EXECUTIVE SUMMARY

ES.1 Introduction

A multi-phase remedial investigation (RI) was conducted at the federally-owned Niagara Falls Storage Site (NFSS) located at 1397 Pletcher Road in the township of Lewiston, Niagara County, New York. The 191-acre parcel is part of the former Lake Ontario Ordnance Works (LOOW) that was used by the War Department beginning in 1942 for the production of trinitrotoluene (TNT). In 1944, the Manhattan Engineer District (MED) began using the site for storage of radioactive residues that resulted from the processing of uranium ores during the development of the atomic bomb. The MED and its successor agencies continued to periodically ship radioactive residues and materials to the NFSS for storage through 1950.

Environmental investigation and remediation activities at the NFSS are managed by the United States Army Corps of Engineers (USACE), Buffalo District, under the Formerly Utilized Sites Remedial Action Program (FUSRAP). The site previously passed through the governmental reorganizations of the MED to the Atomic Energy Commission (AEC), the Energy Research and Development Administration (ERDA) and the United States (U.S.) Department of Energy (DOE). In October 1997, the Energy and Water Development Appropriations Act for Fiscal Year 1998, PL 105-62, was signed into law, transferring responsibility for the administration and execution of FUSRAP from DOE to the USACE. The Energy and Water Development Appropriations Act for Fiscal Year 2000, Public Law 106-60, requires that USACE comply with the Comprehensive Environmental Response, Compensation, and Liability Act, 42 United States Code 9601 et seq., as amended (CERCLA), in conducting FUSRAP cleanup work. Therefore, USACE is conducting FUSRAP cleanups in accordance with CERCLA.

ES.2 Purpose and Objectives

DOE performed various remedial activities at the NFSS prior to transfer of site management to USACE. However, the change in management impacted the regulatory authority and the range of alternatives for the NFSS. Subsequently, as required by law for execution of FUSRAP, USACE selected the CERCLA RI/Feasibility Study (FS) process to reach a decision for the completion of remedial activities at the NFSS. The RI/FS process will consider new alternatives for the site, regulatory changes, stakeholder comments, and additional data which have been generated since alternatives were initially proposed for the site in an Environmental Impact Statement (EIS) issued by DOE in 1986.

This RI was conducted to define the identity, amount, and location of chemicals of concern (COC) and radionuclides of concern (ROC) at the NFSS, and to provide primary data for the FS, which will be used to identify and evaluate various remedial action alternatives and assist in the development of a protective and cost-effective remedy for the site. The long-term objective of this project is to clean up contamination resulting from work related to the Nation's early atomic energy program administered under MED/AEC in a manner that satisfies the requirements of the CERCLA. While chemical contamination is normally addressed only when collocated with radioactive contamination under FUSRAP, USACE will remediate both radioactive and chemical contamination because NFSS is a federally-owned property. An adjacent property, the Niagara-Mohawk property, was also investigated in this RI to determine if radiological constituents have migrated west of the NFSS property boundary. A Baseline Risk Assessment (BRA) and a fate and transport groundwater flow model were completed in support of RI objectives.

ES.3 RI Approach

The RI began with a records review in order to gain an understanding of historic site operations and how these operations may have contributed to potential contamination. Following the records review, site reconnaissance was conducted to identify areas potentially impacted by site operations. Field activities then proceeded in a phased approach in order to refine the understanding of the nature and extent of contamination at the NFSS and their relationships to exposures, risks, and remedial alternatives.

The RI was conducted in three phases. Fieldwork for Phase I occurred from November 1999 until January 2000 and consisted of a wide investigation of the site, involving the collection of groundwater, surface water, sediment, and soil samples that were analyzed for radiological and chemical parameters.

Phase 2 sampling activities were conducted from August through October 2000. Phase 2 of the investigation was guided by sampling results obtained during Phase I and focused on areas that appeared to be adversely impacted by past activities at the site. A sitewide gamma walkover and geophysical survey were conducted during the summer of 2001 to evaluate the presence of surficial gamma-emitting radionuclides and subsurface features that could allow contaminant migration, respectively.

Phase 3 was conducted from May 2001 until October 2003 and focused on the following activities.

- Further characterization of areas that exhibited elevated radioactivity during the gamma walkover survey,
- Further characterization of pipelines and sewers at the site that could serve as sources of contamination and mechanisms of contaminant transport,
- Excavation of exploratory trenches to investigate anomalies identified during a geophysical survey conducted in the summer of 2001,
- Collection of background surface water, sediment, and groundwater samples,
- Collection of soil samples required to support the BRA,
- Sampling and disposal of abandoned drums identified during previous field activities,
- Collection of confirmatory samples from wells and manholes,
- Collection of soil and groundwater samples to further delineate and characterize areas of suspect contamination identified during earlier phases of the RI,
- Collection of samples from the floor drains, the concrete floor slab and below the floor slab of Building 401, and
- Collection of radiological samples from the neighboring Niagara-Mohawk property.

Additional geophysical surveys on the Interim Waste Containment Structure (IWCS) were conducted concurrently with the Phase 3 sampling activities. Resistivity surveys were conducted in May-June 2001 and seismic surveys were conducted in June 2001. Follow-up geophysical investigations, including seismic refraction and electrical imaging/induced polarization were conducted in September 2003.

Since the completion of Phase 3 activities of the RI in October 2003, project work has continued for review and presentation of the RI results. Continued RI activities include: quality review and electronic management of analytical data, preparation of figures and tables to visually summarize environmental sampling results, formulation of a computerized groundwater flow model, performance of human health risk calculations in development of the BRA, and multi-tiered review in preparation of final compilation of this RI report.

In addition to sampling performed during the RI at NFSS, regular sampling of air, surface water, groundwater, and streambed sediment is conducted to support the ongoing environmental surveillance program. Environmental surveillance results are compared to local background conditions and regulatory criteria to determine if radioactive waste stored on-site poses a threat to human health and the environment. By further defining the nature and extent of site-related constituents (SRC) at the site during the RI, goals and objectives of the environmental surveillance program will be better directed to ensure continued safety to human health and the environment.

ES.4 Site Description

Figure ES-1 shows the NFSS and the current surrounding land use. The NFSS is bordered on the north and northeast by the CWM Chemical Services, LLC. hazardous waste disposal facility, on the east and south by the Modern Landfill, Inc. solid waste disposal facility, on the west by a transmission corridor owned by Niagara-Mohawk Power Corporation, and on the northwest by the village of Lewiston (the former LOOW wastewater treatment plant). All of the aforementioned properties were once part of the original LOOW.

The surrounding area land use consists primarily of row-crops and orchards, abandoned agricultural fields, and second-growth forests. The Lewiston-Porter public school property is approximately 1.5 miles northwest of the site and a public campground is approximately 0.5 miles west of the site. The nearest residences are located on Pletcher Road approximately 0.5 miles west-southwest of the site.

