HISTORICAL SITE ASSESSMENT OF THE HAMMOND DEPOT HAMMOND, INDIANA

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Prepared for the
Defense National Stockpile Center
Defense Logistics Agency

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Environmental Survey
and Site Assessment Program

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TABLE OF CONTENTS

1.0 GLOSSARY OF TERMS, ACRONYMS, AND ABBREVIATIONS

AEC	Atomic Energy Commission
dpm	disintegrations per minute
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
DLA	Defense Logistics Agency
DNSC	Defense National Stockpile Center
FSI	focused site investigation
GSA	General Services Administration
HSA	Historical Site Assessment – a detailed investigation to collect existing information, primarily historical, on a site and its surroundings.
HQ	headquarters
Impacted Area	Any area that is not classified as non-impacted; areas with a possibility of containing residual radioactivity in excess of natural background or fallout levels.
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
NTS	Nevada Test Site
Non-Impacted Area	Area where there is no reasonable possibility (extremely low probability) of residual contamination.
NRC	U.S. Nuclear Regulatory Commission
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
QA/QC	Quality Assurance/Quality Control
RSO	radiation safety officer
RSSI	radiation survey and site investigation
ThN	thorium nitrate

2.0 EXECUTIVE SUMMARY

The Defense National Stockpile Center (DNSC) of the Defense Logistics Agency (DLA) is in the process of closing out its depots across the country and seeking to terminate its U.S. Nuclear Regulatory Commission (NRC) license for those facilities. Hammond Depot stores various stockpiled ores and metals such as chrome, ferrochrome, ferromanganese, lead, tin, among others, but no radioactive materials were stored on the outdoor pads. Some of the commodities stored at the Hammond Depot—thorium nitrate (ThN), monazite sands, columbium tantalum and sodium sulfate—are radioactive materials and are listed on the DNSC's NRC source material license STC-133 that permits the storage of uranium and thorium. The license was recently amended to conduct site cleanup activities [1].

According to the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM [2]), radiological surveys in support of decommissioning follow a graded approach that starts with the Historical Site Assessment (HSA). The HSA is an investigation to collect existing information describing a site's complete history from the start of site activities to the present time to determine the potential for radiological contamination and to use the collected data to plan for future radiological surveys at the site.

Visits to review available documentation were performed on April 12 and 13, 2005 to the Hammond Depot and February 8 and 9, 2005 to the DNSC headquarters (HQ) in Fort Belvoir, VA. 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 Hammond Depot. During the site visit to Hammond Depot, information concerning site conditions as it applies to conducting future survey work was noted. In particular, the issue of black-top covering the floor in Warehouse 200E was identified as a challenge for performing effective scoping surveys.

Two areas are considered to be potentially classified as Class 1 or Class 2 impacted areas. These areas are Warehouse 100W and Warehouse 200E. In addition, the existing roads, railroad lines, and the burn cage are also considered to be potentially contaminated and classified as Class 2. The remaining areas are considered to have little potential for contamination, and may be considered Class 3.

3.0 PURPOSE OF THE HISTORICAL SITE ASSESSMENT

The Defense National Stockpile Center (DNSC) of the Defense Logistics Agency (DLA) is in the process of closing out its depots across the country and seeking to terminate its U.S. Nuclear Regulatory Commission (NRC) license for those facilities. Hammond Depot stored five commodities listed on their NRC Source License STC-133 [1]. They are thorium nitrate (Th-232 Reactor Grade), tantalum natural minerals and concentrates, tantalum pentoxide (Ta_20_5), rare earth sodium sulfate, and columbium tantalum source material, both columbium and tantalum natural minerals.

The DNSC contracted with Oak Ridge National Laboratory (ORNL) to assist them with the removal of the thorium nitrate stockpile from the Hammond Depot to its ultimate disposition at a disposal site. Three phases were identified to perform this task: Phase I was historical data assembly, Phase II was the stockpile characterization, and Phase III is stockpile disposition which is currently ongoing [3]. Once the last drum of the thorium nitrate stockpile leaves the Hammond Depot, scheduled for August 2005 for disposal at the Nevada Test Site (NTS), Phase III will be complete. Phase IV is the decommissioning of the Hammond Depot, including Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM [2]) surveys and necessary cleanup of buildings and land areas, to permit unrestricted use of the site.

According to the MARSSIM, surveys in support of decommissioning follow a graded approach that starts with the Historical Site Assessment (HSA) and is later followed by other surveys that lead to the final status survey. The HSA is an investigation to collect existing information describing a site’s complete history from the start of site activities to the present time. The HSA is the first step in the MARSSIM process on the path to license termination.

The purpose of the HSA at Hammond Depot was to:

- identify potential, likely, or known sources of radioactive material and radioactive contamination based on existing or derived information
- provide an assessment of the likelihood of contaminant migration
- provide information useful to scoping and characterization surveys
- provide initial classification of the site or survey unit as impacted or non-impacted

4.0 PROPERTY IDENTIFICATION

4.1 Physical Characteristics

The Hammond Depot property consists of a 57.3-acre parcel of land located on the west side of Hammond, Indiana—about 490 feet east of the Indiana-Illinois state line, within the city limits of Chicago. The depot has eight buildings, mostly in good condition, including three warehouses that are used to store raw materials. Currently, approximately 120,000 ft^2 of the available 150,000 ft^2 of indoor storage space is occupied, as well as 60% of the outdoor storage space. Figure 1 indicates the location of buildings and warehouses at the Hammond Depot [4].

