DEFENSE LOGISTICS AGENCY
DEFENSE NATIONAL STOCKPILE CENTER
8725 JOHN J. KINGMAN ROAD, SUITE 3229
FORT BELVOIR, VIRGINIA 22060-6223

IN REPLY
REFER TO
DNSC-E

SEP 29 2006

U.S. Nuclear Regulatory Commission
Region 1, Nuclear Materials Safety Branch
Division of Nuclear Materials Safety
ATTN: Ms Betsy Ullrich
475 Allendale Road
King of Prussia, PA 19406-1415

Q-5
Q-9

SUBJECT: Decommissioning/Remediation Plan (D/RP) For Hammond Depot And Curtis Bay Depot
License STC-133 04000341

Dear Ms. Ullrich:

We are submitting the attached subject document commensurate with NUREG-1757, Consolidated NMSS Decommissioning Guidance. The Defense National Stockpile Center (DNSC) herein submits its D/RP for our depots in Hammond, IN and Curtis Bay, MD. The plan was prepared for us under the combined efforts of the Oak Ridge Institute of Science and Education and the Oak Ridge National Laboratory. We trust it meets with your approval and upon receipt of notification of same we will move forward expeditiously to conduct remediation activities which are scheduled to commence in March 2007.

Sincerely,

MICHAEL J. PECULLAN
Radiation Safety Officer

Attachment

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DECOMMISSIONING/REMEDIATION PLAN FOR CURTIS BAY DEPOT CURTIS BAY, MARYLAND AND HAMMOND DEPOT HAMMOND, INDIANA

Prepared by

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Prepared for the

Defense National Stockpile Center
Defense Logistics Agency

FINAL REPORT

SEPTEMBER 2006

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1.0 INTRODUCTION

This Decommissioning/Remediation Plan (D/RP) was prepared by the Oak Ridge Institute for Science and Education (ORISE) for the Curtis Bay and Hammond Depots owned by the federal government, General Services Administration (GSA), and operated by the Defense National Stockpile Center (DNSC) of the Defense Logistics Agency (DLA). The two facilities are located in Curtis Bay, Maryland, and Hammond, Indiana, respectively. Decommissioning activities will include removing residual radioactivity from building structures and open land areas at these two facilities to levels that will allow for the unrestricted use in accordance with Title 10, Code of Federal Regulations (CFR), Part 20, Subpart E, *Radiological Criteria for License Termination.*

The principal license activities at the Curtis Bay Depot (CBD) and Hammond Depot (HD) have been storage of strategic materials, including thorium and uranium-bearing materials as part of an overall objective of the federal government of mitigating dependence on foreign sources of vital materials during times of national emergencies. These licensed activities are conducted currently under U.S. Nuclear Regulatory Commission (NRC) Radioactive Material License No. STC-133. However, over the past several years, the mission of the DNSC has changed such that continued storage of nuclear materials at these locations is no longer required. As such, DNSC has removed source materials and initiated timely decommissioning-related activities at these two facilities in accordance with 10 CFR Part 40.42, *Expiration and Termination of Licenses and Decommissioning of Sites and Separate Buildings or Outdoor Areas.* This D/RP has therefore been prepared to facilitate approval as part of the licensing process and initiate decommissioning and license termination at the CBD and HD.

The D/RP has been prepared commensurate with NUREG-1757, *Consolidated NMSS Decommissioning Guidance.* Information contained in the D/RP describes many of DNSC's current radiation protection program elements that have supported these facilities during operations. It also describes those new program elements (e.g., decommissioning cleanup criteria and final status survey plan) developed to support a transition towards decommissioning of these two facilities.

While a summary of the radiological status of these two facilities is contained herein, a thorough analysis of the nature and extent of contamination at these facilities has been provided for review separately (Refs. 1, 2, 7 and 11). Similarly, a summary of the methods used to derive cleanup criteria including the Derived Concentration Guideline Levels (DCGLs) for natural thorium and uranium are also provided herein. However, radiological dose assessments supporting the methods used to calculate these cleanup criteria for unrestricted release of these facilities have been previously provided to the NRC for review and approval (Refs. 3 and 4).

2.0 SITE DESCRIPTION

The site descriptions of the CBD and HD are discussed below.

2.1. CURTIS BAY DEPOT

The CBD site is located approximately 1.6 kilometers [km (one mile)] south of Baltimore, Maryland in an industrialized area of Anne Arundel County, Maryland. The property currently consists of approximately 483 acres bordered on the north by the Army Reserve Facility and Curtis Creek, on the east by Curtis Creek, on the south by Furnace Creek, and on the west by Back Creek and the Anne Arundel County Facility. A 596 meters (m) long dock belonging to the U.S. Army Reserve lies along Curtis Creek; a security fence encloses the facility. The layout of the CBD is depicted in Figure 1.

2.1.1. Facility Operating History

The land area that is currently the CBD in Curtis Bay, Maryland was originally a U.S. Army Depot built in 1918 on 798 acres of farmland. Additional acreage was acquired, increasing the site size to 815 acres. From 1918 to 1954 the site was used for receiving, shipping and storage, and as an ordnance depot (storing ammunition).

In 1946, a National Stockpile program was established as an attempt to mitigate dependence on foreign sources of vital materials during times of national emergencies. In the late 1950s, the DNSC became a tenant at the CBD and began storing strategic materials (bulk ores, minerals, and metals). Included in the materials stored at the CBD were chromite, ferromanganese, and ferrochrome. Additional stored materials were thorium nitrate (ThN) (mantle and reactor grades, average 47 percent thorium dioxide (ThO_2) by weight) in fiber and steel drums, monazite sands, and sodium sulfate—radioactive materials that required a U.S. AEC, predecessor to the U.S. NRC, source material license (License STC-133).

Since the establishment of the CBD, there have been a number of land transfers reducing the footprint of the site and also changes in government agency caretakers. Approximately 37 acres were transferred to the U.S. Army Reserve Command between 1958 and 1966. The remaining 778 acres were excessed to the GSA which had assumed accountability for the facility. In 1966, GSA sold CBD land that included the area of an old burial site to Anne Arundel County for development into an industrial park (Bay Meadows Industrial Park). Material that was in this pit was removed in 1966 and transferred to an on-site burial area. In 1977, GSA notified NRC of its intention to excess empty warehouses on the site as part of a sale of U.S. Government land and buildings. In 1980, GSA sold approximately 87 acres to Anne Arundel County. This property had contained nine warehouses that were used to store thorium nitrate. The site was cleaned up and that portion released from the NRC license. The County eventually built a detention center and ball fields on the property. In 1988, National Defense Stockpile responsibility was transferred from the GSA to the DLA.

2.1.2. License Number/Status/Authorized Activities

The CBD is currently owned by the federal government, GSA, and operated by the DNSC of the DLA. The DNSC headquarters address is 8725 John J. Kingman Road, Ft. Belvoir, Virginia 22060-6223.

Commodities that were licensed under NRC Source Material License No. STC-133 included natural uranium and thorium mixtures as ores, concentrates, and solids. Authorized uses were storage, sampling, repackaging, transfer, and remediation.

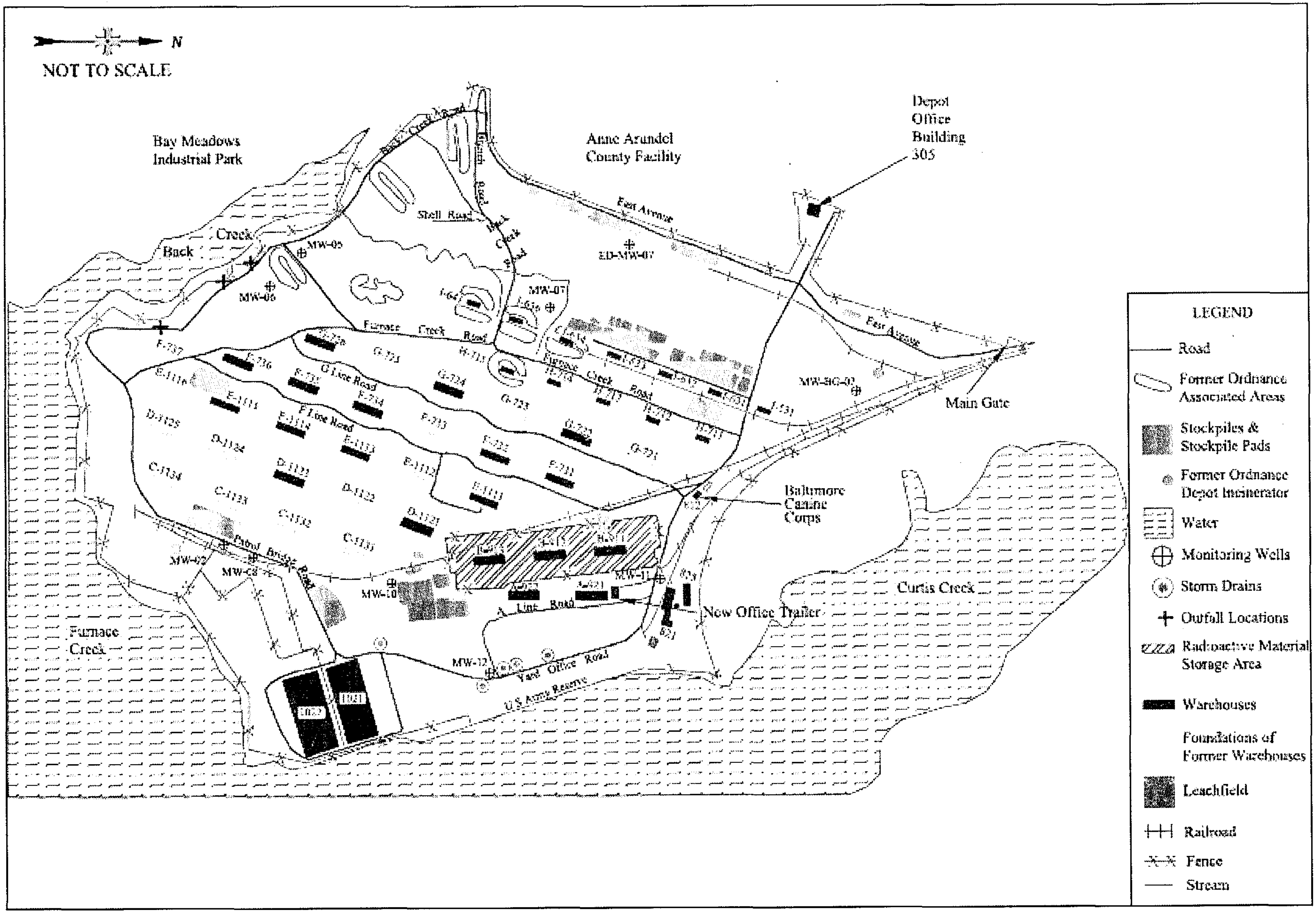

Figure 1: Curtis Bay Depot Layout

2.1.3. Previous Decommissioning Activities

The DNSC of the DLA is seeking to terminate its NRC license for the CBD. A number of building and soil remedial actions have taken place at CBD over the past three decades. All current site clean-up work at the CBD is sponsored by the DLA's DNSC and is being conducted as part of the U.S. DOE-Oak Ridge Operations approved Thorium Nitrate Stewardship and Disposition Program – Phase 4 – Decontamination & Decommissioning. This program is managed by the ORNL, per DOE Proposal Number # 1872-M171-A1. The initial phase of the cleanup activities has been completed as the DNSC removed ThN source material from the site—monazite sands and sodium sulfate had been previously removed. In conjunction with site cleanup, ORISE performed a historical site assessment (HSA) of the CBD in order to plan for future site investigations and eventual remediation activities (Ref. 5). Additionally, ORISE was tasked to conduct scoping and characterization surveys of the site to validate the results of the HSA and to provide radiological information for the development of a decontamination scope of work for areas of the site that have been identified with excessive residual radioactivity levels. The scoping survey was conducted in two phases during the periods of June 13 through 22 and October 24 through 27, 2005. Phase 1 included land areas, concrete pads of previously demolished buildings, and buildings deemed structurally sound for safe entry. Phase 2 included surveys of the floors and the resultant debris of those buildings that required partial deconstruction to allow for survey access. The deconstruction of 24 buildings at the site was completed by the DLA contractor, PIKA International, Inc., on October 14, 2005. The scoping survey results were provided in an earlier report (Ref. 6). The characterization survey was conducted by ORISE during the period May 1 through 19, 2006 with additional investigations conducted on July 25 and 26, 2006 (Ref. 1). The final ORISE CBD characterization survey report was issued in September, 2006 (Ref. 7).

