Department of Energy
West Valley Demonstration Project
10282 Rock Springs Road
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February 5, 2010

Dr. Keith I. McConnell, Deputy Director
Decommissioning and Uranium Recovery Licensing Directorate
Division of Waste Management and Environmental Protection
Office of Federal and State Materials and Environmental Management Programs
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: Submission of the Phase 1 Characterization Sampling and Analysis Plan (CSAP) for the West Valley Demonstration Project (WVDP) for U.S. Nuclear Regulatory Commission (NRC) Review

Dear Dr. McConnell:

The purpose of this letter is to submit the Phase 1 CSAP for the WVDP for NRC review and comment.

Fifteen paper copies of the plan are provided to this end, along with 15 compact disks, each of which contains an electronic copy of the plan.

Basis for NRC Review of the Plan
The U.S. Department of Energy (DOE) understands that this review will be performed by NRC in a manner consistent with Public Law 96-368, the WVDP Act of 1980, which provides authority for NRC to review and consult with DOE informally on matters related to the project.

Submittal of this plan for the Commission's review is consistent with the 1981 Memorandum of Understanding (MOU) between DOE and NRC on the WVDP (the Project), which states that the Department of Energy (DOE) will prepare a Project Decommissioning Plan (DP) which will be reviewed by NRC and comments provided to the DOE. The CSAP is a support document for the implementation of the DP. In a letter dated February 3, 2003, NRC specifically requested that DOE submit a DP for the WVDP portion of the site. DOE agreed to do so in a letter dated February 28, 2003.

Consistent with the MOU and the WVDP Act, the DOE will review and consider the NRC comments on the Phase 1 CSAP and provide responses in writing to NRC prior to initiating the Phase 1 decommissioning activities.

Background
Under provisions of the WVDP Act, New York State has made available to DOE the facilities and high-level radioactive waste at the Western New York Nuclear Center (the Center), which are necessary for completion of the Project. The Center is owned by the New York State Energy Research and Development Authority (NYSERDA), the NRC licensee.

The Phase 1 CSAP describes environmental data collection activities that will be undertaken to support the design and implementation of Phase 1 DP activities. The CSAP is a work-planning document that identifies how data will be provided to support the Phase 1 Final Status Survey Plan (FSSP). It covers environmental data collection activities up to FSSP data collection and was written to be consistent with FSSP data requirements to the extent practicable.

Plan Content
The CSAP scope covers environmental data collection pertinent to the design and implementation of Phase 1 DP activities. There are four primary CSAP data collection purposes: 1) pre-design data collection, 2) remedial support, 3) post-remediation status documentation, and 4) Phase 2 decision-making support. Data collection to support these four main objectives is organized into two distinct data collection efforts. The first is data collection that will take place prior to the initiation of significant Phase 1 decommissioning activities. The second is data collection that will occur during and immediately after environmental remediation in support of remediation activities. Both data collection efforts have a set of well-defined objectives detailed in the CSAP that encompass the data needs of the four main CSAP data collection purposes.

The main body of the CSAP describes the overall data collection strategies that will be used to satisfy data collection objectives. The details of pre-remediation data collection are organized by Waste Management Area (WMA). The CSAP contains an appendix for each WMA that describes WMA-specific pre-remediation data collection activities.

The CSAP covers only radiological sampling needs; the possibility of chemical contamination is addressed in separate documents pertinent to WVDP Resource Conservation and Recovery Act (RCRA) responsibilities. The CSAP does not address remedial action sampling for waste disposition. Those details will be described in a Waste Management Plan that would be developed as part of Phase 1 remedial design documentation.

Given the complexity of the Phase 1 DP, the CSAP, and the WVDP site, a briefing on the CSAP contents may be appropriate before NRC begins its review. DOE can provide such a briefing to NRC staff upon NRC's request.

For Further Information
Please let us know if NRC needs any additional references or other information for review of the plan. Please refer any questions about this submittal to Mark Bellis of my staff at (716) 942-4814.

Sincerely,

Bryan C. Bower, Director
West Valley Demonstration Project

Enclosures: Phase 1 Characterization Sampling and Analysis Plan (15 copies with 15 CDs)

cc: See Page 3

MSB:102312 - 450.4

cc: M. A. Gilbertson, DOE-HQ, EM-50, w/o enc.
M. J. Letourneau, DOE-HQ EM-11, CLOV, w/enc.
J. M. Moon, DOE-HQ, EM-52, FORS, w/enc.
M. S. Bellis, DOE-EMCBC, WV-DOE, w/enc.
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P. J. Bembia, NYSERDA (6 copies)

Reading Rooms: (w/enc.)
U.S. Department of Energy, FOIA Reading Room (DOE-HQ, Room 1E-190)
Hulbert Library, Springville, NY
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Phase 1 Characterization Sampling and Analysis Plan
West Valley Demonstration Project

Revision 0

Prepared for the
U.S. Department of Energy
West Valley Demonstration Project
West Valley, New York

By
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February 3, 2010

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ACRONYMS, ABBREVIATIONS, AND SYMBOLS

Ac	actinium
AGC	U.S. Army Geospatial Center
Am	americium
ASTM	American Society for Testing and Materials
C	carbon
Cd	cadmium
CG	cleanup goal
CG_{emc}	cleanup goal, elevated measurement criterion
CG_w	cleanup goal, wide
Cm	curium
cm	centimeter
Co	cobalt
Cs	cesium
CDDL	Construction and Demolition Debris Landfall
CSAP	Characterization Sampling and Analysis Plan
DCGL	derived concentration guideline level
$DCGL_w$	derived concentration guideline level, wide
DEIS	Draft Environmental Impact Statement
DP	Decommissioning Plan
DOE	Department of Energy
DOT	U.S. Department of Transportation
DQI	data quality indicators
DQO	data quality objective
ELIMS	Electronic Laboratory Information Management System
ESRI	Environmental Sensitivities Research Institute
Eu	europium
FIDLER	Field Instrument for Detection of Low Energy Radiation
FSP	field sampling plan
FSS	Final Status Survey
FSSP	Final Status Survey Plan
ft	foot/feet
GPS	global position system
GWS	gamma walkover survey
H&S	health and safety
H	hydrogen
HASP	Health and Safety Plan
HLW	High Level Waste
I	iodine
IDW	Investigation Derived Waste
LBGR	Lower Bound of the Gray Region

LIDAR	Light Detection and Ranging
m	meter
m^2	square meter
mm	millimeter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
NaI	sodium iodide
NDA	NRC-License Disposal Area
NFS	Nuclear Fuel Services, Inc.
NIST	National Institute of Standards and Technology
Np	neptunium
NRC	Nuclear Regulatory Commission
Pa	protactinium
pCi/g	picoCurie/gram
Phase 1 DP	Decommissioning Plan for the West Valley Demonstration Project
PPE	personal protective equipment
Pu	plutonium
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
Ra	radium
RCRA	Resource Conservation and Recovery Act
ROI	radionuclides of interest
Sb	antimony
SDA	State Licensed Disposal Area
Sn	tin
SOP	standard operating procedure
SOR	Sum of Ratios
Sr	strontium
Tc	technetium
Th	thorium
U	uranium
USACE	United States Army Corps of Engineers
UTL	Upper Tolerance Level
WMA	Waste Management Area
WRS	Wilcoxon Rank Sum
WVDP	West Valley Demonstration Project
WVES	West Valley Environmental Services
ZnS	zinc sulfide

RECORD OF REVISIONS

Date	Section	Revision	Reason

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EXECUTIVE SUMMARY

The Phase 1 Characterization Sampling and Analysis Plan (CSAP) provides details about environmental data collection that will be taking place to support Phase 1 decommissioning activities described in the *Phase 1 Decommissioning Plan for the West Valley Demonstration Project* (Revision 2, December 2009).

There are four primary CSAP data collection purposes: 1) pre-design data collection, 2) remedial support, 3) post-remediation status documentation, and 4) Phase 2 decision-making support. Data collection to support these four main objectives is organized into two distinct data collection efforts. The first is data collection that will take place prior to the initiation of significant Phase 1 decommissioning activities (e.g., the Waste Management Area [WMA] 1 and WMA 2 excavations). The second is data collection that will occur during and immediately after environmental remediation in support of remediation activities. Both data collection efforts have a set of well-defined objectives that encompass the data needs of the four main CSAP data collection purposes that are detailed in the CSAP.

The main body of the CSAP describes the overall data collection strategies that will be used to satisfy data collection objectives. The details of pre-remediation data collection are organized by WMA. The CSAP contains an appendix for each WMA that describes the details of WMA-specific pre-remediation data collection activities.

The CSAP is intended to expand upon the data collection requirements identified in the Phase 1 Decommissioning Plan. The CSAP is intended to tightly integrate with the Phase 1 Final Status Survey Plan (FSSP). Data collection described by the CSAP is consistent with the FSSP where appropriate and to the extent possible.

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1.0 INTRODUCTION AND PURPOSE

The *Phase 1 Decommissioning Plan for the West Valley Demonstration Project* (Revision 2, December 2009) (Phase 1 DP) describes the Phase 1 decommissioning activities planned for the West Valley Demonstration Project (WVDP) premises. These activities will at least partially address residual radionuclide contamination concerns in environmental media (soils and groundwater). The Phase 1 DP includes unrestricted release Derived Concentration Guideline Levels (DCGLs) for the identified radionuclides of interest (ROI) pertinent to the environmental media to be addressed by Phase 1 activities.

The objective of the Phase 1 decommissioning activities is to remove certain facilities and remediate specific portions of the WVDP premises to criteria for unrestricted release consistent with the License Termination Rule in 10 CFR 20.1402 in a manner that will not limit future Phase 2 decommissioning options. The Phase 1 DP activities are intended to reduce short- and long-term health and safety (H&S) risks in a manner that will ultimately support the Phase 2 decommissioning activities required to complete decontamination and decommissioning of the project premises.

To support Phase 1 decommissioning activities, environmental sampling data will be collected for four main purposes. These include (but are not limited to) the following:

- providing data necessary to properly design and implement Phase 1 decommissioning activities intended to address environmental contamination,
- supporting remediation activities while they are underway,
- documenting the post-Phase 1 remediation contamination status of selected areas, and
- providing data necessary for Phase 2 decision-making.

This Phase 1 Characterization Sampling and Analysis Plan (CSAP) provides the basis for this data collection.

The CSAP scope includes environmental media data collection (surface and subsurface soils, sediment and groundwater) to support Phase 1 decommissioning activities. Waste stream characterization data collection during the course of remediation and structure/building characterization is outside the scope of the CSAP; data collection efforts in support of those two activities will be described in separate plans.

However, CSAP pre-remediation data collection will provide information pertinent to waste stream characterization needs.

In addition, the CSAP is focused on radiological parameters of interest. Chemical analyses are also outside the scope of the CSAP. Any chemical analyses required to support *Resource Conservation and Recovery Act* (RCRA) decision-making will be described in separate documentation. Finally, the CSAP does not address Final Status Survey (FSS) data collection requirements. FSS requirements are described in the Phase 1 Final Status Survey Plan (December 2009) for the WVDP.

The contents of this plan supplement and expand upon information contained in the Phase 1 DP. All CSAP field activities conducted will be conducted consistent with the Health and Safety Plan (HASP) described by the Phase 1 DP. Some areas within the WVDP premises have been identified as radiological controlled areas; CSAP work within those areas will comply with pertinent radiologically-controlled area requirements.

Section 9.4.2 of the Phase 1 DP describes EPA's Data Quality Objective (DQO) process (EPA 2006), which is a seven-step process for developing technically defensible data collection programs. These seven steps include: 1) identifying the problem, 2) specifying the decision, 3) determining the potential inputs to the decision, 4) defining the study boundaries, 5) developing decision rules, 6) establishing limits on decision errors, and 7) optimizing the final design. The CSAP does not follow the exact organization of the DQO process, but does address each of the steps. The CSAP introduction states the problem to be addressed: satisfying the data needs of the Phase 1 DP process. Section 2.0 provides the specific decisions/objectives/questions that must be answered by CSAP data collection. Inputs to those questions, study boundaries, decision rules and acceptable errors, and the final data collection designs can be found in Sections 5.0, 6.0, and 7.0, with additional WMA-specific detail for pre-remediation data collection provided in the appendices.

2.0 OBJECTIVES AND OVERVIEW

Section 1.0 identified the following four main CSAP data collection purposes, 1) pre-design data collection, 2) remedial support, 3) post-remediation status documentation, and 4) Phase 2 decision-making support. Data collection to support these four main purposes is organized into two distinct data collection efforts. The first is pre-remediation data collection that will take place prior to the initiation of significant Phase 1 decommissioning activities (e.g., the Waste Management Area [WMA] 1 and WMA 2 excavations). The second is remediation support data collection that will occur during and immediately after environmental remediation in support of remediation activities. Both data collection efforts have a set of well-defined objectives, described in more detail below, that encompass the data needs of the four main CSAP data collection purposes.

2.1 Pre-Remediation Data Collection Objectives

1. Evaluate Appropriateness of the Current List of ROI. The Phase 1 DP contains a master list of 18 ROI for the WVDP premises. This list may not be applicable to all areas of the WVDP premises. Data collection is required to identify area-specific subsets of this list that would need to be addressed by any future area-specific sampling activities (e.g., FSS). These data would be used to ensure that appropriate analytical procedures are employed for specific areas during any follow-on data collection activities. One possible outcome is that the master ROI list is reduced for specific areas (i.e., one or more of the 18 ROI are either not found in the soils/sediments, or are found at such low level activity concentrations that they are inconsequential for Phase 1 decision-making).

2. Verify Absence of Additional ROI. An additional 12 potential ROI have been tentatively identified based on screening analyses described in the 1996 Draft Environmental Impact Statement (DEIS) (DOE 1996). Data collection is required to verify that these 12 potential ROI are not of any significant decision-making concern. These data would be used to determine if the current ROI list contained in the Phase 1 DP should be expanded.

3. Explore the Possibility of Surrogate ROI. There is a question as to whether ROI ratios are consistent enough to allow for the use of surrogates in future data collection efforts (e.g., remedial support and FSS). Data collection is required to determine area-specific radionuclide ratios and

determine their consistency. These data would be used to support the use of surrogates, if the results indicate this is appropriate.

4. Establish Background Data Sets. The Phase 1 DP calls for background surveys to be performed to establish surface soil background conditions in known non-impacted areas. Background survey data are necessary for interpreting gross activity scan results, and may be useful for FSS analysis depending on the type of statistical test used to establish compliance with wide-area DCGL ($DCGL_w$) requirements. Surface soil background data collection will take place from an appropriate area near or within the WVDP premises, possibly an area that has been used to collect previous background data for the WVDP premises.

5. Determine Extent of Surface Soil Contamination. The lateral and vertical extent of surface soil contamination present at activity concentrations that would require an action based on the ROI list and associated surface DCGLs contained in the Phase 1 DP is unknown. Data collection is required to determine the extent of contamination. These data would become the basis for potential excavation footprints (discretionary in Phase 1) and volume estimates that can be used for programmatic planning purposes (i.e., costing, identifying appropriate disposal options, and appropriate material handling needs, etc.), and for FSS design and support in those areas where remediation will, ultimately, be unnecessary.

6. Identify the Presence/Absence of Buried Soil Contamination. The presence/absence and vertical depth (where present) of soil contamination in areas outside the planned WMA 1 and WMA 2 excavations is unknown. Data collection is required to determine presence and extent of contamination outside the planned WMA 1 and WMA 2 excavations. These data may be used to adjust DCGL derivations contained in the Phase 1 DP for subsurface soils and would be used to identify areas suitable for Phase 1 FSS data collection (i.e., areas where surface contamination appears to meet DCLG requirements and subsurface contamination is absent). These data would also be used to determine if thin layers of highly elevated contamination are present in the top 1-m profile that would pose dose concerns if exposed but that may not be identified by FSS protocols or to determine if localized hot spots exist in the subsurface. Additionally, these data would be used to assist with volume estimation and contaminant footprint delineation for programmatic planning purposes and for FSS design purposes, as appropriate.

7. Determine Level and Extent of Sediment Contamination. The level and vertical/lateral distribution of contamination in Erdman Brook and Franks Creek sediments with the WVDP premises are not known. Data collection is required to determine the activity concentrations and vertical/lateral distribution of contamination in stream sediments and in and along the adjacent banks. These data may be used to adjust DCGL derivations contained in the Phase 1 DP for sediments, and would be used to assist with volume estimation and contaminant footprint delineation for programmatic purposes, and for FSS design purposes, as appropriate.

8. Define Required Extent of WMA 1 and 2 Excavations. The nature and extent of subsurface contamination in the area of the planned boundaries of the WMA 1 and WMA 2 excavations is not well defined. The minimum excavation footprints are defined by the need to remove subsurface foundations and infrastructure and contaminated soils down into the Lavery Till interface. The volume of soil to be excavated to meet these minimum excavation requirements is reasonably well known. However, it is particularly important to confirm that there is no significant subsurface contamination on the up-gradient and the southern cross-gradient sides of the WMA 1 excavation. If this contamination is present, it may pose recontamination concerns for the clean backfill used in the WMA 1 excavation after the sheet pile wall impermeable barriers are removed. Data collection is required to determine the presence and level of contamination that might be encountered along the planned boundaries of the WMA 1 and WMA 2 excavations.

9. Identify Soil Waste Stream Characteristics. The characteristics of soil waste streams that will be generated by Phase 1 excavation activities are unknown. Pre-remediation data collection is required to determine the radiological waste profile characteristics of soils from these different waste streams that will be disposed of at an off-site disposal facility. These data would be used to assist with programmatic planning purposes and to support the evaluation of potential H&S concerns. Note that remedial support waste stream characterization activities are outside the scope of the CSAP.

10. Verify Contamination Status of Soils to be Affected by Phase 1 Construction Needs. The current contamination status of soils that will be affected by on-site construction activities needs to be determined. Data collection is required to establish the contamination status of surface soils in areas to be used to support Phase 1 decommissioning activities prior to the initiation of those activities. An example is the area where the new Canister Interim Storage Facility will be

constructed. The purpose of this data collection is to determine contamination status and support corrective action decision-making that might be desirable prior to facility construction/soil re-working.

11. Establish Site-Specific Performance for On-Site and Field-Based Analytical Methods. The site-specific performance of field screening and field deployable analytical methods has not been established for the WVDP premises. The Phase 1 decommissioning process for the WVDP will be a lengthy and expensive program. Field screening and field deployable analytical methods (e.g., trailer-based) have the potential for stream-lining characterization, remediation, waste disposal, and FSS activities. Examples of these are scanning methods (and associated detection limits) for Cs-137, and on-site analytical methods for Cs-137 and Sr-90. CSAP activities will provide an opportunity to demonstrate and optimize performance of field screening and on-site analytical methods for the benefit of future WVDP work. Data are required that can be used for characterization technology performance and long-term deployment purposes.

12. Develop an Inventory of Buried Infrastructure. The WVDP premises are assumed to have a significant amount of buried infrastructure associated with the various WVDP buildings and their historical activities. This infrastructure is important from the perspective of identifying the potential for buried contamination and for the design and implementation of safe characterization and remediation activities. The current understanding of buried infrastructure (location, footprint, original purpose, and contamination status) is incomplete. Data collection is required to develop, as practicable, a complete understanding of the location and footprint of buried infrastructure across the WVDP premises.

13. Obtain Data to Support Phase 2 Planning. A variety of Phase 2 alternatives are under consideration. The WVDP will require data to support the technical evaluation of these options.

14. Determine Groundwater Flow Data Necessary for WMA 1 and WMA 2 Barrier Wall Designs. The design of the barrier walls for WMA 1 and 2 will require area-specific subsurface information to support the groundwater modeling necessary for the design of these walls. Similar data sets are currently being obtained to support the design and installation of the Permeable Treatment Wall; if these data are considered insufficient for the WMA 1 and WMA 2 barrier wall design, then additional subsurface data will be collected from these areas.

15. Obtain Geotechnical Data Required for Barrier Wall Design. Geotechnical data for soils along the planned footprints of the WMA 1 and WMA 2 barrier walls will be required to support the design of these walls and to determine if the planned locations are appropriate.

16. Address Area-Specific Data Gaps. Several of the WMAs have very specific data gaps that need to be addressed by data collection. Examples of these include:

    - Residual contamination levels in lagoon sediments (WMA 2).
    - Residual contamination within the solvent dike and adjacent to the interceptor area and neutralization pit (WMA 2).
    - Nature and extent of surface and subsurface contamination associated with the old sewage treatment drainage (WMA 6).
    - Contamination status of various gullies and seeps that feed Erdman Brook and Franks Creek (WMA 2, WMA 4, WMA 5, WMA 6, WMA 9, WMA 10 and WMA 12).

2.2 Remediation Support Data Collection Objectives

1. WMA 1 and WMA 2 Excavation Support. As part of the WMA 1 and WMA 2 excavations, remediation support data will be collected as the excavations near completion. This will include data collection activities in WMA 1 that specifically target foundation pilings. The contamination status of foundation pilings extending into the Lavery Till is unknown. Data will be collected as WMA 1 excavation work proceeds and the pilings become accessible. In particular, data will be collected to determine whether the pilings have potentially provided vertical preferential groundwater flow paths for contamination to enter the Lavery Till.

2. High Level Waste (HLW) Transfer Trench Contamination Status. Data will be collected to establish the radiological status of the inside of the empty HLW Transfer Trench (WMA 3) post-removal of the transfer lines.

3. Removed Infrastructure Footprints Contamination Status. In many cases, the Phase 1 decommissioning activities will remove infrastructure (including pads and foundations) and thereby expose soils. Where the exposed soils meet DCGL requirements and contamination is not present in underlying soils, FSS data collection may take place. Alternatively, data may be

collected to simply establish the contamination status of the exposed soils when Phase 1 activities are complete for use in determining what additional action may be required in Phase 2.

4. Excavation Efficacy. Where significant removal of soil is required (e.g., WMA 1 and WMA 2) or where contaminated soil is removed outside of the WMA 1 and WMA 2 deep excavations as part of other activities (e.g., hardstand removals), data will be collected to guide soil removal, to support soil segregation for waste disposal purposes, and/or to verify that the remediation goals for that particular location or area have been achieved. When appropriate, these data will be collected consistent with the requirements of the Phase 1 FSSP to assist in demonstrating compliance with relevant DCGL standards.

2.3 CSAP Overview

For planning purposes, the WVDP premises have been divided into WMAs as described in the Phase 1 DP. There are 12 WMAs, numbered 1 through 12. Of these, all will potentially be included in CSAP data collection efforts with the exception of WMA 8 and WMA 11. WMA 8 includes the State-Licensed Disposal Area (SDA), which is not part of the WVDP. WMA 11 includes properties separate from the primary WVDP premises that are not within the scope of Phase 1 DP activities. Figure 1 shows the location of each WMA. Additional descriptive detail is provided below.

- **WMA 1** – WMA 1 is approximately 4.4 acres in size. WMA 1 contains the bulk of the WVDP's facilities, including the Process Building, the Vitrification Building, and supporting facilities. A large, deep excavation is planned for WMA 1 as part of Phase 1 DP activities. The excavation will remove contaminated facilities and address subsurface contamination that is a source for the north plateau groundwater plume, as described in Section 7.3 of the Phase 1 DP.

- **WMA 2** – WMA 2 is approximately 14 acres in size. WMA 2 contains low-level radioactive waste water management facilities, including various lagoons. A large, deep excavation is planned for WMA 2 as part of Phase 1 DP activities. The excavation will remove contaminated waste water management facilities, Lagoons 1, 2 and 3, and associated subsurface soil contamination, as described in Section 7.4 of the Phase 1 DP.

- **WMA 3** – WMA 3 is approximately 2.3 acres in size. WMA 3 contains the HLW tank facilities. Only very limited contaminated facility removal is planned for WMA 3 as part of Phase 1 DP activities; the HLW tanks will remain in place, as described in Section 7.5 of the Phase 1 DP.

- **WMA 4** – WMA 4 is approximately 10 acres in size. WMA 4 contains the Construction and Demolition Debris Landfill (CDDL). There currently are no planned Phase 1 DP activities within WMA 4.

- **WMA 5** – WMA 5 is approximately 19 acres in size. WMA 5 includes a variety of waste processing and storage facilities. Removal of facilities, facility pads, and hardstands are planned for WMA 5 as part of Phase 1 DP activities, as described in Section 7.6 of the Phase 1 DP.

- **WMA 6** – WMA 6 is approximately 14.5 acres in size. WMA 6 contains a variety of support facilities. Removal of facilities, facility pads, and hardstands is planned for WMA 6 as part of Phase 1 DP activities, , as described in Section 7.7 of the Phase 1 DP.

- **WMA 7** – WMA 7 is approximately 8 acres in size. WMA 7 contains the Nuclear Regulatory Commission (NRC)-Licensed Disposal Area (NDA). Removal of a hardstand is the only activity planned for WMA 7 as part of Phase 1 DP activities, , as described in Section 7.8 of the Phase 1 DP.

- **WMA 8** – WMA 8 contains the SDA, which is not within the scope of the WVDP.

- **WMA 9** – WMA 9 is approximately 12 acres in size. WMA 9 contains the Drum Cell. The Drum Cell and several hardstands will be removed from WMA 9 as part of Phase 1 DP activities, as described in Section 7.9 of the Phase 1 DP.

- **WMA 10** – WMA 10 is approximately 30 acres in size. WMA 10 includes several support facilities and parking lots. The removal of some of the facilities, facility pads, hardstands, and parking lots are planned for WMA 10 as part of Phase 1 DP activities, as described in Section 7.10 of the Phase 1 DP.

- **WMA 11** – WMA 11 includes the Bulk Storage Warehouse and Hydrofracture Test Well Area. These facilities/areas are physically separated from the primary WVDP premises. WMA 11 is not within the scope of the Phase 1 DP.

- **WMA 12** – WMA 12 includes all other WVDP areas. As indicated in Figure 1, there are two separate portions of the primary WVDP premises that fall within WMA 12. Currently, there are no Phase 1 DP activities planned for WMA 12.

Figure 1 WVDP Waste Management Areas

The main body of the CSAP provides general information regarding the types of data collection and data collection strategies that will be implemented in support of Phase 1 DP activities. Pre-remediation WMA-specific data collection details are contained in CSAP appendices, with an appendix dedicated to each WMA that is within the WVDP premises. Each appendix also provides further details about the WMA that it addresses, including information about known and suspected contamination releases.

The Phase 1 DP presented 18 ROI and developed DCGLs for each radionuclide appropriate for surface soils, sediments, and deep subsurface soils. The surface soil standards are only applicable in those areas where contamination impacts are limited to the top one meter (m) of soil. The sediment standards are only applicable to specific portions of Erdman Brook and Franks Creek as described in Section 5.1.2 in the Phase 1 DP. The subsurface soil standards are only applicable to the final exposed excavation surfaces that are deeper than one m and are associated with the WMA 1 and WMA 2 excavations as discussed in Section 5.2.5 in the Phase 1 DP. The DCGL standards were further refined by the Phase 1 DP to account for cumulative dose scenarios; the Phase 1 DP refers to the final set of standards as cleanup goals (CG).

Since there are multiple radionuclides, CGs are implemented using a Sum of Ratios (SOR) calculation. The SOR value for a sample is computed as the sum of the radionuclide-specific activity concentrations, with each divided by its respective CG value (the cleanup goal, wide [CG_w] for SOR values pertinent to the CG_w, or the CG_{emc} for SOR values pertinent to the CG_{emc}). Because CG values are incremental to background, for CSAP purposes the average background activity concentration will be subtracted from each radionuclide's result before calculating the sample SOR. SOR calculations address the situation where a sample might have all radionuclides below their CG value, but at a significant fraction of their CG values; the cumulative dose in this instance could exceed the required dose limits. This would be reflected by an SOR value greater than one.

Table 1 reproduces the Phase 1 DP CG values contained in Table 5-14 of that document. These values are incremental to background. For the balance of this document, cleanup requirements will be referred to as CG requirements.

Table 1: Phase 1 Cleanup Goals (picoCurie/gram [pCi/g])
(source: WVDP Phase 1 Decommissioning Plan, Revision 2, Table 5-14)

Nuclide	Surface Soil		Subsurface Soil		Streambed Sediment	
	CG^1_w	CG^2_{emc}	CG_w	CG_{emc}	CG_w	CG_{emc}
Am-241	2.6E+01	3.9E+03	2.8E+03	1.2E+04	1.0E+03	2.1E+04
C-14	1.5E+01	1.6E+06	4.5E+02	8.0E+04	1.8E+02	5.9E+05
Cm-243	3.1E+01	7.5E+02	5.0E+02	4.0E+03	3.1E+02	2.8E+03
Cm-244	5.8E+01	1.2E+04	9.9E+03	4.5E+04	3.8E+03	3.6E+05
Cs-137	1.4E+01	3.0E+02	1.4E+02	1.7E+03	1.0E+02	9.4E+02
I-129	2.9E-01	6.0E+02	3.4E+00	3.4E+02	7.9E+01	2.0E+04
Np-237	2.3E-01	7.5E+01	4.5E-01	4.3E+01	3.2E+01	1.1E+03
Pu-238	3.6E+01	7.6E+03	5.9E+03	2.8E+04	1.2E+03	1.7E+05
Pu-239	2.3E+01	6.9E+03	1.4E+03	2.6E+04	1.2E+03	1.7E+05
Pu-240	2.4E+01	6.9E+03	1.5E+03	2.6E+04	1.2E+03	1.7E+05
Pu-241	1.0E+03	1.3E+05	1.1E+05	6.8E+05	3.4E+04	7.5E+05
Sr-90	3.7E+00	7.9E+03	1.3E+02	7.3E+03	4.7E+02	7.1E+04
Tc-99	1.9E+01	2.6E+04	2.7E+02	1.5E+04	6.6E+04	4.2E+06
U-232	1.4E+00	5.9E+01	3.3E+01	4.2E+02	2.2E+01	2.1E+02
U-233	7.5E+00	8.0E+03	8.6E+01	9.4E+03	2.2E+03	4.4E+04
U-234	7.6E+00	1.6E+04	9.0E+01	9.4E+03	2.2E+03	2.1E+05
U-235	3.1E+00	6.1E+02	9.5E+01	3.3E+03	2.3E+02	2.0E+03
U-238	8.9E+00	2.9E+03	9.5E+01	9.9E+03	8.2E+02	8.2E+03

Notes:

[1]CG_w refers to activity concentrations that must be achieved, on average, over areas the size of FSS units.

[2]CG_{emc} refers to activity concentrations that must be achieved, on average, over one m^2 areas.

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3.0 ORGANIZATION, RESPONSIBILITIES, AND DOCUMENTATION

3.1 Organization

CSAP activities will be managed in accordance with Department of Energy (DOE) requirements. Necessary data collection tasks will be defined and scheduled. Appropriate schedules will be developed for this purpose, such as a long-term schedule, short-term schedules, and plans-of-the-week. NRC will be provided copies of these schedules for information. Implementing plans will be prepared as necessary in support of the work.

3.2 Responsibilities

DOE will employ a characterization contractor to accomplish the planned Phase 1 data collection activities, including those contained in this plan as well as those specified by the FSSP. The characterization contractor will be responsible for developing and implementing task-specific work plans that are consistent with the CSAP and the preparation of data packages and summary reports as deliverables for completed tasks. DOE will provide task-specific work plans and resulting data packages and reports to the NRC as work progresses. DOE and/or its contractors will maintain an administrative record of characterization activities, including electronic and hardcopy documents, data sets, and related information such as maps, diagrams, geologic logs, field notebooks, and photographs.

3.3 Documentation

Prior to the initiation of Phase 1 CSAP activities, the characterization contractor will develop a HASP and Quality Assurance Project Plan (QAPP) applicable to the proposed Phase 1 CSAP work.

Field data collection activities will be initiated through the use of DOE-issued task orders. These task orders may be area specific (e.g., implement pre-remediation data collection necessary for WMA 10) or goal specific (e.g., complete buried infrastructure inventory for the WVDP premises). In either case, any task order requiring field data collection will be accompanied by a field sampling plan (FSP). Field sampling plans will provide details about methods, technologies, and protocols to be used, referencing standard operating procedures (SOPs) as appropriate.

Radiological work permits will be prepared as necessary and approved by the Radiological Control Manager or his or her designee in accordance with applicable DOE procedures. Persons working in areas covered by radiological work permits will be briefed before starting work in accordance with DOE procedures. Training of project personnel will be commensurate with their experience, their responsibilities and the potential hazards to which they could be exposed. Records will be maintained showing the employee's name, training date, type of training received and other relevant information. Training requirements will be consistent with those identified in Section 8.3 of the Phase 1 DP.

4.0 HISTORICAL AERIAL PHOTOGRAPHY ANALYSIS

A comprehensive historical aerial photography analysis has been completed by the U.S. Army Geospatial Center (AGC) (October 2009). As part of this review, the AGC obtained and reviewed historical aerial photographs of the WVDP premises from 1962 to 2007. The AGC report provides a summary of their analyses and conclusions. The aerial photographs that were obtained and geo-referenced by the AGC were used to assist in developing the WMA-specific data collection requirements. In particular, historical aerial photographs were used in the development of this CSAP to identify areas of historic concern from the perspective of environmental contamination release and transport. The WMA-specific aerial photography reviews and conclusions are described in greater detail in the CSAP appendices that contain WMA-specific data collection recommendations.

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5.0 BURIED INFRASTRUCTURE INVENTORY

The current site contractor, West Valley Environmental Services (WVES), along with its supporting contractors, maintains a partial inventory of buried infrastructure in tabular, hardcopy, and electronic AutoCad formats. This inventory is primarily intended to support safe dig/maintenance activities at the WVDP. The quality of the existing inventory ranges from "excellent" for specific locations where recent activities have required a detailed knowledge of buried infrastructure footprints, to "poor" for areas where there has not been a need for this information.

Understanding where buried infrastructure exists, its original purpose, and the contamination status of adjacent subsurface soils is important to the success of Phase 1 decommissioning activities and a necessary input for Phase 2 decision-making. As part of the Phase 1 decommissioning process, facilities will be removed and contaminated soils will be excavated and shipped to an off-site disposal facility. In some cases, these soil excavations will cover several acres, extend to significant depths, and intersect buried infrastructure. In addition, there will be intrusive subsurface sampling in the vicinity of WVDP facilities, as specified in the WMA-specific appendices to this CSAP. Buried infrastructure affects this characterization work from the perspective of safety and also because, in some cases, contamination is expected to be associated with buried infrastructure due to leaks, preferential flow, or the use of contaminated surface soils as backfill when buried infrastructure was installed.

One of the CSAP objectives is to develop a complete electronic inventory (including an integrated electronic map) of buried infrastructure at the WVDP. This inventory will be used to support Phase 1 subsurface characterization activities on the WVDP premises and Phase 2 decision-making. The products of buried infrastructure inventory activities will include the following: (1) an inventory (in a spreadsheet or database format) identifying the buried infrastructure, its purpose, date of installation, depth, whether it is active or abandoned, and the quality of location information; (2) an accompanying report that summarizes the inventory work and identifies remaining data gaps; and (3) an electronic map in both AutoCad and ArcGIS format (either shape file or geodatabase, with coordinates in State Plane feet, New York NAD 1983) that depicts the footprints of buried infrastructure that have been identified and cataloged by the buried infrastructure inventory activities. Each record in the inventory will have a unique identifier linked to electronic map features.

As part of buried infrastructure inventory activities, the CSAP contractor will review, organize, integrate, and complete (as necessary) buried infrastructure records maintained by the current site contractor. The CSAP contractor will work closely with the current site contractor to gain access to the necessary drawings (hardcopy and electronic) and the facility itself. At the conclusion of this activity, the CSAP contractor will have developed a buried infrastructure inventory and corresponding maps to the extent currently available information allows, and will have determined the data gaps that exist in the inventory regarding the presence, location, and depth of buried infrastructure.

The CSAP contractor will identify additional primary data collection activities to resolve the data gaps in the inventory, as deemed practicable. These activities may include (but are not limited to) traces of buried lines and non-intrusive geophysical surveys, as appropriate. All field work involving the determination of buried infrastructure footprints will include civil survey control consistent with accepted industry standards for this type of work.

DOE or its contractors will maintain the buried infrastructure inventory over the life span of Phase 1 and any Phase 2 activities, updating the inventory as new infrastructure is installed, existing infrastructure is removed (by maintenance or remediation activities), or new data become available about the existence, location, and/or contamination status of buried infrastructure. An example of the latter would occur as CSAP intrusive data collection and Phase 1 remediation activities proceed and buried infrastructure is encountered and documented.

6.0 PRE-REMEDIATION DATA COLLECTION

Phase 1 pre-remediation data collection within each of the WMAs will address the CSAP objectives presented in Section 2.1. Not all of those objectives are pertinent to all WMAs. In addition, certain WMAs have very specific characterization data requirements. For example, geotechnical information is required for soils within WMA 1 and WMA 2 to support the design of the barrier walls required for those excavations.

There has been historical environmental data collection conducted to characterize the nature and extent of contamination impacts. In addition, routine environmental compliance monitoring data are collected on a regular basis. The Phase 1 DP provides a general description of historical radiological data collection activities in Section 4.2. The CSAP appendices describe historical data results pertinent to the radiological contamination status of their specific WMAs. Pre-remediation data collection as described in general by the following section and in more detail in the appendices is intended to fill data gaps present in historical data.

The following subsections describe the overall sampling strategies that will be used to address the pre-remediation CSAP objectives contained in Section 2.1. WMA-specific details about the implementation of these strategies and the resulting pre-remediation data collection requirements can be found in the CSAP appendices.

6.1 Evaluate Appropriateness of the Current List of Radionuclides of Interest (ROI)

The Phase 1 DP identified 18 ROI (Table 1) based on a review of historical activities on the WVDP premises. To date, there are no soil samples within the WVDP Electronic Laboratory Information Management System (ELIMS) database that have results for all 18 ROI.

There are 13 subsurface soil samples (all collected in 1998) from three locations that were analyzed for all ROI except the uranium isotopes. Figure 2 shows the locations of these samples; all of the samples were collected from the area potentially impacted by the 1968 subsurface contamination release beneath the Process Building, immediately down-gradient from the release point. Table 2 provides the radionuclide results of these samples. The Sr-90 impacts were observable in all samples and ranged up to 4,230 pCi/g. Eight of the thirteen samples exceeded the subsurface CG_w for Sr-90. In contrast, none of the other ROI exceeded their subsurface CG_w. For the other 17 ROI, only one sample had an ROI activity concentration that was close to its CG_w. The ROI was I-129 with an activity concentration that was 44% of its CG_w; however, the Sr-90 activity concentration for that same sample was more than an order of magnitude higher than its CG_w. On the basis of this very limited data set, (i.e., samples from one specific location fairly proximal to the original Process Building subsurface release point) the subsurface SOR calculation is dominated by Sr-90.

In contrast, there were 27 soil samples explicitly identified in ELIMS as surface samples with both Cs-137 and Sr-90 results. Figure 3 shows the locations of these samples, color-coded by their respective CG_w SOR values, using only Cs-137 and Sr-90 results as the basis for the SOR calculation. Figure 4 shows the samples with SOR values greater than 0.1. In Figure 4, locations are color-coded by whether Cs-137 or Sr-90 dominated the SOR calculation.

These limited data suggest the following: 1) Cs-137 and Sr-90 are likely the radionuclides that will dominate SOR values in areas of contamination, and 2) which of these two isotopes is more significant will vary from location to location, presumably because of different contaminant release histories and the differing environmental transport characteristics between these two radionuclides.

CSAP data collection will be used to determine the set of radionuclides that are of concern for each WMA. Each of the WMAs will have samples that are collected and analyzed for all 18 ROI. These samples will be selected to ensure proper coverage of soil/sediment types and potential contaminant release scenarios that may be present within a specific WMA. Sample results from each WMA will be reviewed to determine the contribution of each radionuclide to the SOR values. ROIs that will be carried forward into the remedial design and the Phase 1 FSS process for a specific WMA will be radionuclides that either contribute more than 10% to the SOR value when an SOR values exceeds unity or are present at levels above their CG_w value. At a minimum, the set of WMA-specific radionuclides will always contain Cs-137 and Sr-90.

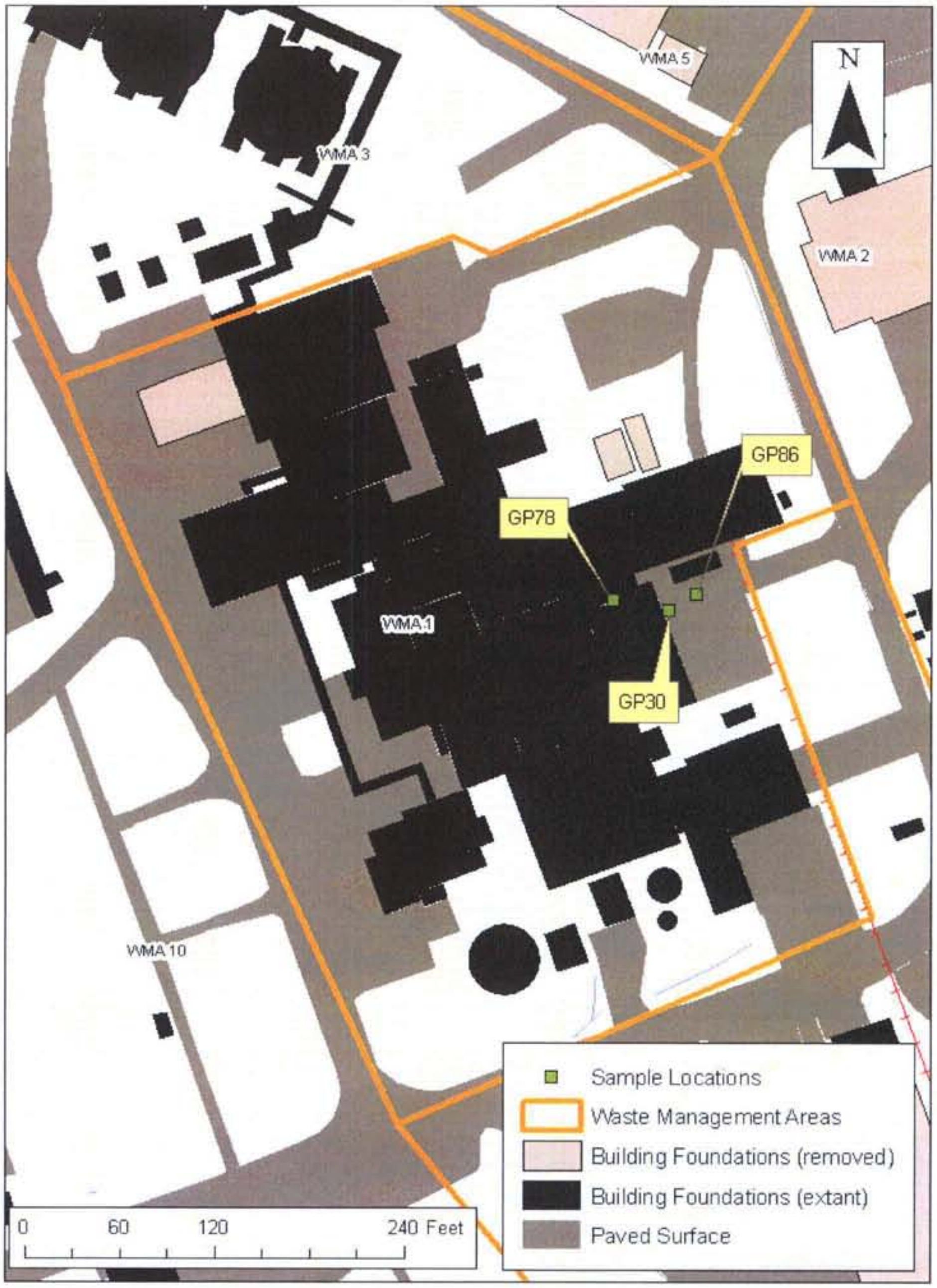

Figure 2 Locations of Subsurface Samples with ROI Results (Except Uranium Isotopes)

Table 2: ROI Sample Results from Three Locations (pCi/g)

Location	GP86	GP86	GP86	GP86	GP78	GP78	GP78	GP78	GP30	GP30	GP30	GP30	GP30
From (ft)	20	24	30	34	21	23	29	33	20	22	22	30	36
To (ft)	22	26	32	36	23	25	31	35	22	24	24	32	36.5
Units	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Am-241	0.016 (J)	0.015 (J)	0.015 (J)	0.005 (UJ)	0.015 (J)	0.037 (J)	0.017 (J)	0.000 (UJ)	0.018 (J)	0.009 (UJ)	0.008 (UJ)	-0.010 (UJ)	-0.002 (UJ)
C-14	-0.040 (UJ)	-0.085 (UJ)	-0.105 (UJ)	-0.077 (UJ)	0.042 (UJ)	0.047 (UJ)	-0.121 (UJ)	-0.072 (UJ)	-0.068 (UJ)	-0.007 (UJ)	-0.038 (UJ)	-0.057 (UJ)	-0.061 (UJ)
Cm-243/244	0.012 (UJ)	0.009 (J)	0.009 (UJ)	0.003 (UJ)	0.003 (UJ)	0.015 (J)	0.009 (UJ)	0.004 (UJ)	0.008 (J)	0.002 (UJ)	0.011 (U)	-0.007 (UJ)	0.010 (J)
Cs-137	0.107	0.014 (UJ)	0.037 (UJ)	0.015 (UJ)	0.050 (J)	0.024 (UJ)	0.038 (UJ)	-0.010 (UJ)	0.002 (UJ)	0.040 (UJ)	0.032 (UJ)	-0.003 (UJ)	-0.007 (UJ)
I-129	0.591 (UJ)	-2.100 (UJ)	0.417 (UJ)	-0.424 (UJ)	-0.130 (UJ)	-0.792 (UJ)	0.450 (UJ)	0.076 (UJ)	0.982 (UJ)	-1.270 (UJ)	1.490 (UJ)	0.927 (UJ)	0.014 (UJ)
Np-237	0.002 (UJ)	0.033 (J)	0.009 (UJ)	-0.007 (UJ)	-0.002 (UJ)	0.003 (UJ)	0.007 (UJ)	0.013 (UJ)	0.028 (J)	0.001 (UJ)	0.018 (UJ)	-0.003 (UJ)	0.004 (UJ)
Pu-238	0.012 (UJ)	0.009 (UJ)	0.002 (UJ)	0.011 (UJ)	-0.001 (UJ)	0.004 (UJ)	0.005 (UJ)	0.003 (UJ)	0.019 (J)	0.004 (UJ)	0.005 (UJ)	-0.004 (UJ)	0.007 (UJ)
Pu-239/240	0.014 (J)	0.010 (UJ)	0.005 (UJ)	0.009 (UJ)	0.007 (UJ)	0.006 (UJ)	0.005 (UJ)	0.003 (UJ)	0.016 (J)	0.002 (UJ)	0.005 (UJ)	0.004 (UJ)	-0.004 (UJ)
Pu-241	0.819 (UJ)	0.171 (UJ)	-0.676 (UJ)	1.020 (UJ)	-1.250 (UJ)	-0.525 (UJ)	0.577 (UJ)	-1.580 (UJ)	-0.155 (UJ)	-0.792 (UJ)	0.188 (UJ)	-4.570 (J)	-0.077 (UJ)
Sr-90	4,230	3,100	2,910	736	1.03	2.98	10.30	5.63	2,840	1,020	3,080	787	2.22
Tc-99	-0.498 (UJ)	-0.218 (UJ)	-0.568 (UJ)	-0.611 (UJ)	0.074 (UJ)	-0.005 (UJ)	-0.468 (UJ)	-0.542 (UJ)	-0.239 (UJ)	-0.245 (UJ)	-0.427 (UJ)	-0.474 (UJ)	-0.634 (UJ)
U-232	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
U-233	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
U-234	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
U-235	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
U-238	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

NA – not available

U – below detection limits

J – estimated value

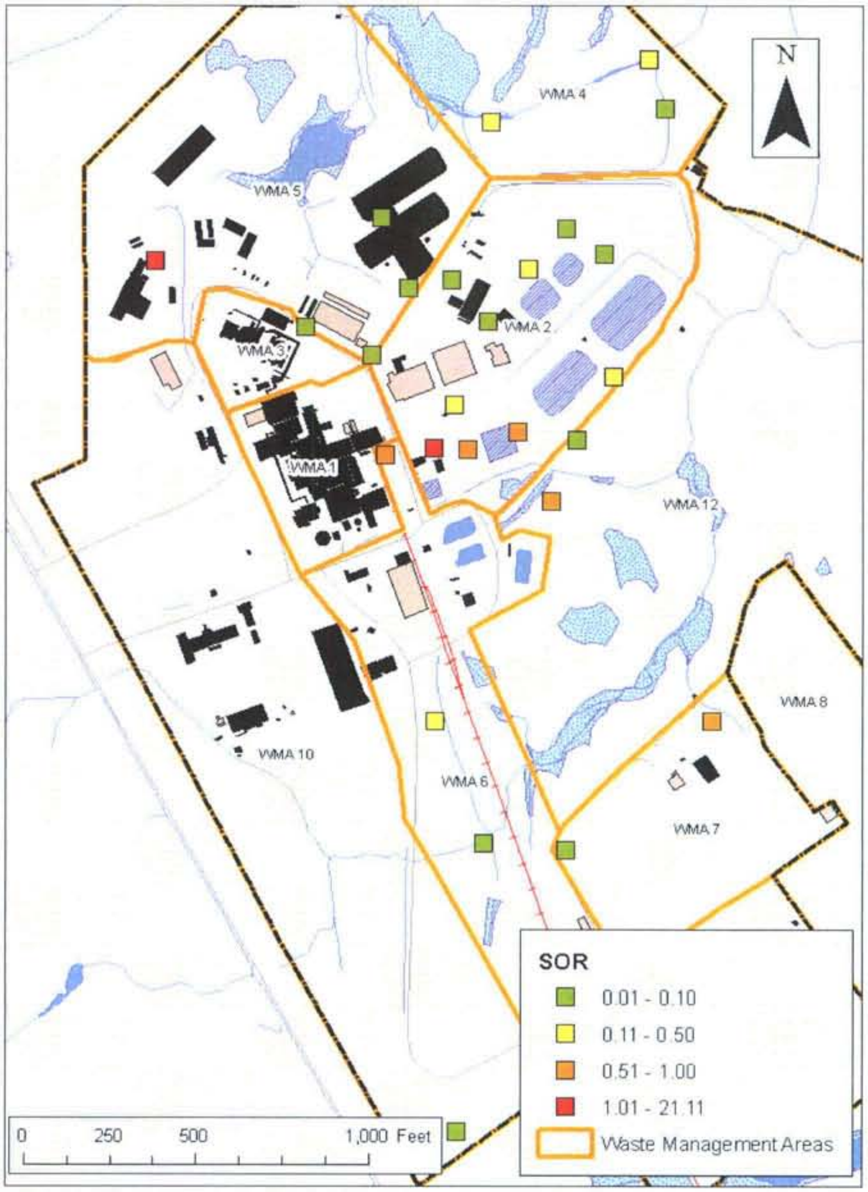

Figure 3 Surface Soil Samples with Both Cs-137 and Sr-90 Results

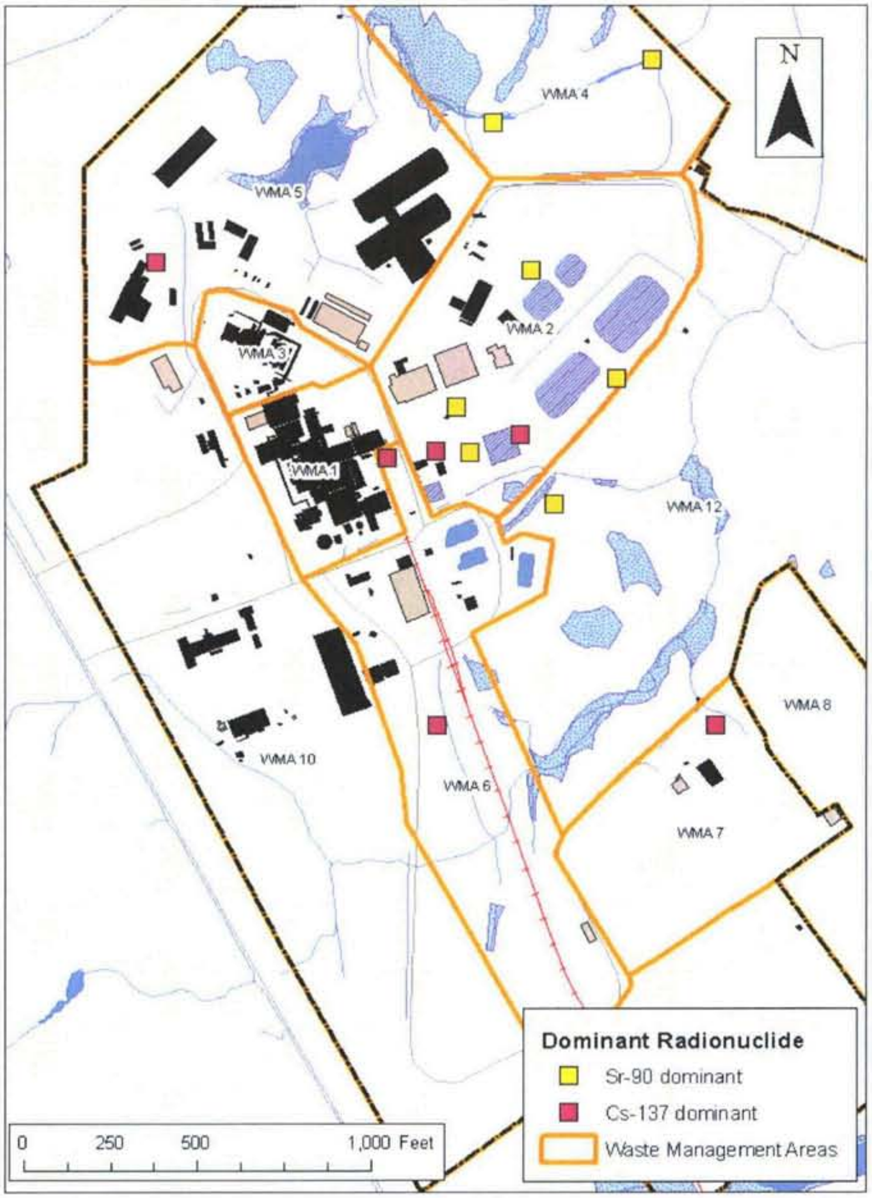

Figure 4 Surface Soil Samples with SOR > 0.1

6.2 Verify Absence of Additional ROI

In addition to the 18 ROI contained in the Phase 1 DP, another 12 radionuclides have been identified as potentially being of interest; these 12 radionuclides are listed in Table 6. The identification process relied on historical process knowledge; to date none of these 12 has been observed in historical samples at levels that would be of dose concern and the belief is that it is unlikely that any of these 12 exist at significant levels in environmental media. Several of the 12 have short half lives relative to the history of WVDP/Nuclear Fuel Services, Inc. (NFS) activities; others would have had very low abundance within the spent fuel that would have been processed at the site as compared to Cs-137 and Sr-90.

CSAP data collection will provide supporting data to determine whether any of these 12 radionuclides should be of interest. A subset of CSAP samples will be analyzed for these additional 12 radionuclides. This subset will focus on samples from WMAs and settings where they would most likely be encountered, if environmental releases at detectable levels had occurred. The WMAs of primary interest include WMA 1, 2, 3, 5, 6, 7, and 9. Example settings of particular interest include elevated areas identified by gross gamma scans that might be indicative of discrete releases, buried infrastructure where associated soil contamination is likely present, areas of known environmental releases, etc.

When soil samples are collected, sufficient soil mass will be obtained to allow for an analysis of all 30 radionuclides (i.e., the 18 ROI plus the 12 potential ROI). For any particular WMA, if an analysis of a sample for the 12 potential ROI identifies one or more present at levels that would be considered potentially significant, the balance of the samples from that WMA will also be analyzed for the radionuclide(s) identified as occurring at levels of potential significance. "Potentially significant" is defined to be a radionuclide that is detectable, exceeds either the 95%UTL value for background or the soil screening level contained in Table 6 plus average background (whichever is greater), and occurs when the SOR value for the sample (based on the 18 ROI) is less than one.

6.3 Explore the Possibility of Surrogate ROI

A surrogate radionuclide is a radionuclide that is consistently present in a predictable ratio whenever contamination is at levels of concern. If such a ROI is identifiable, it may be used as a surrogate for the other radionuclides during remediation and the FSS process. Typically, a modified CG is calculated for the surrogate ROI so that as long as the surrogate is less than the modified CG, one can be confident that if the sample is analyzed for all the ROI, the resulting SOR value would be less than unity.

The data presented in Section 6.1 suggest that it is unlikely that a surrogate ROI can be found that would be applicable across the WVDP premises. CSAP data collection is expected to confirm that this is the case. There will be no CSAP data collection specific to this goal; instead CSAP data collected to support the other goals will be used to explore the possibility of a surrogate ROI.

6.4 Establish Background Data Sets

The Phase 1 DP presented background activity concentrations for surface and subsurface soils based on historical sampling. These background data are sufficient for establishing a general sense of background activity concentrations for surface and subsurface soils for the 18 ROI. However, they do not provide information regarding the background levels of the 12 potential radionuclides of interest, nor do they address the background level of gross activity one might encounter during surface scans, nor do they establish a background data set sufficient for conducting statistical tests such as the Wilcoxon Rank Sum (WRS) test that may be required by the Phase 1 FSS process.

CSAP data collection will establish background values including both average conditions and background variability for gross gamma activity and for radionuclide-specific activity concentrations for surface soils through the use of a reference area. Section 8 discusses the establishment of a reference area and associated data collection in greater detail. Section 11.5 provides details about protocols for establishing background gross gamma activities for surface soil scans.

6.5 Determine Extent of Surface Soil Contamination

Surface contamination is defined as radionuclide contamination above background levels within the 0 to 1-m depth profile. In the case of surfaces covered with concrete slabs, pavement, asphalt, gravel, hardstand material, etc., the start of the 0 to 1 m depth profile is defined as the interface between the overlying cover material and the underlying soil surface. In the case of areas where some surficial soil removal is expected to take place as part of Phase 1 activities (outside of the WMA 1 and WMA 2 deep excavations), the start of the 0 to 1 m depth profile is defined as the exposed soil surface that remains after the initial removal has taken place. As an example, when building slabs are removed it is expected that as much as 60 centimeters (cm) of soil immediately underlying the slab will be removed as well. In some cases, such as hardstands, the overlying cover material may be more than 1-m thick. Phase 1 DP activities will remove existing cover material (building slabs, hardstands, etc.) in many of the WMAs.

CSAP data collection will establish the extent of surface soil contamination above the surface soil CG_w within the WVDP premises. The strategy for establishing surface soil contamination extent has the following components:

- Initial conceptual site models will be established for each of the WMAs that identify, based on existing information, areas within WMAs where surface contamination is suspected to be present. The appendices to the CSAP provide initial conceptual site models for each of the WMAs.

- A complete, logged gamma walkover survey (GWS) will be conducted for accessible surfaces for the WVDP premises. Section 11 describes GWS protocols in greater detail. The goal is to have a data density of at least one measurement per square meter (m^2) with an acquisition time of one second using one or more sodium iodide (NaI) detectors. Based on process knowledge and the limited surface soil samples available, it is expected that surface soil contamination above surface soil CG_w levels will always be accompanied by Cs-137 elevated at levels detectable for a GWS. The GWS data will be used to further refine WMA-specific initial conceptual site models. In particular, GWS data will be used to identify areas where GWS results indicate surface contamination likely exceeds CG_w requirements, areas where it is very unlikely surface contamination exceeds CG_w requirements, and areas where the GWS data are inconclusive. For the purposes of the WVDP Phase 1 process, the first two are analogous to Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Class 1 and Class 2 areas, respectively.

- Areas where GWS data clearly indicate surface contamination exists above CG_w requirements will have very limited sampling conducted to confirm GWS findings. This sampling will typically target the highest gross activity levels encountered.

- Areas where GWS data clearly indicate surface contamination is highly unlikely to exceed CG_w requirements and there are no subsurface contamination concerns will be flagged as potentially ready for Phase 1 FSS data collection. It is likely that no additional surface soil samples will be collected from these areas as part of CSAP efforts unless there is a specific need identified;

sampling for FSS purposes may take place separate from CSAP activities during Phase 1, or FSS sampling may be deferred until Phase 2.

- Areas where GWS data are inconclusive regarding the contamination status of surface soils relative to surface soil CG_w requirements will be systematically sampled. Examples are transition zones between soils clearly above CG_w requirements and soils clearly below CG_w requirements and areas where surface cover limits the utility of GWS data such as hardstands and paved areas. These areas will be systematically sampled to evaluate their contamination status. Systematic sampling density will typically be conducted on a triangular grid with a grid spacing of 20 m. This will result in approximately five sampling locations per 2,000 m^2 area, the minimum number needed to perform a statistical evaluation of the resulting data. A 2,000 m^2 area is the maximum size of a MARSSIM Class 1 survey unit. In this case, soil samples will be collected in a manner consistent with FSS protocols. The expectation is that these data will either indicate an area likely meets FSS requirement or does not. In the former case the area will be flagged as ready for Phase 1 FSS data collection and the data evaluated to determine whether the data sets are sufficient to statistically establish surface soil CG_w compliance. If not, then additional Phase 1 FSS sampling will take place during Phase 1 FSS data collection to statistically establish compliance with surface soil CG_w requirements.

- For some WMAs, there will likely be wetland areas with standing water or saturated soil conditions where a GWS is not appropriate. In these areas systematic soil sampling will be conducted instead. In general, this sampling will consist of collecting at least one and at most five surface soil samples representative of the top 0 – 15 cm depth from the wetland area, with each sample representative of a non-overlapping 200 m^2 area.

- Sufficient soil mass will be collected to allow for the analysis of all 18 ROI and 12 potential ROI; however, initial soil screening may focus on Cs-137 and Sr-90 if evidence for the area of interest indicates that these are the only radionuclides of significance from an SOR perspective. If the systematic soil samples indicate the area likely meets surface soil CG_w requirements, the balance of the 18 ROI would be analyzed to provide FSS-quality data sets.

- If systematic surface soil sampling indicates that contamination exists above surface soil CG_w requirements, soil sampling will be extended laterally until contamination is bounded spatially.

- In general (with the exception of sampling from wetlands in response to GWS inaccessibility), two samples will be collected from each location, one representative of a 0 to 15 cm depth, and one representative of a 0 to 1 m depth. The purpose of the 0 to 1 m depth sample is to provide data directly comparable to the surface soil CG_w. The purpose of the 0 to 15 cm sample is address the concern that elevated contamination levels might be limited to the immediate surface and exist at levels that would cause direct exposure dose issues, but that would be diluted by a 0-to-1 m depth sampling protocol. The exception to the two-sample-per-location requirement are areas where there is no evidence of historical surface soil disruption and no reason to be concerned about buried contamination. An example of this type of area would be portions of WMA 4, 10, and 12. In these cases, CSAP surface soil sampling may be limited to only the top 0 to 15 cm depth interval. However, if only a 0 – 15 cm sample is collected at a location and the results of that sample indicate contamination impacts above background levels, then a 0 – 1 m sample will also be collected and analyzed from that location.

- For the majority of drainage features/ditches within the WVDP premises, the surface soil CG requirements apply. The exceptions to this are well-defined portions of Erdman Brook and Franks Creek within the WVDP premises. When there is a concern about potential ditch contamination, either because of GWS results or historical process knowledge, ditch sediments will be sampled systematically. In general, these samples will be representative of the 0 – 15 cm depth interval, and will be on a 30 m linear grid. The primary reason for this spacing is that if a generic ditch footprint is defined as having a width of 3 m, a 30 m sampling grid spacing results in one sample per approximately 100 m^2, which corresponds to an area equivalent to a stationary external dose scenario. If a ditch sample has results that indicate contamination impacts above background levels, then a 0 -1 sample will also be collected and analyzed from that location.

6.6 Identify the Presence/Absence of Buried Soil Contamination

Buried contamination is defined as contamination impacts that exist deeper than the surface soil definition (i.e., deeper than one m). There are areas of the WVDP premises where contamination at depth is known to exist. In some cases this deep contamination will be addressed by Phase 1 decommissioning activities (e.g., the WMA 1 and WMA 2 excavations). In other cases known deep contamination has been identified as a Phase 2 concern (e.g., the north plateau groundwater plume extending beneath WMA 2 and WMA 4). However there are other areas of the WVDP premises where buried contamination is known to exist but the extent is unknown (e.g., the buried outfall ditch present in WMA 6), or buried contamination is suspected to exist (e.g., portions of WMA 3 and the northern portion of WMA 6).

Understanding where buried contamination is present and the extent is important for the following reasons. First, outside of the WMA 1 and WMA 2 excavations Phase 1 FSS protocols can only be applied to surface soils where there is confidence that deep or subsurface contamination is not present. Second, Phase 2 decision-making requires knowledge of the nature and extent of buried contamination. With the exception of the north plateau groundwater plume in the north plateau there is only very limited data on the nature and extent of subsurface soil contamination within the WVPD premises.

Subsurface contamination has several potential sources. The first is contamination resulting from the presence of buried infrastructure. In this case, contamination at depth could have resulted from leaking infrastructure that carried contaminated waste, from the use of contaminated soils as backfill when infrastructure was installed (particularly pertinent to infrastructure installed after the 1968 releases from the Process Building main stack that resulted in surface soil contamination associated with the cesium prong), and from the potentially preferential flow pathways buried infrastructure provides to contaminated groundwater. A second source is contamination that was buried by WVDP/NFS activities. A prime example is the original outfall ditch in WMA 6 that was covered to control exposure to contaminated sediments. A third source is the migration of contaminated groundwater through the subsurface. The principal example of this is the subsurface contamination that currently exists beneath portions of WMA 2 and WMA 4 resulting from the release of contaminated liquids beneath the Processing Building in WMA 1.

CSAP data collection will verify the presence/absence of buried contamination where it is considered a potential concern, and will provide data to determine its extent when it is encountered. The strategy for investigating subsurface soil contamination has the following components:

- Initial conceptual site models will be established for each of the WMAs that identify, based on existing information, areas within WMAs where subsurface contamination is suspected to be present. The appendices to the CSAP provide initial conceptual site models for each of the WMAs. Historical information pertinent to these initial conceptual site models include the presence/absence of buried infrastructure, evidence of surface soil disturbance in historical aerial photographs, anecdotal evidence of releases that may have resulted in buried contamination, and subsurface soil and groundwater data sets that contain radionuclide results.

- Buried infrastructure will be mapped in each WMA (see Sections 5 and 6.12 for more details). Particular attention will be paid to buried infrastructure that may have carried contaminated liquids and to infrastructure that was installed after 1968. The former is of concern from a subsurface release perspective, and the latter from the perspective of the use of contaminated soils as backfill. Portions of these infrastructure footprints will be excavated and the adjacent soils screened for the presence of contamination. In general, for buried infrastructure that carried waste or waste water, the focus will be on soils immediately beneath the line. For buried infrastructure that did not carry waste or waste water, but was installed after 1968, the focus will be on soils immediately above the line that would be representative of backfill.

  Characterization of soils adjacent to buried infrastructure will be done using trenching techniques. For buried infrastructure that is active or that potentially contains radioactive contamination inside, special care will be taken to not compromise the integrity of the infrastructure. The length, width, and depth of trenches will be dependent on the depth of the buried infrastructure that is of interest and the degree of confidence that its location is known. Soils removed while trenching will be staged adjacent to the trench operation and replaced when the trenching and soil characterization work at a particular location is complete to minimize the volume of investigation-derived waste.

  Gross gamma detectors will be used to assist in the selection of subsurface soil samples associated with buried infrastructure that represent potential contamination impact concerns. Infrastructure that has the potential for radioactive contamination in the line poses shine concerns for gross gamma detectors once the line is exposed. The possibility of shine effects will be monitored as necessary and appropriate mitigating actions taken if necessary. Examples of actions include collimating the detector being used.