The Hammond Depot is connected to the municipal sanitary sewer. However, the site previously operated a septic system north of the storage warehouses. Storm water is discharged off-site through two outfalls to Wolf Lake via drainage ditches [4].

The Oak Ridge Institute for Science and Education (ORISE) performed a limited review of the buildings' conditions on April 12 and 13, 2005.

4.1.1 Licensee Information

The Hammond Depot is currently 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 DLA headquarters address is 8725 John J. Kingman Road, Suite 3229, Ft. Belvoir, VA 22060-6223.

4.1.2 Site Information

The Hammond Depot site is located just inside the Indiana state border with Illinois. The site address is Hammond Depot, 3200 S. Sheffield Avenue, Hammond, IN 46327-1002.

The geographic coordinates of the Hammond Depot are latitude N413936 and longitude W873140 on the 7.5-minute quadrangle U.S. Geological Survey topographical map [4].

4.2 Environmental Setting

In general, the Hammond Depot consists of eight buildings, a few railroad tracks and roads.

4.2.1 Geology

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 [4].

4.2.2 Hydrogeology

Regional groundwater in the northwest Indiana area flows in a north-northeast direction toward Lake Michigan, which is approximately 2.5 miles northeast of the Hammond Depot. However, groundwater flow in the shallow aquifer beneath the Hammond Depot is expected to flow towards and discharge into Wolf Lake [4].

Groundwater is generally not used because water supplies are available from Lake Michigan; in fact, groundwater has not been used by the city of Hammond since 1920 [4].

4.2.3 Hydrology

Surface water drainage is via two outfalls that discharge runoff from the depot to Wolf Lake [4].

The west boundary is defined by Wolf Lake, and north/south drainage ditch. Ditch locations are on the north, south, and southwest boundaries, all discharge into Wolf Lake [4].

4.2.4 Meteorology

Precipitation for the area averages 36 inches per year. The site is reported to frequently flood during periods of heavy rainfall [4].

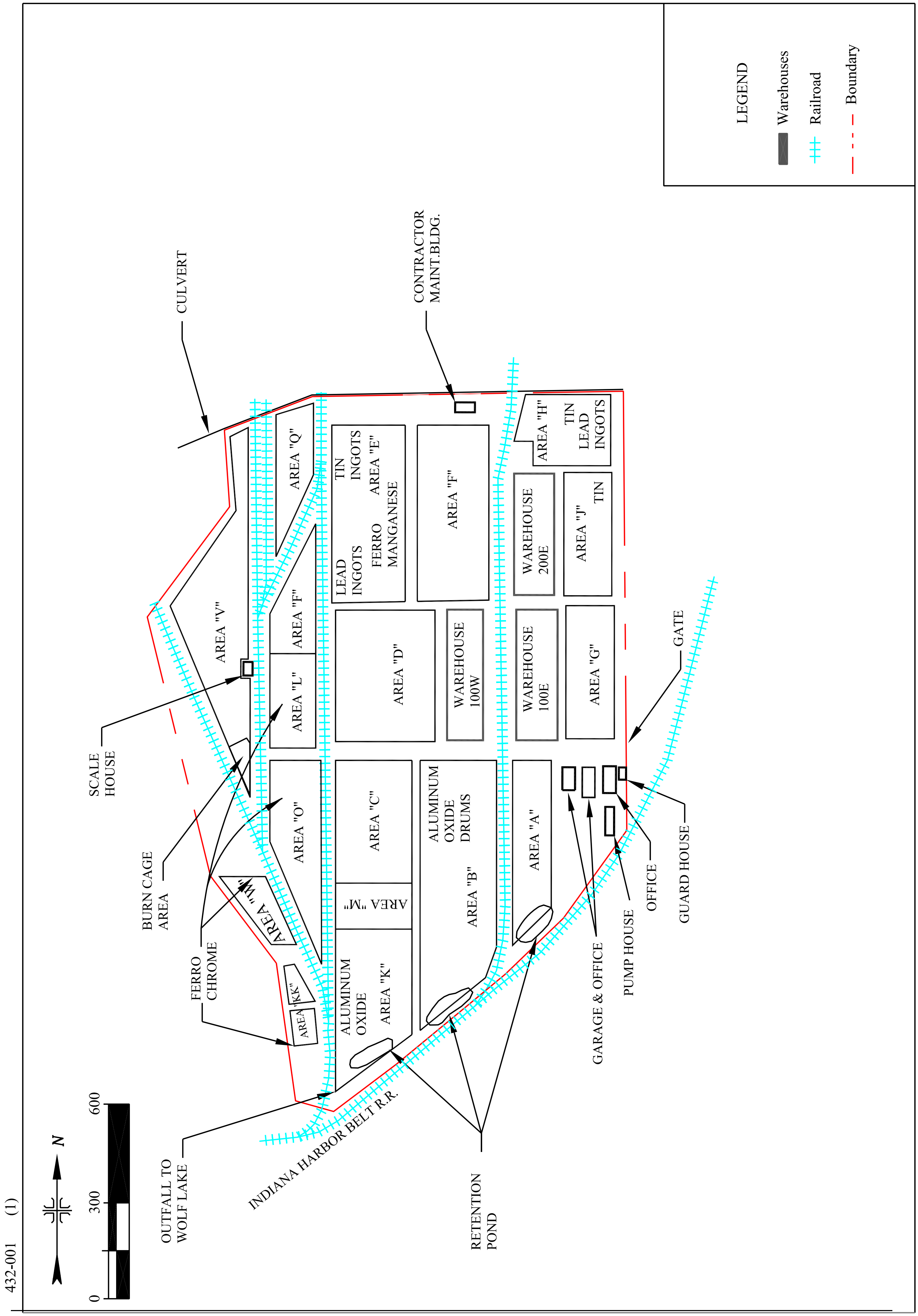

FIGURE 1: Hammond Depot, Hammond, Indiana - Plot Plan

5.0 HISTORICAL SITE ASSESSMENT METHODOLOGY

The following was the approach used to conduct the Historical Site Assessment (HSA).