2.1.4. Spills

Several of the remaining buildings, including B-911 and B-912, are contaminated, particularly the floor surfaces. The suspected source of the contamination was drums containing thorium nitrate that leaked during storage.

2.1.5. Prior Onsite Burials

There are two known waste burial areas at the CBD. The areas are termed the "Radioactive Waste Burial Pit Area" and the "Medical Supplies Burial Area." The latter was not used during DNSC's tenure at the site.

2.1.5.1. Radioactive Waste Burial Pit Area

The original waste disposal site, the "Radioactive Waste Burial Pit," was located approximately 1300 m from the main office building, and was between bunkers 1252-Q and 1253-Q and Farm House Road, which was located in what is now the Bay Meadows Industrial Park, across Back Creek. In 1962, a complete over packaging program for all 20,400 drums was completed. Some fraction of the zinc clad bands and wooden tops and bottoms were placed in the burial pit. The wood tops and bottoms were found to be slightly contaminated at levels below AEC Part 20 Appendix C values. The land was sold in 1966 and the original burial pit was moved to a triangular portion of land located in the far west portion of the north-south central area of the site, bounded to the south by Back Creek Road.

The new burial pit area encompassed an area that is approximately 400 square meter (m^2) and is over 4 m deep, and the waste consists of debris from a thorium nitrate over-packaging project and various other non-radioactive materials shipped to the depot from other stockpile sites. The burial pit contained thorium nitrate contaminated wooden tops, fiber drums, metal banding, etc., and several drums of beryllium compounds. RSO, Inc. performed a radiological environmental assessment during August and September 1985 to establish radiation levels at the burial site. That report concluded that the burial pit residual concentration was indistinguishable from naturally occurring background. The report also concluded that there was no leaching of any radioactive materials from the burial site into the surrounding environment. The burial site was released for unrestricted use (refer to Amendment 9 of STC-133, dated June 16, 1986).

ORISE performed a characterization survey of the burial pit area in May of 2006. Low-level residual contamination (specifically Th-232) was identified in subsurface samples collected from the burial area. The maximum observed Th-232 concentration was approximately 20 picocuries per gram (pCi/g). In general, the contamination was associated with visible debris. The samples indicated that pockets of subsurface contamination remain beginning at between 0.5 to 2 m in depth and extending in some cases past 4 m in depth.

2.1.5.2. Medical Supplies Burial Area

Medical supplies were buried at a location about 91 m from the south end of the G Line Road. Exploratory trenches were dug in 1996 and numerous bottles were discovered about 2.4 m below ground surface. Radiological material was not identified. Two monitoring wells were installed at this time. A review of the 1999 Parsons focused site investigation (FSI) (Ref. 8) indicates that there is very low potential for radioactive material to be buried at this location. No contamination was identified in this area during characterization surveys (Ref. 7).

2.2. HAMMOND DEPOT

The HD site is located on the west side of Hammond, Indiana on Sheffield Avenue—about 152 m east of the Indiana-Illinois state line. The approximately 57 acre property currently consists of ten structures, mostly in good condition, including the three current warehouses used to store raw materials and outdoor storage areas. The depot is bounded on the east and southeast by the Indiana Harbor Belt railway, the Wolf Lake Industrial Center access road on the east, the Wolf Lake industrial/commercial complex on the north, Wolf Lake on the northern one-third of the western property boundary, and a drainage ditch on the west and southwest property boundary. A security fence encloses the facility. A number of roads and railroad tracks provide onsite access. Drainage ditches on site direct surface runoff water to Wolf Lake. The layout of the HD is depicted in Figure 2.

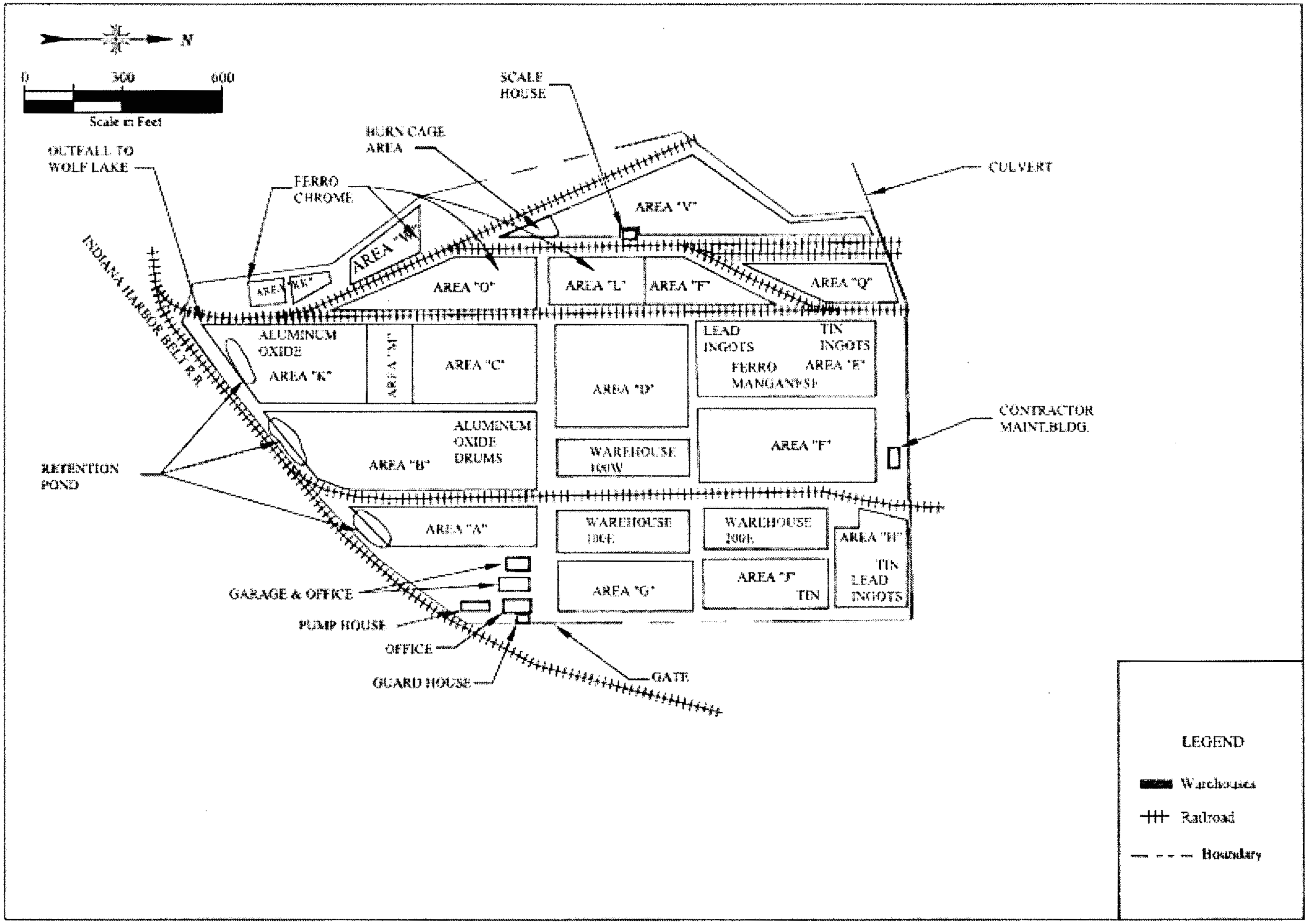

Figure 2: Hammond Depot Layout

2.2.1. Facility Operating History

In 1946, a National Stockpile program began with the goal of mitigating dependence on foreign sources of vital materials during times of national emergencies. The HD was established as part of this program in 1948. The land area for the HD originally consisted of approximately 130.5 acres of land leased on June 24, 1948 from the Indiana Harbor Belt Railroad Company. On June 27, 1969 the GSA purchased the entire site. The original site had eight warehouses and 80 above ground storage tanks. GSA sold portions of the property, including three warehouses, during the 1970s. The current site consists of 57.3 acres.

The DNSC used the HD to store strategic materials (bulk ores, minerals, and metals). The materials stored in outdoor piles either on the ground or on pads included chrome, ferrochrome, ferromanganese, lead, and tin.

Beginning in approximately 1958, additional stored materials included monazite sand comprised of 2.4 to 3.4% thorium dioxide (ThO_2) and bastnesite with 0.01 to 0.11% of ThO_2. Storage of thorium nitrate (ThN) (reactor grade, consisting of 46.0 to 47.15% by weight of ThO_2) began in 1962, followed by sodium sulfate, tantalum pentoxide, and columbium tantalum minerals in the 1980s. These latter materials contained ThO_2 and uranium oxide from <0.001 to 0.053% and 0.012 to 0.156% by weight, respectively. All of these materials were contained in fiber and steel drums and stored in warehouses. Some materials contained radioactive material at concentrations that required a U.S. Atomic Energy Commission (AEC)—predecessor to the NRC—source material license (License STC-133).

2.2.2. License Number/Status/Authorized Activities

The HD is currently owned by the federal government, GSA, and operated by the DNSC of the DLA. See Section 2.1.2 for additional information.

2.2.3. Previous Decommissioning Activities

All current site clean-up work within the present day boundaries of the HD is sponsored by the DLA's DNSC and is being conducted as part of the U.S. Department of Energy (DOE)–Oak Ridge Operations Office approved Thorium Nitrate Stewardship and Disposition Program–Phase 4–Decontamination & Decommissioning. This program is managed by the Oak Ridge National Laboratory (ORNL), per DOE Proposal Number # 1872-M171-A1. The initial phase of the cleanup activities has been completed as the DNSC has removed the remaining source material that had been stored within two of the current site warehouses. In conjunction with site cleanup, ORISE performed a HSA of the HD in order to plan for future site investigations and eventual remediation activities (Ref. 9). Additionally, ORISE has conducted scoping and characterization surveys of the site to validate the results of the HSA and to provide radiological information for the development of a decontamination scope of work for areas of the site identified with excess residual radioactivity levels (Refs. 2 and 10). The final ORISE HD characterization survey report was issued in August, 2006 (Ref. 11).

2.2.4. Spills

Warehouses 2 and 200E housed thorium nitrate drums, some of which leaked during the period of storage. Warehouse 2 is no longer part of the HD as it was remediated to required standards and sold as excess property in the 1970s.

2.2.5. Prior Onsite Burials

There are no known burials of radioactively contaminated materials at the HD.

3.0 FACILITY DESCRIPTION

The facility descriptions of the CBD and HD are discussed below.

3.1. CURTIS BAY DEPOT

3.1.1. Site Location & Description

In general, the CBD terrain is mostly flat to gently hilly with large grassy, open areas, and some lightly wooded areas. A number of roads, mostly asphalt, traverse the site; there are approximately six miles of paved roads. Also noteworthy were the large stockpiles of various ores. Most of the stockpiled materials at CBD were raw ores that were not radioactive. Ores were primarily piled on concrete pads or directly on the ground. Some piles were covered to reduce erosion through weathering and oxidation. Many of these ore piles have been reduced in size or completely eliminated as materials are being removed from the site. There are two miles of railroad tracks that cross the site, a stream, and two leach fields—one in use. There are two wetland areas on the southwest and south sides of the site. Two former burial areas—for medical supplies and radioactive waste—and ordnance areas were also identified on the western sector of the site.

The site contains various structures (buildings and warehouses) - some functional, others that were in a serious state of disrepair and were partially deconstructed in the fall of 2005. A few buildings are surrounded by man-made berms of earth, that over the years since their construction have been vegetated with small trees and brush. A number of these buildings/warehouses have been used to store the thorium, generally in containers. There are five different building construction types ranging in size from 10 m by 30 m to as large as 73 m by 183 m. Construction is either a pitched roof building with transite or asphalt shingles, concrete floor, and terra cotta block walls; or constructed with a flat roof, wooden or concrete floor, and transite or terra cotta block walls. A number of the buildings have been demolished and only the concrete pad remains. Two of the buildings/warehouses were known to be contaminated, some were potentially contaminated, and the others have no known history of radioactive materials use. Characterization survey results indicate that contamination exists in Buildings B-911, B-912, B-913, and F-731, and on the remaining pads for the former Buildings F-737 and G-723 (Ref. 1).