- Biased sampling will target WMA-specific features where subsurface contamination is suspected to be present. For example, areas immediately outside the planned WMA 1 and WMA 2 deep excavations are an example (see Section 6.8 for additional details) as is the buried original outfall ditch in WMA 6 and the original Old Hardstand drainage features in WMA 5. In some cases, subsurface sampling will be conducted by scanning subsurface soil cores or borings. In other cases, where buried linear features are suspected, soil trenching combined with soil screening will be used.

- When soil cores are used for sample collection (either specifically for subsurface contamination characterization or as part of surface soil characterization work), a down-hole gamma scan will be conducted using an appropriate NaI detector (e.g., a 1 inch × 1 inch NaI detector with shielding to control gamma flux through the top and bottom of the detector). Biased samples will be collected from specific subsurface soil intervals that exhibit the most elevated gross activity levels based on the down-hole gamma scan data.

- For locations where systematic or biased surface soil samples are collected, if a 0 – 1 m soil sample identifies contamination above background levels, then an additional sample will be collected from the next 1-m deep interval (i.e., 1 – 2 m) and evaluated to determine the presence or absence of contamination at depth above background concentrations. If contamination is encountered in this deeper interval, then sampling may continue at depth until contamination is bounded vertically.

- For locations where systematic or biased subsurface soil samples indicate contamination is present above background levels, additional sampling locations may be selected to laterally bound subsurface contamination. The decision to laterally bound contamination and the sample spacing/configuration required will be location/situation specific, and will take into account the original release mechanism, the types of radionuclides encountered, and the levels observed.

- There are areas of the WVDP premises where the combination of surface contamination present pre-WVDP combined with extensive surface re-working by WVDP activities raise generic buried contamination concerns over larger areas. Examples of this include portions of WMA 5, WMA 3, and WMA 2. In these cases, systematic subsurface sampling will be conducted with a subsurface core spacing of 20 m. The typical initial depth of evaluation will be 2 m. This sampling will be coordinated with systematic surface soil sampling described in Section 6.5.

- In all cases, the initial soil samples from a location will be analyzed for all 18 ROI. In selected cases, samples will also be analyzed for the additional 12 potential ROI. If initial analyses indicate that only a limited set of radionuclides are present, then subsequent sample analyses used to vertically or laterally bound contamination will be limited to those radionuclides originally identified as being above background conditions.

6.7 Determine Level and Extent of Sediment Contamination

The Phase 1 DP defines CG requirements for sediments. These requirements are applicable to specific reaches of Erdman Brook and Franks Creek as identified in Figure 5. All other sediments associated with drainage features on the WVDP premises will be subject to surface soil CG requirements.

CSAP data collection from Erdman Brook and Franks Creek sediments will be used to evaluate the presence and extent of sediment contamination that exceed sediment CG requirements. This sampling is confined to WMA 12. The strategy has two basic components:

- GWS data will be collected from the reaches of concern as practicable. Biased sediment sampling will occur in response to the identification of anomalies in the GWS data. Biased sampling will consist of discrete samples from the surface to a depth of 15 cm that targets the highest gross activity readings. In the event that a sample identifies contamination impacts above background levels, a second sample will be analyzed from the same location representing a depth of 0 – 1 m. In the event that sample identifies contamination impacts above background, a third sample will be analyzed from the same location representing a depth of 1 – 2 m. This process will continue until contamination impacts above background conditions are vertically bounded.

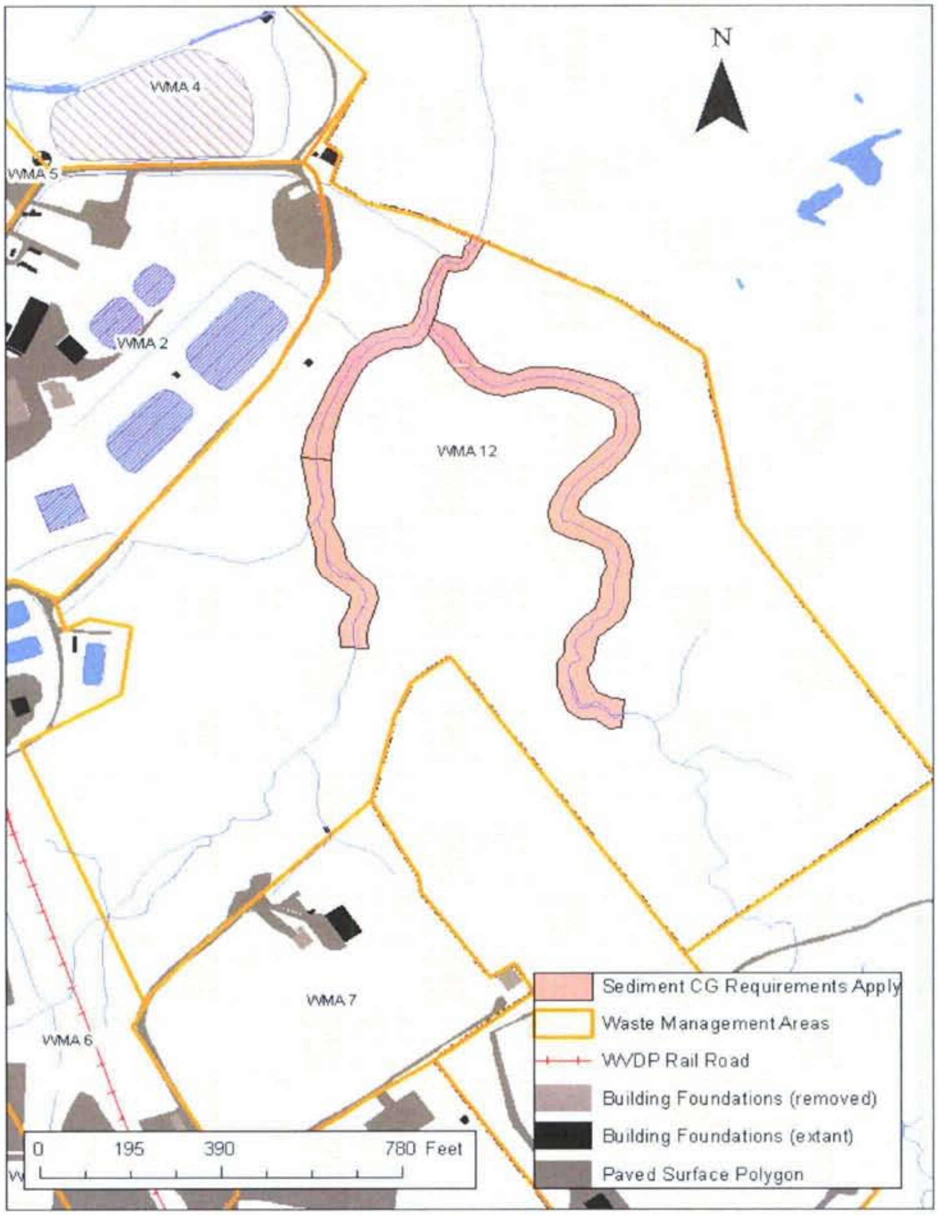

Figure 5 Erdman Brook and Franks Creek Sections Where Sediment CG Requirements Apply

One discrete sample will be selected downstream from the confluence of Erdman Brook and Franks Creek, but within the WVDP premises, that is expected, based on GWS results, to represent the heaviest sediment contamination. This sample will represent a depth of 0 – 15 cm and will be analyzed for the 18 ROI plus the 12 radionucldes of potential interest.

- Systematic composite sampling locations will be distributed along Erdman Brook and Franks Creek for those portions where the sediment CG requirements apply and there is a possibility of contamination exceeding sediment CG_w requirements. Systematic composite samples will be formed from three discrete samples, with one sample collected from the stream center-line and the other two from the banks. A minimum of three composite sample locations will be identified for each portion of the creeks that meet the above criteria, with systematic composite sample location spacing of 30 m. Based on current information, only a portion of Erdman Brook is expected to require this sampling (see Appendix J). Samples will be representative of the 0 to 15 cm depth interval under the assumption that if contamination is present it is most likely confined to near surface sediments. The sample results will be used to determine whether sediment contamination potentially exceeds sediment CG_w requirements. If any sample yields results above background conditions, a second sample will be analyzed from that location representative of a 0 – 1 m depth interval. If that sample yields a result above background conditions, a third sample will be analyzed representative of a 1 – 2 m depth interval. This process will continue until the vertical extent of contamination impacts above background is bounded.

- Biased and systematic samples will be analyzed for all 18 ROI. Biased samples will also be analyzed for the 12 radionculides of potential interest. If any of these 12 are present at potentially significant levels, the balance of sediment samples will also be analyzed for the 12 radionuclides of potential interest.

6.8 Define Required Extent of WMA 1 and 2 Excavations

Two deep, extensive excavations are planned for WMA 1 and WMA 2 as part of Phase 1 decommissioning activities. The excavations will extend, at minimum, one foot (ft) into the underlying Lavery Till. The lateral extent is to some degree fixed by structure constraints. A minimum extent is required to safely remove buried foundations associated with the Process Building. Likewise, the footprint and layout of the lagoons establishes the minimum requirements for the WMA 2 excavation.

The maximum extent is also physically constrained in some instances. For example, the northern wall of the WMA 1 excavation cannot compromise the structure integrity of the HLW Tanks in WMA 3.

Within those constraints, one of the goals of the two excavations is to remove subsurface contamination that exceeds the subsurface CG requirements derived by and contained in the Phase 1 DP.

To verify that the planned excavation footprints do, in fact, address subsurface contamination above CG_w requirements to the extent practicable, subsurface sampling will take place along the planned footprint boundaries for WMA 1 and WMA 2. The sampling strategy defining the lateral extent of the WMA 1 and WMA 2 excavations has the following components:

- Continuous soil cores will be collected with a spacing of 10 m for locations along sheet pile footprints and 20 m for locations along slurry wall footprints, with intact soil cores retrieved. Soil cores will include at least one m of the underlying Lavery Till. The reason for the 10 m spacing along sheet pile footprints is to provide a reasonable probability that contamination with a significant subsurface spatial extent is identified. "Significant extent" is defined as subsurface contamination that may extend more than 10 m beyond the proposed excavation footprints; the assumption is that if this is the case, the contamination would have an extent along the excavation boundary that was at least as great. In the case of slurry walls, contamination is assumed to be present on the side opposite the excavation; in this case the spacing is driven by geotechnical design needs for those walls (e.g., depth to till). For both sheet pile and slurry walls, the proposed spacing may be modified in response to field conditions if those are different from initial assumptions. For example, in the case of the slurry wall, if there was found to be significant variation in the depth to the Lavery Till from core location to core location, the spacing might be reduced to better capture the variations in Lavery Till depth.

- Each core location from sheet piling footprints and from the southern boundary of the WMA 2 excavation will have a down-hole gamma scan performed with an appropriate NaI detector to the extent practicable. Each hole will extend beneath the water table; consequently usable down-hole gamma scan data will likely not be available for the full depth of the core. Each core will also be scanned ex situ for gamma and gross beta activity using an appropriate detector.

- A minimum of four samples will be submitted from each core: one representing the top one m of soil, one representing the top one m of Lavery Till, one representing the m soil interval immediately on top of the Lavery Till, and one representing the m interval straddling the water table. In addition, if the down-hole or ex situ scan identifies elevated readings, and the highest readings do not correspond to one of these four intervals, the m interval representative of the highest gross activity readings will be submitted for analysis. Since the depth to the Lavery Till varies significantly, the total depths of the soil cores will also vary significantly depending on where they are collected. If the depth of till is less than three m, the minimum number of samples will be adjusted accordingly. In the case of slurry wall core locations only two. The reason for collecting a sample from the top one m of soil is to define the extent of surface contamination. The objective of the Lavery Till sample is to understand the contamination status of the underlying Lavery Till. The purpose for the soil samples immediately above the Lavery Till is to determine the presence/absence of contamination immediately above the Lavery Till and to have a point of comparison for Lavery Till sample results. The rationale for the sample from the interval straddling the water table is because contamination migration is likely via contaminated groundwater and releases were likely above the water table. Consequently, in the vicinity of releases, the most likely zone to encounter the highest levels of contamination is in soils along the water table. The reason for the biased sample is to understand the maximum levels of contamination that are present if the depth of that contamination does not correspond to one of the other depth intervals already sampled.

- Three discrete groundwater samples will be collected from each subsurface sample location if possible: one from the water table, one from immediately above the Lavery Till, and one midway between these two intervals. In general, away from source areas, activity concentrations for impacted groundwater, as measured in pCi/l, would be significantly greater than activity concentrations in impacted soils at the same location, as measured in pCi/g. Consequently groundwater activity concentrations serve as a conservative indication of the potential for subsurface soil contamination. These data will also provide insights into the extent of subsurface groundwater contamination.

- If contamination is identified above background in one or more of these locations, additional locations may be selected further away from the planned excavation footprint to bound the lateral extent of subsurface contamination (groundwater or soils) in the case of sheet piling wall footprints and the southern boundary of the WMA 2 excavation. The separation distance from the excavation footprint will be a location-specific decision, and will depend on the level of contamination encountered, the type of contamination (e.g., groundwater versus soil), and the vertical extent of contamination observed. Bounding is not required for the slurry wall footprints; the working assumption is that contamination does exist of the opposite the excavation footprint for slurry wall footprints.

- If buried infrastructure of potential concern is identified that intersects the planned WMA 1 or WMA 2 excavation footprints, one of the trenches used to expose the buried infrastructure will be along the planned excavation boundary and evaluated for the presence of adjacent soil contamination.

6.9 Identify Soil Waste Stream Characteristics

A significant volume of soil will be removed as part of the WMA 1 and WMA 2 excavations. All excavated soils will be disposed of off-site regardless of the soil activity concentrations. The radionuclide activity concentrations of these soils are expected to vary widely, from non-impacted soils, to low level radionuclide contamination, to heavily contaminated soils. For planning purposes it is important to have estimates of the various soil waste streams that will be generated by the WMA 1 and WMA 2 excavations.

CSAP data collection will support the identification and estimation of contaminated waste stream types. Data collection will take the form of soil sampling from soil cores that are systematically collected across the accessible portions of the planned WMA 1 and WMA 2 excavations. Soil cores will be obtained, including at least one m from the Lavery Till. Each soil core will be divided into 1-m intervals with the final sample representing the top one m of Lavery Till, and a sample from each interval submitted for analyses of Cs-137 and Sr-90. For example, if there were 10 soil cores to a total depth of 10 m, this would result in 100 samples. The sample with the highest Cs-137 activity concentration from each core will also be analyzed for the other 12 radionuclides of potential interest.

The number of cores is based on the number of samples required to obtain relatively accurate soil volume estimates. For the purposes of this analysis, "relatively accurate" for every potential waste stream is defined as a volume estimate error that is no more than 10% of the total excavated volume. Using this definition along with a Bernoulli trial/binomial distribution analysis indicates a minimum of 100 systematically placed samples is required to meet this objective (e.g., 10 samples from 10 soil core locations). Table 3 provides the relative volume estimation error expected with 100 systematic samples under different contamination probability assumptions. The "contamination probability" identified in

Table 3 can be interpreted as the fraction of the total excavation volume that meets a particular waste stream definition. The "relative error" is the ratio of the expected error associated with estimating the contamination fraction based on 100 systematic samples. While relative errors grow as contamination probabilities become smaller, absolute errors shrink and never exceed 10% of the total excavated volume if 100 systematic samples are collected.

Table 3: Soil Sample Numbers for Volume Estimation

Contamination Probability:	0.50	0.40	0.30	0.20	0.10
Sample #:	100	100	100	100	100
Volume Error Relative to Contamination Volume:	0.20	0.24	0.30	0.39	0.59
Volume Error Relative to Total Excavation Volume:	0.10	0.10	0.09	0.08	0.06

6.10 Verify Contamination Status of Soils to be Affected by Phase 1 Construction Needs

There will be areas of the WVDP premises that will be used to support Phase 1 decommissioning activities. Examples of these areas include lay-down areas that may be used for excavated soil staging, as necessary. When these areas are identified, and prior to their use in support of Phase 1 decommissioning activities, the contamination status of surface soils in the areas needed to support Phase 1 decommissioning activities will be determined.

CSAP data collection will be used to determine the contamination status of surface soils in the footprints of areas that may be used for Phase 1 construction and remediation activities. Data collection in these areas will consist of two components:

- A logged GWS will be conducted of the area in question consistent with the protocols described in Section 11.

- Systematic surface soil samples will be collected consistent with the protocols described in Section 10. A minimum of five samples will be collected from each area. If areas are larger than 2,000 m^2, a triangular grid spacing of 20 m will be used. Samples will be representative of the top 15 cm of exposed soils. Samples will be submitted for analyses of Cs-137 and Sr-90.

6.11 Establish Site-Specific Performance for On-Site and Field-Based Analytical Methods

CSAP data collection will use a variety of on-site and field-based data collection methods. A component of CSAP data collection will be to establish site-specific performance for these methods to ensure data of sufficient quality to satisfy decision-making requirements. Examples of field-based and on-site methods include various gamma walkover NaI detectors, down-hole NaI detectors, detectors for conducting ex situ core scans, and rapid-turn on-site methods for Cs-137 and Sr-90 soil sample analyses.

For field or on-site methods deployed as part of Phase 1 CSAP data collection, the following are the minimum generic performance verification requirements:

- ***Precision:*** Precision is a measure of the degree of variability or "error" in a method's results. Precision is usually expressed as either a standard deviation, or as a relative percent error. Precision is typically a function of contaminant concentration. The precision of field and on-site laboratory methods will be established for contaminant levels that are of significance from a decision-making perspective.

- ***Accuracy:*** Accuracy refers to how close a reported result from a method is to the true value. Accurate methods are methods with acceptable precision and an absence of bias. Bias is evaluated by comparing average reported results with known values for repeated measurements of standard reference materials.

- ***Reproducibility***: Reproducible results refer to results that can be replicated, typically within a specified percentage of the original value. Acceptable percentages are technology/application-specific. In the case of detectors, reproducibility is demonstrated by replicate measurements. For analytical methods, reproducibility is demonstrated by split sample analyses.

- ***Completeness***: Completeness is a measure of how often data are rejected or lost due to method problems and/or data quality issues. Methods must be shown to produce useable (i.e., satisfying data quality requirements) data sets at least 80% of the time.

Method performance can also be evaluated by the level of decision-making error associated with a method's data sets. For example, if the decision was whether contamination was present or absent at a location, errors would include falsely identifying contamination when it was not present at levels of concern or missing contamination when, in fact, it was present at levels of concern.

6.11.1 NaI Gamma Walkover Survey Detector Performance

There are a variety of NaI detector geometries that can potentially be used for GWS. Because of low-energy gamma emitting radionuclides that are ROI, a FIDLER will be used. A 2×2 NaI detector may also be used to enhance the detectability of Cs-137 at CG_w levels, if necessary. To evaluate Field Instrument for Detection of Low Energy Radiation (FIDLER) detector performance and to determine whether a 2×2 or 3×3 NaI detector is necessary, the following data collection activities will be performed:

- A reference area will be established with a portion (100 m^2) used for detector evaluation (see Section 8 for more details). Each gross gamma activity detector used in support of Phase 1 activities for logged surveys will be evaluated by surveying and logging the data for this area. Key parameters will include average response of the detector and the variability in data results observed. Data density will be at least one reading per m^2; data will be collected in a manner that results in relatively uniform coverage for the area.

- At least 20 locations will be selected from the WVDP premises before premise-wide GWS data collection for comparative sample collection. The key characteristics desired for each location: indications of elevated surface activity at levels that would likely be near or above CG_w requirements for Cs-137, an area likely impacted primarily by Cs-137 impacts, an absence of any shine concerns, no surface cover (e.g., pavement, gravel, asphalt, etc.), with relative constant gross activity readings over a small area (2 – 3 m^2), and in an area that will unlikely be immediately affected by Phase 1 remediation activities. WMAs most likely to have these conditions are the northern portion of WMA 10, the northern portions of WMA 5, and the western portions of WMA 4. Under ideal conditions, the 20 locations would span gross activity levels ranging from slightly above background through approximately three times background gross activity levels.

- Each location selected will be flagged and marked in a manner that allows it to be recovered exactly. Each detector type (e.g., FIDLER, 2×2, 3×3) planned for use as part of Phase 1 activities will have, at minimum, a static 30-second reading obtained at a height of 15 cm above the location prior to soil sampling. Detector measurements will not take place if soil moisture conditions may adversely affect results (i.e., immediately after heavy rains or in the presence of saturated or near-saturated surface soil conditions).

- After detector measurements have been made, each location will be sampled. Samples will consist of five point composite samples representative of a 0 – 15 cm soil depth, with four of the soil samples coming from the corners of a one m^2 area centered on the location, and the fifth from directly below the detectors in the center of the one m^2 area. One composite will be formed from these five samples for each location.

- Composite samples will be submitted for an analysis of all 18 ROI.

- Regression analyses will be used to develop a relationship between sample results and detector responses. In particular, gross activity responses per pCi/g will be estimated. These responses will be used in conjunction with background data sets to estimate the minimum detectable Cs-137 activity concentrations (i.e., the activity concentrations that can be reliably differentiated from background conditions) for each detector type.

- If the minimum detectable activity concentrations for the FIDLER are below the CG_w requirements for Cs-137, then only a FIDLER will be used for the balance of WVDP premise-wide gamma scans. If the minimum detectable activity concentrations for the FIDLER are above CG_w requirements for Cs-137, but the minimum detectable activity concentrations for an alternate detector (e.g., 2x2 or 3x3) are below, then an alternative detector will also be deployed in addition to the FIDLER as part of WVDP premise-wide GWS.

Additional GWS-related Quality Assurance/Quality Control (QA/QC) requirements related to performance are described in Sections 11 and 14.

6.11.2 Down-Hole and Ex Situ Core Scans

Down-hole scans and/or ex situ core scans will be used as part of CSAP soil coring activities to determine the vertical distribution of contamination in the subsurface. Down-hole scans are the preferred method; however, site conditions may at times preclude the collection of down-hole gross activity scans for the entire length of soil cores. In these instances ex situ core scans may be substituted. Ex situ core scans will also be used to identify the portion of a soil core that would be a biased-sample in response to a down-hole gamma scan elevated reading.

The performance of down-hole and ex situ core scans will be monitored by electronically recording scan results, matching scans with corresponding soil core sample results, and evaluating the relationship between core scan results and corresponding soil core sample results. The general relationship evaluation process is similar to that for GWS detectors as described in Section 6.12.

Data collection specific to down-hole and ex situ core scan performance will not be collected; however, performance will be evaluated and monitored as down-hole and ex situ core scan datasets become available. This evaluation will include two components:

- Average background values and background variability for down-hole gamma scans and ex situ soil core scans will be determined based on data from CSAP soil cores where no contamination is found present above background levels. This variability will, in turn, allow the development of field investigation levels that can be applied to down-hole and ex situ surveys to flag results that are inconsistent with background and potentially indicative of the presence of radionuclides above background levels.

- In many cases, CSAP data collection protocols call for biased sampling of soil cores if/when elevated readings are encountered from either down-hole or ex situ surveys of the soil cores. In these cases the resulting laboratory data will be matched with the corresponding survey scan data, and the results used in combination with the background data sets to estimate minimum detectable concentrations.

6.11.3 On-Site Cs-137 and Sr-90 Analytical Performance

Rapid screening of soil and groundwater samples for Cs-137 and Sr-90 is a key component of the various CSAP sampling strategies. Cs-137 and Sr-90 are believed to be the two radionuclides in environmental media that will drive Phase 1 decision-making for most of the WVDP premises. Rapid screening for Cs-137 and Sr-90 in environmental media will likely take place on-site in an appropriate facility.

The detection limit requirements for Cs-137 and Sr-90 are the same as those for standard off-site laboratory analyses as described in Section 12. These detection limits may not be required for all samples analyzed on-site, but the on-site analytical capacity must exist for meeting these detection limits when necessary.

The accuracy and precision of on-site methods will be determined and monitored through the use of certified standards.

Of particular concern is the ability of an on-site laboratory to adequately prepare and homogenize soil samples for analysis. Soil sample preparation protocols will be developed as part of the overall standard laboratory operating procedures. The goal of soil sample preparation is that the error introduced by residual within-sample heterogeneity should be no more than the measurement error associated with the analytical procedure at the relevant CG_w. Conformance with this goal will be evaluated through the use of replicate sub-sampling and analysis of soil samples. The soil samples selected for replicate sub-sampling and analysis will be soil samples that exhibit activity concentrations for either Cs-137 or Sr-90 within the immediate range of the relevant CG_w requirement (i.e., from one half of the CG_w to three times the CG_w).

6.12 Develop an Inventory of Buried Infrastructure

Buried infrastructure is important to Phase 1 decommissioning activities for a number of reasons. Buried infrastructure has the potential to be associated with subsurface soil and groundwater contamination, either as a source (e.g., leaking lines), because of contaminated backfill, or because the buried infrastructure provides preferential flow paths for the movement of contaminated groundwater. Buried infrastructure is a consideration from a safety and engineering perspective for intrusive CSAP characterization work and for planned Phase 1 remediation activities that involve excavation of subsurface soils.

CSAP data collection will develop an inventory of buried infrastructure within the WVDP premises. The details of the strategy for developing this inventory are described in Section 5 of this plan. DOE will maintain this inventory through the life cycle of Phase 1 activities, updating and amending the inventory as necessary and appropriate.

6.13 Data to Support Phase 2 Planning

Phase 2 planning will be initiated early on in the Phase 1 decommissioning process. Phase 2 planning and decision-making will determine the ultimate end-state of the WVDP premises. Phase 2 planning and decision-making requires knowledge of the nature and extent of environmental contamination associated with the WVDP premises that is not directly addressed by WVDP Phase 1 decommissioning activities.

CSAP data collection will provide the information necessary to accurately understand the nature and extent of radionuclide environmental contamination within the WVDP premises but outside planned Phase 1 decommissioning activities. This information will include identifying area-specific radionuclides of concern that will be important for Phase 2 planning, the presence of radionuclide contamination of potential concern in surface or subsurface soils and sediments, and the extent of that contamination where it is found present.

Strategies for identifying area-specific radionuclides are described in Sections 6.1 and 6.2 of this plan. Strategies for determining the presence and extent of surface soil contamination are described in Section 6.5 of this plan. Strategies for evaluating the presence and extent of subsurface soil contamination are described in Section 6,6 of this plan. Strategies for characterizing the presence and extent of sediment contamination are described in Section 6.7 of this plan. Area-specific details of these strategies can be found in the relevant CSAP appendices.

6.14 Determine Groundwater Flow Data Necessary for WMA 1 and WMA 2 Barrier Wall Designs

A significant amount of groundwater flow parameter estimation and modeling work has been performed for the FEIS and DP, and is currently being conducted in support of the North Plateau Plume Permeable Treatment Wall to be installed in WMA 2 to address the north plateau groundwater plume. The results of those data collection and modeling efforts will be reviewed by the contractor responsible for designing the WMA 1 and 2 barrier walls in the context of WMA 1 and WMA 2 barrier wall groundwater flow data needs. In the event that additional data is deemed necessary to support barrier wall design, wells/piezometers will be installed as necessary and the appropriate tests conducted to fill the data gaps.

6.15 Geotechnical Data Required for Barrier Wall Design

The barrier walls that are planned for the WMA 1 and WMA 2 excavations require geotechnical data for proper design. CSAP data collection will provide the information required for the design of the WMA 1 and WMA 2 barrier walls. The strategy for collecting this information and the types of information to be collected are as follows:

- Soil cores will be collected along the planned footprints of the barrier walls. In the case of slurry walls, core spacing will be 20 m. In the case of sheet pile walls, core spacing will be 10 m. The reason for the closer spacing along the sheet piling walls is to provide a higher level of confidence in the contamination status of soils along the footprint. Core spacing, particularly for the slurry walls, may be modified based on the initial set of results. For example, a critical design parameter is the depth to the Lavery Till; if the initial set of slurry wall core locations show signs of significant variations in till depth between adjacent core locations, the spacing will be tightened.

- Intact soil cores will be collected to the extent possible. Cores will include at least one m of the Lavery Till. Each core will be divided into 1-m segments.

- A variety of geotechnical field data will be collected from each core location, as necessary and required for sheet piling/slurry wall design. In addition soil samples will be collected and submitted for geotechnical analyses (e.g., grain size, Atterberg limits, triaxial strength, etc.) as required by sheet piling/slurry wall design.

6.16 WMA-Specific Data Gaps

WMA-specific data gaps are identified in the WMA-specific appendices, along with data collection to address those gaps.

7.0 REMEDIAL ACTION SURVEYS

Remedial action surveys refer to collecting data to assist in guiding remedial activities. In the context of the Phase 1 soil excavation program, these surveys can include guiding the progress of excavation (e.g. determining how far laterally excavation should proceed to address contamination), supporting the segregation of soils for waste disposition, and determining when cleanup objectives have been achieved so that the exposed excavation floors and walls are ready for Phase 1 FSS data collection. Additionally, remedial action surveys may include documenting the contamination status of exposed surfaces when Phase 1 activities are complete for those areas where Phase 1 FSS protocols will not be applied to demonstrate closure. An example of this is hardstand removal in areas where contamination is known to exist at depths greater than one m, precluding the application of the Phase 1 FSS process for surface soils.

This section of the CSAP discusses remedial action surveys to guide excavation, to determine when cleanup objectives have been achieved, and to document the contamination status of exposed surfaces after Phase 1 activities are complete for those areas that will not be included in Phase 1 FSS. All soils excavated as part of Phase 1 activities will be sent off site for disposition following the requirements of the DOE radioactive waste management program. The required data collection and decision-making process for waste disposition are a function of the facilities available to receive the various waste streams Phase 1 activities will generate and are a function of their waste acceptance criteria and documentation requirements. Data collection during remediation for waste disposition purposes is outside the scope of the Phase 1 DP and CSAP; data collection to support waste disposition will not be addressed as part of this plan, but may be addressed in a Waste Management Plan developed to support the Phase 1 remediation.

The historical soil sample data indicate that Cs-137 and Sr-90 will likely be the primary contaminants of concern from a CG_w perspective in soils to be addressed by Phase 1 activities. On the basis of the historical data, there are areas of the WVDP premises where these two contaminants exist relatively independently of each other and there are other areas where they are commingled. Elevated (above levels that would occur in background soils) Cs-137 activity concentrations in soils are readily identifiable by a variety of NaI-based gross gamma detectors when those activity concentrations are at CG_w activity concentrations; consequently, Cs-137 can be at least partially addressed by gross gamma activity scans as part of a remedial action survey. However, this is not the case with Sr-90. DOE is currently exploring prototype systems based on gas proportional counting detectors that may prove to be valuable for real-time screening of exposed excavation surfaces for Sr-90. However, this plan assumes that in areas where either pre-excavation CSAP data collection or historical data sets identified Sr-90 impacts, soil sampling and analysis will be required as part of remedial action survey activities. The expectation for both Cs-137 and Sr-90 is that rapid turn-around analytical support will be available as part of remedial action survey activities, and that those methods (gamma spectroscopy for Cs-137 and liquid scintillation for Sr-90) will have sufficiently low detection limits to support the required decision-making at CG_w activity concentrations.

If pre-excavation CSAP data results determine that there are other radionuclides that are also potential risk drivers in addition to Cs-137 and Sr-90, the remedial action survey approaches described here will be modified to address those radionuclides as well.

The following sections describe remedial action survey data collection in support of specific Phase 1 activities.

7.1 WMA 1 and WMA 2 Excavation Support

In both the WMA 1 and WMA 2 excavations, initial excavation footprints will have been defined on the basis of CSAP data results and the physical requirements associated with subsurface building/lagoon infrastructure removal. The presence of slurry or sheet pile walls on all four sides of the WMA 1 excavation and along the north, west, and east sides of the WMA 2 excavation will limit the extent the excavations can extend laterally in response to encountering unexpected subsurface contamination in excavation side walls as the excavations proceed. The depth of both the WMA 1 and WMA 2 excavations will extend a minimum of one ft into the Lavery till.

In the case of WMA 1, along the north, west, and south sides of the excavation the soil surface will be sloped from the floor of the excavation up to land surface at an angle of approximately 45 degrees. Along these sides at the land surface, the top of the excavation will have extended up to the sheet piling installed for water control. Along the east side of the excavation, the excavation floor will extend to the slurry wall.

In the case of WMA 2, the southern side of the excavation will be sloped at an angle from the floor to the land surface. Along the west, north, and east sides of the excavation, the excavation floor will extend to the slurry wall.

For both WMA 1 and WMA 2, remedial support data collection will begin as the excavations approach their design extent (i.e., when excavation is within two ft of the design surface). The reason for starting remedial support data collection at this point is to provide information on the contamination status of soils immediately above the till. In the case of WMA 1, these data will be used to assist in determining which foundation pilings are of potential concern. In the case of WMA 1 and WMA 2, these data are expected to provide insights into where contamination might extend deeper into the till. The assumption is that contamination within the till would likely be overlain by soils with much higher activity concentrations.

The initial round of remedial support data collection will consist of complete coverage by scans with a FIDLER detector for the floor of the excavations. The FIDLER has sufficient sensitivity for identifying Cs-137 at its subsurface CG_w value, is well suited for excavation work (i.e., relatively insensitive to shine from excavation walls or adjacent facilities), and is capable of detecting other low-energy gamma emitting radionuclides such as Am-241 and U-238 at relatively low levels if they are present. Scans will be logged as they progress using surveying instrumentation capable of three-dimension locational control to less than one ft in accuracy and the resulting data (measurements results and coordinates) recorded electronically. Scan data will be recorded in a manner that identifies the excavation surfaces to which they apply. Scan data will be mapped and reviewed for completeness and for indications of gross activity results that are not consistent with background. At its subsurface CG_w value, Cs-137 will have a FIDLER response significantly greater than background. However, the primary contaminant of concern at the bottom of the excavations will likely be Sr-90 which will not be detectable directly by gross gamma activity scans. It is possible, though, that Sr-90 may be commingled with other slightly elevated radionuclides with activity concentrations detectable by a FIDLER that would flag areas as potentially of concern.

Since a deep subsurface background reference area will not be available prior to the initiation of WMA 1 and WMA 2 excavations, the initial round of scanning results will also be used to identify a portion of the excavation surface that appears to be at background conditions. This area will be systematically sampled with six discrete soil samples collected across the area to a depth of 15 cm and analyzed for Cs-137 and Sr-90 via fast-turn around to confirm their absence, and then the samples will submitted for off-site analysis for all ROI. Assuming the analyses confirmed background conditions for these soils, the scan data from this area would be used as a point of comparison for scan data collected as part of remedial action support elsewhere in the excavations.

When excavations have reached their design extent, a second round of remedial support surveys will be conducted. The second round will begin with complete excavation surface coverage (floors and sloped walls) using a FIDLER detector. If scan results for any portion of the excavations indicate evidence of measurable impacts, either additional excavation may take place or the area of interest will be biased sampled to a depth of 15 cm and submitted for fast turn-around for analyses of Cs-137 and Sr-90. If the results indicate soil activity concentrations exceeding subsurface CG_w standards, excavation in that area will continue until scans/sampling indicate the standards have been achieved or the excavation has reached its physical limits.

If scanning of the exposed excavation surface does not indicate evidence of elevated activity that would be a concern and the excavation has reached its design extent, then remedial action survey soil sampling will take place. A 5-increment composite soil sample will be collected systematically on a random start triangular grid across the excavation surface (floor and sloped walls) to a depth of 15 cm at a density of one composite sample per 200 m^2. In the case of WMA 1, this will result in approximately 60 composite samples collected from the floor and walls of the excavation. In the case of WMA 2, this will result in approximately 90 composite samples from the excavation floor and walls. These samples will be submitted for quick turn-around analysis of Sr-90. The results from these samples will be used, in conjunction with the scan information, to determine if additional excavation is necessary or if the excavation face is ready for FSS data collection following the FSSP protocols. If the latter, the Sr-90 sample results will be used to fine tune FSS sample numbers by providing an estimate of the lower bound of the gray region (LBGR) and variability observed. If contamination above the cleanup standards is found in the sloped soil walls of the excavation in WMA 1, the impermeable sheet piling will limit the extent to which this contamination can be pursued laterally.

In the case of WMA 1, approximately 476 foundation pilings will be present that extend into the till (and in some cases through the till). Per the Phase 1 DP, these pilings will be cut just below the final excavation surface. If scans identify elevated activity of potential CG exceedances in the till material adjacent to the pilings, excavation will continue until CG exceedance concerns are no longer present. Biased soil samples with rapid Sr-90 turn-around results may be used to further interpret scan readings for these piles. Remedial action surveys combined with quick turn-around Sr-90 sample results will be used to segregate pilings into two groups: those that clearly have contamination present in soils above them and those that do not. These groupings will be used to implement Phase 1 FSS data collection protocols as described in the FSSP.

7.2 HLW Transfer Trench Contamination Status

The planned Phase 1 decommissioning activities in WMA 3 will remove the HLW transfer lines and leave behind the concrete HLW transfer trench. The assumption is that the exterior of the trench has not been impacted. Remedial action surveys will be conducted inside the empty HLW transfer trench to establish the radiological status of the trench after removal of the transfer line. The trench is approximately 500 ft long, six to 20 ft wide, with a height of six to nine ft.

Before initiating data collection with the trench, radiological safety surveys conducted during the removal of the transfer lines will be reviewed to determine if there is any immediate evidence of elevated areas.

Data collection for the trench will include two types of scans, one using an appropriately shielded NaI detector to evaluate the potential for volumetric contamination within the concrete, and the second with a zinc sulfide (ZnS) scintillation or gas proportional detector to evaluate for the presence of surface beta contamination. In the case of an NaI detector, shielding may be required to limit the field of view of the detector to the area of concrete of interest, and to mitigate potential shine effects from other portions of the trench. In both cases, surveys will be conducted to provide 100% coverage of the trench floor and 25% coverage of the trench sides. If appropriate coordinate/measurement logging systems are combined with the detectors, digitally recorded scans will be employed in a manner that captures readings and coordinates digitally. Otherwise, direct readings will be taken at a density of one reading per one m^2 with the results recorded in field notebooks.

The purpose of these scans is to document the contamination status of the transfer trench upon completion of planned Phase 1 activities.

7.3 Removed Infrastructure Footprint Contamination Status

There are a number of Phase 1 activities that will result in the removal of concrete pads, hardstands, etc. outside the footprint of the WMA 1 and WMA 2 deep excavations. In each of these cases, the presence of this infrastructure would have precluded thorough characterization of underlying soils by the CSAP data collection prior to infrastructure removal.

- In some cases, this infrastructure will exist in areas where there is known contamination at depths greater than one m. At these locations, the area will not be a candidate for Phase 1 FSS data collection, even if there is not a reason to believe surface soils exposed by infrastructure removal are contaminated above surface soil CG levels. In these cases, the purpose of remedial action survey data collection after infrastructure removal is to document the contamination status of the exposed soils for Phase 2 planning purposes.

- In other cases, the exposed soils themselves may clearly pose surface soil CG concerns. At these locations, DOE may choose to remove contaminated soils as part of Phase 1 activities until surface soil CG standards have been achieved. In these cases, the purpose of remedial action surveys is to support the removal of contaminated soils and to indicate when surface soil CG standards have likely been achieved.

- Finally, there may be cases where there is no evidence of subsurface contamination at depths greater than one m, and the exposed soils resulting from infrastructure removal likely meet surface soil CG requirements. At these locations, the purpose of the remedial action survey data collection is to document the contamination status of the exposed soils in preparation for Phase 1 FSS data collection, should DOE choose to perform Phase 1 FSS activities.

In all three of the cases described above, the following minimum remedial action survey data collection will take place. A logged GWS will be performed consistent with the FSS protocols (as defined in the Phase 1 FSSP). If there are indications of surface soil CG exceedances based on scan results, biased samples will be collected from those locations and submitted for quick turn-around analysis for Cs-137 and Sr-90. If DOE chooses to remove soils exceeding surface soil CG standards, soil removal will take place and logged GWS combined with biased soil sampling will be repeated for the affected areas. If DOE chooses not to remove soils or scan/biased sampling data indicate contamination levels likely meet surface soil CG requirements, one 5-increment composite sample per 200 m^2 area will be collected to a depth of 15 cm and submitted for quick turn-around analysis for Cs-137 and Sr-90.

In some instances, there may be concerns about subsurface contamination beneath infrastructure that could not be fully addressed until the infrastructure was removed. In these cases, the minimum remedial action survey data collection described above may be supplemented with vertical soil cores from an appropriate depth, with down-hole bore scans every 15 cm and selective biased sampling of specific vertical subsurface soil layers based on scan results. In the case of biased sampling, the samples will be submitted for quick turn-around analyses of Cs-137 and Sr-90.

7.4 Excavation Efficacy

Data will be collected to guide Phase 1 DP soil removal, to support soil segregation for waste disposal purposes, and/or to verify that the remediation goals for that particular location or area have been achieved. Details about data collection to support soil removal and to verify that remediation goals have been met for the deep WMA 1 and WMA 2 excavations are described in Section 7.1. Details about data collection verify that remediation goals have been met and/or to establish the contamination status of remaining exposed soils are described in Section 7.3. Details about data collection to support soil segregation for waste disposal purposes may be described in a Phase 1 DP waste management plan developed for this purpose.

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8.0 REFERENCE AREA

A surface soil reference area will be established and maintained for the duration of Phase 1 activities. The reference area will be approximately 2,000 m^2 in size and will encompass surface soil types and conditions similar to those expected within the WVDP premises. The reference area will have no historical evidence of contamination from NFS or WVDP activities and there will be no reason to believe such impacts might exist. Once established, the perimeter of the reference area will be clearly demarcated, the interior brushed to allow easy access for sampling and gross activity surveying, and the area protected from intrusion or disturbance for the duration of Phase 1 activities.

8.1 Gross Activity Survey Reference Data Collection

One purpose of the reference area is to assist in the development of gross activity survey data sets that can be used for background purposes and to evaluate background performance of various detectors that may be deployed on the WVDP premises in support of gamma surveys.

A 100 m^2 area within the reference area will be selected and further protected through the use of a removable cover in a manner that maintains relatively stable soil moisture conditions for this area. The purpose of this cover is to allow reproducible results from gross gamma scans and ensure comparability between gross activity scans of this area conducted by different detectors at different times.

Section 11.5 contains details about the data collection required for this 100 m^2 area.

8.2 Background Soil Sample Reference Data Collection

The reference area will be sampled once, at the initiation of CSAP activities. The purpose of this sampling and analysis will be (1) to establish a background data set that can be used for WRS statistical tests as part of the FSS process, if that proves necessary, and (2) to establish background performance for the analytical methods that will be used to support Phase 1 decommissioning data collection activities.

Sampling and analysis will proceed as follows:

1. The reference area will be divided into ten 200 m^2 areas. Two sets of five soil samples will be collected from locations systematically distributed across each 200 m^2 area. One set of samples

will be representative of soils from the surface to a depth of 15 cm. The second set will be representative of soils from the surface to a depth of one m. Each sample will consist of a minimum of 1 kg of soil. Each sample will be field homogenized, containerized, and labeled in a manner that clearly identifies the area from which it was taken and the depth profile it represented.

2. One composite sample will be formed for each 200 m^2 area using samples representative of the 15 cm depth interval, and one composite will be formed for each 200 m^2 area using samples representative of the 1-m depth interval. In each case, the composites will be formed by sub-sampling the original samples in a manner that results in a composite soil sample mass sufficient to allow analysis of all 18 ROI and the 12 radionuclides of potential interest, and in a manner that results in each sample contributing the same mass of soil to the composite.

3. The resulting 20 composite samples (10 samples representing a 15 cm surface soil depth and 10 samples representing a 1-m surface soil depth) will be submitted for analysis of all 18 ROI and the 12 radionuclides of potential interest. In addition, one of the original samples representing a 15 cm soil depth and one representing a 1 m soil depth from each of the 200 m^2 areas will be selected at random and will be submitted for analysis of all 18 ROI and the 12 radionuclides of potential interest. The remaining original soil samples will be archived.

8.3 Radionuclide-Specific Background Activity Concentrations

In many instances, the CSAP pre-remediation decision-making process described in the attached appendices requires a determination of whether soil sample results are consistent with background conditions or not. The Phase 1 DP provides an analysis of background activity concentrations for radionuclides of interest in Section 4.2.2 and Appendix B based on historical data, in the case of surface soils and sediments, and on a combination of historical data and more recent sampling results for subsurface soils. As part of the analysis, average and maximum results were presented.

For CSAP pre-remediation decision-making, background comparisons will be based on results from the reference area surface soil sampling. The 95%UTL will be estimated for each radionuclide that could be expected to be present in measurable quantities in background soils (i.e., naturally-occurring radionuclides and those anthropogenic radionuclides present in background surface soils due to historical fall-out) based on the 0 – 15 cm deep composite sample results, the 0 – 1 m deep composite sample results, and the 0 – 15 cm deep discrete sample results. The raw sample results will be used to perform this calculation regardless of whether sample results are considered detections or not.

Background comparisons will be based on sample type and depth (i.e., composite samples will be compared to reference area composite sample results, discrete sample results to discrete sample results, 1 m deep samples to 1 m deep reference area sample results, 15 cm deep samples to 15 cm deep reference area sample results). For surface soils, a sample result will be considered inconsistent with background if the activity concentration of one or more radionuclides exceed their respective 95%UTL by more than three times the reported error associated with the reported result. For subsurface soils, the same rule will apply as for surface soils for those radionuclides that are naturally occurring. For those radionuclides that are anthropogenic (and consequently not expected to exist at measurable levels in subsurface soils), a result that is greater than three times its reported uncertainty will be considered inconsistent with background conditions.

Sediment sample results will be compared to 15 cm deep discrete surface soil sample results, using the same protocol as described above for surface soils.

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9.0 CIVIL SURVEYING AND COORDINATE CONTROL

Phase 1 decommissioning data collection will require various levels of civil surveying support. The section identifies the various levels of civil surveying support that may be required as part of Phase 1 activities. The information contained in this overview is based on the USACE EM 1110-1-1005 "Engineering and Design: Control and Topographic Surveying" and USACE EM 1110-1-1003 "NAVSTAR GPS Surveying".

9.1 Civil Survey Types

The general types of survey support potentially required by Phase 1 decommissioning activities going forward include the following:

1. ***Reconnaissance Topographic Surveys***. Reconnaissance surveys are site mapping surveys intended to layout general site features in support of general decision making. Reconnaissance survey information can potentially be taken from existing aerial fly-overs, hand-held differentially corrected global position system (GPS) surveys, or existing maps. Relative feature coordinate accuracy is of importance; absolute feature coordinate accuracy is of lesser importance. Reconnaissance surveys may be a precursor to more detailed, accurate, and costly civil surveys.

2. ***Detailed Topographic Surveys***. Detailed surveys are the basis for detailed plans showing site layout and facilities. Detailed topographic surveys can be completed using a total station, GPS, laser scanning, plane table, and/or photogrammetric methods. In the context of the WVDP premises, detailed surveys are also used to support environmental data collection efforts. Detailed topographic surveys are for planning and data collection support purposes and have accuracy standards that are specified suitable for the planning needs requiring support. Accuracy standards can vary widely depending on data quality needs. For example, an accurate elevation measurement for a gamma reading of a soil surface may not be necessary but, for a monitoring well, an accurate top-of-casing measurement is essential.

3. ***Utility Surveys***. Utility surveys typically fall into two categories: surveys of newly installed utilities (see As Built Surveys) and surveys of existing utility systems, including above ground,

ground surface, and subsurface utilities. For the WVDP premises, existing utility surveys potentially serve several very important purposes such as identifying subsurface areas where contamination may be present and providing information necessary for remedial and decommissioning design work. Additionally, the existing utility surveys are essential for safety reasons during on-site decommissioning work (safe overhead clearance, safe digs, etc.). Section 5 of this plan described buried infrastructure/utility survey requirements.

4. ***Site Plan Engineering Drawing Surveys***. Site plan engineering drawing surveys are surveys conducted to support the conception, justification, design, and build process for maintenance, construction, decommissioning, and remediation activities. The accuracy requirements for site engineering drawings can vary dramatically from feature to feature depending on the significance of the feature to the ultimate design.

5. ***As-Built Surveys***. As-built surveys are intended to show actual site conditions for completed projects for record and/or payment purposes. As-built surveys typically have accuracy requirements similar to detailed surveys completed for planning purposes. In the case of excavations, as-built surveys are important for costing and payment purposes. In the case of utilities and structures, as-built surveys are an important part of appropriate facilities management. In all cases, as-built surveys are important quality control checks on work that was performed to determine that required specifications were met, and if there were deviations from drawn plans, to document the reasons why those deviations occurred. In the case of WVDP, as-built surveys will also document Phase 1 decommissioning activities that affect the premise's land surfaces for FSS purposes and Phase 2 planning.

9.2 Survey Accuracy Requirements

Reconnaissance surveys will be conducted with accuracy sufficient to obtain accurate relative locations of important site features. Typically in this context differentially corrected GPS is sufficient.

In situ field screening data collection (e.g., gross activity scans) will be conducted with data quality expectations as specified in related task orders. This may range from horizontal +/- 1 m to horizontal +/- 1 centimeter (cm). Vertical accuracy may range from "not pertinent" to +/- 1 cm. Examples of where vertical accuracy is not important are in area-wide gamma surveys of existing land surfaces. Examples where vertical accuracy is important are surveys of the floors and walls of excavations.

Fixed point data collection (e.g., soil sample, monitoring well installation, etc.) will be conducted with data quality expectations as specified in related task orders. This may range from +/- 10 cm to +/- 1 millimeter (mm) for both vertical and horizontal coordinates.

For utility, engineering designs, and as-built surveys, accuracy requirements reference USACE EM 1110-1-1005 (January 2007) recommendations, and generally follow recognized industry standards. Earthwork is associated with Third Order (Class II) to Fourth Order accuracy. Utility surveys are typically associated with Third Order (Class II) accuracy. Engineering design and as-built surveys may range up to Second Order, Class II requirements depending on the structure component.

9.3 Survey Documentation

For the sake of consistency and data integration, all data sets generated that include spatial dimensions will have, at minimum, feature coordinates provided in State Plane feet, New York NAD 1983. Electronic coordinate information must be provided, and may be supplied in one of the following formats: ASCII text, Excel, or Environmental Sensitivities Research Institute (ESRI) shapefile. Electronic data deliverables will be organized and submitted in a fashion consistent with survey objectives.

Electronic maps, as required by task orders, will be delivered in AutoCAD dwg format.

The WVDP maintains a set of survey monuments for the WVDP premises suitable for horizontal and vertical control. Phase 1 data collection activities that involve the collection of survey coordinates will use these monuments as reference points and for quality control purposes.

Field notebooks will be maintained and used to identify (at a minimum) for each round of data collection the following: date, crew member names, survey instruments used including serial numbers as appropriate, data collection purpose, information pertinent to the quality of coordinate information, and supplemental descriptive data as appropriate (e.g., descriptive text, sketches, etc.).

Data sets that include spatial coordinates will be delivered electronically in a manner that clearly links site features with their coordinates, that specifies the method for obtaining coordinates, that time stamps coordinates (as appropriate), and that describes the level of accuracy associated with the coordinate data.

All delivered data sets will include documentation that the surveying performance requirements as specified in associated task orders were met.

A variety of surveying methods can potentially be used for determining coordinate information for site features. These include (but are not limited to) total stations (robotic or manually operated), differentially corrected GPS, kinematic and real-time kinematic GPS, and terrestrial Light Detection and Ranging (LIDAR). The appropriate technology selection will depend on the accuracy needs associated with specific task orders, logistical parameters (i.e., presence of interfering tree cover, line-of-sight issues, etc.), and cost. Surveying requirements specifications will be performance based with the expectation that contractors will deploy the most appropriate technology meeting those performance requirements given the context of the work to be done.

10.0 FIELD ACTIVITIES

This section provides additional detail regarding CSAP field activities.

10.1 Soil Sampling Protocols

Systematic and biased CSAP soil sampling, in general, will follow the protocols outlined below. Exceptions may be made for biased soil samples where the nature of the location (e.g., adjacent to infrastructure, excavation walls, etc.) requires an adjustment. In those cases, the reason for the deviation and the nature of the deviation must be noted in a preservable manner (e.g., field notebook dedicated to this purpose). Additional details about sampling tools and related field protocols will be described in standard operating procedures to be developed by the contractor responsible for CSAP data collection.

In general, surface soil sampling will be conducted in a manner that yields a sample representative of the top 0 to 15 cm of soil and/or the top 0 to 1 m of soil. Where surface soil cover is present (e.g., gravel, asphalt, concrete, etc.), the top of soil is defined as the interface between the overlying surface cover and the underlying soils. In some cases, such as hardstands, surface cover can be more than 1-m thick. For areas where surface cover and some underlying soil is removed in support of Phase 1 decommissioning activities (e.g., building slab removal), the exposed underlying soil surface will be considered surface soils (with the exception of the deep WMA 1 and WMA 2 excavations).

Surface soil samples may be discrete "grab" samples representative of a specific location or composite samples representative of specific areas of interest formed from multiple discrete samples systematically placed across the area of interest. Examples of the former are samples collected from the footprint of ditches or streams. Examples of the latter are most surface soil sampling scenarios. In the latter case the size of areas of interest can range from small (e.g., one m^2 in the case of samples collected to evaluate GWS performance) up to 200 m^2 in size. The latter is consistent with protocols contained in the Phase 1 FSSP; a justification for composite sampling can also be found in the Phase 1 FSSP.

In general, discrete soil sampling will be used in the following situations:

- Sampling of ditches – the exception to this rule is sampling to evaluate sediment CG_w compliance in those portions of Erdman Brook and Franks Creek where the sediment CG_w requirements apply.

- Subsurface sampling involving soil the retrieval of soil cores to depths greater than one meter, or subsurface sampling through surface cover (e.g., asphalt, concrete, hardstands, etc.).

In general, composite soil sampling will be used in the following situations:

- Sampling of sediments in those portions of Erdman Brook and Franks Creek where CG_w requirements apply. In this setting composites will typically be three-sample composites, with one sample coming from the stream centerline and the other two from opposing banks.

- Biased sampling of surface soils in response to GWS data where those data indicate the presence of an elevated area or potential "hot spot". In this instance, a composite sample will be formed to be representative of the area of concern using a five-sample compositing strategy. The maximum area to be represented by a composite sample will be 100 m^2. If elevated areas or "hot spots" exceed 100 m^2 in size, more than one composite sample will be required to represent that area.

- Systematic surface soil sampling where significant surface cover is not an issue. In this setting, composites will be formed to be representative of a 200 m^2 area using a five-sample compositing strategy. The rationale for a 200 m^2 area is that when areas are sampled as part of the FSS process, a typical MARSSIM Class 1 FSS unit will be 2,000 m^2 in size and will have approximately ten sampling locations allocated to it, resulting in a sampling density of one per 200 m^2 area.

Composite surface soil samples will be 5-point composite samples formed from five increments or discrete soil samples representative of a specific area. The five increments will be collected with one increment centered on the location of interest, and the other four increments equally spaced along diagonals associated with a square centered on the location of size equal to the area to be represented. Soil increment mass must be identical for each of the five increments. Sampling tools must be thoroughly decontaminated (if reused) between composite samples; however, between increments for any given composite sample wiping the tool clean of visible dirt will be sufficient.

In general, subsurface soil samples will be representative of 1-m intervals. Depending on the type of method used to retrieve a soil core, samples may be formed from all of the soils within a 1-m interval, or they may be formed by systemically sub-sampling soils from a 1-m interval.

In the case of all soil sampling, sufficient mass will always be collected to allow for the analysis of all 18 ROI plus the 12 radionuclides of potential interest.

10.2 Groundwater Sampling Protocols

Limited groundwater sampling will occur as part of planned CSAP activities. Groundwater data collection will primarily be focused on determining the presence/absence of groundwater contamination for specific areas and also on contamination extent.

Many of the ROI are not particularly mobile in groundwater. The primary exception is Sr-90, which has been encountered at detectable activity concentrations in groundwater across the WVDP premises. Tritium has also historically been observed in groundwater above background levels across the WVDP premises, although tritium is not considered a Phase 1 ROI. Tritium can be a useful indicator of groundwater contamination since its movement through the subsurface is not constrained by soil interactions; however, in the case of the WVDP, tritium's relatively short half-life means that it may no longer be a reliable indicator for specific areas of contamination impacts. Approximately two to four tritium half-lives have passed since the time that most subsurface releases would have taken place.

Accordingly, groundwater sampling and analysis will focus on Sr-90. Groundwater samples will primarily be "grab" samples collected from specific depth intervals. Task-specific work plans and associated standard operating procedures will specify the methods to be used to obtain depth-specific groundwater samples. In general, sufficient volume will be collected to allow for analysis of Sr-90; groundwater samples collected in this manner will be filtered prior to analysis. Additional details about sampling tools and related field protocols will be described in standard operating procedures to be developed by the contractor responsible for CSAP data collection.

10.3 Sample Chain-of-Custody/Documentation

10.3.1 Field Logbooks

All information pertinent to field activities, including field instrument calibration data, will be recorded in field logbooks. The logbooks will be bound and the pages will be consecutively numbered. Entries in the logbooks will be made in black waterproof ink and will include, at a minimum, a description of all activities, individuals involved in field activities, dates and times of sampling, weather conditions, any problems encountered, and all field measurements. Lot numbers, manufacturer names, and expiration dates of standards used for field instrument calibration will be recorded in the field logbooks. A summary of each day's activities also will be recorded in the logbooks.

Sufficient information will be recorded in the logbooks to permit reconstruction of all CSAP data collection activities conducted. Information recorded on other project documents will not be repeated in the logbooks except in summary form where determined necessary. When not being utilized during field work, all field logbooks will be kept in the possession of the appropriate field personnel or in a secure place. Upon completion of the field activities, all logbooks will become part of the final project records file.

Entries recorded in logbooks will include, but not be limited to, the following information:

- Author, date, and times of arrival to and departure from the work site;
- Purpose of the CSAP field activity and summary of daily tasks;
- Names and responsibilities of field crew members;
- Sample collection method;
- Number and volume of samples collected;
- Information regarding sampling changes, scheduling modifications, and change orders;
- Details of sampling locations, including a sketch map illustrating the sampling locations (in the case of composite samples, this includes the locations of contributing soil increments);
- Field observations;
- Types of field instruments used and purpose of use, including calibration methods and results;
- Any field measurements made that were not recorded electronically;
- Sample identification number(s); and
- Sample documentation information.

10.3.2 Photographs

Photographs can be an important source of supplemental information for the CSAP data collection process. Examples where photographs are appropriate include visual evidence of potential contamination, evidence of obstructions that require moving sampling locations, documentation of sampling points, and anomalous conditions that might affect either data quality or data interpretation. Photographs taken during CSAP activities will be noted in the field logbook in accordance with the requirements of the field procedure. If photographs are taken to document sampling points to facilitate relocating the point at a later date, two or more permanent reference points should be included within the photograph. In addition to the information recorded in the field logbook, one or more site photograph reference maps will be prepared as required.

10.3.3 Sample Numbering System

A unique sample numbering scheme will be used to identify each sample collected for laboratory analysis. The purpose of this numbering scheme is to provide a tracking system for the retrieval of analytical and field data on each sample. Sample identification numbers will be used on all sample labels or tags, field data sheets and/or logbooks, chain-of-custody records, and all other applicable documentation used during the project.

The sample numbering scheme used for field samples will also be used for duplicate samples so that these types of samples will not be discernible by the laboratory. Other field QC samples, however, will be numbered so that they can be readily identified.

10.3.4 Sample Labels

Labels will be affixed to all sample containers during sampling activities. Information will be recorded on each sample container label at the time of sample collection. The information to be recorded on the labels will be as follows:

- Sample identification number,
- Sample type,
- Sampled interval (e.g., 0 – 15-cm),
- Site name and sampling station number,
- Analysis to be performed,
- Type of chemical preservative present in container,

- Date and time of sample collection, and
- Sampler's name and initials.

10.3.5 Cooler Receipt Checklist

The condition of shipping coolers and enclosed sample containers will be documented upon receipt at the analytical laboratory. This documentation will be accomplished by using the cooler receipt checklist as described in the project's QAPP. A copy of the checklist will either be placed into each shipping cooler along with the completed chain-of-custody form or provided to the laboratory at the start of the project. Another copy of the checklist will be faxed to the contractor's field manager immediately after it has been completed by the laboratory. The original completed checklist will be transmitted with the final analytical results from the laboratory.

10.3.6 Chain-of-Custody Records

Chain-of-custody procedures implemented for the project will provide documentation of the handling of each sample from the time of collection until completion of laboratory analysis. The chain-of-custody form serves as a legal record of possession of the sample. A sample is considered to be under custody if one or more of the following criteria are met:

- The sample is in the sampler's possession,
- The sample is in the sampler's view after being in possession,
- The sample was in the sampler's possession and then was placed into a locked area to prevent tampering, and
- The sample is in a designated secure area.

Custody will be documented throughout the project field sampling activities by a chain-of-custody form initiated on each day that samples are collected. The chain-of-custody form will accompany the samples from the project premises to the laboratory and will be returned to the laboratory coordinator with the final analytical report. All personnel with sample custody responsibilities will be required to sign, date, and note the time on a chain-of-custody form when relinquishing samples from their immediate custody (except in the case where samples are placed into designated secure areas for temporary storage prior to shipment). Bills of lading or air-bills will be used as custody documentation during times when the samples are being shipped from the project premises to the laboratory, and they will be retained as part of the permanent sample custody documentation.

Chain-of-custody forms will be used to document the integrity of all samples collected. To maintain a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory, chain-of-custody forms will be filled out for sample sets as deemed appropriate during the course of fieldwork. An example of the chain-of-custody form to be used for the project will be provided in the project QAPP.

The individual responsible for shipping the samples from the field to the laboratory will be responsible for completing the chain-of-custody form and noting the date and time of shipment. This individual will also inspect the form for completeness and accuracy. After the form has been inspected and determined to be satisfactorily completed, the responsible individual will sign, date, and note the time of transfer on the form. The chain-of-custody form will be sealed in a plastic bag and placed inside the cooler used for sample transport after the field copy of the form has been detached. The field copy of the form will be appropriately filed and kept at the project premises for the duration of the activities.

In addition to the chain-of-custody form, chain-of-custody seals will also be placed on each cooler used for sample transport. These seals will consist of a tamper-proof adhesive material placed across the lid and body of the coolers. The chain-of-custody seals will be used to ensure that no sample tampering occurs between the time the samples are placed into the coolers and the time the coolers are opened for analysis at the laboratory. Cooler custody seals will be signed and dated by the individual responsible for completing the chain-of-custody form contained within the cooler.

10.3.7 Receipt of Sample Forms

The contracted laboratory will document the receipt of environmental samples by accepting custody of the samples from the approved shipping company. In addition, the contracted laboratory will document the condition of the environmental samples upon receipt.

10.4 Documentation Procedures

The tracking procedure to be utilized for documentation of all samples collected during the project will involve the following series of steps.

- Collect and place samples into laboratory sample containers.
- Complete sample container label information.
- Complete sample documentation information in the field logbook.

- Complete project and sampling information sections of the chain-of-custody form(s).
- Complete the air bill for the cooler to be shipped.
- Perform a completeness and accuracy check of the chain-of-custody form(s).
- Complete the sample relinquishment section of the chain-of-custody form(s) and place the form(s) into cooler.
- Place chain-of-custody seals on the exterior of the cooler.
- Package and ship the cooler to the laboratory.
- Receive cooler at the laboratory, inspect contents, and fax (or scan and email) contained chain-of-custody form(s) and cooler receipt form(s), as defined in the project QAPP.
- Transmit original chain-of-custody form(s) with final analytical results from the laboratory.

10.5 Corrections to Documentation

All original information and data in field logbooks, on sample labels, on chain-of-custody forms, and on any other project-related documentation will be recorded in black waterproof ink and in a completely legible manner. Errors made on any accountable document will be corrected by crossing out the error and entering the correct information or data. Any error discovered on a document will be corrected by the individual responsible for the entry. Erroneous information or data will be corrected in a manner that will not obliterate the original entry, and all corrections will be initialed and dated by the individual responsible for the entry.

10.6 Sample Packaging and Shipping

10.6.1 Sample Packaging

Sample containers will be packaged in thermally insulated rigid-body coolers. Sample packaging and shipping will be conducted in accordance with procedures that will be described in the project QAPP and applicable U.S. Department of Transportation (DOT) specifications. A checklist to be provided in the project QAPP will be used by the individual responsible for packaging environmental samples to verify completeness of sample shipment preparations. In addition, the laboratory will document the condition of the environmental samples upon receipt. This documentation will be accomplished by using the cooler receipt checklist to be provided in the project QAPP.

10.6.2 Additional Requirements for Samples Classified as Radioactive Material

Transportation of radioactive materials is regulated by the DOT under 49 CFR 173.401. Samples generated during project activities will be transported in accordance with procedures that ensure compliance with regulatory requirements. The following will be performed for radioactive materials:

The cooler must have the shipper and receiver addresses affixed to it in case the courier air bill is lost during shipping.

- Samples will be screened prior to packing to determine if they meet the definition of a DOT class 7 (radioactive) material.

- For samples that meet DOT requirements for radioactive materials:
  - The cooler will be surveyed for radiation and to ensure the package meets the requirements for limited quantity as found in 49 CFR 173.421.
  - A notice must be enclosed on the inside of the cooler that includes the name of the consignor and the statement "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910." The outside of the inner packaging or, if there is no inner packaging the outside of the package itself, must be labeled "Radioactive."

- The following labels will be placed on the cooler:
  - Appropriate hazard class label; and
  - "Cargo Aircraft Only," if applicable.

- The air bill for the shipment will be completed and attached to the top of the shipping systematic gamma scan box/cooler which will then be transferred to the courier for delivery to the laboratory.

10.6.3 Sample Shipping

All environmental samples collected during the project will be shipped no later than 48 to 72 hours after the time of collection. The latter time of 72 hours may be necessary if the samples are collected on a Friday and have to be shipped on a Monday via commercial courier. During the time period between collection and shipment, all samples will be stored in a secure area. All coolers containing environmental samples will be shipped overnight to the laboratory via Federal Express, similar courier, or laboratory courier.

10.7 Investigation Derived Waste

The field activities described in this plan will generate Investigation Derived Waste (IDW) materials. These materials generally will consist of soil, sludge, water, and spent personal protective equipment (PPE) resulting from sampling and associated project premises activities. When accumulated, these materials must be managed appropriately to minimize the exposure and risks to human health and the environment while adhering to applicable regulatory requirements. IDW will be managed and disposed of consistent with DOE waste management procedures. The objective of this section is to establish specific management practices for the handling and subsequent disposition of these materials.

The IDW includes all materials generated during project performance that cannot be effectively reused, recycled, or decontaminated in the field. It consists of materials that could potentially pose a risk to human health and the environment (e.g., sampling and decontamination wastes) and also materials that have little potential to pose risk to human health and the environment (e.g., sanitary solid wastes). Two types of IDW will be generated during the implementation of field activities: indigenous and non-indigenous. Indigenous IDW expected to be generated during CSAP activities will primarily be soils or soil-like material. Non-indigenous IDW expected to be generated includes decontamination fluid/water and miscellaneous trash, including PPE. When accumulated, the media will be managed appropriately to minimize exposure and risks to human health and the environment while adhering to applicable regulatory requirements.

In some instances, it may be appropriate to return IDW to its original location; an example of this would be returning trenched soils to their trench after characterization work at a particular location is complete. In other cases, returning IDW to its original location is not an option. IDW minimization is a goal; for each field activity that is expected to generate IDW, the field sampling plan will identify the nature of the IDW expected to be generated, and the approaches to be used to minimize the amount of IDW that will require handling and disposal.

10.8 Field Decontamination

Field sampling equipment used during soil sampling will be decontaminated between samples. Equipment to be decontaminated includes stainless steel scoops, bowls, spoons, split spoon samplers, core barrels, and hand auger barrels. Other equipment used during sampling activities that does not directly contact sample materials (down-hole rods, shovels, etc.) will be cleaned by a pressurized steam cleaner to remove visible soil contamination.

In the case of composite samples, wiping sampling equipment clean of visible removable soils will be sufficient between increments for any given composite sample; however full decontamination as described above is required between the collection of composite samples.