5.1 Approach and Rationale

This limited scope investigation serves to collect readily available information concerning the Hammond Depot. Visits to review available documentation were performed on April 12 and 13, 2005 at the Hammond Depot and February 8 and 9, 2005 at Fort Belvoir, VA. The investigation is designed to obtain sufficient information to provide initial classification of the site or survey unit as impacted or non-impacted. Information on the potential distribution of radioactive contamination may be used for classifying each part of the site or survey unit as Class 1, 2, or 3 and is useful for planning scoping and characterization surveys.

Appendix A provides a set of questions that was used to assist in the preliminary HSA investigation (adapted from MARSSIM Table 3.1). This table focuses on characteristics that may help to identify a previously unrecognized source of potential contamination. Furthermore, these questions may identify confounding factors for selecting reference sites.

5.2 Boundaries of Site

The property consists of 57.3 acres 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. Security of the facility is maintained by a chain-link fence with barbed wire on top [4].

5.3 Documents Reviewed

Documents reviewed included historical radiological survey reports, Focused Site Investigation Report (FSI), the U.S. Nuclear Regulatory Commission (NRC) license and associated letters, various internal memos, inventory record cards, and preliminary assessment reports. This section discusses some of the information identified in the reviewed documents. Refer to Section 9.0 for a specific listing of documents reviewed.

5.3.1 Existing Radiation Data

Existing site data may provide specific details about the identity, concentration, and areal distribution of contamination. A number of reports were reviewed that related to Warehouses 100W and 200E. These reports contained survey data. However, these data should be examined carefully because:

- Previous survey and sampling efforts may not be compatible with HSA objectives or may not be extensive enough to characterize the facility or site fully.

- Measurement protocols and standards may not be known or compatible with HSA objectives (*e.g.*, Quality Assurance/Quality Control (QA/QC) procedures, limited analysis rather than full-spectrum analysis) or may not be extensive enough to characterize the facility or site fully.

- Conditions may have changed since the site was last sampled (*i.e.*, substances may have been released, migration may have spread the contamination, additional waste disposal may have occurred, or decontamination may have been performed). An important point is the on going disposition of radiological material after a record was generated stating the building was released.

5.3.2 NRC Licenses

Amendment No. 22 of license number STC-133 (February 10, 2000) licenses uranium and thorium specifically as natural uranium and thorium mixtures as ores, concentrates, and solids [1]. The identified radioactive materials indicated in NRC correspondence include thorium nitrate, columbium, columbium tantalum materials—all radioactive materials that contain thorium, and to a lesser amount, uranium.

5.3.3 Operating Records

A number of records were reviewed that described onsite activities; current and past contamination control procedures; and past operations involving material storage, spills, release of facilities or equipment from radiological controls, and onsite or offsite radioactive and hazardous waste disposal. Of particular interest were the records describing that Warehouse 200E had a total of 611 leaking drums and a black-top covering of the previously contaminated floor [5].

Corporate contract files, especially those reviewed at the DNSC Fort Belvoir HQ, provided useful information about the potential contamination at Hammond Depot. Records were identified that provided information helpful to reconstruct the site's operational history.

5.4 Property Inspections

The objective of the April 12 to 13, 2005 site visit was to gather sufficient information to support a decision regarding further survey actions. The site visit offered an opportunity to record information concerning hazardous site conditions as they apply to conducting future survey work. In this regard, information describing physical hazards, structural integrity of buildings, accessibility issues, or other conditions, defined potential problems that may impede future survey work.

5.5 Personal Interviews

Interviews with current or previous employees were performed to collect first-hand information about the site and to verify or clarify information gathered from existing records. Interviews covered general topics, such as thorium nitrate handling and disposal procedures.

The following DNSC employees and former employee working with thorium nitrate were interviewed by the Oak Ridge Institute for Science and Education (ORISE) during the HSA visit to Hammond Depot.

Mike Pecullan

M. Pecullan (Radiation Safety Officer (RSO), Environmental Specialist, DNSC) provided historical information. The interview extensively discussed history of site operations and nature and locations of radioactive materials. M. Pecullan also assisted with a tour of the facility to review the site layout and buildings [6].

Eric Deal

E. Deal (General Supply Specialist, DNSC) provided historical documents and Hammond Depot history spanning back approximately 10 years [7].

Harry Szczepanski

H. Szczepanski (former radiation safety employee) provided more details on Warehouse 2 survey and repackaging of ThN from 200E to 100W, and the burn cage [8].

6.0 HISTORY AND CURRENT USAGE

6.1 History

The original Hammond Depot property consisted of approximately 130.5 acres of land leased from the Indiana Harbor Belt Railroad Company on June 24, 1948. On June 27, 1969 the General Services Administration (GSA) purchased the entire site. It has always been used to stockpile raw materials [4]. The original property consisted of six warehouses, support buildings, and 80 above ground storage tanks in a single tank farm.

