ≥ 50 ppm PCB-contaminated soils and sediments AOIs 4 and 8

Attachment 1



APPENDIX H

LIST OF ACRONYMS AND ABBREVIATIONS

LIST OF ACRONYMS AND ABBREVATIONS

AOC	Administrative Order on Consent
AOI	Areas of Investigation
ARAR	Applicable or Relevant and Appropriate Requirement
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BHHRA	Baseline Human Health Risk Assessment
BSAF	Biota-Soil Accumulation Factor
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
cm	centimeter
CMR	Code of Massachusetts Regulations
COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
CREW	Citizens Research and Environmental Watch
CSGWPP	Comprehensive State Ground Water Protection Program
CSM	Conceptual Site Model
CTEs	Central Tendency Exposures
CWA	Clean Water Act
cy	cubic yard
DCA	Dichloroethane
DCE	Dichloroethene
DU	Depleted Uranium
EA	Exposure Area
EDI	Estimated Daily Intake
EE/CA	Engineering Evaluation/Cost Analysis
EPA	United States Environmental Protection Agency
EPC	Exposure Point Concentration
ESD	Explanation of Significant Differences
FETAX	Frog Embryo teratogenesis assay - using *Xenopus*
FS	Feasibility Study
GERE	Grant of Environmental Restriction and Easement
GWTP	Ground Water Treatment Plant
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
ICs	Institutional Controls
Id	*Idem* (“the same”)
ILCR	Incremental Lifetime Cancer Risk
IR	Incremental Risk
ISRZ	*In-Situ* Reactive Zones

kg	kilogram
L	liter
LLC	Limited Liability Company
m	meter
MADPH	Massachusetts Department of Public Health
MADPH-RCP	Massachusetts Department of Public Health-Radiation Control Program
MANHESP	Massachusetts Natural Heritage and Endangered Species Program
MassDEP	Massachusetts Department of Environmental Protection
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MCP	Massachusetts Contingency Plan
mg	milligram
M.G.L.	Massachusetts General Law
MM	Management of Migration
NAUL	Notice of Activity and Use Limitation
NCP	National Contingency Plan
NMI	Nuclear Metals, Incorporated
NPL	National Priorities List
NTCRA	Non-Time Critical Removal Action
O&M	Operation and Maintenance
OSRR	Office of Site Remediation and Restoration
OSWER	Office of Solid Waste and Emergency Response
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethene
ppb	parts per billion
ppm	parts per million
PRG	Preliminary Remediation Goal
PRP	Potentially Responsible Party
RAGS	Risk Assessment Guidance for Superfund
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RfC	reference concentration
RfD	reference dose
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SC	Source Control
SLERA	Screening Level Ecological Risk Assessment
SQT	Sediment Quality Triad
SRI	Superfund Redevelopment Initiative
SSL	Soil Screening Level
SVOC	Semivolatile Organic Compound
TAG	Technical Assistance Grant
TBC	To Be Considered
TCA	1,1,1-Trichloroethane

TCE	Trichloroethene
TRV	Toxicity Reference Value
TSCA	Toxic Substances Control Act
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
ug	microgram
USC	United States Code
VISL	Vapor Intrusion Screening Guidance
VOC	Volatile Organic Compound
ZVI	Zero-Valent Iron

APPENDIX I

ADMINISTRATIVE RECORD INDEX

Nuclear Metals

NPL Site Administrative Record

Record of Decision (ROD)
And Non-Time Critical Removal Action
(NTCRA)

Index

ROD Signed: September 2015
Admin. Record Released: September 2015

Prepared by
EPA New England
Office of Site Remediation & Restoration

Introduction to the Collection

This is the Administrative Record Index for the Administrative Record (AR), for the Nuclear Metals Superfund Site (Site), located in Concord, Massachusetts. This Record of Decision (ROD) and Non-Time Critical Removal Action (NTCRA) Memorandum was released in September, 2015. The file contains site-specific documents and a list of guidance documents used by EPA staff in selecting a proposed response action at the Site.

This Administrative Record replaces the Administrative Record File for the ROD Proposed Plan released in November 2014. This Administrative Record index includes, by reference, the following Administrative Records issued on dates indicated: Removal Action in August 2002, Supplemental Removal Action in April 2003, Removal Action in February 2008, and Non-Time Critical Removal Action (NTCRA) in September 2008. This Administrative Record index includes, by reference, the following Administrative Records issued on dates indicated: Removal Action in August 2002, Supplemental Removal Action in April 2003, Removal Action in February 2008, and Non-Time Critical Removal Action (NTCRA) in September 2008. Documents listed in a bibliography to a document included in the administrative record (e.g., listed in the bibliography to the RI/FS) are included in this administrative record by reference and might not be listed separately in this index.

The administrative record file is available for review at:

Concord Public Library, Concord, MA
129 Main St, Concord, MA 01742
Phone: (978) 318-3300
Email: concord@minlib.net
Concord Free Public Library Homepage: http://www.concordlibrary.org/

U.S. Environmental Protection Agency
Office of Site Remediation and Restoration Records Center
5 Post Office Square, Suite 100
Boston, MA 02109-3912
Tel. (617)918-1440
Hours: Monday - Friday 9:00 a.m. to 5:00 p.m.
Website: http://www.epa.gov/region1/cleanup/resource/records/

An administrative record file is required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA).

Please note that the compact disc(s) (CD) containing this Administrative Record may include index data and other metadata (hereinafter collectively referred to as metadata) to allow the user to conduct index searches and key word searches across all the files contained on the CD. All the information that appears in the metadata, including any dates associated with creation of the indexing data, is not part of the Administrative Record for the Site under CERCLA and shall not

be construed as relevant to the documents that comprise the Administrative Record. This metadata is provided as a convenience for the user and is not part of the Administrative Record.

Questions about this administrative record file should be directed to the EPA New England project manager.

NUCLEAR METALS, INC.
AR Collection: 63554
Record of Decision (ROD) and Non-Time Critical Removal Action (NTCRA)
AR Collection Index Report
For External Use

Phase 02: REMOVAL RESPONSE

582987 **ENGINEERING EVALUATION / COST ANALYSIS (EE/CA) EQUIVALENT APPROVAL MEMORANDUM FOR NON-TIME CRITICAL REMOVAL ACTION (NTCRA)**

Author: MELISSA TAYLOR, US EPA REGIO
Addressee: NANCY BARMAKIAN, US EPA REGION 1
Doc Type: CORRESPONDENCE
EE/CA START APPROVAL
MEMO
Doc Date: 09/18/2015
# of Pages: 8
File Break: 02.02

Phase 03: REMEDIAL INVESTIGATION (RI)

519891 **LETTER COMMENTING ON DRAFT REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS) WORK PLAN**

Author: DANIEL KEEFE, MA DEPT OF ENV
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER
PUBLIC (AND OTHER) COMMENTS
Doc Date: 03/24/2004
# of Pages: 7
File Break: 03.07

567928 **LETTER PROVIDING COMMENTS ON DRAFT REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS) WORK PLAN**

Author: MICHAEL J WEBSTER, GEOINSIGI
Addressee: , CITIZENS RESEARCH AND ENV
MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER
PUBLIC (AND OTHER) COMMENTS
Doc Date: 04/23/2004
# of Pages: 42
File Break: 03.07

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Phase 03: REMEDIAL INVESTIGATION (RI)

567930 **LETTER PROVIDING RESPONSE TO COMMENTS ON DRAFT REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS) WORK PLAN**

Author: MELISSA TAYLOR, US EPA REGIO
Addressee: , CONCORD (MA) TOWN OF
Doc Type: CORRESPONDENCE
LETTER
PUBLIC (AND OTHER) COMMENTS
Doc Date: 05/19/2004
# of Pages: 7
File Break: 03.07

568462 **MEMO REGARDING RESPONSE TO COMMENTS ON DRAFT REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS) WORK PLAN**

Author: MELISSA TAYLOR, US EPA REGIO
Addressee: DANIEL KEEFE, MA DEPT OF ENVIRONMENTAL PR
Doc Type: CORRESPONDENCE
MEMO
PUBLIC (AND OTHER) COMMENTS
Doc Date: 05/19/2004
# of Pages: 10
File Break: 03.07

457308 **FIELD SAMPLING PLAN (FSP)**

Author: , DE MAXIMIS INC
Addressee: , GEOSYNTEC CONSULTANTS IN
, MACTEC ENGINEERING AND C
Doc Type: WORK PLAN
Doc Date: 09/29/2004
# of Pages: 540
File Break: 03.07