Field decontamination will be conducted in an area near the field equipment staging area or in an area approved by the DOE. Decontamination activities will be conducted so that all solid and liquid wastes generated can be containerized and disposed.

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11.0 GROSS ACTIVITY SURVEYS

Gross gamma activity surveys are an important component of the Phase 1 CSAP data collection effort. An initial, site-wide gross GWS will be conducted to provide a better understanding of the contamination status of accessible surfaces within the WVDP fence line. Gross gamma surveys will also be used to support soil remediation activities, both as part of the large WMA 1 and WMA 2 excavations, and during the removal of soils, hardstands, and building pads outside the WMA 1 and WMA 2 excavation footprints.

This section describes how these surveys will be conducted. All survey data will be logged along with coordinate information so as to allow the preservation of results and subsequent presentation and analysis of the data collected for decision-making purposes.

11.1 Surface Conditions

The property within the WVDP fence line contains a variety of surface conditions. These include (but are not limited to) the following: vegetated soil surfaces, gravel hardstands, unpaved roads, paved roads, parking lots and sidewalks, surface impoundments, geomembrane-capped landfills, structure footprints (building slabs where buildings have been removed as well as existing structures), marshes, and streams. Measurable radionuclide surface contamination is known to exist for portions of the WVDP premises; portions of the property are currently fenced and identified as radiologically-controlled areas because of surface soil or sediment contamination (Figure 6). Not all 165 acres of land will be accessible for the site-wide GWS. For planning purposes it is estimated that the accessible portion of the site comprises approximately 140 acres of property. Land grubbing will be conducted as necessary to allow for access where vegetation growth is problematic.

Areas that will not be surveyed include marshes/wetlands where soil moisture conditions or standing water preclude GWS, the cap of the NDA, and building pads.

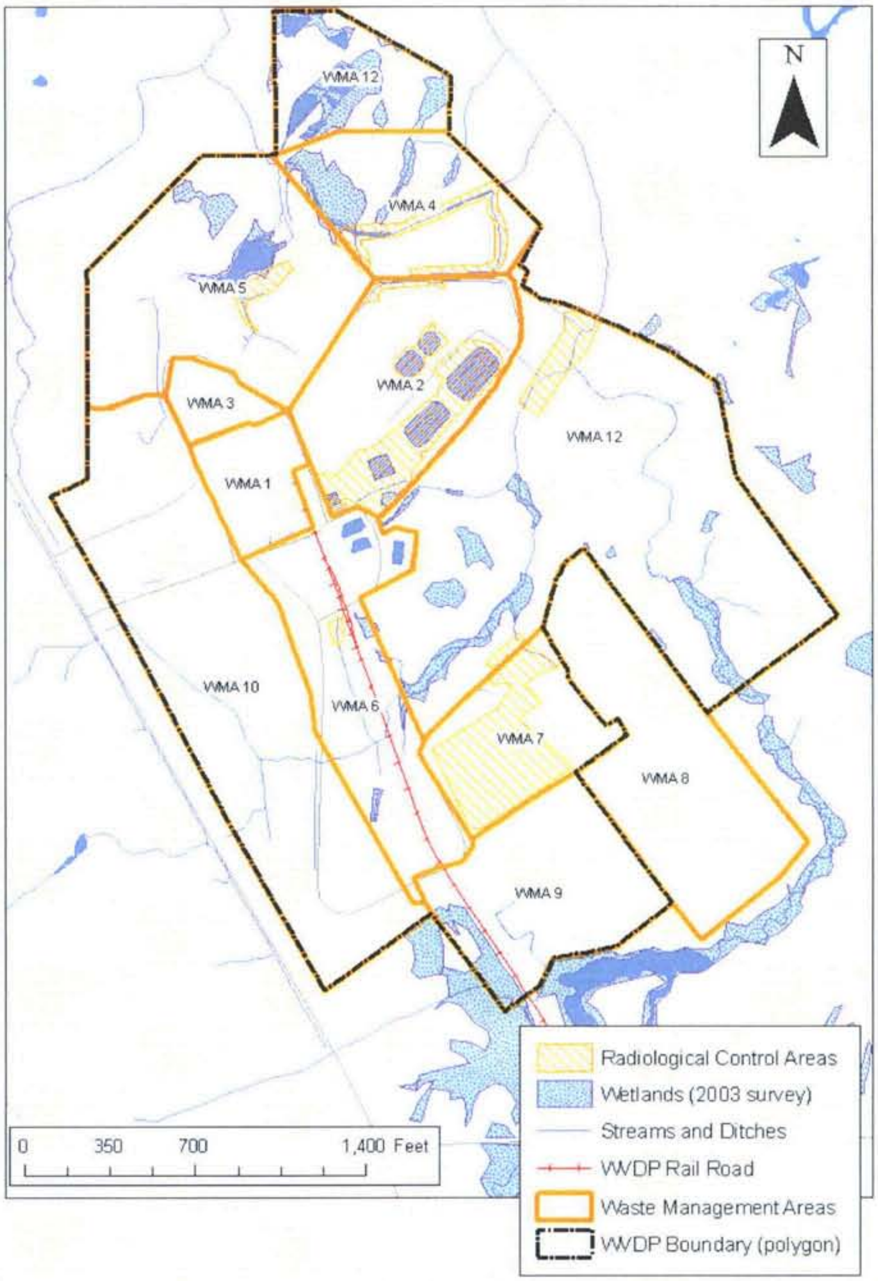

Figure 6 WVDP Radiologically-Controlled Areas

11.2 Detector Technologies

The Phase 1 DP identified 18 ROI. Some of the 18 are readily detectable by gross activity gamma surveys and others are not. Two radionuclides are known to have relatively widespread environmental impacts on-site: Cs-137 and Sr-90. Cs-137 is readily detectable at its CG levels but Sr-90 is not. There are areas of the WVDP premises where one or the other of these radionuclides exists in isolation. Examples include the northern border of the premises where surface contamination is likely only Cs-137 and its progeny (associated with the Cs-137 prong that extends to the north), and the north plateau groundwater plume extending underneath WMA 4, where subsurface contamination is likely only Sr-90 and its progeny. There are other areas of the WVDP premises where these two radionuclides are likely both present in varying ratios. In these instances they may also be commingled with one or more of the other 16 ROI.

Field survey instruments for soil contamination are generally limited to those that can detect photons (gamma ray and X-ray) only, given the uneven terrain and conditions encountered in the field. This is in contrast to survey instruments that can be used for buildings, many of which allow for the detection of alpha and beta contamination as well as photon emissions.

Four ROI have no or minimal photon emissions, making them impractical to detect with field scanning instruments. The other 14 ROI are potentially detectable by a field NaI detector. Table 4 provides estimates of minimum detectable concentrations (MDCs) for the 14 ROI that are potentially detectable by a NaI detector, along with the type of NaI detector expected to provide the lowest MDC.

As indicated by Table 4, a thin-crystal NaI detector, known as a FIDLER, provides the best performance for the greatest number of ROIs. Consequently, all GWS conducted as part of the CSAP will make use of a FIDLER.

In the case of Cs-137, MDC performance is better with a 2"x2" NaI detector. The FIDLER is relatively less sensitive to the higher-energy Cs-137 photons; however, a FIDLER is more sensitive to the low-energy Compton scattering that is associated with Cs-137 soil contamination. Consequently, the expectation is that a FIDLER will also provide a sufficiently low MDC for Cs-137. To test this assumption, early in the CSAP data collection process 2"x2" NaI detector performance will be compared with FIDLER detector performance for an area of the premises known to have Cs-137 surface soil contamination present. The methods for this comparison are explained in detail in Section 6.11. If the results are that the FIDLER provides sufficiently low MDC levels for Cs-137, only a FIDLER will be deployed for the remainder of gross gamma survey work. Alternatively, if the 2"x2" detector proves capable of identifying Cs-137 at levels that would be CG_w concerns and that the FIDLER cannot identify, then both a FIDLER and a 2"x2" NaI detector will be used for GWS.

Because of the range of field conditions and data collection requirements that fall under the CSAP, providing details about all potential detectors and their performance characteristics is beyond the scope of this document. However, for each field data collection activity conducted under the CSAP, a field sampling plan will be prepared. If the field work includes the collection of scanning data, the detector(s) to be used will be identified, their deployment configurations and protocols specified, their MDCs estimated, and appropriate QC details provided.

Table 4: Estimated Scanning Minimum Detectable Concentrations (MDCs) of Radionuclides in Soil

Radionuclide	Type of detector	Scan MDC (pCi/g)
Am-241	FIDLER	30
C-14	NA[1]	-
Cm-243	2" by 2" NaI	50
Cm-244	FIDLER	300
Cs-137	2" by 2" NaI	7[2]
I-129	FIDLER	60
Np-237	FIDLER	30
Pu-238	FIDLER	100[3]
Pu-239	FIDLER	200[3]
Pu-240	FIDLER	100
Pu-241	NA[1]	-
Sr-90	NA[1]	-
Tc-99	NA[1]	-
U-232	FIDLER	60
U-233	FIDLER	500
U-234	FIDLER	60
U-235	FIDLER	30
U-238	FIDLER	60

NOTES:

1 NA means not applicable; either there are no photons associated with the radionuclide or the photon yield is too low to allow for detection by field scanning instruments.

2 A specific calculation of scanning minimum detectable count rate for Cs-137 in soil performed in connection with preparation of the Phase 1 Decommissioning Plan yielded a value equivalent to 7 pCi/g Cs-137. A comparable value of 6.4 pCi/g is given in Table 6.7 of the MARSSIM when units are given in pCi/g.

3 While scan MDCs of 10 and 20 pCi/g are reported for Pu-238 and Pu-239, respectively, in Appendix H of MARSSIM, much larger values were reported elsewhere. The values given here are those expected to be reasonably achievable under field conditions.

11.3 Background

Because of the variety of surface cover that is present on the WVDP premises, background detector responses are expected to also vary significantly depending on the nature of the surface being scanned. While a surface soil reference area will be established and a background detector response developed for each detector used on the WVDP premises (see Sections 8 and 11.5), this reference area background will only be applicable to comparable areas of the WVDP premises where other types of ground cover such as pavement or hardstand material are not present.

Because of varying background conditions and because areas where contamination is present in surface soils may have more than one gamma-emitting radionuclide above background conditions, it will not be possible to establish a unique field investigation level for determining when contamination is present that potentially exceeds surface soil CG levels. Instead, gamma walkover data will be mapped and reviewed to identify spatial trends or localized anomalies that are indicative of the potential presence of contamination.

11.4 Protocols

Gross gamma activity surveys will use the following protocols:

- All gross gamma activity surveys will be conducted in a manner that allows the resulting data to be matched to coordinates and electronically logged.
- In general, measurement acquisition time will be one second.
- Surface scans will be conducted in a manner that provides at least one measurement per m^2.
- In general, surveys will be conducted with the detector approximately 15 cm from the ground surface.
- In general, surveys will be conducted by walking parallel lines with the detector swung in a serpentine fashion.

- In the event that a clearly elevated area has been identified, the field technician will collect additional static readings in the vicinity to more clearly define the footprint of the elevated area.

- In the event that shine is potentially present (see Section 11.5), steps will be taken to mitigate the effects of the shine on survey data quality.

- Scans will be electronically logged. Each measurement record will include a detector identifier, a technician identifier, a date and time stamp, coordinate information, a qualifier indicating coordinate measurement quality, and the gross activity observed (either as counts per minute or counts per second). Electronically logged data will be organized and files will be named in a manner that facilitates matching data files with specific areas. Different types of surface cover (e.g., exposed soils versus hardstand material versus asphalt versus compacted roads) will not be mixed in the same data file.

- For each area surveyed, field notebook notations will be made. The notations will include the date, a description of the area, the type of surface cover, the purpose of the survey, the name of the file(s) containing the logged data, soil moisture conditions, the name of the technician, the detector identifier, the form of coordinate capture used, and any pertinent meteorological information. Different types of surface cover will not be mixed in the same logged file.

11.5 Quality Control and Quality Assurance

The following activities represent the minimum quality control and quality assurance requirements for gross gamma activity surveys.

- Each detector used on the WVDP premises will undergo check source evaluations each day that it is used. The evaluations will follow a control chart developed and maintained for this purpose. The purpose of daily check source evaluations is to identify any deviations in expected detector response.

- A background reference area will be established and used for detector data quality evaluation purposes (see Section 8.1). The background reference area will be surveyed with each detector prior to the detector's initial use on the WVDP premises. These data will be logged. A 100 m^2 portion of the reference area will be covered in a manner that maintains relatively stable soil moisture conditions (the cover will be removed prior to each survey). Data from the reference area as a whole will be used to evaluate the range of detector background responses. Data from the covered area will be used to compare responses across detectors. The purpose of these comparisons is to allow the development of scaling factors, as necessary, to be used to standardize gamma walkover data from different detectors. Key parameters of interest are the average activity concentration observed, the standard deviation (as a measure of background variability), and the 95% and 99% Upper Tolerance Level (UTL) for the background concentration.

- A surface soil control point will be established and maintained through the life of Phase 1 activities. Each detector used on the WVDP premises will have two 30-second measurements made at the control point each day it is deployed, one at the start of a day's activities, and one at the end. These data will be recorded and a control chart developed and maintained for each detector. The purpose of this activity and the control chart is to identify transient soil/meteorological conditions that may be adversely affecting detector response or trends in detector behavior that may be a concern.

- Prior to surveying an area of interest, the potential for shine will be evaluated. Shine may be the result of proximity to a building with a history of structural contamination in the case of surface soil scans, or it may be a product of geometry and contamination in excavation walls, as may be the case in deep excavations. If shine is identified as a potential concern, the potential shine impact will be assessed through the use of shielding and/or comparing results from 15 cm height readings with 1 m height readings. If a determination is made that shine impacts could be significant, a mitigating strategy will be deployed. Examples of mitigating strategies would include the use of a shielded detector or the application of shine correction factors to acquired data.

- Data that are collected as part of gross gamma activity surveys will be mapped and reviewed for completeness (i.e., to ensure that there are no areas that lack survey coverage) and for indications of data quality problems, either in coordinate information or detector response. Examples of the former would be mapped data lines that deviate significantly from the known path or data points that clearly fall outside the area being surveyed. Examples of the latter are inexplicable trends in sequential readings that appear to be a function of time rather than location.

12.0 LABORATORY ANALYSES

Two levels of laboratory analyses are called for in this CSAP: Rapid and Standard.

12.1 Rapid Laboratory Analyses

The first level of laboratory analyses is for rapid turn-around analyses of Cs-137 and Sr-90 for soils and groundwater. "Rapid" is defined as results available within 48 hours of sample collection. Rapid turn-around is intended to support situations where decisions are being made about whether to continue sampling to depth, or to extend sampling laterally to bound contamination, or to continue excavation of contaminated soils, etc. In these cases, subsequent field activities are contingent on sample results and rapid availability of those results is a requirement. "Rapid" turn-around will likely be accomplished by deployment of on-site, dedicated analytical capabilities for Cs-137 and Sr-90, but may also be accomplished through the use of expedited shipping and quick-turnaround analyses at an off-site laboratory.

Although not expected, CSAP data collection activities may determine that other radionuclides are also significant dose concerns and potentially significant decision-drivers for in-field decision-making. If this occurs, rapid turn-around requirements may be expanded to include other radionuclides.

The detection limit requirements for rapid turn-around analyses of Cs-137 and Sr-90 are the same as those for standard off-site laboratory analyses. These detection limits may not be required for all samples analyzed on-site, but the on-site analytical capacity must exist for meeting these detection limits if necessary.

The accuracy and precision of on-site methods will be determined and monitored through the use of certified standards.

Other data quality parameters as described in Section 6.11 and Section 14.0 will also apply.

12.2 Standard Laboratory Analyses

The second level of laboratory analyses is for off-site laboratory analyses of the ROI. Table 5 lists the 18 ROI along with the required minimum detectable concentrations. MDC requirements are set to whichever is lower: (1) approximately 10 percent of the most restrictive radionuclide-specific CG, (2) 25 percent of background for naturally occurring radionuclides, or (3) standard laboratory MDCs. All laboratory instrumentation will be calibrated using National Institute of Standards and Technology (NIST)-traceable standards. In addition, the laboratory must be capable of analyzing for the additional 12 ROI as identified in Table 6. For these 12 radionuclides, standard laboratory detection limit requirements apply.

Laboratory methods, instruments, and sensitivities will be in accordance with New York State protocols for environmental analysis. Any laboratory used for environmental sample analysis will have appropriate New York State Department of Health Environmental Laboratory Approval Program certification or equivalent. Activity concentrations in soil will be reported in units of pCi/g. Groundwater/surface water sample results will be reported in units of pCi/l. Other quality control activities are incorporated into specific field survey procedures.

Of particular concern for both the on-site and off-site laboratory is the ability of the laboratories to adequately prepare and homogenize soil samples for analysis. Soil sample preparation protocols will be developed and presented as part of the overall standard laboratory operating procedures. The goal of soil sample preparation is that the error introduced by residual within-sample heterogeneity should be no more than the measurement error associated with the analytical procedure when activity concentrations are around the relevant CG. Conformance with this goal will be evaluated through the use of replicate sub-sampling and analysis of soil samples. The soil samples selected for replicate sub-sampling and analysis will be soil samples that exhibit activity concentrations for either Cs-137 and Sr-90 within the immediate range of the relevant surface soil CG_w requirement (i.e., from one half of the surface soil CG_w to three times the CG_w).

Off-site laboratory analytical quality will be monitored through the use of an independent QC laboratory and DOE data verification and validation procedures.

Table 5: Radionuclide Target Sensitivity for Laboratory Sample Analysis (source: Phase 1 DP, Table 9-5)

Nuclide	Instrument/Method	Target Sensitivity pCi/g[1]
Am-241	Alpha and/or gamma spectrometry	1[4]
C-14	Sample oxidizer and liquid scintillation	2[4]
Cm-234/244	Alpha and/or gamma spectrometry	1[4]
Cs-137	Gamma spectrometry	0.1[4]
I-129	Gamma spectrometry	0.06[2]
Np-237	Alpha and/or gamma spec	0.01[2]
Pu-238	Alpha spectrometry	1[3]
Pu-239/240	Alpha spectrometry	1[3]
Pu-241	Liquid scintillation	15[3]
Sr-90	Liquid scintillation	0.9[2]
Tc-99	Gas flow proportional counting	3[2]
U-232	Alpha spectrometry	0.5[2]
U-233/234	Alpha spectrometry	0.2[3]
U-235 (-236)	Alpha spectrometry	0.1[3]
U-238	Alpha spectrometry	0.2[3]

NOTES:

1 Dependent on sample size, counting time, etc.

2 Approximately 10% of the most restrictive radionuclide-specific cleanup goal identified in Table 5-14

3 25% of background for naturally occurring radionuclides

4 Standard laboratory MDCs

Table 6: Twelve Radionuclides of Potential Interest

Radionuclide	Naturally Occurring (Yes/No) / Half Life	Typical Soil Background Activity Concentrations (pCi/g)	NUREG 1757 Vol. 2 Appendix H Soil Screening Value (pCi/g)
Ac-227	Yes / 21.8 years	~ 0.05	0.5
Co-60	No / 5.3 years	not applicable	3.8
Cd-113m	No / 14.1 years	not applicable	NA
Eu-154	No / 8.6 years	not applicable	8
H-3	Yes / 12.3 years	negligible quantities	110
Pa-231	Yes / 32,760 years	~ 0.05	0.3
Ra-226	Yes / 1,602 years	~ 1	0.6
Ra-228	Yes / 5.8 years	~ 1	NA
Sb-125	No / 2.8 years	not applicable	NA
Sn-126	No / 12.4 days	not applicable	NA
Th-229	No / 7,340 years	not applicable	NA
Th-232	Yes / 1.4E10 years	~ 1	1.1

Notes: NA – screening value not available in Appendix H

Appendix H soil screening values are incremental to background

13.0 DOCUMENTATION AND REPORTING

A variety of data collection activities for a variety of purposes will be conducted as part of the CSAP. These activities will, in general, produce reports that summarize and analyze data and also present the data sets themselves. The reporting and documentation activities required by particular data collection tasks will be specified in task-specific work plans. However, the requirements are as follows.

The results from task-specific data collection activities (e.g., completing a premises-wide surface GWS) will be summarized and presented in formal reports. These reports will include, at minimum, the purpose of the data collection, the methods used to collect the data, a summary of the data results, a reference to where complete data results are available, a review of data quality indicators (DQI), and an analysis, as appropriate of the data results in the context of task-specific decision to be made.

Field notebooks will be maintained through the course of field work to capture data collection details that are pertinent to data interpretation and an evaluation of data quality. Field data will be entered and notebooks preserved in a manner that prevents inappropriate modification or loss of data.

All environmental data will be associated with coordinates of known and reported quality, as appropriate. In the case of subsurface samples (soil or groundwater), depths in relationship to a known and accurate elevation will be provided. All environmental data will be recorded, delivered, and preserved in an appropriate electronic format to facilitate storage, retrieval, dissemination, and analysis.

DOE or its contractors will maintain CSAP-related datasets in an electronic format that facilitates their maintenance, integration, retrieval, dissemination, and analysis through the life cycle of Phase 1 decommissioning activities.

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14.0 QUALITY ASSURANCE AND QUALITY CONTROL

QA/QC measures will be employed throughout the CSAP data collection process to ensure that the data produced are of acceptable quality. As necessary, a QAPP will be prepared to cover all project QA/QC requirements and activities that have not already been addressed by existing QA/QC procedures associated with the Phase 1 decommissioning process, consistent with the Phase 1 DP. Part of the QA/QC process is data validation. Data validation will take place as described in the Phase 1 DP QAPP.

DQI are quantitative and qualitative measures of the usability of the selected measurement methods (laboratory and field screening) for decision-making purposes. Such indicators include (but are not necessarily limited to) the accuracy, precision, representativeness, completeness, and comparability of the data. Data resulting from measurement instruments and methods will be evaluated in terms of these indicators.

- Accuracy addresses the potential for bias and lack of precision in laboratory analytical results and is typically monitored through the use of standards, spikes, blanks, and control charts, as appropriate, depending on the method. The accuracy requirement for off-site laboratory analyses is a relative standard error of 10%, as measured at the CG_w value, after correcting for precision.

- Precision reflects measurement variability as observed in repeated measurements of the same sub-sample; for radio-analytical methods the required precision is reflected by required method detection limits; in other words, specifying the required detection limits (see Table 5) is equivalent to specifying the required method precision. Required method detection limits are as specified in Section 12.

- Representativeness is guaranteed by appropriate sampling and analytical protocols and by collecting sufficient samples or obtaining sufficient measurements such that uncertainties introduced by the heterogeneity of contaminated media are sufficiently controlled for decision-making purposes. There is no formal quantitative requirement for representativeness; representativeness is monitored by ensuring that sampling and analytical protocols are, in fact, carried out during field and laboratory work and that the quantity of data collected are sufficient to allow decision-making with the necessary level of confidence.

- The data completeness goal for the CSAP is 80%, consistent with the Phase 1 FSSP. Comparability refers to how well data sets generated by CSAP work pertain to the decisions that need to be made. Comparability (or the lack thereof) is an aggregate QA measure that reflects the overall level of accuracy, precision, completeness and representativeness.

A QA program will be conducted during data collection. In accordance with established procedures, the QA program will specify and measure the performance of measurement methods through the collection of an appropriate number or frequency of QC samples. Such samples could include field and laboratory blanks, field duplicates, laboratory replicates, and spiked samples. Field measurements will be calibrated on NIST-traceable standards at a frequency prescribed in the QAPP. Twice-daily response checks will be performed for all field instruments before use. Corrective actions will be conducted if performance falls outside of expected ranges.

All surveys and sample collection that are part of the CSAP will be performed in accordance with established QC requirements. Replicate surveys, sample recounts, instrument performance checks, chain of custody, control of field survey data and databases, and QC investigations provide the highest level of confidence in the data collected to support the survey outcome.

In addition, QA/QC measures will ensure that trained personnel conduct surveys with approved procedures and properly calibrated instruments. Procedures will cover sample documentation, chain of custody, field and laboratory QC measurements, and data management. The CSAP contractor will be required to develop and supply these procedures either as appendices to this plan, or as stand-alone standard operating procedures.

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APPENDICES

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APPENDIX A

WMA 1 PRE-REMEDIATION DATA COLLECTION

A.1 Background

Waste Management Area 1 (WMA 1) is approximately 4.4 acres in size (see Figures A.1 and A.2 for maps). WMA 1 includes facilities associated with processing spent fuel.

Descriptions of the various features of WMA 2 follow, and are taken from the Phase 1 DP, Section 3.1.2:

Main Plant Process Building. The Main Plant Process Building (Process Building) was built between 1963 and 1966. It was used by Nuclear Fuel Services (NFS) from1966 to 1971 to recover uranium and plutonium from spent nuclear fuel. The multi-story Process Building structure is approximately 130 feet by 270 feet in area and rises approximately 79 feet above ground at its highest point (not including the main stack). Most of the structure is constructed of reinforced concrete. The major Process Building structure rests on approximately 476 driven steel H-piles. Most of the facility was constructed above grade, with some of the cells extending below ground (i.e., below the ground surface reference elevation of 100 feet) (Figure A.3). The deepest cell, the General Purpose Cell, extends approximately 27 feet below-grade. Some portions of the Process Building extend into the Lavery Till.

Liquid waste generated during reprocessing was managed in one of two ways, depending on activity. High-level waste was transferred from the Process Building to the Waste Tank Farm (WMA 3) via two underground transfer lines (7P-113 and 7P-120) to Tank 8D-2 and Tank 8D-4. Low-level wastewater was transferred to the Low Level Waste Treatment Facility (WMA 2) via below-grade transfer lines associated with the Interceptor System (WMA 2).

Fuel Receiving and Storage Area. On the east side of the Process Building stands the Fuel Receiving and Storage Area. This steel-framed, steel-sheathed structure contains two fuel pools: the Cask Unloading Pool and the Fuel Storage Pool. These pools were used to receive and store spent fuel received for reprocessing, and extend approximately 49 and 34 feet below grade, respectively. The floor of the deeper pool lies 45 feet below grade at its lowest point.

Vitrification Facility. The Vitrification Facility, which was constructed by the WVDP, is attached to the north side of the Process Building. The Vitrification Facility is a structural steel frame and sheet metal building housing the reinforced concrete Vitrification Cell, operating aisles, and a control room. It is approximately 91 feet wide and 150 feet long with the peak of the roof standing approximately 50 feet high. The pit in the Vitrification Cell extends 14 feet below grade.

Load-In/Load-Out Facility. The steel-framed, steel-sheathed Load-In/Load-Out Facility connects to the west side of the Process Building as does the concrete block Main Plant Office Building.

01-14 Building. The 60-foot tall concrete and steel frame 01-14 Building stands at the southwest corner of the Process Building.

Miscellaneous Structures. On the south side of the Process Building is the concrete-block Utility Room, with an addition known as the Utility Room Expansion, and the Laundry. The Fire Pump House and a large Water Storage Tank stand south of the Process Building and an Electrical Substation is located on the east side.

The surface area surrounding buildings within WMA 1 is mostly covered with asphalt or concrete. The area of grass-covered soils is limited.

A.2 Physical Setting

WMA 1 is located on the north plateau. It is bounded to the west by WMA 10, to the north by WMA 3, to the east by WMA 2 and WMA 6, and to the south by WMA 6.

The surface of WMA 1 consists primarily of building footprints and paved surfaces and is relatively flat.

The subsurface of WMA 1 consists of a relatively permeable sand and gravel layer that overlies the impermeable Lavery Till (Figure A.4). Because of the depth of some portions of building foundations and subsurface structures, some of them were constructed into the Lavery till. In addition, portions of WMA 1 structure foundations are built on foundation pilings (approximately

476) that extend into the Lavery Till, and in some cases through the Till into the Kent Recessional Sequence.

Groundwater flow is, in general, towards the northeast. Groundwater flows primarily through the relatively permeable layer above the Lavery Till. The Lavery Till is relatively impermeable to groundwater flow; groundwater that does pass vertically through the Lavery Till enters the Kent Recessional Sequence.

There is known to be a significant amount of buried infrastructure (piping, etc.) associated with the WMA 1 facilities.

A.3 Area History

The WMA 1 area surrounding the Process Building has undergone significant reworking since the initiation of NFS activities.

Figure A.5 shows WMA 1 in 1962 prior to NFS site development. At this time WMA 1 was farmed.

Figure A.6 shows WMA 1 in 1966. The bulk of the initial set of NFS buildings was complete by this time.

Figure A.7 shows WMA 1 in 1968. Some additional construction has taken place in the north part of WMA 1. The area around the buildings is grass/bare earth.

Figure A.8 shows WMA 1 in 1977. There is some additional construction in the southwest corner of WMA 1.

Figure A.9 shows WMA 1 in 1984. The Vitrification Facility is now present along the northern end of WMA 1. Open areas within WMA 1 still appear to be grass covered/bare earth.

Figure A.10 shows WMA 1 in 1995.

Figure A.11 shows WMA 1 in 2007. By this time most open areas are paved.

A.4 Known and Suspected Releases

In 1968, a ventilation system filter in the Process Building failed, releasing contaminated particulate up the Process Building stack. The Cs-137-contaminated particulate was deposited on surface soils along with other radionuclides, resulting in a large area of contamination known as the "cesium prong" around the Process Building and to the north-northwest. The surface soils surrounding the Process Building within WMA 1 were exposed at the time of this release, and would have been contaminated (Phase 1 DP Rev 2 Table 2-17; Urbon 1968a; Marchetti 1982).

In 1968, releases of radioactive acid leaked into soil under the southwest corner of the Process Building, resulting in the north plateau groundwater plume. The leak released an estimated 200 gallons of radioactive nitric acid from the Off-Gas Operating Aisle within the Process Building down to the underlying Off-Gas Cell and the adjacent southwest stairwell. The leakage apparently flowed through an expansion joint in the concrete floor of the Off-Gas Cell and migrated into the sand and gravel underlying the Process Building (Phase 1 DP Rev 2 Table 2-17; Carpenter and Hemann 1995). This leak also contributed to sewage treatment system contamination. Since that time, mobile radionuclides such as Sr-90 have gradually migrated vertically more than 40 feet under the building and approximately one-quarter mile northeast of the building.

Line 7P-160-2-C (wastewater line to Tank 7D-13 near the south side of the Process Building) leaked an unknown amount of radioactive wastewater in February 1967 during transfer from Tank 7D-13 (Phase 1 DP Rev 2 Table 2-17; Lewis 1967).

Historically, the Process Building was connected to the old sewage treatment facility (WMA 6) via an underground wastewater line. The old sewage treatment plant outfall drainage (WMA 6) extends approximately 650 feet to the south of a culvert near the Old Warehouse location (WMA 6), flowing into the first culvert under the railroad tracks on the South Plateau. In the 1960s and 1970s, the old sewage treatment plant experienced several contamination events, some of which were expressed as radioactivity increases in the treated effluent. Actions were taken to find and repair the suspected sewage line leak, but when the line near the south side of the Process Building was excavated, radiation levels from soil contamination hampered the project (Phase 1 DP Rev 2 Table 2-17; Duckworth 1972b; Marchetti 1982).

In 2003, a breach was discovered in a wastewater drain line (drain line 15-ww-569 from Laundry to Interceptors (WMA 2)) allowing contaminated laundry water to leak into adjacent soils. A sample of subsurface soil near the breach showed 3,300 pCi/g Cs-137 and 87 pCi/g Am-241 (Phase 1 DP Rev 2 Table 2-18; Maloney 2003; WVNSCO 2006).

In addition to these known releases, additional spills and other forms of less significant releases were likely to have occurred in the immediate vicinity of the Process Building. Examples of these include Resin Pit spills during activities in the Fuel Receiving and Storage Building, and maintenance of the spent nuclear fuel pool water filtration system, located within the Fuel Receiving and Storage Building (Phase 1 DP Rev 2 Table 2-17; Carpenter and Hemann 1995).

A.5 Existing Data

Existing data sets for this area include:

- In 1982, static direct exposure readings were collected across the WVDP premises (WVNS 1982). A portion of WMA 1 was covered by these measurements on a 10-m grid. Figure A.12 shows these results color-coded by the exposure readings encountered. These data indicated the potential for significant surface contamination within the WMA 1 boundary; their interpretation, however, is complicated by potential shine from the Process Building.

- In 1990 and 1991, a second static direct exposure measurement program was conducted across the WVDP premises, including the accessible portions of WMA 1 (WVNS 1992). This data collection used different instrumentation and protocols than the 1982 study, so the results are not quantitatively comparable. Figure A.13 shows these results. These data show a significant change for the western and southern portions of WMA 1, with significantly lower measured gross activity than the 1982 study. There are a couple of possible explanations for the decrease: (1) this could reflect the removal of contaminated surface soil associated with maintenance and construction activities around WMA 1; or (2) it could reflect the placement of surface material (e.g., gravel or pavement) on top of contaminated soils; or (3) it could be that the 1982 readings were affected by shine from Process Building and associated structures whose sources were mitigated by decommissioning activities in the intervening years.

- There is some soil sampling data for WMA 1 available within ELIMS. Figure A.14 shows the locations of soil cores with subsurface soil samples. There are no sediment or surface soil results for WMA 1. The bulk of the data were collected either in 1993, 1994, 1998, or 2008, and most targeted the north plateau groundwater plume source area adjacent to and beneath the Process Building. The exception is location SNLAUB1, a soil sample collected in 2004 from an unreported depth just east of the utility room and north of the utility room expansion. Table A.1 summarizes which radionuclides have data for WMA 1.

  Each core from WMA 1 had at least one subsurface soil sample analyzed for Sr-90 and yielded at least one detectable Sr-90 result. The results ranged from approximately 0.1 pCi/g along the southern boundary of WMA 1 (BH-20) to more than 9,000 pCi/g (GP-7608) directly beneath the center of the Process Building. Figure A.15 shows a profile view for some of these cores with their Sr-90 results.

- There is a significant amount of groundwater data for WMA 1 available within ELIMS from historical characterization work addressing the north plateau groundwater plume. These data were obtained from monitoring wells and from discrete groundwater samples obtained by GeoProbe. Figures A.16 and A.17 show the locations of groundwater data collection color-coded by Sr-90 and tritium results, respectively. The detection limits for Sr-90 and tritium varied widely among ELIMS samples. 10 pCi/L and 500 pCi/L were selected as thresholds for Sr-90 and tritium, respectively, because based on ELIMS data results above these activity concentrations were consistently above method detection limits and so indicative of contamination impacts rather than simply measurement error. Contamination was encountered throughout WMA 1 and was dominated by Sr-90, with highest concentrations immediately down gradient of the presumed 1968 release point, and lowest concentrations along the southern boundary of WMA 1.

A.6 Planned Phase 1 DP Activities

For a more complete description of planned Phase 1 DP activities, see the Phase 1 DP, Section 3.1 and Section 7.3.

All buildings within WMA 1 are slated for demolition and removal as part of Phase 1 activities as well as the three underground waste water tanks and the underground lines that fall within the excavation footprint.

The deep excavation currently planned for WMA 1 would cover approximately 3 acres. The lateral extent of the excavation is not expected to deviate significantly from the design (Figure A.18). In fact, along its eastern and northeastern edges, the excavation will be constrained by an impermeable barrier slurry wall; and to the south, west, and northwest, the excavation will be constrained by sheet piling that will serve as a groundwater barrier wall. In the case of the impermeable slurry wall, the excavation floor will extend to the wall, and excavation may actually continue into the wall to address contamination. In the case of the sheet piling, excavation will be sloped up to the sheet piling at an angle of 45 degrees to provide stability. Figure A.18 shows a plan view and cross section of the planned excavation. The slurry wall will remain in place after the WMA 1 excavation is complete and backfilled; however the sheet piling walls will be removed after backfilling is complete.

Excavation will continue vertically into the Lavery Till at least one foot until cleanup goals have been achieved. The Phase 1 DP has specified cleanup goals to be achieved prior to excavation halting.

Beneath the Process Building there are about 476 foundation pilings that extend into, and in some cases through, the Lavery Till. These will be cut below the final excavation grade and left in place (Figure A.19).

A.7 Conceptual Site Model

Based on the available information, the conceptual site model (CSM) for WMA 1 is as follows. A number of releases within the WMA 1 footprint are known to have occurred, or may have occurred, and likely impacted surface and subsurface soils and groundwater. The most significant of these were the 1968 stack release that produced the cesium prong and the 1968 subsurface release that produced the north plateau groundwater plume. In addition to these two major releases, there were several known or suspect releases associated with building infrastructure and processes that likely contributed to surface soil, subsurface soil, and groundwater contamination and that may have resulted in more localized contamination at significant levels.

After initiation of the WVDP, portions of the surface of WMA 1 underwent significant reworking. This reworking occurred primarily along the western and northern portions of WMA 1 and included the construction of the Vitrification Facility. This reworking may have covered contaminated surface soils with clean cover, removed contaminated surface soils for disposition elsewhere, and/or re-used contaminated soils as backfill for building foundations or buried infrastructure. The sharp change in direct gamma reading results within WMA 1 between 1982 and 1991 indicate that there may have been a significant change in contamination status of the immediate WMA 1 surface.

Groundwater flow underneath WMA 1 is expected to be, in general, towards the northeast. The core of the north plateau groundwater plume has been steadily migrating in an easterly/northeasterly direction. There likely are high activity concentrations of less mobile radionculides such as Cs-137 sorbed to soils in the immediate vicinity of the original release. The Lavery Till is expected to have acted as a barrier to vertical Sr-90 migration. Limited soil cores that include samples from the top of the Lavery Till have confirmed this is the case.

There are concerns that the foundation pilings beneath the Process Building may provide preferential flow pathways for vertical migration of contaminated groundwater into and potentially through the Lavery Till. Presently these pilings are inaccessible for characterization, but as part of the planned decommissioning activities these pilings will be exposed and the possibility of vertical contaminant migration into the Lavery Till will be evaluated at that time.

Figure A.20 shows the current CSM for surface soils. The assumption is that all surface soils in WMA 1 area to a depth of one meter possibly contain contamination above CG_w standards. Figure A.21 shows the CSM for soils deeper than 1 m. The assumption is that there is the potential across WMA 1 for subsurface soils to have impacts greater than background conditions. Figure A.22 shows the CSM for contaminated groundwater beneath WMA 1. The assumption is that groundwater across WMA 1 has the potential for contamination above background levels.

A.8 WMA 1-Specific Characterization Goals

- Develop an inventory of buried infrastructure
- Evaluate appropriateness of the current list of ROI

- Verify absence of additional ROI
- Determine level and extent of surface contamination
- Identify the presence/absence of buried contamination
- Identify soil waste stream characteristics
- Define required extent of WMA 1 excavation
- Obtain data to support Phase 2 planning
- Obtain geotechnical data required for barrier wall design

A.9 CSAP Pre-Remediation Data Collection and Associated Decision-Making

CSAP pre-remediation data collection will consist of a number of components described in more detail below.

A.9.1 Buried Infrastructure

The footprint of buried infrastructure will be identified and mapped with a focus on areas outside the planned excavation and infrastructure that crosses into the planned excavation. A significant amount of buried infrastructure is believed to exist within WMA 1, and in particular in the western portion of WMA 1. This infrastructure would include waste and wastewater lines and as well buried utilities. **[required]**

A.9.2 Gamma Walkover Survey Data

The purpose of performing a gamma walkover survey of the WMA 1 area is to identify the level and extent of surface contamination. This includes both general trends in average activity concentrations pertinent to the surface soil CG_w requirement, as well as the identification of isolated, more-elevated anomalies that might be indicative of discrete releases and/or surface soil CG_{emc} concerns.

A complete (100%) logged gamma walkover survey (GWS) will be conducted for accessible areas within WMA 1. Examples of areas that would not be accessible are existing building footprints and building pads. Based on the GWS results, surface soil within WMA 1 will be divided into three categories: (1) surface soils where GWS indicates possible surface soil CG_w

exceedances; (2) surface soils where GWS indicate impacts, but those impacts are not expected to exceed surface soil CG_w standards; and (3) surface soils where there is no indication of impacts above background conditions. The purpose of this data collection is to provide insights into the spatial distribution of surface contamination, and to guide subsequent soil sampling. **[required]**

A.9.3 Surface Soil Sampling

Surface soil sampling will be used to address areas inaccessible to GWS data collection, to resolve hot spots identified by the GWS data, and to evaluate the presence, absence, and/or extent of surface contamination above surface soil CG_w requirements based on GWS results.

- **Hot Spots.** If GWS data indicate the presence of contamination that possibly exceeds "hot spot" (CG_{emc}) standards or an isolated elevated area is identified that appears indicative of a discrete release, the location of concern will be sampled with a biased sample. Within WMA 1, hot spots will be biased sampled if they are outside the planned WMA 1 deep excavation footprint. If biased samples are collected from a particular location, they will be collected from two depth intervals: 0–15 cm, and 0–1 m. In the case of surface soils, each biased sample will be a composite sample formed from 5 increments systematically distributed over the area of interest. The 0–15 cm samples will be analyzed for the 12 radionuclides of potential interest in addition to the 18 ROI. One down-hole gamma scan will be conducted from each biased location. The purpose of these samples is to resolve GWS anomalies, evaluate the appropriateness of the current ROI list, and verify the absence of additional ROI. **[contingent]**

- **CG_w Sampling.** Surface soil sampling may be conducted after the GWS to further clarify results, with the level and nature of sampling dependent on GWS results. For WMA 1, surface soil CG_w sampling in response to GWS results will primarily focus on areas that are currently not paved and that are not within the planned WMA 1 excavation footprint.

    - If GWS results indicate contamination impacts above background levels but that surface soil contaminant levels exceeding surface soil CG_w requirements are unlikely, a minimum of five surface soil sample locations will be identified and sampled that target the areas with the highest gross activity levels. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a

5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap. The purpose is to document the maximum activity concentrations present in surface soils within WMA 1. **[contingent]**

- If GWS results indicate surface soil contaminant levels exceeding surface soil CG_w requirements likely exist, one sampling location will be selected at the highest gross activity level to confirm surface soil CG_w exceedances and another set of sampling locations will be identified to spatially bound the extent of contamination (i.e., along the boundary of what is considered likely above surface soil CG_w requirements). Two samples will be collected from the location targeting high gross activity levels, one representative of a 0–15 cm depth interval, and one representative of a 0-1 m depth interval. One sample will be collected from each location intended to laterally bound contamination, representative of a 0-15 cm depth interval. Each sample will be a 5-increment composite formed to be representative of a 200 m^2 area. In addition, the location targeting high gross activity levels will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. Locations will be selected so that each representative area does not overlap. The purpose is to document surface soil CG_w requirement exceedances and bound the lateral extent of contamination. **[contingent]**

- If GWS results indicate areas with surface soil contamination impacts but it is unclear whether surface soil CG_w requirement exceedances are present, at most five sampling locations will be selected that systematically cover the areas of interest. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap. The purpose is to resolve the question of whether surface soil CG_w requirement exceedances exist for areas where GWS results are ambiguous. **[contingent]**

- If any 0-15 cm interval yields a sample result indicating a surface soil CG_w requirements exceedance and that sample location is not laterally bounded either by existing sampling locations with results less than surface soil CG_w requirements or by GWS data that clearly indicate contamination is not a concern, additional sampling locations will be selected so that the contamination encountered is spatially bounded. The purpose is to laterally bound contamination that is above CG_w requirements. **[contingent]**

A.9.4 Subsurface Soil Sampling

Subsurface soil sampling within WMA 1 has three purposes: (1) to determine presence and vertical extent of contamination impacts above background levels for WMA 1 areas along the edge of and outside the planned deep excavation, (2) to estimate waste stream volumes in support of the planned WMA 1 deep excavation, and (3) to provide geotechnical and contamination status information for the footprints of the slurry and sheet walls.

- **Paved Portions of WMA 1.** The assumption is that because of surface cover added to the site as part of WVDP activities, surface contamination that pre-dated the WVDP may now be covered by clean material and may not readily detectable by GWS scans. Areas of WMA 1 that are paved but outside the planned excavation footprint will by systematically sampled for subsurface contamination concerns. Systematic sampling locations arranged on a triangular grid with a 20-m grid spacing will be used to evaluate the contamination status beneath the existing ground cover. Approximately 15 discrete sampling locations will be required. Each location will have one discrete sample collected to a depth of 1 m. In addition, each will have a down-hole gross activity scan with one measurement taken each 15 cm. **[required]**

- **WMA 1 Waste Characterization.** Subsurface soil cores will be obtained within the footprint of the planned WMA 1 excavation to address contaminated soil volume estimation needs. Of the three acre excavation footprint, only approximately 1.2 acres would likely be readily accessible for intrusive subsurface sampling. This 1.2 acres is about evenly divided between the western edge of the excavation, the northeastern corner of the excavation, and the southeastern corner of the excavation. Sixteen core locations will be placed within these accessible areas to a depth of 1 m into the Lavery Till. The cores will be located to provide systematic coverage of the accessible areas (approximately one core per 300 m^2). Each one meter interval of each core will be sub-sampled in a fashion to obtain a representative sample, and those samples submitted for quick turn-around analysis of Sr-90 and Cs-137. With an average expected depth-to-till of 35 feet, approximately 192 samples will be collected and analyzed. These data will be used to estimate waste stream volumes resulting from the excavation of WMA 2. **[required]**

- **Sheet Piling Footprint Characterization.** Subsurface soil coring, scanning, and sampling will take place along the western and southern boundaries of the planned excavation, as well as the portions of the northern boundary associated with the sheet piling footprint, to confirm the contamination status of adjacent surface and subsurface soils. An initial set of approximately 30 locations will be sampled; these locations will be separated by 10 m (Figure A.23). At each location, one core that extends 1 m into the Lavery Till will be retrieved. A down-hole scan will be conducted to the extent possible at each location with a static measurement every 30 cm. Each core will be divided into 1 m segments.

    - A variety of geotechnical field data will be collected from each core location, as necessary and required for sheet piling/slurry wall design. In addition soil samples will be collected and submitted for geotechnical analyses (e.g., grain size, Atterberg limits, triaxial strength, etc.) as required by sheet piling/slurry wall design. **[required]**

    - At minimum, the following soil core segments will be submitted for laboratory radiological analysis: the top meter (representative of surface soils), the meter directly above the Lavery till, the top meter of Lavery till, and the meter straddling the water table. In addition, if the bore/core scan identifies an elevated zone not included in one of these three, the meter interval containing the elevated zone will be submitted for laboratory radiological analysis. **[required]**

    - From each location three discrete groundwater samples will be collected: one from the water table, one from immediately above the Lavery till, and one midway between these two, if possible. **[required]**

    - If any interval other than the top 1 m identifies contaminants above background levels, then additional soil core locations will be placed on a triangular grid with a separation of 10 m to the south of the location(s) of concern in a manner that bounds the original contamination as the terrain allows and sampled as described above. This process will continue until the lateral extent of subsurface contamination is bounded. If extensive subsurface contamination is encountered a field decision may be made to increase the separation distance between the original set of core locations and the next set of bounding core locations. The ultimate intent is to spatially bound subsurface contamination to the south, west, and north of the planned WMA 1 excavation. This sampling may extend into WMA 3, 10, and 6 as necessary. In the case of WMA 3, sampling will not extend beyond the planned slurry wall footprint. **[contingent]**

- **Slurry Wall Footprint Characterization.** Subsurface soil coring and scanning will take place following the planned impermeable slurry wall footprint along the northern and eastern portion of the WMA 1 excavation. These cores will be separated by 20 m. Approximately 10 cores will be required. At each core location, one core will be retrieved that extends one meter into the Lavery till. A down-hole scan will be conducted to the extent possible at each location with a static measurement every 30 cm. Each core will be divided into one meter segments.

    - Subsurface soil sampling, groundwater sampling, and core scanning protocols will be the same for soil cores from the slurry wall footprints as for sheet piling footprints. **[required]**

    - A variety of geotechnical field data will be collected from each core location, as necessary and required for sheet piling/slurry wall design. In addition soil samples will be collected and submitted for geotechnical analyses (e.g., grain size, Atterberg limits, triaxial strength, etc.) as required by sheet piling/slurry wall design. **[required]**:

- **Additional Contingencies.**

    - If any 0-15 cm surface soil sample result indicates contamination impacts above background levels and there was not a 0–1 m sample collected from that location, a 0-1 m sample will be collected from that location following the protocols used for the original 0-15 cm surface soil sample. In addition, each soil location will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. **[contingent]**

- If a 0-1 m sample result exceeds background levels, then an additional sample from a depth of 1–2 m will be collected and analyzed from that location. In addition, down-hole gamma data will be collected from the location with static measurements collected for every 15-cm depth interval. If that sample has contamination above background conditions, then the next deeper 1-m interval will be sampled and analyzed and a down-hole gamma scan performed. This process will continue until background conditions are reached. **[contingent]**

- If systematic subsurface sampling identified contamination that appears to extend laterally beyond the boundaries of WMA 1, such as into WMA 3, WMA 6, or WMA 10, then the grid will be extended and additional sampling conducted until the lateral extent of contamination has been bounded. In the case of WMA 3, sampling will not extend beyond the planned slurry wall footprint. **[contingent]**

A.9.5 Buried Infrastructure Soil Sampling

Soils associated with buried infrastructure of potential concern within WMA 1 will be sampled to determine their contamination status. Buried infrastructure that is of potential concern in WMA 1 is defined to be buried infrastructure that either carried contaminated waste/wastewater or was installed after 1968.

- Three locations along the each piece of buried infrastructure that is of concern within WMA 1 will be trenched. These locations will be selected to maximize the possibility that contamination will be encountered (e.g., locations where historical or current GWS data indicate surface contamination exists). For infrastructure that crosses the planned WMA 1 excavation boundary, one of these locations will be at the boundary. Trenching will not take place within the planned WMA 1 excavation footprint. During excavation, exposed soils will be monitored by scans for evidence of elevated gross activity. The purpose of this sampling is to evaluate the presence of contaminated soils associated with buried infrastructure. **[required]**

  - If elevated readings are encountered below a depth of 1 m, soils exhibiting the highest levels of gross activity will be sampled and analyzed.

  - If elevated readings are not encountered below a depth of 1 m, a sample representative of soils deeper than 1 m will be collected. In the case of infrastructure that did not carry waste or wastewater, the sample will be from soils immediately above the line. In the case of infrastructure that did carry waste or wastewater, the sample will be from soils immediately beneath the line.

- If contamination above background conditions is encountered at any selected location, trenching will continue to depth until background conditions are observed. An additional sample will be collected from the base of the trench to verify background conditions. The purpose is to vertically bound observed contamination. **[contingent]**

- If buried infrastructure soil sampling identifies contamination impacts greater than background, biased sampling will continue following the line until at least two consecutive locations yield soil samples below surface soil CG_w requirements. Location spacing will be based on engineering judgment, including the geometry of the line, the level of contamination encountered, and surface evidence of contamination. Buried infrastructure characterization will not extend into the planned WMA 1 deep excavation footprint. The purpose of this sampling is to bound the extent of contamination associated with buried infrastructure, as necessary. **[contingent]**

A.9.6 Additional Contingencies

Sampling and/or GWS data may indicate that contamination exists or extends beneath surfaces currently covered by existing structures, concrete, asphalt, or hardstand material. In this case, "surface soil" will be defined as soil immediately beneath the cover. If sampling or GWS data indicate that contamination may exist beneath existing structures (e.g., existing buildings and building pads), then sampling locations will be offset along the foundation edge to determine contamination extent. The purpose of the offset is to allow safe acquisition of data. Data collection through building pads and hardstands in WMA 1 will not be required as part of this effort.

A.9.7 Required Laboratory Analyses

All samples will be submitted for analysis of all 18 ROI.

A select portion of the samples as described above may be analyzed for the additional 12 radionuclides of potential interest. In addition, ten percent of soil samples collected outside the WMA 1 excavation footprint will also be analyzed for the 12 radionuclides of potential interest. If these sample results indicate the presence of the one or more of those radionuclides at levels of potential significance, then the balance of samples from WMA 1 will also be analyzed for the additional radionuclides that were identified.

Table A.2 summarizes the required sample numbers and the estimated number of contingency samples for WMA 1.

This sampling plan assumes that quick turn-around analyses are available for Sr-90 and Cs-137 and that soil samples will be screened for Sr-90 and Cs-137 prior to being analyzed for the balance of the ROI. Based on these screening data, contingency sampling requirements as described above may be undertaken without the benefit of the remaining analyses.

A.9.8 Decision-Making Summary

A summary of decision-making based on the WMA 1 data is as follows:

- If GWS data indicate anomalies are present outside the planned excavation footprint, biased samples will be selected to target those anomalies.
- If sample results from biased or systematic surface samples for the 0-1 m depth interval indicate contamination above CG requirements, an additional sample from that location representing the depth interval 1–2 m will be collected and this process will be repeated until contamination is vertically bounded.
- If scans of soil cores along the WMA 1 excavation boundary or slurry wall indicate intervals with elevated activity, the interval with the highest activity will be targeted for analysis.

- If one or more soil cores along the WMA 1 excavation boundary encounter soil contamination at depths greater than 1 m, additional locations will be selected further to the outside of the WMA 1 excavation boundary to laterally bound contamination.

- For each set of buried infrastructure that is identified as a potential concern, at least two trenches that uncover the infrastructure will be scanned and sampled. If contamination appears to extend laterally along the line of the infrastructure, additional sampling will take place until contamination is bounded.

Table A.1 Historical Data Analyses

Nuclide	# of Surface Soil Locations	# of Subsurface Soil Locations	# of Sediment Locations
Am-241	0	21	0
C-14	0	20	0
Cm-243	0	14	0
Cm-244	0	14	0
Cs-137	0	25	2
I-129	0	20	0
Np-237	0	13	0
Pu-238	0	21	0
Pu-239	0	21	0
Pu-240	0	21	0
Pu-241	0	22	0
Sr-90	0	24	0
Tc-99	0	21	0
U-232	0	19	0
U-233	0	18	0
U-234	0	18	0
U-235	0	18	0
U-238	0	19	0

Table A.2 Sample Number Estimates

	Required	Contingent	Total
Systematic Sediment Samples (0-15 cm)	0	0	0
Systematic Sediment Samples (0-1 m)	0	0	0
Biased Sediment Samples (0-15 cm)	0	0	0
Biased Sediment Samples (0-1 m)	0	0	0
Systematic Surface Soil Samples (0-15 cm)	20	0	20
Systematic Surface Soil Samples (0-1 m)	20	0	20
Biased Surface Soil Samples (0-15 cm)	0	3	3
Biased Surface Soil Samples (0-1 m)	0	3	3
Systematic Subsurface Soil Samples (1-m intervals)	332	58	390
Biased Subsurface Soil Samples (1-m intervals)	0	5	5
Buried Infrastructure Soil Samples	18	12	30
Discrete Groundwater Samples	90	36	126
Total:	480	117	597

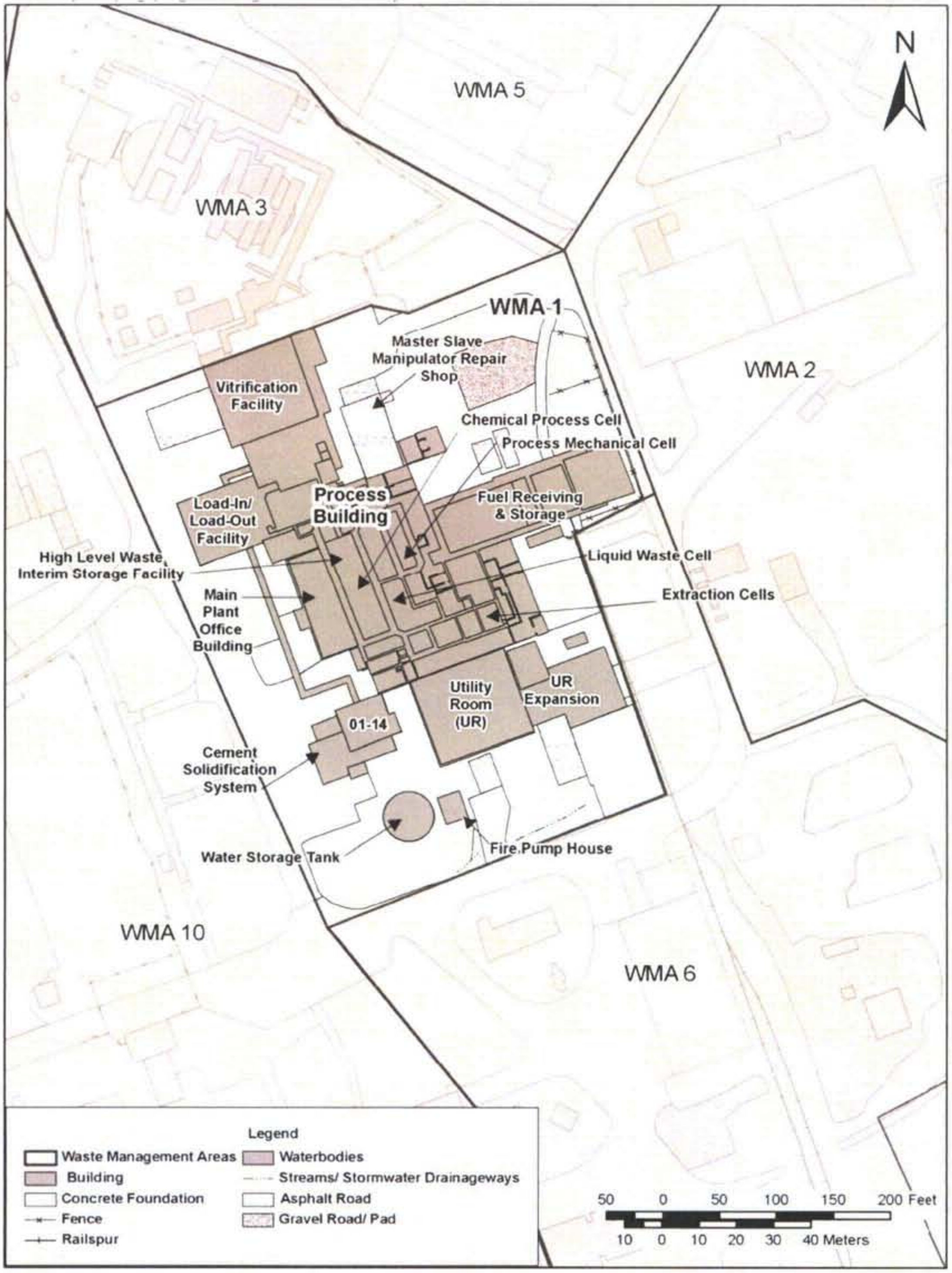

Figure A.1 WMA 1 Facilities (from Phase 1 DP, Figure 3-10)

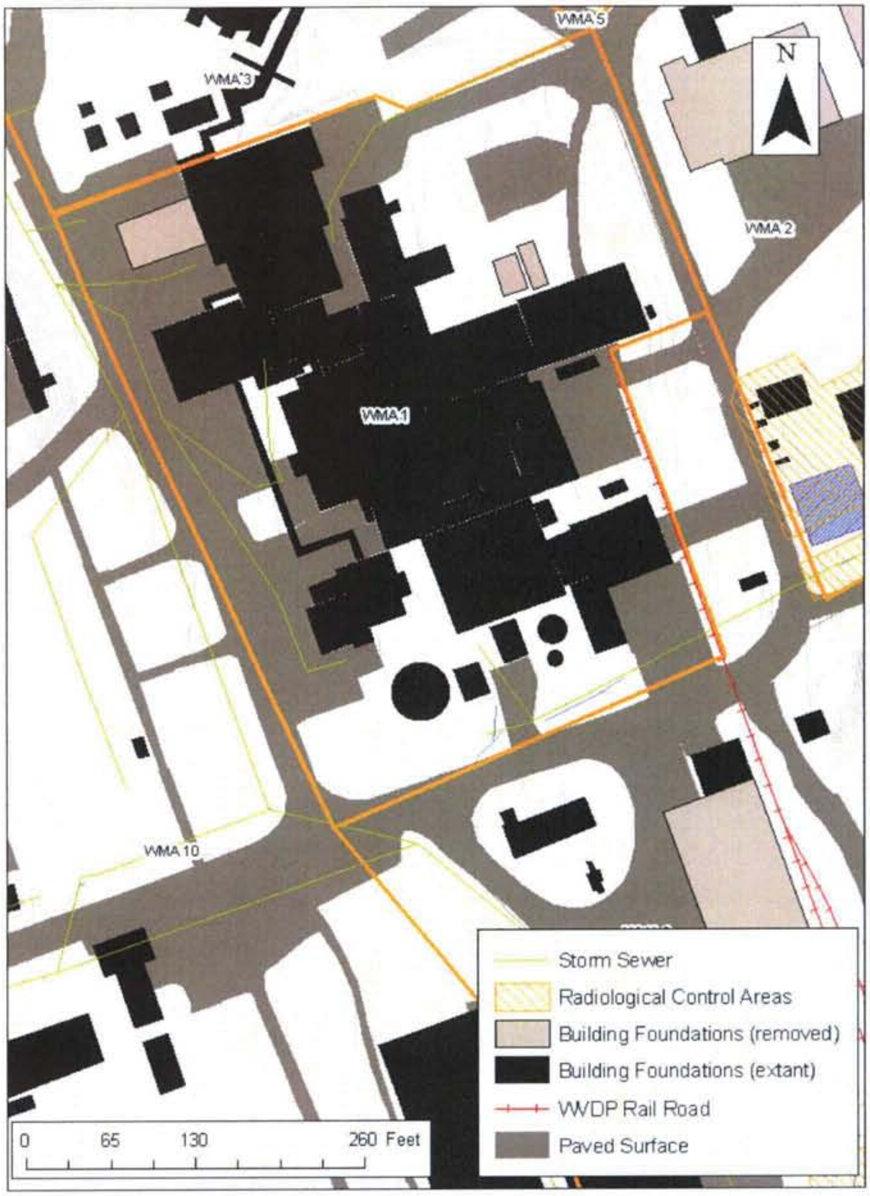

Figure A.2 WMA 1 with Topography

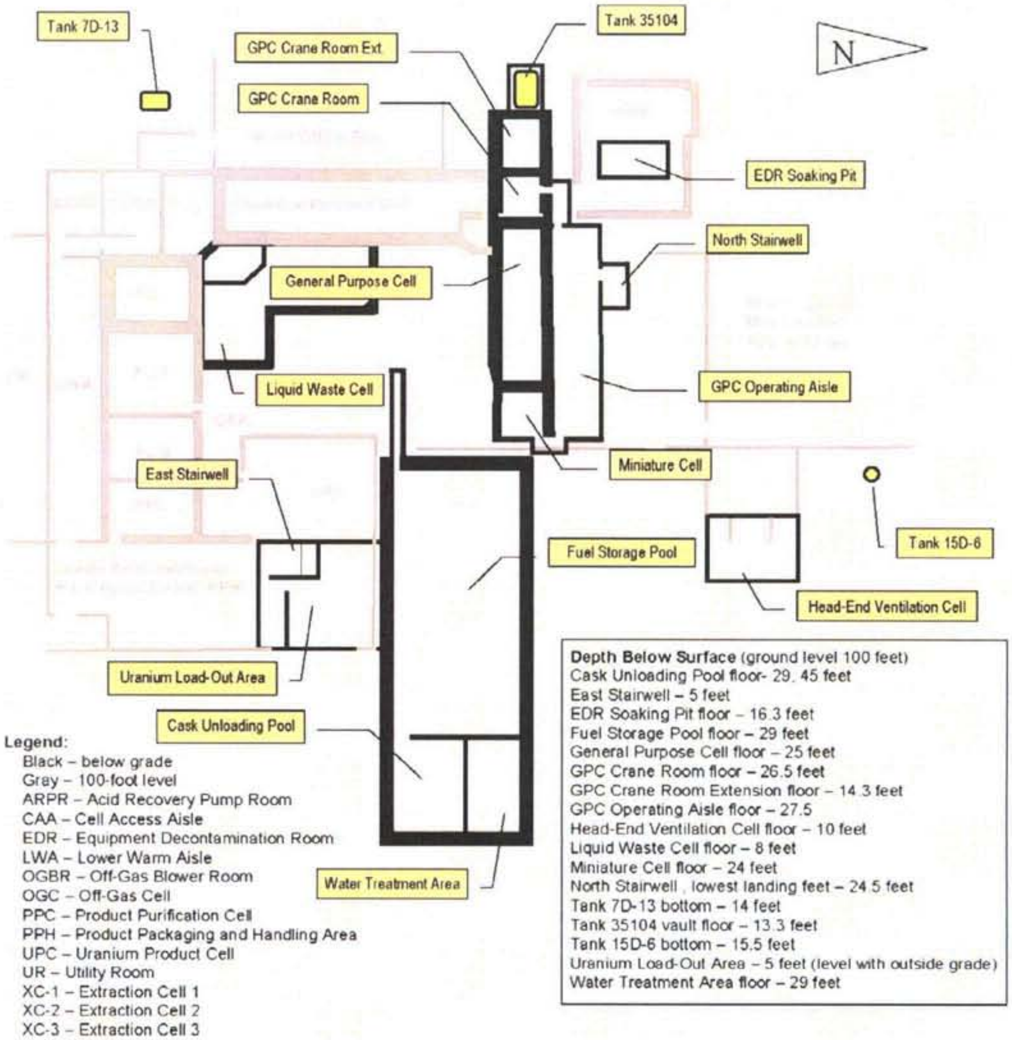

Figure A.3 Process Building Subsurface Structures (from Phase 1 DP, Figure 7-5)

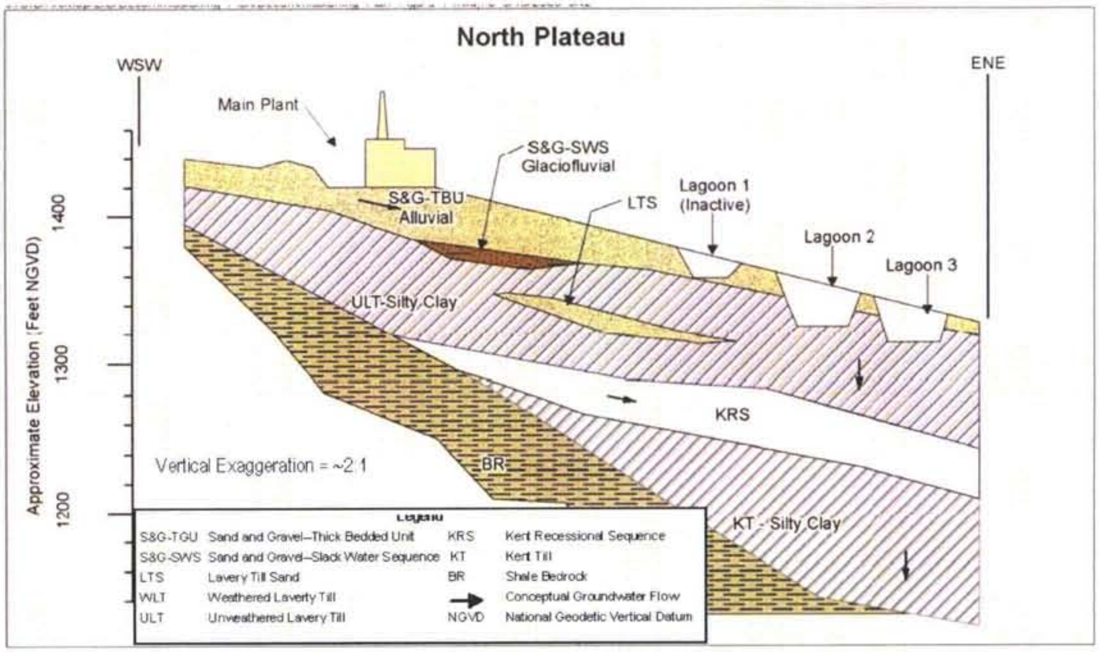

Figure A.4 North Plateau Cross-Section (from Phase 1 DP, Figure 3-6)