The site formerly operated a septic system north of the storage warehouses.

Materials have been delivered to the depot via tractor trailer or rail car [4].

6.1.1 Land Areas

The 57.3 acres that comprise the current Hammond Depot site include stockpiled ores, warehouses, buildings, paved and dirt roads, and natural features such as grassy open areas, wet lands, and an adjacent lake. The next few sections provide additional details on the stockpiled ores and burn cage located on the site.

While radioactive materials were generally stored in strong containers, the potential for contamination of land and related infrastructure due to movement of materials throughout the site should be evaluated.

An interview with Harry Szczepanski states pallets were burned at a spot north of the burn cage under a rubble pile that is still present.

6.1.2 Stockpiles/Stockpile Pads

The ores at Hammond Depot are stored in piles, either on concrete pads or directly on the ground surface. Other materials are stored in warehouses in drums [4].

Ores and metals that are or were stored in piles outside (and not covered) include chrome, ferrochrome, ferromanganese, lead, tin, among others, but no radioactive materials (columbium tantalum) were stored on the pads [4].

6.1.3 Warehouses

<u>Warehouse 1</u>

This building is no longer part of the Depot and was sold as excess property in the 1970s [6]. According to a site map, the building dimensions were 201 ft by 1,006 ft.

Bastnesite was stored in drums in Bay A [9].

Warehouse 2

This building is no longer part of the Depot and was sold as excess property in the 1970s [6]. According to a site map, the building dimensions were 201 ft by 1,006 ft.

In 1968, all thorium nitrate drums on hand (2,472 [10]) were moved from this warehouse to Warehouse 200E. Contamination was found on the floor and also on small areas outside the exterior doors on both sides of the building. Site personnel decontaminated the exterior areas and a contract was placed for decontaminating the floor by chipping then disposal. Warehouse 2 was declared excess [11].

After removal of the leaking thorium nitrate drums, a material consisting of two layers of kraft paper, with a layer of asphalt in between, was removed from the floor and burned on site [8].

In 1970, a test was conducted to evaluate the effectiveness of using nitric acid to remediate hot spots. This method reduced surface contamination from 30,000 to 45,000 disintegrations per minute (dpm) to approximately 6,000 to 7,000 dpm. Further remediation reduced the contamination to approximately 2,000 dpm. The report further stated that a thorough survey would need to be made to mark all hot spots [12].

The floor area of Warehouse 2 was monitored and reported to not exceed 5,000 dpm/100 cm^2 fixed alpha contamination and 1,000 dpm/100 cm^2 removable alpha [12].

Bastnesite was stored in drums in Bays C, D, and E [9].

Warehouse 3

This building is no longer part of the Depot and was sold as excess property in the 1970s [6]. According to a site map, the building dimensions were 201 ft by 1,006 ft.

No history of radioactive materials storage was noted for this building.

Warehouse 100W

The warehouse is a concrete structure with dimensions of 401 ft by 126 ft. Exterior walls are cinder block with glass block windows, 14 overhead doors, and two personal doors on each end. The floor is concrete slab on grade and the structure is steel beams, columns, and roof joists. The roof deck is 3-ply gypsum board and the roofing is 3-ply built up asphalt with a smooth surface sloping to the perimeter gutters on the east and west elevations. Electrical conduits and light fixtures hang from roof joists. A dry pipe sprinkler system is installed [4, 13]. Figure 2 shows Warehouse 100W.

Figure 2 – Warehouse 100W

Four commodities listed on the NRC Source License STC-133 (in October 1997) were stored in this warehouse: thorium nitrate in Bays 8 through 16 B, C, and D; tantalum natural minerals and concentrates (tantalum pentoxide (Ta_20_5)) in Bays 15 D, 16 D, 17 A through D, and 18 A through D; columbium tantalum source material (tantalum natural minerals) in Bays 7 B, 8 A, and 8 B; and columbium tantalum source material (columbium natural minerals) in Bays 8 E and 9 E [14].

From the "Hammond Depot History of Radiological Material Storage", Warehouse 100W currently is used to store ThN in Bays 8 through 16 B, C, and D. Past storage in this warehouse included tantalum pentoxide in Bays 15 and 16 D, 17 A through D, and 18 A through D. Columbium tantalum (columbium natural mineral) was formerly stored in Bays 8 and 9 E; columbium tantalum (tantalum natural minerals) was formerly stored in Bays 7 B, 8 A, and 8 B [15].

Monazite sand stored in 2,602 21-gallon drums was moved to this warehouse from Warehouse 200E [16].

Sodium sulfate was also stored in this warehouse [17].

<u>Warehouse 100E</u>

The warehouse is a concrete structure with dimensions of 401 ft by 126 ft. Exterior walls are cinder block with glass block windows, 14 overhead doors, and two personal doors on each end. The floor is concrete slab on grade and the structure is steel beams, columns, and roof joists. The roof deck is 3-ply gypsum board and the roofing is 3-ply built up asphalt with a smooth surface sloping to the perimeter gutters on the east and west elevations. Electrical conduits and light fixtures hang from roof joists. A dry pipe sprinkler system is installed [4, 13]. Figure 3 shows Warehouse 100E.

Figure 3 – Across the rail road tracks from Warehouse 100W (left) is Warehouse 100E (on the right).

No history of radioactive materials storage was noted for this building.