There are two large warehouses on the site designated as Buildings 1021 and 1022 that measure 73 m by 183 m. Building 1021 has no history of radioactive material storage. Building 1022 is known to have formerly stored thorium and a "clean-up action" was noted in historical documentation. The remaining storage buildings, a number of which have stored radioactive materials, are designated according to groupings as A through I Line Buildings. Two additional building lines, J and K Lines, have been completely demolished. Lastly, Building 821 was a former change house and Building 825 housed machining and carpentry equipment, neither of which have had a history of radioactive material use.

3.1.2. Population Distribution

The CBD is less than 0.8 km (0.5 miles) from Baltimore County, Maryland. The 2000 census lists 51,141 residents within 5.0 km (3.1 miles) of the site. The nearest residents are about 160 m from the site boundary. The nearest residence is over 760 m from the warehouse where thorium nitrate was stored (Ref. 12).

3.1.3. Current/Future Land Use

The drums of thorium nitrate that were stored at CBD were removed for disposal in 2004-2005. CBD also stored other non-radioactive strategic materials including bulk ores, minerals and metals that are being removed from the site (Ref. 5).

CBD is presently an unmanned storage depot; it will not remain a functioning depot. Following remediation/decommissioning, release from the NRC license, and removal of the remaining stockpile materials, the depot will be returned to GSA. Currently, the remaining material stockpiles are being removed from the CBD.

3.1.4. Meteorology & Climatology

The average annual total precipitation reported for Anne Arundel County is 106.5 centimeters (cm) and 113.5 cm at the Baltimore airport and Annapolis Police Barracks, respectively. Precipitation between the months of April and October accounts for 60% of the average. The heaviest 1-day rainfall event recorded at the Annapolis Police Barracks—during the reporting period covering the years 1971-2000—was 21.1 cm in 1999. Thunderstorms occur roughly 28 days a year, mostly between the months of May and August. The average seasonal snowfall is 45.7 cm and 18.8 cm at the Baltimore airport and Annapolis Police Barracks, respectively. The prevailing wind is from the west, with the average speed highest between 4.5 to 4.9 meters per second (10 to 11 miles per hour) from February to April (Ref. 5).

3.1.5. Geology & Seismology

The CBD is approximately 8 km (5 miles) east of the boundary between the Coastal Plain and the Piedmont Physiographic Province known as the Fall Line. The alluvial Coastal Plain sediments beneath the CBD generally thicken from west to east and are a part of the Lower Cretaceous Potomac Group. In the Baltimore area, the Potomac Group consists primarily of unconsolidated clays, silts, sands, and gravels. A silt-clay facies of the Potomac Formation consisting of shallow clay underlain by a water-bearing sand and gravel unit exists beneath the CBD (Ref. 5).

3.1.6. Surface Water Hydrology

Surface water drainage routes at the CBD generally flow from north to south and east to large bodies of water. Ground surface elevations range from 3 m to 15 m above mean sea level. CBD is surrounded by three creeks—bordered on the southwest by Back Creek, on the south by Furnace Creek, and on the east by Curtis Creek. Two small streams on the western portion of the site, beginning at and flowing west from the I Line, converge and empty into Back Creek. Furnace Creek flows into Curtis Creek which flows into Curtis Bay. Approximately 4 km (2.5 miles) from CBD, Curtis Bay flows into the Patapsco River, and approximately 13 km (8 miles) from CBD, the Patapsco River flows into the Chesapeake Bay (Ref. 5).

3.1.7. Ecology

There are two wetland areas on the site, including a smaller wetland located on the east side and another wetland on the south side of CBD (Ref. 12).

3.1.8. Natural Resources

The CBD borders Back, Curtis, and Furnace creeks. In addition, the Chesapeake Bay is located approximately 13 km (8 miles) from the site. Groundwater occurs in surficial sediments overlying shallow clay, at depths 3.3 to 4.8 m below the surface in the eastern part of the site, and at 6.1 to 12.1 m below the surface in the western part of the site. The shallow aquifer flow is generally west to east, with components of groundwater potentially flowing westward with discharge to Back Creek (Ref. 12).

3.2. HAMMOND DEPOT

3.2.1. Site Location & Description

The three current site warehouses are located in the central area of the site and are designated as Buildings 100W, 100E, and 200E. The dimensions of the three warehouses are each 38 m by 122 m and are constructed of cinder block walls on a concrete slab floor with steel beams, columns, and roof joists. Building 200E is divided by a cinder block wall into a northern and southern half. The southern half has been used for radioactive material storage and also has an asphalt layer covering the building floor where remediation was previously conducted. Building 100W was used for radioactive material storage with no history of any previous remedial activities. Building 100E had no history of radioactive material storage. For storage purposes, the interior of each warehouse was subdivided into 20 bay areas.

3.2.2. Population Distribution

The HD is located in an industrial area in Lake County, Indiana. The depot is less than 0.2 km (0.1 miles) from Cook County, Illinois. The 2000 census lists 85,269 residents within 5.0 km (3.1 miles) of the site. The nearest residents are about 160 m from the site boundary. The nearest residence is over 520 m from the warehouse where thorium nitrate was stored (Ref. 12).

3.2.3. Current/Future Land Use

The drums of thorium nitrate that were stored in the 100W warehouse buildings were removed for disposal in 2005. HD also stores non-radioactive strategic materials including bulk ores, minerals and metals.

The HD will remain a functioning depot, and the land associated with the current decommissioning activities will remain under stewardship by the DNSC.

3.2.4. Meteorology & Climatology

Precipitation for the area averages 91 cm per year. The site is reported to frequently flood during periods of heavy rainfall.

3.2.5. Geology & Seismology

Soils underlying the depot are characterized as Urban Land. These soils are generally found in areas that have been disturbed and filled with earth, cinders, slag, or combinations of these materials. The soils have been disturbed to such a degree that native soils can no longer be identified.

3.2.6. Surface Water Hydrology

Surface water drainage is via two outfalls that discharge runoff from the depot to Wolf Lake. Drainage ditch locations on the north, south, and southwest boundaries all discharge into Wolf Lake.

3.2.7. Ecology

The area encompassing the HD was a wetland in the mid-1940s which has since been filled with a large amount of blast-furnace slag to establish a stable and level foundation (Ref. 12). Industrial properties border the entire site with the exception of the west side of the site, which is bordered by Wolf Lake. An unidentified bamboo species is dense along the southeast perimeter of the site. The remainder of the site has been disturbed due to industrial activities. No wetlands or other habitats suitable to support typical wildlife species are present at or adjacent to the depot (Ref. 12).

3.2.8. Natural Resources

The HD borders Wolf Lake. In addition, Lake Michigan is located approximately 4.0 km (2.5 miles) from the site. Regional shallow groundwater around HD flows north-northeast. Groundwater beneath HD may flow toward and discharge into Wolf Lake (Ref. 12).

4.0 RADIOLOGICAL STATUS OF FACILITY

The current radiological status of the CBD and HD is discussed below. The current radiological status is based on completed scoping and characterization deployments to each site, with the full reports included as references.

4.1. CURTIS BAY DEPOT

4.1.1. Historical Site Assessment & Characterization Summary

HSA reconnaissance visits to review available documentation were performed in 2005 at the CBD and DNSC headquarters in Fort Belvoir, Virginia. Documents reviewed included historical radiological survey reports, decontamination reports, the NRC license and associated letters; various internal memos, inventory record cards, and preliminary assessment reports of CBD. During the site visit to CBD, information concerning hazardous site conditions as it applies to conducting future survey work was noted. The structural integrity of buildings was identified as a potential problem that could impede future radiological survey work.

At the HSA conclusion, a number of building and soil areas were considered to be potentially classified as Class 1 or Class 2 impacted areas. These included areas known to be contaminated from leaking ThN containers (B-911 and B-912); areas that were previously contaminated as a result of leaking ThN containers or unpackaged monazite sand and remediated or demolished (F-731, F-737, and J and K Line buildings); and areas potentially contaminated (Buildings 1022, A-921, B-913, F-734, F-735, F-736, FG-721, and the H Line buildings). Existing roads, railroad lines, and areas where railroad lines were removed were also considered to be potentially contaminated (Class 2). A radioactive burial pit in the southwest western portion of the site was considered to be potentially contaminated (Class 1). The remaining land areas were considered to have little potential for contamination, and were classified as Class 3. The CBD land area classifications are depicted in Figure 3.

Scoping and characterization surveys of the site were performed during 2005 and 2006. These surveys determined that contamination was present on the floors, sub-floor soil, walls, and overhead surfaces of Building B-911, floors and walls of Building B-912, floors of Building B-913, floors and walls of Building F-731, and minor isolated locations on the

Building F-737 and G-723 pads. Soil contamination was identified at 12 locations around the site, all of which were associated with either buildings known to have stored radioactive material or transport routes.

4.1.2. Contaminated Structures

Scoping and characterization surveys of the site were performed during 2005 and 2006. Six of the 50 buildings on site are contaminated to varying degrees. Both Buildings B-911 and B-912 have extensive floor contamination. Additionally, the horizontal surfaces of the roof trusses and a gable vent in Building B-911 have low-level contamination. The sub-floor soils of Building B-911 are contaminated as a result of material migrating through floor cracks and one location is present beneath the loading dock. The Building B-912 floor is intact, although contamination was noted in some expansion joint locations. Isolated lower wall contamination is present in both buildings. Building B-913 has two small, isolated locations of floor contamination. The floors and lower walls in Building F-731 have isolated areas of contamination. The concrete pads of the Building F-737 and G-723 pads have isolated locations of contamination.

4.1.3. Contaminated Systems & Equipment

There are no contaminated systems or equipment within the warehouses. The warehouses contained minimal support equipment other than closed sprinkler systems and electrical conduit.

4.1.4. Surface Soil Contamination

There are twelve areas of soil contamination identified at various locations around the site. The total impacted soil area is estimated to be 500 m^2. Although not all locations could be sampled below the initial 15 cm depth due to the presence of obstructions, similar locations where subsurface samples were successfully collected did not have contamination beneath the initial 30 cm depth interval. Remedial action support surveys will be conducted to ensure that contamination does not extend below the initial 30 cm depth for those areas where subsurface sampling was not performed. Each soil area of concern (AOC) is discussed below.

AOC 1 is a former radiological waste burial area with no surface soil contamination issues. The status of subsurface contamination is described in Section 4.1.5.

AOC 2 is an isolated 1 m^2 area located to the west of Patrol Bridge Road and due east of the Building C-1134 and C-1133 pads on the southeast end of the site. The maximum observed Th-232 concentration was 94 pCi/g. The volume of contaminated soil is estimated to be 0.3 cubic meter (m^3).