Figure A.5 WMA 1 Aerial Photograph from 1962

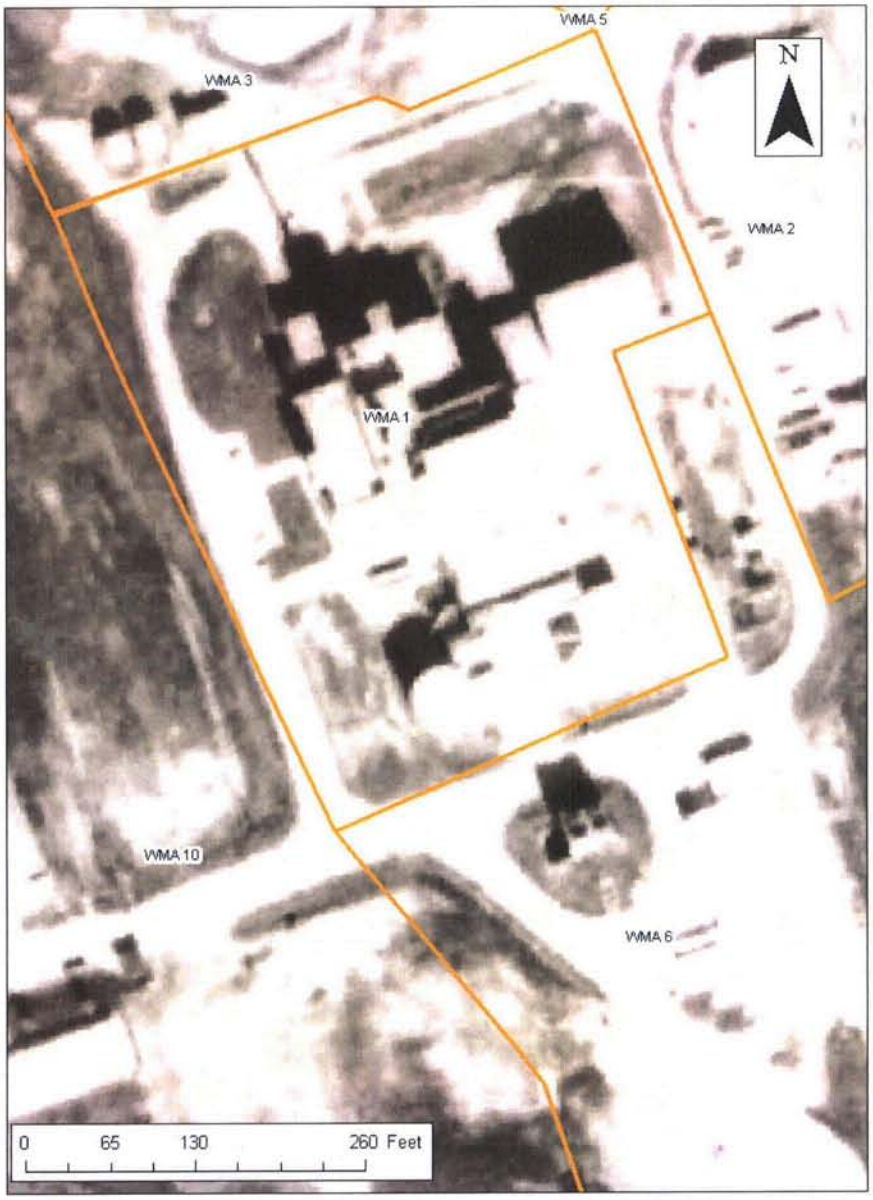

Figure A.6 WMA 1 Aerial Photograph from 1966

Figure A.7 WMA 1 Aerial Photograph from 1968

Figure A.8 WMA 1 Aerial Photograph from 1977

Figure A.9 WMA 1 Aerial Photograph from 1984

Figure A.10 WMA 1 Aerial Photograph from 1995

Figure A.11 WMA 1 Aerial Photograph from 2007

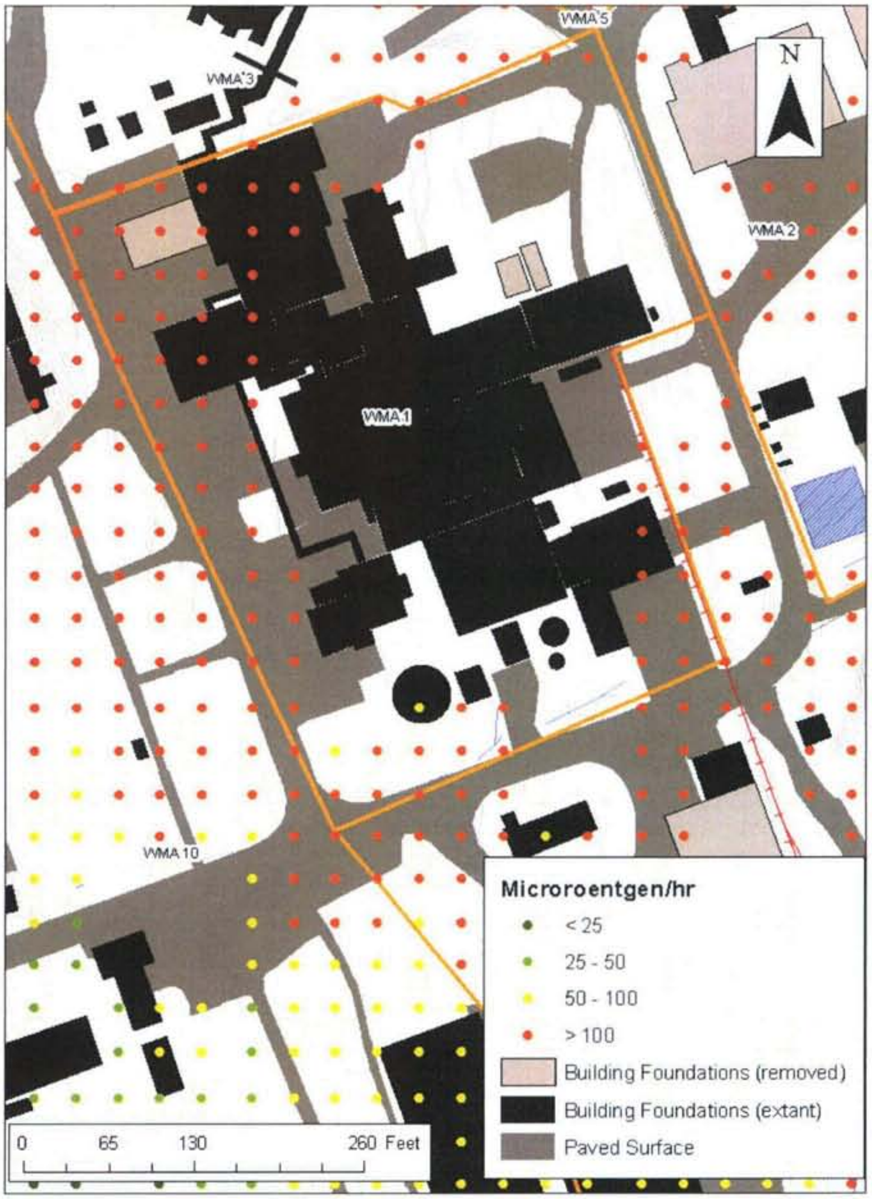

Figure A.12 WMA 1 1982 Direct Gamma Measurement Results

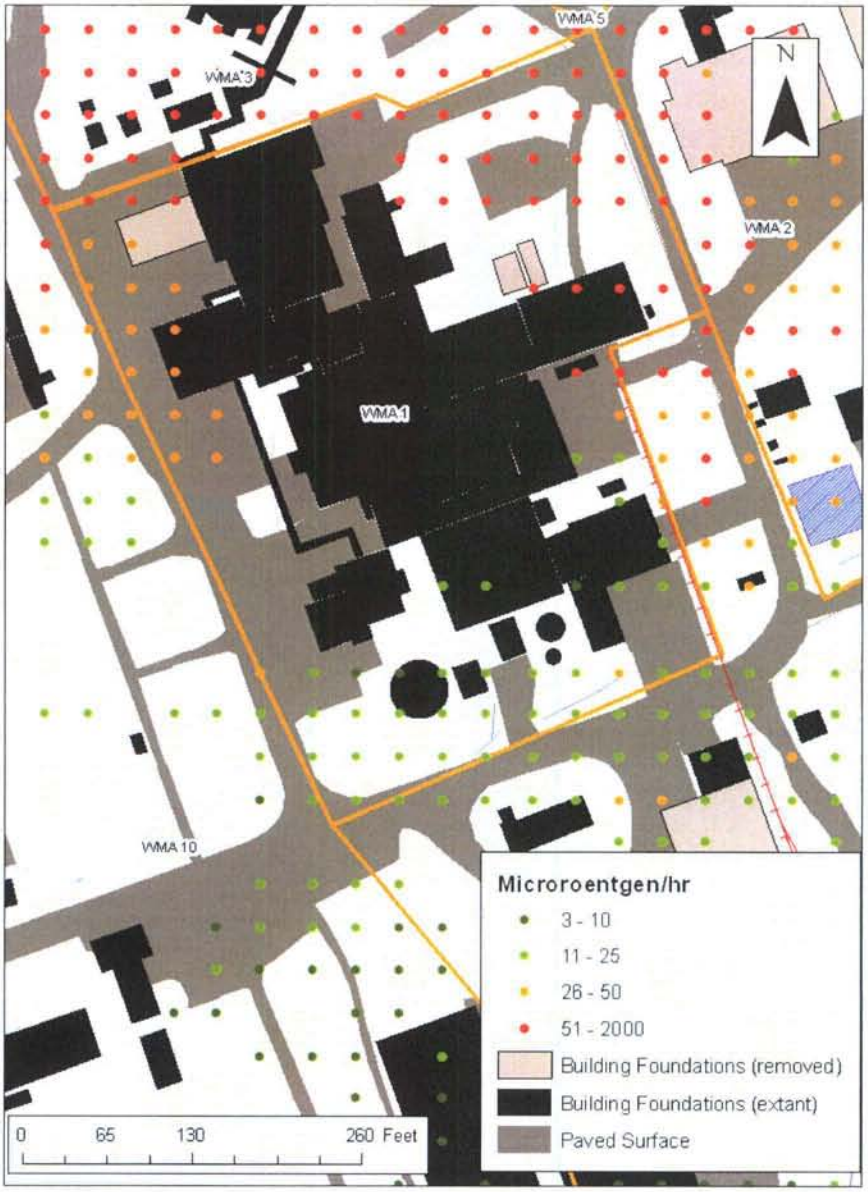

Figure A.13 WMA 1 1990-1991 Direct Gamma Measurement Results

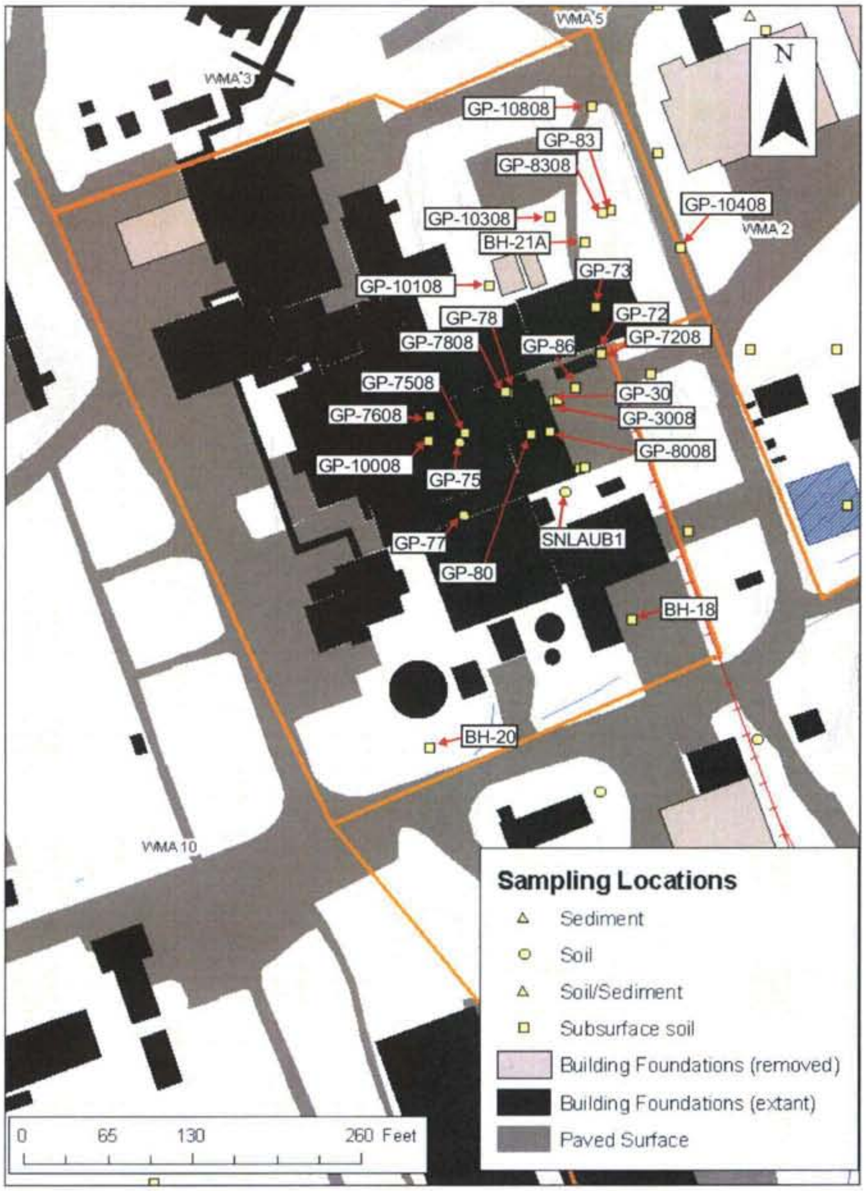

Figure A.14 WMA 1 Historical Sampling Locations

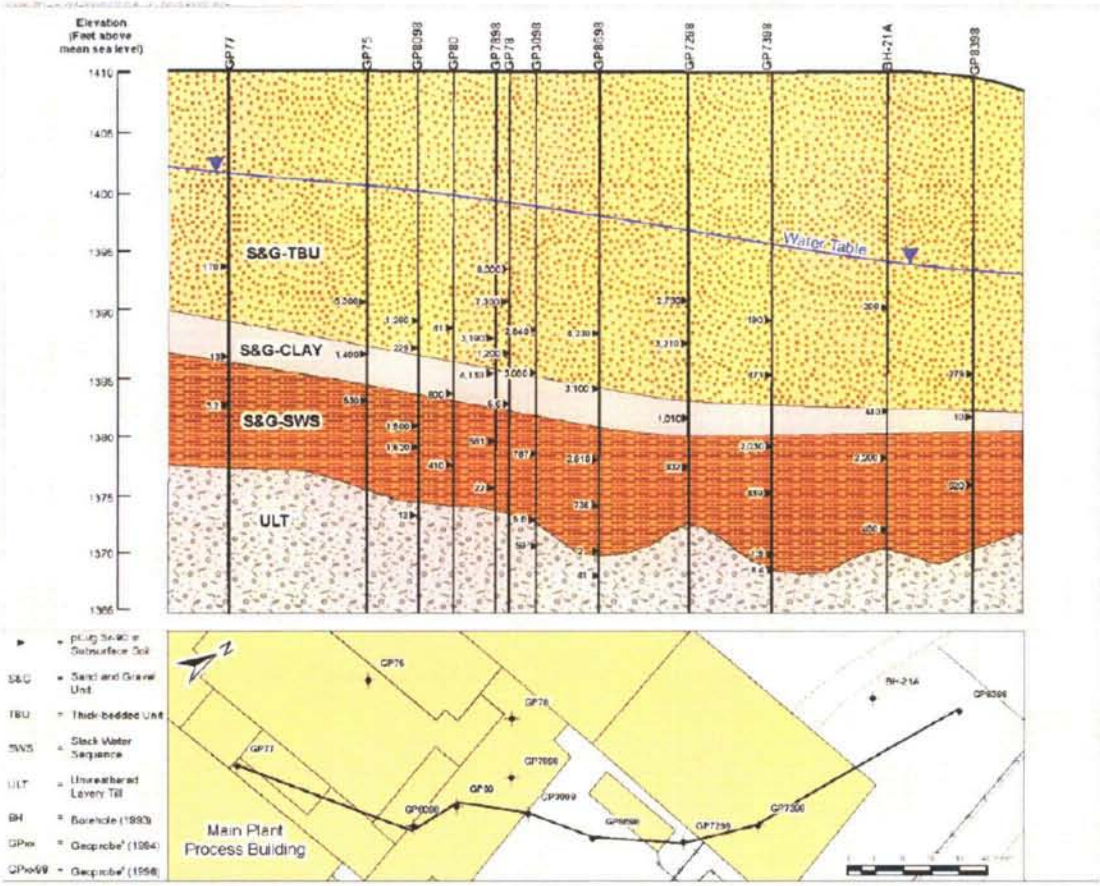

Figure A.15 Profile View of Cores with Sr-90 Results (pCi/g)

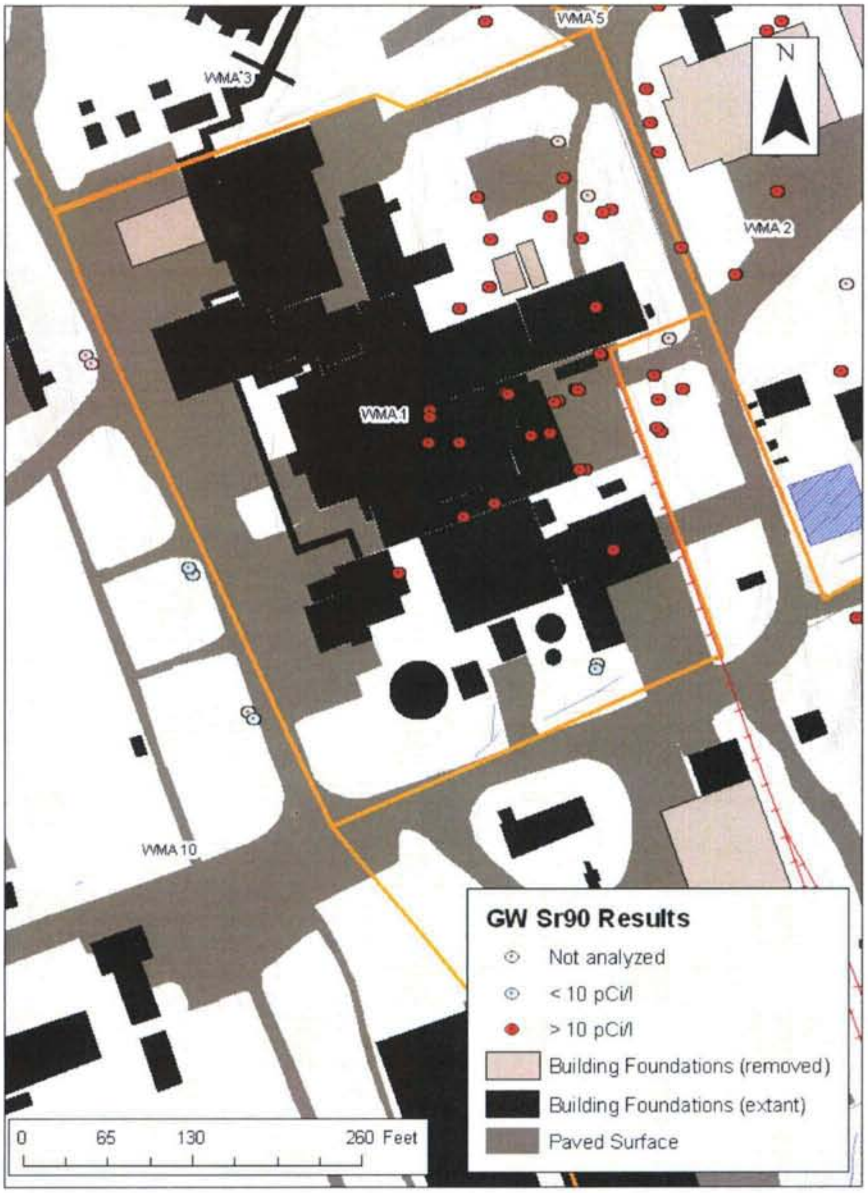

Figure A.16 WMA 1 Sr-90 Groundwater Results

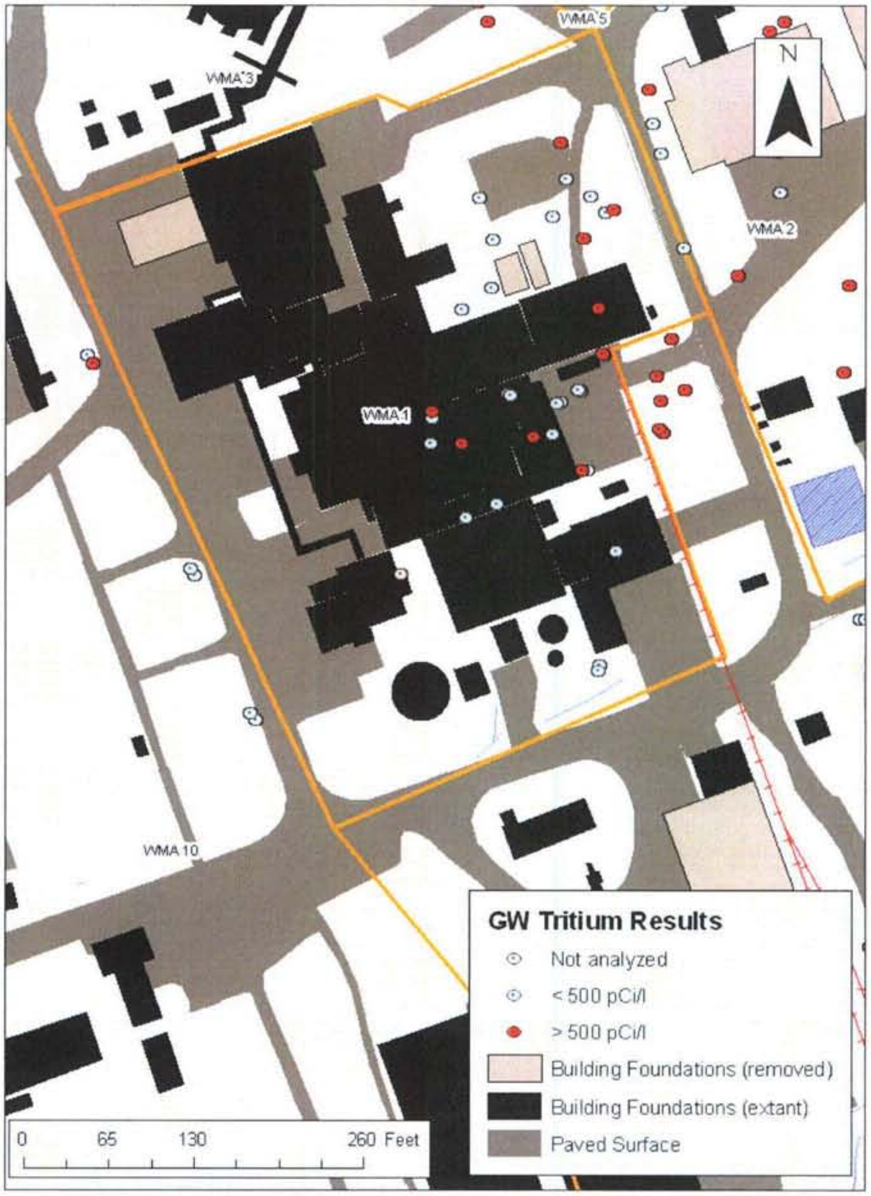

Figure A.17 WMA 1 Tritium Groundwater Results

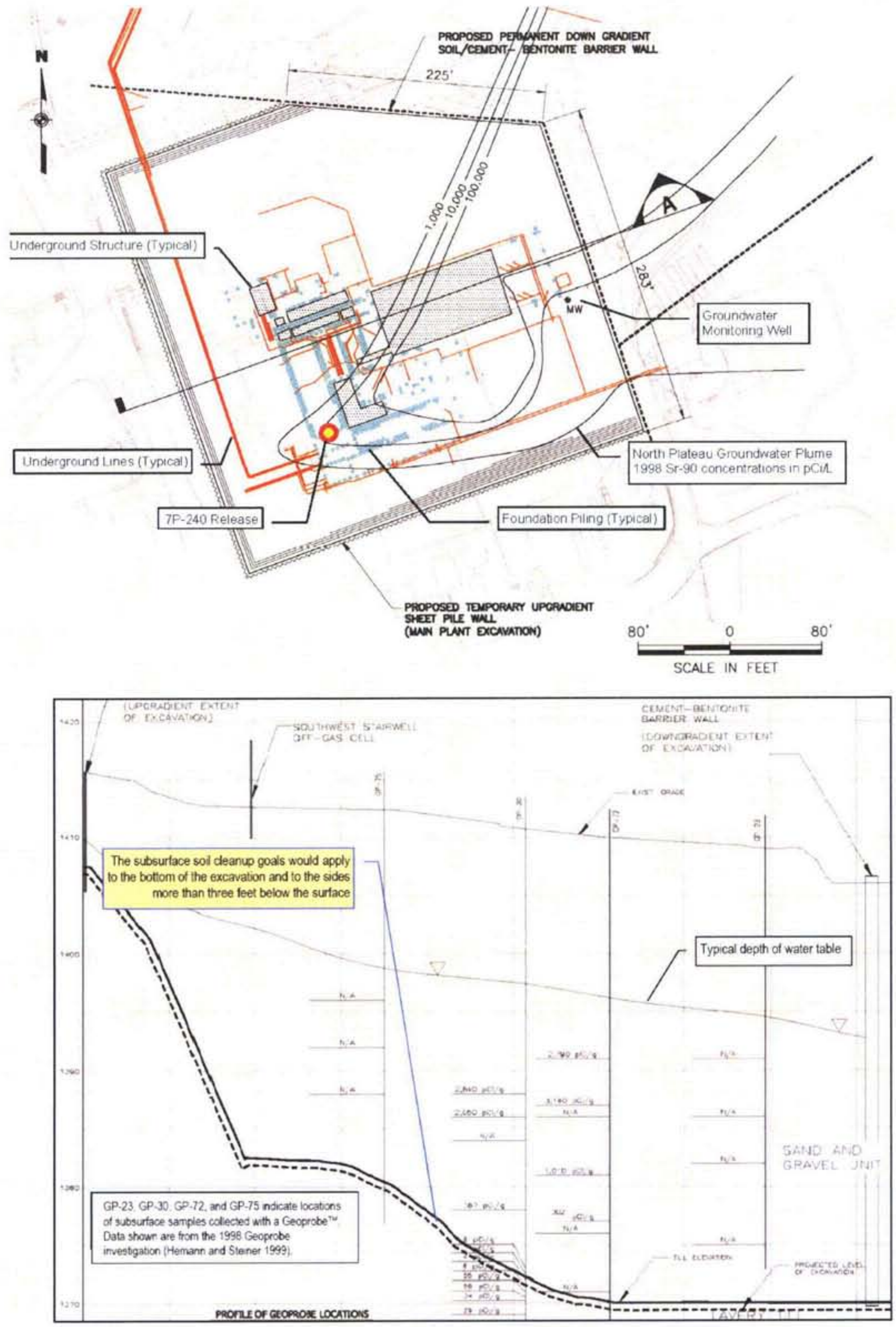

Figure A.18 Phase 1 WMA Excavation with A-A' Cross-Section (taken from Phase 1 DP, Figure 7-6 and Figure 7-7)

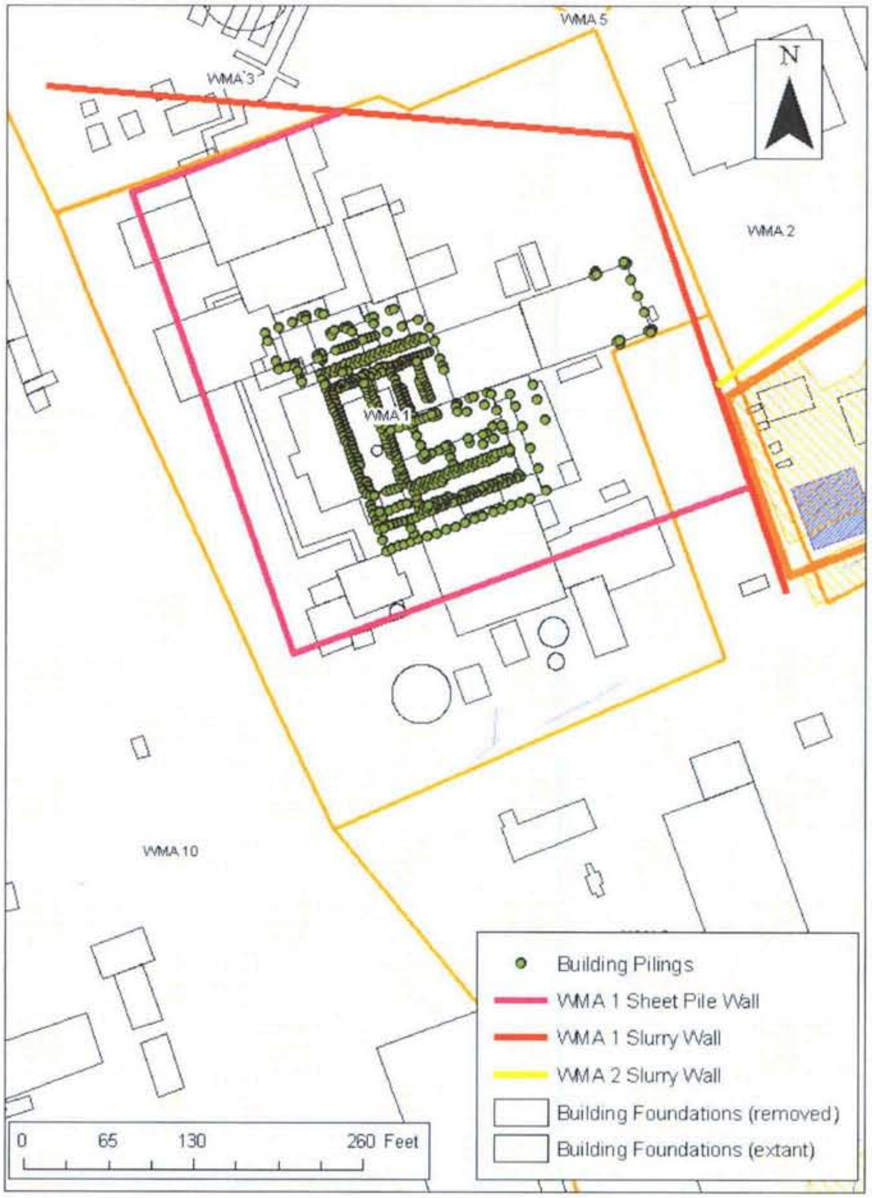

Figure A.19 Foundation Piling Locations

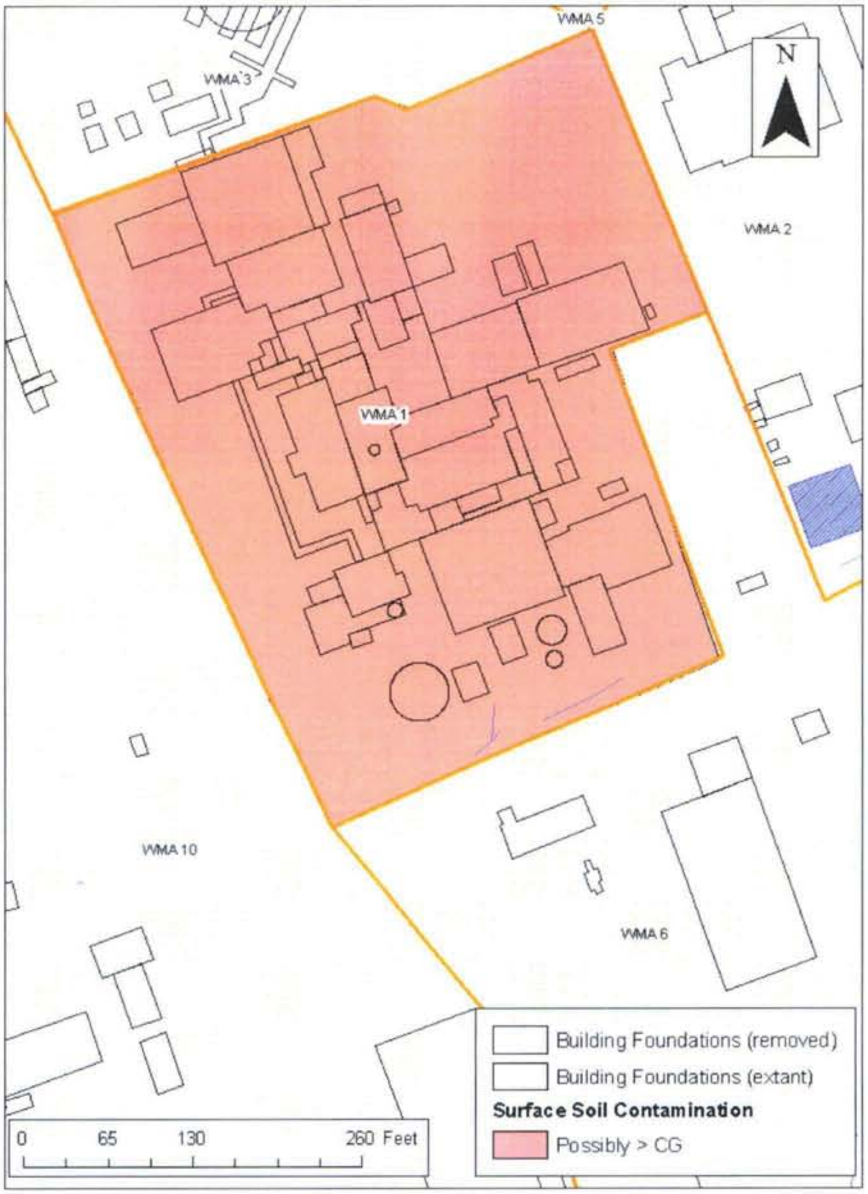

Figure A.20 Initial WMA 1 Surface Soil CSM

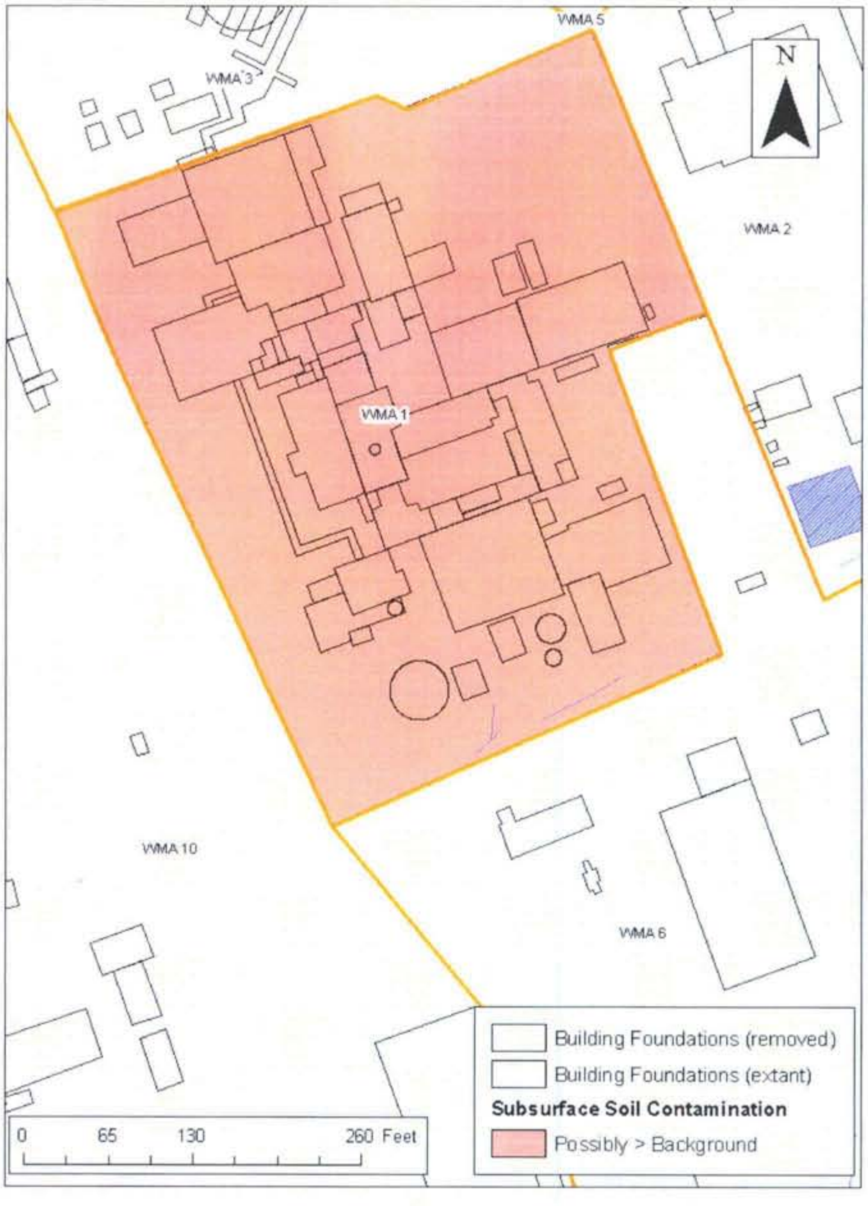

Figure A.21 Initial WMA 1 Subsurface Soil CSM

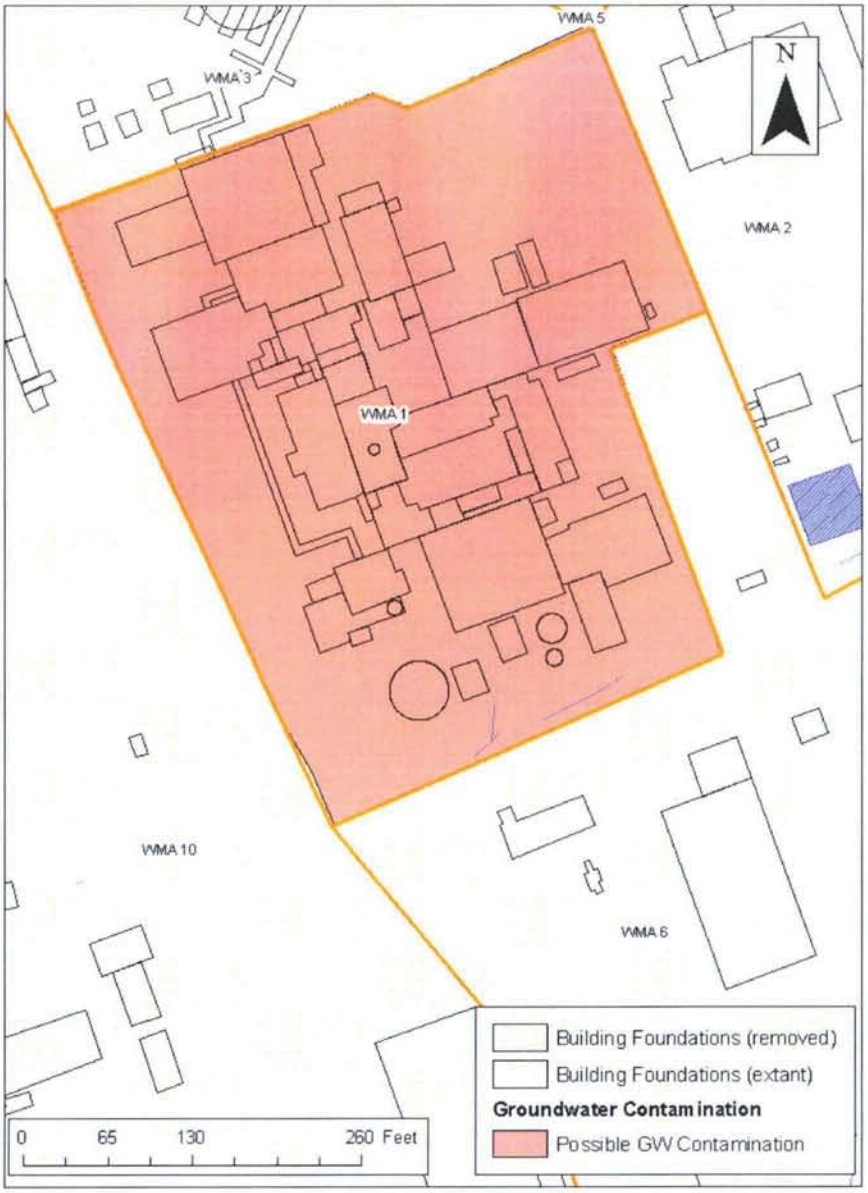

Figure A.22 Initial WMA 1 Groundwater CSM

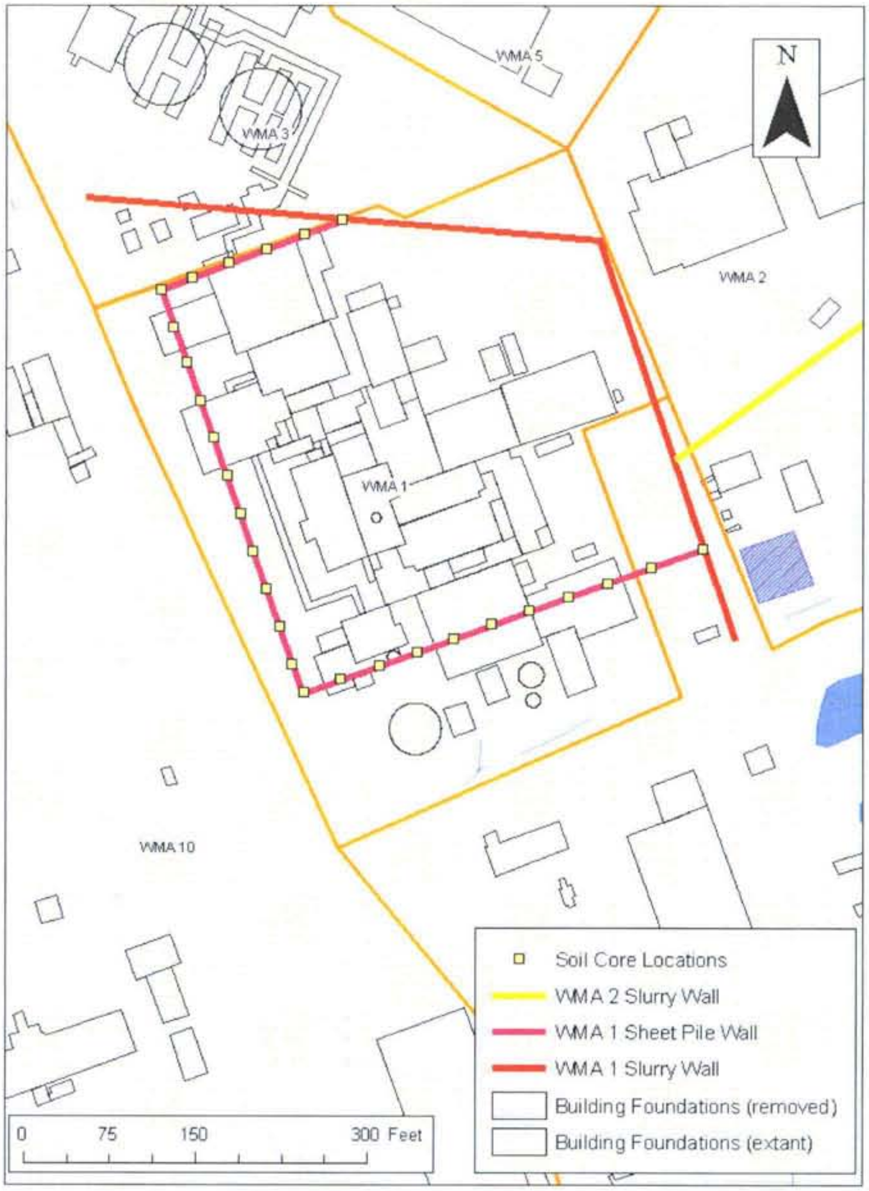

Figure A.23 Example Soil Core Locations

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APPENDIX B

WMA 2 PRE-REMEDIATION DATA COLLECTION

B.1 Background

Waste Management Area 2 (WMA 2) is approximately 14 acres in size (see Figures B.1 and B.2 for maps). WMA 2 includes facilities historically used for managing low-level radioactive wastewater generated on site.

Descriptions of the various features of WMA 2 follow, and are taken from the Phase 1 DP, Section 3.1.2:

Low-Level Wastewater Building. The Low-Level Wastewater (LLW2) Building is located towards the center of WMA 2, southwest of Lagoon 4. This pre-engineered, single-story, metal-sided building rests on a concrete wall foundation, measuring 40 feet by 60 feet. The building houses two skid-mounted process equipment modules that are used to treat wastewater from WMA 1 and WMA 2, and radiologically contaminated groundwater from the WMA 7 NDA Interceptor Trench, groundwater collected from within the tank farm in WMA-3, and groundwater collected from the North Plateau Groundwater Recovery System. The LLW2 Building was built in 1998 to replace the adjacent O2 Building. The O2 Building was the original low-level wastewater treatment facility that was built by NFS in 1971, decommissioned in the 1990s, and demolished to slab in 2006 (see discussion of O2 Building below).

Lagoons. From 1965 to 1971, low-level wastewater was routed from the Old and/or New Interceptors through Lagoons 1, 2, and 3 in series before discharge to Erdman Brook. In 1971, the low-level waste treatment facility system was installed; this system initially consisted of the O2 Building and Lagoons 4 and 5, and now consists of the LLW2 Building and Lagoons 4 and 5. Between 1971 and 1982, low-level wastewater was routed sequentially from the Interceptors through Lagoon 1, Lagoon 2, and the O2 Building for treatment, then to Lagoon 4 or 5, and finally to Lagoon 3 before discharge to Erdman Brook. Lagoon 1 was closed in 1982; from 1982 to the present, low-level wastewater has been routed sequentially through Lagoon 2, the O2 Building or LLW2 Building for treatment, Lagoon 4 or 5, and finally to Lagoon 3 before discharge to Erdman Brook.

- ***Lagoon 1*** was an unlined basin excavated into the sand and gravel unit. It measured approximately 80 feet long on each side and 5 feet deep. It had a storage capacity of more than 200,000 gallons. Lagoon 1 was fed directly from the Old Interceptor and the New Interceptors. It was removed from service in 1984. Most of the contaminated sediment was transferred to Lagoon 2. Lagoon 1 was filled with contaminated debris from the Old Hardstand (WMA 5) and then capped with clay and topsoil.

- ***Lagoon 2*** is an unlined basin excavated in the un-weathered Lavery Till. It measures approximately 200 feet long by 100 feet wide and 17 feet deep. It has a storage capacity of 2.4 million gallons. Lagoon 2 is fed directly from the New Interceptors, the NDA interceptor trench, the tank farm and at times the North Plateau Groundwater Recovery System; it is part of the Low-Level Water Treatment Facility.

- ***Lagoon 3*** is an unlined basin excavated in the unweathered Lavery till. It measures approximately 230 feet long by 130 feet wide and 24 feet deep. It has a storage capacity of 3.3 million gallons. Lagoon 3 receives treated water from Lagoons 4 and 5. Lagoon 3 is periodically batch discharged to Erdman Brook through a State Pollutant Discharge Elimination System (SPDES) permitted discharge; it is part of the Low-Level Water Treatment Facility.

- ***Lagoon 4*** is a lined basin constructed in the sand and gravel unit on the North Plateau. It measures approximately 100 feet long by 90 feet wide. It has a storage capacity of 204,000 gallons. It receives only treated water from the LLW2 Building and discharges to Lagoon 3. Lagoon 4 was originally lined with reworked glacial tills. In 1974, a synthetic membrane liner was installed after NFS identified that Lagoons 4 and 5 were potential sources of tritium to groundwater in the sand and gravel unit. In the late 1990s, the synthetic membrane liners were removed and replaced with concrete grout and a XR-5 liner, which is an ethylene inter-polymer alloy membrane.

- ***Lagoon 5*** is very similar in form and function to Lagoon 4, and shares the same history. It is a lined basin constructed in the sand and gravel unit on the North Plateau. It measures approximately 90 feet long by 80 feet wide. It has a storage capacity of 166,000 gallons. It receives only treated water from the LLW2 Building and discharges to Lagoon 3. Lagoon 5 was originally lined with reworked glacial tills, was later relined with a synthetic membrane liner, and finally was lined with concrete grout and a XR-5 liner.

French Drain. In 1965, a French drain was installed on the northwest sides of Lagoons 2 and 3 and the northeast side of Lagoon 3 to prevent groundwater from flowing into Lagoons 2 and 3. The French drain discharged to Erdman Brook. The French drain was capped in 2001 and no longer discharges into Erdman Brook.

Neutralization Pit. The Neutralization Pit is a nine feet by seven feet by 5.5 feet deep concrete tank constructed with six-inch thick concrete walls and floor that are lined with stainless steel. The pit receives low-level radioactive wastewater from WVDP process areas. This liquid is subsequently transferred to the Interceptors. Between about 1965 and 1988 NaOH was added in the Neutralization Pit to neutralize slightly acidic wastewaters.

Old Interceptor. The Old Interceptor is a liquid waste storage tank. It is an unlined concrete tank, located below-grade, with a steel roof. It measures 40 feet by 25 feet by 11.5 feet deep. The floor is 24 inches thick and the walls are 12 inches thick. The Old Interceptor received low-level liquid wastewater generated at the Process Building. The wastewater was collected and sampled, then discharged to Lagoons 1 or 2. It was in use from the time of initial plant operation until 1967, when the Old Interceptor was replaced by the New Interceptors. The Old Interceptor is currently used for temporary storage of radiologically contaminated liquids that exceed the effluent release criterion of 0.005 µCi/mL gross beta activity. After verification of acceptable radiological contamination concentrations, the contents are transferred by steam jet to the New Interceptors.

New Interceptors. The New Interceptors are twin liquid waste storage tanks. Each is an open-top, lined concrete tank, located below-grade, with a steel roof. Each measures 22 feet by 20 feet by 11.5 feet deep. The walls and floor are 14 inches thick, and are lined with stainless steel. The New Interceptors were built in 1967 to replace the Old Interceptor, which had high levels of radioactivity. As with the Old Interceptor, the New Interceptors receive wastewater and are used to collect and sample the wastewater before transfer to Lagoon 2.

Solvent Dike. The Solvent Dike is located approximately 300 feet east of the Process Building. It was an unlined basin excavated in the sand and gravel layer. It measured 30 feet by 30 feet. The Solvent Dike received rainwater runoff from the Solvent Storage Terrace, which housed an acid storage tank and three storage tanks containing a mixture of used n-dodecane and tributyl phosphate. The sediment has been removed and the area has been backfilled, but the Solvent Dike still contains radiologically contaminated soil.

Maintenance Shop Leach Field. The Maintenance Shop Leach Field is located directly northeast of where the Maintenance Shop stood. It consists of three septic tanks, a distribution box, a tile drain field, and associated piping. It occupies an area of approximately 1500 square feet. The leach field was used until 1988; all three tanks are now out of service and filled with sand. Because it is located within the area of the north plateau groundwater plume, low levels of contamination may be present.

Groundwater Recovery System. The Groundwater Recovery System is located in the northwest corner of WMA 2. It was installed in 1995. The groundwater recovery system includes 3 wells although most of the time water is pumped from two recovery wells at the western lobe of the north plateau groundwater plume. Groundwater is pumped from the wells to the LLW2 Building for treatment by ion exchange to remove Sr-90 contaminants. Like all discharge from the LLW2 Building, the treated groundwater is pumped to Lagoon 4 or Lagoon 5, then to Lagoon 3, and, eventually, discharged into Erdman Brook through the permitted outfall.

Pilot Scale Permeable Treatment Wall. The Pilot Scale Permeable Treatment Wall is located northwest of Lagoon 5. It was installed in 1999. This treatment wall is approximately 30 feet wide, seven feet thick, and 25 feet deep, extending into the Lavery till. It is filled with clinoptilolite, a natural zeolite material, and covered with soil. Its purpose was to evaluate the effectiveness of such systems in treating groundwater contaminated with Sr-90.

O2 Building. The O2 Building was located southwest of the Low Level Wastewater Building. It was a two-story, steel-framed concrete block structure, measuring 27 feet wide, 39 feet long, and 30 feet high. It contains a 16 feet deep stainless steel-lined sump. The O2 Building once housed filters, ion exchangers and other equipment used by NFS and the WVDP to treat low-level wastewater before transfer to Lagoon 3. The O2 Building was built in 1971 and operated until 1998, when it was replaced by the LLW2 Building. It was demolished down to its concrete floor slab at grade in October 2006.

Test and Storage Building. The Test and Storage Building was located northeast of the Process Building. It was a timber frame and metal sided building, measuring 80 feet by 120 feet by 22 feet high. It contained office spaces, a tool crib, and garage space. A concrete block addition housed radiation and safety operations; it measured 18 feet by 26 feet by 12 feet high. The Test and Storage Building and its addition were demolished down to its concrete floor slab at grade in June 2007.

Maintenance Shop. The Maintenance Shop was located adjacent to the east end of the Test and Storage Building. It was a metal building with steel supports, measuring 60 feet by 100 feet by 28 feet high. It housed locker rooms, lavatories, instrument shops, work areas, and a finished office area. The Maintenance Shop was demolished down to its concrete floor slab at grade in June 2007.

Full Scale Permeable Treatment Wall. A full-scale permeable treatment wall is currently under design for installation in the near future to address the further migration of the north plateau groundwater plume. This zeolite-filled wall will run in a U-shape from the eastern end of the Lag storage buildings in WMA 5 to the northern end of Lagoon 3, and will be tied to the underlying Lavery Till.

Underground Pipelines. Approximately 50 underground wastewater pipelines totaling more than 4,000 linear feet lie within WMA 2. Some of these pipelines run from the Process Building area (WMA 1) and the Waste Tank Farm (WMA 3) to the WMA 2 Neutralization Pit and Interceptors. They also connect the Interceptors to Lagoon 2; connect Lagoon 2 to the O2 Building and the LLW2 Building; connect these treatment facilities to Lagoons 4 and 5; connect Lagoons 2, 3, 4, and 5 to each other; and discharge treated wastewater from Lagoon 3 to Erdman Book through the permitted outfall. When Lagoon 1 was taken out of service in 1984, piping to Lagoon 1 from the New Interceptors was realigned to Lagoon 2.

- The wastewater pipelines are Duriron pipes. They range from two to six inches in diameter and typically are buried eight to 12 feet below grade.

- An exception to Duriron piping is the leachate transfer pipeline that runs from the NDA (WMA 7) to Lagoon 1 and Lagoon 2. This is a two inch polyvinylchloride pipeline, buried approximately five feet below grade. It runs for approximately 400 feet within WMA 2. The leachate transfer pipeline originally delivered water that collected in SDA lagoons (WMA 8) to the lagoons in WMA 2.

- All underground wastewater pipelines within WMA 2 are known to be radioactively contaminated. The leachate transfer pipeline has been determined to contain an insignificant amount of residual radioactivity.

Certain facilities that were located in WMA 2 have been removed during deactivation work to achieve the EIS starting point. These facilities include the O2 Building, the Test and Storage Building, the Vitrification Test Facility, the Maintenance Shop, the Vehicle Maintenance Shop, the Maintenance Storage Area, miscellaneous "O" series office trailers, and a group of storage trailers. Of these facilities, only the O2 Building was radioactively contaminated. Concrete floor slabs and foundations associated with these facilities, except for the trailers, remain in place.

B.2 Physical Setting

WMA 2 is located on the north plateau. It is bounded to the west by WMA 1, WMA 3, WMA 5, and WMA 6, to the north by WMA 5 and WMA 4, to the east by WMA 12, and to the south by WMA 6 and WMA 12.

The surface of WMA 2 consists of building footprints, parking lots/hardstands, waste lagoons, and vegetated soils. WMA 2 has a complex topography, reflecting the significant reworking of soils over the years to install and decommission various waste lagoons and supporting infrastructure. In general, surfaces slope from the west towards the east. Surface runoff discharges to ditches that run along the northern and southern boundaries of WMA 2. The northern ditch joins the Swamp Ditch (WMA 4), which discharges to Franks Creek to the east of the WVDP premises. The southern ditch feeds Erdman Brook in WMA 12.

The subsurface of WMA 2 consists of a relatively permeable sand and gravel layer that overlies the impermeable Lavery Till (Figure B.3). Some of the lagoons extend into the Lavery Till. Groundwater generally flows from west to east; however, there are some deviations from this rule in the northern and southern parts of WMA 2. In the northern part of WMA 2, some groundwater flows north to discharge into the Swamp Ditch, which is a drainage feature that runs west-to-east along the north side of the CDDL (WMA 4). Along the southern boundary of WMA 2, groundwater likely has a southern component, leading to discharge into Erdman Brook. Further, Lagoons 2 and 3, near the eastern boundary, are unlined.

There is known to be a significant amount of buried infrastructure (piping, etc.) associated with the WMA 2 facilities.

B.3 Area History

The WMA 2 area (and in particular surface soils) has undergone significant reworking since the initiation of NFS activities.

Figure B.4 shows WMA 2 in 1962 prior to site development. At this time WMA 2 was farmed.

Figure B.5 shows WMA 2 in 1966. The surface of WMA 2 shows surface scarring over almost its entirety, with scarring extending from Lagoon 2 to the southeast into WMA 12. Lagoons 1, 2, and 3 are clearly visible.

Figure B.6 shows WMA 2 in 1968. Re-vegetation has occurred over much of the site. Discharge points from Lagoons 2 and 3 are clearly visible. The neutralization pit, solvent dike, and Test and Storage Building are also clearly visible along the western edge of WMA 2.

Figure B.7 shows WMA 2 in 1977. A significant amount of additional construction has taken place in WMA 2 since 1968. In particular, Lagoons 4 and 5 have been added, as well as a number of additional structures in the western portion of WMA 2. Note that these activities would have resulted in a potentially significant displacement of surface soils that would have been contaminated by the 1968 Process Building stack releases.

Figure B.8 shows WMA 2 in 1984. The area is basically unchanged since 1977. The footprint of the French Drain is visible in this photograph.

Figure B.9 shows WMA 2 in 1995. Lagoon 1 had been filled and covered in this photograph. There also is a significant surface disturbance in the northeast corner of WMA 2, adjacent to Lagoon 3 which later became a hardstand area.

Figure B.10 shows WMA 2 in 2007.

Figure B.11 shows a 1982 oblique aerial photograph of the WMA 2 area taken from the east.

B.4 Known and Suspected Releases

Lagoon 1 is expected to contain a substantial amount of radioactivity, with more than 90 percent in the remaining sediment. Lagoon 2 is expected to contain residual radioactivity of the same order of magnitude as Lagoon 1 with a similar radionuclide distribution. Lagoon 3 is expected to contain less radioactivity in its sediment than Lagoons 1 and 2. Lagoons 4 and 5 are expected to contain relatively low levels of radioactivity in sediment both above and below their liners.

The Old Interceptor is expected to contain a significant amount of radioactivity based on available data, which include a gamma radiation level of 408 mR/h measured near the tank bottom in 2003. Twelve inches of concrete were poured on the tank floor by NFS as radiation shielding. The New Interceptors and the Neutralization Pit are both expected to contain low levels of radioactive contamination. The three septic tanks and other equipment in the Maintenance Shop Leach Field may have been impacted by the north plateau groundwater plume, but any resulting contamination levels are expected to be low.

The contaminated underground wastewater lines within WMA 2 were estimated to contain a total of approximately 0.3 curies of residual radioactivity in 2004. The French drain is expected to contain very low levels of residual radioactivity.

In 1967, contaminated groundwater was encountered during the construction of the new interceptor drain, indicating leakage or a release associated with the old interceptor drain line (south side) (Phase 1 DP Rev 2 Table 2-17; Taylor 1967).

The Lagoon 1 design (to allow liquid to seep from the impoundment while retaining sediment) allowed tritiated water, originally containing about 6,000 curies of tritium in leachate pumped from the SDA for treatment, to infiltrate areas of the north plateau groundwater in the mid-1970s. These conditions were an unintended consequence of the lagoon design, and resulted in an extensive investigation by NFS, extending through the transfer of operational control to DOE in the 1982.

In addition to the known acid spill within WMA 1 that affected groundwater in the north plateau, during NFS operations several incidents such as inadvertent transfers of higher-than-intended activity occurred in the interceptor basin system upstream of the lagoon system. Documented accounts of leakage and spills in the area corroborate the generally elevated observed subsurface soil contamination in the area west of Lagoon 1 to the vicinity of the Process Building in WMA 1. Localized subsurface soil contamination can be attributed to these unintended operational releases.

Lagoons 2 and 3 may have discharged to groundwater over the years. Lagoons 2 and 3 are currently operated such that their levels are maintained below the interface of the sand and gravel and the Lavery till. As such, they are not considered to contribute to groundwater in the sand and gravel. They may contribute small amounts to the Lavery till and likely act as local drains to groundwater in the sand and gravel. However, historically there may have been times when elevated liquid levels within Lagoons 2 and 3 allow discharge of contaminated water to the subsurface; this would have primarily impacted subsurface soils to the south/southeast of these lagoons. While contamination levels in the discharged water would have been relatively low, soil sorption would likely have led to an accumulation of contamination in subsurface soils adjacent to these lagoons.

Lagoons 4 and 5 overflowed in 1974 due to loss of capacity at Lagoon 3; this resulted in unplanned treated water released to local soil and groundwater northeast of the O2 Building (Phase 1 DP Rev 2 Table 2-17; Taylor 1972). Treated water activity concentrations were likely around surface water free release levels.

The neutralizer pit overflowed on February 25, 1987 due to a malfunctioning drain valve. The overflow went to the ground near the interceptors and Lagoon 1. The flow was stopped when noted by an operator. Approximately 5,000 gallons of wastewater was spilled (Phase 1 DP Rev 2 Table 2-18; WVNSCO 1987c).

The soils within WMA 2 would have been impacted by air deposition of radionuclide contaminants from the Process Building's activities. Groundwater and consequently subsurface soils beneath the WMA 2 footprint also have been impacted by subsurface migration of contaminants released by Process Building activities. Those releases resulted in the north plateau groundwater plume, which now extends from WMA 1 underneath WMA 2 in the direction of the CDDL and the eastern WVDP fence line.

All significant subsurface contamination is believed to be confined to soils and groundwater above the Lavery Till; the upper few feet of the Lavery Till may also have contamination impacts present.

B.5 Existing Data

Existing data sets for this area include:

- In 1982 static direct exposure readings were collected across the WVDP premises (WVNS 1982). A portion of WMA 2 was covered by these measurements on a 10-m grid. Figure B.12 shows these results color-code by the exposure readings encountered. These data indicated potentially significant surface contamination within the WMA 2 boundary, with activity levels in general falling as one moves from west to east; interpretation of these data is complicated by the possibility of shine effects from the Process Building and other facilities.

- In 1990 and 1991 a second static direct exposure measurement program was conducted (WVNS 1992). In the case of WMA 2, this effort provided systematic coverage for all of the WMA 2 area on a 10-m grid. This data collection used different instrumentation and protocols than the 1982 study, so the results are not quantitatively comparable. Figure B.13 shows these results. These data also indicated potentially significant surface contamination within the WMA 2 boundary, with the same general pattern of falling activity levels as one moves from west to east; interpretation of these data is complicated by the possibility of shine effects from the Process Building and other facilities. In addition, the 1990/1991 survey identified more localized elevated areas immediately adjacent to Lagoons 2, 3, 4, and 5.

- There are some soil sampling data for WMA 2 available within ELIMS. Figure B.14 shows the locations of surface soil samples, sediment samples and soil cores with subsurface soil samples. The bulk of the data was either collected as part of the 1993 site-wide characterization effort, or as part of the 2008 north plateau groundwater plume characterization work. The exception is NP5, which was completed in 1994. Table B.1 summarizes which radionuclides have data for WMA 2. Figure B.14 also shows surface soil Cs-137 and Sr-90 activity concentrations where those were available.

There are very limited surface soil data available within ELIMS. In general these data show higher activity concentrations in the western portion of WMA 2 and lower activity concentrations to the east, as one would expect. Subsurface data identified elevated activity concentrations throughout WMA 2 to depth. The mix of radionuclides present and the depth where maximum concentrations are encountered varies depending on location. For contamination associated with the north plateau groundwater plume originating from a subsurface release beneath the Process Building, Sr-90 is the only radionuclide significantly elevated above background levels in soils. For contamination associated with discrete releases within WMA 2, such as leaching from Lagoon 1 or releases in the western portion of the site, Cs-137 often dominates. Figure B.18 provides a cross-sectional view that includes several soil core locations along with their sampling results in the lagoon area of WMA 2.

- There is a significant amount of groundwater data for WMA 2 available within ELIMS from historical characterization work addressing the north plateau groundwater plume. These data were obtained from monitoring wells and from discrete groundwater samples obtained by GeoProbe. Figures B.15 and B.16 show the locations of groundwater data collection color-coded by Sr-90 and tritium results, respectively. The detection limits for Sr-90 and tritium varied widely among ELIMS samples. 10 pCi/L and 500 pCi/L were selected as thresholds for Sr-90 and tritium, respectively, because based on ELIMS data results above these activity concentrations were consistently above method detection limits and so indicative of contamination impacts rather than simply measurement error. Groundwater contamination was encountered throughout WMA 2.

B.6 Planned Phase 1 DP Activities

For a more complete description of planned Phase 1 DP activities, see the Phase 1 DP, Section 3.1 and Section 7.4.

In WMA 2, the five lagoons, the Interceptors, the Neutralization Pit, the LLW2 Building, the Solvent Dike, the Maintenance Shop Leach Field, the remaining concrete slabs and foundations, and the underground wastewater lines within the large excavation will all be removed as part of Phase 1 decommissioning activities. Figures B.17 and B.18 show the location of the large excavation and provide a cross-sectional view of the planned excavation, respectively. The large excavation is intended to address the bulk of discrete releases and heavy subsurface contamination within WMA 2 associated with the lagoons and lagoon support facilities, but not the deep north plateau groundwater plume that originated from a release underneath the Process Building and that has migrated into WMA 2's subsurface.

The DP Phase 1 activities will not include the North Plateau Pump and Treat System, the Pilot Scale Permeable Treatment Wall, the Full-Scale Permeable Treatment Wall, and underground lines not within the excavated areas.

The Full-Scale Permeable Treatment Wall is currently under design and will be installed as an activity separate from Phase 1 decommissioning activities.

B.7 Conceptual Site Model

Based on the limited available information, the conceptual site model (CSM) for WMA 2 is as follows. A number of potential releases within the WMA 2 footprint are known to have occurred, or may have occurred that likely impacted surface and subsurface soils and groundwater. In addition, environmental media within WMA 2 have likely been affected to some degree by releases elsewhere at the WVDP site. These include air deposition contamination on surface soils and subsurface contamination resulting from contaminant migration via groundwater from the Process Building.

During NFS operations, portions of the surface of WMA 2 underwent significant reworking. This reworking occurred in the western portion of WMA 2 and included the installation of Lagoons 4 and 5 as well as additional facilities. This reworking may have covered contaminated surface soils with clean cover, contaminated surface soils may have been removed for disposition elsewhere, and/or contaminated soils may have been re-used as backfill for building foundations or buried infrastructure.

Groundwater flow underneath WMA 2 is expected to be, in general, from west to east. The core of the north plateau groundwater plume has been steadily migrating in an easterly/northeasterly direction. Groundwater flow also includes some northerly components along the west end of the CDDL, where discharge to the Swamp Ditch takes place, and also likely includes some southerly components along the southern boundary of WMA 2, with discharge to Erdman Brook. Impacts to groundwater include the original Sr-90 release from beneath the Process Building in WMA 1, from leaching from Lagoon 1, from lagoon overflows (Lagoons 4 and 5), from seepage from Lagoons 2 and 3, and from various discrete releases associated with activities/infrastructure in the southwestern end of WMA 2.

Figure B.19 shows the current CSM for surface and near surface soils. Figure B.20 shows the CSM for soils deeper than 1 m. Figure B.21 shows the CSM for contaminated groundwater beneath WMA 2.