<u>Warehouse 200E</u>

The warehouse is a concrete structure with dimensions of 401 ft by 126 ft. Exterior walls are cinder block with glass block windows, 14 overhead doors, and two personal doors on each end. The interior is divided into north and south sections by a cinder block partition firewall. The floor is concrete slab on grade except that the south side was completely covered with black-top after the top surface was remediated. The structure is steel beams, columns, and roof joists. The roof deck is 3-ply gypsum board and the roofing is 3-ply built up asphalt with a smooth surface sloping to the perimeter gutters on the east and west elevations. Portions of the roof gypsum board decking were replaced with metal decking after wind tore off the original roof. Electrical conduits and light fixtures hang from roof joists. A sheet metal return air duct is also hung below the roof deck in a north-south direction but is not operational. A dry pipe sprinkler system is installed [4, 13]. Figure 4 shows Warehouse 200E.

Figure 4 – Warehouse 200E

From the "Hammond Depot History of Radiological Material Storage", Warehouse 200E was used to store ThN in Bays 1 though 10 A, B, C, D and E

[15]. Alpha survey records indicate that ThN drums leaked in this warehouse with residual contamination ranging from 100 to 500 dpm [18].

Monazite sand stored in 2,602 21-gallon drums was moved from this warehouse to Warehouse 100W [16]. Other records indicate 5,898 drums were stored in this warehouse [19]. Monazite sand was stored in areas where ThN was not stored [20].

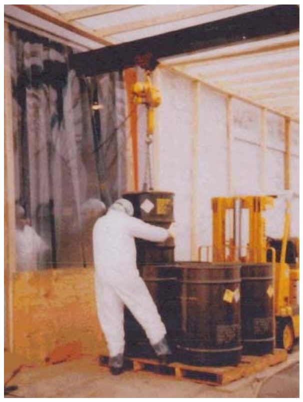

Figure 5 –Overpack Project

Figure 6 – Compromised Storage Drum

Thorium drums were overpacked from 55 to 85 gallon drums in an area west of and adjacent to the building [21]. Right after the overpackaging, the drums were moved to Warehouse 100W [6]. Figures 5 through 7 show the overpack project.

Figure 7 – ThN Packaging Shelter and Decontamination Trailer

Sodium sulfate was also stored in this warehouse in 20-gallon drums, specifically in areas where ThN was not stored [22].

Decontamination and survey services were completed by AWC Inc. from August 27, 1979 through September 25, 1979 and survey results indicated thorium levels were less than specified in NRC guidelines [23].

6.2 Current Usage

Hammond Depot is actively removing drums of thorium nitrate that are stored in the 100W warehouse buildings. The removal process is estimated to be completed by the end of August 2005. Hammond Depot also stores other strategic materials including bulk ores, minerals and metals.

6.3 Adjacent Land Usage

Warehouses 1, 2 and 3 described in Section 6.1.3 are presently being used by private industry. In addition to bastnesite having been stored in Warehouses 1 and 2, Warehouse 2 stored thorium nitrate and has a documented history of radiological contamination.

The last documented survey in Warehouse 2 states "…the contaminated floor area does not exceed the following at any location: 5,000 dpm/100 cm^2 fixed alpha, 1,000 dpm/100 cm^2 removable alpha…" [24].

7.0 FINDINGS

The main purpose of the Historical Site Assessment (HSA) was to determine the potential for radiological contamination currently existing at the Hammond Depot site and to use the collected data to plan for future surveys at the site. It is recognized that much of the data collected during HSA activities was qualitative or was analytical data of unknown quality; therefore, many decisions regarding the site are the result of professional judgment.

In general, there are three possible recommendations that follow the HSA:

- An emergency action is needed to reduce the risk to human health and the environment.

- The site is impacted and further investigation is needed before a decision regarding final disposition can be made. The area may be Class 1, Class 2, or Class 3, and a scoping survey or a characterization survey should be performed. Information collected during the HSA can be very useful in planning these subsequent survey activities.

- The site or area is non-impacted. There is no possibility or an extremely low probability of residual radioactive materials being present at the site. The site or area can be released.

Based on the Hammond Depot HSA, the general finding is that the site is impacted, and that scoping surveys should be planned to validate the HSA and better identify the general locations of contamination.

7.1 Potential Contaminants

The HSA gathered information sufficient to identify the radionuclides used at the site, including their chemical and physical form. The first step in evaluating HSA data was to estimate the potential for residual contamination posed by these radionuclides. Secondly, site operations were evaluated to assess the potential for residual contamination. The Hammond Depot operation was storage of strategic materials. Fortunately, the ores that were stockpiled outdoors are not considered radioactive materials. Rather, the materials that have radioactive constituents, which included thorium nitrate (ThN), were stored in drums. As such, the materials identified as being potential sources of radioactive contamination at the Hammond Depot are thorium nitrate, monazite sands, sodium sulfate, bastnesite, tantalum pentoxide, and columbium tantalum.

The thorium nitrate stockpile was produced to be nuclear grade material for the Atomic Energy Commission (AEC) from 1959 to 1964 [15]. The domestic inventories were produced by the Lindsay Chemical Company from monazite sands and brought to the Hammond Depot beginning in March 1962 [25]. Thorium nitrate is comprised of thorium dioxide (ThO_2) ranging from 46.0 to 47.15% by weight and was first brought onto the site in March 1962 [25]; the material still exists on the site as of April 2005. The chemical formula for thorium nitrate is: $Th(NO_3)_4 \cdot 4H_2O$. According to the U.S. Nuclear Regulatory Commission (NRC) license it is 40.5% thorium. The thorium nitrate was originally delivered in 55-gallon drums, but was repackaged into 85-gallon drums.