Drainage at the NFSS is poor because of the flat terrain and the relatively impermeable nature of surface soils. Much of the NFSS property has the potential to collect and hold standing water for lengthy periods. However, several ditches on site collect surface water runoff. Over most of the site, surface water is conveyed through east-west ditches that empty into the Central Ditch. The Central Ditch flows north and joins Four Mile Creek about 1.5 miles north of the NFSS. Four Mile Creek, in turn, empties into Lake Ontario. Surface water runoff from the western periphery of the site and from the Baker-Smith area in the northwest corner of the site flows to the West Ditch. The West Ditch flows north and joins the Central Ditch approximately 0.5 miles north of the NFSS.

Unconsolidated geologic units present at the NFSS consist mainly of glacial tills containing clay, silt, sand, and gravel. These unconsolidated materials are approximately 40 feet thick at the NFSS and include, in order of shallowest to deepest: surficial soils and fill, the Brown Clay Unit, the Gray Clay Unit, the Middle Silt Till Unit, the Sand and Gravel Unit, and the Red Silt Unit. The

Queenston Formation forms the bedrock at the site and consists of brownish red shale, siltstone, and mudstone. The Queenston Formation is over 1,200 feet thick and is typically encountered 32 to 49 feet below ground surface (bgs) (BNI 1994b, Acres American, Inc. 1981a). A geologic column is shown in Figure ES-2.

Within 100 feet of the ground surface, there are two water-bearing zones at the NFSS and surrounding vicinity. The upper water-bearing zone (UWBZ) is present in the Brown Clay Unit. The lower water-bearing zone (LWBZ) is associated with the Queenston Formation and the unconsolidated materials immediately above the bedrock (Red Silt and Sand and Gravel Units). The Gray Clay Unit acts as an aquitard between the UWBZ and the LWBZ. A regional groundwater divide exists approximately two miles south of the NFSS. Regional groundwater flow north of the divide is toward the northwest, whereas groundwater flow south of the divide is toward the southwest (BNI 1982b).

Former production facilities located on the portion of the LOOW that later became the NFSS included the acid area where nitric acid was know to have been stored; the shops area where machine shops and storage areas were located; an administrative area referred to as the Baker-Smith area; the Power Area which housed the original steam plant for the LOOW; and the Freshwater Treatment Plant which included circular clarifiers and several water storage reservoirs.

Currently, the IWCS is the dominant site feature, occupying approximately 10 acres in the southwest portion of the site. During the 1980's, the DOE performed various remedial activities at the site and consolidated the radioactive wastes and contaminated materials at the NFSS into the IWCS, which was engineered to retard radon emissions, infiltration from precipitation, and migration of contamination to groundwater. The base of the IWCS consists of naturally occurring clay. A clay dike, which was keyed 1.5 to 2 feet into the underlying gray clay, surrounds the stored radioactive materials. The IWCS is covered with an interim clay cap consisting of three layers. The bottom layer includes three feet of compacted clay keyed into the dike followed by a one foot layer of fill. The upper layer is a 6-inch topsoil vegetative cover. The cap is considered 'interim' because it does not include a barrier layer (typically a riprap layer at least three feet thick) and the side slopes of the structure, currently 3:1, were not constructed with a slope of 5:1. Also, the side slopes do not have a riprap covering, which is required for a long-term cap (BNI, 1994a).

ES.5 Determination of Exposure Units and Site-Related Constituents

To facilitate accurate estimation of exposure and dose in the BRA, the NFSS was divided into 18 exposure units (EU). An EU is the geographic area in which a receptor is assumed to work or live, and where a receptor may be exposed to SRCs detected during the RI. These EUs provided the geographical framework for the determination of SRCs. SRCs are defined as those compounds that exceed background screening levels in their respective EUs.

The area of investigation considered by this RI, consisting of the NFSS and the neighboring Niagara-Mohawk property, was divided into 14 distinct physical EUs, numbered 1 through 14 as shown on Figure ES-3. These EUs formed the basis for the evaluation of surface soils, subsurface soils, and some of the sediment and surface water samples. SRCs were determined for each EU for soil (0 to 10 feet bgs), surface soil (0 to 0.5 feet bgs), sediments, surface water, groundwater, pipeline/utility sediments, and pipeline/utility water. An additional four EUs (EUs 15 through 18) were created to accommodate special circumstances of the site or needs of the BRA. Throughout

the RI report, references may be made to 14 physical EUs or 18 risk EUs depending on the topic of discussion.

For the purpose of discussing RI results in this document, EUs 1 through 14 were grouped with respect to site features or former site operations. The following EU groupings were identified: Baker-Smith Area and Vicinity, Acid Area and Vicinity, Panhandle Area, IWCS and Vicinity, Shops Area, Niagara-Mohawk Property, and Building 401 and Vicinity. A brief description of each EU, including its grouping, follows.

EU 1 (Baker-Smith Area and Vicinity)
EU 1 is located in the northwest corner of the NFSS. The West Ditch flows to the north through EU 1. During the operation of the LOOW, a pipe shop, machine shop, welding shop, and a store house were located in EU 1 near a rail line that ran roughly parallel to the West Patrol Road. Except for the West Ditch, the ditches in EU 1 are typically dry and carry water only after storm events. During operation of the NFSS by AEC, K-65 and Knolls Atomic Power Laboratory (KAPL) wastes were stored in buildings located in this area. The KAPL wastes were later transferred to Oak Ridge National Laboratory and the K-65 wastes were moved to a silo in EU 6. The DOE performed remedial actions in the Baker-Smith area in 1981.

EU 2 (Baker-Smith Area and Vicinity)
EU 2 is located along the northern boundary of the NFSS property east of EU 1. A small portion of the New Naval Waste Area, where construction debris was stored, was also located in EU 2. The DOE performed remedial actions in the New Naval Waste Area in 1983.

EU 3 (Acid Area and Vicinity)
EU 3 is located along the northern boundary of the NFSS property and is bordered by EU 2 on the west and EU 4 on the east. The major portion of the New Naval Waste Area, where building debris was stored, was located within EU 3. Building 433, also known as the former radium storage vault used to store sealed radium sources, was located in EU 3. The exact location of this building is not known with certainty and during sampling efforts for this RI, areas in both EUs 2 and 3 were investigated as potential former locations of the building.

EU 4 (Acid Area and Vicinity)
EU 4 is located along the northern boundary of the NFSS property and is bordered by EU 3 on the west and EU 5 on the east. During the operation of the LOOW, nitric acid and other materials related to the manufacture of TNT were stored in EU 4. During the 1950's, uranium rods from several uranium metal production facilities in the New York area were stored in Buildings 431 and 432. These buildings, formerly located near the boundary between EU 3 and EU 4, were decontaminated and demolished by the DOE in 1986. Several subsurface pipelines used to transfer acids north to the former TNT production facilities remain in the EU.