B.8 WMA 2-Specific Characterization Goals

- Develop an inventory of buried infrastructure
- Evaluate appropriateness of the current list of ROI
- Verify absence of additional ROI
- Determine extent of surface contamination
- Identify the presence/absence of buried contamination
- Identify soil waste stream characteristics
- Define required extent of WMA 2 excavation
- Obtain data to support Phase 2 planning
- Obtain geotechnical data required for barrier wall design

B.9 CSAP Pre-Remediation Data Collection and Associated Decision-Making

CSAP pre-remediation data collection will consist of a number of components described in more detail below.

B.9.1 Buried Infrastructure

The footprint of buried infrastructure will be identified and mapped. A significant amount of buried infrastructure is believed to exist within WMA 2, and in particular in the western portion of WMA 2. This infrastructure would include wastewater lines and as well buried utilities. **[required]**

B.9.2 Gamma Walkover Survey Data

The purpose of performing a gamma walkover survey of the WMA 2 area is to identify the level and extent of surface contamination. This includes both general trends in average activity concentrations pertinent to the surface soil CG_w requirement, as well as the identification of isolated, more-elevated anomalies that might be indicative of discrete releases and/or surface soil CG_{emc} concerns.

A complete (100%) logged gamma walkover survey (GWS) will be conducted for accessible areas within WMA 2. Examples of areas that would not be accessible are areas where standing water is present in wetlands, existing building footprints, building pads, and lagoons. Based on the GWS results, surface soil within WMA 2 will be divided into three categories: (1) surface soils where GWS indicates possible surface soil CG_w exceedances; (2) surface soils where GWS indicate impacts, but those impacts are not expected to exceed surface soil CG_w standards; and (3) surface soils where there is no indication of impacts above background conditions. The purpose of this data collection is to provide insights into the spatial distribution of surface contamination, and to guide subsequent soil sampling. **[required]**

B.9.3 Surface Soil Sampling

Surface soil sampling will be used to address areas inaccessible to GWS data collection, to resolve hot spots identified by the GWS data, and to evaluate the presence, absence, and/or extent of surface contamination above surface soil CG_w requirements based on GWS results.

- **Wetlands.** It is possible that standing water will be present in wetlands that prevent GWS data collection from those areas. Soil sampling will be required for wetland footprints and for any other areas where standing water prevents the collection of GWS data. Within WMA 2, this is most likely to occur in the eastern portion of the WMA.

  For every area where standing water or saturated soil conditions prevent GWS data collection and that is outside the planned WMA 2 excavation, systematic soil sampling will take place. At least one and at most five sampling locations will be selected per area. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. In the case where an area has more than one location, locations will be selected so that each representative area does not overlap and provides systematic coverage of the area of interest. If a wetland area is less than 200 m^2 in size, one 5-point composite will be formed to be representative of the wetland's area. **[contingent]**

- **Hot Spots.** If GWS data indicate the presence of contamination that possibly exceeds "hot spot" (CG_{emc}) standards or an isolated elevated area is identified that appears indicative of a discrete release, the location of concern will be sampled with a biased sample. Within WMA 2, hot spots will be biased sampled if they are outside the planned WMA 2 deep excavation footprint. If biased samples are collected from a particular location, they will be collected from two depth intervals: 0-15 cm, and 0-1 m. In the case of surface soils, each biased sample will be a composite sample formed from 5 increments systematically distributed over the area of interest. The 0-15 cm samples will be analyzed for the 12 radionuclides of potential interest in addition to the 18 ROI. One down-hole gamma scan will be conducted from each biased location. The purpose of these samples is to resolve GWS anomalies, evaluate the appropriateness of the current ROI list, and verify the absence of additional ROI. **[contingent]**

- **CG_w Sampling.** Surface soil sampling may be conducted after the GWS to further clarify results, with the level and nature of sampling dependent on GWS results. For WMA 2, surface soil CG_w sampling in response to GWS results will primarily focus on areas that are currently not paved and that are not within the planned WMA 2 excavation footprint.

  - If GWS results indicate contamination impacts above background levels but that surface soil contaminant levels exceeding surface soil CG_w requirements are unlikely, a minimum of five surface soil sample locations will be identified and sampled that target the areas with the highest gross activity levels. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap. The purpose is to document the maximum activity concentrations present in surface soils within WMA 2. **[contingent]**

  - If GWS results indicate surface soil contaminant levels exceeding surface soil CG_w requirements likely exist, one sampling location will be selected at the highest gross activity level to confirm surface soil CG_w exceedances and another set of sampling locations will be identified to spatially bound the extent of contamination (i.e., along the boundary of what is considered likely above surface soil CG_w requirements). Two samples will be collected from the location targeting high gross activity levels, one representative of a 0-15 cm depth interval, and one representative of a 0-1 m depth interval. One sample will be collected from each location intended to laterally bound contamination, representative of a 0-15 cm depth interval. Each sample will be a 5-increment composite formed to be representative of a 200 m^2 area. In addition, the location targeting high gross activity levels will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. Locations will be selected so that each representative area does not overlap. The purpose is to document surface soil CG_w requirement exceedances and bound the lateral extent of contamination. **[contingent]**

  - If GWS results indicate areas with surface soil contamination impacts but it is unclear whether surface soil CG_w requirement exceedances are present, at most five sampling locations will be selected that systematically cover the areas of interest. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap. The purpose is to resolve the question of whether surface soil CG_w requirement exceedances exist for areas where GWS results are ambiguous. **[contingent]**

- If any 0-15 cm interval yields a sample result indicating a surface soil CG_w requirements exceedance and that sample location is not laterally bounded either by existing sampling locations with results less than surface soil CG_w requirements or by GWS data that clearly indicate contamination is not a concern, additional sampling locations will be selected so that the contamination encountered is spatially bounded. The purpose is to laterally bound contamination that is above CG_w requirements. **[contingent]**

B.9.4 Subsurface Soil Sampling

Subsurface soil sampling within WMA 2 has three purposes: (1) to determine presence and vertical extent of contamination impacts above background levels in WMA 2 along the edge of and outside the planned deep excavation, (2) to estimate waste stream volumes in support of the planned WMA 2 deep excavation, and (3) to provide geotechnical and contamination status information for the footprints of the slurry and sheet walls.

The area in the western central portion of WMA 2 where surface soils were reworked and subsequently paved by WVDP activities is of specific concern for potential subsurface contamination issues. Much of the WMA subsurface has also been impacted by the north plateau groundwater plume to varying degrees. A significant amount of historical data collection has already taken place to characterize the nature and extent of that plume; additional characterization is outside the scope of the CSAP.

- **Central Western Area of WMA 2.** The assumption is that because of surface cover added to the site as part of WVDP activities, surface contamination that pre-dated the WVDP may now be covered by clean material and may not readily detectable by GWS scans. Figure B.22 shows the area of WMA 2 where this is a concern. (Note that the contamination status of soils beneath building slabs will be addressed by remedial support surveys after slabs have been removed.) This area is approximately 1.7 acres in size. Systematic sampling locations arranged on a triangular grid with a 20-m grid spacing will be used to evaluate the contamination status beneath the existing ground cover. Approximately 20 sampling locations will be required. Each location will have one discrete sample collected to a depth of 1-m. In addition, each will have a down-hole gross activity scan with one measurement taken each 15 cm. **[required]**

- **WMA 2 Waste Characterization.** Subsurface soil cores will be obtained within the footprint of the planned WMA 2 excavation to address contaminated soil volume estimation needs. Sixteen core locations will be placed within the excavation footprint (excluding the footprints of Lagoons 1, 2, and 3) to a depth of 1 m into the Lavery Till. The cores will be located to provide systematic coverage of the area (approximately one core per 1,000 m^2). Each one meter interval of each core will be sub-sampled in a fashion to obtain a representative sample, and those samples submitted for quick turn-around analysis of Sr-90 and Cs-137. With an average expected depth-to-till of 20 feet, approximately 100 samples will be collected and analyzed. These data will be used to estimate waste stream volumes resulting from the excavation of WMA 2. **[required]**

- **Lagoon 2 Sediment Characterization.** Because of the placement of highly contaminated Lagoon 1 sediments into Lagoon 2, there is the potential for TRU-contaminated sediments to be present in Lagoon 2 sediments. Five locations will be systemically identified across Lagoon 2's surface, and sediment cores retrieved representing the top one meter of sediments/soils. These samples will be analyzed for the 12 potential radionuclides of interest, in addition to the 18 ROI. **[required]**

- **Southern WMA 2 Excavation Boundary.** Subsurface soil coring, scanning, and sampling will take place along the southern boundary of the planned excavation to confirm the contamination status of surface and subsurface soils adjacent to the southern edge of the planned WMA 2 excavation. An initial set of 30 sampling locations separated by 10 m starting from the southwestern corner of the WMA 2 excavation and running east along planned excavation boundary will be sampled (Figure B.23). At each location, one core will be retrieved that extends one meter into the Lavery till. A down-hole scan will be conducted to the extent possible at each location with a static measurement every 30 cm. Each core will be divided into one meter segments.

- At minimum, the following soil core segments will be submitted for analysis: the top meter (representative of surface soils), the meter directly above the Lavery till, the top meter of Lavery till, and the meter straddling the water table. In addition, if the bore/core scan identifies an elevated zone not included in one of these three, the meter interval containing the elevated zone will be submitted for laboratory radiological analysis. Towards the eastern end of the planned excavation, the overlying sand/gravel unit may pinch out; in this case there may be less than four samples submitted for analysis if the depth to till is less than four meters. **[required]**

- From each location three discrete groundwater samples will be collected: one from the water table, one from immediately above the Lavery till, and one midway between these two, if possible. In areas where the overlying sand/gravel unit pinches out, the number of groundwater samples may be reduced accordingly. **[required]**

- If any interval other than the top 1 m identifies contaminants above background levels, then additional soil core locations will be placed on a triangular grid with a separation of 10 meters to the south of the location(s) of concern in a manner that bounds the original contamination as the terrain allows and sampled as described above. This process will continue until the southern extent of subsurface contamination is bounded. If extensive subsurface contamination is encountered a field decision may be made to increase the separation distance between the original set of core locations and the next set of bounding core locations. The ultimate intent is to spatially bound subsurface contamination to the south of the planned WMA 2 excavation. This sampling may extend into WMA 12. **[contingent]**

- **Slurry Wall Footprint Characterization.** Subsurface soil coring and scanning will take place following the planned slurry wall footprint along the western, northern, and eastern portion of the WMA 2 excavation. These core locations will be separated by 20 m. Approximately 20 cores will be required. At each location, one core will be retrieved that extends one meter into the Lavery till. A down-hole scan will be conducted to the extent possible at each location with a static measurement every 30 cm. Each core will be divided into one meter segments.

- Subsurface soil sampling, groundwater sampling, and core scanning protocols will be the same for soil cores from the slurry wall footprints as for the southern boundary of the WMA 2 excavation. **[required]**

- A variety of geotechnical field data will be collected from each core location, as necessary and required for sheet piling/slurry wall design. In addition soil samples will be collected and submitted for geotechnical analyses (e.g., grain size, Atterberg limits, triaxial strength, etc.) as required by sheet piling/slurry wall design. **[required]**

- **Additional Contingencies.**

  - If any 0-15 cm surface soil sample result indicates contamination impacts above background levels and there was not a 0-1 m sample collected from that location, a 0 – 1 m sample will be collected from that location following the protocols us0-1ed for the original 0-15 cm surface soil sample. In addition, each soil location will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. **[contingent]**

  - If a 0-1 m sample result exceeds background levels, then an additional sample from a depth of 1–2 m will be collected and analyzed from that location. In addition, down-hole gamma data will be collected from the location with static measurements collected for every 15 cm depth interval. If that sample has contamination above background conditions, then the next deeper 1 m interval will be sampled and analyzed and a down-hole gamma scan performed. This process will continue until background conditions are reached. **[contingent]**

  - If systematic subsurface sampling identified contamination that appears to extend laterally beyond the grid boundaries in WMA 2, such as into WMA 4 or WMA 12, then the grid will be extended and additional sampling conducted until the lateral extent of contamination has been bounded. **[contingent]**

B.9.5 Drainage Feature Sampling

WMA 2 contains one primary drainage feature outside the planned WMA 2 deep excavation that runs along the WMA 2 boundary with WMA 4. For drainage features within WMA 2, the surface soil CG_w requirements apply. Surface drainage feature sampling will be conducted to determine ditch sediment contamination status relative to surface soil CG_w requirements. Surface drainage features will be sampled as follows:

- Discrete samples representing a 0-15 cm depth interval will be collected from ditch sediments. In WMA 2, the primary drainage feature has a length of approximately 210 m. Samples will be systematic located using a random start, separated by 30 m. **[required]**

- If any 0-15 cm sample result indicates contamination impacts above background levels and a 0-1 m sample was not also collected, a 0-1 m sample will be collected from that location following the protocols used for the original 0-15 cm sample. **[contingent]**

- If a sample indicates contamination impacts above background levels for the 0-1 m depth interval, an additional sample from a depth of 1–2 m will be collected and analyzed from that location. This will be repeated, as necessary, until the vertical extent of contamination impact is bounded at that location. **[contingent]**

B.9.6 Buried Infrastructure Soil Sampling

Soils associated with buried infrastructure of potential concern within WMA 2 will be sampled to determine their contamination status. Buried infrastructure that is of potential concern in WMA 2 is defined to be buried infrastructure that either carried contaminated waste/wastewater or was installed after 1968.

- Three locations along the each piece of buried infrastructure that is of concern within WMA 2 will be trenched. These locations will be selected to maximize the possibility that contamination will be encountered (e.g., locations where historical or current GWS data indicate surface contamination exists). For infrastructure that crosses the planned WMA 2 excavation boundary, one of these locations will be at the boundary. Trenching will not occur within the planned WMA 2 excavation footprint. During excavation, exposed soils will be monitored by scans for evidence of elevated gross activity. The purpose of this sampling is to evaluate the presence of contaminated soils associated with buried infrastructure. **[required]**

- If elevated readings are encountered below a depth of 1 m, soils exhibiting the highest levels of gross activity will be sampled and analyzed.

- If elevated readings are not encountered below a depth of 1 m, a sample representative of soils deeper than 1 m will be collected. In the case of infrastructure that did not carry waste or wastewater, the sample will be from soils immediately above the line. In the case of infrastructure that did carry waste or wastewater, the sample will be from soils immediately beneath the line.

- If contamination above background conditions is encountered at any selected location, trenching will continue to depth until background conditions are observed. An additional sample will be collected from the base of the trench to verify background conditions. The purpose is to vertically bound observed contamination. **[contingent]**

- If buried infrastructure soil sampling identifies contamination impacts greater than background, biased sampling will continue following the line until at least two consecutive locations yield soil samples below surface soil CG_w requirements. Location spacing will be based on engineering judgment, including the geometry of the line, the level of contamination encountered, and surface evidence of contamination. Buried infrastructure characterization will not extend into the planned WMA 2 deep excavation footprint. The purpose of this sampling is to bound the extent of contamination associated with buried infrastructure, as necessary. **[contingent]**

B.9.7 Additional Contingencies

Sampling and/or GWS data may indicate that contamination exists or extends beneath surfaces currently covered by existing structures, concrete, asphalt, or hardstand material. In this case, "surface soil" will be defined as soil immediately beneath the cover. If sampling or GWS data indicate that contamination may exist beneath existing structures (e.g., existing buildings and building pads), then sampling locations will be offset along the foundation edge to determine contamination extent. The purpose of the offset is to allow safe acquisition of data. Data collection through building pads and hardstands in WMA 2 will not be required as part of this effort.

B.9.8 Required Laboratory Analyses

All samples will be submitted for analysis of all 18 ROI.

A select portion of the samples as described above may be analyzed for the additional 12 radionuclides of potential interest. In addition, ten percent of soil samples collected outside the WMA 1 excavation footprint will also be analyzed for the 12 radionculides of potential interest. If these sample results indicate the presence of the one or more of those radionuclides at levels of potential significance, then the balance of samples from WMA 2 will also be analyzed for the additional radionuclides that were identified.

Table B.2 summarizes the required sample numbers and the estimated number of contingency samples for WMA 2.

This sampling plan assumes that quick turn-around analyses are available for Sr-90 and Cs-137 and that soil samples will be screened for Sr-90 and Cs-137 prior to being analyzed for the balance of the ROI. Based on these screening data, contingency sampling requirements as described above may be undertaken without the benefit of the remaining analyses.

B.9.9 Decision-Making Summary

A summary of decision-making based on the WMA 2 data is as follows:

- If GWS indicate anomalies are present, biased samples will be selected to target those anomalies.

- If the GWS data identify areas likely exceeding CG requirements, one sample will be placed to verify contamination and another set of surface soil samples used to laterally bound contamination. Additional locations may be selected, as necessary, to laterally bound contamination extent.

- If sample results from biased or systematic surface samples for the 0–1 m depth interval indicate contamination above CG requirements, an additional sample from that location representing the depth interval 1–2 m will be collected and this process repeated until contamination is vertically bounded.

- If scans of soil bores/cores along the WMA boundary indicate intervals with elevated activity, the interval with the highest activity will be targeted for analysis.

- If one or more soil cores locations along the southern WMA 2 excavation boundary encounter either soil or groundwater contamination at depths greater than one meter, additional locations will be selected further to the south into WMA 12 to laterally bound contamination.

- For each set of buried infrastructure that is identified as a potential concern at least three trenches that uncover the infrastructure will be scanned and sampled. If contamination appears to extend laterally along the line of the infrastructure, additional sampling will take place until contamination is bounded.

Table B.1 Historical Data Analyses

Nuclide	# of Surface Soil Locations	# of Subsurface Soil Locations	# of Sediment Locations
Am-241	0	18	1
C-14	0	5	0
Cm-243	0	5	0
Cm-244	0	5	0
Cs-137	13	22	2
I-129	0	5	0
Np-237	0	5	0
Pu-238	0	18	1
Pu-239	0	18	1
Pu-240	0	18	1
Pu-241	0	18	1
Sr-90	13	31	2
Tc-99	0	5	0
U-232	0	18	1
U-233	0	18	1
U-234	0	18	1
U-235	0	13	1
U-238	0	18	1

Table B.2 Sample Number Estimates

	Required	Contingent	Total
Systematic Sediment Samples (0-15 cm)	7	0	7
Systematic Sediment Samples (0-1 m)	5	0	5
Biased Sediment Samples (0-15 cm)	0	0	0
Biased Sediment Samples (0-1 m)	0	0	0
Systematic Surface Soil Samples (0-5 cm)	20	0	20
Systematic Surface Soil Samples (0-1 m)	20	0	20
Biased Surface Soil Samples (0-15 cm)	0	3	3
Biased Surface Soil Samples (0-1 m)	0	3	3
Systematic Subsurface Soil Samples (1-m intervals)	260	34	294
Biased Subsurface Soil Samples (1-m intervals)	0	5	5
Buried Infrastructure Soil Samples	18	12	30
Discrete Groundwater Samples	90	18	108
Total:	420	75	495

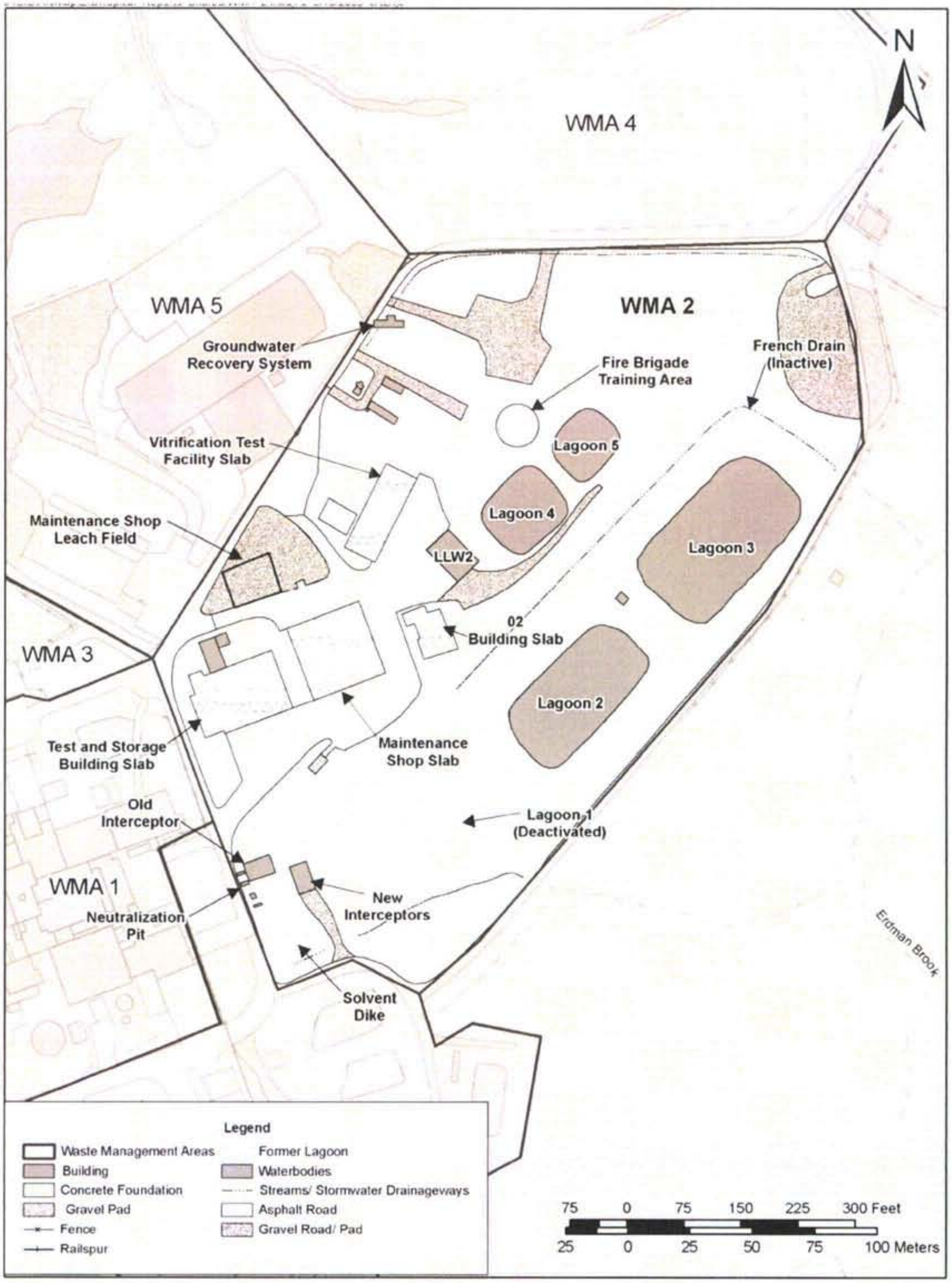

Figure B.1 WMA 2 Facilities (from Phase 1 DP, Figure 3-24)

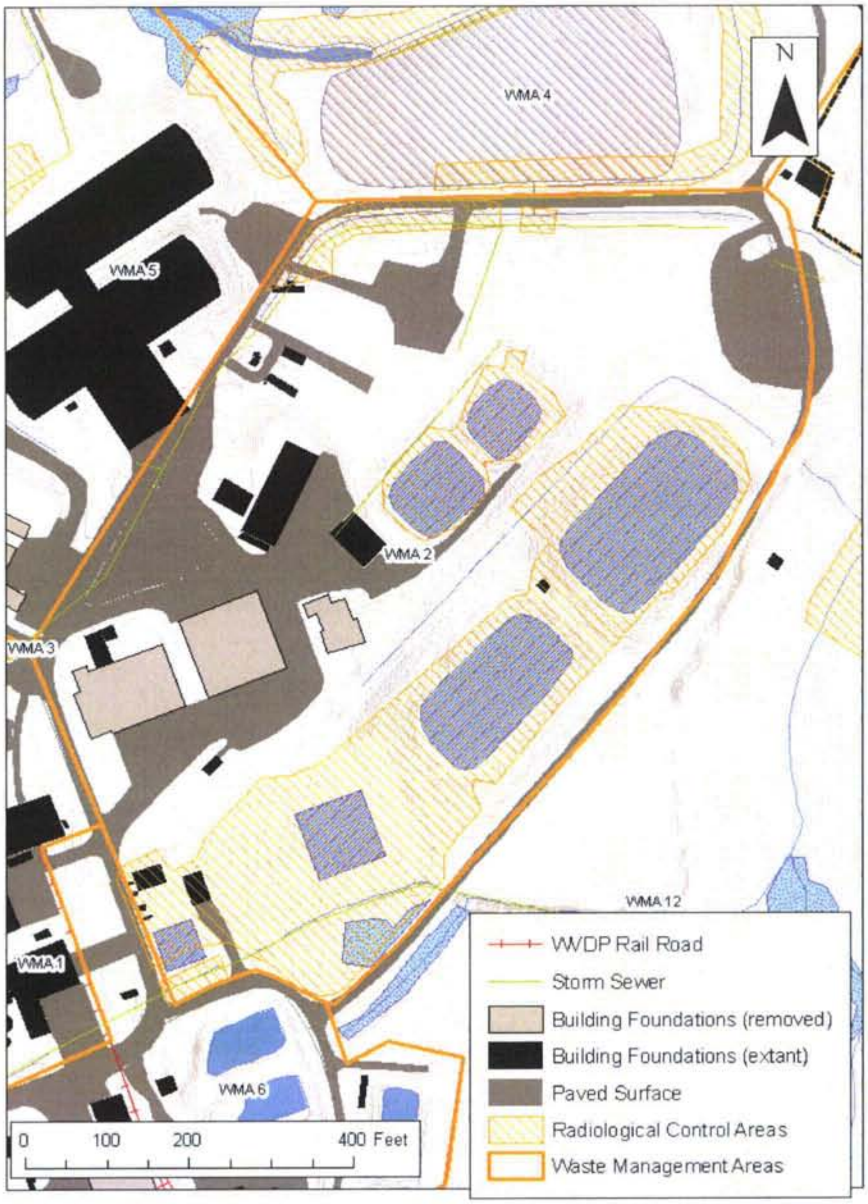

Figure B.2 WMA 2 with Topography

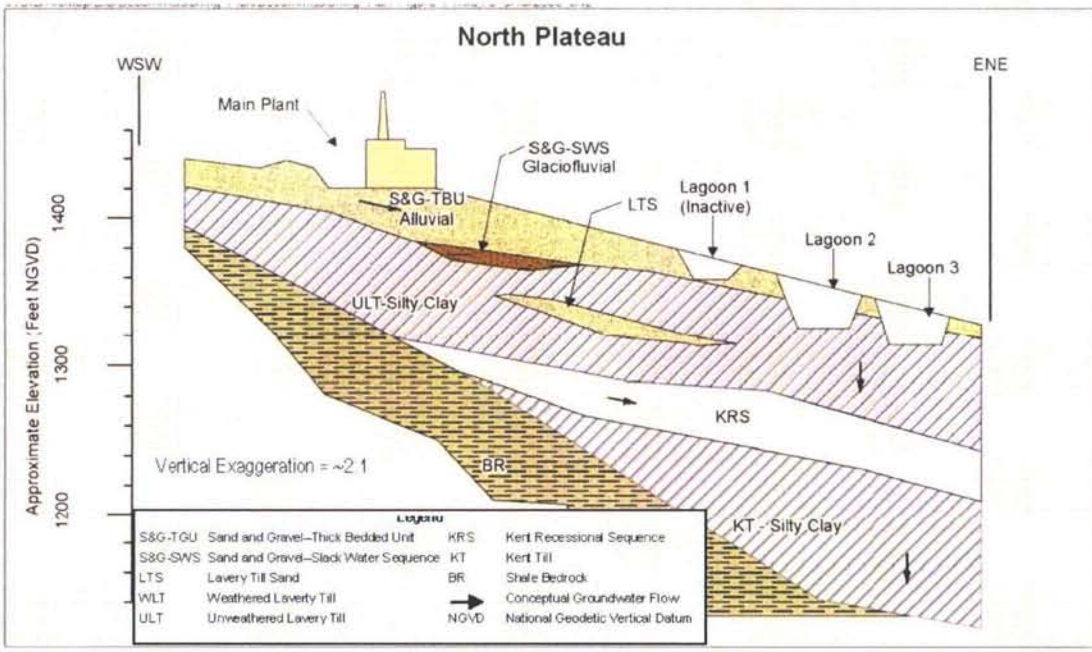

Figure B.3 North Plateau Cross-Section (from Phase 1 DP, Figure 3-6)

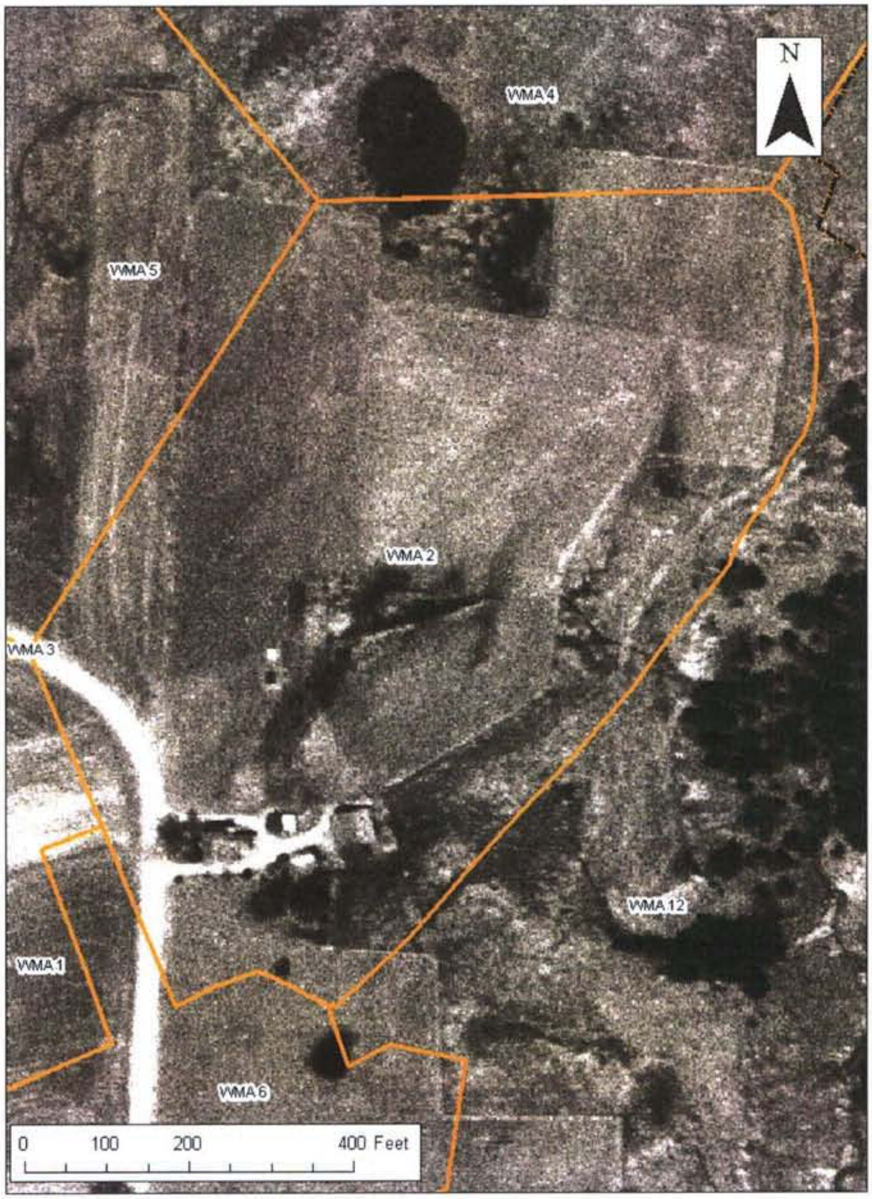

Figure B.4 WMA 2 Aerial Photograph from 1962

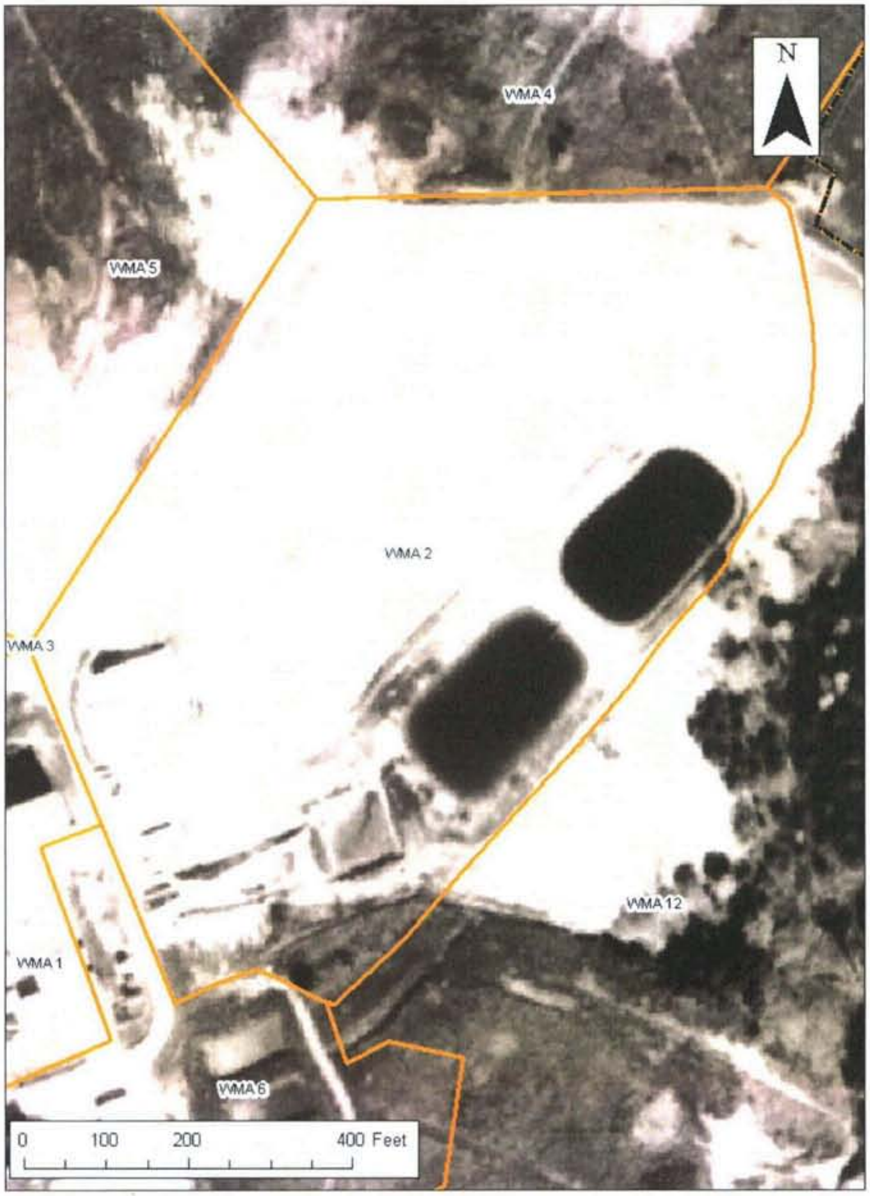

Figure B.5 WMA 2 Aerial Photograph from 1966

Figure B.6 WMA 2 Aerial Photograph from 1968

Figure B.7 WMA 2 Aerial Photograph from 1977

Figure B.8 WMA 2 Aerial Photograph from 1984

Figure B.9 WMA 2 Aerial Photograph from 1995

Figure B.10 WMA 2 Aerial Photograph from 2007

Figure B.11 WMA 2 1982 Oblique Aerial Photograph (from Phase 1 DP, Figure 3-25)

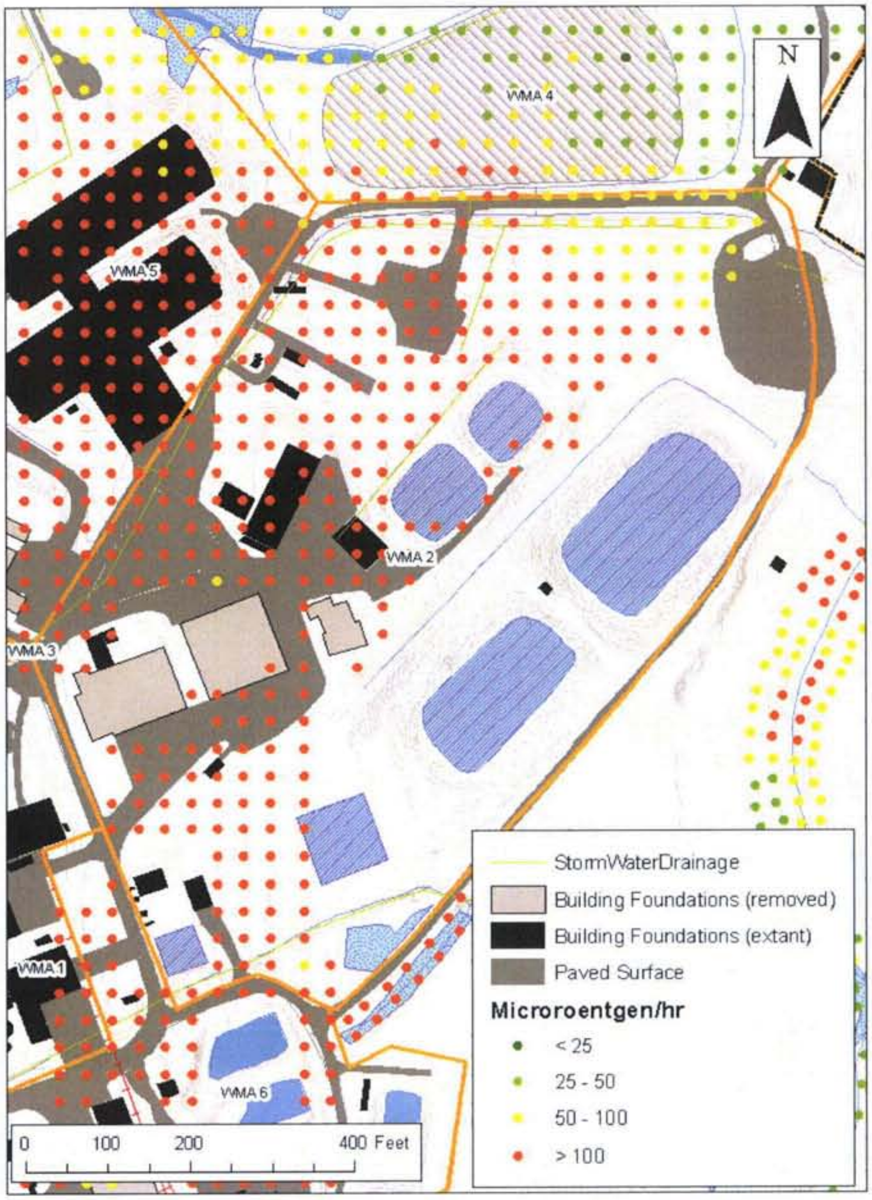

Figure B.12 WMA 2 1982 Direct Gamma Measurement Results

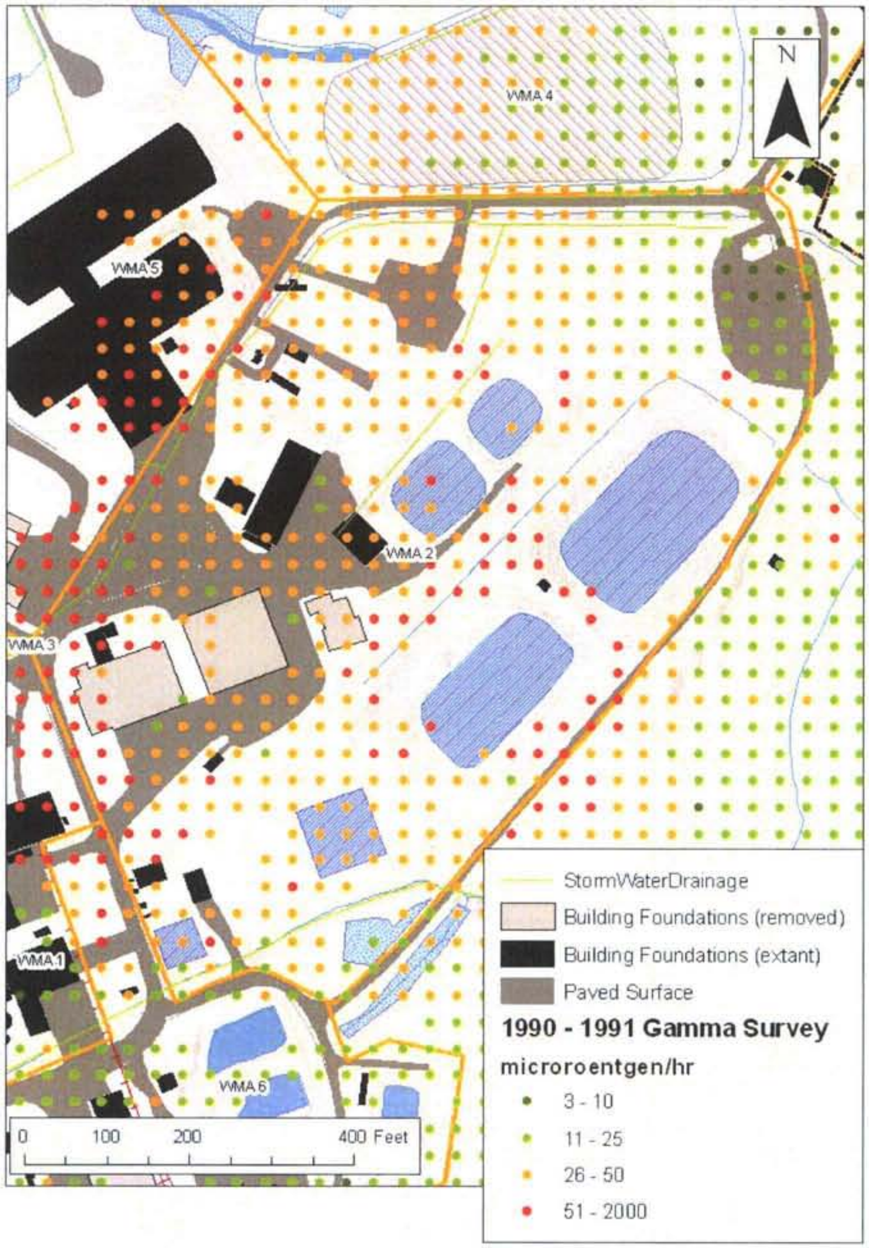

Figure B.13 WMA 2 1990 - 1991 Direct Gamma Measurement Results

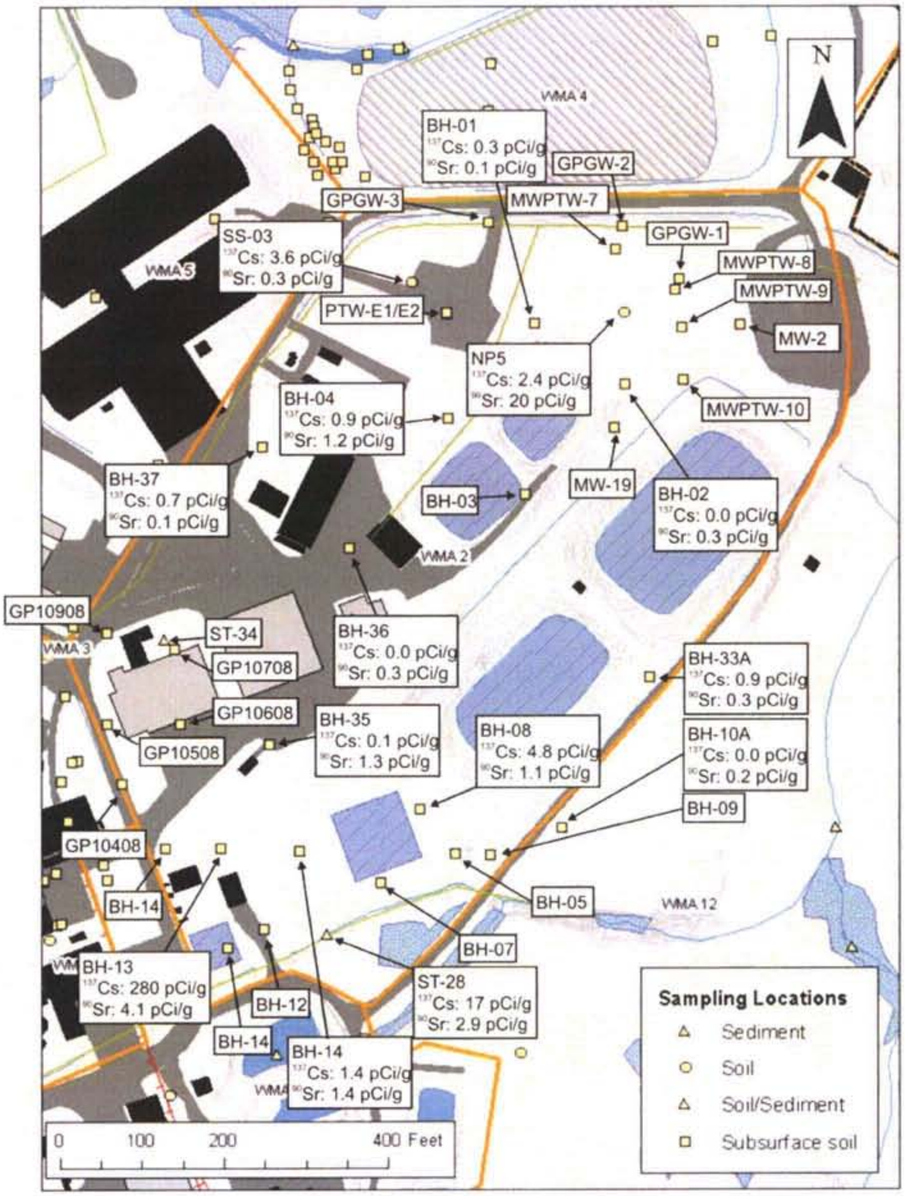

Figure B.14 WMA 2 Historical Sampling Locations

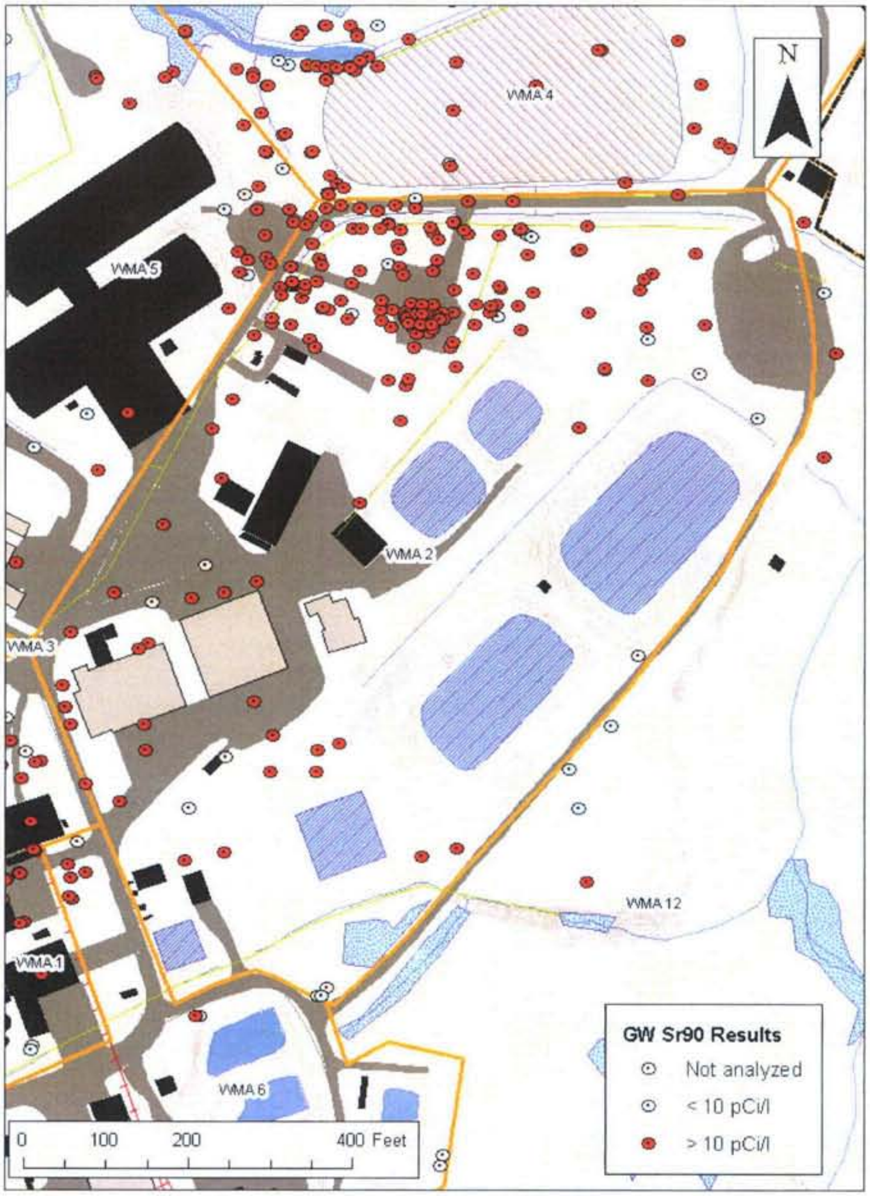

Figure B.15 WMA 2 Sr-90 Groundwater Results

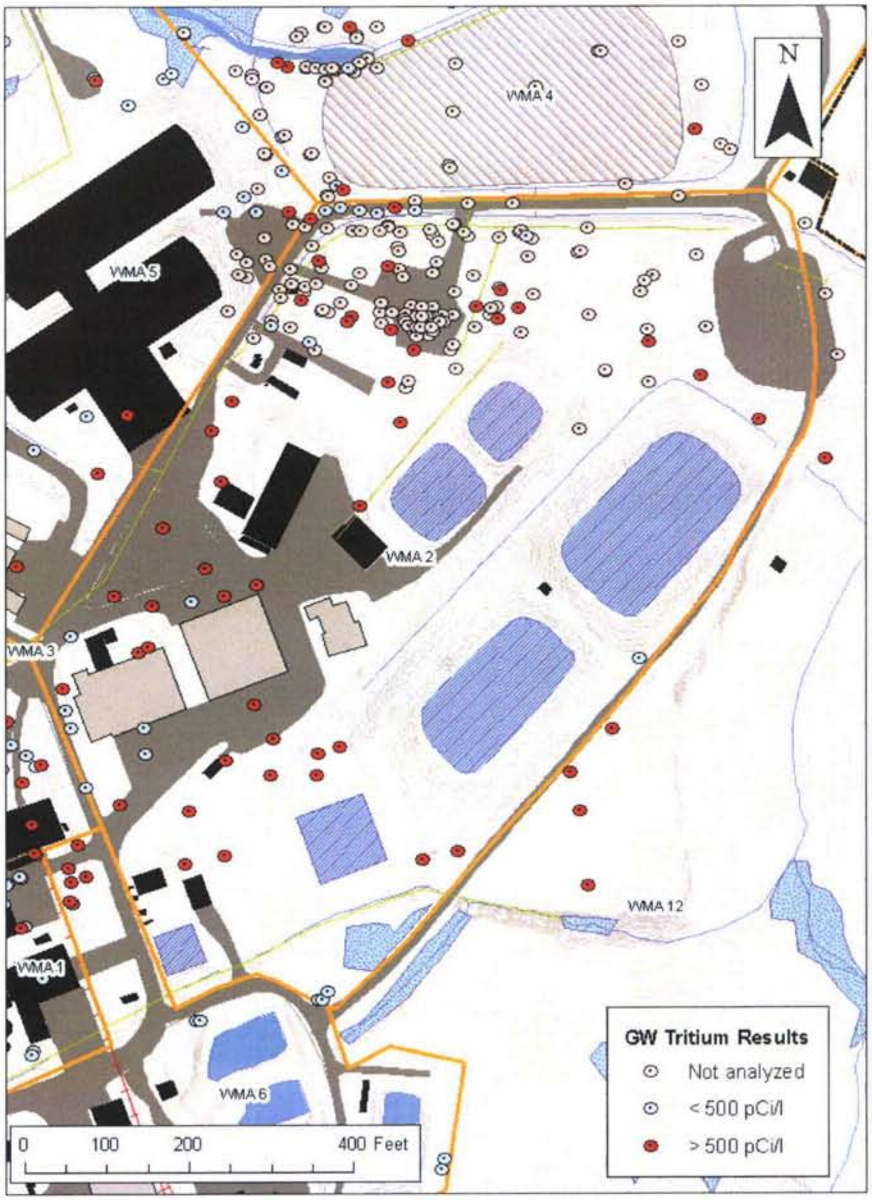

Figure B.16 WMA 2 Tritium Groundwater Results

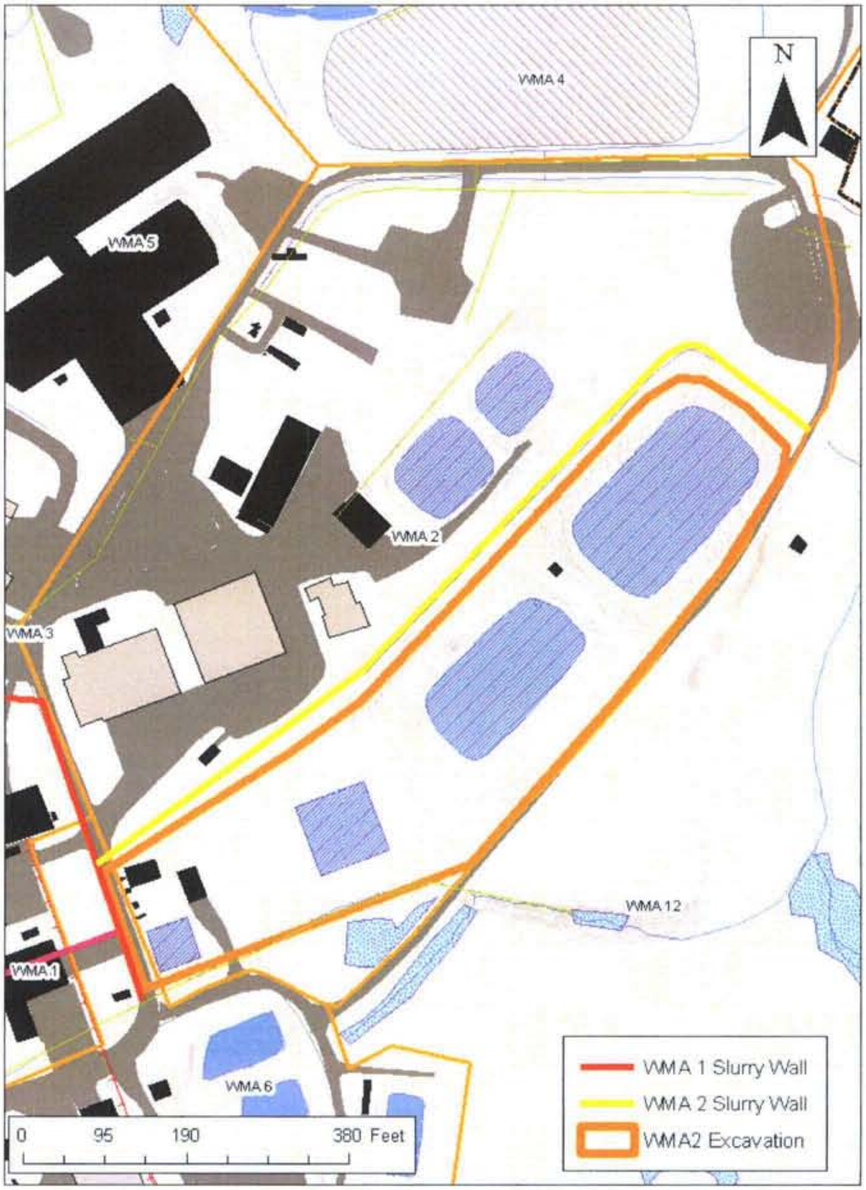

Figure B.17 Phase 1 Subsurface Hydraulic Barrier Wall Placement and Excavation Location

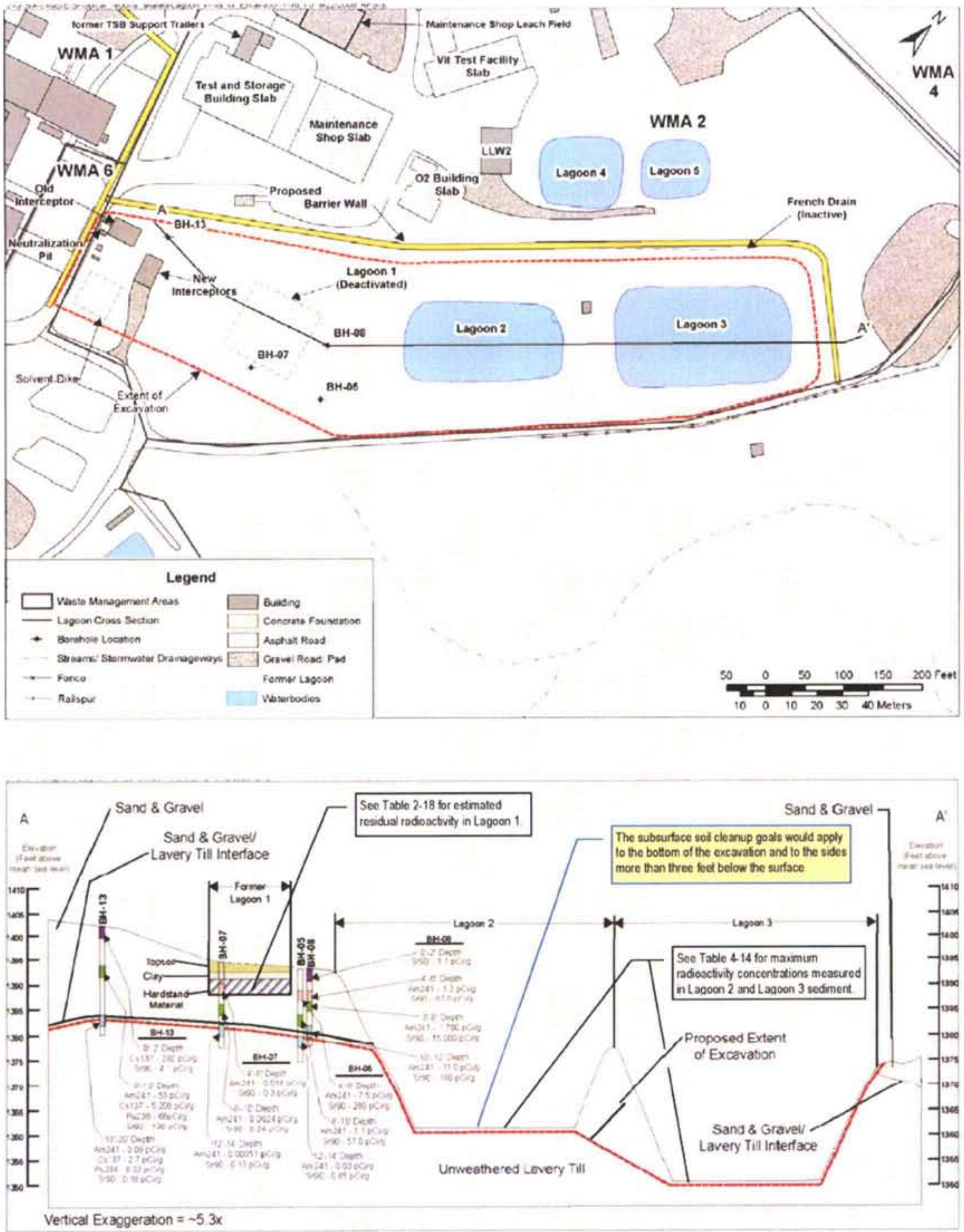

Figure B.18 WMA 2 Excavation and Cross-Section

(from Phase 1 DP, Figures 7-11 and 7-12)

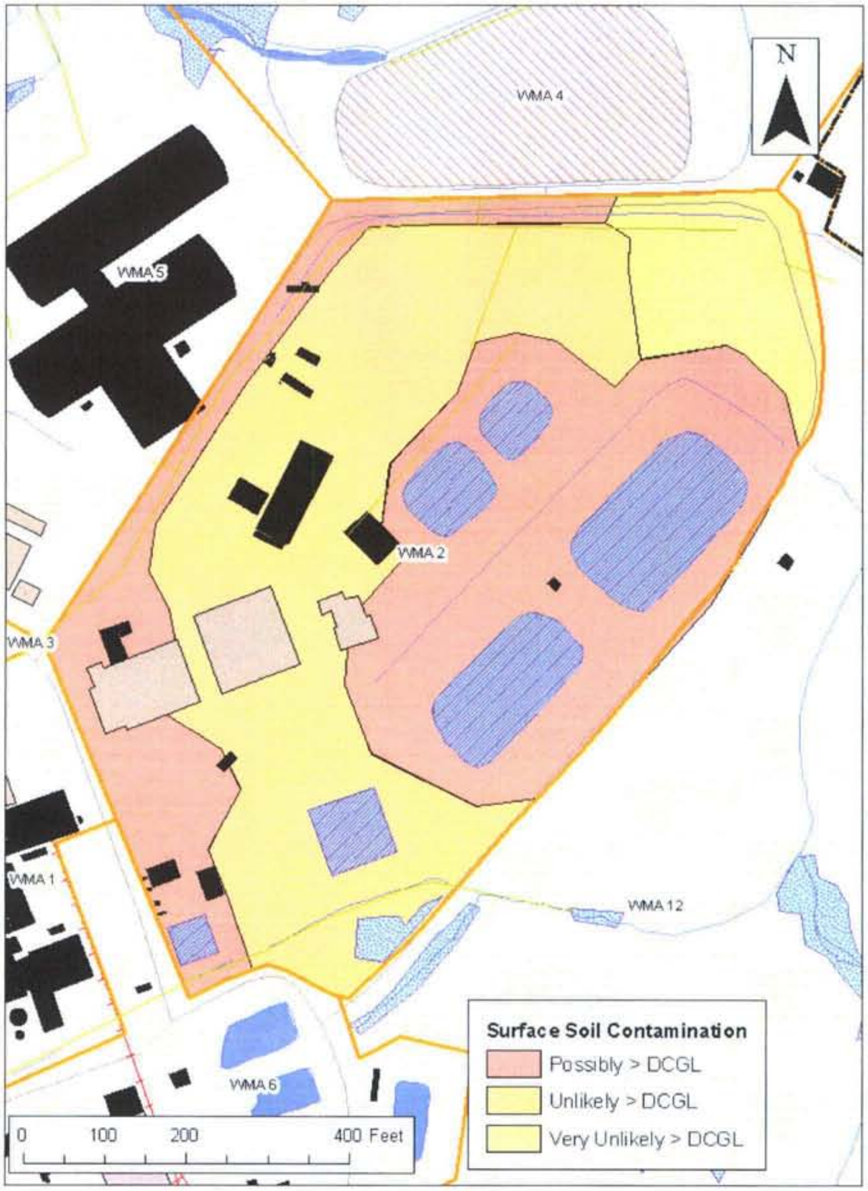

Figure B.19 Initial WMA 2 Surface Soil CSM

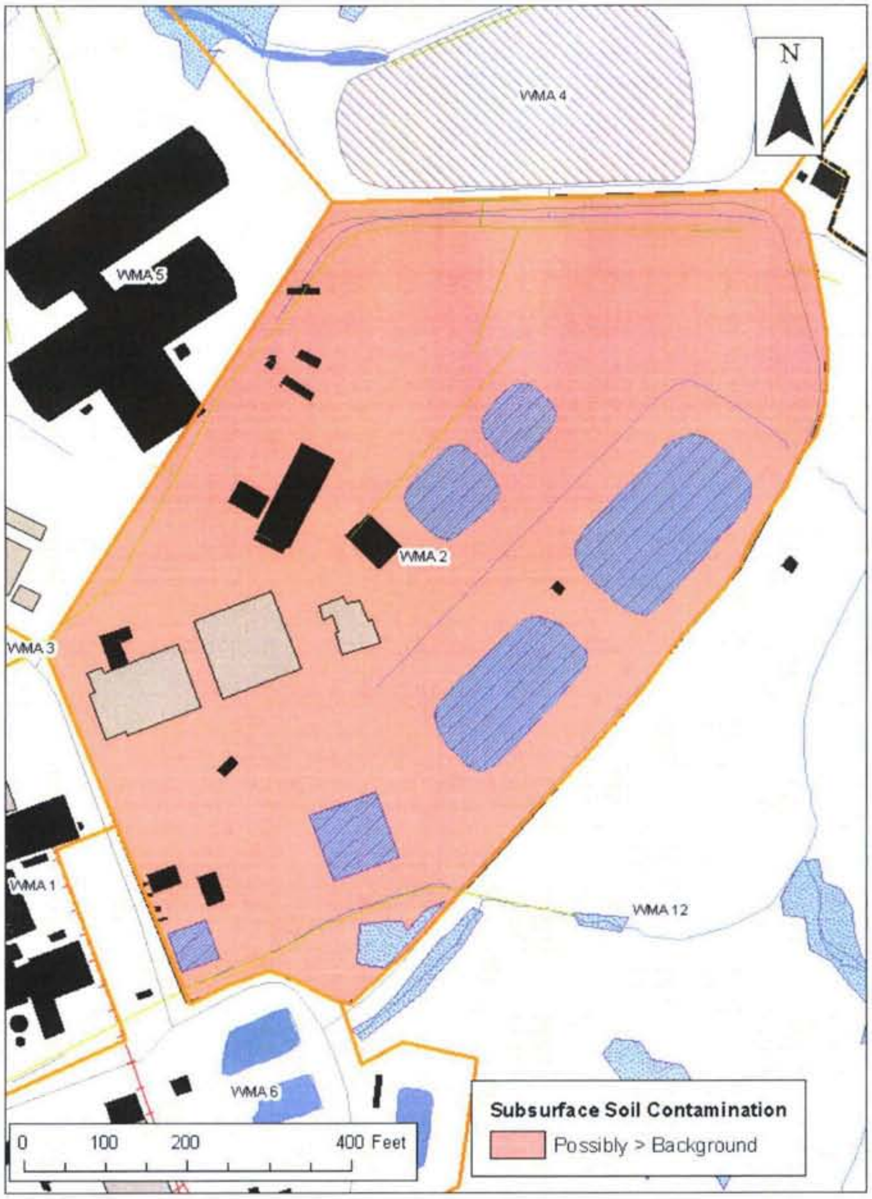

Figure B.20 Initial WMA 2 Subsurface Soil CSM

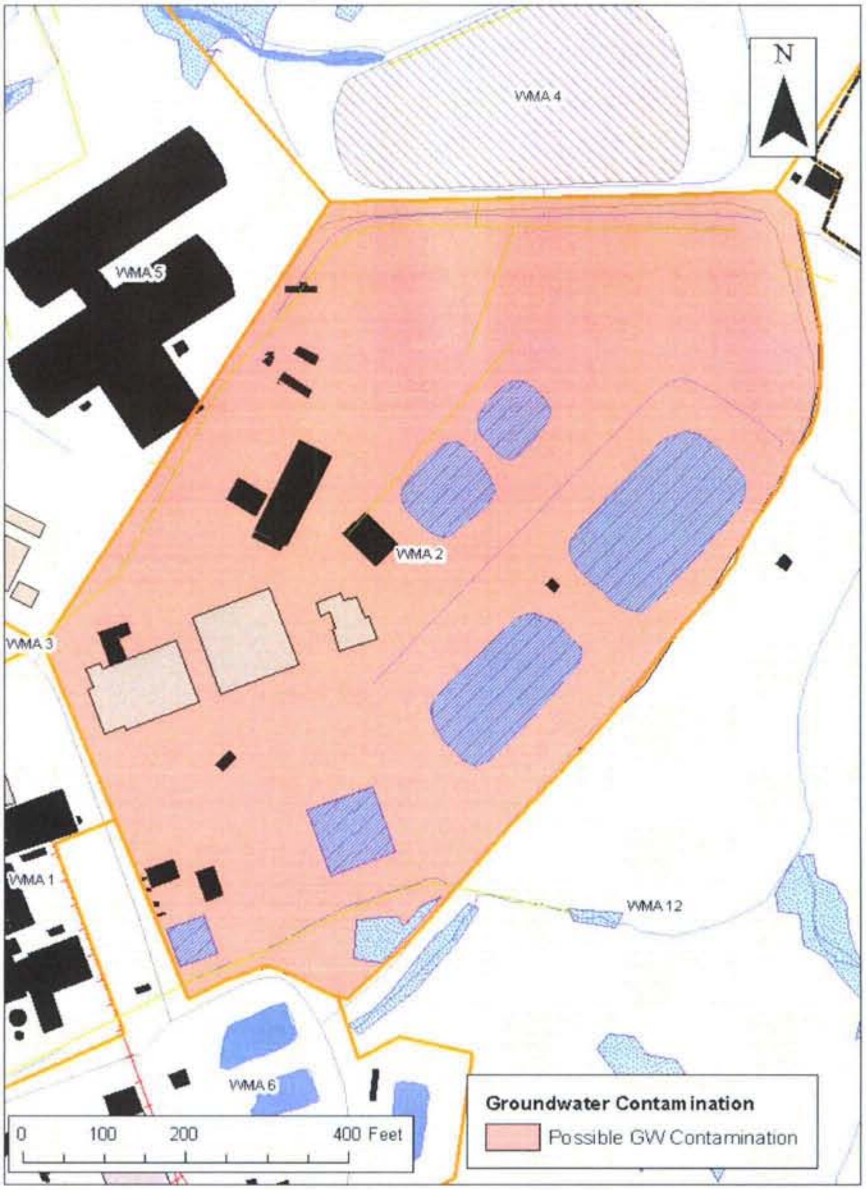

Figure B.21 Initial WMA 2 Groundwater CSM

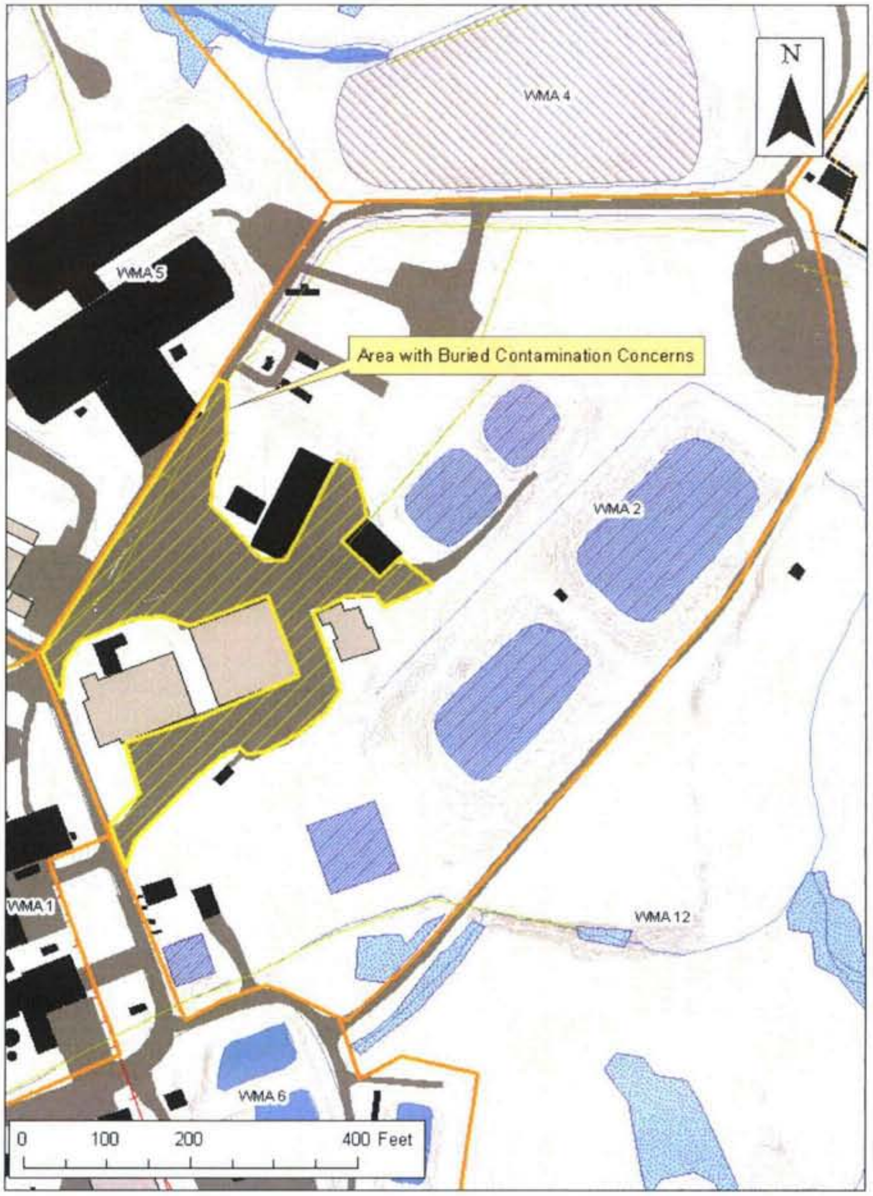

Figure B.22 WMA 2 Area with Potential Near Surface Buried Contamination Concerns

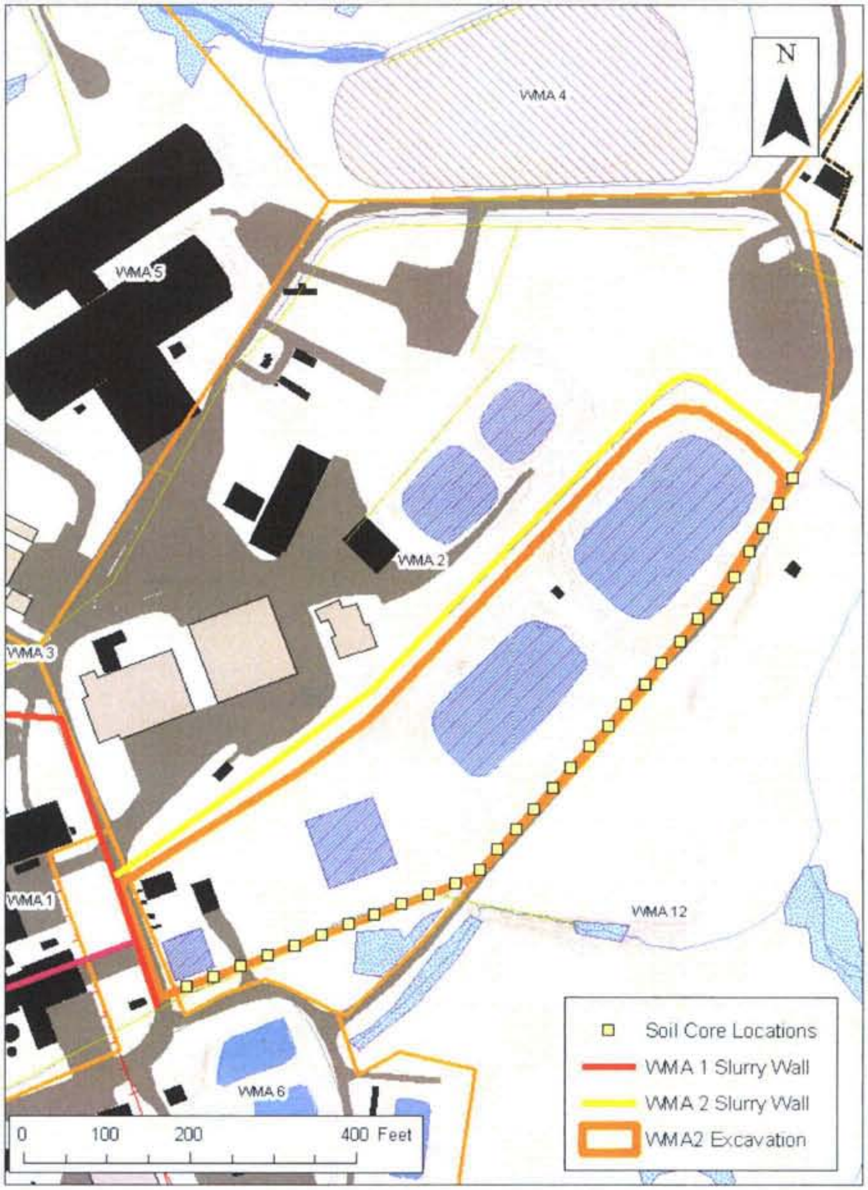

Figure B.23 Example Soil Core Locations

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APPENDIX C

WMA 3 PRE-REMEDIATION DATA COLLECTION

C.1 Background

Waste Management Area 3 (WMA 3) is approximately 2.3 acres in size and contains the four underground waste storage tanks (8D-1, 8D-2, 8D-3, and 8D-4) and their associated supporting facilities and infrastructure (see Figures C.1 and C.2 for maps).