457309 **QUALITY ASSURANCE PROJECT PLAN (QAPP)**

Author: , DE MAXIMIS INC
Addressee: , GEOSYNTEC CONSULTANTS IN
, MACTEC ENGINEERING AND C
Doc Type: WORK PLAN
Doc Date: 09/29/2004
# of Pages: 657
File Break: 03.07

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457310 **HEALTH AND SAFETY PLAN**

Author: , DE MAXIMIS INC
Addressee: , GEOSYNTEC CONSULTANTS IN
, MACTEC ENGINEERING AND C
Doc Type: WORK PLAN
Doc Date: 09/29/2004
# of Pages: 558
File Break: 03.07

457311 **SITE MANAGEMENT PLAN**

Author: , DE MAXIMIS INC
Addressee: , GEOSYNTEC CONSULTANTS IN
, MACTEC ENGINEERING AND C
Doc Type: WORK PLAN
Doc Date: 09/29/2004
# of Pages: 118
File Break: 03.07

557003 **LETTER REGARDING REMEDIAL INVESTIGATION / FEASIBILITY STUDY (RI/FS) WORK PLAN MODIFICATION REQUEST NO. 1**

Author: BRUCE R THOMPSON, DE MAXIM
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER
Doc Date: 10/19/2004
# of Pages: 56
File Break: 03.07

457304 **PROJECT SUMMARY AND OPERATIONS PLAN**

Author: , DE MAXIMIS INC
Addressee: , GEOSYNTEC CONSULTANTS IN
, MACTEC ENGINEERING AND C
Doc Type: WORK PLAN
Doc Date: 04/15/2005
# of Pages: 629
File Break: 03.07

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Phase 03: REMEDIAL INVESTIGATION (RI)

457305 **GROUNDWATER MODELING PLAN**

Author: , DE MAXIMIS INC
Addressee: , GEOSYNTEC CONSULTANTS IN
, MACTEC ENGINEERING AND C
Doc Type: WORK PLAN
Doc Date: 04/15/2005
# of Pages: 79
File Break: 03.07

457306 **RISK ASSESSMENT PLAN**

Author: , DE MAXIMIS INC
Addressee: , GEOSYNTEC CONSULTANTS IN
, MACTEC ENGINEERING AND C
Doc Type: WORK PLAN
Doc Date: 04/15/2005
# of Pages: 195
File Break: 03.07

567936 **REVISED PHASE 1B SCOPE OF WORK (SOW)**

Author: BRUCE R THOMPSON, DE MAXIM
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER
Doc Date: 09/27/2005
# of Pages: 854
File Break: 03.03

568430 **MEMO REGARDING REVIEW OF CITIZENS RESEARCH AND ENVIRONMENTAL WATCH (CREW) TECHNICAL NOTE 2006-01: COMMENTS ON RADIOLOGICAL REVIEW OF FALL 2004 REMEDIAL INVESTIGATION (RI) ANALYTICAL DATA**

Author: ANDREW SCHKUTA, METCALF &
Addressee: EDWARD A CONROY, METCALF & EDDY INC
Doc Type: CORRESPONDENCE
MEMO
Doc Date: 01/13/2006
# of Pages: 6
File Break: 03.02

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568449 **DRAFT FOR AGENCY REVIEW AND COMMENT LETTER REGARDING RESPONSE TO COMMENTS IN CITIZENS RESEARCH AND ENVIRONMENTAL WATCH (CREW) TECHNICAL NOTE NO. 2006-1 - RADIOLOGICAL REVIEW OF FALL 2004 ANALYTICAL DATA [REDLINE, HIGHLIGHTING, MARGINALIA]**

Author: , DE MAXIMIS INC
Addressee: , US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER
Doc Date: 03/09/2006
# of Pages: 12
File Break: 03.02

568448 **LETTER REGARDING RESPONSE TO COMMENTS IN CITIZENS RESEARCH AND ENVIRONMENTAL WATCH (CREW) TECHNICAL NOTE NO. 2006-1**

Author: BRUCE R THOMPSON, DE MAXIM
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER
Doc Date: 04/03/2006
# of Pages: 66
File Break: 03.02

568433 **MEMO REGARDING RESPONSE TO COMMENTS ON RADIOLOGICAL REVIEW OF FALL 2004 ANALYTICAL DATA, CITIZENS RESEARCH AND ENVIRONMENTAL WATCH (CREW) TECHNICAL NOTE NO. 2006-1 (12/15/2005 URANIUM ANALYSIS MEMO ATTACHED)**

Author: MELISSA TAYLOR, US EPA REGIO
Addressee: JAMES L WEST, CREW (NUCLEAR METALS)
Doc Type: CORRESPONDENCE
MEMO
Doc Date: 04/25/2006
# of Pages: 7
File Break: 03.02

567935 **REVISED PHASE 1C WORK PLAN**

Author: BRUCE R THOMPSON, DE MAXIM
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER
WORK PLAN
Doc Date: 05/07/2007
# of Pages: 718
File Break: 03.07

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AR Collection: 63554
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AR Collection Index Report
For External Use

Phase 03: REMEDIAL INVESTIGATION (RI)

568437 **MEMO REGARDING THOREAU HILLS SURFICIAL SOIL SAMPLING RESULTS**

Author: MICHAEL J WEBSTER, GEOINSIGI
Addressee: , DE MAXIMIS INC
, US EPA
Doc Type: CORRESPONDENCE
MEMO
SAMPLING DATA

Doc Date: 03/17/2008 **# of Pages:** 36
File Break: 03.02

567934 **LETTER REGARDING ADDITIONAL PHASE 1C SAMPLING (05/2008 GROUNDWATER SAMPLING TABLE, 2008 GROUNDWATER MONITORING SCHEDULE AND FIGURE ATTACHED)**

Author: JOHN M HUNT, DE MAXIMIS INC
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER

Doc Date: 04/14/2008 **# of Pages:** 6
File Break: 03.01

70002852 **DRAFT ASSABET RIVER SEDIMENT STATISTICAL REPORT: AN EXAMINATION OF SITE AND BACKGROUND SEDIMENT SAMPLE DATA WITH STATISTICAL COMPARISONS**

Author: , MACTEC ENGINEERING AND C
Addressee: , DE MAXIMIS INC
Doc Type: REPORT
SAMPLING DATA

Doc Date: 07/30/2008 **# of Pages:** 71
File Break: 03.10

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Phase 03: REMEDIAL INVESTIGATION (RI)

555798 **TECHNICAL MEMO REGARDING DELINEATION OF GROUNDWATER CONTAMINANTS**

Author: DAVID ADILMAN, GEOSYNTEC C
Addressee: PETER ZEEB, GEOSYNTEC CONSU
JOHN M HUNT, DE MAXIMIS INC
BRUCE R THOMPSON, DE MAXIMIS INC
Doc Type: CORRESPONDENCE
MEMO

Doc Date: 01/12/2009 **# of Pages:** 132
File Break: 03.02

557000 **TECHNICAL MEMO REGARDING DELINEATION OF SOIL, SEDIMENT AND SURFACE WATER CONTAMINATION**

Author: NADIA GLUCKSBERG, MACTEC F
Addressee: ROD PENDLETON, MACTEC ENGI
JAY PETERS, MACTEC ENGINEER
BRUCE R THOMPSON, DE MAXIMIS INC
Doc Type: CORRESPONDENCE
MEMO

Doc Date: 01/16/2009 **# of Pages:** 1,310
File Break: 03.02

567929 **LETTER PROVIDING COMMENTS ON DELINEATION OF SOIL, SEDIMENT, SURFACE WATER AND GROUNDWATER CONTAMINATION TECHNICAL MEMORANDUM**

Author: MELISSA TAYLOR, US EPA REGIO
Addressee: , METCALF & EDDY INC
Doc Type: CORRESPONDENCE
MEMO
PUBLIC (AND OTHER) COMMENTS

Doc Date: 04/28/2009 **# of Pages:** 4
File Break: 03.07

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Phase 03: REMEDIAL INVESTIGATION (RI)

555799 **LETTER REGARDING RESPONSE TO COMMENTS ON DELINEATION MEMORANDA**

Author: BRUCE R THOMPSON, DE MAXIM
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER
Doc Date: 09/08/2009
# of Pages: 31
File Break: 03.02