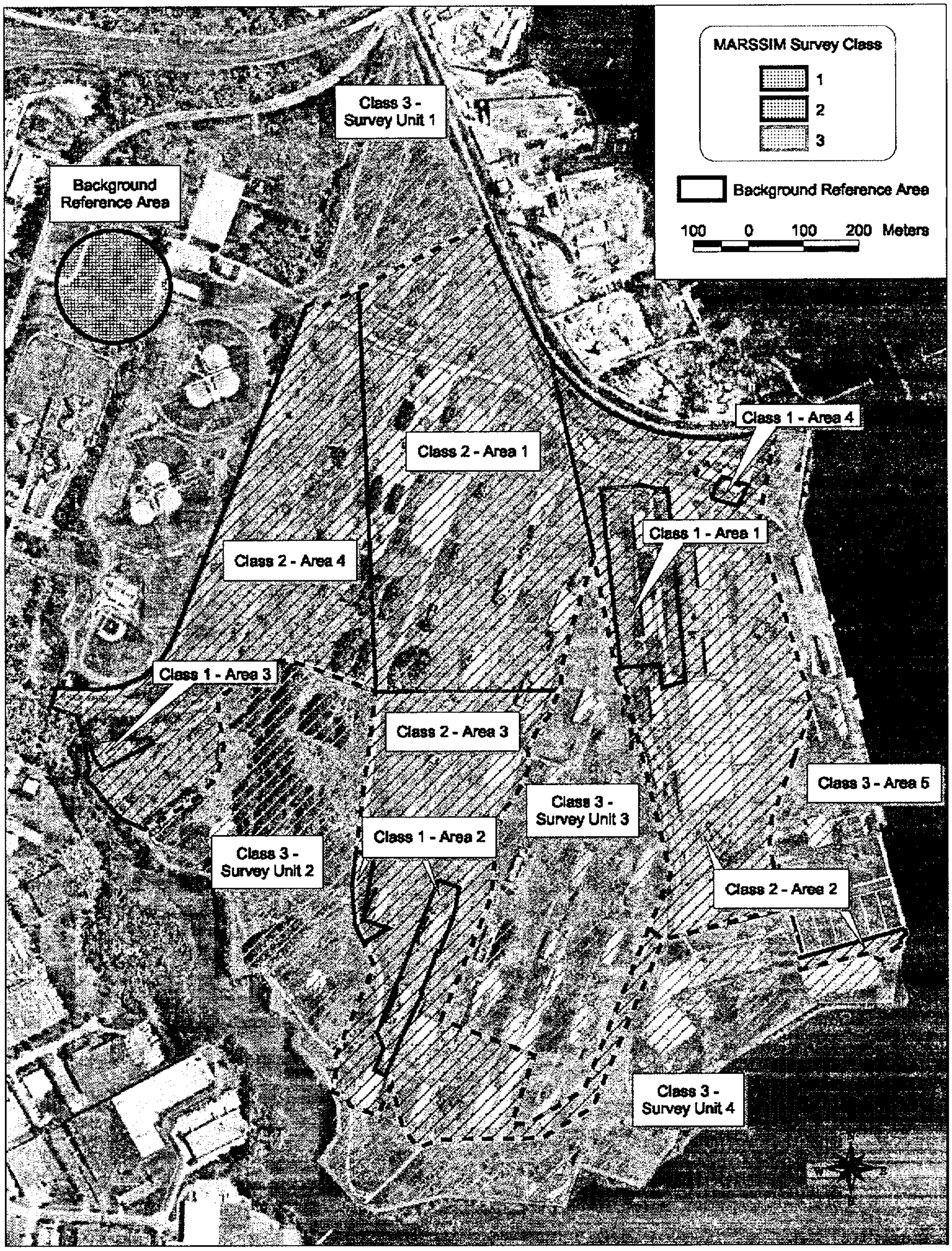

Figure 3: Curtis Bay Depot Area Classifications

AOC 3 is an area of soil contamination identified near the northwest corner of Building F-735 covering an area of approximately 200 m^2 to a depth of 0.3 m. The total volume of soil is therefore estimated to be 60 m^3. The maximum observed Th-232 concentration was approximately 50 pCi/g.

AOC 4 is located at Furnace Creek Road/F Line Road due south of Building F-736. The area of contamination is estimated to be 100 m^2 to a depth of 0.15 to 0.3 m. The total volume of soil is 30 m^3 with a maximum observed Th-232 concentration of 84 pCi/g. Subsurface samples could only be collected to a depth of 20 cm due to interfering subsurface rock/ore.

AOC 5 is at Furnace Creek Road/F Line Road, north of Building F-737. This AOC is directly across the road from AOC 4 and measures approximately 60 m^2 in area. Subsurface samples could not be collected in the area due to large pieces of rock at the 15 centimeter depth. The volume estimate of 18 m^3 is therefore based on the results from other site locations where contamination was limited to the initial 0.3 m. There are also several related small AOCs each measuring less than 5 m^2 within the contiguous area. The maximum observed Th-232 concentration was approximately 450 pCi/g.

AOC 6 is a narrow zone of contamination on the edge of Furnace Creek Road due west of Building G-726. The 80 m^2 area is contaminated at a maximum Th-232 concentration of approximately 8 pCi/g in the uppermost 0.15 m. The corresponding volume of soil is 12 m^3.

AOC 7 is a small, isolated location east of Building B-913 in a lay down/parking area. The area is less than 2 m^2. Subsurface samples were not collected, although contamination depth is not expected to exceed the initial 0.3 m depth interval. The estimated volume of soil is 0.6 m^3 with a maximum Th-232 concentration of approximately 40 pCi/g.

AOC 8 was identified as a narrow strip on the edge of the B Line road due east of Building B-912. The 20 m^2 area is contaminated to a depth of 0.15 m with a maximum Th-232 concentration of approximately 18 pCi/g. The estimated impacted soil volume is 3 m^3.

AOC 9 measures approximately 5 m^2 in area and is located at the edge of the driveway that enters the Building 821/825 complex. The contamination is approximately 0.15 m in depth with a maximum Th-232 concentration of approximately 20 pCi/g.

AOC 10 is located adjacent to Building I-632 and is approximately 5 m^2 in size with contamination extending to 0.15 m. The identified contaminant was U-238 at a concentration of approximately 12 pCi/g. This was the only sample collected where the U-238 concentration was significantly elevated without a corresponding elevated activity concentration result for Th-232. Soil volume is estimated to be 0.75 m^3.

AOC 11 was identified in the footprint of the former Building K-611 and is a small 2 m^2 area with a Th-232 concentration of approximately 10 pCi/g. The estimated volume of soil is 0.3 m^3.

AOC 12 is located in the northern section of the site on Yard Office Road. The area is approximately 24 m^2 in size with a maximum Th-232 concentration of approximately

6 pCi/g. The depth of contamination is limited to 0.15 m. The volume of impacted soil is therefore estimated to be 3.6 m^3.

4.1.5. Subsurface Soil Contamination

Low-level residual contamination was identified in a number of the subsurface samples collected from the burial area. In general, the contamination was associated with visible debris. Seven of the twelve boreholes showed residual Th-232 contamination present in at least one of the depth interval samples indicating that pockets of subsurface contamination remains beginning at between 0.5 to 2 m in depth and extending in some cases past 4 meters in depth. The estimated volume of potentially impacted soil is 470 m^3 based on a weighted average depth of contamination over a 440 m^2 area. Actual volumes are expected to be less than this estimate. The maximum observed Th-232 concentration was approximately 20 pCi/g.

4.1.6. Surface & Groundwater

The HSA review identified a previous concern for contamination in Back Creek from the radiological waste burial site. This concern was previously addressed via a water sampling campaign. At this time, surface water is not considered to be a potentially contaminated medium. Several groundwater monitoring wells are located across the site. The operational status of the monitoring wells is unknown. Samples collected from a single monitoring well located next to the radiological waste burial site indicate thorium levels consistent with natural background (0.3 pCi/L) (Ref. 13). Therefore, it is expected that there is limited potential for groundwater contamination, based on the monitoring well sample results, the minimal source term present at the site and other physio-chemical properties that inhibit migration of the thorium contaminant.

4.2. HAMMOND DEPOT

4.2.1. Historical Site Assessment & Site Characterization Summary

HSA reconnaissance visits to review available documentation were performed during 2005 at the HD and DNSC Headquarters in Fort Belvoir, Virginia. Documents reviewed included historical radiological survey reports, decontamination reports, the NRC license and associated letter, various internal memos, inventory record cards, and preliminary assessment reports of HD. During the site visit to HD, information concerning site conditions as they apply to conducting future survey work was noted. In particular, the issue of black-top covering the floor in Building 200E was identified as a challenge for performing effective scoping surveys.

At the conclusion of the HSA, two areas were considered to be potentially classified as Class 1 or Class 2 impacted areas. These areas were Building 100W and Building 200E. In addition, the existing roads, railroad lines, and the Burn Cage were also considered to be potentially contaminated and classified as Class 2. The remaining areas were considered to have little potential for contamination, and were classified as Class 3. The HD land area classifications are depicted in Figure 4.

The southern half of Building 200E was used to store ThN, which had leaked and contaminated the floor. The drums of ThN were overpacked and transferred to Building 100W for storage. Remediation was completed in 1979. Monazite sand stored in 21-gallon drums was also moved from Building 200E to Building 100W. Building 100W also stored columbium-tantalum ore in containers. The other current site warehouse, Building 100E, did not have a history of radioactive material storage. The only land area identified during the HSA with a potential for contamination was an area north of the Burn Cage under a rubble pile where potentially contaminated pallets were burned.

Scoping and characterization surveys of the site were performed during the latter half of 2005 and first half of 2006. These surveys determined that contamination was present on the floors, sub-floor strata, walls, and overhead surfaces of the southern half of Building 200E. Jars of source material solution were recovered from a small closet area located in the northwest corner of Building 200E. One jar was noted to have leaked and contaminated the floor. All jars containing source material were removed for disposal during the spring of 2006. Additionally, several pallets that were stored in Building 100E were identified during the scoping survey as having residual contamination. Over 300 contaminated pallets were surveyed, cut up, and removed for disposal during the spring of 2006. Follow-up investigations identified minor contamination in localized areas within expansion joints in Building 100E. During characterization contamination was also identified within soils on the western portion of the site covering a total area of approximately 2700 m^2.

4.2.2. Contaminated Structures

There is extensive contamination on the floors of the south half of Building 200E where containers of ThN were stored and known to have leaked. The contamination was on the original concrete floor of the building, beneath the asphalt overlayment. However, it was also determined during investigations that pieces of asphalt that were removed to gain access to the concrete floor had elevated levels of contamination that had been transferred to and adhered to the underside of the overlayment. There are five distinct floor AOCs totaling approximately 900 m^2 that will require removal of the asphalt overlayment and subsequent decontamination of the floor, including removing expansion joints through the full thickness of the floor slab and other varying degrees of removing contamination that has migrated into floor cracks, floor/wall interfaces, and column base interfaces. There are 13 columns with contamination up to 2 m on the column and/or on the column base, essentially all of an estimated 500 linear m of overhead structural steel I-beams and piping within Bays 6 through 10, and 5 m^2 of lower wall surfaces that require remediation. Additionally, there is a sub-floor slag monolith that is contaminated to depths in excess of 10 cm at some locations and extends laterally in some cases greater than 30 cm from each expansion joint or crack where contamination has migrated through.

One 2 m^2 area of contamination was identified in the closet area at the northwest end of Building 200E where small jars of source material were found and removed during 2006. Because the contamination had spread to the floor/wall interface, there is a high probability that contamination migrated into the interface.

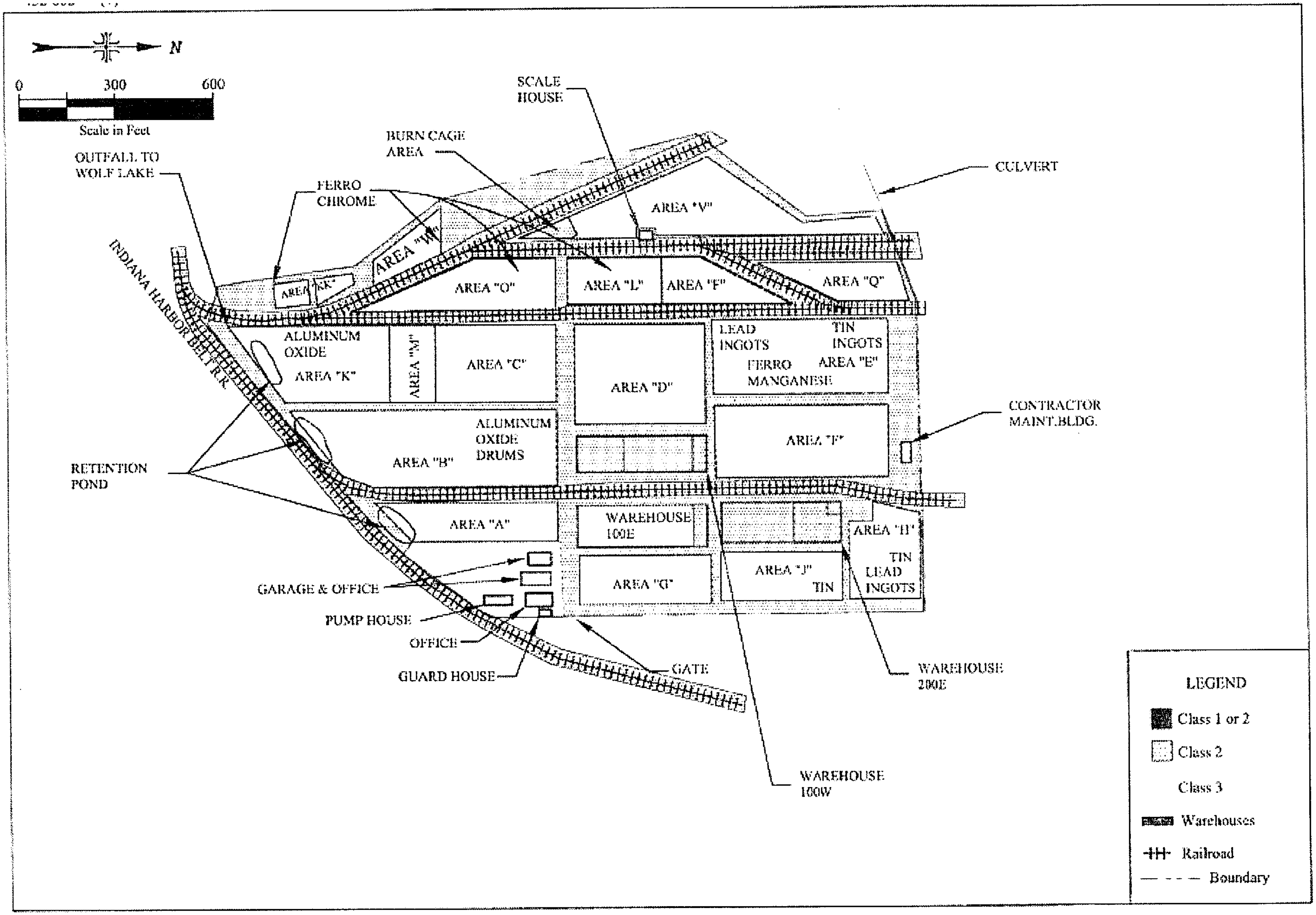

Figure 4: Hammond Depot Area Classifications

There are three expansion joint locations within Building 100E where debris from the pallet clean-up operation concentrated within the expansion joint floor depressions. Approximately 0.5 linear m would require remediation.