Descriptions of the various features of WMA 3 follow, and are taken from the Phase 1 DP, Section 3.1.2. A description of planned Phase 1 DP activities in WMA 3 can be found in Section C.6.

Waste Storage Tanks. The waste storage tanks were built to store the liquid high level waste generated during the NFS spent nuclear fuel reprocessing operations. The WVDP subsequently modified these tanks to support treatment and vitrification of the HLW. Modifications included constructing a fabricated steel truss system over tanks 8D-1 and 8D-2 to carry the weight of sludge mobilization and transfer pumps and installation of treatment equipment in Tank 8D-1.

Tanks 8D-1 and 8D-2 are identical in size and construction, with each tank housed within its own cylindrical concrete vault. Each tank is 27 feet high by 70 feet in diameter, with a storage capacity of 750,000 gallons. The tanks were constructed with reinforced carbon steel plate ranging in thickness from 0.4375 inch for the roofs and walls to 0.656 inch for the floors. The roof of each tank is supported internally by 45 eight-inch diameter vertical pipe columns that rest on a horizontal gridwork of wide flange beams and cross members in the bottom two feet of each tank. Each tank rests on two six-inch-thick layers of perlite blocks that rest on a three inch layer of pea gravel. The tank, perlite blocks, and pea gravel are contained within a carbon steel pan which rests on a three-inch layer of pea gravel that separates the pan from the floor of the vault. Each tank and its associated pan are housed within a cylindrical reinforced concrete vault that has an outside diameter of 78.6 feet. The walls of each vault are 18 inches thick and extend nearly 36 feet above the floor of the vaults. The floor of each vault is 27 inches thick, except under the six 30-inch diameter vertical concrete columns that support the vault roof. These columns pass upward from the floor of the vault through the tanks and are encased in steel pipes 48 inches in diameter that are welded to the top and bottom of each tank. The columns are located approximately 16 feet from the center of the tank. The floor of each vault is underlain by a four feet thick bed of gravel. The concrete vault roof is two feet thick and is supported by the six concrete columns. The top of the vaults are six to eight feet below grade. Despite their robust construction, the tank vaults have not proven to be watertight. Groundwater seeps into both vaults and has to be regularly pumped out.

Tanks 8D-3 and 8D-4 are identical in size and construction, and both are housed within a single reinforced concrete vault. Each tank is 12 feet in diameter and 15.67 feet high, with a nominal volume of 15,000 gallons. The shell of each tank is 0.313 to 0.375 inch thick; both the tanks and their associated piping were constructed from 304L stainless steel. The concrete vault that houses the tanks is approximately 32-feet long, 19-feet wide, and 25-feet tall. The walls, floor, and roof of the vault are 21-inches thick. The bottom of the vault is lined with stainless steel to a height of 18 inches above the floor. The floor contains a stainless-steel-lined sump. The top of the vault is six to eight feet below grade.

High-Level Waste Transfer Trench. The HLW transfer trench is a long concrete vault containing piping that conveyed waste between the Waste Tank Farm and the Vitrification Facility. Approximately 500 feet long, the trench extends from the Tank 8D-3/Tank 8D-4 vault along the north side of Tank 8D-1 and Tank 8D-2 at ground level, before turning to the southwest and entering the north side of the Vitrification Facility. It is six to 20 feet wide and its height ranges from six to nine feet. The trench was constructed with reinforced concrete walls and floors, with pre-cast concrete covers. Stainless steel-lined concrete pump pits that house the upper sections of HLW transfer pumps are located on top of each of the tank vaults. The walls and floors of the pump pits are reinforced concrete, with pre-cast concrete covers forming the roof. There are six piping runs in the trench, two of which are unused spares, comprising approximately 3000 linear feet of double-walled stainless steel pipe. The trench also contains associated valves and jumpers. The pump pits each contain the upper part of the HLW transfer pump and flow monitoring equipment. Pump Pit 8Q-2 over Tank 8D-2 also contains grinding equipment used to size reduce zeolite.

Permanent Ventilation System Building. The Permanent Ventilation System Building is located approximately 50 feet north of Tank 8D-2. This steel framed and sided building is 40 feet wide, 75 feet long, and 16 feet tall and is attached to a 12 inch thick concrete floor slab supported by concrete footings. The building has a sheet metal roof which supports the Permanent Ventilation System discharge stack. The Permanent Ventilation System was designed to provide ventilation to the Supernatant Treatment System Support Building, the Supernatant Treatment System valve aisle, the Supernatant Treatment System pipeway, and the HLW tanks. A skid-mounted, Permanent Ventilation System Stack Monitoring Building is located near the east end of the building.

Equipment Shelter and Condensers. The Equipment Shelter is a one-story concrete block building lies immediately north of the Vitrification Facility. It is 40 feet long, 18 feet wide, and 12 feet high and has a concrete floor six inches thick, with a small extension on the west side. This structure houses the Waste Tank Farm ventilation system that was formerly used to ventilate the four waste storage tanks and the Supernatant Treatment System vessels in HLW Tank 8D-1. The condensers are located immediately west of the Equipment Shelter. They were designed to condense the overheads from Tanks 8D-1 and 8D-2, which were originally designed to be in a self-boiling condition during NFS operations.

Con-Ed Building. The Con-Ed Building is a concrete block building located on top of the concrete vault containing Tank 8D-3 and Tank 8D-4. This building, which is 10 feet wide, 13 feet long, and 11 feet high, houses the instrumentation and valves used to monitor and control the operation of Tanks 8D-3 and 8D-4.

Supernatant Treatment System Support Building. This building is located adjacent to and above Tank 8D-1. It is a two-story structure that contains equipment and auxiliary support systems needed to operate the Supernatant Treatment System. The upper level is a steel framework structure covered with steel siding. The lower level of the building was constructed with reinforced concrete walls, floors, and ceilings. This building contains a control room; heating, ventilation and air conditioning equipment; utilities; and storage tanks for fresh water and fresh zeolite to support Supernatant Treatment System operations. A shielded valve aisle is located on the lower level of the support building, adjacent to Tank 8D-1. The Supernatant Treatment System pipeway is located on top of the Tank 8D-1 vault. This concrete and steel structure contains the Supernatant Treatment System piping and structural members that support the Supernatant Treatment System equipment located in Tank 8D-1.

C.2 Physical Setting

WMA 3 is located on the north plateau. It is bounded to the west by WMA 10 and WMA 5, to the north by WMA 5, to the east by WMA 5, and to the south by WMA 1.

The surface of WMA 3 consists of building footprints and compacted surface cover with no appreciable vegetation. WMA 3 is relatively flat and is drained by storm sewer lines.

The four waste storage tanks contained within WMA 3 are buried and extend to a depth of 50 to 60 feet below grade, including foundations and footer material. This depth is well below the water table and extends into the Lavery Till.

WMA 3 is underlain by the sand and gravel unit, a relatively permeable layer. In general groundwater beneath WMA 3 flows to the east and northeast, following surface topography. Underneath the sand and gravel unit is the Lavery Till, a relatively impermeable layer that is a partial barrier to vertical groundwater flow. A limited amount of groundwater does flow vertically downward through this unit, recharging the underlying Kent Recessional Sequence.

There is believed to be a significant amount of buried infrastructure (piping, etc.) associated with the WMA 3 facilities.

C.3 Area History

The WMA 3 area (and in particular its surface soils) has undergone significant reworking since the initiation of NFS activities.

Figure C.3 shows WMA 3 in 1962 prior to WVDP site development. At this time WMA 3 was farmed.

Figure C.4 shows WMA 3 in 1966. The footprints of waste tanks 8D-1 and 8D-2 are visible in this photograph along with the condenser and equipment shelter footprints. The surface of WMA 3 appears to be predominately exposed soils.

Figure C.5 shows WMA 3 in 1968. Vegetative cover appears to be returning to the WMA 3 surface in this photograph.

Figure C.6 shows WMA 3 in 1977. There are no significant changes from 1968.

Figure C.7 shows WMA 3 in 1984. There are no significant changes from 1977. As is clear from this photograph, the majority of the WMA 3 surface is vegetated or exposed soils.

Figure C.8 shows WMA 3 in 1995. Significant surface changes have occurred since 1984, with the construction of numerous new facilities and above-ground infrastructure.

Figure C.9 shows WMA 3 in 2007. There are no significant changes since 1995.

Figure C.10 shows a recent oblique aerial photograph of the WMA 3 area taken from the northwest. As is clear from this photo, the ground surface has been covered by paving material with little evidence of vegetation remaining. Based on historic aerial photographs, the ground surface was paved sometime after 1984.

C.4 Known and Suspected Releases

The total activity in the 40 underground lines in the immediate vicinity of the Waste Tank Farm has been estimated to be approximately 117 curies in 2004, with more than 99 percent of this activity associated with Cs-137 and Sr-90. The integrity of these lines is not known.

In 1967, the Tank 8D-2 ventilation condensate line (operates under vacuum) was noted to be breached. One leak was noted between the high level waste tanks and southwest side of the Process Building (Phase 1 DP Rev 2 Table 2-17; Duckworth 1977); other leaks are thought to exist in WMA 3 that may have released Cs-137, tritium-contaminated liquids, and other radionuclides to groundwater and soils. There is no surface evidence of out-leakage, but the possibility exists of localized groundwater effects.

In 1985, a spill of radioactive water occurred at the Waste Tank Farm. The spill was from a valve pit located northwest of 8D-2, between 8D-2 and 8D-1. Contaminated soil was removed at the time (Phase 1 DP Rev 2 Table 2-18; WVNSCO 1985b). Some of this condensate flowed into the drainage ditch extending from WMA 3 towards the Old Hardstand in WMA 5.

A portable ventilation unit was disassembled after operations on March 2, 1987, near Tank 8D-2. Condensate from the housing spilled on to the gravel surface on top of Tank 8D-2. No soil or water contamination was noted in samples collected (Phase 1 DP Rev 2 Table 2-18; WVNSCO 1987a).

There is no evidence that any of the four waste storage tanks themselves have ever leaked.

The soils within WMA 3 would have been impacted by air deposition of radionuclide contaminants from the main processing facility's activities. Groundwater, and consequently subsurface soils, beneath the WMA 3 footprint may have been impacted by subsurface migration of contaminants released by Process Building activities. This includes the north plateau groundwater plume that developed as a result of a 1968 subsurface release associated with the Process Building. The north plateau groundwater plume impacts would be greatest in the southeaster portion of WMA 3.

C.5 Existing Data

Existing data sets for this area include:

- In 1982, static direct gamma exposure readings were collected across the WVDP premises (WVNS 1982). A portion of WMA 3 was covered by these measurements on a 10-m grid. Figure C.11 shows these results color-coded by the exposure readings encountered. These data indicated the potential for significant surface contamination within the WMA 3 boundary; however, the interpretation of these data is complicated by the possibility of shine from the Process Building and other facilities.

- In 1990 and 1991, a second static direct gamma exposure measurement program was conducted across the WVDP premises (WVNS 1992). In the case of WMA 3, this effort provided systematic coverage for the entire WMA 3 area on a 10-m grid. This data collection used different instrumentation and protocols than the 1982 study, so the results are not quantitatively comparable. Figure C.12 shows these results. These data also indicated the potential for significant surface contamination within the WMA 3 boundary; however, like the 1982 data sets, the interpretation of these data is complicated by the possibility of shine from the Process Building and other facilities.

- There is no soil sampling data from within the footprint of WMA 3 available with ELIMS.

- There is limited groundwater data for WMA 3 available within ELIMS from a GeoProbe core and a monitoring well, both located in the southeast corner of the WMA 3 footprint. Figures C.13 and C.14 show the locations of groundwater data collection in the vicinity of WMA 3 (including some from WMA 5) color-coded by Sr-90 and tritium results, respectively. The detection limits for Sr-90 and tritium varied widely among ELIMS samples. 10 pCi/L and 500 pCi/L were selected as thresholds for Sr-90 and tritium, respectively, because based on ELIMS data results above these activity concentrations were consistently above method detection limits and so indicative of contamination impacts rather than simply measurement error. Contamination was encountered at both locations. It is not clear if this contamination represented releases from WMA 3 activities, or originated from releases associated with the main processing facility's activities.

C.6 Planned Phase 1 DP Activities

For a more complete description of planned Phase 1 DP activities, see the Phase 1 DP, Section 3.1 and Section 7.5.

The waste tank mobilization and transfer pumps, the Con-Ed Building, the Equipment Shelter and condensers, and the piping and equipment in the HLW transfer trench are slated for removal as part of Phase 1.

Phase 1 does not include the four underground waste tanks, the Permanent Ventilation System Building, the Supernatant Treatment System Support Building, the high level waste transfer trench itself, or the underground infrastructure.

Some Phase 1 activities planned for WMA 1 affect WMA 3. These include a temporary sheet piling wall that will run along a portion of the WMA 1 and WMA 3 boundary, and a permanent slurry wall that will extend into WMA 3 (Figure C.15). Depending on the outcome of CSAP data collection work, the planned excavation in WMA 1 may be revised in a way that extends into WMA 3.

C.7 Conceptual Site Model

Based on the limited available information, the conceptual site model (CSM) for WMA 3 is as follows. A number of potential releases within the WMA 3 footprint are known to have occurred, or may have occurred that likely impacted surface and subsurface soils and groundwater. In addition, environmental media within WMA 3 have likely been affected to some degree by releases elsewhere at the WVDP site. These include air deposition contamination on surface soils and subsurface contamination resulting from contaminant migration via groundwater from the Process Building.

After initiation of the WVDP, the surface of WMA 3 underwent significant reworking. This reworking may have covered contaminated soils with clean cover, removed contaminated surface soils for disposition elsewhere, and/or re-used contaminated soils as backfill for building foundations or buried infrastructure.

Groundwater flow underneath WMA 3 is expected to be, in general, towards the northeast. Consequently one would expect a greater likelihood for groundwater contamination as one moves from west to east (assuming releases within the WMA 3 footprint) and from south to north (assuming impacts from contaminated groundwater originating with Process Building activities).

Figure C.16 shows the current CSM for surface and near surface soils. Figure C.17 shows the CSM for soils deeper than 1 m. Figure C.18 shows the CSM for contaminated groundwater beneath WMA 3.

C.8 WMA 3-Specific Characterization Goals

- Develop an inventory of buried infrastructure
- Evaluate appropriateness of the current list of Radionuclides of Interest (ROI)

- Verify absence of additional ROI
- Determine level and extent of surface contamination
- Identify the presence/absence of buried contamination
- Identify soil waste stream characteristics
- Define required extent of WMA 1 excavation
- Obtain data to support Phase 2 planning

C.9 CSAP Pre-Remediation Data Collection and Associated Decision-Making

CSAP pre-remediation data collection will consist of a number of components described in more detail below.

C.9.1 Buried Infrastructure

The footprint of buried infrastructure will be identified and mapped. There is believed to be a significant quantity of buried infrastructure within the WMA 3 area that would be of potential interest. **[required]**

C.9.2 Gamma Walkover Survey Data

The purpose of performing a gamma walkover survey of the WMA 3 area is to identify the level and extent of surface contamination. This includes both general trends in average activity concentrations pertinent to the surface soil CG_w requirement, as well as the identification of isolated, more-elevated anomalies that might be indicative of discrete releases and/or surface soil CG_{emc} concerns.

A complete (100%) logged gamma walkover survey (GWS) will be conducted for accessible areas within WMA 3. Examples of areas that would not be accessible are areas where there are existing building footprints and building pads. Based on the GWS results, surface soil within WMA 3 will be divided into three categories: (1) surface soils where GWS indicates possible surface soil CG_w exceedances; (2) surface soils where GWS indicate impacts, but those impacts are not expected to exceed surface soil CG_w standards; and (3) surface soils where there is no indication of impacts above background conditions. The purpose of this data collection is to provide insights into the spatial distribution of surface contamination, and to guide subsequent soil sampling. Because of the existing surface cover within the WMA 3 area, the area that can be confidently assessed for surface contamination by GWS may be limited. **[required]**

C.9.3 Surface Soil Sampling

Because of the existing surface cover which is expected to be found over the majority of the WMA 3 area, GWS data collection will be supplemented with systematic surface soil sampling, in addition to biased surface soil sampling that will be conducted in response to elevated GWS data that might be indicative of hot spots.

- **Hot Spots.** If GWS data indicate the presence of contamination that possibly exceeds "hot spot" (CG_{cmc}) standards or an isolated elevated area is identified that appears indicative of a discrete release, the location of concern will be sampled with a biased sample. If biased samples are collected from a particular location, they will be collected from two depth intervals: 0-15 cm, and 0-1 m. In the case of surface soils, each biased sample will be a composite sample formed from 5 increments systematically distributed over the area of interest. The 0-15 cm samples will be analyzed for the 12 radionuclides of potential interest in addition to the 18 ROI. One down-hole gamma scan will be conducted from each biased location. The purpose of these samples is to resolve GWS anomalies, evaluate the appropriateness of the current ROI list, and verify the absence of additional ROI. **[contingent]**

- **CG_w Sampling.** Accessible WMA 3 areas will undergo systematic sampling for surface contamination concerns. Sampling locations will be arranged on a systematic, triangular grid with a grid separation of 20 m. Two samples will be collected from each location, one representative of a 0–15 cm depth and one representative of a 0–1 m depth. Depth will be measured from the interface of cover material and soils. Down-hole gamma data will be collected from each location with static measurements collected for every 15 cm depth interval. An estimated 20 locations will undergo this data collection. **[required]**

- If systematic surface soil sampling identifies contamination that appears to extend beyond the boundaries of WMA 3 into either WMA 5 or WMA 10 and has not been laterally bounded by sampling activities in those WMAs, the sampling grid will be extended and sampling continue following the protocols described above until the encountered contamination is laterally bounded. **[contingent]**

C.9.4 Subsurface Soil Sampling

The purpose of subsurface soil sampling within WMA 3 is to determine presence and vertical extent of contamination impacts above background levels. The whole of the WMA 3 area is considered as potentially having subsurface contamination at depths greater than 1 m.

- If a 0–1 m sample result exceeds background levels, then an additional sample from a depth of 1–2 m will be collected and analyzed from that location. In addition, down-hole gamma data will be collected from the location with static measurements collected for every 15 cm depth interval. If that sample has contamination above background conditions, then the next deeper 1 m interval will be sampled and analyzed and a down-hole gamma scan performed. This process will continue until background conditions are reached. **[contingent]**

- If systematic subsurface sampling identified contamination that appears to extend laterally beyond the grid boundaries in WMA 3, then the grid will be extended and additional sampling conducted until the lateral extent of contamination has been bounded. **[contingent]**

C.9.5 Buried Infrastructure Soil Sampling

Soils associated with buried infrastructure within WMA 3 will be sampled to determine their contamination status. Because of the likely complexity and amount of subsurface infrastructure features within the WMA 3 area, these efforts will focus on infrastructure considered of greatest concern, such as waste or wastewater lines and buried infrastructure footprints installed after 1968 that potentially carried several different buried utility lines.

- Three locations along the each piece of buried infrastructure that is of concern within WMA 3 will be trenched. These locations will be selected to maximize the possibility that contamination will be encountered (e.g., locations where historical or current GWS data indicate surface contamination exists). For infrastructure that crosses the boundary between WMA 1 and 3 or that intersects the planned footprint of the WMA 1 slurry wall, one of these locations will be at the boundary/slurry wall intersection. During excavation, exposed soils will be monitored by scans for evidence of elevated gross activity. The purpose of this sampling is to evaluate the presence of contaminated soils associated with buried infrastructure. **[required]**

 - If elevated readings are encountered below a depth of 1 m, soils exhibiting the highest levels of gross activity will be sampled and analyzed.

 - If elevated readings are not encountered below a depth of 1 m, a sample representative of soils deeper than 1 m will be collected. In the case of infrastructure that did not carry waste or wastewater, the sample will be from soils immediately above the line. In the case of infrastructure that did carry waste or wastewater, the sample will be from soils immediately beneath the line.

- If contamination above background conditions is encountered at any selected location, trenching will continue to depth until background conditions are observed. An additional sample will be collected from the base of the trench to verify background conditions. The purpose is to vertically bound observed contamination. **[contingent]**

- If buried infrastructure soil sampling identifies contamination impacts greater than background, biased sampling will continue following the line until at least two consecutive locations yield soil samples below surface soil CG_w requirements. Location spacing will be based on engineering judgment, including the geometry of the line, the level of contamination encountered, and surface evidence of contamination. The purpose of this sampling is to bound the extent of contamination associated with buried infrastructure, as necessary. **[contingent]**

C.9.6 Additional Contingencies

Sampling and/or GWS data may indicate that contamination exists or extends beneath surfaces currently covered by existing structures, concrete, asphalt, or hardstands. In this case, "surface soil" will be defined as soil immediately beneath the cover. If sampling or GWS data indicate that contamination may exist beneath existing structures (e.g., existing buildings and building pads), then sampling locations will be offset along the foundation edge to determine contamination extent. The purpose of the offset is to allow safe acquisition of data. Data collection through building pads in WMA 3 will not be required as part of this effort.

C.9.7 Required Laboratory Analyses

All samples will be submitted for analysis of all 18 ROI.

A select portion of the samples as described above may be analyzed for the additional 12 radionuclides of potential interest. In addition, 10% of the surface soil samples submitted for analysis will be analyzed for the 12 radionuclides of potential interest in addition to the 18 ROI. If these sample results indicate the presence of the one or more of those radionuclides at levels of potential significance, then the balance of samples from WMA 3 will also be analyzed for the additional radionuclides that were identified.

Table C.1 summarizes the required sample numbers and the estimated number of contingency samples for WMA 3.

This sampling plan assumes that quick turn-around analyses are available for Sr-90 and Cs-137 and that soil samples will be screened for Sr-90 and Cs-137 prior to being analyzed for the balance of the ROI. Based on these screening data, contingency sampling requirements as described above may be undertaken without the benefit of the remaining analyses.

C.9.9 Decision-Making Summary

A summary of decision-making based on the WMA 3 data is as follows:

- If GWS data indicate anomalies are present, biased samples will be selected to target those anomalies.

- If the GWS data identify areas likely exceeding surface soil CG_w requirements, one sample will be placed to verify contamination and another set of surface soil samples used to laterally bound contamination. Additional locations may be selected, as necessary, to laterally bound contamination extent.

- If sample results from biased or systematic surface samples for the 0–1 m depth interval indicate contamination above CG requirements, an additional sample from that location representing the depth interval 1–2 m will be collected and this process repeated until contamination is vertically bounded.

- For each set of buried infrastructure that is identified as a potential concern, at least three trenches that uncover the infrastructure will be scanned and sampled. If contamination appears to extend laterally along the line of the infrastructure, additional sampling will take place until contamination is bounded.

Table C.1 Sample Number Estimates

	Required	Contingent	Total
Systematic Sediment Samples (0-15 cm)	0	0	0
Systematic Sediment Samples (0-1 m)	0	0	0
Biased Sediment Samples (0-15 cm)	0	0	0
Biased Sediment Samples (0-1 m)	0	0	0
Systematic Surface Soil Samples (0-15 cm)	20	0	20
Systematic Surface Soil Samples (0-1 m)	20	0	20
Biased Surface Soil Samples (0-15 cm)	0	3	3
Biased Surface Soil Samples (0-1 m)	0	3	3
Systematic Subsurface Soil Samples (1-m intervals)	0	6	6
Biased Subsurface Soil Samples (1-m intervals)	0	5	5
Buried Infrastructure Soil Samples	18	12	30
Discrete Groundwater Samples	0	0	0
Total:	58	29	87

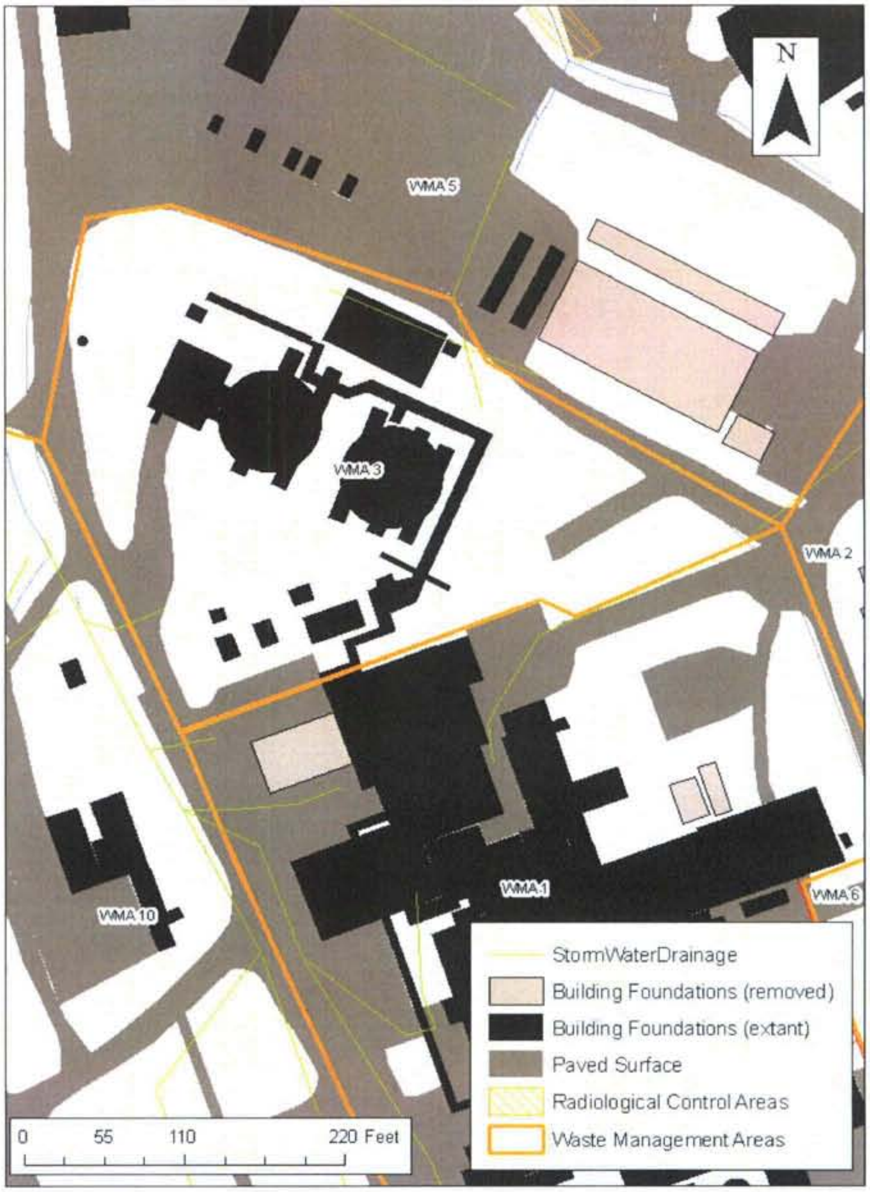

Figure C.1 WMA 3

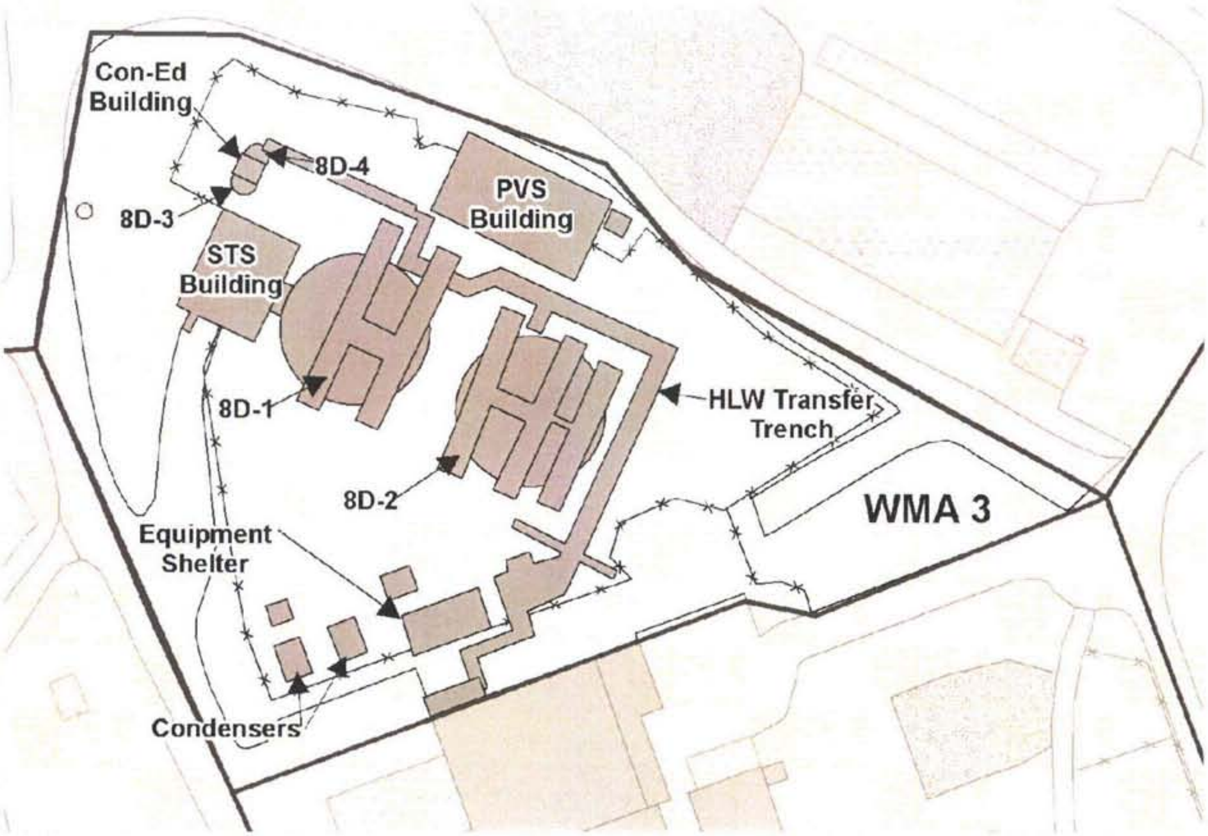

Figure C.2 WMA 3 Facilities (from Phase 1 DP, Figure 3-29)

Figure C.3 WMA 3 Aerial Photograph from 1962

Figure C.4 WMA 3 Aerial Photograph from 1966

Figure C.5 WMA 3 Aerial Photograph from 1968

Figure C.6 WMA 3 Aerial Photograph from 1977

Figure C.7 WMA 3 Aerial Photograph from 1984

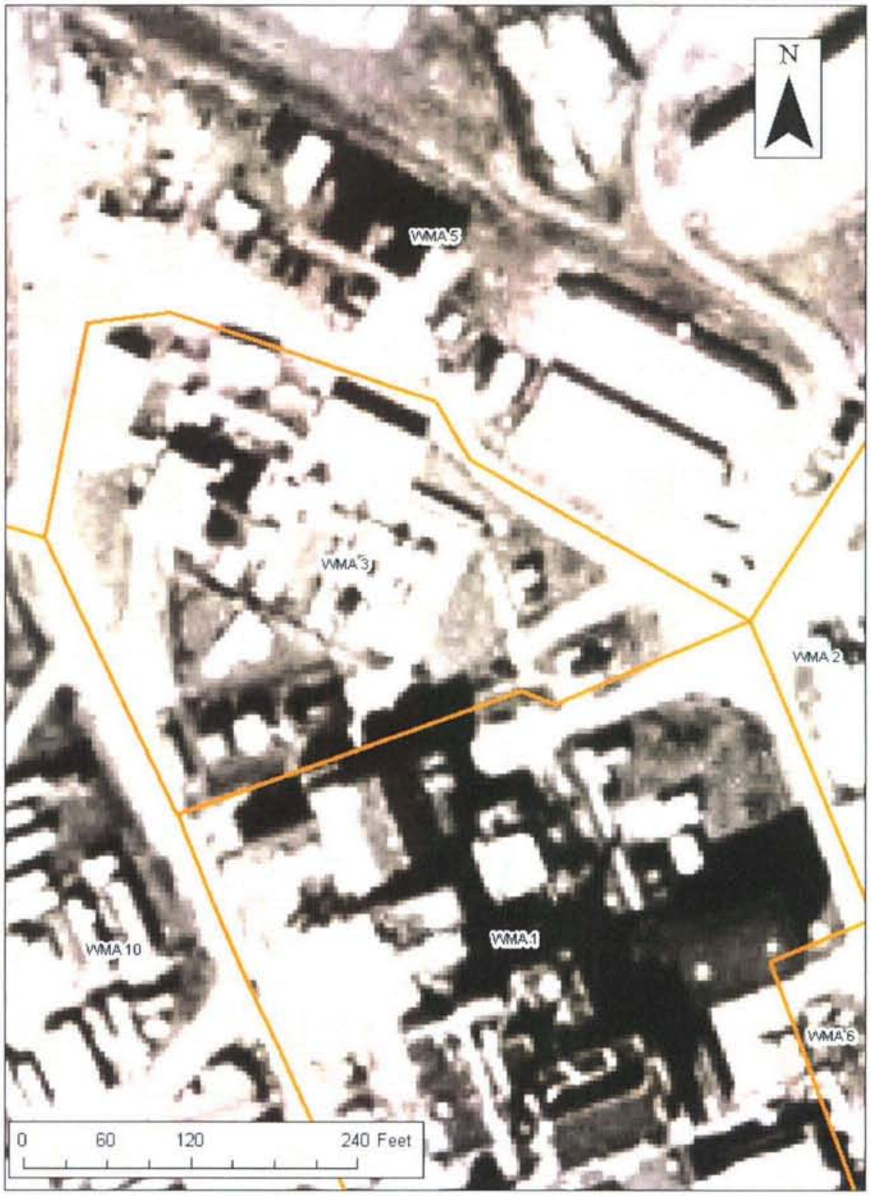

Figure C.8 WMA 3 Aerial Photograph from 1995

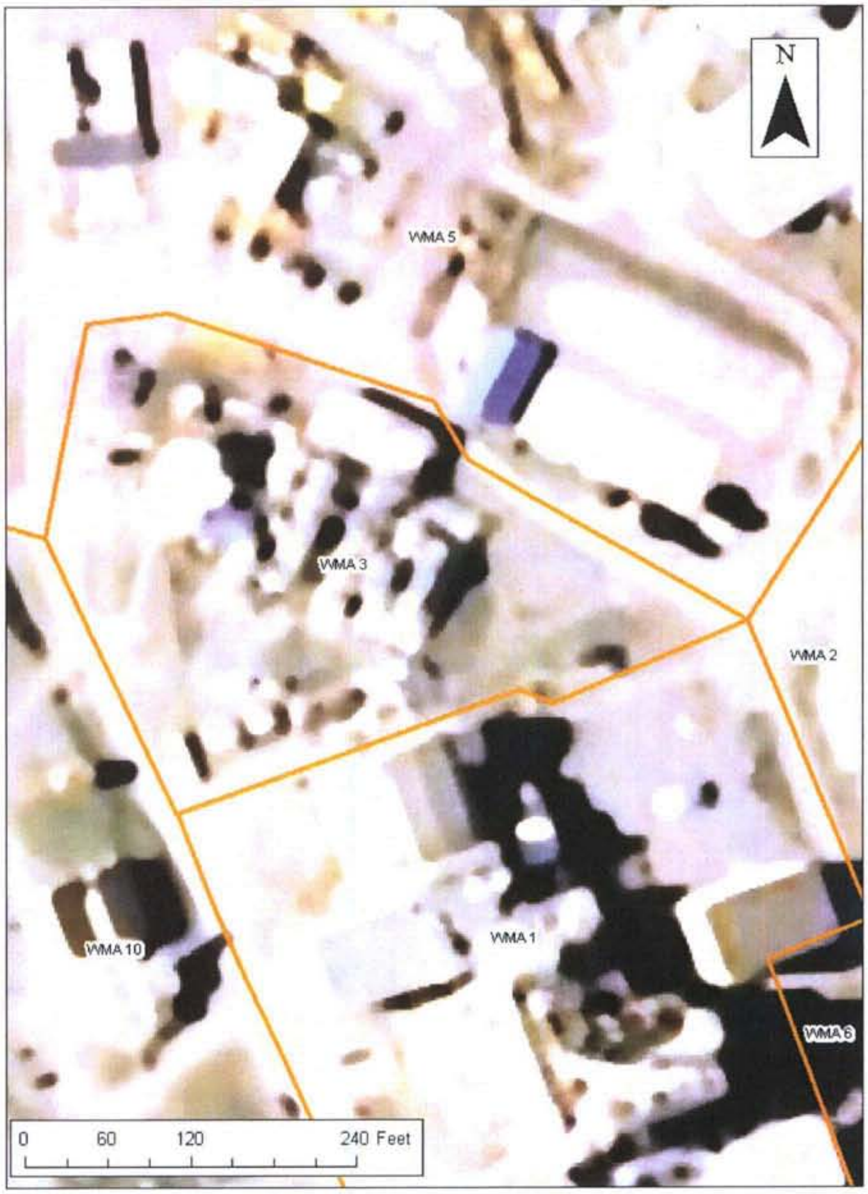

Figure C.9 WMA 3 Aerial Photograph from 2007

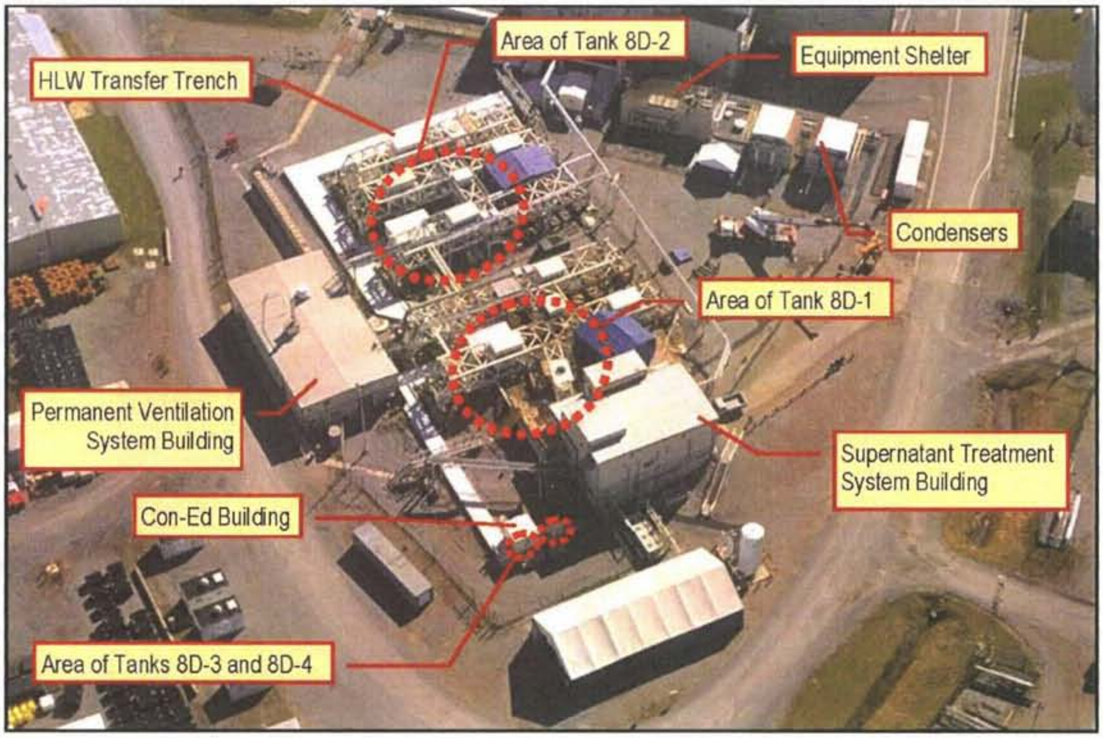

Figure C.10 WMA 3 Oblique Aerial Photograph (from Phase 1 DP, Figure 3-30)

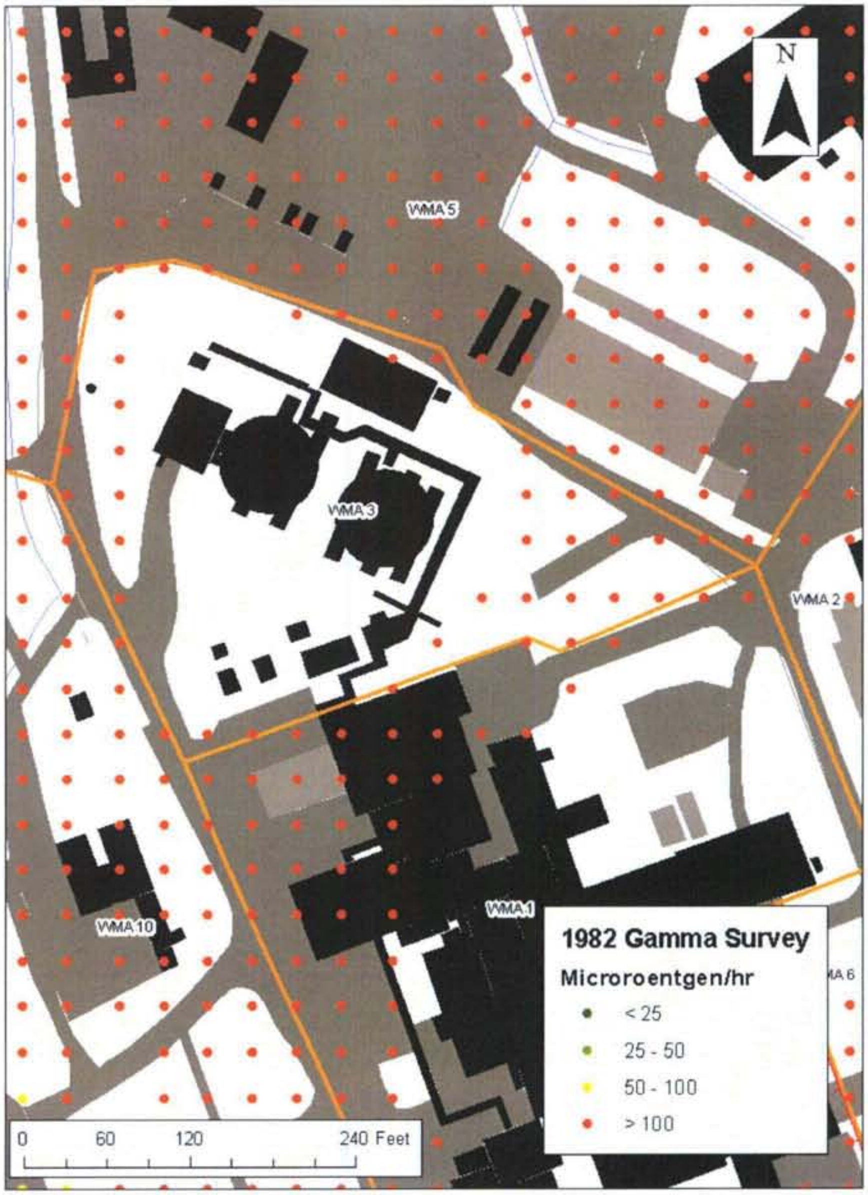

Figure C.11 WMA 3 1982 Direct Gamma Measurement Results

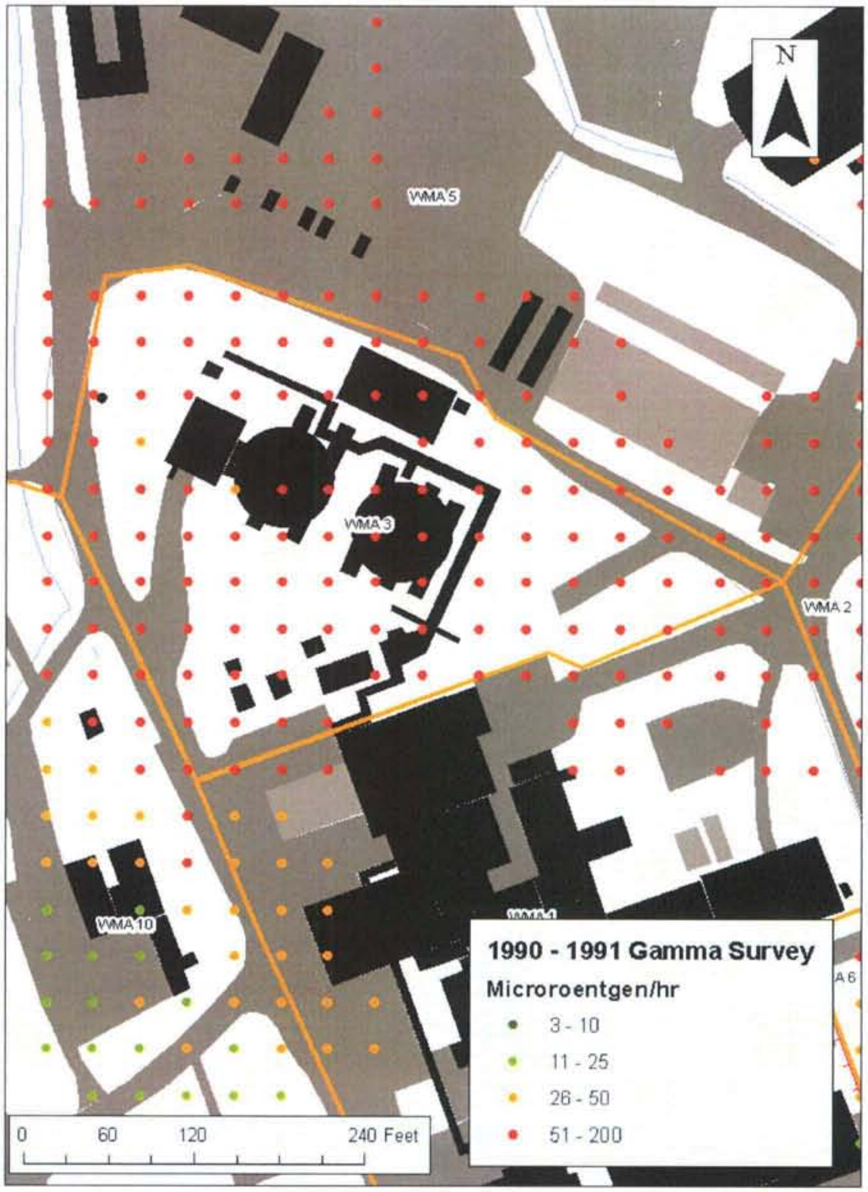

Figure C.12 WMA 3 1990 - 1991 Direct Gamma Measurement Results

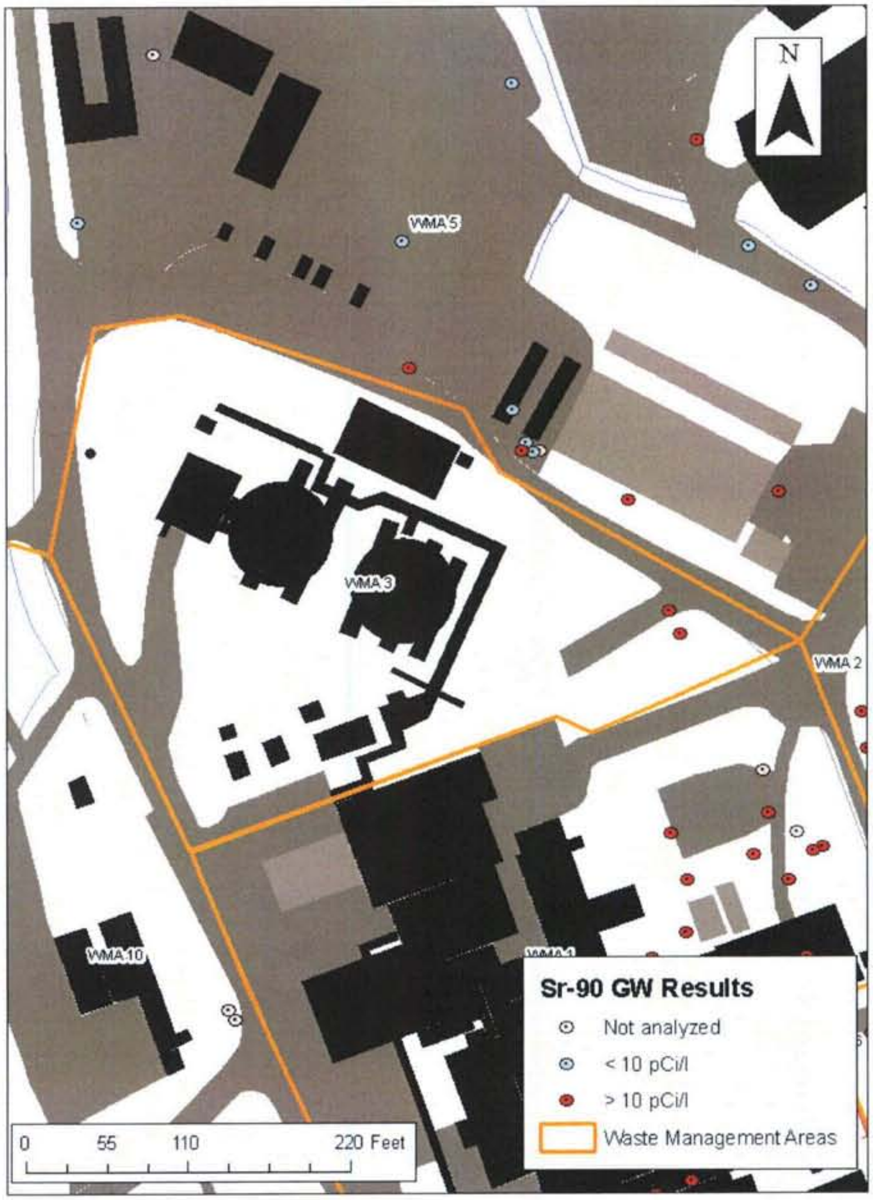

Figure C.13 WMA 3 Sr-90 Groundwater Results

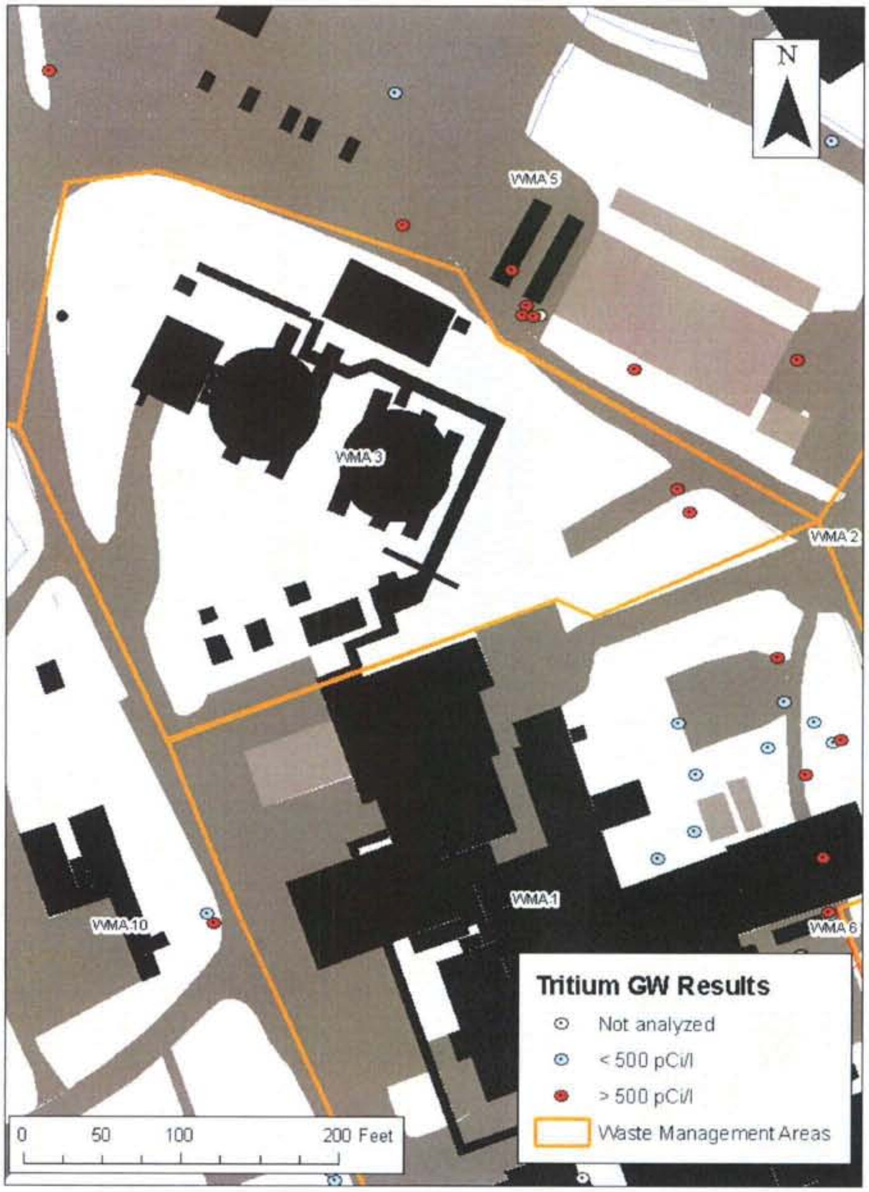

Figure C.14 WMA 3 Tritium Groundwater Results

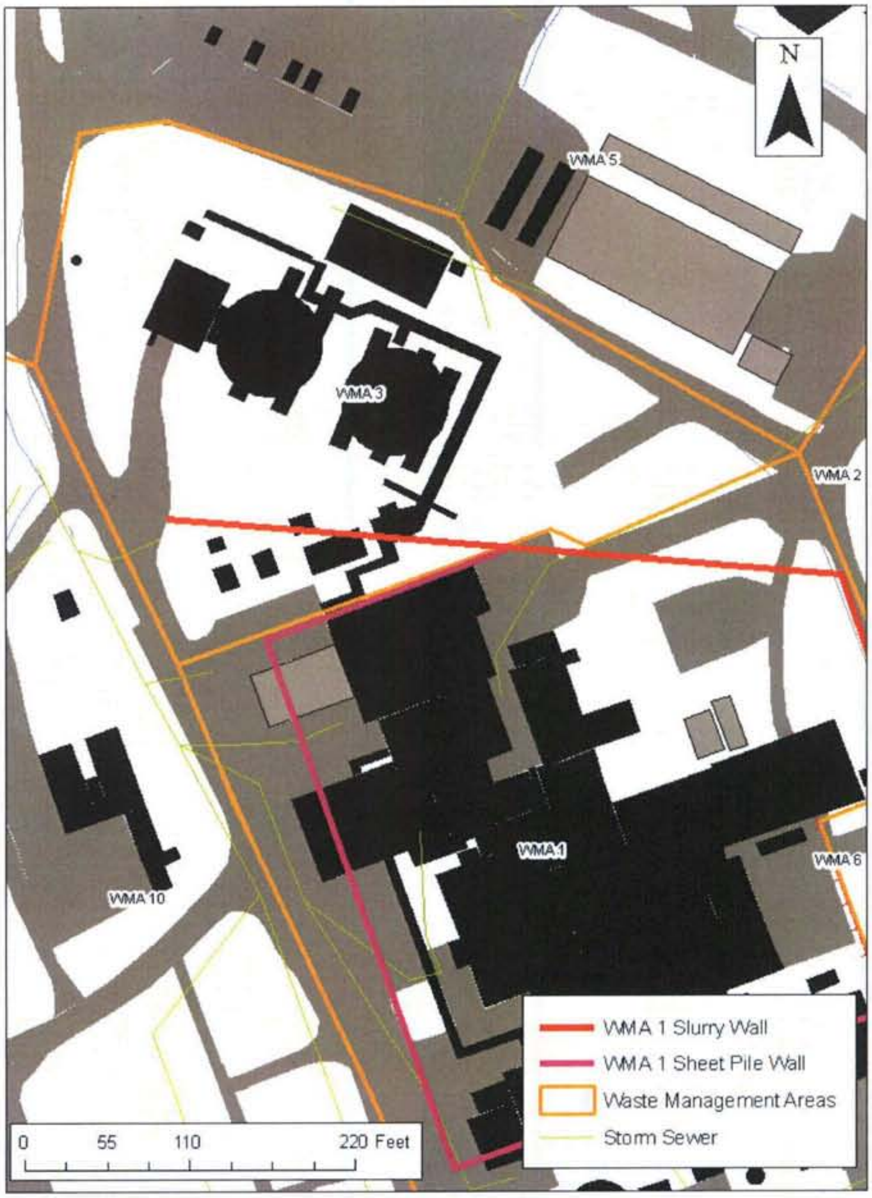

Figure C.15 Phase 1 Subsurface Wall Placement

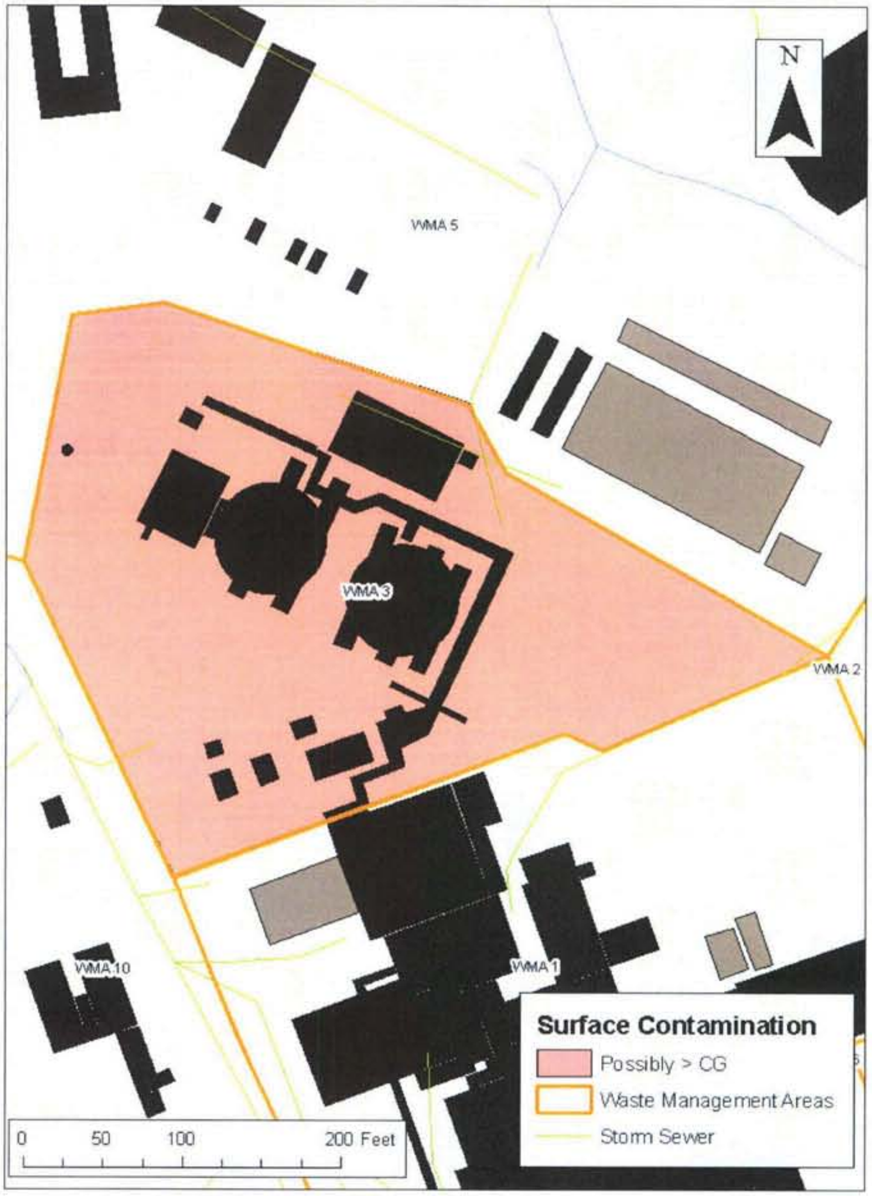

Figure C.16 Initial WMA 3 Surface Soil CSM

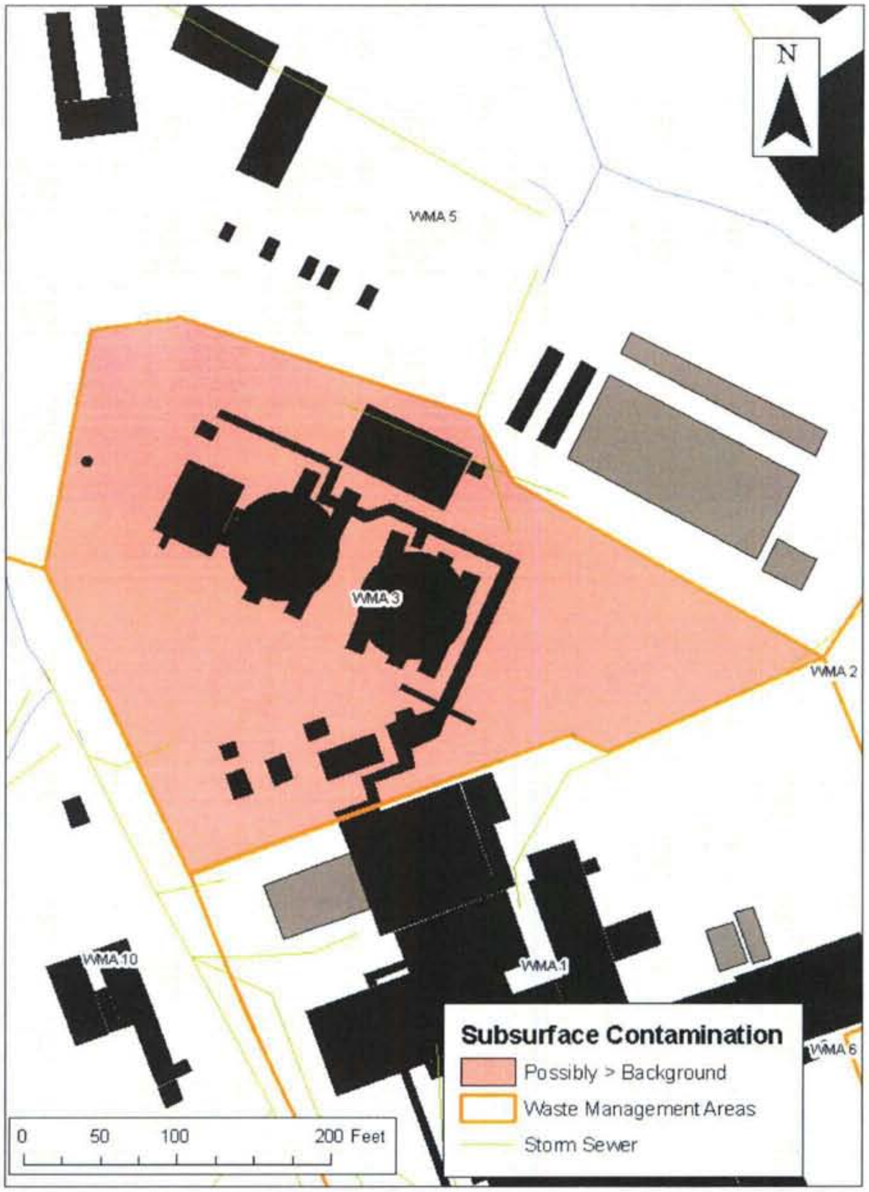

Figure C.17 Initial WMA 3 Subsurface Soil CSM

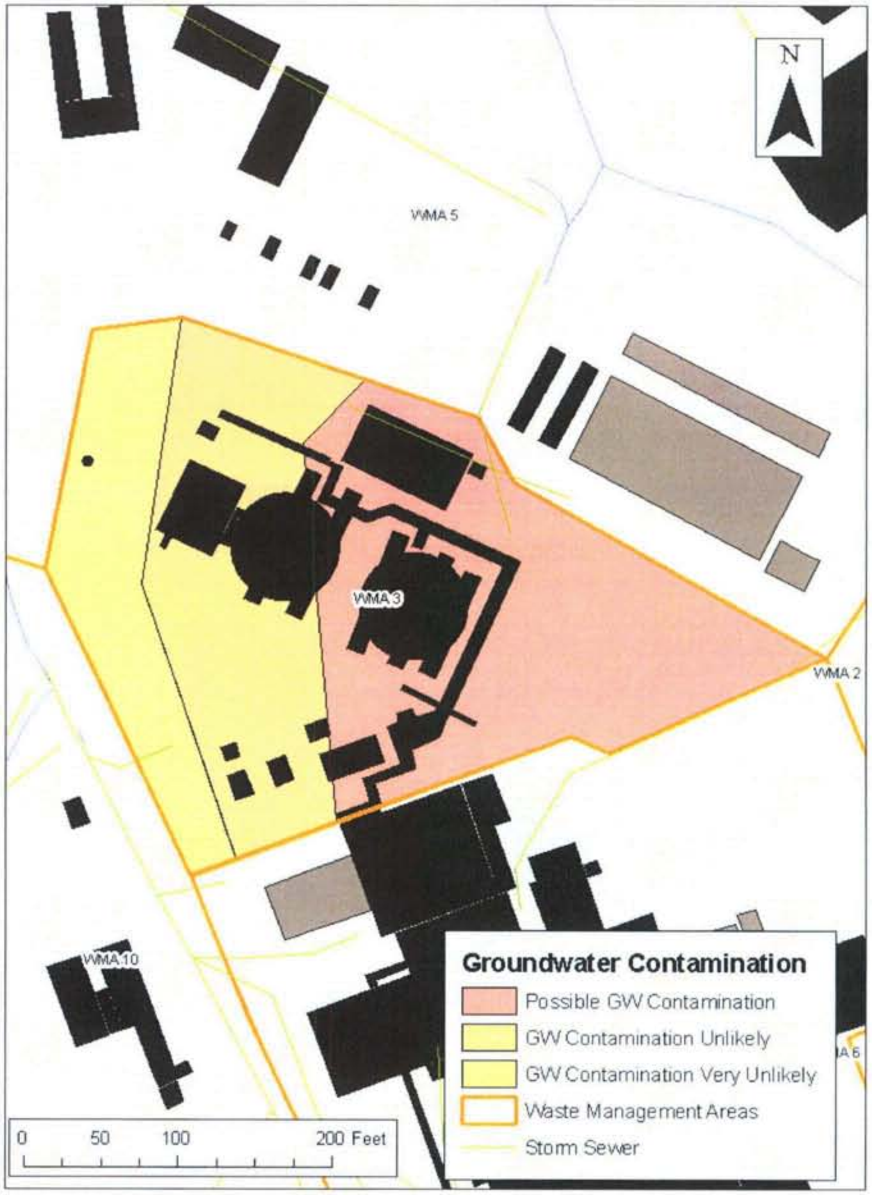

Figure C.18 Initial WMA 3 Groundwater CSM

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APPENDIX D

WMA 4 PRE-REMEDIATION DATA COLLECTION

D.1 Background

Waste Management Area 4 (WMA 4) is approximately 10 acres in size. The only WVDP facility within WMA 4 is the Construction and Demolition Debris Landfill (CDDL) (see Figure D.1 for map).