75000293 **CITIZENS RESEARCH AND ENVIRONMENTAL WATCH (CREW) COMMENTS ON THE BASELINE ECOLOGICAL RISK ASSESSMENT (BERA)**

Author: , CITIZENS RESEARCH AND ENV
Addressee:
Doc Type: PUBLIC (AND OTHER) COMMENTS
REPORT
Doc Date: 08/19/2011
# of Pages: 5
File Break: 03.10

567932 **DEPLETED URANIUM FATE AND TRANSPORT MODEL**

Author: , GEOSYNTEC CONSULTANTS
Addressee: , DE MAXIMIS INC
Doc Type: REPORT
Doc Date: 01/01/2012
# of Pages: 80
File Break: 03.01

567933 **REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS) STATUS REPORT, GROUND WATER SAMPLES - METALS/RAD - 07/30/2013 - 08/05/2013**

Author:
Addressee:
Doc Type: REPORT
SAMPLING DATA
Doc Date: 08/05/2013
# of Pages: 10
File Break: 03.02

Phase 03: REMEDIAL INVESTIGATION (RI)

555797 **FINAL HUMAN HEALTH RISK ASSESSMENT (HHRA)**

Author: , HALEY & ALDRICH INC
Addressee: , DE MAXIMIS INC
Doc Type: REPORT
RISK/HEALTH ASSESSMENT
Doc Date: 09/04/2013
# of Pages: 4,609
File Break: 03.09

555795 **REMEDIAL INVESTIGATION (RI) REPORT**

Author: , AMEC ENVIRONMENT AND INF
Addressee: , DE MAXIMIS INC
, GEOSYNTEC CONSULTANTS IN
, HALEY & ALDRICH INC
Doc Type: REMEDIAL INVESTIGATION (RI)
REPORT
Doc Date: 04/01/2014
# of Pages: 5,888
File Break: 03.06

555796 **MEMO REGARDING APPROVAL OF DRAFT HUMAN HEALTH RISK ASSESSMENT (HHRA) AND CONDITIONAL APPROVAL OF DRAFT REMEDIAL INVESTIGATION (RI) REPORT**

Author: MELISSA TAYLOR, US EPA REGIO
Addressee: BRUCE R THOMPSON, DE MAXIMIS INC
Doc Type: CORRESPONDENCE
MEMO
Doc Date: 04/02/2014
# of Pages: 2
File Break: 03.06

561873 **BASELINE ECOLOGICAL RISK ASSESSMENT (ERA)**

Author: , HALEY & ALDRICH INC
Addressee: , DE MAXIMIS INC
Doc Type: REPORT
RISK/HEALTH ASSESSMENT
Doc Date: 06/03/2014
# of Pages: 1,549
File Break: 03.10

Phase 04: FEASIBILITY STUDY (FS)

568426 **LETTER REGARDING COMMENTS ON REVISED PHASE 1B SCOPE OF WORK (SOW), SUBMITTED ON BEHALF OF CITIZENS RESEARCH AND ENVIRONMENTAL WATCH (CREW)**

Author: MICHAEL J WEBSTER, GEOINSIGI
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER
Doc Date: 12/01/2005
# of Pages: 9
File Break: 04.03

567938 **LETTER REGARDING US EPA NATIONAL REMEDY REVIEW BOARD (NRRB) MEETING TO REVIEW CLEANUP ALTERNATIVES FOR SITE**

Author: ROBERT G CIANCIARULO, US EP/
Addressee:
Doc Type: CORRESPONDENCE
LETTER
Doc Date: 08/22/2013
# of Pages: 2
File Break: 04.09

568453 **LETTER REGARDING RESPONSE TO COMMENTS ON DEPLETED URANIUM (DU) METAL EXTERIOR SITE CHARACTERIZATION SURVEY PLAN**

Author: BRUCE R THOMPSON, DE MAXIM
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER
Doc Date: 09/24/2013
# of Pages: 33
File Break: 04.07

568451 **EMAIL REGARDING APPROVAL OF REVISED DEPLETED URANIUM (DU) SCANNING PLAN (EMAIL HISTORY ATTACHED)**

Author: MELISSA TAYLOR, US EPA REGIO
Addressee: ANDREW SCHKUTA, AECOM ENVIRONMENT
BRUCE R THOMPSON, DE MAXIMIS INC
Doc Type: CORRESPONDENCE
EMAIL
Doc Date: 09/25/2013
# of Pages: 1
File Break: 04.07

NUCLEAR METALS, INC.
AR Collection: 63554
Record of Decision (ROD) and Non-Time Critical Removal Action (NTCRA)
AR Collection Index Report
For External Use

Phase 04: FEASIBILITY STUDY (FS)

568450 **GROUNDWATER USE AND VALUE DETERMINATION (10/29/2013 TRANSMITTAL LETTER ATTACHED)**

Author: , MA DEPT OF ENVIRONMENTAL
Addressee:
Doc Type: REPORT
Doc Date: 10/28/2013
# of Pages: 6
File Break: 04.04

567937 **NATIONAL REMEDY REVIEW BOARD (NRRB) INFORMATION PACKAGE**

Author: , US EPA REGION 1
Addressee:
Doc Type: REPORT
Doc Date: 11/01/2013
# of Pages: 182
File Break: 04.09

568447 **EMAIL REGARDING ZONING - 2229 MAIN STREET (EMAIL HISTORY ATTACHED)**

Author: PAMELA ROCKWELL, CONCORD
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
EMAIL
Doc Date: 11/19/2013
# of Pages: 3
File Break: 04.01

567931 **MEMO CONCERNING HEADQUARTERS CONSULTATION FOR SITE**

Author: MELISSA TAYLOR, US EPA REGIO
Addressee: STUART WALKER, US EPA
Doc Type: CORRESPONDENCE
MEMO
Doc Date: 02/05/2014
# of Pages: 10
File Break: 04.01

Phase 04: FEASIBILITY STUDY (FS)

568452 **FINAL REPORT, FIELD AND LABORATORY MEDIA TESTING FOR DEPLETED URANIUM (DU) SEQUESTRATION IN OVERBURDEN GROUNDWATER**

Author: , GEOSYNTEC CONSULTANTS IN(
Addressee: , DE MAXIMIS INC
Doc Type: REPORT
SAMPLING DATA

Doc Date: 09/01/2014 **# of Pages:** 79
File Break: 04.02

564689 **MEMO REGARDING NATIONAL REMEDY REVIEW BOARD (NRRB) RECOMMENDATIONS**

Author: AMY LEGARE, US EPA - HEADQU.
Addressee: JAMES T OWENS III, US EPA REGION 1
Doc Type: CORRESPONDENCE
MEMO

Doc Date: 09/04/2014 **# of Pages:** 6
File Break: 04.09

564690 **MEMO REGARDING RESPONSES TO NATIONAL REMEDY REVIEW BOARD (NRRB) RECOMMENDATIONS (07/11/2014 EMAIL ON RADIATION CONSULTATION ATTACHED)**

Author: NANCY BARMAKIAN, US EPA RE(
Addressee: JAMES T OWENS III, US EPA REGI
AMY LEGARE, US EPA - HEADQUARTERS
Doc Type: CORRESPONDENCE
MEMO

Doc Date: 09/10/2014 **# of Pages:** 13
File Break: 04.09

568091 **PROPOSED PLAN**

Author: , US EPA REGION 1
Addressee:
Doc Type: PROPOSED PLAN
PUBLIC INFORMATION
REPORT

Doc Date: 10/01/2014 **# of Pages:** 29
File Break: 04.09

NUCLEAR METALS, INC.
AR Collection: 63554
Record of Decision (ROD) and Non-Time Critical Removal Action (NTCRA)
AR Collection Index Report
For External Use

Phase 04: FEASIBILITY STUDY (FS)

568423 **FEASIBILITY STUDY (FS) REPORT**

Author: , DE MAXIMIS INC
Addressee: , GEOSYNTEC CONSULTANTS IN
, HALEY & ALDRICH INC
Doc Type: FEASIBILITY STUDY (FS)
REPORT

Doc Date: 11/01/2014 **# of Pages:** 884
File Break: 04.06

Phase 05: RECORD OF DECISION (ROD)

581153 **EMAIL REGARDING PUBLIC COMMENTS ON PUBLIC MEETING**

Author: PAUL LOVECCHIO, CONCORD (M
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
EMAIL
PUBLIC (AND OTHER) COMMENTS