No contamination was found in Building 100W.

4.2.3. Contaminated Systems & Equipment

There are no contaminated systems or equipment within the warehouses. The warehouses contained minimal support equipment other than closed sprinkler systems, electrical conduit, and heating ducts.

4.2.4. Surface Soil Contamination

There are seven areas of soil contamination identified on the western-most section of the site. The total impacted soil area is about 2700 m^2. The site surface soil was found to be over a monolithic slag layer which is present at an average depth of 30 cm below the soil surface.

AOC 1 encompasses approximately 50 m^2 due east of the rubble pile. The depth of soil to slag ranges from 0.18 to 0.45 m with an average depth of 0.37 m. Therefore, the estimated volume of affected soil is 18.5 m^3. The average Th-232 activity is 9.2 pCi/g. During site remediation, DNSC is planning to remove the rubble pile so that the area beneath it can be surveyed.

AOC 2 encompasses 2625 m^2 directly south of an ore pile referred to as Ferrochrome Pile #6 and south-southwest of the Burn Cage and rubble pile. The depth of soil to slag ranges from 0.02 to a maximum depth of approximately 0.5 m. The average depth to slag is 0.15 m and an overall estimated average depth of soil to slag of 0.3 m. Therefore, the estimated volume of affected soil is 790 m^3. The average Th-232 activity is 115 pCi/g.

AOC 3 is immediately across the site perimeter road west of AOC 2. There are three small locations totaling less than 10 m^2 of area with a soil depth to slag ranging from 0.10 to 0.22 m. The approximate volume of impacted soil is 1.5 m^3. The average Th-232 activity is 28 pCi/g.

AOC 4 has two small areas of less than 10 m^2 identified near a Scale House. The depth of soil to slag is 0.3 m and the average Th-232 activity is 150 pCi/g, impacting 3 m^3 of soil.

AOC 5 is located at the southern end of the site and is adjacent to where a railroad spur enters the site. The impacted area is approximately 2 m^2 with slag encountered at 0.15 to 0.3 m. The contamination was identified in the subsurface sample (15 to 30 cm) with the average Th-232 soil concentration being 32 pCi/g. Therefore the estimated soil volume is 0.6 m^3.

AOC 6 is located where a contaminated pallet was identified. The area is small, less than 0.25 m^2, and slag was encountered at 10 cm. Therefore, the estimated maximum impacted soil volume is 0.03 m^3.

AOC 7 is located adjacent to a railroad track that bounds the Burn Cage area and the Ferrochrome Pile #6 AOCs. The area measures approximately 2 m^2 in size and slag was encountered at 0.15 m. The estimated impacted soil volume is 0.3 m^3.

4.2.5. Subsurface Soil Contamination

There is no history of on-site burials, process piping, ponds, tanks or other avenues to result in subsurface soil contamination. All contamination identified has been the result of surface deposition.

4.2.6. Surface & Groundwater

At this time, surface water is not considered to be a potentially contaminated medium. Groundwater contamination is not suspected because of the effective barrier the slag monolith provides and other physio-chemical properties that inhibit migration of the thorium contaminant.

5.0 DECOMMISSIONING CLEANUP CRITERIA

As a step in the license termination process, DCGLs were determined to provide clean-up criteria that satisfy regulatory requirements. Decommissioning cleanup criteria set forth a radiation protection standard of 25 mrem/y total effective dose equivalent (1000-year peak dose) above background in accordance with 10 CFR Part 20.1402. Based on a radiation protection standard of 25 mrem/y, DCGLs were calculated for soil and building surfaces in units of pCi/g and disintegrations per minute per 100 square centimeters (dpm/100cm^2), respectively, for a 1000-y peak annual dose to the average member of the critical group, for both natural thorium and uranium.

Derivation of the 25 mrem/y release criteria into site-specific DCGL values was accomplished using the most current RESRAD (Version 6.3) and RESRAD-BUILD (Version 3.3) computer codes developed by the Argonne National Laboratory (ANL) for soil and building assessments, respectively. A complete description of the methodology, including an assessment of the input parameters, model inputs, and results is provided in the dose modeling reports (Refs. 3 and 4). The overall approach to the DCGL derivation was to adopt a reasonable, yet conservative approach to the analysis, consistent with NRC's Consolidated NMSS Decommissioning Guidance (Ref. 15).

DCGL derivation began with a thorough environmental engineering assessment to establish representative exposure pathways from residual radioactivity for land uses representative of the appropriate critical groups. Relevant information was extracted from project and site records and prior site environmental studies. Additional information was gathered during the conduct of a HSA by ORISE that included interviews with facility staff and the subsequent performance of two ORISE scoping surveys in 2005.

The conclusion of the engineering assessment resulted in a series of site-specific input parameters to the RESRAD codes for soil and buildings. An iterative approach was chosen to conduct the radiological dose assessment using a combination of site-specific and default input parameters in accordance with NUREG-1757.

Model outputs were evaluated by statistical sensitivity and uncertainty analyses to ensure that important exposure pathways were clearly characterized. Parameters that were identified during the engineering assessment or the mathematical model phases were reassessed and analyzed in an iterative fashion to ensure completeness of the reported results.

5.1. SOIL DCGLS VIA RESRAD

The resident farmer scenario was selected as the conceptual site model for its conservatism in the dose assessment. While the sites are located in industrial areas and most likely will remain that way following license termination, uncertainty in this conclusion, especially as it pertains to use of the site hundreds of years in the future, resulted in the selection of the resident farmer scenario rather than industrial or recreational alternatives. The resident farmer land use scenario assumes that the site will subsequently be inhabited by an individual(s) after license termination. Additionally, future site inhabitants are assumed to build a house, grow crops, obtain drinking water supplies and raise livestock for consumption, and therefore receive potential radiological doses attributable to residual radioactivity present remaining at the site. As such, the resident farmer family constitutes the critical group and a reasonable (credible) scenario.

Unit (normalized) concentrations of one pCi/g for each of the site's radionuclides of concern were used for the RESRAD evaluations. This approach provided dose-to-source ratios (DSRs), i.e., dose per unit activity (mrem/y per pCi/g) factors, calculated for exposed individuals over a 1000 year time period. The DSRs represent maximum doses—a conservative approach since peak doses for specific radionuclides often occur at different times. The DSRs were divided into the primary dose limit, resulting in a DCGL for that radionuclide in units of pCi/g.

For purposes of the dose assessment, principal radionuclides and decay products were mathematically treated assuming secular equilibrium. Contamination was assumed to be limited to the top 15 cm of soil based on an evaluation of the site history, including anticipated mobility of thorium in the environment and ORISE preliminary (scoping) radiological survey results.

All pathways, with the exception of the radon pathway, were utilized to add conservatism to the dose assessment. As confirmed by sensitivity and uncertainty analyses, the exposure pathway of most significance for the predominant thorium radionuclides was external gamma radiation. All other pathways and radionuclide contributors are considerably less significant. The drinking water pathway was the predominant source of radiation exposure for uranium. However, the uranium contribution to total dose does not become significant until many (hundreds) of years into the future.

Other measures of conservatism in the DCGL determination for soil included using the groundwater pathway as an "active" pathway, taking no credit for the potential of diluting any contaminated soils with a clean soil cover during remedial activities, and selecting the mass balance model for the placement of a hypothetical well in the contaminated zone.

Using the most realistically conservative models allowed within the context of the computer models, the soil DCGLs computed for the two sites are presented in Table 1.

Table 1: Soil DCGL Values

	Thorium-232 DCGL (pCi/g)	Uranium-238 DCGL (pCi/g)
Curtis Bay Depot	2.9	2.2
Hammond Depot	2.9	2.5

5.2. BUILDING SURFACES VIA RESRAD-BUILD

The RESRAD-BUILD assessment utilized the "Warehouse Worker" scenario. While this may not appear equivalent to the soil scenario, this method enabled a similar, more conservative approach to the determination of thorium and uranium DCGLs. The RESRAD-BUILD code was used to determine unit dose factors, in mrem/y per pCi/m^2. The unit dose factors were divided into the primary dose limit to determine the preliminary thorium and uranium DCGLs, and then converted into typical field units of dpm/100 cm^2.

Conservative factors introduced into the RESRAD-BUILD evaluation included the modeling of rooms with physical dimensions much smaller than the actual size of the existing onsite warehouse (to reduce the effect of dilution as it pertains to resuspension) and using the default (low) RESRAD-BUILD value for building ventilation.

Deterministic sensitivity analyses were performed to ensure that no single parameter (or group of five parameters) would have a significant impact on the results. Probabilistic uncertainty analyses were performed as a last step to ensure that no obvious errors were made on model inputs. And finally, DCGL results were discussed with the measurement team to ensure that no particularly extensive measures would need to be taken in order to develop an acceptable radiological measurement and characterization plan, for which the selected "conservative" model parameters would need to be more accurately defined.

As with the soil DCGL, using the most realistically conservative models allowed within the context of the computer models, the building surface DCGLs computed for the two sites are presented in Table 2.

Table 2: Building Surface DCGL Values

	Thorium-232 DCGL (dpm/100 cm^2)	Uranium-238 DCGL (dpm/100 cm^2)
Curtis Bay Depot	400	800
Hammond Depot	400	800

6.0 PLANNED DECOMMISSIONING ACTIVITIES

6.1. CURTIS BAY DEPOT

Decommissioning activities are planned for the CBD to remove contamination and allow the return of impacted building and land areas to the GSA.

6.1.1. Contaminated Structures

Buildings B-911, B-912, B-913 and F-731; and the F-737 and G-723 pads are contaminated. Contamination has been found on floors, walls, upper surfaces, and in soils beneath the buildings. Specific details on contaminated structures at CBD may be found in Section 4.1.2.

Decontamination of floors may include removal by scabbling and/or scarification of floor surfaces and removal of portions of the concrete floor slab around contaminated expansion joints or cracks. Minor surface decontamination may include scabbling, strippable coatings, grinding and vacuuming. Any soil found to be contaminated will be excavated.

6.1.2. Contaminated Soil

Contaminated surface soils will be excavated to remove contamination at concentrations greater than the DCGLs. Remediation of the former radiological waste burial area will be accomplished by removing the non-contaminated overburden followed by excavation and segregation of all contaminated soils encountered and removal of debris from the overpacking project.

6.1.3. ALARA

Decommissioning and remediation of soils at CBD will involve use of standard industrial equipment needed to excavate residual contamination to levels that are ALARA as specified in NUREG-1757.

For building surfaces, decommissioning and remediation at CBD will involve the use of good housekeeping practices and decontamination of floors and building surfaces as necessary. Decontamination techniques are expected to remove residual contamination to levels below the building surface DCGLs such that they may approximate background levels of radiation. As such, these commitments to remove residual contamination to levels that are ALARA are sufficient to comply with 10 CFR 20.1402.

6.1.4. Schedule

A detailed project schedule for decommissioning activities has been prepared. The schedule includes tasks and milestones associated with preparing the decommissioning scope-of-work, waste packaging and transportation, assessing remedial action methods, and monitoring and evaluation of the decontamination activities. On-site decommissioning and remediation activities are currently scheduled to commence early in March 2007 and be completed in July 2007.

6.2. HAMMOND DEPOT

Decommissioning activities are planned for the HD to remove contamination and allow the return of impacted building and land areas for storage.