EU 5 (Panhandle Area)
EU 5 is located in the northeastern portion of the site property along the northern property boundary and is bordered by EU 4 on the west and EU 6 on the east. It is bordered to the north by CWM Chemical Services Inc. Landfill and Modern Landfill to the south. Ammonia storage facilities were present in EU 5 during operation of the LOOW and some foundation material was found in the EU. In 1953, an explosion and fire that was not related to the storage or use of ammonia occurred immediately south of the Panhandle Area. The cause of the fire is unknown. The pipeline that transferred K-65 slurry from EU 6 to the IWCS passed through EU 5 along O Street.

EU 6 (Panhandle Area)
EU 6 is located in the northeastern corner of the site property and is bordered by EU 5 on the west, CWM Chemical Services Inc. Landfill to the north and east, and Modern Landfill to the south. Building 434, a water tower during the operation of the LOOW and later a storage facility for the K-65 residues, was located in EU 6. In the 1980's under direction of the DOE, the K-65 residues were slurry transferred to the IWCS through a temporary transfer pipeline and the water tower was removed.

EU 7 (IWCS and Vicinity)
EU 7 is a large grassy area north of the IWCS (EU 10). In a 1944 oblique, a large building was located in EU 7; however, no buildings currently exist in this EU. During the remedial actions performed by the DOE in the 1980's, several large temporary ponds, principally used for the management and storage of stormwater, were located in this area. EU 7 is also the location of the former DOE Organic Burial Area where roofing timbers, wooden debris, and organic material from clearing activities were disposed.

EU 8 (Shops Area)
EU 8 is located in the east-central portion of the NFSS, north of Building 401. It is bordered to the north by the acid area, to the south by the Building 401 Area, to the east by Modern Landfill, and to the west by Campbell Street. This area once contained a parking garage, equipment maintenance garage, material shed, general storehouse, combined shops, millwright shop, and riggers shop. None of these buildings remain although some concrete building foundations are still present. Radioactive residues were stored in several of the former buildings and corroded uranium billets were cut into smaller sections in the riggers shop. A debris pile is present in the southeastern portion of the EU.

EU 9 (Niagara-Mohawk Property)
The Niagara-Mohawk property is adjacent to the western boundary of the NFSS. The West Ditch is the principal site feature of the Niagara-Mohawk property. Impacted soils in the West Ditch were removed during a previous removal action.

EU 10 (IWCS and Vicinity)
EU 10 is located along the western border of the NFSS property boundary south of EU 7. The predominant feature in EU 10 is the IWCS. Prior to the construction of the IWCS, the LOOW freshwater treatment plant was located at the southern end of the EU. The Middlesex Sands, F-32, L-30, L-50, and K-65 residues are currently stored in the remnants of the freshwater treatment plant, which are now contained in the IWCS. Likewise, the R-10 pile, formerly unprotected and stored in the open north of the freshwater treatment plant, is also contained in the IWCS.

EU 11 (IWCS and Vicinity)
EU 11 is 'L' shaped and located both east and south of EU 10. During the operation of the LOOW, a fire house was located in the central portion this EU and a parking lot was located in the southern portion. Later, during the remedial actions performed by the DOE in the 1980's, a water treatment plant and several temporary ponds used to hold treated slurry water, decontamination water and stormwater prior to release were located here.

EU 12 (Building 401 and Vicinity)
EU 12 is a vacant wooded tract located between the shops area (EU 8) and Building 401. No production or storage activities are known to have occurred in EU 12. The Building 401 Ditch flows north through the EU where it joins the South 16 Ditch, which continues to the west joining the Central Ditch in EU 10.

EU 13 (Building 401 and Vicinity)
EU 13 is surrounded by EUs 11, 12, and 14. The main feature in EU 13 is Building 401, a large structural steel building. During the operation of the LOOW, Building 401 was a power house, generating steam for use in the TNT production facilities. Later, the building housed a boron-10 (a nonradioactive isotope) separation process. During active use of the NFSS as well as during previous remedial activities, the building was used to temporarily store and stage radioactive waste.

EU 14 (Building 401 and Vicinity)
EU 14, bounded on two sides by Modern Landfill, is a wooded tract. Both the South 31 Ditch and the Modern Ditch flow through the area and join near the northwest corner of the EU The South 31 Ditch continues to the west joining the Central Ditch in EU 10. No production or storage activities are known to have occurred in EU 14.

EU 15 (Interconnected Drainageways)
EU 15 consists of the Central Ditch, South 16 Ditch, South 31 Ditch, and Modern Ditch. All sediment and surface water samples collected from these ditches were evaluated in EU 15. Sediment and surface water samples collected from ditches other than those in EU 15 were evaluated in the EUs from which they were collected.

EU 16 (Pipelines and Subsurface Utilities)
EU 16 contains on-site subsurface pipelines used in former site operations. These pipelines include acid lines, water lines, sanitary sewers, and storm sewers. All sediment and water samples collected from these pipelines were evaluated in EU 16.

EU 17 (Sitewide Media)
EU 17 is a site-wide EU and includes all areas and media within the property boundary of NFSS. This includes all soil, sediment, surface water, and pipeline material in EUs 1 through 16. In addition, it contains site-wide groundwater, including both the UWBZ and the LWBZ.

EU 18 (Background Samples)
EU 18 consists of all background samples that were used for the determination of SRCs in EUs 1 through 17.

ES.6 Nature and Extent of SRCs

For the purpose of discussing the nature and extent of SRCs in soil within each EU, surface soil samples were considered to be samples collected from 0 to 0.5 feet bgs and subsurface soil samples were considered to be samples collected from 0.5 to 10 feet bgs. Soil samples collected at depths greater than 10 feet bgs were addressed separately. This approach to the discussion of the nature and extent of soil SRCs corresponds to figures presented in Section 4 of this report that show the horizontal and vertical distribution of SRCs in soil within each EU. Additionally, for the purposes of determining nature and extent of SRCs, water and sediment samples included in EUs 15 and 16 are presented in the discussion of the EU from which they were collected.

Table ES-1 provides a summary of SRCs of significance for each media within each EU. SRCs of significance were identified for each media. The criteria used to determine significance of SRCs included, but was not limited to:

- high frequency of detection,
- high magnitude of observed concentrations,
- widespread occurrence,
- multiple depth occurrences in soil,
- clustered concentrations,
- constituent of an identified groundwater plume, and
- high probability of media interaction.

The BRA evaluated soils to depths of 10 feet to remain consistent with reasonable exposure scenarios; however, the RI considered soil samples from depths greater than 10 feet bgs to evaluate SRCs of significance and to define nature and extent of contaminants. General conclusions concerning SRCs developed from the evaluation of RI data collected from EUs 1 through 14 are summarized in this section for each media of concern.

Surface and Subsurface Soil

EUs 4 and 8 appear to be impacted by the most types of SRCs. SRCs of significance identified for the two EUs include radionuclides, volatile organic compounds (VOCs), pesticides, polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), and boron. Metals and semi-volatile organic compounds (SVOCs) were also identified as SRCs of significance in EU 8.