Doc Date: 11/13/2014 **# of Pages:** 1
File Break: 05.03

581154 **EMAIL REGARDING PUBLIC COMMENTS ON PROPOSED REMEDIATION PLAN**

Author: PAMELA ROCKWELL, CONCORD
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
EMAIL
PUBLIC (AND OTHER) COMMENTS

Doc Date: 11/19/2014 **# of Pages:** 2
File Break: 05.03

NUCLEAR METALS, INC.
AR Collection: 63554
Record of Decision (ROD) and Non-Time Critical Removal Action (NTCRA)
AR Collection Index Report
For External Use

Phase 05: RECORD OF DECISION (ROD)

581155 **EMAIL REGARDING REQUEST FOR EXTENSION OF PUBLIC COMMENT PERIOD**

Author: MICHAEL J WEBSTER, GEOINSIG
Addressee: , CREW (NUCLEAR METALS)
MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
EMAIL
PUBLIC (AND OTHER) COMMENTS

Doc Date: 11/24/2014 **# of Pages:** 1
File Break: 05.03

581156 **LETTER REGARDING PUBLIC COMMENT ON PROPOSED PLAN (EMAIL TRANSMITTAL ATTACHED)**

Author: CATHERINE PERRY, CONCORD (M
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER
PUBLIC (AND OTHER) COMMENTS

Doc Date: 11/29/2014 **# of Pages:** 2
File Break: 05.03

581152 **MEMO REGARDING PUBLIC COMMENTS ON PUBLIC MEETING AND REPORT**

Author: DOUGLAS GIFFORD, CONCORD (
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
MEMO
PUBLIC (AND OTHER) COMMENTS

Doc Date: 12/07/2014 **# of Pages:** 18
File Break: 05.03

Phase 05: RECORD OF DECISION (ROD)

581157 **EMAIL REGARDING PUBLIC COMMENT ON PROPOSED CLEANUP PLAN**

Author: SUE FELSHIN, CONCORD (MA) RE
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
EMAIL
PUBLIC (AND OTHER) COMMENTS

Doc Date: 12/09/2014
# of Pages: 1
File Break: 05.03

581158 **EMAIL REGARDING PUBLIC COMMENT ON PROPOSED CLEANUP PLAN**

Author: C ROSE CORTESE, CONCORD (MA
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
EMAIL
PUBLIC (AND OTHER) COMMENTS

Doc Date: 12/10/2014
# of Pages: 1
File Break: 05.03

581159 **LETTER REGARDING PUBLIC COMMENT ON PUBLIC HEARING AND PROPOSED REMEDIAL ACTION PLAN (EMAIL TRANSMITTAL ATTACHED)**

Author: JANE CERASO, ACTON CITIZENS
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER
PUBLIC (AND OTHER) COMMENTS

Doc Date: 12/10/2014
# of Pages: 2
File Break: 05.03

581161 **PUBLIC HEARING COMMENTS ON PROPOSED PLAN**

Author: , CREW (NUCLEAR METALS)
Addressee: , US EPA REGION 1
Doc Type: PUBLIC (AND OTHER) COMMENTS
REPORT

Doc Date: 12/10/2014
# of Pages: 3
File Break: 05.03

Phase 05: RECORD OF DECISION (ROD)

581160 **EMAIL REGARDING PUBLIC COMMENT PROPOSED REMEDIATION PLAN**

Author: MARGARET M WARGELIN, CONC
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
EMAIL
PUBLIC (AND OTHER) COMMENTS

Doc Date: 12/14/2014 **# of Pages:** 1
File Break: 05.03

581162 **LETTER REGARDING COMMENTS ON PROPOSED PLAN**

Author: JEFFREY ADAMS, CONCORD (MA
Addressee: ELISSA BROWN, CONCORD (MA)
GREGORY HIGGINS, CONCORD (M
LYNN HUGGINS, CONCORD (MA)
STEPHEN VERRILL, CONCORD (M
MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER
PUBLIC (AND OTHER) COMMENTS

Doc Date: 12/17/2014 **# of Pages:** 2
File Break: 05.03

581163 **LETTER REGARDING COMMENTS ON PROPOSED REMEDIAL ACTION PLAN**

Author: SUZANNE K CONDON, MA DEPT (
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER
PUBLIC (AND OTHER) COMMENTS

Doc Date: 01/07/2015 **# of Pages:** 4
File Break: 05.03

Phase 05: RECORD OF DECISION (ROD)

581164 **LETTER REGARDING COMMENTS ON PROPOSED PLAN (EMAIL TRANSMITTAL ATTACHED)**

Author: PAUL BOEHM, CONCORD (MA) TC
Addressee: RAY BRUTTOMESSO, CONCORD (
LEN RAPPOLLI, CONCORD (MA) T
PAMELA ROCKWELL, CONCORD
FRED SEWARD, CONCORD (MA) T
STEVE VERRILL, CONCORD (MA)
MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER
PUBLIC (AND OTHER) COMMENTS

Doc Date: 01/09/2015 **# of Pages:** 9
File Break: 05.03

581165 **MEMO REGARDING PUBLIC COMMENTS ON PUBLIC MEETING AND REPORT (EMAIL TRANSMITTAL ATTACHED)**

Author: DOUGLAS GIFFORD, CONCORD (
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
MEMO
PUBLIC (AND OTHER) COMMENTS

Doc Date: 01/12/2015 **# of Pages:** 5
File Break: 05.03

581166 **LETTER REGARDING COMMENTS ON PROPOSED REMEDIAL ACTION PLAN (EMAIL TRANSMITTAL ATTACHED)**

Author: KERRY DISKIN, CONCORD (MA) E
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER
PUBLIC (AND OTHER) COMMENTS

Doc Date: 01/13/2015 **# of Pages:** 2
File Break: 05.03

Phase 05: RECORD OF DECISION (ROD)

581167 **LETTER REGARDING COMMENTS ON PROPOSED PLAN (01/14/2015 EMAIL TRANSMITTAL ATTACHED)**

Author: GARRY WALDECK, MA DEPT OF E
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER
PUBLIC (AND OTHER) COMMENTS

Doc Date: 01/13/2015 **# of Pages:** 3
File Break: 05.03

581168 **LETTER REGARDING COMMENTS ON PROPOSED PLAN**

Author: STEVEN NG, CONCORD (MA) BOA
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER
PUBLIC (AND OTHER) COMMENTS

Doc Date: 01/13/2015 **# of Pages:** 3
File Break: 05.03

581169 **LETTER REGARDING COMMENTS ON PROPOSED CLEANUP PLAN AND FEASIBILITY STUDY (FS) (EMAIL TRANSMITTAL ATTACHED)**

Author: CHRIS ALLEN, ACTON (MA) WATE
Addressee: MATTHEW MOSTOLLER, ACTON (
MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
LETTER
PUBLIC (AND OTHER) COMMENTS

Doc Date: 01/14/2015 **# of Pages:** 5
File Break: 05.03

NUCLEAR METALS, INC.
AR Collection: 63554
Record of Decision (ROD) and Non-Time Critical Removal Action (NTCRA)
AR Collection Index Report
For External Use

Phase 05: RECORD OF DECISION (ROD)

581170 **MEMO REGARDING COMMENTS ON PROPOSED PLAN (EMAIL TRANSMITTAL ATTACHED)**

Author: DOUGLAS GIFFORD, CREW (NUC
Addressee: VIRGINIE LANDRE, CREW (NUCL
RICK OLESON, CREW (NUCLEAR
LEN RAPPOLI, CREW (NUCLEAR
TIM ROSE, CREW (NUCLEAR ME
BOB VAN DYKE, CREW (NUCLEA
MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
MEMO
PUBLIC (AND OTHER) COMMENTS

Doc Date: 01/14/2015 **# of Pages:** 4
File Break: 05.03

Phase 09: STATE COORDINATION

48359 **THESIS: PRE-CONSTRUCTION RADIOLOGICAL ASSESSMENT AND DECONTAMINATION OF A DEPLETED URANIUM WASTE HANDLING SITE**

Author: ADAM S WEAVER, UNIVERSITY C
Addressee:
Doc Type: REPORT

Doc Date: 09/25/1985 **# of Pages:** 60
File Break: 09.10

48391 **APPLICATION FOR RENEWAL OF SOURCE MATERIAL LICENSES SMB-179 AND SUB-1452**

Author: TONY CARPENTINO, NUCLEAR M
Addressee: , NUCLEAR REGULATORY COMMISSION
Doc Type: REPORT