Monazite sand was comprised of a range of thorium dioxide of 2.4 to 3.4% [26]. It was first brought onto the site prior to February 1958 and last stored in March 1980 [27, 28].

Sodium sulfate was comprised of a range of thorium dioxide of 0.12 to 0.15% [29, 30]. It was brought on site in August 1980 and last stored in December 1997 [31].

Bastnesite was comprised of a range of thorium dioxide of 0.01 to 0.11% [26]. It was brought on site prior to February 1958 and last stored in March 1986 [32].

Tantalum pentoxide was last stored on site as of February 1999 [33]

Columbium tantalum materials, noted as columbium natural minerals, tantalum natural minerals, and concentrates, were comprised of a range of thorium dioxide of <0.001 to 0.053% and a range of uranium oxide of 0.012 to 0.156% [34]. These materials were first brought on site in July 1980 and last stored in November 2000 [35, 36, 37].

The predominant radioactive material identified during the HSA was from the thorium series. The thorium series has Th-232 as the parent, followed by ten progeny radionuclides—expected to be in equilibrium with Th-232. The thorium series emits alpha, beta, and gamma radiations.

The uranium series radionuclides are also associated with these materials, but to a substantially lesser degree. Furthermore, the NRC license lists uranium, as well as thorium, as radioactive material licensed at the Hammond Depot.

7.2 Potential Contaminated Areas

Information gathered during the HSA was used to provide an initial classification of the site areas as impacted or non-impacted.

Impacted areas have a potential for radioactive contamination (based on historical data) or contain known radioactive contamination (based on past or preliminary radiological surveillance). This includes areas where 1) radioactive materials were used and stored; 2) records indicate spills, discharges, or other unusual occurrences that could result in the spread of contamination; and 3) radioactive materials were buried or disposed of. Areas immediately surrounding or adjacent to these locations are included in this classification because of the potential for inadvertent spread of contamination [2].

Non-impacted areas—identified through knowledge of site history or previous survey information—are those areas where there is no reasonable possibility for residual radioactive contamination. The criteria used for this segregation need not be as strict as those used to demonstrate final compliance with the regulations. However, the reasoning for classifying an area as non-impacted should be maintained as a written record. Note that based on accumulated survey data an impacted area's classification may change as the radiation survey and site investigation (RSSI) process progresses [2].

The initial classification of the site involves developing a conceptual model based on the existing information collected during the preliminary investigation. Conceptual models describe a site and its environs and present hypotheses regarding the radionuclides for known and potential residual contamination. For this evaluation, the following qualitative classifications, consistent with MARSSIM, were used:

<u>Class 1</u> Areas known to be contaminated or to likely be contaminated

<u>Class 2</u> Areas that are possibly contaminated (including those previously remediated)

<u>Class 3</u> Areas that have a slight potential for contamination.

7.2.1 Impacted Areas

Warehouse 100W, 200E, and the former repackaging area outside the southwest corner of Warehouse 200E are potentially Class 1 or Class 2 impacted areas. These include areas that were previously contaminated and remediated, and areas potentially contaminated.

Existing roads and railroad lines and the burn cage are also considered to be potentially contaminated (Class 2) because they served as transportation routes. Areas where railroad lines have been removed will also be considered potentially contaminated (Class 2).

The remaining land areas and Warehouse 100E, largely due to the inadvertent spread of contamination, are considered to have little potential for contamination, and may be considered Class 3.

7.2.2 Non-impacted Areas

No areas were identified as non-impacted, although many buildings and land areas could arguably be classified as either Class 3 or non-impacted.

7.3 Potential Contaminated Media

The next step in evaluating the data gathered during the HSA was to identify potentially contaminated media at the site. This section provides guidance on evaluating the likelihood for release of radioactivity into the following environmental media: surface soil, subsurface soil, sediment, surface water, groundwater, and buildings. While MARSSIM's scope is focused on surface soils and building surfaces, this section makes note of still other media to provide a starting place to identify and address all possible media.

7.3.1 Surface Soil

Surface soil is the top layer (15 cm) of soil on the site that is available for direct exposure, growing plants, resuspension of particles for inhalation, and mixing from human disturbances. Surface sources may include gravel fill, waste piles, concrete, or asphalt paving.

The Hammond Depot HSA identified that radioactive material overpacking operations were conducted outside of the existing buildings. Surface soils may have also become contaminated via the inadvertent spread of contamination during transportation. The pallet burn cage is also a potential source of surface soil contamination.

7.3.2 Subsurface Soil and Media

Subsurface soil and media are defined as any solid materials not considered to be surface soil. The purpose of these investigations is to locate and define the vertical extent of the potential contamination. Subsurface measurements can be expensive, especially for beta- or alpha-emitting radionuclides.

Additionally, surface soil contamination can migrate deeper into the soil. Surface soil sources should be evaluated based on radionuclide mobility, soil permeability, and infiltration rate to determine the potential for subsurface contamination. Some consideration for contaminants that may exist beneath parking lots, buildings, or other onsite structures may be warranted as part of the investigation. There may be underground piping, drains, sewers, or tanks that caused contamination.

7.3.3 Surface Water

At this time, surface water is not considered to be a potentially contaminated medium.

7.3.4 Groundwater

Groundwater contamination is not suspected because no significant radioactive source term is expected in the ground. Also, it is expected that thorium migrates slowly and is not likely to reach groundwater.