D.2 Physical Setting

WMA 4 is located on the north plateau. It is bounded to the east by the WVDP fence line, to the north by WMA 12, to the west by WMA 5, and to the south by WMA 2.

WMA 4 is vegetated. It is relatively flat, sloping towards the north and east. It is drained primarily by the Swamp Ditch which runs through WMA 4, along the north side of the CDDL. The Swamp Ditch and associated contributing ditches have been identified as radiological control areas because of the discharge of contaminated groundwater from the north plateau groundwater plume. North of the CDDL there are several wetland areas where groundwater discharges before flowing off the WVDP project premises.

WMA 4 is underlain by the sand and gravel unit which overlies the Lavery till. The sand and gravel unit has been subdivided into the Thick Bedded Unit (TBU) and the underlying Slack Water Sequence (SWS) both of which are present beneath WMA 4. Groundwater in the sand and gravel unit flows to the northeast across the north plateau, discharging to surface drainage features such as the wetlands and Swamp Ditch, and to seeps off-premises along Franks Creek and Quarry Creek. The Lavery till has low permeability but groundwater does flow vertically downward through this unit recharging the underlying Kent Recessional Sequence.

D.3 Area History

WMA 4 was not used for any structural purposes during the lifespan of the NFS reprocessing activities on-site or for any WVDP-related activities other than solid waste disposal in the CDDL. The surface drainage features have been reworked over time to accommodate the CDDL.

Figure D.2 shows WMA 4 in 1962 prior to site development. At this time WMA 4 was grassland and woodland with a marsh or pond in the vicinity of what is now the southwestern corner of the CDDL.

Figure D.3 shows WMA 4 in 1966. Development of WMA 5 and WMA 2 is visible. Apart from some surface scarring in what is now the eastern end of the CDDL, there are no visible impacts in WMA 4.

Figure D.4 shows WMA 4 in 1968. There is no visible change from 1966.

Figure D.5 shows WMA 4 in 1977. Some development of the CDDL area has started. In particular there is some surface scarring, and what appears to be a trench or linear drain installed from southwest to northeast across what is now the CDDL footprint, presumably to improve drainage of the area, and a similar parallel feature to the north of the present CDDL footprint.

Figure D.6 shows WMA 4 in 1984. In this photograph, construction of the CDDL is underway, with placement of material visible. In the eastern end of the CDDL footprint, flowing groundwater discharge is visible.

Figure D.7 shows WMA 4 in 1995. Disposal operations in the CDDL were terminated in December 1984 and the closure of the landfill was certified complete by NYSDEC in 1986. The current configuration of the Swamp Ditch is visible. The Lag Storage additions in WMA 5 have also been completed adjacent to WMA 4.

Figure D.8 shows WMA 4 in 2007. There is no visible change in WMA 4 since 1995.

D.4 Known and Suspected Releases

There are no known or suspected releases within the WMA 4 footprint. Debris and waste placed in the CDDL was supposed to have been free of radioactive contaminants.

The soils within WMA 4 potentially would have been impacted by air deposition of radionuclide contaminants from the Process Building activities, including Cs-137 (Phase 1 DP Rev 2 Table 2-17; Urbon 1968a; Marchetti 1982). In addition, the drainage features within WMA 4 are known to have been impacted by the discharge of contaminated groundwater carrying Sr-90 from the north plateau groundwater plume, resulting in sediment contamination.

Large portions of the WMA 4 subsurface are known to be impacted by groundwater contaminated with Sr-90. These impacts probably also affect the contents of the CDDL since contaminated groundwater is passing beneath/through the CDDL.

D.5 Existing Data

Existing data sets for this area include:

- In 1982 static direct exposure readings were collected across the WVDP premises (WVNS 1982). Figure D.9 shows these data. At the time, the greatest WMA 4 impacts were apparent along the western and southern portions of WMA 4.

- In 1990 and 1991 a second static direct exposure measurement program was conducted across the WVDP premises (WVNS 1992). In the case of WMA 4, this effort provided systematic coverage of its area on a 10-m grid. It used different instrumentation/protocols than the 1982 study, so the results are not quantitatively comparable. However, the 1990-1991 data collection effort did provide insights into surface soil contamination across WMA 4 (Figure D.10). Impacts were more pronounced and widespread across WMA 4 in this data set, indicating additional impacts may have occurred since the prior 1982 survey.

- There have been several historical soil/sediment sampling activities in WMA 4. Environmental monitoring via soil/sediment sampling has taken place since 1991 to the present at location SNSWAMP (Figure D.1). Soil and sediment samples were also collected in 1993 as part of the RFI. Finally, in 2008, a fairly intensive sampling program was conducted in the ditch portions of WMA 4 to support planned remediation activities for the north plateau groundwater plume. Table D.1 summarizes the amount of soil data available for the 18 Radionuclides of Interest (ROI).

Figure D.11 shows soil/sediment sampling locations and provides surface Cs-137 and Sr-90 results for those locations with surface soil samples or sediment samples. The bulk of historical data collection has focused on ditches and so provides little information about the contamination status of soils in the rest of the WMA 4 area. The historical sampling did find Cs-137 and Sr-90 contamination in most samples that included some well above surface soil CG_w standards in surface sediments/soils associated with the ditches. The observed Cs-137 is likely due to a combination of surficial deposition and consolidation of contamination within ditch sediments through erosional processes. The observed Sr-90 contamination is likely tied to contaminated groundwater discharges to the ditches. The SS/SB-PRB series samples from the ditch along the west side of the CDDL only measured gross alpha and gross beta; for many of these samples gross beta activity was significantly elevated above background indicating likely Sr-90 contamination.

- There is a significant amount of groundwater data collection from the southern portion of the WMA 4 area, linked to historical efforts to characterize Sr-90 contamination in groundwater in that area. Figure D.12 shows the locations of groundwater data collection color-coded by Sr-90 results. Figure D.13 shows the locations of groundwater data collection color-coded by tritium results. These locations are a mixture of GeoProbe locations where discrete groundwater samples were collected at a specific point in time, monitoring wells with a limited duration of sampling events, and monitoring wells with extensive sampling histories, all from the sand and gravel unit overlying the Lavery Till. The detection limits for Sr-90 and tritium varied widely among ELIMS samples. 10 pCi/L and 500 pCi/L were selected as thresholds for Sr-90 and tritium, respectively, because based on ELIMS data results above these activity concentrations were consistently above method detection limits and so indicative of contamination impacts rather than simply measurement error.

In general, Sr-90 and tritium groundwater impacts are present in the southern portion of WMA 4. The Sr-90 and tritium activity concentrations, in general, decrease as one moves to the east and north. However, there is a lack of groundwater data from the northern portion of the WMA 4 to definitively state that groundwater impacts do not exist in that portion of WMA 4.

D.6 Planned Phase 1 DP Activities

There are no planned Phase 1 decommissioning remediation activities for WMA 4.

As a separate activity, DOE intends to install a permeable treatment wall to address the north plateau groundwater plume south of the CDDL, in WMA 2. The north plateau groundwater plume and this treatment wall are discussed in more detail in Appendix B.

D.7 Conceptual Site Model

Based on the available information, the conceptual site model (CSM) for WMA 4 is as follows. No environmental releases of radioactive contamination within WMA 4 are believed to have occurred. However, environmental media within WMA 4 have been affected to some degree by releases elsewhere at the WVDP site. These impacts include air deposition contamination on surface soils at least along the western and southern portions of WMA 4, contamination in ditches resulting from erosion and sedimentation from other contaminated portions of the site and from the discharge of contaminated groundwater, and groundwater contamination beneath at least the southern portion of WMA 4. In particular, significant ditch soil and sediment contamination exists that exceeds Phase 1 surface soil CG_w standards.

Wastes placed in the CDDL were reportedly un-impacted by radionuclide contamination. However, given the fact that contaminated groundwater is moving through the contents of the CDDL, the working assumption is that currently CDDL contents likely have low-level radioactive contamination present (Phase 1 DP, Section 2.4.3).

Figure D.14 shows the current CSM for surface and near surface soils. Figure D.15 shows the CSM for soils deeper than 1 m. Subsurface soil contamination is assumed to be the result of and coincide with groundwater contamination, although detectable groundwater contamination may exist in areas where soil contamination levels would not be detectable or differentiable from background. Figure D.16 shows where measurable groundwater impacts likely exist based on existing information.

D.8 WMA 4-Specific Characterization Goals

- Evaluate appropriateness of the current list of ROI
- Determine level and extent of surface contamination
- Identify soil waste stream characteristics
- Obtain data to support Phase 2 planning

A significant portion of the WMA 4 subsurface is known to be impacted by contaminated groundwater. In this portion of the WVDP premises, contaminated groundwater movement is on-going, with the north plateau groundwater plume growing as time progresses. A permeable treatment wall is currently being designed to address this contamination, and will likely alter the future fate and transport of Sr-90 in this area. Additional characterization and enhanced monitoring are part of the remedial design. Further characterization of subsurface contamination (soil and groundwater) in WMA 4 is not within the current scope of the CSAP, beyond potentially vertically bounding the extent of surface contamination.

D.9 CSAP Pre-Remediation Data Collection and Associated Decision-Making

CSAP pre-remediation data collection will consist of a number of components described in more detail below.

D.9.1 Gamma Walkover Survey Data

The purpose of performing a gamma walkover survey of the WMA 4 area is to identify the level and extent of surface contamination. This includes both general trends in average activity concentrations pertinent to the surface soil CG_w requirement, as well as the identification of isolated, more-elevated anomalies that might be indicative of discrete releases and/or surface soil CG_{emc} concerns.

A complete (100%) logged gamma walkover survey (GWS) will be conducted for accessible areas within WMA 4. Examples of areas within WMA 4 that would not be accessible are areas where standing water is present in wetlands. Based on the GWS results, surface soil within WMA 4 will be divided into three categories: (1) surface soils where GWS indicates possible surface soil CG_w exceedances; (2) surface soils where GWS indicate impacts, but those impacts are not expected to exceed surface soil CG_w standards; and (3) surface soils where there is no indication of impacts above background conditions. The purpose of this data collection is to provide insights into the spatial distribution of surface contamination, and to guide subsequent soil sampling. **[required]**

D.9.2 Surface Soil Sampling

Surface soil sampling will be used to address areas inaccessible to GWS data collection, to resolve hot spots identified by the GWS data, and to evaluate the presence, absence, and/or extent of surface contamination above surface soil CG_w requirements based on GWS results.

- **Wetlands.** It is possible that standing water will be present in wetlands that prevent GWS data collection from those areas. Soil sampling will be required for wetland footprints and for any other areas where standing water prevents the collection of GWS data. Within WMA 4, this is most likely to occur in the northern and northwestern portion of the WMA.

  For every area where standing water or saturated soil conditions prevent GWS data collection, systematic soil sampling will take place. At least one and at most five sampling locations will be selected per area. One sample will be collected from each location representative of a 0–15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. In the case where an area has more than one location, locations will be selected so that each representative area does not overlap and provides systematic coverage of the area of interest. If a wetland area is less than 200 m^2 in size, one 5-point composite will be formed to be representative of the wetland's area. **[contingent]**

- **Hot Spots.** If GWS data indicate the presence of contamination that possibly exceeds "hot spot" (CG_{cmc}) standards or an isolated elevated area is identified that appears indicative of a discrete release, the location of concern will be sampled with a biased sample. If biased samples are collected from a particular location, they will be collected from two depth intervals: 0-15 cm, and 0-1 m. In the case of surface soils, each biased sample will be a composite sample formed from 5 increments systematically distributed over the area of interest. The 0–15 cm samples will be analyzed for the 12 radionuclides of potential interest in addition to the 18 ROI. One down-hole gamma scan will be conducted from each biased location. The purpose of these samples is to resolve GWS anomalies, evaluate the appropriateness of the current ROI list, and verify the absence of additional ROI. **[contingent]**

- **CG_w Sampling.** Surface soil sampling may be conducted after the GWS to further clarify results, with the level and nature of sampling dependent on GWS results.

    - If GWS results indicate contamination impacts above background levels but that surface soil contaminant levels exceeding surface soil CG_w requirements are unlikely, a minimum of five surface soil sample locations will be identified and sampled that target the areas with the highest gross activity levels. One sample will be collected from each location representative of a 0–15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap. The purpose is to document the maximum activity concentrations present in surface soils within WMA 4. **[contingent]**

    - If GWS results indicate surface soil contaminant levels exceeding surface soil CG_w requirements likely exist, one sampling location will be selected at the highest gross activity level to confirm surface soil CG_w exceedances and another set of sampling locations will be identified to spatially bound the extent of contamination (i.e., along the boundary of what is considered likely above surface soil CG_w requirements). Two samples will be collected from the location targeting high gross activity levels, one representative of a 0–15 cm depth interval, and one representative of a 0-1 m depth interval. One sample will be collected from each location intended to laterally bound contamination, representative of a 0-15 cm depth interval. Each sample will be a 5-increment composite formed to be representative of a 200 m^2 area. In addition, the location targeting high gross activity levels will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. Locations will be selected so that each representative area does not overlap. The purpose is to document surface soil CG_w requirement exceedances and bound the lateral extent of contamination. **[contingent]**

- If GWS results indicate areas with surface soil contamination impacts but it is unclear whether surface soil CG_w requirement exceedances are present, at most five sampling locations will be selected that systematically cover the areas of interest. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap. The purpose is to resolve the question of whether surface soil CG_w requirement exceedances exist for areas where GWS results are ambiguous. **[contingent]**

- If any 0-15 cm interval yields a sample result indicating a surface soil CG_w requirements exceedance and that sample location is not laterally bounded either by existing sampling locations with results less than surface soil CG_w requirements or by GWS data that clearly indicate contamination is not a concern, additional sampling locations will be selected so that the contamination encountered is spatially bounded. The purpose is to laterally bound contamination that is above CG_w requirements. **[contingent]**

D.9.3 Subsurface Soil Sampling

The purpose of subsurface soil sampling within WMA 4 is to determine presence and vertical extent of contamination impacts above background levels. Much of the WMA 4 subsurface is potentially impacted by contamination associated with the north plateau groundwater plume. Significant historical data collection has been dedicated to characterizing the extent and level of this plume. The sampling described by this section is not intended to further characterize the north plateau groundwater plume. It is intended to characterize surface contamination that extends to depths greater than a meter and/or near surface contamination overlain by a thin layer of clean soil.

- If any 0-15 cm surface soil sample result indicates contamination impacts above background levels and there was not a 0-1 m sample collected from that location, a 0-1 m sample will be collected from that location following the protocols used for the original 0-15 cm surface soil sample. In addition, each soil location will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. **[contingent]**

- If a 0-1 m sample result exceeds background levels, then an additional sample from a depth of 1-2 m will be collected and analyzed from that location. In addition, down-hole gamma data will be collected from the location with static measurements collected for every 15 cm depth interval. If that sample has contamination above background conditions, then the next deeper 1 m interval will be sampled and analyzed and a down-hole gamma scan performed. This process will continue until background conditions are reached. **[contingent]**

D.9.4 Drainage Feature Sampling

WMA 4 contains two primary drainage features. The first runs from the northwestern corner of WMA 4 towards the east, along the CDDL, discharging on the east side of WMA 4 at the WVDP fence line. This feature is known as the Swamp Ditch. The portion of the Swamp Ditch that runs along the north side of the CDDL is carried by a buried pipe. The second drainage feature runs east along the southern edge of the CDDL before turning north and connecting with the Swamp Ditch. For drainage features within WMA 4, the surface soil CG_w requirements apply. Surface drainage feature sampling will be conducted to determine ditch sediment contamination status relative to surface soil CG_w requirements. Surface drainage features will be sampled as follows:

- Discrete samples representing a 0-15 cm depth interval will be collected from ditch sediments. In WMA 4, the primary drainage features have a combined length of approximately 450 m. Samples will be systematic located using a random start, separated by 30 m. This sampling will not address the buried portion of the Swamp Ditch along the north side of the CDDL. **[required]**

- If any 0-15 cm sample result indicates contamination impacts above background levels and a 0-1 m sample was not also collected, a 0-1 m sample will be collected from that location following the protocols used for the original 0-15 cm sample. **[contingent]**

- If a sample indicates contamination impacts above background levels for the 0-1 m depth interval, an additional sample from a depth of 1-2 m will be collected and analyzed from that location. This will be repeated, as necessary, until the vertical extent of contamination impact is bounded at that location. **[contingent]**

D.9.5 Additional Contingencies

Sampling and/or GWS data may indicate that contamination exists or extends beneath surfaces currently covered by existing structures, concrete, asphalt, or gravel. In this case, "surface soil" will be defined as soil immediately beneath the cover. If sampling or GWS data indicate that contamination may exist beneath existing structures (e.g., the CDDL), then sampling locations will be offset along the foundation edge to determine contamination extent. The purpose of the offset is to allow safe acquisition of data. Data collection through the CDDL in WMA 4 will not be required as part of this effort.

D.9.6 Required Laboratory Analyses

All samples will be submitted for analysis of all 18 ROI.

A select portion of the samples as described above may be analyzed for the additional 12 radionuclides of potential interest. If these sample results indicate the presence of the one or more of those radionuclides at levels of potential significance, then the balance of samples from WMA 4 will also be analyzed for the additional radionuclides that were identified.

Table D.2 summarizes the required sample numbers and the estimated number of contingency samples for WMA 4.

This sampling plan assumes that quick turn-around analyses are available for Sr-90 and Cs-137 and that soil samples will be screened for Sr-90 and Cs-137 prior to being analyzed for the balance of the ROI. Based on these screening data, contingency sampling requirements as described above may be undertaken without the benefit of the remaining analyses.

D.9.7 Decision-Making Summary

A summary of decision-making based on the WMA 4 data is as follows:

- If portions of WMA 4 are too wet to conduct a GWS, systematic surface soil sampling locations will be conducted to characterize those areas.
- If GWS indicate anomalies are present, biased samples will be selected to target those anomalies.
- If biased sample results for the 0-1 m depth interval indicate contamination above CG requirements, an additional sample from that location representing the depth interval 1-2 m will be collected and this process repeated until contamination is vertically bounded.
- The WMA 4 surface soil initial CSM as contained in Figure D.14 will be adjusted based on GWS results. These adjustments may affect systematic sample number requirements.
- If GWS results do not indicate likely surface soil CG_w requirement exceedances, five locations with the highest GWS results will be selected for sampling.
- If the GWS results indicate areas that likely exceed surface soil CG_w requirements, one location will be selected for sampling with the highest GWS results, and surface soil sample locations will be selected to laterally bound contamination.
- If the GWS results are ambiguous with respect to surface soil CG_w requirements, surface sampling locations will be selected to clarify GWS results.
- If systematic surface soil samples exceed background levels, sampling will continue to depth at those locations until the encountered contamination is vertically bounded.

Table D.1 Historical Data Analyses

Nuclide	# of Surface Soil Locations	# of Subsurface Soil Locations	# of Sediment Locations
Am-241	0	0	5
C-14	0	0	0
Cm-243	0	0	0
Cm-244	0	0	0
Cs-137	5	4	5
I-129	0	0	0
Np-237	0	0	0
Pu-238	0	0	5
Pu-239	0	0	5
Pu-240	0	0	5
Pu-241	0	0	4
Sr-90	7	13	5
Tc-99	0	0	0
U-232	0	0	5
U-233	0	0	5
U-234	0	0	1
U-235	0	0	5
U-238	0	0	5

Table D.2 Sample Number Estimates

	Required	Contingent	Total
Systematic Sediment Samples (0-15 cm)	15	0	15
Systematic Sediment Samples (0-1 m)	0	8	8
Biased Sediment Samples (0-15 cm)	0	2	2
Biased Sediment Samples (0-1 m)	0	0	0
Systematic Surface Soil Samples (0-15 cm)	0	15	15
Systematic Surface Soil Samples (0-1 m)	0	4	4
Biased Surface Soil Samples (0-15 cm)	0	3	3
Biased Surface Soil Samples (0-1 m)	0	3	3
Systematic Subsurface Soil Samples (1-m intervals)	0	0	0
Biased Subsurface Soil Samples (1-m intervals)	0	0	0
Total:	15	35	50

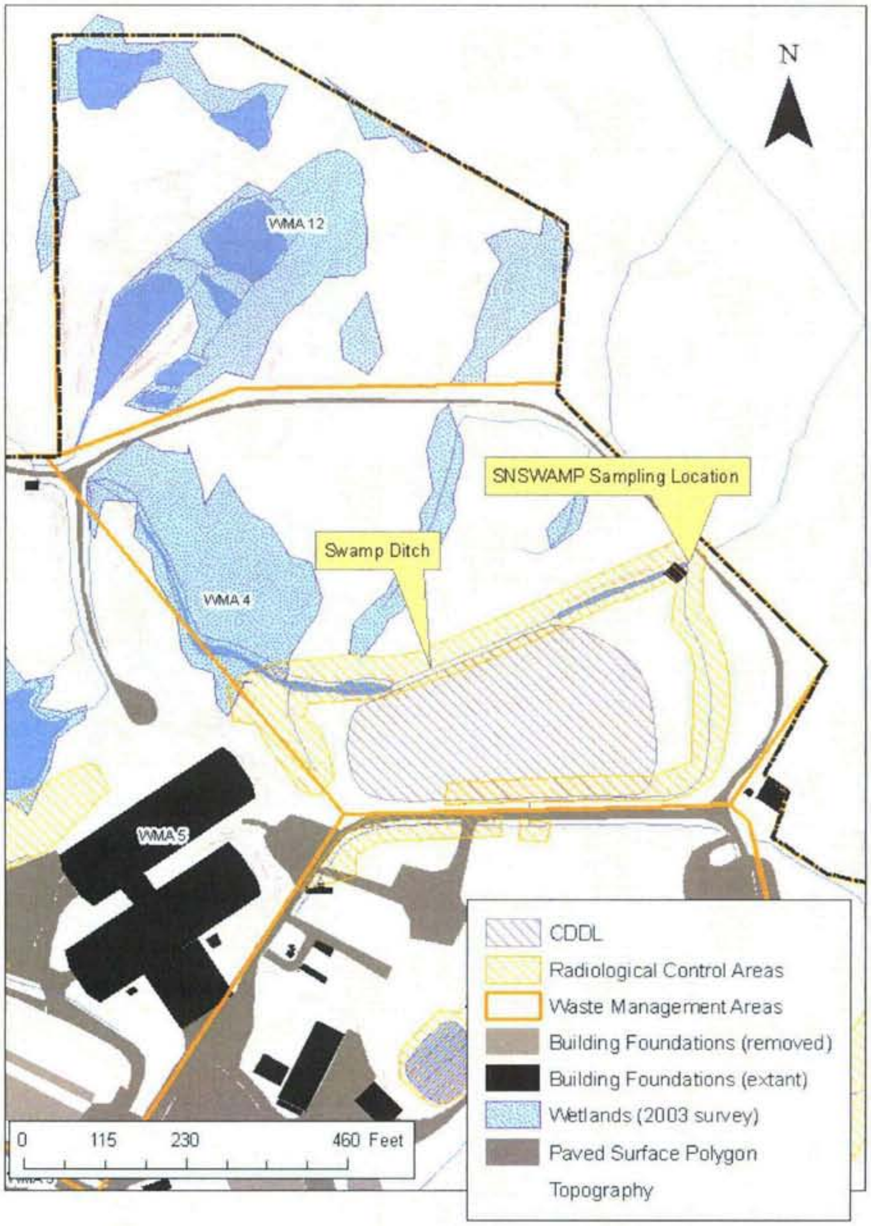

Figure D.1 WMA 4

Figure D.2 WMA 4 Aerial Photograph from 1962

Figure D.3 WMA 4 Aerial Photograph from 1966

Figure D.4 WMA 4 Aerial Photograph from 1968

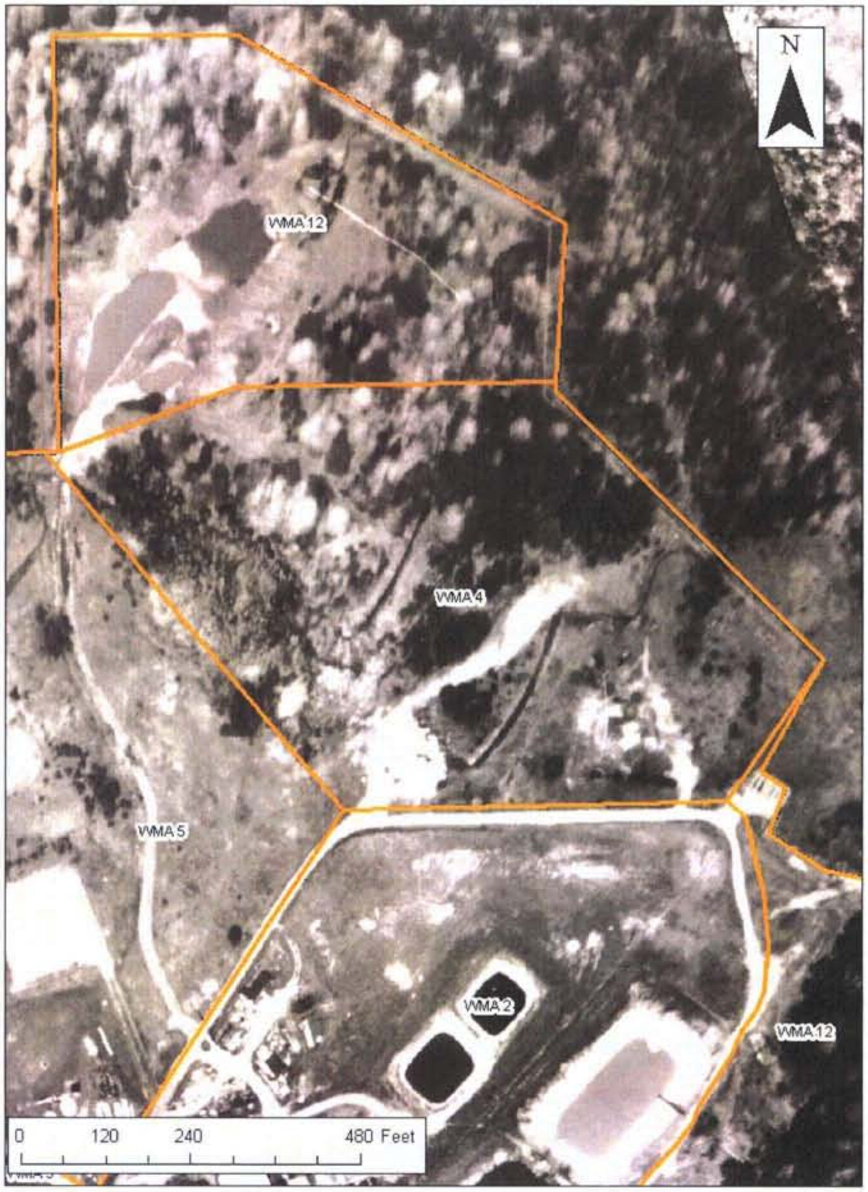

Figure D.5 WMA 4 Aerial Photograph from 1977

Figure D.6 WMA 4 Aerial Photograph from 1984

Figure D.7 WMA 4 Aerial Photograph from 1995

Figure D.8 WMA 4 Aerial Photograph from 2007

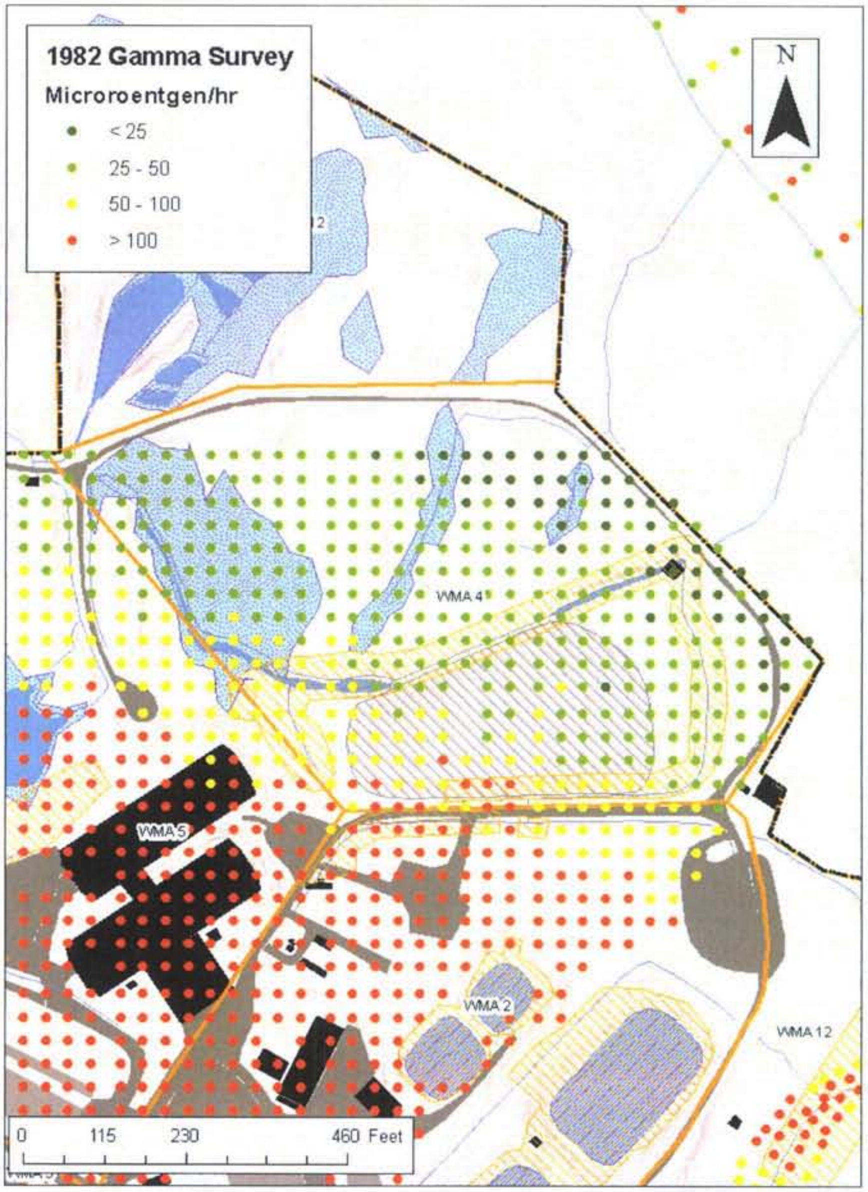

Figure D.9 1982 Direct Gamma Measurement Results for WMA 4

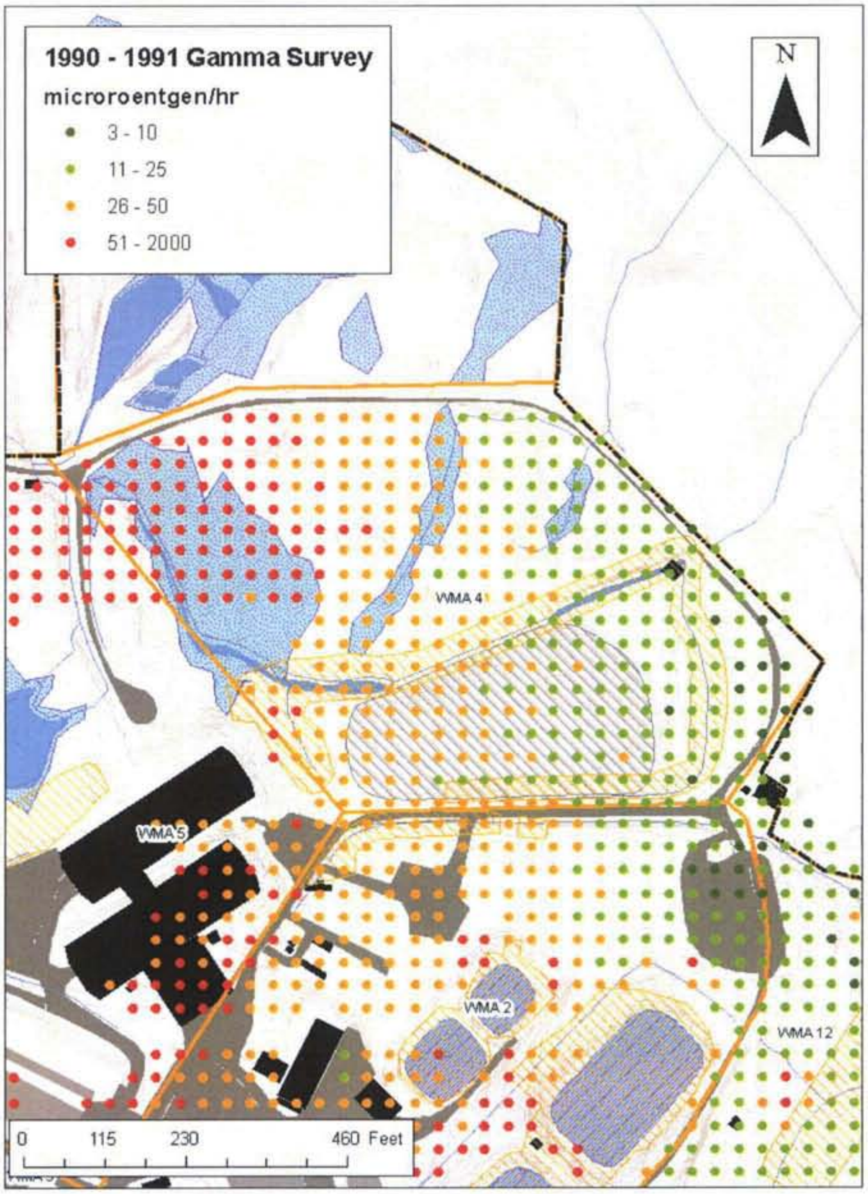

Figure D.10 1990 – 1991 Direct Gamma Measurement Results

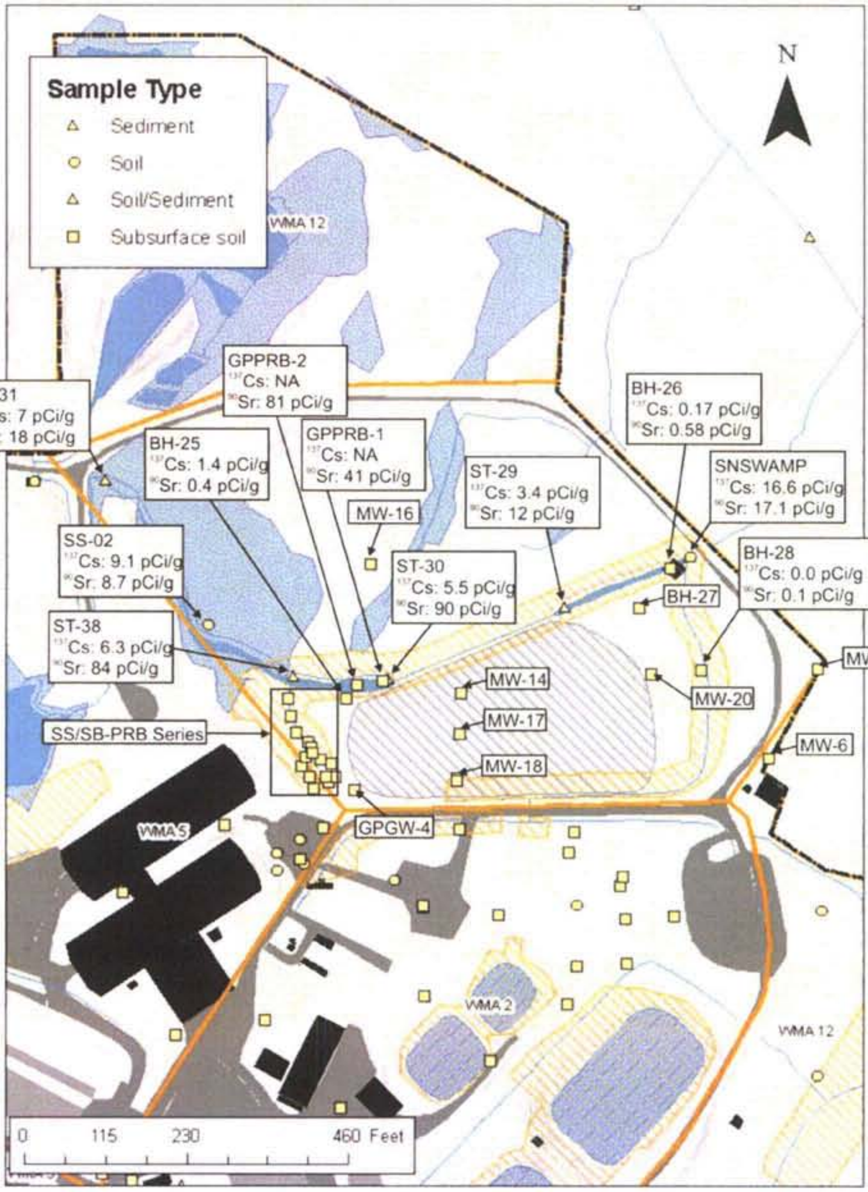

Figure D.11 Historical Surface Sampling Locations and Surface Results

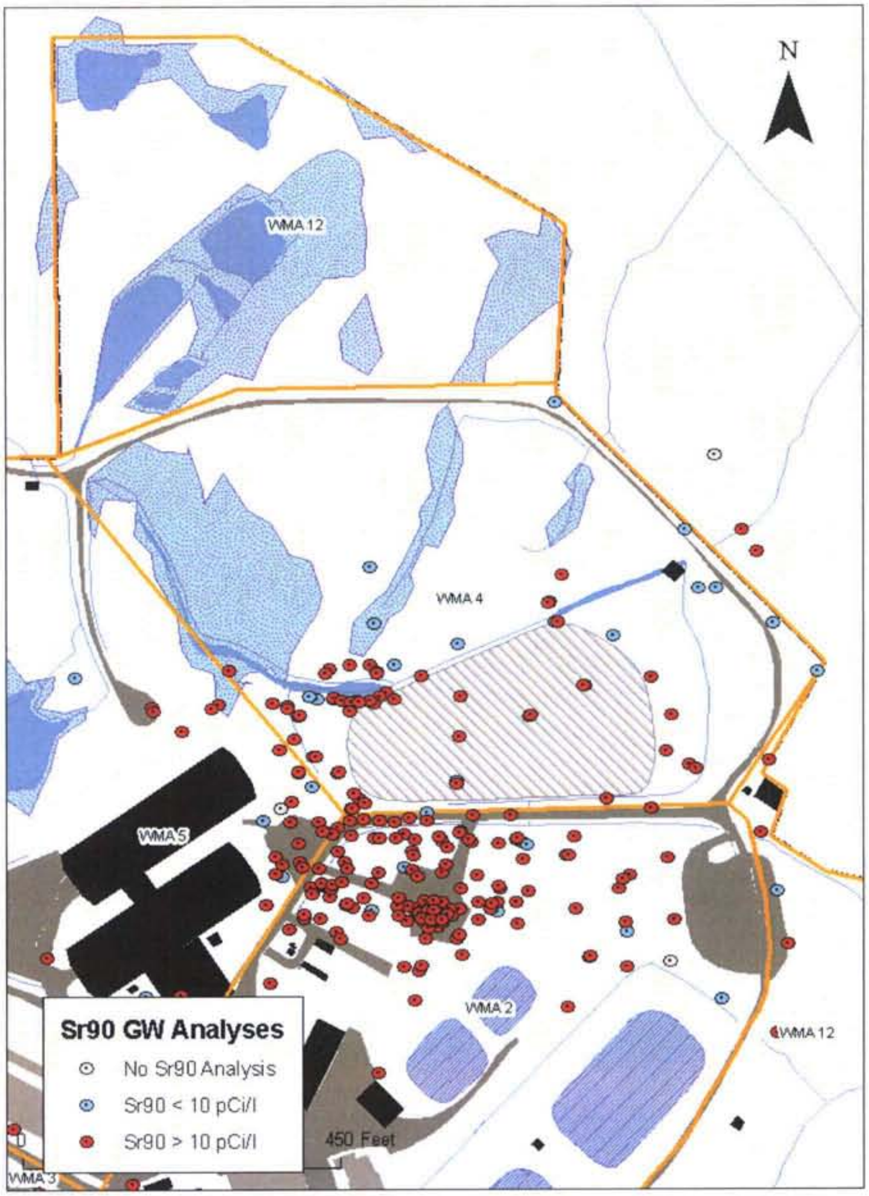

Figure D.12 Historical Groundwater Sr-90 Results

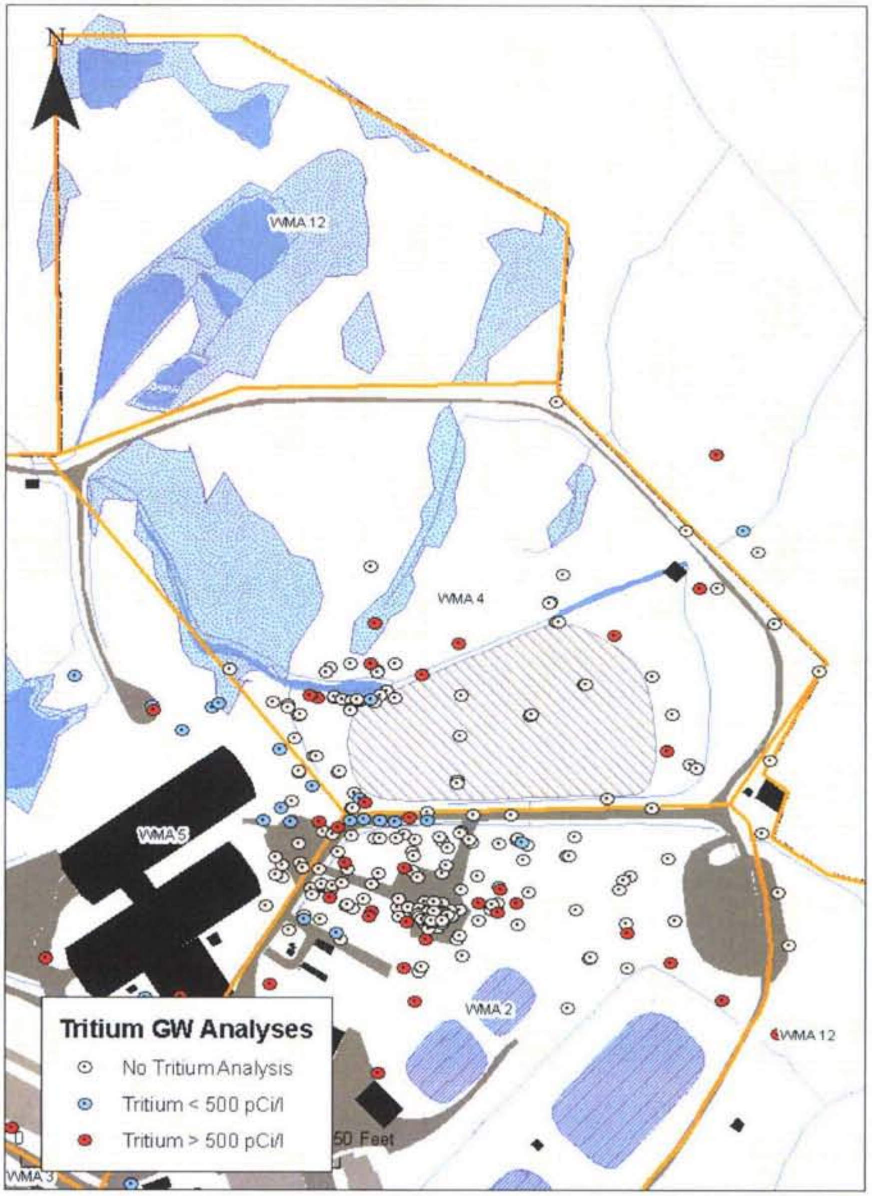

Figure D.13 Historical Groundwater Tritium Results

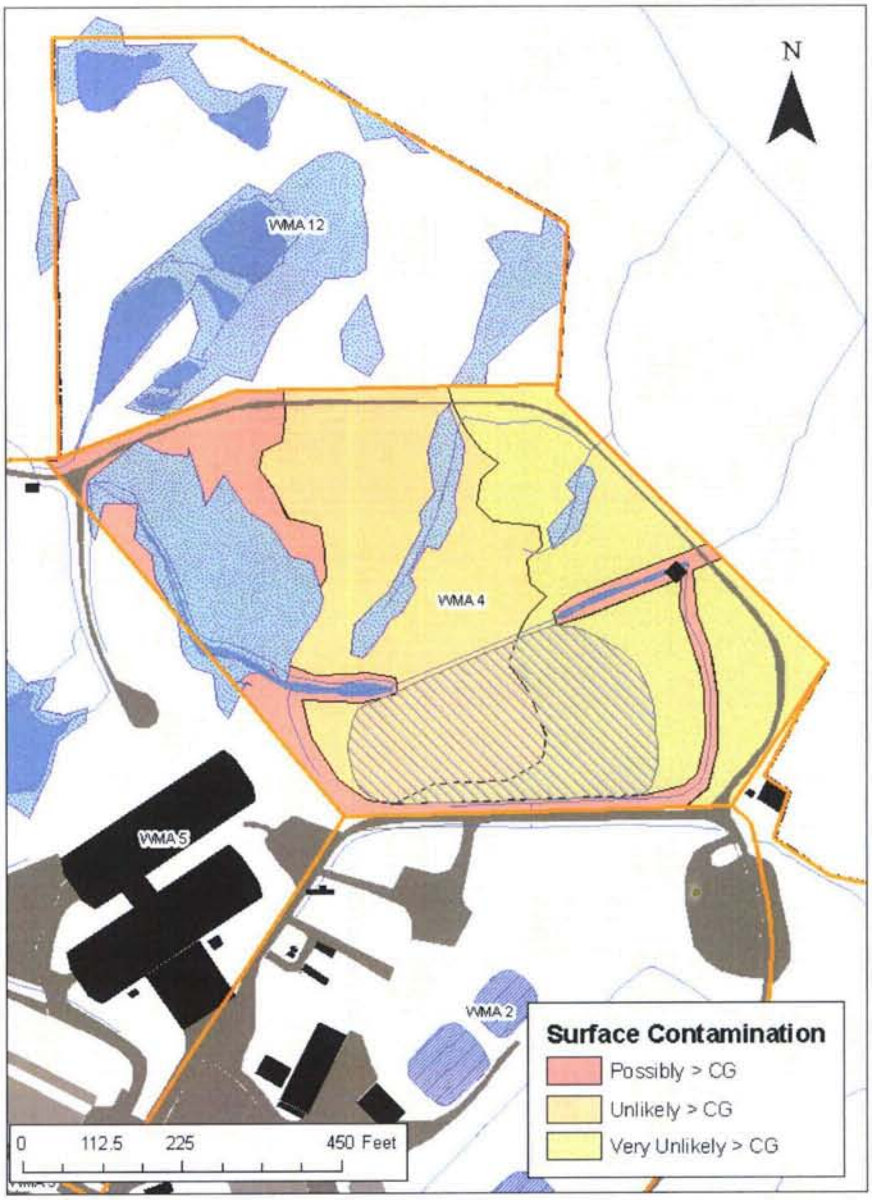

Figure D.14 Initial WMA 4 Surface Soil CSM

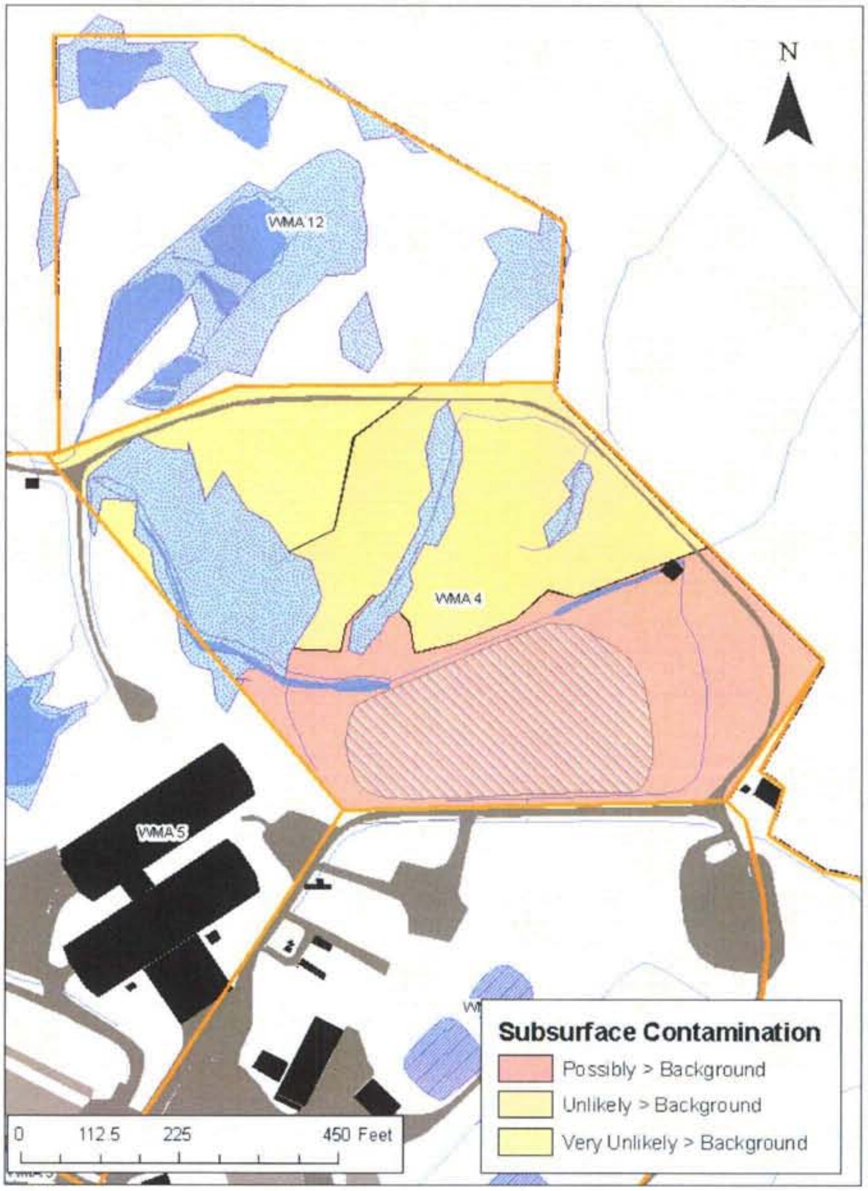

Figure D.15 Initial WMA 4 Subsurface Soil CSM

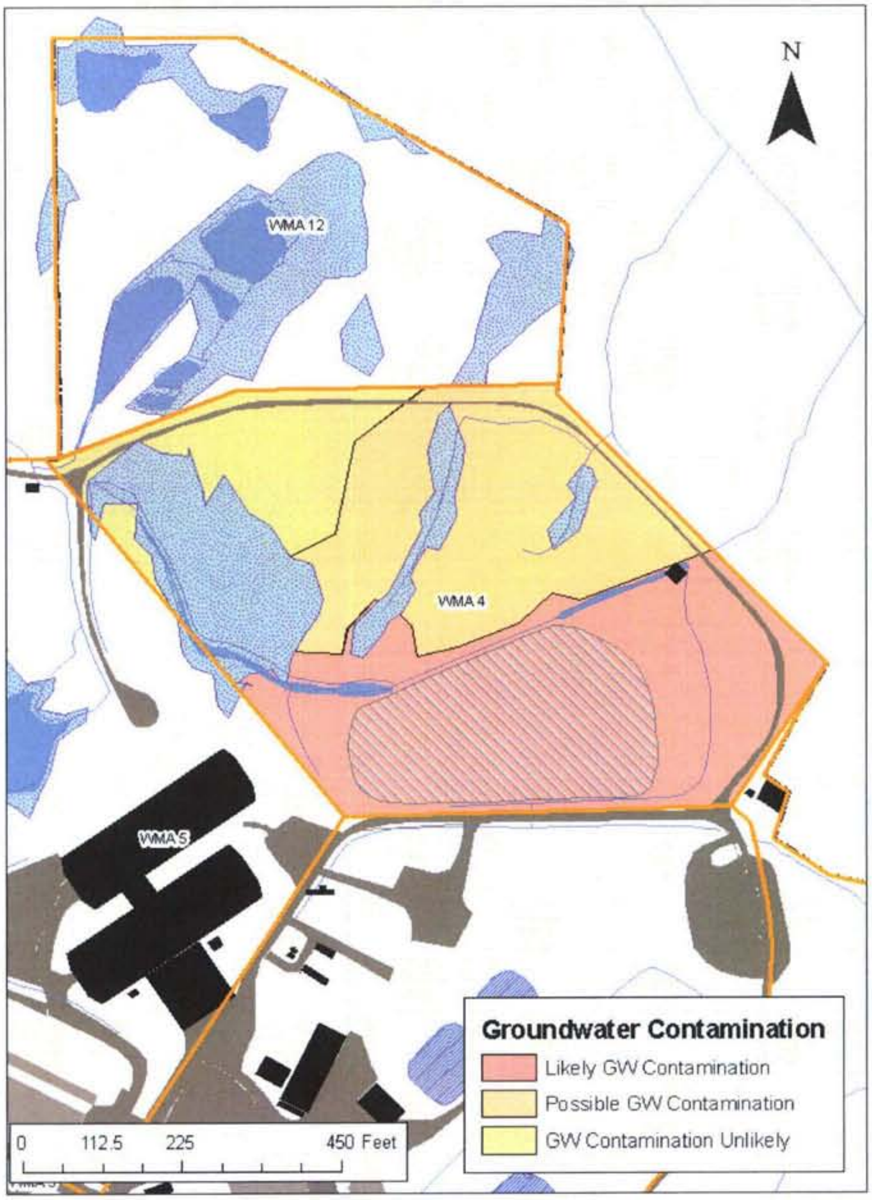

Figure D.16 Initial WMA 4 Groundwater CSM

APPENDIX E

WMA 5 PRE-REMEDIATION DATA COLLECTION

E.1 Background

Waste Management Area 5 (WMA 5) is approximately 19 acres in size and contains various buildings, building pads from buildings previously removed, paved surfaces, open grassland and wetlands, and hardstands historically used for storage (see Figures E.1 and E.2 for maps).

Descriptions of the various features of WMA 5 follow, and are taken from the Phase 1 DP, Section 3.1.2:

Remote-Handled Waste Facility. The Remote-Handled Waste Facility is located in the western portion of WMA 5. It is a metal-sided, steel-frame building that includes a Receiving Area, a Buffer Cell, a Work Cell, a Waste Packaging Area, an Operating Aisle, and a Load-Out /Truck Bay. The Receiving Area includes a 20-ton bridge crane that also provides access into the adjacent Buffer Cell. The Buffer Cell is an air lock between the Receiving Area and the contaminated Work Cell. The Work Cell is the primary work area, with provisions for fully remote handling, surveying, segmenting, decontaminating, and repackaging operations. This shielded space is 55 feet by 22 feet by 26 feet high, and is served by a 30-ton bridge crane. Any spent decontamination solutions generated during operations were transferred to below-grade wastewater storage tanks located in a vault below the building for management before treatment. These tanks and vault will be removed during Phase 1 decommissioning. The Waste Packaging Area includes capability to load both waste drums and boxes. The Operating Aisle houses two waste processing and packaging work stations and one waste sampling transfer work station. Each work station includes a shield window in the shield wall, and controllers for remotely operating facility equipment. This facility and its concrete floor slab will be removed during Phase 1 decommissioning.

Lag Storage Building Slab. The Lag Storage Building was a sheet metal structure built in 1984 to store low level waste. It was supported by a clear span frame and anchored to a 140 feet long by 60 feet wide concrete slab foundation. The slab surface was coated with an acid-resistant, twocoat, application of epoxy sealer. It was demolished down to its concrete floor slab in October 2006.

Lag Storage Addition 1 Slab. Lag Storage Addition 1 was a pre-engineered steel frame and fabric structure built in 1987 to store containerized LLW. It was 191 feet long by 55 feet wide by 23 feet high. It was removed down to its grade level floor in October 2006. It falls within the CPC-WSA hardstand footprint.

Lag Storage Addition 2 Foundation. Lag Storage Addition 2 was a tent structure that was built in 1988 and dismantled in 1993 after it was damaged by high winds. The foundation consists of eight inches of crushed stone covering an area 65 feet by 200 feet. It falls within the CPC-WSA hardstand footprint.

Lag Storage Addition 3. Lag Storage Addition 3, like Lag Storage Addition 4, is a clear-span structure, with a pre-engineered steel frame and steel sheathing, about 290 feet long, 90 feet wide and 40 feet high, on a seven-inch concrete slab. It is scheduled to be removed down to its concrete floor slab during the work to achieve the interim end state.

Lag Storage Addition 4. Lag Storage Addition 4 is a clear-span structure, with a pre-engineered steel frame and steel sheathing. It measures approximately 290 feet long, 90 feet wide, and 40 feet high, and it rests on a seven-inch concrete slab. It is similar to Lag Storage Addition 3, except that it includes a Shipping Depot, a Container Sorting and Packaging Facility, and a covered Passageway between the Lag 3 and Lag 4 buildings. The Shipping Depot is connected to Lag Storage Addition 4 and is a 91 feet by 85 feet metal frame structure. This facility and its concrete floor slab will be removed during Phase 1 decommissioning.

Chemical Process Cell Waste Storage Area. Also known as the CPC-WSA hardstand, this waste storage area includes a structure used to store equipment removed from the Chemical Process Cell. The structure is a 200 feet by 70 feet by 30 feet high galvanized steel-panel enclosure with a gravel pad floor. It will be removed down to its gravel pad during the work to achieve the interim end state.

Hardstands. Several compacted gravel pads (also known as hardstands) are located within WMA 5:

- The Lag Hardstand, also known as the New/Old Hardstand, is located southwest of Lag Storage Additions 3 and 4 and is used to store packaged equipment and containers of low level waste. The original hardstand ("Old Hardstand") was reworked as part of WVDP activities, with a portion of its original footprint now under Lag Storage Additions 3 and 4, and part incorporated into the New Hardstand.

- The Cold Hardstand, which is located west of the Construction and Demolition

- Debris Landfill (WMA 4), has been used as a nonradioactive material staging and storage area.

- The Vitrification Vault and Empty Container Hardstand is located north and west of the Hazardous Waste Storage Lockers, and falls within the CPC-WSA hardstand footprint.

- The HLW Tank Pump Storage Vault Area. This falls within the CPC-WSA hardstand footprint.

Hazardous Waste Storage Lockers. Four steel hazardous waste storage lockers are located east of the Waste Tank Farm (WMA 3). Each locker measures eight feet by 16 feet by eight feet high and is used for short-term storage of hazardous waste. The lockers will be removed during the work to achieve the interim end state. The lockers fall within the footprint of the CPC-WSA hardstand.

E.2 Physical Setting

WMA 5 is located in the northwest corner of the WVDP premises on the north plateau. To the north and west is the WVDP fence line. To the northeast is a portion of WMA 12. To the south are WMA 10 and WMA 3. To the east are WMA 2 and WMA 4.

WMA 5 includes a significant amount of wetlands in its northeast portion. It is drained by a combination of storm sewer lines and a surface drain that flows to the northeast, exiting the WVDP project premises in the northeast corner of WMA 5 and eventually emptying into Quarry Creek through surface water discharge location WSNSW74A north of the project premises.

WMA 5 is underlain by the sand and gravel unit which overlies the Lavery till. The sand and gravel unit has been subdivided into the Thick Bedded Unit (TBU) and the underlying Slack Water Sequence (SWS). The SWS is only present in WMA 5 along the boundary separating WMA 5 from WMA 2. Groundwater in the sand and gravel unit flows to the northeast across the north plateau. Groundwater eventually discharges to ditches draining the site and to seeps along Quarry Creek to the north, and Franks Creek to the east. The Lavery till has low permeability but groundwater does flow vertically downward through this unit recharging the underlying Kent Recessional Sequence.

Approximately five acres of WMA 5 are currently covered by asphalt or compacted gravel. An additional 2.5 acres are covered by building foundations.

The majority of WMA 5's soil surface has been reworked at least once since the inception of the site.

E.3 Area History

Figure E.3 shows WMA 5 in 1962, prior to site development. At this time, a road passed through the WMA 5 area and the majority of its surface was farmed (with the exception of wetlands in the northeast portion of WMA 5).

Figure E.4 shows WMA 5 in 1966, after site development began. Approximately four acres in its south central area had been cleared and the Old Hardstand is clearly visible (approximately 0.75 acres in size).

Figure E.5 shows WMA 5 in 1968. No further development of the area is visible.

Figure E.6 shows WMA 5 in 1977. No further development of the area is visible.

Figure E.7 shows WMA 5 in 1984. The Lag Storage Building has been added to WMA 5 and the Old Hardstand is clearly delineated in this photograph.

Figure E.8 shows WMA 5 in 1995. The majority of buildings and hardstands that currently exist within the WMA 5 area had been completed by this time, likely resulting in a significant reworking of surface soils to support construction.

Figure E.9 shows WMA 5 in 2007. Much of the surface scarring visible in E.7 due to construction activities has been re-vegetated. The Remote Handled Waste Facility had been built by 2007.