Doc Date: 09/06/1996 **# of Pages:** 110
File Break: 09.10

Phase 09: STATE COORDINATION

20515 **DECOMMISSIONING PLAN FOR HOLDING BASIN, REVISION 1**

Author: , GZA GEOENVIRONMENTAL INC
Addressee: , STARMET CORPORATION
Doc Type: WORK PLAN
Doc Date: 01/01/1997
# of Pages: 146
File Break: 09.10

Phase 10: ENFORCEMENT/NEGOTIATION

567942 **DRAFT TSCA 40 CFR SECTION 761.61(C) DETERMINATION (MAP ATTACHED)**

Author: JAMES T OWENS, US EPA REGION
Addressee:
Doc Type: REPORT
Doc Date: 01/01/1111
# of Pages: 3
File Break: 10.01

273482 **ADMINISTRATIVE ORDER BY CONSENT (AOC) FOR REMEDIAL INVESTIGATION / FEASIBILITY STUDY (RI/FS)**

Author: RICHARD CAVAGNERO, US EPA R
Addressee:
Doc Type: ADMIN ORDER ON CONSENT
ENFORCEMENT & SETTLEMENT
Doc Date: 06/13/2003
# of Pages: 140
File Break: 10.07

282734 **AMENDMENT TO ADMINISTRATIVE ORDER BY CONSENT (AOC) FOR REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)**

Author: , US EPA REGION 1
Addressee: , DEPARTMENT OF ENERGY
, MONY LIFE INSURANCE CO
, TEXTRON INC
, US ARMY
, WHITTAKER CORP
Doc Type: ADMIN ORDER ON CONSENT
ENFORCEMENT & SETTLEMENT
Doc Date: 02/13/2008
# of Pages: 24
File Break: 10.07

Phase 10: ENFORCEMENT/NEGOTIATION

75000256 **ADMINISTRATIVE SETTLEMENT AGREEMENT AND ORDER ON CONSENT (AOC) FOR NON-TIME CRITICAL REMOVAL ACTION (NTCRA), CERCLA DOCKET NO. CERCLA-01-2011-004**

Author: , TEXTRON INC
Addressee: , US ARMY
, US DEPT OF ENERGY
, US EPA REGION 1
, WHITTAKER CORP
Doc Type: ADMIN ORDER ON CONSENT
ENFORCEMENT & SETTLEMENT

Doc Date: 06/22/2011 **# of Pages:** 47
File Break: 10.07

524097 **SECOND AMENDMENT TO ADMINISTRATIVE SETTLEMENT AGREEMENT AND ORDER ON CONSENT (AOC) FOR REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS). US EPA DOCKET #CERCLA-01-2012-0096**

Author: , US EPA REGION 1
Addressee:
Doc Type: ADMIN ORDER ON CONSENT
ENFORCEMENT & SETTLEMENT

Doc Date: 10/02/2012 **# of Pages:** 11
File Break: 10.07

Phase 11: POTENTIALLY RESPONSIBLE PARTY

16911 **104 INFORMATION REQUEST - US ARMY LEGAL SERVICES AGENCY (CERTIFIED MAIL RECEIPT IS ATTACHED)**

Author: BRUCE MARSHALL, US EPA REGI
Addressee: LT COLONEL DAVID HOWLETT, US ARMY LEGAL S
Doc Type: 104 INFO REQUEST
CORRESPONDENCE
LETTER

Doc Date: 11/07/2000 **# of Pages:** 18
File Break: 11.09

Phase 11: POTENTIALLY RESPONSIBLE PARTY

16913 **104 INFORMATION REQUEST - STARMET CORP (CERTIFIED MAIL RECEIPT IS ATTACHED)**

Author: BRUCE MARSHALL, US EPA REGI
Addressee: ROBERT E QUINN, STARMET CORPORATION
Doc Type: 104 INFO REQUEST
CORRESPONDENCE
LETTER
Doc Date: 11/07/2000
File Break: 11.09
# of Pages: 31

16914 **104 INFORMATION REQUEST - WHITTAKER CORP (CERTIFIED MAIL RECEIPT IS ATTACHED)**

Author: BRUCE MARSHALL, US EPA REGI
Addressee: JOSEPH F ALIBRANDI, WHITTAKER CORP
Doc Type: 104 INFO REQUEST
CORRESPONDENCE
LETTER
Doc Date: 11/07/2000
File Break: 11.09
# of Pages: 28

16915 **104 INFORMATION REQUEST - TEXTRON INC (CERTIFIED MAIL RECEIPT IS ATTACHED)**

Author: BRUCE MARSHALL, US EPA REGI
Addressee: LEWIS B CAMPBELL, TEXTRON INC
Doc Type: 104 INFO REQUEST
CORRESPONDENCE
LETTER
Doc Date: 11/07/2000
File Break: 11.09
# of Pages: 28

16871 **104 INFORMATION REQUEST RESPONSE - TEXTRON INC (ANNUAL REPORT IS ATTACHED)**

Author: JAMIESON M SCHIFF, TEXTRON I
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: 104 INFO REQUEST RESPONSE
CORRESPONDENCE
LETTER
Doc Date: 12/11/2000
File Break: 11.09
# of Pages: 235

Phase 11: POTENTIALLY RESPONSIBLE PARTY

16845 **[REDACTED] 104 INFORMATION REQUEST RESPONSE - WHITTAKER CORPORATION**

Author: ERIC G LARDIERE, WHITTAKER C
Addressee: MELISSA TAYLOR, US EPA REGION 1
AUDREY ZUCKER, US EPA REGION 1
Doc Type: 104 INFO REQUEST RESPONSE
CORRESPONDENCE
LETTER
Doc Date: 12/15/2000
# of Pages: 457
File Break: 11.09

568461 **104 INFORMATION REQUEST RESPONSE - UNITED STATES ARMY LEGAL SERVICES AGENCY [LETTER ONLY WITHOUT ATTACHMENTS]**

Author: LT COLONEL DAVID HOWLETT, U
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: 104 INFO REQUEST RESPONSE
CORRESPONDENCE
LETTER
Doc Date: 01/30/2001
# of Pages: 8
File Break: 11.09

16755 **[REDACTED] 104 INFORMATION REQUEST RESPONSE - STARMET CORP (PART 1 OF 5) (02/07/01 COVER LETTER IS ATTACHED)**

Author: ROBERT E QUINN, STARMET COR
Addressee: , US EPA REGION 1
Doc Type: 104 INFO REQUEST RESPONSE
CORRESPONDENCE
LETTER
Doc Date: 02/06/2001
# of Pages: 90
File Break: 11.09

Phase 11: POTENTIALLY RESPONSIBLE PARTY

16760 **104 INFORMATION REQUEST RESPONSE - STARMET CORP (PART 2 OF 5) (EXHIBITS A-Q)**

Author: ROBERT E QUINN, STARMET COR
Addressee: , US EPA REGION 1
Doc Type: 104 INFO REQUEST RESPONSE
CORRESPONDENCE
LETTER
Doc Date: 02/06/2001
# of Pages: 478
File Break: 11.09

16762 **[REDACTED] 104 INFORMATION REQUEST RESPONSE - STARMET CORP (PART 3 OF 5) (EXHIBITS R-DD)**

Author: ROBERT E QUINN, STARMET COR
Addressee: , US EPA REGION 1
Doc Type: 104 INFO REQUEST RESPONSE
CORRESPONDENCE
LETTER
Doc Date: 02/06/2001
# of Pages: 360
File Break: 11.09

16763 **[REDACTED] 104 INFORMATION REQUEST RESPONSE - STARMET CORP (PART 4 OF 5) (EXHIBITS EE-QQ)**

Author: ROBERT E QUINN, STARMET COR
Addressee: , US EPA REGION 1
Doc Type: 104 INFO REQUEST RESPONSE
CORRESPONDENCE
LETTER
Doc Date: 02/06/2001
# of Pages: 454
File Break: 11.09

16764 **[REDACTED] 104 INFORMATION REQUEST RESPONSE - STARMET CORP (PART 5 OF 5) (EXHIBITS RR-RRR)**

Author: ROBERT E QUINN, STARMET COR
Addressee: , US EPA REGION 1
Doc Type: 104 INFO REQUEST RESPONSE
CORRESPONDENCE
LETTER
Doc Date: 02/06/2001
# of Pages: 677
File Break: 11.09