7.3.5 Structures

The following table shows the buildings and portions thereof that were identified as having been used for the storage of radioactive material.

Building	Location of Potential Contaminant
Warehouse 100W	Bays 8 through 18
Warehouse 200E	Bays 1 through 10

8.0 CONCLUSIONS AND CONCEPTUAL SITE MODEL

The conceptual site model is essentially a site diagram showing locations of known contamination, areas of suspected contamination, types and concentrations of radionuclides in impacted areas, and potentially contaminated media. The diagram includes the general layout of the site including buildings and property boundaries. The conceptual site model will be upgraded and modified as information becomes available throughout the radiation survey and site investigation (RSSI) process.

The model is used to assess the nature and the extent of contamination, to identify potential contaminant sources, release mechanisms, exposure pathways, human and/or environmental receptors, and to develop exposure scenarios. This information is detailed in Section 7.0. Perhaps more importantly, this model helps to identify data gaps, determine media to be sampled, and assists staff in developing strategies for data collection during the scoping and characterization surveys.

For example, the scoping survey will be performed to provide sufficient information for determining 1) whether present contamination warrants further evaluation and 2) initial estimates of the level of effort for decontamination and preparing a plan for a more detailed survey. The scoping survey allows the scope of the characterization survey to be streamlined.

The conceptual site model is shown in Figure 8. The list below summarizes the conceptual model.

- Class 1 and 2 areas include areas that were previously contaminated and remediated (Warehouses 100W, 200E and the repackaging area outside 200E).
- Additional Class 2 areas that are considered to be potentially contaminated include the burn cage, existing roads and railroad lines, including where railroad lines have been removed, because they served as transportation routes.
- Class 3 areas include Warehouse 100E and the remaining land areas that are considered to have little potential for contamination, due to inadvertent spread of contamination.

432-003 (4)

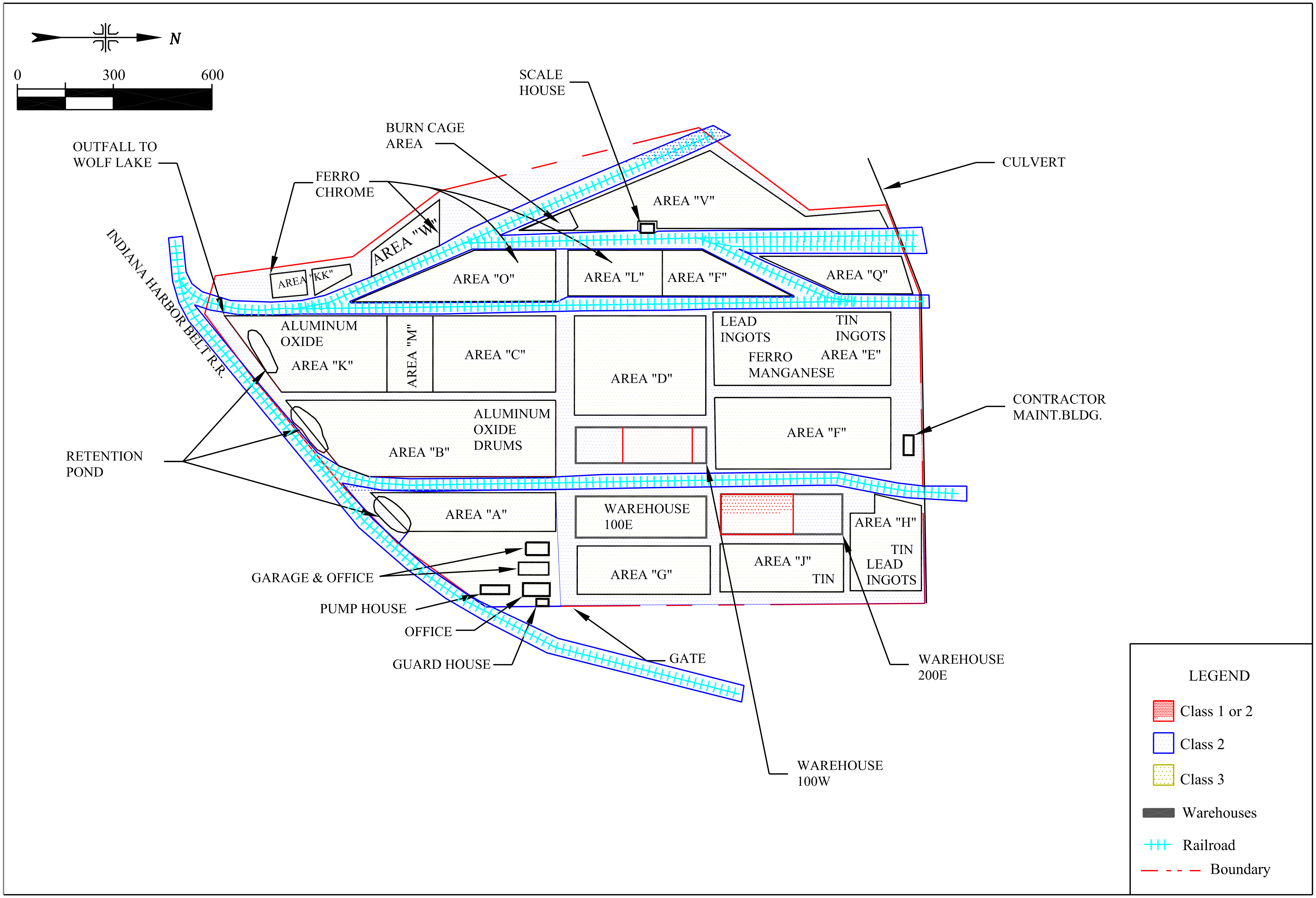

FIGURE 8: Hammond Depot - Conceptual Model

9.0 REFERENCES

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20. Monitoring Radiation Report. January 22, 1980.