Radionuclides impacted soils in all 14 physical EUs. Radionuclides exceeded the background upper tolerance limits (UTLs) by factors of 100 or greater in EUs 1, 5, 6, 7, 8, 11, 13, and 14. Exceedances of the background UTLs by a factor greater than 100 occurred approximately 10 times or less in each of these EUs. In decreasing order, radium-226, thorium-230, uranium-238, and cesium-137 were the four radionuclides with the highest frequency of detection above the background UTLs in surface soil. However, uranium-234 and uranium-238 exhibited some of the highest exceedances above background UTLs (greater than 4,000 times) in surface soil samples. Several surface soil samples also exhibited concentrations of radium-226 and thorium-230 that exceeded background UTLs by factors greater than 100. Likewise, thorium-230, uranium-238, radium-226, and uranium-234 were the four radionuclides with the highest frequency of detection above the background UTLs in subsurface soil. Radium-226 and thorium-230 exhibited the highest exceedances above background UTLs (greater than 100 times) in subsurface soil samples.

Radionuclides detected above background UTLs may be related to radioactive waste storage operations (EUs 1, 8, and 13), activities conducted at the former radium storage vault (EU 3), activities conducted and waste stored at the New Naval Waste Area (EU 3), wind erosion of the uncovered R-10 pile (sitewide), the storage of K-65 residues in Building 434 (EU 6), dewatering of slurried residues (EU 11), and general transportation and storage practices employed at the NFSS prior to remedial activities in the 1980's. Residual radionuclide contamination could be the result of difficulties encountered during historical cleanup activities. In addition, the soils may have been cleaned up to standards deemed appropriate by DOE at the time; however, technology improvements and the conservative screening criteria used during this RI indicate that further evaluation of contaminants in soil may be warranted. The widespread presence of radionuclides in subsurface soil at the NFSS may also be partly attributed to the migration of constituents along subsurface utility lines. Cracks or leaks in the subsurface utility lines may provide a pathway for constituents to reach subsurface soil where further migration can occur via infiltration of precipitation and interaction with shallow groundwater.

It should be noted that migration of contaminants along subsurface utilities is limited to those outside of the IWCS. During construction, the pipes, culverts, and canals within the footprint of the IWCS were excavated and/or sealed to close pathways for possible migration of radionuclides out of the IWCS (BNI, 1986c). Those pipelines utilities that extended off-site have also been sealed to prevent any contamination from migrating across the site boundary.

VOCs were considered to be SRCs of significance in all 14 physical EUs except EUs 9 and 11. Acetone was the most frequently detected VOC in surface and subsurface soils. However, roughly 75% of all acetone detections in surface and subsurface soil samples were at concentrations less than 20 µg/kg. Chlorinated solvents (i.e. TCE, cis/trans-1,2-dichloroethene (DCE), PCE, 1,1,1-trichloroethane, and 1,1-DCE), benzene, toluene, methylene chloride, carbon disulfide, and 2-butanone were also commonly detected in soils. VOCs were frequently detected below a depth of 10 feet bgs. The source of VOCs in soils at the NFSS is most likely associated with activities conducted at former LOOW buildings. Transportation of supplies and chemicals along haul roads and inappropriate disposal of drums and debris could also have contributed to releases of VOCs in soil.

Pesticides, PCBs, PAHs, and metals were identified as SRCs of significance in soil in several EUs. SVOCs were infrequently identified as SRCs of significance in soil. Pesticides may have been used for insect control across most of the NFSS, especially near building and former work areas. However, no specific pesticide storage facility could be identified in historical documents. PCBs may be the result of spills during transportation, disposal of debris as observed in excavation trenches, or from PCB-containing oil that may have been used for dust control on the site roads. Pesticides, PCBs, PAHs, SVOCs, and metals may also be related to general site activities conducted at the NFSS, including storage of chemicals and materials within some of the buildings.

Groundwater

Over 200 groundwater samples were collected from temporary and permanent wells at the NFSS. Groundwater plumes containing radionuclides, metals and organic compounds were identified in the UWBZ; however, no groundwater plumes were identified in the LWBZ because the nature and extent of SRCs detected in the LWBZ did not warrant the identification of a plume. Most of the plumes are geographically associated with past site uses or activities. There are some site areas where materials were buried or where drums were found that may have contained the constituents identified in groundwater plumes. In some cases, there appears to be a relationship between buried utilities and groundwater concentrations of SRCs; infiltration of precipitation that can promote the migration of constituents to shallow groundwater or the interaction of utility lines with shallow groundwater may allow utility lines to act as preferential pathways for constituent migration.

Groundwater plumes were identified for dissolved total uranium, thorium-230, manganese, boron, tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-DCE, trans-1,2-dichlroethene, vinyl chloride, and bis(2-ethylhexyl)phthalate. The plumes are briefly described in the following paragraphs.

Dissolved total uranium groundwater plumes impact ten EUs and were located in the following areas:

- In EUs 1 and 2 extending from the west-central portion of EU 2 through the northwest portion of EU 1,

- In the north-central portion of EU 4 near the former nitric acid concentrator,
- In the northwest corner of EU 7 near the West Ditch,
- In the southeastern portion of EU 8 near the area of the former storehouse Buildings 420 and 421 and the debris pile and in the southwestern portion of EU 8 between Buildings 422 and 423,
- On the west and north sides of the IWCS in EU 10,
- In the southern portion of EU 10 and in areas of EU 11, and extending along the water line that cuts diagonally across the southeastern corner of EU 10,
- In EUs 10 and 11 in the vicinity of some former dewatering ponds,
- Just north of Building 401 in EU 13 and across the northwest corner of EU 12, and
- In EU 13 covering the entire southwestern portion of the EU from Building 401 to the EU boundary.

Other groundwater plumes identified at the NFSS include:

- A dissolved manganese plume in the central portion of EU 3,
- A dissolved boron plume in the central portion of EU 4,
- A dissolved boron plume in the central portion of EU 13,
- A dissolved thorium-230 plume spanning the boundary between EUs 7 and 10,
- A small dissolved thorium-230 plume in the north central portion of EU 4,
- A dissolved thorium-230 plume extending from EU 11 into EU 10 in the area south of the IWCS,
- PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride groundwater plumes in EU 4 at a depth of approximately 10 to 15 feet bgs where PCE and TCE (dense non-aqueous phase liquids (DNAPL)) sources may exist, and
- A small bis(2-ethylhexyl)phthalate groundwater plume along the east side of the IWCS.

Other SRCs of significance were identified in groundwater for several EUs as shown on Table ES-1; however, groundwater plumes for these SRCs were not identified.

Sediment

Samples collected from locations that are inundated at least 50% of the year were considered to be representative of sediment.

EU 5 was the only physical EU where SRCs of significance were identified for sediment. Cesium-137 and total uranium exceeded the background UTLs in sediment by factors less than

10. Radionuclides may be present in EU 5 due to transportation and storage practices employed at the NFSS prior to the remedial activities in the 1980's. Also, because the R-10 pile was uncovered and unprotected for a number of years, wind erosion of the pile and the subsequent downwind deposition and migration of constituents to surface water and sediment likely account for some of the wide-spread low-level radionuclide SRCs observed here and elsewhere on the site.