Phase 13: COMMUNITY RELATIONS

568432 **LETTER REGARDING COMMUNITY INVOLVEMENT PLAN (CIP)**

Author: ROBERT G CIANCIARULO, US EP/
Addressee: JAMES L WEST, CREW (NUCLEAR METALS)
Doc Type: CORRESPONDENCE
LETTER
Doc Date: 06/15/2004
# of Pages: 2
File Break: 13.01

457307 **COMMUNITY INVOLVEMENT SUPPORT PLAN**

Author: , DE MAXIMIS INC
Addressee: , GEOSYNTEC CONSULTANTS IN
, MACTEC ENGINEERING AND C
Doc Type: COMMUNITY INVOLVEMENT PLAN
WORK PLAN
Doc Date: 04/15/2005
# of Pages: 84
File Break: 13.02

568436 **DRAFT PRESENTATION - REVIEW OF HUMAN HEALTH RISK ASSESSMENT (HHRA)**

Author: , US EPA REGION 1
Addressee: , CREW (NUCLEAR METALS)
Doc Type: MEETING RECORD
Doc Date: 11/29/2006
# of Pages: 42
File Break: 13.04

568439 **DRAFT PRESENTATION - ECOLOGICAL RISK ASSESSMENT (ERA) UPDATE**

Author: , US EPA REGION 1
Addressee: , CREW (NUCLEAR METALS)
Doc Type: MEETING RECORD
Doc Date: 11/29/2006
# of Pages: 13
File Break: 13.04

Phase 13: COMMUNITY RELATIONS

568438 **FEASIBILITY STUDY (FS) PRESENTATION**

Author: , GEOSYNTEC CONSULTANTS
Addressee:
Doc Type: MEETING RECORD
Doc Date: 02/12/2013
# of Pages: 45
File Break: 13.04

568445 **EMAIL REGARDING PRIVATE SIDE OF WEB SITE (10/01/2007, 09/01/2000, AND 06/01/2009 GUIDANCES, PAPER ON APATITE 2, AND EMAIL HISTORY ATTACHED)**

Author: BRUCE R THOMPSON, DE MAXIM
Addressee: MICHAEL J WEBSTER, GEOINSIGHT INC
Doc Type: CORRESPONDENCE
EMAIL
Doc Date: 03/01/2013
# of Pages: 470
File Break: 13.01

568429 **MEMO REGARDING PRELIMINARY COMMENTS / OBSERVATIONS REGARDING THE FEASIBILITY STUDY (FS) OVERVIEW PRESENTATION**

Author: , CREW (NUCLEAR METALS)
Addressee: , GEOINSIGHT INC
MELISSA TAYLOR, US EPA REGION 1
BRUCE R THOMPSON, DE MAXIMIS INC
Doc Type: CORRESPONDENCE
MEMO
Doc Date: 03/07/2013
# of Pages: 4
File Break: 13.04

Phase 13: COMMUNITY RELATIONS

568442 **EMAIL REGARDING CITIZENS RESEARCH AND ENVIRONMENTAL WATCH (CREW) / 229 MAIN STREET COMMITTEE MEETING ON 04/10/2013 (03/13/2013 SOIL AND GROUNDWATER ALTERNATIVE LIST ATTACHED)**

Author: BRUCE R THOMPSON, DE MAXIM

Doc Date: 04/05/2013 **# of Pages:** 2

File Break: 13.01

Addressee: PAUL BOEHM, CONCORD (MA) TOWN OF
RAY BRUTTOMESSO, CONCORD (MA) TOWN OF
KAREN BYRNE, NONE
KERRY DISKIN, NONE
VIRGINIE LANDRE, NONE
RICK OLESON, CREW (NUCLEAR METALS)
LEN RAPPOLI, NONE
SUSAN RASK, CONCORD (MA) TOWN OF
PAMELA ROCKWELL, CREW (NUCLEAR METALS)
TIM ROSE, NONE
FRED SEWARD, CONCORD (MA) TOWN OF
ANN SHAPIRO, NONE
PHIL STARK, NONE
BOB VANDYCK, NONE
STEVE VERRILL, CONCORD (MA) TOWN OF
MIKE WEBSTER, GEOINSIGHT INC
JAMES L WEST, CREW (NUCLEAR METALS)
CANDACE WIGHT, NONE

Doc Type: CORRESPONDENCE
EMAIL

Phase 13: COMMUNITY RELATIONS

568441 **SITE PRESENTATION**

Author: , DE MAXIMIS INC
Addressee:
Doc Type: MEETING RECORD

Doc Date: 09/04/2013
# of Pages: 48
File Break: 13.04

Phase 13: COMMUNITY RELATIONS

568443 **EMAIL REGARDING DEPLETED URANIUM (DU) SEQUESTRATION TESTING (11/01/2013 SCOPE OF WORK (SOW), FIELD AND LABORATORY MEDIA TESTING FOR URANIUM SEQUESTRATION IN GROUNDWATER ATTACHED)**

Author: BRUCE R THOMPSON, DE MAXIM

Doc Date: 11/25/2013 **# of Pages:** 64

File Break: 13.01

Addressee: PAUL BOEHM, CONCORD (MA) TOWN OF
RAY BRUTTOMESSO, CONCORD (MA) TOWN OF
KAREN BYRNE, NONE
KERRY DISKIN, NONE
VIRGINIE LANDRE, NONE
RICK OLESON, CREW (NUCLEAR METALS)
LEN RAPPOLI, NONE
SUSAN RASK, CONCORD (MA) TOWN OF
PAMELA ROCKWELL, CREW (NUCLEAR METALS)
TIM ROSE, NONE
FRED SEWARD, CONCORD (MA) TOWN OF
ANN SHAPIRO, NONE
PHIL STARK, NONE
BOB VANDYCK, NONE
STEVE VERRILL, CONCORD (MA) TOWN OF
MIKE WEBSTER, GEOINSIGHT INC
JAMES L WEST, CREW (NUCLEAR METALS)
CANDACE WIGHT, NONE

Doc Type: CORRESPONDENCE
EMAIL

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Phase 13: COMMUNITY RELATIONS

568428 **EMAIL REGARDING PURCHASE OF GRACE SUPERFUND LAND BY TOWN OF CONCORD FOR SOLAR ARRAYS AND BUS STORAGE**

Author: PAMELA ROCKWELL, CREW (NU(
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
EMAIL

Doc Date: 12/10/2013
# of Pages: 1
File Break: 13.01

568446 **EMAIL CONFIRMING 02/06/2014 2229 COMMITTEE / CITIZENS RESEARCH AND ENVIRONMENTAL WATCH (CREW) MEETING (EMAIL HISTORY ATTACHED)**

Author: BRUCE R THOMPSON, DE MAXIM
Addressee: JOHN M HUNT, DE MAXIMIS INC
TIM ROSE, NONE
Doc Type: CORRESPONDENCE
EMAIL

Doc Date: 02/03/2014
# of Pages: 2
File Break: 13.01

568424 **EMAIL TRANSMITTING NAMES OF 229 MAIN STREET OVERSIGHT COMMITTEE CONTACTS**

Author: PAMELA ROCKWELL, CREW (NU(
Addressee: MELISSA TAYLOR, US EPA REGION 1
Doc Type: CORRESPONDENCE
EMAIL

Doc Date: 02/26/2014
# of Pages: 1
File Break: 13.06

Phase 13: COMMUNITY RELATIONS

568444 **EMAIL TRANSMITTING PRESENTATION REGARDING APATITE / DEPLETED URANIUM (DU) SEQUESTRATION PILOT STUDY**

Author: BRUCE R THOMPSON, DE MAXIM

Doc Date: 04/08/2014 **# of Pages:** 1

Addressee: PAUL BOEHM, CONCORD (MA) TOWN OF

File Break: 13.01

RAY BRUTTOMESSO, CONCORD (MA) TOWN OF

KAREN BYRNE, NONE

KERRY DISKIN, NONE

DEBORAH FARNSWORTH, PINE & SWALLOW ASSO

VIRGINIE LANDRE, NONE

RICK OLESON, CREW (NUCLEAR METALS)

LEN RAPPOLI, NONE

SUSAN RASK, CONCORD (MA) TOWN OF

PAMELA ROCKWELL, CREW (NUCLEAR METALS)