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22. Monitoring Radiation Report. Date unreadable.

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26. Letter from E. L. Harper, Office of Property Management, to Ms. L. S. Dragonette, U.S. Nuclear Regulatory Commission (NRC). No Subject. January 27, 1976.

27. Inventory Record Card for monazite sand sweepings; General Services Administration (GSA) Form 46.

28. Inventory Record Card for monazite sand; General Services Administration (GSA) Form 46.

29. Letter from Chief Plant Chemist, American Potash & Chemical Corporation, to Services Administration (GSA). Analysis of Lot #8. June 17, 1960.

30. Letter from Chief Plant Chemist, American Potash & Chemical Corporation, to Services Administration (GSA). Analysis of Lot #11. June 17, 1960.

31. Inventory Record Card for sodium sulfate; General Services Administration (GSA) Form 46.

32. Inventory Record Card for bastnesite; General Services Administration (GSA) Form 46.

33. Material Locator Card for tantalum pentoxide; General Services Administration (GSA) Form 1661.

34. Tantalum Source Materials (Concentrates) Analyses. Attachment to E-mail from R. Foster to M. Pecullan. March 28, 2000.

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36. Inventory Record Card for columbium/tantalum, columbium natural minerals, 8-gallon drums, 30-gallon drums; General Services Administration (GSA) Form 46.

37. Inventory Record Card for tantalum natural mineral and concentrates; General Services Administration (GSA) Form 46.

APPENDIX A

Questions Useful for the Preliminary HSA Investigation (from MARSSIM)

1.	Was the site ever licensed for the manufacture, use, or distribution of radioactive materials under Agreement State Regulations, NRC licenses, or Armed Services permits, or for the use of 91B material?	Indicates a higher probability that the area is impacted.
2.	Did the site ever have permits to dispose of, or incinerate, radioactive material onsite? Is there evidence of such activities?	Evidence of radioactive material disposal indicates a higher probability that the area is impacted.
3.	Has the site ever had deep wells for injection or permits for such?	Indicates a higher probability that the area is impacted.
4.	Did the site ever have permits to perform research with radiation generating devices or radioactive materials except medical or dental x-ray machines?	Research that may have resulted in the release of radioactive materials indicates a higher probability that the area is impacted.
5.	As a part of the site's radioactive materials license were there ever any Soil Moisture Density Gauges (Americium-Beryllium or Plutonium-Beryllium sources), or Radioactive Thickness Monitoring Gauges stored or disposed of onsite?	Leak test records of sealed sources may indicate whether or not a storage area is impacted. Evidence of radioactive material disposal indicates a higher probability that the area is impacted.
6.	Was the site used to create radioactive material(s) by activation?	Indicates a higher probability that the area is impacted.
7.	Were radioactive sources stored at the site?	Leak test records of sealed sources may indicate whether or not a storage area is impacted.
8.	Is there evidence that the site was involved in the Manhattan Project or any Manhattan Engineering District (MED) activities (1942-1946)?	Indicates a higher probability that the area is impacted.
9.	Was the site ever involved in the support of nuclear weapons testing (1945-1962)?	Indicates a higher probability that the area is impacted.
10.	Were any facilities on the site used as a weapons storage area? Was weapons maintenance ever performed at the site?	Indicates a higher probability that the area is impacted.
11.	Was there ever any decontamination, maintenance, or storage of radioactively contaminated ships, vehicles, or planes performed onsite?	Indicates a higher probability that the area is impacted.

12.	Is there a record of any aircraft accident at or near the site (*e.g.*, depleted uranium counterbalances, thorium alloys, radium dials)?	May include other considerations such as evidence of radioactive materials that were not recovered.
13.	Was there ever any radiopharmaceutical manufacturing, storage, transfer, or disposal onsite?	Indicates a higher probability that the area is impacted.
14.	Was animal research ever performed at the site?	Evidence that radioactive materials were used for animal research indicates a higher probability that the area is impacted.
15.	Were uranium, thorium, or radium compounds (NORM) used in manufacturing, research, or testing at the site, or were these compounds stored at the site?	Indicates a higher probability that the area is impacted or results in a potential increase in background variability.
16.	Has the site ever been involved in the processing or production of Naturally Occurring Radioactive Material (*e.g.*, radium, fertilizers, phosphorus compounds, vanadium compounds, refractory materials, or precious metals) or mining, milling, processing, or production of uranium?	Indicates a higher probability that the area is impacted or results in a potential increase in background variability.
17.	Were coal or coal products used onsite? If yes, did combustion of these substances leave ash or ash residues onsite? If yes, are runoff or production ponds onsite?	May indicate other considerations such as a potential increase in background variability.
18.	Was there ever any onsite disposal of material known to be high in naturally occurring radioactive materials (*e.g.*, monazite sands used in sandblasting)?	May indicate other considerations such as a potential increase in background variability.
19.	Did the site process pipe from the oil and gas industries?	Indicates a higher probability that the area is impacted or results in a potential increase in background variability.
20.	Is there any reason to expect that the site may be contaminated with radioactive material (other than previously listed)?	See MARSSIM Section 3.6.3.