6.2.1. Contaminated Structures

Building 200E will require the most significant decontamination activities. Decontamination of the floor will include removal of contaminated asphalt overlayment, scabbling and/or scarification of floor surfaces, removal of portions of the concrete floor slab around contaminated expansion joints or cracks, and removal of contaminated slag. The minor lower surface contamination and overhead surface contamination will be decontaminated using various technologies yet to be determined, but may include scabbling, strippable coatings, grinding, and vacuuming.

The closet area of Building 200E will require scabbling of the floor and investigation of the floor/wall interface where material may have migrated.

The slightly impacted expansion joints in Building 100E will be decontaminated to remove the accumulated residue.

6.2.2. Contaminated Soil

Contaminated surface soils will be excavated to the slag interface. Evaluations have shown that the contamination has not penetrated the slag surface (Ref. 11); therefore, there are no anticipated remedial actions planned for the slag layer underlying the soil. Following the excavations, any residual contamination will be removed from the slag surface.

6.2.3. ALARA

Decommissioning and remediation of soils at HD will involve use of standard industrial equipment needed to excavate residual contamination to levels that are ALARA as specified in NUREG-1757.

For building surfaces, decommissioning and remediation at HD will involve the use of good housekeeping practices and decontamination of floors and building surfaces as necessary. Decontamination techniques are expected to remove residual contamination to levels below the building surface DCGLs such that they may approximate background levels of radiation. As such, these commitments to remove residual contamination to levels that are ALARA are sufficient to comply with 10 CFR 20.1402.

6.2.4. Schedule

A detailed project schedule for decommissioning activities has been prepared. The schedule includes tasks and milestones associated with preparing the decommissioning scope-of-work, waste packaging and transportation, assessing remedial action methods, and monitoring and evaluation of the decontamination activities. On-site decommissioning and remediation activities are currently scheduled to commence early in July 2007 and be completed in October 2007.

7.0 PROJECT MANAGEMENT & ORGANIZATION

A description of the project management and organizational functionality necessary for ensuring that decontamination and decommissioning operations will be conducted at the CBD and HD are described in Radioactive Material License No. STC-133 and the DNSC Occupational Radiation Protection Program (ORPP). Information and commitments contained in the licensing documents provide ample assurances that the project management has responsibility and authority to safely conduct decommissioning operations at these facilities. As such, the project management and the functional organization responsible for overseeing the safe decommissioning of the CBD and HD are described herein.

7.1. DECOMMISSIONING MANAGEMENT ORGANIZATION

As outlined in the statement of work (SOW) developed by DNSC, the decontamination contractor shall meet all requirements for health and safety, radiation protection, and contamination clean-up to comply with approved DCGLs. ORNL and ORISE will function as on-site oversight consultants to meet SOW requirements, in support of DNSC. ORISE will perform remediation support activities to verify that discrete, elevated radioactivity areas are cleaned up to meet the release criteria. Periodic spot audits will be conducted by DNSC.

The DNSC Director of Stockpile Operations (DNSC-O) is responsible for nominating personnel to be Radiation Protection Officers (RPOs), assuring that they attend the required training course(s) approved by the Occupational Radiation Protection Manager (ORPM), and ensuring the establishment of an Emergency Procedures Program by the managers of the CBD and HD.

The Radiation Safety Officers (RSOs) for CBD and HD are responsible for monitoring the effectiveness of their radiological programs and extending the training program to all appropriate personnel.

The Distribution Facility managers and RPOs are responsible for the day-to-day supervision of the ORPP at these depots. They are also responsible for and will ascertain that prescribed monitoring and safety precautions are taken with respect to radioactive materials.

The RPOs are responsible for notifying the appropriate officials (i.e., fire department, DNSC officials, etc.) and taking appropriate actions in the event of an incident involving the release or potential release of radioactive materials in accordance with the depot Emergency Plan.

7.2. *DECOMMISSIONING CONTRACT MANAGEMENT*

Decommissioning activities at CBD and HD will be performed by a qualified contractor as specified in an SOW. The Army Joint Munitions Command (AJMC) will perform contract management. Oversight of the remediation and decommissioning activities will be performed by ORNL and ORISE. The SOW describes the decommissioning work activities and performance–based safety requirements that must be adhered to. The DNSC's management organization shall oversee and maintain the direct responsibility for ensuring that decommissioning activities are conducted in accordance with all federal, state and local requirements in addition to those specified in Radioactive Materials License No. STC-133 and the ORPP.

8.0 TRAINING

Decommissioning activities are much different from the typical activities conducted at CBD and HD. Because of these differences, DNSC will require additional training for personnel and contractors involved in decommissioning activities at these two sites. Individuals, contractors and visitors who require access into radiologically controlled areas will receive training commensurate with the potential hazards to which they may be exposed as required under 10 CFR Part 19.

The training program administered by DNSC requires that radiological officers be given at least 40 hours of formal classroom training that enables these staff to recognize and evaluate, through monitoring and surveys, radiological activities prior to assuming duties within their areas of responsibility. Training courses must be approved by the ORPM. As a minimum, the training includes the fundamentals of ionizing radiation, its characteristics, and appropriate units of measure, evaluation techniques, instrumentation, biological effects, NRC regulatory requirements, and control measures. Refresher training is provided triennially. Additionally, radiological officers receive training in Department of Transportation regulations.

ORNL will provide a decommissioning/remediation safety briefing to depot personnel.

9.0 RADIATION SAFETY DURING DECOMMISSIONING

9.1. *Radiation Safety Controls*

DNSC radiation safety controls ensure that exposures to ionizing radiation are kept ALARA. The radiation safety program places the primary emphasis on engineering controls, e.g. ventilation, dust collection, and shielding. These goals are supported by emphasizing good radiological work practices, providing radiation safety training, the use of personal protective clothing, and contamination surveys.

An assessment is conducted by the ORPM, the radiological officers, and other personnel prior to beginning a project to determine the need for engineered controls, personal protective equipment (PPE), and respiratory protection. The respiratory protection program is administered in compliance with 10 CFR 20, Subpart H. Details on the engineering controls and precautionary measures can be found in Sections 5, 6 and 17 of the ORPP.

The Contractor shall submit a safety and health plan for review and approval by DNSC with review and concurrence provided by ORNL and ORISE. The safety and health plan shall include a radiation protection plan.

9.2. MONITORING FOR WORKERS

9.2.1. External Exposure

The RSO has evaluated the potential for external exposures in excess of 500 mrem in one year. Such doses are not possible because the licensable source material has been removed. Therefore, DNSC is not providing monitoring devices for external radiation exposure.

9.2.2. Internal Exposure (Bioassay)

For selected contaminated buildings, the contractor may incorporate air sampling in their detailed work plans and procedures as a conservative measure to assess airborne conditions and verify assumptions. Care is required for specifying the filter count duration to assure Rn-220 (thoron) and its progeny are distinguished from actual airborne contamination. For most, if not all areas, monitoring for internal exposures of radioactivity is not expected to be required since personnel involved in decommissioning related activities are not expected to receive an annual intake in excess of 10 percent of the applicable annual limit on intakes (ALI(s)) in Table 1, Columns 1 and 2, of Appendix B to 10 CFR Parts 20.1001 and 20.2402.

9.3. SURVEY INSTRUMENTATION

The SOW states that the Contractor shall furnish radiological instruments and calibration sources for those instruments. The SOW also specifies that the Contractor shall submit a detailed calibration program and requires the use of calibration sources traceable to the National Institute of Standards and Technology (NIST).

9.4. SURVEYS FOR RELEASE OF SOLID MATERIALS

9.4.1. Supplies & Equipment

As described in Section 12.2 of the ORPP, residual radioactivity for supplies and equipment that will be removed from a site for unrestricted release will be surveyed to ensure that residual surface radioactivity present does not exceed the limits established in the NRC document "Guidelines for Decommissioning of Facilities and Equipment Prior to Release for Unrestricted Use or the Termination of Licenses for By-Product, Source, or Special Nuclear Material," July 1982.

A listing of radionuclides and guidelines for assessing surface radioactivity levels for items and equipment that may be released for unrestricted use is provided in Table 3.

Table 3: Contamination Release Criteria (adapted from NRC Regulatory Guide 1.86)

Nuclide[a]	Average[b,c]	Maximum[b,d]	Removable[b,e]
U-nat, U-235, U-238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000 dpm β-γ/100 cm^2	15,000 dpm β-γ/100 cm^2	1,000 dpm β-γ/100 cm^2

[a]Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha and beta-gamma-emitting nuclides should apply independently.
[b]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
[c]Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.
[d]The maximum contamination level applies to an area of not more than 100 cm^2.
[e]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

9.5. HEALTH PHYSICS AUDITS & INSPECTIONS

No licensable materials are stored at either CBD or HD. There are no areas at either depot where the dose rate approaches 4 mrem/hr. On behalf of DNSC, ORNL and ORISE will be at each site continuously during decontamination and packaging activities. They will perform radiological audits and inspections as part of the oversight work scope. DNSC will receive weekly status reports that will include a progress summary as well as a detailed description of any technical issues and new findings that require management and resolution. Two ORISE CHPs will review radiological safety and functional field activities on a periodic basis and generate a report for DNSC.

9.6. RECORDKEEPING PROGRAM

Neither CBD nor HD has licensable material in storage. Records are kept in accordance with applicable regulations at DNSC Headquarters, including all personnel dose and cleanup-related radiological records.

9.7. POSTING OF AREAS

Radiological areas shall be posted per the requirements of 10 CFR 20 and applicable written procedures.

9.8. DOSE TO WORKERS

All worker radiation doses will be maintained below the annual limits prescribed in 10 CFR 20. According to DNSC records, typical doses from activities at the CBD and HD are less than 0.2% of the annual limit for radiation workers (5,000 mrem) prescribed in 10 CFR 20.1201. During the proposed actions, the operations crews have the potential to receive the largest radiation doses. In accordance with best industry practices, the dose to all workers will be kept ALARA, and well below the allowable annual limit.

10.0 ENVIRONMENTAL MONITORING & CONTROL PROGRAM

Decommissioning-related activities at CBD and HD are not expected to result in significant adverse impacts to public health or the environment from the presence of very low levels of radioactivity at the site. However, administrative and engineering controls will be established in accordance with written plans and/or procedures to ensure that members of the public and the environment are protected against any potential releases of radioactive material in compliance with 10 CFR Parts 20.1301 and 20.1302 during decommissioning of these depots.

11.0 RADIOACTIVE WASTE MANAGEMENT PROGRAM

The removal and packaging of radioactive waste originating from the CBD and HD will be performed by a contractor in accordance with written instructions and the ORPP for the DNSC (Ref. 14). The shipment of radioactive waste will be performed by a broker under contract to the decontamination contractor.

The contractor excavates and packages wastes on the site. The contractor will upgrade the rail pathway if it is cost effective. The contractor will work hand-in-hand with the broker and licensed disposal facilities. The DNSC program ensures that the decontamination contractor, shipping broker, and waste disposal facility personnel are working together to make compliant, timely shipments.

11.1. SOLID RADIOACTIVE WASTE

The types of solid radioactive waste to be generated at the CBD and HD include structural materials (e.g., concrete, metal, piping, wood, and plastic), soil, slag, and secondary waste (contaminated material generated from decommissioning and waste packaging activities).

All radioactive waste generated by decommissioning activities is anticipated to be Class A, comprised of Th-232 and its associated decay progeny, and to a lesser extent, U-238/235 and their associated decay progeny. The current Class A waste volume estimate is 1120 m^3 of soil and 270 m^3 of structural material debris, slag, and miscellaneous contaminated materials at HD. Volume estimates for CBD are 930 m^3 of soil and 200 m^3 of structural material.

Staging areas for collecting debris and secondary waste generated during remediation activities will be established. To assure that contaminated soil and other loose solid radioactive waste is not re-disbursed after removal and staging, administrative and engineering controls will be established to protect the public and the environment during packaging and transportation activities. Barriers will also be employed as necessary to prevent the inadvertent contamination of the land areas used for radioactive waste staging.

Decommissioning personnel will also be required to decontaminate the waste staging areas to acceptable levels in the event they become contaminated and to minimize the generation of secondary waste. In addition, decommissioning personnel will package and tag all radiologically-contaminated secondary waste, and will complete log-sheets that include the description of the contents of each waste container in accordance with written plans and/or procedures.

The waste will be packaged to meet the acceptance criteria for the disposal facility. As such, all shipping documentation, to include, at a minimum, NRC Form 54 and Bills of Lading, will be prepared for such shipments. Certificates of disposal from the disposal sites will be maintained in the project files.