Surface Water

SRCs of significance in surface water were only identified for EUs 7 and 9, and in the interconnected drainageways (EU 15). General conclusions concerning SRCs of significance in surface water include:

- Thorium-228 and thorium-230 were identified in surface water at EU 7 at concentrations greater than 40 times their respective background UTLs.

- Uranium-234, uranium-235 and uranium-238 exceed the background UTL in the dissolved phase at several locations along the West Ditch in EU 9.

- Several metals were found in the Central Drainage Ditch at levels approximately 2 times the background UTL. Dissolved silver was detected at levels approximately 20 times the background UTL at one location just inside the site boundary in the Modern Ditch and at the next three samples downstream in the South 31 Ditch. The three samples collected from the South 16 Ditch also exhibited dissolved silver at these levels.

- Thorium-232 was detected at five locations, three in the Central Ditch and two in the South 31 Ditch. Radium-226 was also detected at levels slightly above the background UTL at two of these locations. However, the fact that radionuclide concentrations do not exceed background UTLs at sampling locations near the northern boundary of the property suggests that radiological SRCs are not migrating off-site (i.e. radionuclide concentrations near the northern boundary of the property are within the expected range of naturally occurring concentrations suggesting that radiological impacts from the site have not extended beyond the northern property boundary).

- Two VOCs, 4-methyl-2-pentanone and benzene, were detected in an isolated sample collected at the conjunction of the South 31 Ditch and the Modern Ditch.

Although metals were not identified as an SRC of significance in surface water in any other EUs, dissolved silver was detected at levels 20 times greater than the background UTL in EUs 5 and 8. No known source for the silver was identified in the historical review.

- Dissolved silver was detected at levels 20 times greater than the background UTL in four samples collected from the O Street North Pond and a pond in the northern portion of the EU 5.

- Dissolved silver was detected at levels 20 times greater than the background UTL in three samples collected from small ditches in the northern and eastern portions of EU 8.

The elevated concentrations of thorium and uranium isotopes in surface water in EUs 7 and 9 can likely be attributed to runoff from surface soil. Metals and radionuclides in the interconnected drainageways may be the result of past activities including the construction and filling of the

IWCS. Metals, specifically dissolved silver, may also be entering the site from surface water to the east and south. The VOCs are likely a result of the nearby AEC sludge pit as surface and subsurface soil samples near this location also exhibited concentrations of VOCs above the background UTL.

Metal SRCs in surface water and sediment within the interconnected drainageways are likely migrating offsite at concentrations above background levels. SRCs in groundwater could migrate to surface water and sediment in drainageways where the groundwater table is above the elevation of the bottom of the drainageway. This likely occurs in the Central Ditch, which appears to be hydraulically connected to the UWBZ. SRCs in surface water have the potential to migrate to groundwater only when surface water in the drainageways is flowing above the elevation of the groundwater table.

Sediment and Water in Pipelines and Subsurface Utilities

Pipelines and subsurface utilities are present on the majority of the NFSS property, particularly in EUs 3, 4, 8, 10, 11, 12 and 13, and to a lesser extent in EUs 2, 5 and 6. SRCs of significance were identified for EUs 2, 4, 8, 10, 11, and 13; however, EUs 4, 8 and 13 exhibited the most frequent and widespread occurrence SRCs of significance in pipelines and subsurface utilities. Most of the SRCs identified in EU 13 occurred in floor drain samples from beneath Building 401. Background UTLs for sediment and water in pipelines and subsurface utilities are based on sediment and surface water background samples.

- Radionuclides were identified as SRCs of significance in sediment in subsurface utility lines in EUs 2, 4, 8, 10, and 13. Radiological SRCs were detected above the background UTLs in several water samples collected from pipelines and subsurface utilities in EUs 4, 8 10, 11, and 13.

- Three metals (boron, cadmium and mercury) in subsurface utility sediments from EU 13 exceeded their respective background UTLs by more than a factor of 100. A number of others metals exceeded their respective background UTLs by a factor of 10 to 100 in EU 13. Several metals in water samples collected from the subsurface utility lines in EU 11 exceeded their respective background UTLs by factors of up to 27. Numerous metals exceeded the background UTL in both the dissolved and total phase in four drain samples from Building 401 and two samples outside the building in EU 13.

- PAHs were identified as SRCs of significance in sediment in subsurface utility lines in EUs 2, 4, 8, 11, and 13. Several PAHs were detected in water from the subsurface utilities within EU 4 at concentrations up to approximately 280 times the background UTL.

- VOCs were detected in multiple locations in sediment from the drain samples in Building 401 within EU 13. VOCs were also detected above the background UTL at four locations in the EU 8 subsurface utilities. VOCs were detected in water from the subsurface utilities within EU 4 with two locations having concentrations of PCE greater than 20 times the background UTL.

- Several pesticides were found in six subsurface utility samples in EU 4 with concentrations exceeding the background UTL by as many as 600 times. Pesticides were also found in the floor drains in Building 401 at concentrations up to approximately 27,000 times the background UTL.

- PCBs in sediment from the drains in Building 401 in EU 13 exceeded their background UTLs by factors ranging from 14 to approximately 1,400. Aroclor-1260 concentrations exceeded the background UTL in 5 locations in EU 4 by factors ranging from 14 to 100 times.

Radionuclides may exist in the pipeline and subsurface utility line sediments and water as a result of residues being stored and staged in various buildings onsite, primarily in EUs 4, 10, and 13. Constituents found in subsurface utilities in the EU 8 shops area, including metals, SVOC, VOCs, PCBs and PAHs, are likely from historical operations conducted in these buildings. Pesticides may be present in the pipelines and subsurface utilities as a result of a possible spill in a storage area or surface drainage into manholes. It is possible that the pipelines/subsurface utilities and surrounding gravel-fill provide a pathway for SRCs to travel betweens EUs and may explain the existence of constituents in many of the areas. Some of the results, especially in EU 4, are very high but not wide-spread. Also, many manholes are damaged and allow surface water to enter the sewer system. Finally, given the age and generally poor repair of the system, infiltration and exfiltration are likely occurring.

ES.7 Identification of COCs and ROCs

The process of identifying SRCs, COCs, and ROCs is outlined in the BRA. SRCs are initially identified in the BRA using a series of statistical methods to consider whether a chemical is site-related or naturally occurring including a comparison to background. Chemicals and radionuclides that are determined to be site-related are identified as SRCs. Further screening against preliminary remediation goals (PRG) or site-specific radiological risk-based screening levels, as appropriate, is performed to eliminate SRCs that pose negligible risk to human health. SRCs exceeding PRGs or radiological screening levels are identified as chemicals of potential concern (COPC) or radionuclides of potential concern (ROPC), respectively and are evaluated quantitatively in the BRA. COCs and ROCs are constituents (COPCs and ROPCs) that were determined in the BRA to pose unacceptable risk.