TIM ROSE, NONE

FRED SEWARD, CONCORD (MA) TOWN OF

ANN SHAPIRO, NONE

PHIL STARK, NONE

BOB VANDYCK, NONE

STEVE VERRILL, CONCORD (MA) TOWN OF

MIKE WEBSTER, GEOINSIGHT INC

JAMES L WEST, CREW (NUCLEAR METALS)

CANDACE WIGHT, NONE

Doc Type: CORRESPONDENCE
EMAIL

Phase 13: COMMUNITY RELATIONS

568431 **MEETING NOTES ON 04/09/2014 MEETING WITH COMMUNITY RESEARCH AND ENVIRONMENTAL WATCH (CREW)**

Author: , US EPA REGION 1
Addressee:
Doc Type: MEETING RECORD
Doc Date: 04/09/2014
# of Pages: 1
File Break: 13.04

568440 **PRESENTATION ON APATITE 2(TM) PILOT TEST PRELIMINARY RESULTS: IN-SITU DEPLETED URANIUM (DU) IMMOBILIZATION**

Author: , GEOSYNTEC CONSULTANTS
Addressee:
Doc Type: MEETING RECORD
Doc Date: 04/09/2014
# of Pages: 20
File Break: 13.04

568434 **EMAIL REGARDING 04/29/2014 INTERNET SEMINAR ON RENEWABLE ENERGY AT SUPERFUND SITES (EMAIL HISTORY ATTACHED)**

Author: MELISSA TAYLOR, US EPA REGIO
Addressee: PAMELA ROCKWELL, CREW (NUCLEAR METALS)
Doc Type: CORRESPONDENCE
EMAIL
Doc Date: 05/07/2014
# of Pages: 1
File Break: 13.01

568435 **EMAIL REGARDING TRANSMITTAL OF RENEWABLE ENERGY AND LIABILITY FACT SHEETS AND STATUS OF FEASIBILITY STUDY (FS) (EMAIL HISTORY ATTACHED)**

Author: MELISSA TAYLOR, US EPA REGIO
Addressee: PAMELA ROCKWELL, CREW (NUCLEAR METALS)
Doc Type: CORRESPONDENCE
EMAIL
Doc Date: 07/22/2014
# of Pages: 2
File Break: 13.01

568425 **HANDWRITTEN SIGN-IN SHEET FOR SITE MEETING**

Author: , US EPA REGION 1
Addressee:
Doc Type: MEETING RECORD
Doc Date: 09/17/2014
# of Pages: 1
File Break: 13.04

Phase 13: COMMUNITY RELATIONS

568427 **NEWS ARTICLE: MEETINGS ON 2229 MAIN STREET REMEDIATION PLANNED**

Author: , CONCORD JOURNAL
Addressee:
Doc Type: ARTICLE - PERIODICAL
NEWS ARTICLE
PUBLIC INFORMATION

Doc Date: 10/27/2014 **# of Pages:** 1
File Break: 13.03

568422 **NEWS RELEASE: CLEANUP PLAN PROPOSED FOR THE NUCLEAR METALS SITE IN CONCORD, MA**

Author: , US EPA REGION 1
Addressee:
Doc Type: PRESS RELEASE
PUBLIC INFORMATION

Doc Date: 11/03/2014 **# of Pages:** 2
File Break: 13.03

582973 **PUBLIC NOTICE: US EPA ANNOUNCES A PROPOSED PLAN FOR CLEANUP OF THE NUCLEAR METALS SITE IN CONCORD, MA**

Author: , US EPA REGION 1
Addressee:
Doc Type: PRESS RELEASE
PUBLIC INFORMATION

Doc Date: 11/06/2014 **# of Pages:** 3
File Break: 13.03

568484 **PRESENTATION: PUBLIC MEETING ON PROPOSED REMEDIAL ACTION (RA) PLAN**

Author: MELISSA TAYLOR, US EPA REGIO
Addressee: BRUCE R THOMPSON, DE MAXIM
Doc Type: MEETING RECORD

Doc Date: 11/12/2014 **# of Pages:** 62
File Break: 13.04

582403 **SIGN-IN SHEET FOR PUBLIC HEARING**

Author: , US EPA REGION 1
Addressee:
Doc Type: MEETING RECORD

Doc Date: 11/12/2014 **# of Pages:** 4
File Break: 13.04

Phase 13: COMMUNITY RELATIONS

581150 **PUBLIC HEARING TRANSCRIPT ON PROPOSED REMEDIAL ACTION PLAN**

Author: JOAN M CASSIDY, EPPLEY COUR
Addressee:
Doc Type: MEETING RECORD
Doc Date: 12/10/2014
# of Pages: 46
File Break: 13.04

581151 **SIGN-IN SHEET FOR PUBLIC HEARING**

Author: , US EPA REGION 1
Addressee:
Doc Type: MEETING RECORD
Doc Date: 12/10/2014
# of Pages: 4
File Break: 13.04

582972 **PRESENTATION AT PUBLIC HEARING ON PROPOSED REMEDIAL ACTION PLAN**

Author: , US EPA REGION 1
Addressee:
Doc Type: MEETING RECORD
Doc Date: 12/10/2014
# of Pages: 10
File Break: 13.04

Phase 17: SITE MANAGEMENT RECORDS

567900 **SITE CHARACTERIZATION REPORT FOR HOLDING BASIN**

Author: , NUCLEAR METALS INC
Addressee: , US NUCLEAR REGULATORY COMMISSION (NRC)
Doc Type: REPORT
Doc Date: 02/12/1993
# of Pages: 96
File Break: 17.08

568458 **APATITE 2 TO REMEDIATE SOIL OR GROUNDWATER CONTAINING URANIUM OR PLUTONIUM**

Author: JAMES CONCA, LOS ALAMOS NA
Addressee: JUDITH WRIGHT, PIMS NW INC
Doc Type: REPORT
Doc Date: 01/01/2000
# of Pages: 17
File Break: 17.07

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Phase 17: SITE MANAGEMENT RECORDS

568457 **ARTICLE IN GROUND WATER CURRENTS: MONTICELLO PERMEABLE REACTIVE BARRIER PROJECT**

Author: CLAY CARPENTER, MACTEC
Addressee: DON METZLER, US DEPT OF ENEI
STAN MORRISON, ROY F WESTOI
Doc Type: ARTICLE - PERIODICAL
Doc Date: 06/01/2000 **# of Pages:** 4
File Break: 17.07

22170 **HISTORICAL AERIAL PHOTO SITE ANALYSIS, EPIC BOOK**

Author: , US EPA - ENVIRONMENTAL PHC
Addressee:
Doc Type: PHOTOGRAPH
Doc Date: 06/01/2001 **# of Pages:** 40
File Break: 17.04

568455 **USE OF APATITE FOR CHEMICAL STABILIZATION OF SUBSURFACE CONTAMINANTS, FINAL REPORT**

Author: WILLIAM D BOSTICK, MATERIAL
Addressee: L A HARRIS, MATERIALS AND CH
R J JARABEK, MATERIALS AND C
E B MUNDAY, MATERIALS AND C
D PEERY, MATERIALS AND CHEM
J L SHOEMAKER, MATERIALS AN
R J STEVENSON, MATERIALS ANI
, US DEPT OF ENERGY
Doc Type: REPORT
Doc Date: 05/01/2003 **# of Pages:** 195
File Break: 17.07

567444 **SEDIMENT STUDIES IN THE ASSABET RIVER, CENTRAL MASSACHUSETTS, 2003**

Author: JASON R SORENSON, US GEOLOC
Addressee: MARC J ZIMMERMAN, US GEOLC
Doc Type: REPORT
Doc Date: 01/01/2005 **# of Pages:** 94
File Break: 17.07

Phase 17: SITE MANAGEMENT RECORDS

568456 **PERFORMANCE ASSESSMENT AND RECOMMENDATIONS FOR REJUVENATION OF A PERMEABLE REACTIVE BARRIER: COTTER CORPORATION'S CANON CITY, COLORADO, URANIUM MILL**

Author: , US DEPT OF ENERGY
Addressee: , US EPA REGION 8
Doc Type: REPORT
Doc Date: 04/01/2005
# of Pages: 130
File Break: 17.07