11.2. LIQUID RADIOACTIVE WASTE

No known liquid radioactive waste currently exists at the CBD and HD. In addition, administrative controls will be established to minimize or prevent the generation of liquid radioactive wastes. Therefore, it is not anticipated that any liquid radioactive waste will be generated at the two depots.

11.3. MIXED WASTE

Mixed waste at the CBD and HD are not expected to be encountered or generated during decommissioning operations. However, should mixed waste be encountered/generated then such waste will be handled, transported, and disposed in accordance with requirements mandated by the NRC, the Environmental Protection Agency, the Department of Transportation, and all other applicable federal, state, and local regulations.

12.0 FINAL STATUS SURVEY QUALITY ASSURANCE PROGRAM

The DNSC will be responsible for establishing a Final Status Survey Quality Assurance (FSS QA) program for decommissioning activities conducted at the CBD and HD under the auspices of ORNL and ORISE.

12.1. ORGANIZATION

The functional duties, authorities, and responsibilities of managerial, operations, and safety personnel are contained in Radioactive Material License No. STC-133 and the DNSC ORPP. Personnel assigned organizational responsibilities for performing QA functions will be given the necessary independence and authority to allow them to identify issues or non-conformances related to quality of the FSS, and to initiate, recommend, and verify resolution of any necessary corrective actions needed to address any issues or non-conformances.

Personnel from ORNL and ORISE will ensure effective implementation of all relevant aspects of the FSS QA program. As such, they will ensure that survey activities meet the requirements outlined in the FSS QA program. Personnel from ORNL and ORISE are responsible for reviewing the adequacy of the FSS QA program. Additionally, they will inform appropriate decommissioning staff and contractors on decommissioning activities related to the FSS QA program.

Personnel from ORNL and ORISE are responsible for ensuring that the contractor complies with the FSS QA program, satisfies the objectives and requirements for the FSS, and that all activities are performed in a manner to permit the termination of the radioactive material for CBD and HD.

12.2. QUALITY ASSURANCE RECORD & DOCUMENT CONTROL

Sufficient records will be specified, prepared, reviewed and maintained to reflect the achievement of the required quality. Records will include documents such as operating logs, results of survey reviews, inspections, tests, assessments, and sample analysis. Records will be identifiable, available and retrievable. These records will be reviewed to ensure completeness and ability to serve their intended function. Requirements will be consistent with applicable regulations and the potential for impact on quality and radiation exposure to workers and the public.

12.3. CONTROL OF MEASURING EQUIPMENT

Administrative controls will be established to assure that instruments and other measuring devices used in activities affecting the FSS quality are properly controlled, calibrated, and adjusted at specified periods to maintain accuracy within necessary limits.

Selection of instruments will be based on the type, range, accuracy, and tolerance needed to accomplish the required measurements for determining conformance to specified requirements. Selection and use of instrumentation for the FSS will also be based upon the need to ensure that the residual radioactivity remaining at the sites meets the specified cleanup criteria. Additional information on the types of instrumentation and quality controls that will be used to support decommissioning activities is provided in Section 13.2, *Major Instrumentation.*

12.4. AUDITS & CORRECTIVE ACTIONS

Project audits will be planned and conducted using criteria that describe acceptable practices, including performance. Audits will verify compliance with applicable requirements of the FSS QA program and will determine its effectiveness. The scheduling of audits and allocation of resources will be based on the work and complexity of the task being assessed. Audits will be performed and results reported to the DNSC ORPM for review and approval.

Conditions adverse to quality shall be identified promptly and corrected as soon as practicable.

13.0 FINAL STATUS SURVEY PLAN

This section provides the outline for the FSS plan that will be implemented at both the CBD and HD. Because of the similarity of the two sites regarding the contaminants of concern, causes of contamination and common building types, this outline is proposed for both sites. Although a combined outline is being provided in this work plan, individual FSS plans will be prepared unique to each site and provided to the NRC for approval. This outline is intended to provide information to the NRC in determining the adequacy of understanding of the final status plan as it pertains to the goal of remediation in a manner satisfying the radiological criteria for license termination. The FSS plans will provide the detailed procedures for demonstrating compliance with the radiological criteria for license termination for the contaminants of concern.

The FSS plans will be prepared in accordance with the guidance presented in NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (Ref. 15). The plans will follow the Data Quality Objectives (DQOs) process and ensure that all buildings and land areas are surveyed with the necessary rigor that corresponds with a given building or land area contamination potential. The plan will detail site classification and survey unit designations, survey planning parameters, instrumentation, measurement and sampling procedures, and the data quality assessments that will be implemented.

All FSS planning and implementation will be performed by trained personnel following appropriate regulatory guidance; programmatic protocols; approved written survey, quality assurance, and laboratory procedures; and using properly calibrated instruments and laboratory analyses sensitive to the potential contaminants.

Scoping and/or characterization survey data that have been developed to satisfy FSS DQOs may be used for both planning the FSS and as FSS data for buildings or land areas that do not require remediation.

13.1. CONTAMINANTS OF CONCERN & DERIVED CONCENTRATION GUIDELINE LEVELS

Th-232 and its associated decay products and U-238/U-235 and their associated decay products have been identified through process knowledge and characterization survey results as the contaminants of concern. Proposed site-specific $DCGL_W$s for both Th-232 and U-238 on building surfaces and within soils have been developed using the RESRAD and RESRAD-BUILD computer codes and provided to the NRC for review and approval (Refs. 3 and 4). These DCGLs have accounted for all important decay products found in secular equilibrium, including, the slight natural contribution from U-235 and its decay products. The proposed above background $DCGL_W$s for structural surfaces at both sites are 400 dpm/100 cm^2 for Th-232 and its decay products and 800 dpm/100 cm^2 for natural U-238/235 and their decay products. It is anticipated that FSS planning and data quality assessment will use only the proposed site-specific surface activity $DCGL_W$ for Th-232. Use of only the more restrictive Th-232 surface activity $DCGL_W$, rather than modifying the $DCGL_W$ to also account for any small percentage of natural uranium activity that may be present, will allow for simplification of the survey process yet provide an overall more conservative approach for determining future remediation requirements. Soil survey unit planning and data quality assessment will be compared with the proposed above background DCGLs of approximately 2.9 pCi/g of Th-232 at both sites, and 2.2 pCi/g and 2.5 pCi/g of U-238 at the CBD and HD, respectively. In addition, FSS planning and data quality assessment (DQA) will include an appropriate application of the unity rule in accordance with the equation:

$$\frac{Conc._{Th-232}}{DCGL_{Th-232}} + \frac{Conc._{U-238/235}}{DCGL_{U-238/235}} < 1$$

13.2. MAJOR INSTRUMENTATION

The following, or similar, survey and laboratory instrumentation will be used during the FSS.

SCANNING INSTRUMENT/DETECTOR COMBINATIONS

Alpha plus Beta

Ludlum Floor Monitor Model 239-1 combined with Ludlum Ratemeter-Scaler Model 2221 coupled to Ludlum Gas Proportional Detector Model 43-37, Physical Area: 550 cm^2 (Ludlum Measurements, Inc., Sweetwater, TX), Minimum Detectable Concentration (MDC) = 300 dpm/100 cm^2

Beta

Ludlum Ratemeter-Scaler Model 2221 coupled to Ludlum Gas Proportional Detector Model 43-68, Physical Area: 126 cm^2 equipped with a 3.8 mg/cm^2 Mylar window (Ludlum Measurements, Inc., Sweetwater, TX) MDC = 800 dpm/100 cm^2

The actual scanning MDC for the instrumentation will be compared with required scanning MDC determined at the time of final status survey plan development. Sample spacing will be adjusted if necessary to ensure that the actual scan MDC is less than the required scan MDC for each Class 1 survey unit.

Gamma

Ludlum Pulse Ratemeter Model 12 (Ludlum Measurements, Inc., Sweetwater, TX) coupled to Victoreen sodium iodide (NaI) Scintillation Detector Model 489-55, Crystal: 3.2 cm x 3.8 cm (Victoreen, Cleveland, OH) MDC = 2.8 pCi/g Th-232. (assumes secular equilibrium with progeny in the decay series) and MDC = 4.5 pCi/g for U-238 (assumes secular equilibrium with the decay series).

Based on characterization data demonstrating that U-238 concentrations from licensed material contamination exists as a mixture with Th-232 in virtually every case, a combined scan MDC for the mixture may be calculated from the observed fractional amounts. The observed Th-232:U-238 ratio ranged from approximately 10:1 to 20:1. The calculated scan MDC for the 10:1 activity ratio is calculated to be 2.9 pCi/g total activity and can be compared with the similarly calculated total activity DCGL of 2.81 and 2.85 pCi/g for the CBD and HD, respectively. The actual scanning MDC for the instrumentation will be compared with required scanning MDC determined at the time of final status survey plan development. Sample spacing will be adjusted if necessary to ensure that the actual scan MDC is less than the required scan MDC for each Class 1 survey unit.

DIRECT MEASUREMENT INSTRUMENT/DETECTOR COMBINATIONS

Alpha or Beta

Ludlum Ratemeter-Scaler Model 2221 coupled to Ludlum Gas Proportional Detector Model 43-68, Physical Area: 126 cm^2 (Ludlum Measurements, Inc., Sweetwater, TX)
MDC = 200 dpm/100 cm^2

LABORATORY ANALYTICAL INSTRUMENTATION

Low Background Gas Proportional Counter Model LB-5100-W (Tennelec/Canberra, Meriden, CT)

High Purity Extended Range Intrinsic Detector CANBERRA/Tennelec Model No: ERVDS30-25195 (Canberra, Meriden, CT) used in conjunction with Lead Shield Model G-11 (Nuclear Lead, Oak Ridge, TN) and Multichannel Analyzer DEC ALPHA Workstation (Canberra, Meriden, CT)

High Purity Extended Range Intrinsic Detector Model No. GMX-45200-5 (AMETEK/ORTEC, Oak Ridge, TN) used in conjunction with Lead Shield Model SPG-16-K8 (Nuclear Data) Multichannel Analyzer DEC ALPHA Workstation (Canberra, Meriden, CT)

High-Purity Germanium Detector Model GMX-30-P4, 30% Eff. (AMETEK/ORTEC, Oak Ridge, TN) used in conjunction with Lead Shield Model G-16 (Gamma Products, Palos Hills, IL) and Multichannel Analyzer DEC ALPHA Workstation (Canberra, Meriden, CT)

Gamma Spectroscopy MDC = 0.11 pCi/g Th-232 and 0.70 pCi/g U-238.

13.3. CALIBRATION & QUALITY ASSURANCE

Calibration of all field and laboratory instrumentation will be based on standards/sources, traceable to NIST.

Analytical and field survey activities will be conducted in accordance with procedures from the following ORISE documents:

- Survey Procedures Manual
- Laboratory Procedures Manual
- Quality Assurance Manual

The procedures contained in these manuals were developed to meet the requirements of DOE Order 414.1C and the U.S. NRC *Quality Assurance Manual for the Office of Nuclear Material Safety and Safeguards* and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in the Mixed Analyte Performance Evaluation Program (MAPEP), NIST Radiochemistry Intercomparison Program (NRIP), and Intercomparison Testing Program (ITP) Laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

Detectors used for assessing surface activity will be calibrated in accordance with ISO-7503[1] recommendations. Total alpha and beta efficiencies (ε_{total}) will be determined for each instrument/detector combination and consist of the product of the 2π instrument efficiency

[1]International Standard. ISO 7503-1, Evaluation of Surface Contamination - Part 1: Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters. August 1, 1988.

(ε_i) and surface efficiency (ε_s): $\varepsilon_{total} = \varepsilon_i \times \varepsilon_s$. Beta total efficiencies will be determined based on a beta energy multi-point calibration, development of instrument efficiency to beta energy calibration curves, and the calculation of the weighted efficiency representing the Th-232 decay series. Included in the weighted efficiency will be an empirically determined correction for disequilibrium in the decay series that results from Rn-220 loss. A 3.8 mg/cm^2 density thickness mylar window will be used on the beta detectors to block detector response contributions from alpha radiation.

Th-230 will be selected as the alpha calibration source. The 2π alpha instrument efficiency (ε_i) factors are approximately 0.41 for the gas proportional detectors. Carbon-14, Tc-99, Tl-204, and Sr/Y-90 will be selected as the beta calibration sources to represent the energy distribution of the detectable beta-emitters in the Th-232 decay series. The 2π interpolated ε_i factors for the detectable beta-emitters will range from 0.19 to 0.60 for the gas proportional detectors. ISO-7503 recommends an ε_s of 0.25 for alpha emitters and also beta emitters with a maximum energy of less than 0.4 MeV and an ε_s of 0.5 for maximum beta energies greater than 0.4 MeV. The thorium series total weighted alpha efficiency is expected to be 0.55 with a corresponding total weighted beta efficiency for the beta detectors ranged from 0.40 to 0.42.