Table ES-1 summarizes the COCs and ROCs identified for each media within each EU for the subsistence farmer scenario, only. Due to the extensive number of risk scenarios evaluated in the BRA, only the most conservative risk scenario generating the highest number of COCs is discussed here. It should be noted that the subsistence farmer land use scenario is overly conservative for the NFSS and is highly unlikely due to proximity of the site to surrounding landfills and poor yield and quality of on-site groundwater resources. A more detailed evaluation of COCs for each risk scenario that will provide the basis for identifying COCs and remedial action objectives (RAO) in the FS is presented in the BRA. Table ES-1 also identifies constituents considered to be risk drivers in the exposure pathways. The subsistence farming scenario includes the development of a working farm with livestock for meat and dairy products plus cultivated land for grains, fruits, and vegetables. It is assumed that a subsistence farmer could be exposed to contaminated surface soil, surface water/sediment, impacted home-grown produce, impacted meat and dairy products, and upper and lower groundwater while on site. Carcinogenic COCs and ROCs are constituents that exceed the 10^{-5} risk level. A risk of 10^{-5} is defined as the probability that one additional person in a population of 100,000 people may develop cancer as a result of exposure to contaminants at NFSS. Non-carcinogenic COCs are constituents that show risks exceeding a hazard index (HI) of one. A HI greater than one is defined as the level of concern for potential adverse non-carcinogenic health effects. Risk was determined for the following media pathways: surface soil (0-0.5 feet), soil (0-10 feet), sediment,

surface water, groundwater, and food. COCs identified for the food pathway correspond to soil samples collected from 0-0.5 feet.

The majority of COCs and ROCs identified for the adult/child subsistence farmer pose risk in soil only; however, COCs and ROCs were also identified for the groundwater and food pathways. No COCs or ROCs were identified in sediment or surface water in any of the 14 physical EUs. Sediment and surface water COCs and ROCs also were not identified for pipelines and subsurface utilities (EU 16) or for interconnected drainageways (EU 15). No COCs or ROCs were identified for EU 16 because the BRA assumes that the subsistence farmer will not be exposed to the subsurface utilities. However, the high concentrations of constituents found in both the sediment and water in pipelines and subsurface utilities could remain a potential source for groundwater migration. Additionally, no COCs or ROCs were identified for EU 10 in the BRA because the subsistence farmer will not be exposed to the constituents in or around the IWCS.

COCs were identified as posing risk in soil at EUs 2, 4, 8, and 12. Several PAHs, arsenic, boron, and Aroclor-1260 were identified as soil COCs in one or more of these EUs. Of these soil COCs, arsenic, benzo(a)anthracene, benzo(a)pyrene, and Aroclor-1260 were identified as risk drivers in soil at one or more EUs. ROCs were identified as posing risk in soil at EUs 1 through 9, 11, 12, 13, and 14. Radium-226 was identified as a risk driver in soil at all of these EUs. Additionally, uranium was identified as a soil risk driver to the child subsistence farmer in EUs 8 and 11.

COCs were identified for the food pathway in EUs 2, 4, 8, 11, 12, 13, and 14. PAHs, arsenic, boron, copper, zinc, Aroclor-1254 and -1260, PCE, di-n-octylphthalate, carbazole, and heptachlor epoxide were identified as posing risk in the food pathway at one or more of these EUs. ROCs were identified in the food pathway at EUs 1 through 9, 11, 12, 13, and 14. Actinium-227, protactinium-231, lead-210, radium-226 and -228, thorium-230 and -232, and uranium-234 and -238 were identified as food ROCs in one or more of these EUs.

Groundwater COCs and ROCs were identified for EUs 4, 13, and 17. Several metals, bis(2-ethylhexyl)phthalate, and several VOCs were identified as groundwater COCs in one or more of these EUs. Of the groundwater COCs, arsenic was identified as a risk driver in EU 13, while PCE was identified as a risk driver in EUs 4 and 17. Cesium-137, lead-210, radium-226 and -228, thorium-228, and uranium-234 and -238 were identified as groundwater ROCs in one or more of these EUs. Of the groundwater ROCs, radium-226 was identified as a risk driver in EUs 4 and 17.

ES.8 Groundwater Fate and Transport Modeling

The fate and transport of groundwater at the NFSS is detailed in the modeling report prepared by HydroGeoLogic, Inc. (HGL 2007). The groundwater flow and transport model indicates that organic and metal plumes located outside the area of the IWCS exhibit only minor dispersion due to low infiltration rates. VOCs in groundwater will continue to degrade and maximum concentrations of metals are not expected to increase above the current concentrations of the plumes.

Within 1,000 years, the maximum concentrations of uranium isotopes are predicted to occur in the Brown Clay Till beneath the IWCS, near Building 411. Additionally, model results indicate that the screening levels for uranium-234 and uranium-235 will be exceeded in even the deepest of the aquifers (the upper Queenston Formation) within 1,000 years. This is likely the result of potential leaching of residues within Building 411 in the IWCS. Groundwater modeling also

predicts that metals that may leach from within the IWCS will not migrate offsite in groundwater at concentrations above screening levels.

Uranium isotopes are predicted to migrate offsite within 1,000 years at concentrations that exceed the screening levels in EUs 1 and 11. This offsite migration is due to continued migration of existing groundwater contamination, contributions predicted from SESOIL modeling, or a combination of both. However, the conclusions made regarding the fate and transport of uranium isotopes in site groundwater are somewhat dependant on the conservative K_d value of 3.6 L/kg that was used in the modeling simulations. Use of this K_d value causes the model to predict greater concentrations of radionuclides in groundwater due to increased leaching of site soils. The results of a sensitivity analysis for the uranium K_d value are discussed later in this report in Section 6.6.4. A modified K_d value for uranium may be used in the FS for determining cleanup criteria.

ES.9 Recommendations

The presence of COCs and ROCs identified in the BRA as posing risk in soil for the adult/child subsistence farmer are recommended to be further addressed in the FS at each EU in which they were identified. There are soil COCs and ROCs that are recommended to be addressed in the FS at all 14 physical EUs.

Groundwater modeling results support the conclusion that no further action or evaluation is needed for COCs and ROCs in groundwater in EUs 3, 5, 6 and 14. Further evaluation of COCs and ROCs in the FS is recommended for all of the other 14 physical EUs, with the exception of EU 9 where no groundwater samples were collected. Additionally, further evaluation of COCs and ROCs in sitewide groundwater (EU 17) is recommended.

No human health COCs or ROCs were identified for sediment or surface water at any of the 14 physical EUs or in interconnected drainageways (EU 15) due to the short duration of exposure for individuals who may come in contact with surface water or sediment at NFSS.

The presence of SRCs in sediment and water within pipelines and subsurface utilities is recommended for further consideration in the FS as it pertains to groundwater plume and soil remediation. As mentioned previously, high concentrations of constituents found in both the sediment and water in pipelines and subsurface utilities could remain a potential source for groundwater migration..