568460 **300 AREA URANIUM STABILIZATION THROUGH POLYPHOSPHATE INJECTION: FINAL REPORT**

Author: B N BJORNSTAD, BATTELLE
Addressee: B G FRITZ, BATTELLE
J S FRUCHTER, BATTELLE
R D MACKLEY, BATTELLE
D P MENDOZA, BATTELLE
D R NEWCOMER, BATTELLE
M L ROCKHOLD, BATTELLE
V R VERMEUL, BATTELLE
D M WELLMAN, BATTELLE
M D WILLIAMS, BATTELLE
, US DEPT OF ENERGY
Doc Type: REPORT
Doc Date: 06/01/2009
# of Pages: 188
File Break: 17.07

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Phase 17: SITE MANAGEMENT RECORDS

568454 **A RISK / BENEFIT APPROACH TO THE APPLICATION OF IRON NANOPARTICLES FOR THE REMEDIATION OF CONTAMINATED SITES IN THE ENVIRONMENT**

Author: PAUL BARDOS, UK DEPT FOR EN
Addressee: BRIAN BONE, UK DEPT FOR ENV
DANIEL ELLIOTT, UK DEPT FOR E
NIELS HARTOG, UK DEPT FOR EN
JOHN HENSTOCK, UK DEPT FOR I
PAUL NATHANAIL, UK DEPT FOR
Doc Type: REPORT

Doc Date: 10/01/2011 **# of Pages:** 111
File Break: 17.07

70002993 **MATERIAL LICENSE SUPPLEMENTARY SHEET TERMINATING STARMET CORPORATION LICENSE NUMBER SU-1453**

Author:
Addressee:
Doc Type: CONTRACT DOCUMENTATION

Doc Date: 11/08/2011 **# of Pages:** 2
File Break: 17.01

567445 **RECORD OF DECISION (ROD) FOR 300-FF-2 AND 300-FF-5, AND RECORD OF DECISION (ROD) AMENDMENT FOR 300-FF-1, HANFORD SITE**

Author: , US DEPT OF ENERGY
Addressee: , US EPA REGION 10
Doc Type: DECISION DOCUMENT
RECORD OF DECISION (ROD)
REPORT

Doc Date: 11/26/2013 **# of Pages:** 129
File Break: 17.07

568459 **LIST OF EPA DOCUMENTS TO BE INCLUDED BY REFERENCE, FEASIBILITY STUDY (FS) REPORT**

Author: , US EPA
Addressee:
Doc Type: LIST

Doc Date: 11/01/2014 **# of Pages:** 3
File Break: 17.07

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Phase 20: RECORDS MANAGEMENT

567943 **NUCLEAR METALS, OPERABLE UNIT (OU) 1 PROPOSED PLAN ADMINISTRATIVE RECORD (AR) INDEX**

Author: , US EPA REGION 1
Addressee:
Doc Type: ADMIN RECORD (AR) INDEX
INDEX

Doc Date: 10/01/2014
# of Pages: 45
File Break: 20.01

Number of Documents in Administrative Record: 125

Selected Key Guidance Documents

EPA Guidance Documents may be reviewed at the OSRR Records and Information Center in Boston, MA

DOCNUMBER	DOCDATE	TITLE	OSWEREPAID
2013	01-Nov-89	GETTING READY - SCOPING THE RI/FS [QUICK REFERENCE FACT SHEET]	OSWER #9355.3-01FS1
2014	01-Aug-90	GUIDANCE ON REMEDIAL ACTIONS FOR SUPERFUND SITES WITH PCB CONTAMINATION	OSWER #9355.4-01
2016	02-Jun-89	MODEL STATEMENT OF WORK FOR A REMEDIAL INVESTIGATION AND FEASIBILITY STUDY CONDUCTED BY POTENTIALLY RESPONSIBLE PARTIES	OSWER #9835.8
2328	01-Aug-88	TECHNOLOGICAL APPROACHES TO THE CLEANUP OF RADIOLOGICALLY CONTAMINATED SUPERFUND SITES	EPA/540/2-88/002
C018	17-Oct-86	COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT OF 1980. AMENDED BY PL 99-499, 10/17/86.	
C254	01-Aug-90	GUIDE ON REMEDIAL ACTIONS AT SUPERFUND SITES WITH PCB CONTAMINATION. QUICK REFERENCE FACT SHEET.	OSWER 9355.4-01FS
C278	04-Apr-96	FINAL GROUND WATER USE AND VALUE DETERMINATION GUIDANCE	
C317	01-Jan-95	LAND USE IN THE CERCLA REMEDY SELECTION PROCESS	OSWER 9355.7-04
C363	01-May-93	REVIEW OF ECOLOGICAL ASSESSMENT CASE STUDIES FROM A RISK ASSESSMENT PERSPECTIVE	EPA 630/R-92-005
C478	01-Sep-94	INNOVATIVE SITE REMEDIATION TECHNOLOGY: CHEMICAL TREATMENT, VOL. 2	EPA 542-B-94-004
C479	01-Nov-93	INNOVATIVE SITE REMEDIATION TECHNOLOGY, SOIL WASHING/SOIL FLUSHING, VOL. 3	EPA 542-B-93-012
C502	01-Aug-97	EXPOSURE FACTORS HANDBOOK; ACTIVITY FACTORS, VOLUME III	EPA/600/P-95/002FC
C510	01-Aug-91	NATIONAL STATUS AND TRENDS PROGRAM	GC57 N6
C622	01-Nov-91	A GUIDE TO PRINCIPLE THREAT AND LOW LEVEL THREAT WASTES	9380.3-06FS
C720	08-May-98	CONTAMINATED SEDIMENT MANAGEMENT STRATEGY	
C723	01-May-09	TECHNICAL GUIDE: MONITORED NATURAL RECOVERY AT CONTAMINATED SEDIMENT SITES	
C744	29-Apr-96	REQUIREMENTS FOR MANAGEMENT OF HAZARDOUS CONTAMINATED MEDIA (40 CFR PARTS 260, 261, 262, 264, 268, 269, 271)	
C851	02-Feb-12	USEPA CONTRACT LABORATORY PROGRAM STATEMENT OF WORK FOR ORGANIC ANALYSIS, SOM01.2	

Selected Key Guidance Documents

EPA Guidance Documents may be reviewed at the OSRR Records and Information Center in Boston, MA

DOCNUMBER	DOCDATE	TITLE	OSWEREPAID
C854	01-Apr-92	FINAL GUIDANCE DATA USABILITY IN RISK ASSESSMENT (PART A) (PUBLICATION 9285.7-09A	PB92-963356
C859	01-Mar-01	GUIDANCE FOR PREPARING STANDARD OPERATING PROCEDURES (SOPS), QA/G-6	EPA/240/B-01/004
C863	01-Jan-99	COMPENDIUM OF METHODS FOR THE DETERMINATION OF TOXIC ORGANIC COMPOUNDS IN AMBIENT AIR. SECOND EDITION, COMPENDIUM METHOD TO-15	EPA/625/R-96/010b
C864	01-Oct-04	USEPA CONTRACT LABORATORY PROGRAM NATIONAL FUNCTIONAL GUIDELINES FOR INORGANIC DATA REVIEW	OSWER 9240.1-45 /EPA 540-R-04-004
C875	20-Sep-10	REVISED GUIDANCE ON COMPILING ADMINISTRATIVE RECORDS FOR CERCLA RESPONSE	
C914	19-Jun-98	GUIDANCE FOR PREPARING SUPERFUND REMEDIAL DECISION DOCUMENTS, FINAL REVIEW DRAFT	EPA 540-R-98-031, OSWER 9200.1-23
C916	17-Mar-10	CONSIDERING REASONABLY ANTICIPATED FUTURE LAND USE AND REDUCING BARRIERS TO REUSE AT EPA-LEAD SUPERFUND REMEDIAL SITES	OSWER 9355.7-19
C942	01-Jan-11	ENVIRONMENTAL FACT SHEET: 1,4 DIOXANCE AND DRINKING WATER	WD-DWGB-3-24
C957	01-Oct-07	TECHNOLOGY REFERENCE GUIDE FOR RADIOACTIVELY CONTAMINATED MEDIA	EPA 402-R-07-004
C958	01-Sep-00	SOLIDIFICATION/STABILIZATION USE AT SUPERFUND SITES	EPA 542-R-00-010
C959	01-Apr-13	USE OF AMENDMENTS FOR IN SITU REMEDIATION AT SUPERFUND SEDIMENT SITES	OSWER 9200.2-128FS
C960	22-Aug-97	ESTABLISHMENT OF CLEANUP LEVELS FOR CERCLA SITES WITH RADIOACTIVE CONTAMINATION	OSWER 9200.4-18