13.4. CLASSIFICATION OF AREAS BY CONTAMINATION POTENTIAL

Both sites will be subdivided into three categories, based on contamination potential, as either Class 1, 2, or 3 in accordance with the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (Ref. 15). A description of each is as follows:

Class 1: Buildings or land areas that have a significant potential for radioactive contamination (based on site operating history) or known contamination (based on previous radiological surveys) that exceeds the expected $DCGL_W$.

Class 2: Buildings or land areas, often contiguous to Class 1 areas, that have a potential for radioactive contamination but at levels less than the expected $DCGL_W$.

Class 3: Remaining buildings and land areas that are expected to contain little or no residual contamination based on site operating history or previous radiological surveys.

Furthermore, buildings and land areas will be further subdivided into survey units, which will provide the fundamental compliance unit for demonstrating compliance with the derived concentration guideline levels. Survey unit size restrictions will generally follow the recommended size limitations provided in MARSSIM, although it is anticipated that in some Class 2 survey unit cases, where justifiable, these limits may be exceeded.

13.5. BACKGROUND REFERENCE AREA & MATERIALS

Background reference areas will be selected for comparing site soil sample data to and in evaluation of the FSS data in accordance with the planned non-parametric Wilcoxon Rank Sum (WRS) statistical test that will be used for land area survey units. The background reference areas selected will share similar geo-physical properties as the respective sites that have not been impacted by site operations. Structural survey units will be evaluated using the non-parametric Sign Test, which does not require comparison of the data to a background reference area data set. However, construction material-specific backgrounds will be determined in areas of similar construction but without a history of radioactive material use. These construction material-specific measurements will be used to correct direct measurement for background contributions, prior to converting data to the DCGL compliance unit of dpm/100 cm^2.

13.6. SURVEY DESIGN

Data needs for statistical tests will be determined as follows:

1. Calculate the relative shift (Δ/σ)

   Δ/σ = DCGL - LBGR

   The DCGL is the gross or nuclide specific guideline.
   The LBGR (Lower Bound of the Gray Region) should be established as the estimated mean activity within the survey, but may be adjusted to maximize survey design. σ will be determined empirically from scoping, characterization, or remedial action support survey data.

2. Determine decision errors

   The DQOs for both projects will establish a Type 1 decision error of 0.05. Type II errors are expected to be 0.05 to 0.10.

3. Determine the number of data points required

   The number of data points required for statistical testing is obtained from MARSSIM (Ref. 15) Tables 5.3 (WRS test) and 5.5 (Sign test). The required number of data points that result from the calculated relative shift and selected decision errors will then be collected from the survey unit.

The number of data points will be determined in this manner for each survey unit undergoing final status survey and documented in the final status survey design applicable to that survey unit. This planning stage is performed to determine the data requirements, based on the estimated parameters and decision errors, necessary to reject the null hypothesis: residual radioactivity in the survey unit exceeds the release criterion.

13.7. DETERMINING MEASUREMENT/SAMPLING LOCATIONS

Measurement/sampling locations will be established in either a random start/systematic fashion for Class 1 and Class 2 survey units or at randomly generated locations for Class 3 survey units. Random start/systematic determinations will follow the recommended guidance using a triangular measurement or sampling pattern to increase the probability of identifying small areas of residual activity. The spacing (L) between data points on a triangular pattern is determined by:

$L = [(\text{Survey Unit Area})/(0.866 \times \text{number of data points})]^{1/2}$. The spacing between rows is calculated as $0.866 \times L$.

13.8. INTEGRATED SURVEY STRATEGY

FSS data collected for structural surfaces will consist of gamma and alpha plus beta or beta scans to identify locations of residual contamination and direct measurements of beta surface activity. Smear samples, although not used in the final Data Quality Assessment, will be collected to measure removable alpha and beta surface activity. Final status surveys of open land areas will consist of gamma scans to identify locations of residual contamination and samples of soil, analyzed for potential contaminants. Additional judgmental measurements and samples will be obtained, as necessary, from locations where scans indicate potential residual contamination.

13.8.1. Surface Scans

Class 1 area floors, lower walls, or upper surfaces will be 100% scanned for alpha plus beta/beta radiation using large-area and hand-held gas proportional detectors coupled to ratemeter-scalers with audible indicators. Scanning of Class 2 and 3 floors, lower walls, or upper surfaces will be performed using a graded approach with 10 to 50% of Class 2 surfaces scanned and a minimum coverage of 10% for Class 3 surfaces. Similarly, Class 1 land areas will be scanned 100% for gamma radiation using NaI detectors coupled to ratemeters with audible indicators and a graded approach of 10 to 50% for Class 2 land areas and a minimum coverage of 10% for Class 3 land areas.

13.8.2. Surface Activity Measurements

Direct measurements to quantify total beta activity levels will be performed within any areas of residual contamination identified by surface scans, at contiguous locations to delineate contamination boundaries, and also at pre-determined random start/systematic or random locations as applicable. Measurements will be made using gas proportional detectors coupled to ratemeter-scalers. Surface activity data will be converted to units of dpm/100 cm^2.

13.8.3. Soil Sampling

Surface (0 to 0.15 m) soil samples will be collected from judgmental locations where elevated direct gamma radiation is detected by surface scans and from the pre-determined random-start/systematic or random locations as applicable. Soil samples will then be analyzed by gamma spectroscopy and results reported in units of pCi/g. Samples will be maintained under formal chain-of-custody procedures.

13.9. DATA REVIEW & INVESTIGATION THRESHOLDS

Data will be reviewed to assure that the type, quantity, and quality are consistent with the survey plan and design assumptions. Data standard deviations will be compared with the assumptions made in establishing the number of data points. Individual and average data values will be compared with guideline values and proper survey area classifications will be confirmed. Individual measurements in excess of the guideline level for Class 2 areas will be investigated. For Class 3 survey units, although less conservative than the recommendation provided in MARSSIM, measurements in excess of 75 percent of the guideline for Class 3 areas will prompt investigation. The requirement for increasing the investigation threshold is due to the low DCGLs relative to background. Should a survey unit require investigation, reclassification, remediation, and/or resurvey, a determination of the cause will be initiated and the data conversion and assessment process repeated for new data sets.

13.10. DETERMINING COMPLIANCE WITH GUIDELINES

Survey unit and background reference area soil sample results will be converted to unity in accordance with the equation in Section 13.1. The DCGL in this case is also established as 1. The reference area results will then be adjusted by adding the DCGL to the unity concentration value. The results for both data sets are then ranked as follows:

- Rank all (survey unit and reference area) measurements in order of increasing size from 1 to N, where N is the total number of pooled measurements.
- If several measurements have the same value, assign them the average ranking of the group of tied measurements.
- Sum the ranks of the adjusted reference area measurements; this value is the test statistic, WR.
- Compare the value of WR to the critical value in MARSSIM Table I.4 for the appropriate sample size and decision level.

Prior to applying the test, if the difference between the largest survey unit result and the smallest reference area result is less than the DCGL, the survey unit will always pass a complete application of the WRS test. No further evaluation is necessary as the survey unit will always pass the WRS test and the null hypothesis rejected. Otherwise, WR must be calculated. If WR is greater than the critical value, the null hypothesis is rejected, and the survey unit meets the established criteria. If WR is smaller than the critical value, the null hypothesis is accepted, and the survey unit does not meet the established criteria; investigation, remediation, reclassification, and/or resurvey should be performed as appropriate.

Structural survey units will be evaluated using the Sign test. Individual activity values and the average activity value will be calculated.

If all values for a survey unit are less than the guideline level, the survey unit satisfies the criterion and no further evaluation is necessary.

If the average activity value is greater than the guideline, the survey unit does not satisfy the criterion, and further investigation, remediation, and/or resurvey is required.

If the average activity value is less than the guideline level, but some individual values are greater than the guideline, data evaluation by the Sign test proceeds, as follows:

- List each of the survey unit measurements.
- Subtract each measurement from the guideline level.
- Discard all differences which are "0"; determine a revised sample size.
- Count the number of positive differences; this value is the test statistic, S+.
- Compare the value of S+ to the critical value in MARSSIM Table I.3 for the appropriate sample size and decision level.

If S+ is greater than the critical value, the null hypothesis is rejected, and the survey unit meets the established criteria. If S+ is smaller than the critical value, the null hypothesis is accepted, and the survey unit does not meet the established criteria; investigation, remediation, reclassification, and/or resurvey should be performed, as appropriate.

14.0 DECOMMISSIONING CHANGE CONTROL PROCEDURE

An evaluation will be performed for changes to decommissioning procedures and plans to determine whether prior approval by the NRC is required. For all such changes, the ORPM is responsible for ensuring such evaluations are conducted against the following criteria:

- Requires NRC approval pursuant to 10 CFR 40.42(g)(1);
- Uses a statistical test other than the Sign Test or Wilcoxon Rank Sum test for evaluation of the final status survey;
- Increases the radioactivity level, relative to the applicable DCGL, at which an investigation occurs;
- Reduces the coverage requirements for scan measurements;
- Decreases an area classification (i.e., impacted to unimpacted, Class 1 to Class 2; Class 2 to Class 3; or Class 1 to Class 3);
- Increases the Type I decision error;
- Increases the DCGLs and related minimum detectable concentrations (for both scan and fixed measurement methods);
- Modifies the approved area factors in a non-conservative manner; and
- Results in significant environmental impacts not previously reviewed.

15.0 FINANCIAL ASSURANCE

The DNSC has provided a decommissioning cost estimate and has secured an appropriate financial assurance instrument in the form of a Statement of Intent for decommissioning consistent with NUREG-1757 and in accordance with 10 CFR 40.36(e)(4) (Ref. 16).

16.0 REFERENCES

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17.0 LIST OF ACRONYMS

ε_i	instrument efficiency
ε_s	surface efficiency
ε_{total}	total efficiency
AEC	Atomic Energy Commission
AJMC	Army Joint Munitions Command
ALARA	As Low As Reasonably Achievable
ALI	annual limit on intake
ANL	Argonne National Laboratory
AOCs	areas of concern
cm	centimeters
CBD	Curtis Bay Depot
CFR	Code of Federal Regulations
CHP	Certified Health Physics
DCGL	Derived Concentration Guideline Level
$DCGL_w$	Derived Concentration Guideline Level (evenly distributed residual radioactivity)
DLA	Defense Logistics Agency
DNSC	Defense National Stockpile Center
DNSC-O	DNSC Director of Stockpile Operations
DOE	U.S. Department of Energy
$dpm/100cm^2$	disintegrations per minute per 100 square centimeters
DQA	data quality assessment
DQOs	Data Quality Objectives
D/RP	Decommissioning/Remediation Plan
DSR	dose-to-source ratios
FSI	focused site investigation
FSS	Final Status Survey
FSS QA	Final Status Survey Quality Assurance
GSA	General Services Administration
HD	Hammond Depot
HSA	historical site assessment
ITP	Intercomparison Testing Program
km	kilometer
LBGR	Lower Bound of the Gray Region
MAPEP	Mixed Analyte Performance Evaluation Program
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimum Detectable Concentration
MeV	million electron volts
m	meters
m^2	square meter
m^3	cubic meter
mg/cm^2	miliigrams per square centimeters
mi	mile
mrem	millirem
mrem/h	millirem per hour

mrem/y	millirem per year
NaI	Sodium Iodide
NIST	National Institute of Standards and Technology
NMSS	Nuclear Materials Safety and Safeguards
NRIP	NIST Radiochemistry Intercomparison Program
NRC	U.S. Nuclear Regulatory Commission
ORPP	Occupational Radiation Protection Program
ORISE	Oak Ridge Institute for Science and Education
ORPM	Occupational Radiation Protection Manager
ORNL	Oak Ridge National Laboratory
pCi/g	picocuries per gram
pCi/m^2	picocuries per square meter
PPE	personal protective equipment
QA	quality assessment
RESRAD	Residual Radioactivity in soil
Rn	thoron
RPO	Radiation Protection Officer
RSO	Radiation Safety Officer
RWP	Radiation Work Permit
SOW	statement of work
Th	thorium
ThN	thorium nitrate
ThO_2	thorium dioxide
U	uranium
WRS	Wilcoxon Rank Sum
y	year