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Table ES-1. Summary of SRCs of Significance, COCs, and ROCs for Exposure Units 1 through 17

Exposure Unit	SRCs/COCs/ROCs[1]	Soil	Food[2]	Groundwater	Sediment	Surface Water[5]	Utilities[3]
EU 1	SRCs	Radionuclides VOCs Pesticides	NA	Radionuclides	See Footnote 7	See Footnote 7	NA
	COCs	None	None	None	See Footnote 7	See Footnote 7	NA
	ROCs	Actinium-227 Cesium-137 Protactinium-231 Lead-210 Radium-226*, 228 Thorium -230, 232 Uranium-234, 235, 238	Actinium-227 Protactinium-231 Lead-210 Radium-226, 228 Thorium -230, 232 Uranium-234, 238	None	See Footnote 7	See Footnote 7	NA
EU 2	SRCs	Radionuclides VOCs PAHs PCBs Pesticides	NA	Radionuclides	See Footnote 7	See Footnote 7	Radionuclides PAHs
	COCs	Benzo(a)anthracene Benzo(a)pyrene* Benzo(b)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene Boron	Benzo(a)anthracene Benzo(a)pyrene* Benzo(b)fluoranthene Benzo(k)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene Boron	None	See Footnote 7	See Footnote 7	None
	ROCs	Actinium-227 Cesium-137 Protactinium-231 Lead-210 Radium-226*, 228 Thorium-230, 232	Actinium-227 Protactinium-231 Lead-210 Radium-226, 228 Thorium-232	None	See Footnote 7	See Footnote 7	None

Table ES-1. Summary of SRCs of Significance, COCs, and ROCs for Exposure Units 1 through 17

Exposure Unit	SRCs/COCs/ROCs[1]	Soil	Food[2]	Groundwater	Sediment	Surface Water[5]	Utilities[3]
EU 3	SRCs	Radionuclides VOCs PCBs Pesticides	NA	Manganese	NA	NA	None
	COCs	None	None	None	NA	NA	None
	ROCs	Actinium-227 Protactinium-231 Lead-210 Radium-226*	Actinium-227 Protactinium-231 Lead-210 Radium-226	None	NA	NA	None
EU 4	SRCs	Radionuclides Boron VOCs PAHs PCBs/ Pesticides	NA	Radionuclides Metals SVOCs VOCs	NA	See Footnote 7	Radionuclides VOCs PAHs PCBs Pesticides
	COCs	Arsenic Aroclor-1260* Benzo(a)pyrene	Arsenic Boron Aroclor-1254 Aroclor-1260* Benzo(a)pyrene Benzo(b)fluoranthene Indeno(1,2,3-cd)pyrene Tetrachloroethene	Arsenic Barium Boron Copper Lead[6] Manganese Nickel Vanadium Bis(2-ethylhexyl)phthalate cis-1,2-Dichloroethene Methylene Chloride Tetrachloroethene* Trichloroethene Vinyl Chloride	NA	See Footnote 7	None
	ROCs	Cesium-137 Lead-210 Radium-226*	Lead-210 Radium-226	Lead-210 Radium-226*, 228 Thorium-228 Uranium-234, 238	NA	See Footnote 7	None

Table ES-1. Summary of SRCs of Significance, COCs, and ROCs for Exposure Units 1 through 17

Exposure Unit	SRCs/COCs/ROCs[1]	Soil	Food[2]	Groundwater	Sediment	Surface Water[5]	Utilities[3]
EU 5	SRCs	Radionuclides VOCs PCBs	NA	None	Radionuclides[7]	See Footnote 7	None
	COCs	None	None	None	See Footnote 7	See Footnote 7	None
	ROCs	Actinium-227 Cesium-137 Protactinium-231 Lead-210 Radium-226*, 228 Thorium-232	Actinium-227 Protactinium-231 Lead-210 Radium-226, 228 Thorium-232	None	See Footnote 7	See Footnote 7	None
EU 6	SRCs	Radionuclides VOCs PCBs Pesticides	NA	None	See Footnote 7	See Footnote 7	NA
	COCs	None	None	None	See Footnote 7	See Footnote 7	NA
	ROCs	Actinium-227 Cesium-137 Protactinium-231 Lead-210 Radium-226* Thorium-230 Uranium-234, 235, 238	Actinium-227 Protactinium-231 Lead-210 Radium-226 Thorium-230 Uranium-234, 238	None	See Footnote 7	See Footnote 7	NA
EU 7	SRCs	Radionuclides VOCs	NA	Radionuclides	See Footnote 7	Radionuclides[7]	NA
	COCs	None	None	None	See Footnote 7	See Footnote 7	NA
	ROCs	Actinium-227 Cesium-137 Protactinium-231 Lead-210 Radium-226* Thorium -230	Actinium-227 Protactinium-231 Lead-210 Radium-226 Thorium -230	None	See Footnote 7	See Footnote 7	NA

Table ES-1. Summary of SRCs of Significance, COCs, and ROCs for Exposure Units 1 through 17

Exposure Unit	SRCs/COCs/ROCs[1]	Soil	Food[2]	Groundwater	Sediment	Surface Water[5]	Utilities[3]
EU 8	SRCs	Radionuclides Metals VOCs SVOCs PAHs PCBs Pesticides	NA	Radionuclides	See Footnote 7	See Footnote 7	Radionuclides VOCs PAHs
	COCs	Benzo(a)anthracene* Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene Total Uranium*[,4]	Aroclor-1260 Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Carbazole Dibenz(a,h)anthracene Heptachlor Epoxide Indeno(1,2,3-cd)pyrene	NA	See Footnote 7	See Footnote 7	None
	ROCs	Actinium-227 Cesium-137 Protactinium-231 Lead-210 Radium-226* Thorium -230 Uranium 234, 235, 238	Actinium-227 Protactinium-231 Lead-210 Radium-226 Thorium -230 Uranium 234, 238	NA	See Footnote 7	See Footnote 7	None
EU 9	SRCs	Radionuclides	NA	NA	See Footnote 7	Radionuclides[7]	NA
	COCs	None	None	NA	See Footnote 7	See Footnote 7	NA
	ROCs	Lead-210 Radium-226*, 228 Thorium -230, 232	Lead-210 Radium-226 Thorium -232	NA	See Footnote 7	See Footnote 7	NA

Table ES-1. Summary of SRCs of Significance, COCs, and ROCs for Exposure Units 1 through 17

Exposure Unit	SRCs/COCs/ROCs[1]	Soil	Food[2]	Groundwater	Sediment	Surface Water[5]	Utilities[3]
EU 10	SRCs	Radionuclides Metals VOCs PAHs Pesticides	NA	Radionuclides Metals SVOCs	See Footnote 7	See Footnote 7	Radionuclides
	COCs	None	None	None	See Footnote 7	See Footnote 7	None
	ROCs	None	None	None	See Footnote 7	See Footnote 7	None
EU 11	SRCs	Radionuclides SVOCs PAHs	NA	Radionuclides Metals	See Footnote 7	See Footnote 7	Radionuclides
	COCs	Total Uranium*,[4]	Benzo(a)pyrene* Benzo(b)fluoranthene Indeno(1,2,3-cd)pyrene	None	See Footnote 7	See Footnote 7	None
	ROCs	Actinium-227 Protactinium-231 Lead-210 Radium-226*, 228 Thorium-230, 232 Uranium-234, 235, 238	Actinium-227 Protactinium-231 Lead-210 Radium-226 Thorium-230, 232 Uranium-234, 235, 238	None	See Footnote 7	See Footnote 7	None

Table ES-1. Summary of SRCs of Significance, COCs, and ROCs for Exposure Units 1 through 17

Exposure Unit	SRCs/COCs/ROCs[1]	Soil	Food[2]	Groundwater	Sediment	Surface Water[5]	Utilities[3]
EU 12	SRCs	Radionuclides Metals VOCs PAHs	NA	Radionuclides Metals	See Footnote 7	See Footnote 7	None
	COCs	Arsenic* Benzo(a)pyrene	Arsenic Benzo(a)pyrene Benzo(b)fluoranthene Indeno(1,2,3-cd)pyrene	None	See Footnote 7	See Footnote 7	None
	ROCs	Actinium-227 Cesium-137 Protactinium-231 Lead-210 Radium-226*, 228 Thorium-230, 232 Uranium-238	Actinium-227 Protactinium-231 Lead-210 Radium-226 Thorium-230, 232 Uranium-238	None	See Footnote 7	See Footnote 7	None

Table ES-1. Summary of SRCs of Significance, COCs, and ROCs for Exposure Units 1 through 17

Exposure Unit	SRCs/COCs/ROCs[1]	Soil	Food[2]	Groundwater	Sediment	Surface Water[5]	Utilities[3]
EU 13	SRCs	Radionuclides Metals VOCs	NA	Radionuclides Metals SVOCs VOCs	See Footnote 7	See Footnote 7	Radionuclides Metals VOCs SVOCs Pesticides PCBs PAHs
	COCs	None	Aroclor-1254 Boron Copper Zinc	Arsenic* Boron Copper Manganese Lead Vanadium Bis(2-ethylhexyl)phthalate Cis-1,2-dichloroethene Trichloroethene	See Footnote 7	See Footnote 7	None
	ROCs	Actinium-227 Protactinium-231 Lead-210 Radium-226* Thorium-230 Uranium-238	Actinium-227 Protactinium-231 Lead-210 Radium-226 Thorium-230	Cesium-137 Lead-210 Radium-226 Uranium-234, 238	See Footnote 7	See Footnote 7	None

Table ES-1. Summary of SRCs of Significance, COCs, and ROCs for Exposure Units 1 through 17

Exposure Unit	SRCs/COCs/ROCs[1]	Soil	Food[2]	Groundwater	Sediment	Surface Water[5]	Utilities[3]
EU 14	SRCs	Radionuclides Metals VOCs	NA	Radionuclides	See Footnote 7	See Footnote 7	None
	COCs	None	Di-n-octylphthalate Boron*	None	See Footnote 7	See Footnote 7	None
	ROCs	Actinium-227 Cesium-137 Protactinium-231 Lead-210 Radium-226*	Actinium-227 Protactinium-231 Lead-210 Radium-226	None	See Footnote 7	See Footnote 7	None
EU 15	SRCs	NA	NA	NA	See Footnote 7	Radionuclides[7] Metals VOCs	NA
	COCs	NA	NA	NA	See Footnote 7	See Footnote 7	NA
	ROCs	NA	NA	NA	See Footnote 7	See Footnote 7	NA
EU 16	SRCs	NA	NA	NA	NA	NA	<u>Sediment/Water</u> Radionuclides Metals VOCs PAHs <u>Sediment Only</u> PCBs Pesticides.
	COCs	NA	NA	NA	NA	NA	See Footnote 3.
	ROCs	NA	NA	NA	NA	NA	See Footnote 3.

Table ES-1. Summary of SRCs of Significance, COCs, and ROCs for Exposure Units 1 through 17

Exposure Unit	SRCs/COCs/ROCs[1]	Soil	Food[2]	Groundwater	Sediment	Surface Water[5]	Utilities[3]
EU 17 Groundwater	SRCs	NA	NA	Radionuclides Metals SVOCs VOCs	NA	NA	NA
	COCs	NA	None	Arsenic Boron Manganese Vanadium Bis(2-ethylhexyl)phthalate Tetrachloroethene* Methylene Chloride	NA	NA	NA
	ROCs	NA	None	Lead-210 Radium-226*, 228 Uranium-234, 238	NA	NA	NA

NA – Not applicable

* - Constituent has been identified as a risk driver in the BRA. Total uranium identified as a risk driver applies to the child subsistence farmer only (see EUs 8 and 11).

1. The COCs and ROCs identified in the BRA represent the RME cancer risk for the conservative adult/child subsistence farmer scenario. The carcinogenic COCs are constituents that exceed the 10^{-5} risk level. For ROCs, if total cancer risk exceeds 10^{-4}, only the ROCs exceeding 10^{-5} risk levels are identified. ROCs included on this table are in secular equilibrium with other isotopes that may not exceed a risk level of 10^{-5}. For example, uranium-234, -235, and -238 are always present with one another, but there are occurrences where only one or two of these isotopes are identified as a ROC in any given EU medium. Similarly, thorium-228 will be present whenever radium-228 is present; however, thorium-228 may not exceed risk levels even when radium-228 has been identified as a ROC.
2. Food represents a risk pathway only and corresponds to a plant root depth of 0-0.5 feet in soil. No SRCs of significance were identified for the food pathway.
3. No COCs or ROCs were identified for individual physical EUs (1 through 14) or for EU 16 (pipelines and subsurface utilities) because the BRA assumes that the subsistence farmer will not be exposed to the subsurface utilities. However, the high concentrations of constituents found in both the sediment and water in these utilities could remain a potential source for soil and groundwater contamination due to cracks in the utility lines. Therefore, the presence of SRCs identified in sediment and water in subsurface utilities should be further addressed in the FS.
4. Total uranium is listed as a COC based on its chemical toxicity; however, for presentation purposes in this RI, total uranium is included as a radionuclide in the Section 4 figures and in the nature and extent discussions in Sections 5 and 7.
5. Surface water SRCs for interconnected Drainageways (Central Ditch, South 16 Ditch, South 31 Ditch, and Modern Ditch) are evaluated in EU 15, not in the individual physical EUs.
6. Lead was retained as a COC because the EPC exceeds the drinking water action level.
7. No human health COCs or ROCs were identified for sediment or surface water in any of the 14 physical EUs or in the interconnected Drainageways (EU 15) due to the short duration of exposure for individuals who may come in contact with surface water or sediment at NFSS.