E.4 Known and Suspected Releases

In 1983, evidence of a significant release of radioactivity was discovered at the Old Hardstand (Phase 1 DP Rev 2 Table 2-17; WVNSCO 1983b). This release was apparently associated with outdoor storage of contaminated equipment and radioactive waste by NFS. Gamma radiation levels as high as 1.5 R/hr were measured two inches from the surface. In 1984, approximately 46,000 cubic feet of contaminated soil, asphalt, tree stumps, roots, and other vegetation were removed from the area and placed in the decommissioned Lagoon 1 after waste from Lagoon 1 was transferred to Lagoon 2 (Phase 1 DP Rev 2 Table 2-17; WVNSCO 1995). Lagoon 1 was then capped with a clay cover.

In 1987, water from a 55-gallon drum containing spent resin leaked. Water (<15 gal) was spilled on the ground before or during transfer of the drum to a processing station. The drum was being transferred from the New/Old Hardstand to a waste solidification area in the Process Building when leakage was noted (Phase 1 DP Rev 2 Table 2-18; WVNSCO 1987c).

A leak beneath the Process Building in 1968 resulted in a significant subsurface Sr-90 release to groundwater. Contaminated groundwater followed natural flow pathways towards the northeast from the release point. The subsurface groundwater plume likely impacts subsurface soils and groundwater beneath the southeastern portion of WMA 5.

In 1985, leaking radioactive condensate overran a valve pit northeast of Tank 8D-2 and entered the drainage ditch leading to WMA 5. Approximately 500 gallons with gross beta activity of 0.046 μCi/mL were released. The radioactive condensate reached the point near the drainage ditch turns to the northeast near the corner of the New/Old hardstand where the ditch was blocked to prevent further downstream flow.

WMA 5 is also expected to have surface soil contamination for exposed surface soils resulting from the airborne releases of radioactivity from the 1968 Process Building stack. As originally deposited, surface soil activity concentrations should have decreased as one moved to the north away from WMA 1. However the surface of WMA 5 has been reworked significantly since the original release and so the present spatial distribution of soil contamination from this event may be significantly different from its original footprint.

E.5 Existing Data

Existing data sets for this area include:

- In 1982, static direct exposure readings were collected across the WVDP premises (WVNS 1982). All of WMA 5 was covered by these measurements on a 10-m grid. Figure E.10 shows these results color-coded by the exposure readings encountered, with the data overlain on a 1977 aerial photograph. Interpretation of these data in the vicinity of the Process Building is complicated by possible shine impacts. These data indicate the potential for significant surface contamination extending north from the WMA 3 boundary. Although the color-coding used for Figure E.10 does not show it, the footprint of the Old Hardstand had direct gamma readings as much as ten times higher than the surrounding soils. In general, direct gamma readings decreased with distance from the Process Building. Table E.1 summarizes the availability of historical analytical data for soils for each of the eighteen ROI.

- In 1990 and 1991, a second static direct exposure measurement program was conducted across the WVDP premises (WVNS 1992). In the case of WMA 5, this effort provided systematic coverage for most of the WMA 5 area on a 10-m grid with the exception of the Old Hardstand and its immediate surroundings (likely due to construction activities at the time). This data collection used different instrumentation and protocols than the 1982 study, so the results are not quantitatively comparable. Also, interpretation of these data in the vicinity of the Lag storage buildings may be affected by possible shine impacts. Figure E.11 shows these results overlain on a 1984 aerial photograph. Unlike other areas of the site, the 1990/91 survey for WMA 5 encountered values significantly higher than those originally encountered in 1982, particularly along the northern boundary of WMA 5. In addition, the spatial pattern of surface direct reading results was the opposite of

1982 – areas closer to the Process Building had lower values than areas more distant. A possible explanation is the construction activities in WMA 5 that were taking place resulting in displaced and/or covered surface soil nearer to the Process Building, and the potential for run-off of contaminated surface soils towards the drainage features that border WMA 5 to the north.

- Soil sample data have been collected for WMA 5 that are available in ELIMS. Figure E.12 shows the locations of surface soil samples and soil cores with subsurface soil samples. GPBG0208, MWPTW-1, and MWPTW-2 were completed in 2008. The NP series cores were completed in 1994. All other sampling was done in 1993. Figure E.12 also shows the Cs-137 and Sr-90 results for surface samples from these locations when surface samples were collected. Surface contamination is scattered throughout WMA 5, with observed activity concentrations likely controlled by historical activities that have modified surface features in this area. In the subsurface there was evidence of Sr-90 impacts that extended along the southeastern border of WMA 5 and that extended west at least to beneath the footprints of Lag Storage Buildings 3 and 4.

- Groundwater sample data also have been collected for WMA 5 that are available within ELIMS. Figure E.13 shows the locations of groundwater data collection color-coded by Sr-90 results. Figure E.14 shows the locations of groundwater data collection color-coded by tritium results. These locations are a mixture of GeoProbe locations where discrete groundwater samples were collected at a specific point in time, monitoring wells with a limited duration of sampling events, and monitoring wells with extensive sampling histories. The detection limits for Sr-90 and tritium varied widely among ELIMS samples. 10 pCi/L and 500 pCi/L were selected as thresholds for Sr-90 and tritium, respectively, because based on ELIMS data results above these activity concentrations were consistently above method detection limits and so indicative of contamination impacts rather than simply measurement error.

  In general, Sr-90 and tritium groundwater impacts are present in the eastern half of WMA 5, although in some cases at levels close to detection limits. The Sr-90 activity concentrations, in general, increase as one moves from west to east in WMA 5. In the eastern corner of WMA 5, groundwater impacts likely reflect the north plateau groundwater plume.

E.6 Planned Phase 1 DP Activities

For a more complete description of planned Phase 1 DP activities, see the Phase 1 DP, Section 3.1 and Section 7.6.

Two WMA 5 structures will remain standing at the initiation of Phase 1 activities: Lag Storage Addition 4 and the Remote-Handled Waste Facility. These structures and all remaining gravel pads, concrete floor slabs, and foundations within WMA 5 will be removed as part of Phase 1 activities, including the top two feet of soil beneath hardstands and building pads.

E.7 Conceptual Site Model

WMA 5 potentially has impacts from a variety of releases. Some of these impacts are to the surface, and some are to the subsurface. In addition, historic surface soil reworking throughout WMA 5 has possibly resulted in buried contamination. Specifically:

- WMA 5 surface soils were affected by the 1968 airborne releases of radioactivity. These impacts originally would have been greatest proximal to the Process Building and would have decreased as one moved north in WMA 5. Since 1968, however, there has been significant surface soil reworking throughout much of WMA 5. These activities could have removed contaminated soil layers, buried those layers under clean backfill, and/or redistributed/mixed contamination in surface and near surface soils. As a result, it is likely that contamination, if present, would be isolated and associated with physical features (e.g., buried infrastructure, building foundations, hardstands, etc.). Consequently, this contamination would not necessarily be detectable by surface scanning techniques such as a gross activity gamma scan. The disposition of potentially contaminated surface soils within WMA 5 during the WVDP construction process is not known.

- Along with the construction of new facilities within WMA 5 as part of the WVDP, there likely was the placement of significant amounts of buried infrastructure. Given the fairly heavy surface soil contamination present at the time of the initiation of the WVDP, it is possible that backfill used for buried infrastructure is also contaminated at levels that would be of concern. Depending on the depth of the buried infrastructure, this could have resulted in contamination at depths significantly greater than one meter.

- The Old Hardstand was known to have been contaminated by releases associated with its use. The Old Hardstand was reworked as part of WVDP activities and the area is now occupied by the Lag Storage Buildings and the New Hardstand. As a result, soils in the vicinity of the Old Hardstand and beneath its footprint (now covered by pavement and portions of the Lag Storage Buildings' slabs) are likely impacted also.

- The 1985 WMA 3 condensate release likely resulted in contamination of the drainage ditch that connected WMA 3 with the Old Hardstand area in WMA 5.

- Sediments in the drainage feature that originally ran along the Old Hardstand and discharged out the through the northeastern corner of WMA 5 is likely impacted from Old Hardstand releases, and from contaminated surface soil erosion/deposition processes.

- The foundation of the Lag Storage Addition 2 and associated soils are expected to be contaminated by releases associated with material stored in that facility.

- Subsurface releases from the Process Building may have impacted subsurface soils and groundwater in WMA 5 along its southeastern border. The western and northern extent of these subsurface soil impacts is unknown.

- The prevalence of low levels of Sr-90 and tritium groundwater contamination in the eastern half of WMA 5 indicate other sources of contamination besides the Process Building. These could include contamination arising from historic hardstand spills, from WMA 3, from buried infrastructure, or from other releases within WMA 5 that were not documented.

Figure E.15 shows the current Conceptual Site Model (CSM) for surface and near surface soils. Based on historical direct gamma readings and the limited available historical surface soil sampling results, all surface soils within WMA 5 are considered potentially above surface soil CG_w standards. Figure E.16 shows the CSM for soils deeper than 1 m. Subsurface soil contamination, if it exists, is most likely associated with those areas affected by WVDP construction activities. Figure E.17 shows where measurable groundwater impacts likely exist based on existing information.

E.8 WMA 5-Specific Characterization Goals

- Evaluate Appropriateness of the Current List of Radionuclides of Interest (ROI)
- Verify Absence of Additional ROI
- Explore the Possibility of Surrogate ROI
- Determine Extent of Surface Contamination
- Identify the Presence/Absence of Buried Contamination
- Identify Soil Waste Stream Characteristics
- Develop an Inventory of Buried Infrastructure
- Obtain Data to Support Phase 2 Planning

E.9 CSAP Pre-Remediation Data Collection and Associated Decision-Making

CSAP pre-remediation data collection will consist of a number of components described in more detail below.

E.9.1 Buried Infrastructure

The footprint of buried infrastructure will be identified and mapped. Buried infrastructure that may exist or is known to exist within WMA 5 includes storm sewer lines and buried utilities. **[required]**

E.9.2 Gamma Walkover Survey Data

The purpose of performing a gamma walkover survey of the WMA 5 area is to identify the level and extent of surface contamination. This includes both general trends in average activity concentrations pertinent to the surface soil CG_w requirement, as well as the identification of isolated, more-elevated anomalies that might be indicative of discrete releases and/or surface soil CG_{emc} concerns.

A complete (100%) logged gamma walkover survey (GWS) will be conducted for accessible areas within WMA 5. Examples of areas that would not be accessible are areas where standing water is present in wetlands, existing building footprints, and building pads. Based on the GWS results, surface soil within WMA 5 will be divided into three categories: (1) surface soils where GWS indicates possible surface soil CG_w exceedances; (2) surface soils where GWS indicate impacts, but those impacts are not expected to exceed surface soil CG_w standards; and (3) surface soils where there is no indication of impacts above background conditions. The purpose of this data collection is to provide insights into the spatial distribution of surface contamination, and to guide subsequent soil sampling. **[required]**

E.9.3 Surface Soil Sampling

Surface soil sampling will be used to address areas inaccessible to GWS data collection, to resolve hot spots identified by the GWS data, and to evaluate the presence, absence, and/or extent of surface contamination above surface soil CG_w requirements based on GWS results.

- **Wetlands.** It is possible that standing water will be present in wetlands that prevent GWS data collection from those areas. Soil sampling will be required for wetland footprints and for any other areas where standing water prevents the collection of GWS data. Within WMA 5, this is most likely to occur in the northeast portion of the WMA.

  For every area where standing water or saturated soil conditions prevent GWS data collection, systematic soil sampling will take place. At least one and at most five sampling locations will be selected per area. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. In the case where an area has more than one location, locations will be selected so that each representative area does not overlap and provides systematic coverage of the area of interest. If a wetland area is less than 200 m^2 in size, one 5-point composite will be formed to be representative of the wetland's area. **[contingent]**

- **Hot Spots.** If GWS data indicate the presence of contamination that possibly exceeds "hot spot" (CG_{emc}) standards or an isolated elevated area is identified that appears indicative of a discrete release, the location of concern will be sampled with a biased sample. If biased samples are collected from a particular location, they will be collected from two depth intervals: 0-15 cm, and 0-1 m. In the case of surface soils, each biased sample will be a composite sample formed from 5 increments systematically distributed over the area of interest. The 0-15 cm samples will be analyzed for the 12 radionuclides of potential interest in addition to the 18 ROI. One down-hole gamma scan will be conducted from each biased location. The purpose of these samples is to resolve GWS anomalies, evaluate the appropriateness of the current ROI list, and verify the absence of additional ROI. **[contingent]**

- **CG_w Sampling.** Surface soil sampling may be conducted after the GWS to further clarify results, with the level and nature of sampling dependent on GWS results. For WMA 5, surface soil CG_w sampling in response to GWS results will primarily focus on areas that are currently not paved; the paved central portion of WMA 5 will be addressed with systematic surface and subsurface sampling described in the next section.

    - If GWS results indicate contamination impacts above background levels but that surface soil contaminant levels exceeding surface soil CG_w requirements are unlikely, a minimum of five surface soil sample locations will be identified and sampled that target the areas with the highest gross activity levels. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap. The purpose is to document the maximum activity concentrations present in surface soils within WMA 5. **[contingent]**

    - If GWS results indicate surface soil contaminant levels exceeding surface soil CG_w requirements likely exist, one sampling location will be selected at the highest gross activity level to confirm surface soil CG_w exceedances and another set of sampling locations will be identified to spatially bound the extent of contamination (i.e., along the boundary of what is considered likely above surface soil CG_w requirements). Two samples will be collected from the location targeting high gross activity levels, one representative of a 0-15 cm depth interval, and one representative of a 0-1 m depth interval. One sample will be collected from each location intended to laterally bound contamination, representative of a 0-15 cm depth interval. Each sample will be a 5-increment composite formed to be representative of a 200 m^2 area. In addition, the location targeting high gross activity levels will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. Locations will be selected so that each representative area does not overlap. The purpose is to document surface soil CG_w requirement exceedances and bound the lateral extent of contamination. **[contingent]**

- If GWS results indicate areas with surface soil contamination impacts but it is unclear whether surface soil CG_w requirement exceedances are present, at most five sampling locations will be selected that systematically cover the areas of interest. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap. The purpose is to resolve the question of whether surface soil CG_w requirement exceedances exist for areas where GWS results are ambiguous. **[contingent]**

- If any 0-15 cm interval yields a sample result indicating a surface soil CG_w requirements exceedance and that sample location is not laterally bounded either by existing sampling locations with results less than surface soil CG_w requirements or by GWS data that clearly indicate contamination is not a concern, additional sampling locations will be selected so that the contamination encountered is spatially bounded. The purpose is to laterally bound contamination that is above CG_w requirements. **[contingent]**

E.9.4 Subsurface Soil Sampling

The purpose of subsurface soil sampling within WMA 5 is to determine presence and vertical extent of contamination impacts above background levels. There are several areas within WMA 5 that have subsurface soil contamination concerns that are discussed below. These include subsurface soils associated with a large area in the center of WMA 5 where surface soils were reworked and subsequently paved by WVDP activities, areas along the New Hardstand that were originally drainage features but subsequently filled in with soils, and a drainage feature that originally connected WMA 3 with the Old Hardstand ditches, but that was subsequently filled with soils and paved.

- A minimum of six soil trenches will be completed orthogonal to the drainage ditch that originally ran along the west and north side of the Old Hardstand. These trenches will be to a minimum of 1 meter depth. Soils will be scanned for elevated activity as the trench proceeds. A minimum of two samples will be collected from each trench. The first will represent those soils with the highest elevated activity. If the floor of the trench indicates that contamination above background levels extends deeper than 1 m, the trench will be extended vertically until there is no detectable evidence via scans of elevated activity in the trench floor. The second soil sample will represent soils from final floor of the trench. All samples will be analyzed for the 18 ROI and the additional 12 radionuclides of potential interest. **[required]**

- A minimum of three soil trenches will be completed orthogonal to the original drainage ditch that connected WMA 3 with the Old Hardstand's drainage features. These trenches will be to a minimum of 1-m depth. Soils will be scanned for elevated activity as the trench proceeds. A minimum of two samples will be collected from each trench. The first will represent those soils with the highest elevated activity. If the floor of the trench indicates that contamination above background levels extends deeper than 1 m, the trench will be extended vertically until there is no detectable evidence via scans of elevated activity in the trench floor. The second soil sample will represent soils from final floor of the trench. All samples will be analyzed for the 18 ROI and the additional 12 radionuclides of potential interest. **[required]**

- The area where buried soil contamination is of primary concern (see Figure E.16, approximately 9 acres) will undergo systematic sampling for subsurface concerns. Sampling locations will be arranged on a systematic triangular grid with a grid separation of 20 m. One soil sample would be collected from each location representative of a depth of 0-1 m. Down-hole gamma data will be collected from each location with static measurements collected for every 15 cm depth interval. An estimated 120 locations will undergo this data collection. **[required]**

- If a 0-1 m sample result exceeds background levels, then an additional sample from a depth of 1-2 m will be collected and analyzed from that location. In addition, down-hole gamma data will be collected from the location with static measurements collected for every 15-cm depth interval. If that sample has contamination above background conditions, then the next deeper 1-m interval will be sampled and analyzed and a down-hole gamma scan performed. This process will continue until background conditions are reached. **[contingent]**

- If any 0-15 cm surface soil sample result indicates contamination impacts above background levels and there was not a 0-1 m sample collected from that location, a 0-1 m sample will be collected from that location following the protocols used for the original 0-15 cm surface soil sample. In addition, each soil location will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. **[contingent]**

- If systematic subsurface sampling identified contamination that appears to extend laterally beyond the grid boundaries in WMA 5, then the grid will be extended and additional sampling conducted until the lateral extent of contamination has been bounded. **[contingent]**

E.9.5 Drainage Feature Sampling

WMA 5 contains two primary drainage features. The first runs from the New Hardstand to the WVDP fence line in the northeast corner of WMA 5 (Figure E.1), discharging at location WSNSW74A. The second runs north-to-south along the western edge of the paved WMA 5 area. For drainage features within WMA 5, the surface soil CG_w requirements apply. Surface drainage feature sampling will be conducted to determine ditch sediment contamination status relative to surface soil CG_w requirements. Surface drainage features will be sampled as follows:

- Discrete samples representing a 0-15 cm depth interval will be collected from ditch sediments. In WMA 5, the primary drainage features have a combined length of approximately 360 m. Samples will be systematic located using a random start, separated by 30 m. **[required]**

- If any 0-15 cm sample result indicates contamination impacts above background levels and a 0-1 m sample was not also collected, a 0-1 m sample will be collected from that location following the protocols used for the original 0-15 cm sample. **[contingent]**

- If a sample indicates contamination impacts above background levels for the 0-1 m depth interval, an additional sample from a depth of 1-2 m will be collected and analyzed from that location. This will be repeated, as necessary, until the vertical extent of contamination impact is bounded at that location. **[contingent]**

E.9.6 Buried Infrastructure Soil Sampling

Soils associated with buried infrastructure within WMA 5 will be sampled to determine their contamination status.

- Three locations along the each piece of buried infrastructure that is of concern within WMA 5 will be trenched. These locations will be selected to maximize the possibility that contamination will be encountered (e.g., locations where historical or current GWS data indicate surface contamination exists). During excavation, exposed soils will be monitored by scans for evidence of elevated gross activity. The purpose of this sampling is to evaluate the presence of contaminated soils associated with buried infrastructure. **[required]**

  - If elevated readings are encountered below a depth of 1 m, soils exhibiting the highest levels of gross activity will be sampled and analyzed.

  - If elevated readings are not encountered below a depth of 1 m, a sample representative of soils deeper than 1 m will be collected. In the case of infrastructure that did not carry waste or wastewater, the sample will be from soils immediately above the line. In the case of infrastructure that did carry waste or wastewater, the sample will be from soils immediately beneath the line.

- If contamination above background conditions is encountered at any selected location, trenching will continue to depth until background conditions are observed. An additional

sample will be collected from the base of the trench to verify background conditions. The purpose is to vertically bound observed contamination. **[contingent]**

- If buried infrastructure soil sampling identifies contamination impacts greater than background, biased sampling will continue following the line until at least two consecutive locations yield soil samples below surface soil CG_w requirements. Location spacing will be based on engineering judgment, including the geometry of the line, the level of contamination encountered, and surface evidence of contamination. The purpose of this sampling is to bound the extent of contamination associated with buried infrastructure, as necessary. **[contingent]**

E.9.7 Additional Contingencies

Sampling and/or GWS data may indicate that contamination exists or extends beneath surfaces currently covered by existing structures, concrete, asphalt, or gravel. In this case, "surface soil" will be defined as soil immediately beneath the cover. If sampling or GWS data indicate that contamination may exist beneath existing structures (e.g., existing buildings and building pads), then sampling locations will be offset along the foundation edge to determine contamination extent. The purpose of the offset is to allow safe acquisition of data. Data collection through building pads in WMA 5 will not be required as part of this effort.

E.9.8 Required Laboratory Analyses

All samples will be submitted for analysis of all 18 ROI.

A select portion of the samples as described above may be analyzed for the additional 12 radionuclides of potential interest. If these sample results indicate the presence of the one or more of those radionuclides at levels of potential significance, then the balance of samples from WMA 5 will also be analyzed for the additional radionuclides that were identified.

Table E.2 summarizes the required sample numbers and the estimated number of contingency samples for WMA 5.

This sampling plan assumes that quick turn-around analyses are available for Sr-90 and Cs-137 and that soil samples will be screened for Sr-90 and Cs-137 prior to being analyzed for the balance of the ROI. Based on these screening data, contingency sampling requirements as described above may be undertaken without the benefit of the remaining analyses.

E.9.9 Decision-Making Summary

A summary of decision-making based on the WMA 5 data is as follows:

- For each piece of buried infrastructure of concern that is identified, three biased locations will be selected, excavation conducted to expose the line, and a soil sample formed from soils most likely contaminated. If contamination is encountered above surface soil CG_w requirements, sampling will continue along these lines until it is bounded.

- If the GWS identifies a surface soil anomaly that potentially exceeds the surface soil CG_{emc}, that location will be sampled and analyzed.

- Biased soil sampling from trenches orthogonal to the western and northern edges of the Old Hardstand. In the event that the initial sampling work does not bound the vertical extent of contamination, soil cores will be extended/vertical trenching continued until background soil conditions are reached.

- Systematic subsurface soil sampling will take place on a triangular grid within the zone of WMA 5 where buried contamination is a concern. In the event that contamination is encountered that is not laterally bounded, the sampling grid will be extended until contamination is laterally bounded.

- The WMA 5 surface soil area classification as contained in Figure E.15 will be adjusted based on GWS results. These adjustments may affect systematic surface sample number requirements and will affect the placement of the initial round of systematic surface soil sample locations.

- If any 0-1 m soil interval encounters contamination above surface soil CG_w requirements, additional deeper 1-m interval soil samples will be required for that location to determine vertical extent of contamination. If additional vertical samples are required, vertical sampling will continue until background conditions are observed.

Table E.1 Historical Data Analyses

Nuclide	# of Surface Soil Locations	# of Subsurface Soil Locations	# of Sediment Locations
Am-241	2	6	1
C-14	0	1	0
Cm-243	0	0	0
Cm-244	0	0	0
Cs-137	11	8	1
I-129	0	1	0
Np-237	0	1	0
Pu-238	1	6	2
Pu-239	1	6	2
Pu-240	1	6	2
Pu-241	1	6	1
Sr-90	9	10	2
Tc-99	0	1	0
U-232	1	6	2
U-233	1	6	2
U-234	1	6	2
U-235	1	6	2
U-238	1	6	2

Table E.2 Sample Number Estimates

	Required	Contingent	Total
Systematic Sediment Samples (0-15 cm)	12	0	12
Systematic Sediment Samples (0-1 m)	0	4	4
Biased Sediment Samples (0-15 cm)	0	0	0
Biased Sediment Samples (0-1 m)	0	0	0
Systematic Surface Soil Samples (0-15 cm)	18	0	18
Systematic Surface Soil Samples (0-1 m)	120	10	130
Biased Surface Soil Samples (0-15 cm)	0	6	6
Biased Surface Soil Samples (0-1 m)	0	6	6
Systematic Subsurface Soil Samples (1-m intervals)	0	12	12
Biased Subsurface Soil Samples (1-m intervals)	0	6	6
Buried Infrastructure Soil Samples	12	12	24
Total:	162	56	218

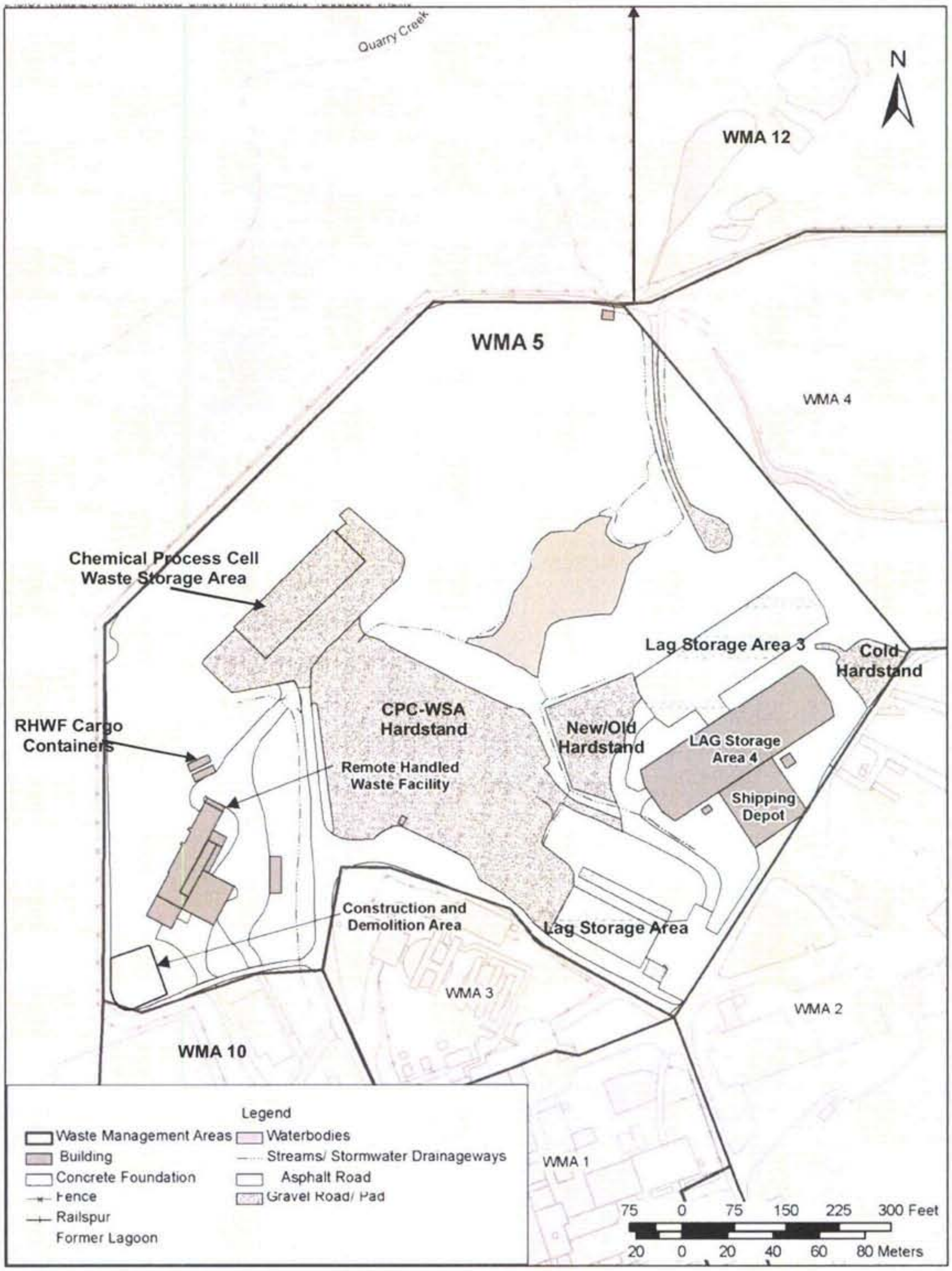

Figure E.1 WMA 5 (adapted from Phase 1 DP, Figure 3-5)

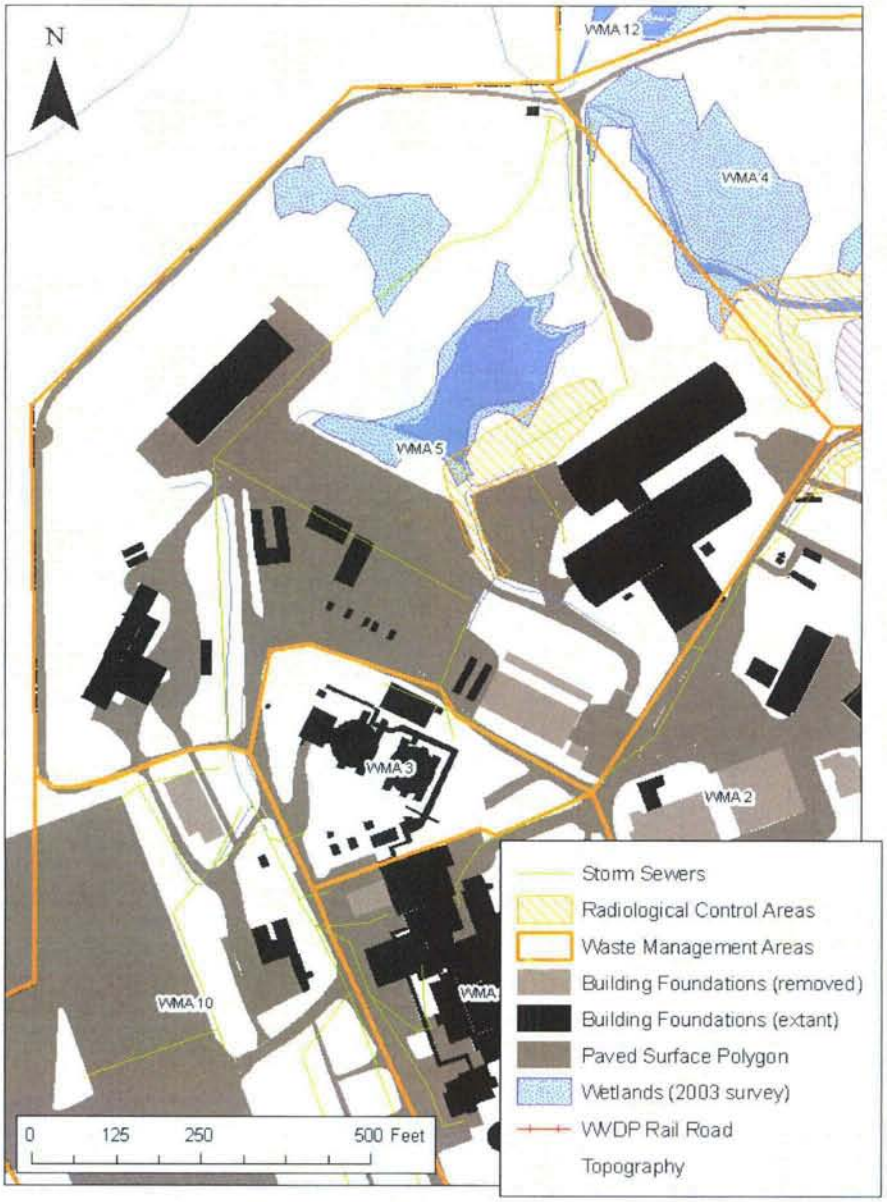

Figure E.2 WMA 5 with Topography

Figure E.3 WMA 5 1962 Aerial Photograph

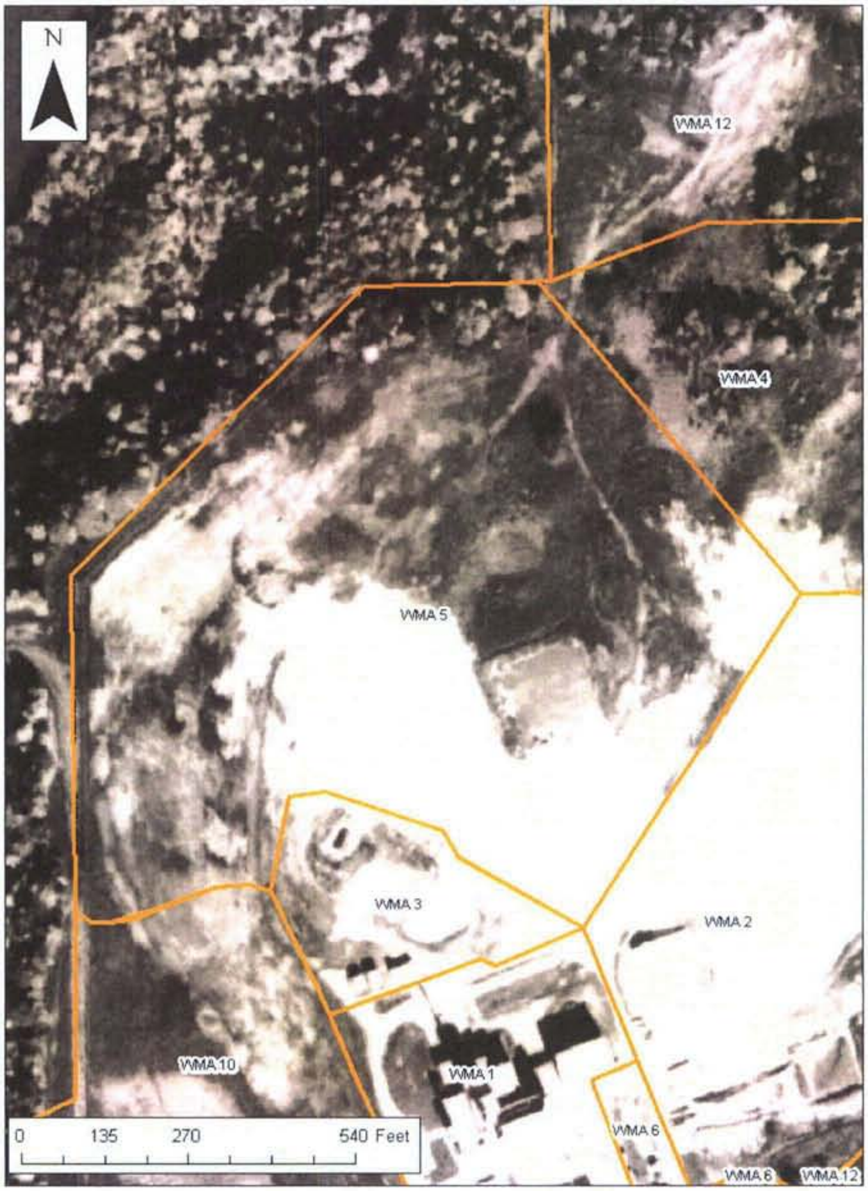

Figure E.4 WMA 5 1966 Aerial Photograph

Figure E.5 WMA 5 1968 Aerial Photograph

Figure E.6 WMA 5 1977 Aerial Photograph

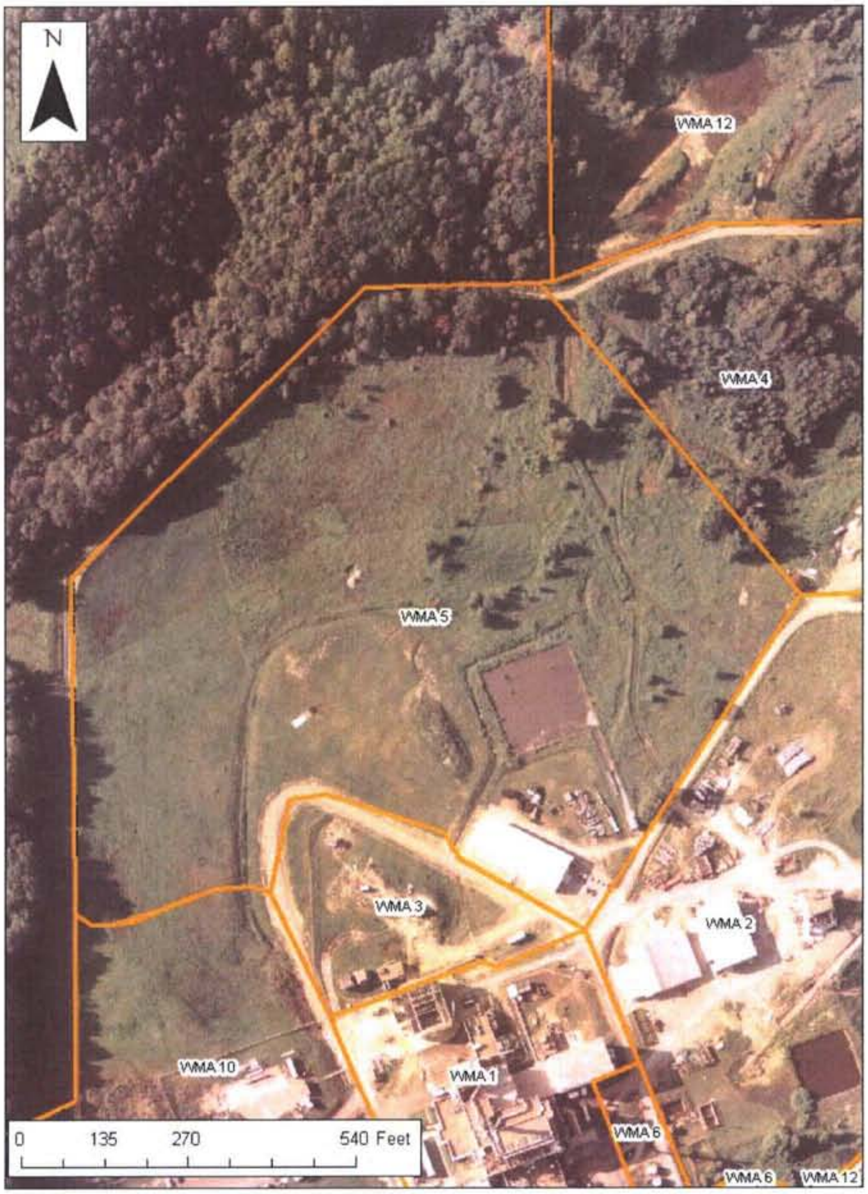

Figure E.7 WMA 5 1984 Aerial Photograph

Figure E.8 WMA 5 1995 Aerial Photograph

Figure E.9 WMA 5 2007 Aerial Photograph

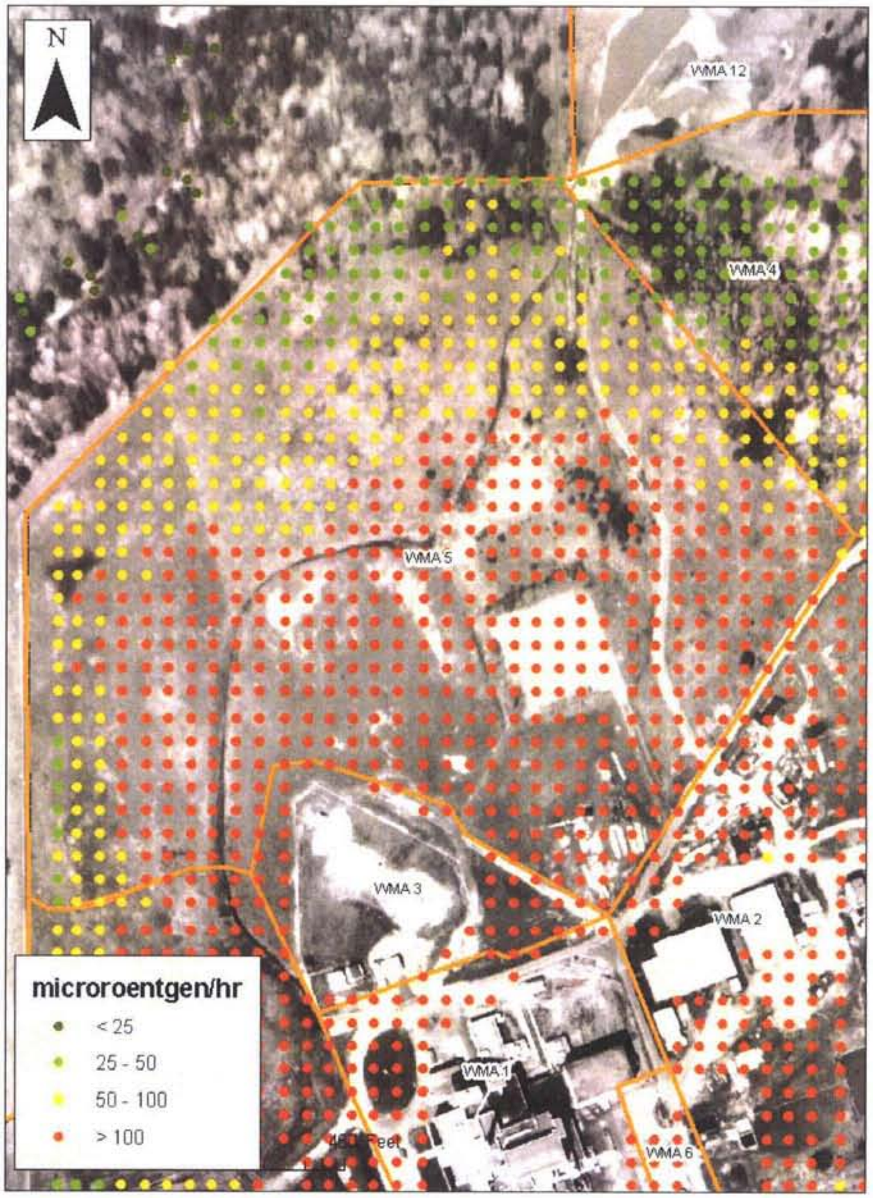

Figure E.10 WMA 5 1982 Direct Gamma Measurement Results

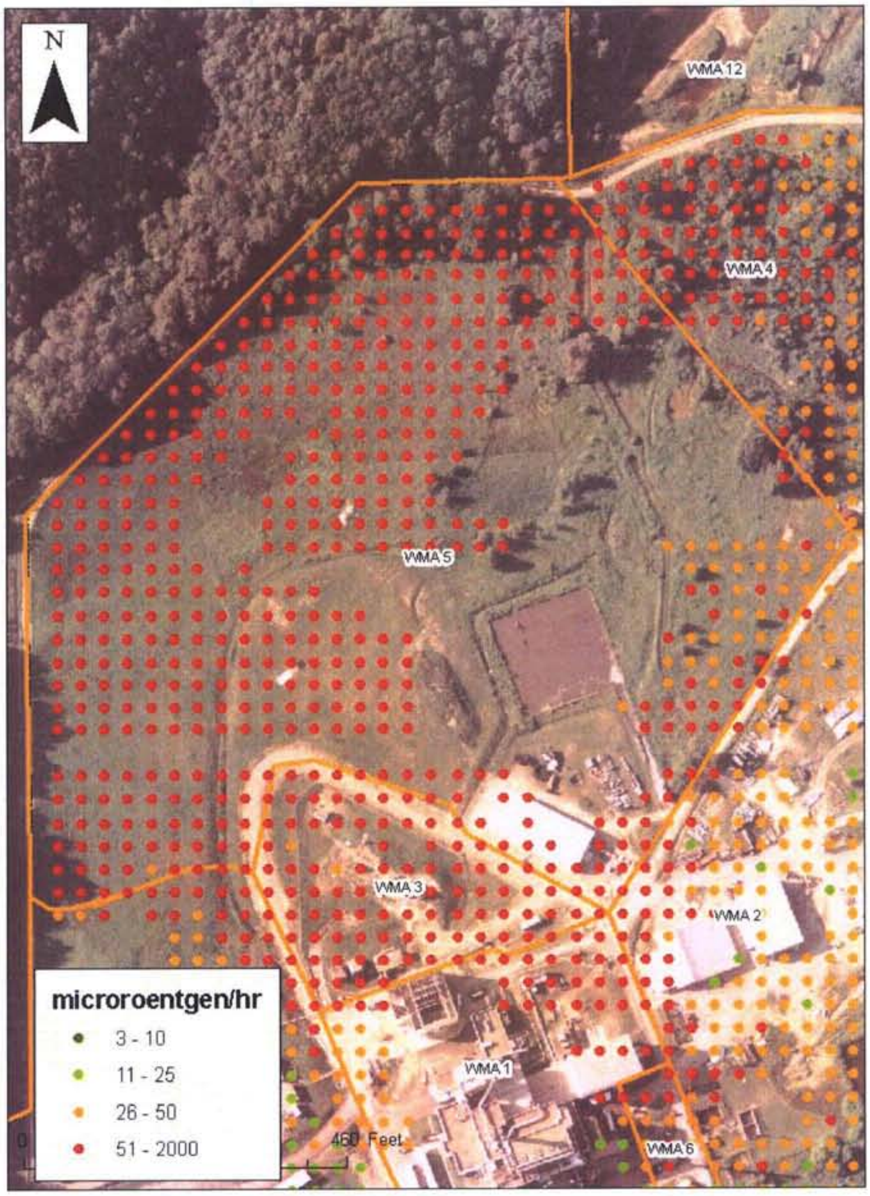

Figure E.11 WMA 5 1990 - 1991 Direct Gamma Measurement Results

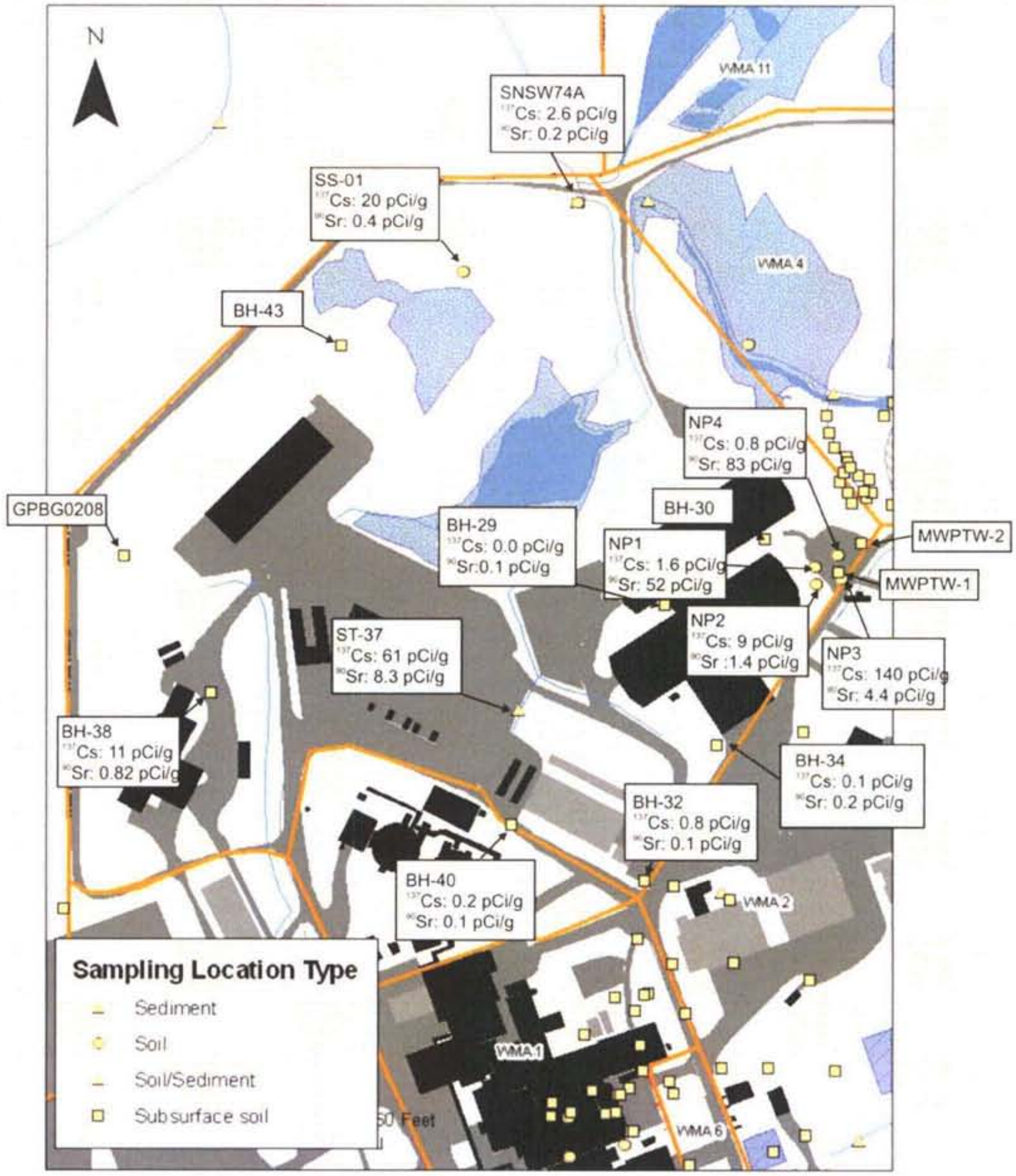

Figure E.12 WMA 5 Historical Soil Sampling Locations

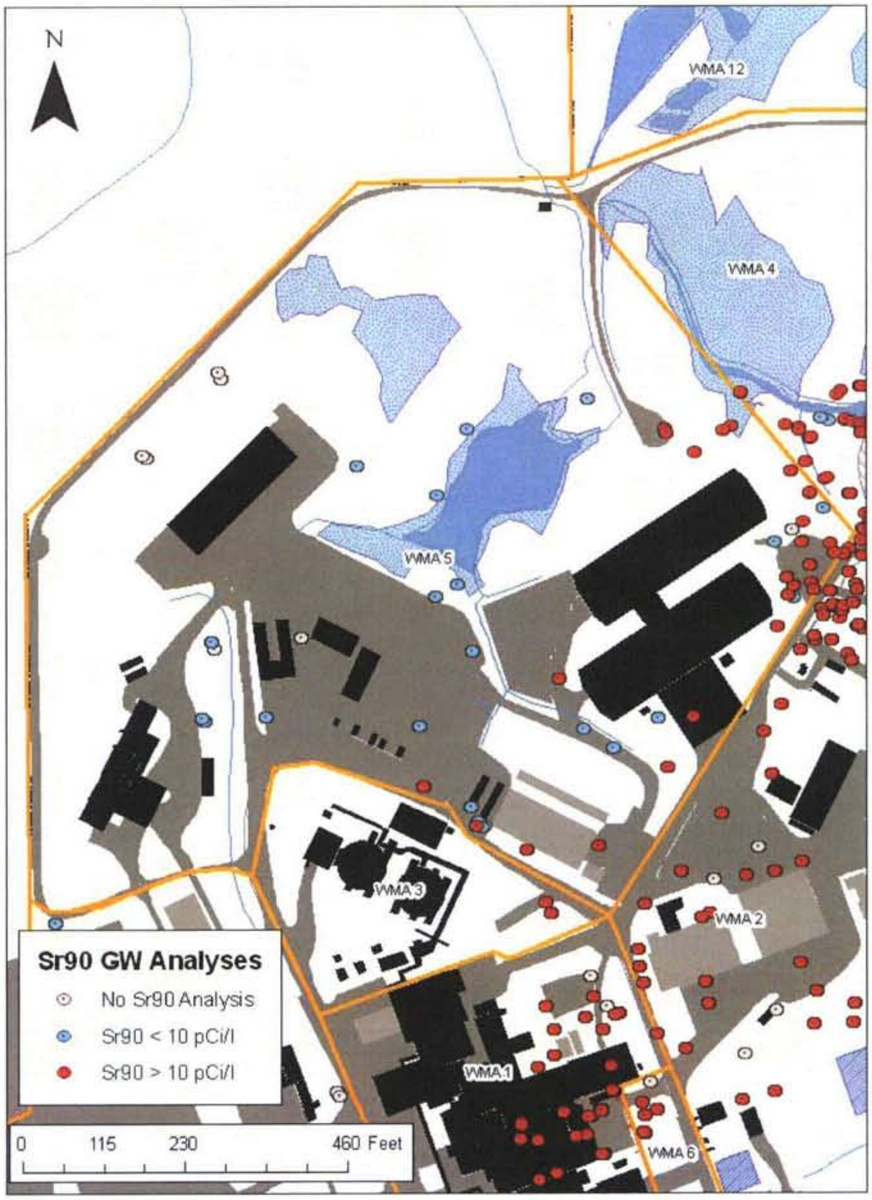

Figure E.13 Historical Groundwater Sr-90 Results

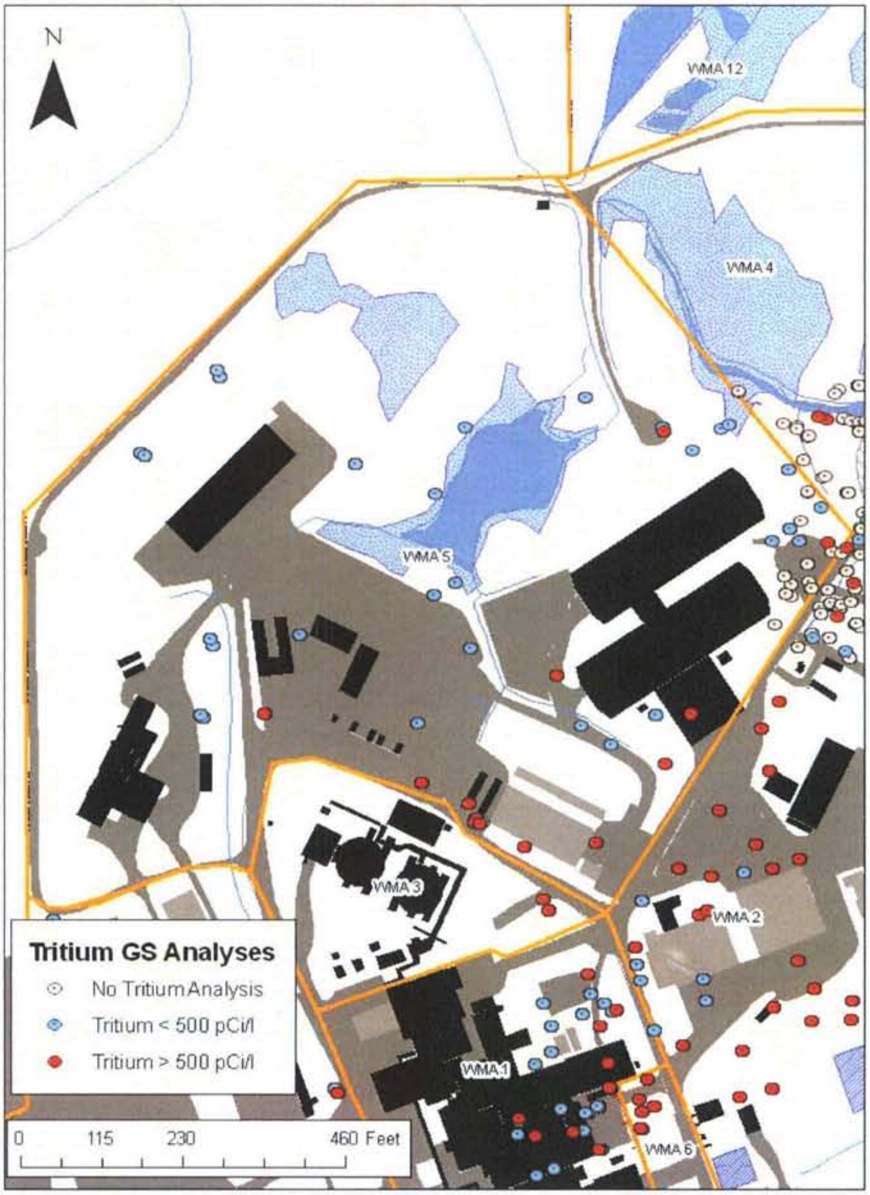

Figure E.14 Historical Groundwater Tritium Results

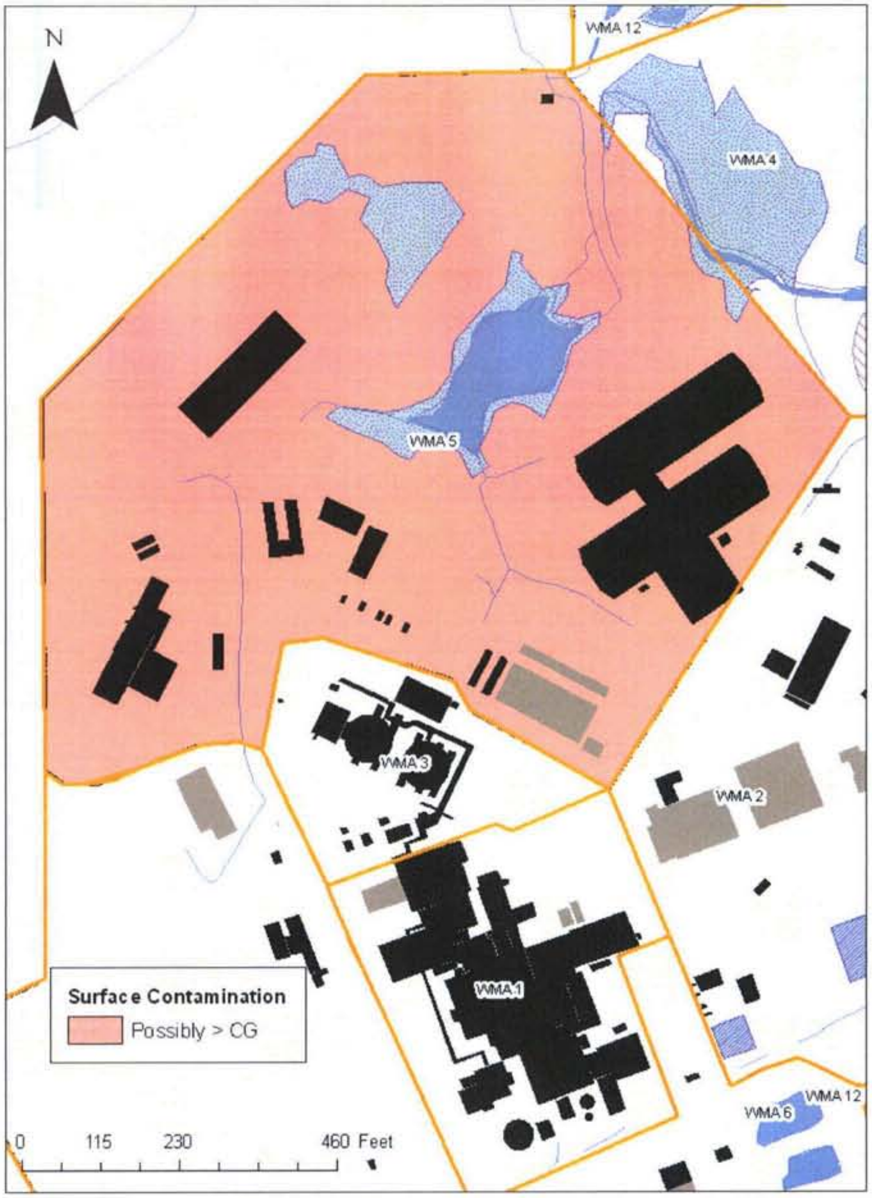

Figure E.15 WMA 5 Initial Surface Soil CSM

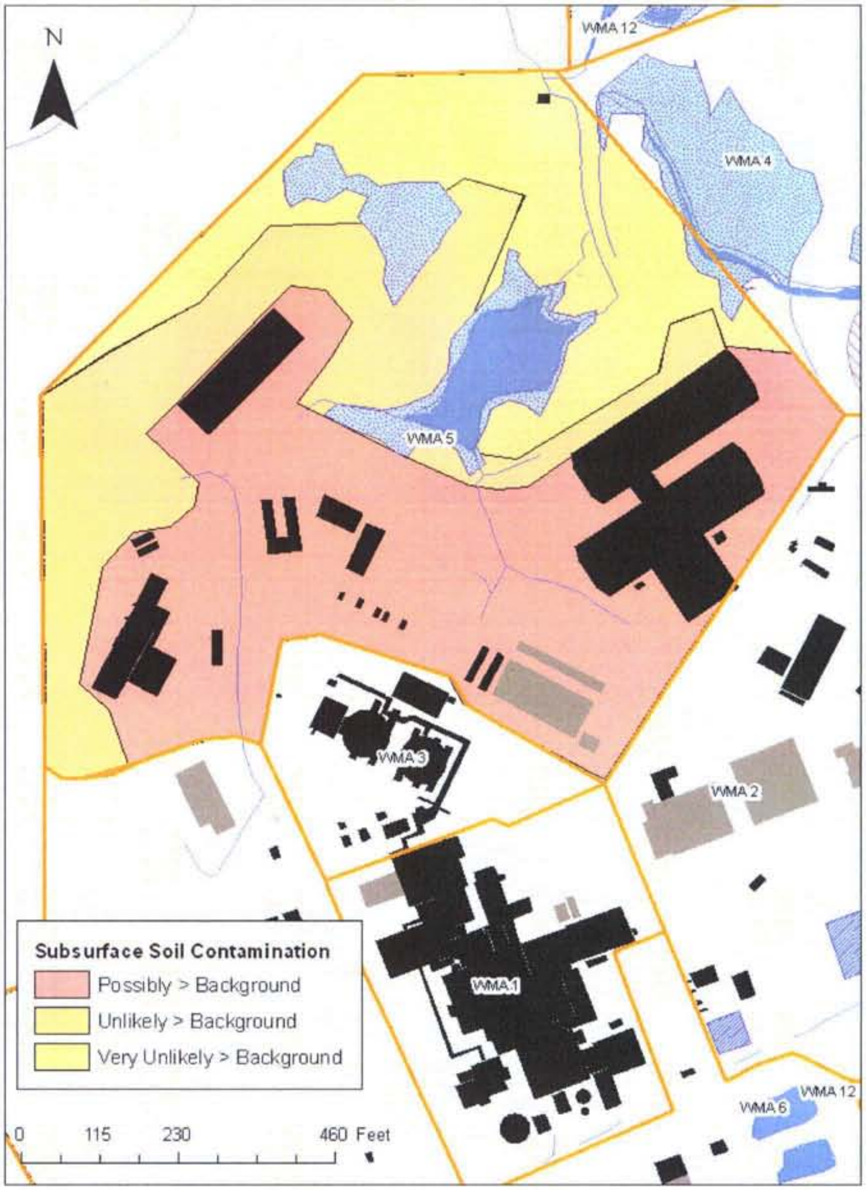

Figure E.16 WMA 5 Initial Subsurface Soil CSM

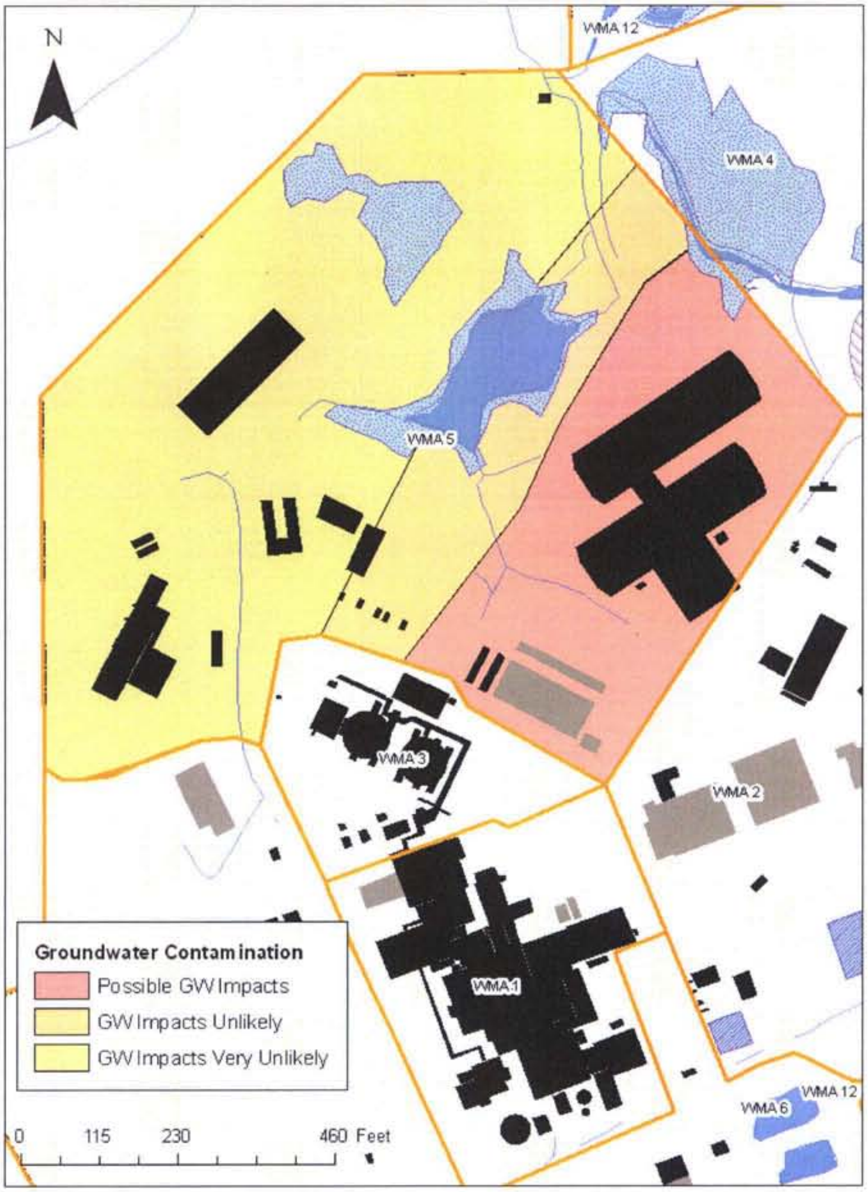

Figure E.17 WMA 5 Assumed Extent of Groundwater Impacts

APPENDIX F

WMA 6 PRE-REMEDIATION DATA COLLECTION

F.1 Background

Waste Management Area 6 (WMA 6) is approximately 14.5 acres in size and contains a variety of facilities, including the Rail Spur, the Above-Ground Petroleum Storage Tank, the Sewage Treatment Plant, the New Cooling Tower, the two Demineralizer Sludge Ponds, the Equalization Basin, the Equalization Tank, the South Waste Tank Farm Test Tower, the Road-Salt and Sand Shed, and the LLW Rail Packaging and Staging Area (see Figures F.1 and F.2 for maps).

Descriptions of the various features of WMA 6 follow, and are taken from the Phase 1 DP, Section 3.1.2.:

Rail Spur. The rail spur runs about 8,000 feet from the south side of the Process Building to where it connects to the main line of the railroad. The rails are cast iron and the ties are creosote pressure-treated wood. The Rail Spur will not be addressed by Phase 1 decommissioning activities.

Sewage Treatment Plant. The Sewage Treatment Plant is a wood frame structure 41 feet by 44 feet by 15 feet high, with metal siding and roofing. The base of the facility is concrete and crushed stone. The Sewage Treatment Plant is used to treat sanitary wastewater and contains six in-ground concrete tanks, one above-ground polyethylene tank, and one above-ground stainless steel tank. The Sewage Treatment Plant will be removed during Phase 1 decommissioning activities, along with its concrete foundation and the underground concrete tanks.

New Cooling Tower. The New Cooling Tower is 20 feet by 20 feet by 11 feet high and it stands on a concrete basin. The floor of the basin is an eight inch-thick concrete slab. The underground structure of the New Cooling Tower will be removed during Phase 1 decommissioning activities.

Demineralizer Sludge Ponds. The north and south Demineralizer Sludge Ponds are separate, unlined basins excavated in the sand and gravel layer. They are approximately 100 feet long, 50 feet wide, and five feet deep. They were used to receive water softener regeneration waste, clarifier overflow and blow-down, boiler blow-down, sand filter backwash, and demineralizer regeneration waste from the Utility Room. The north pond is nearly filled with sediment. Both ponds are radiologically contaminated. As of 2004, the ponds were no longer in service. The Demineralizer Sludge Ponds will be removed as part of Phase 1 decommissioning activities.

Equalization Basin. The Equalization Basin is a lined basin excavated into the sand and gravel layer. It measures 75 feet wide, 125 feet long, by 10 feet deep. It has been used for non-radioactive discharges. The Equalization Basin will be removed as part of Phase 1 decommissioning activities.

Equalization Tank. The Equalization Tank is a 20,000-gallon underground concrete tank immediately north of the Equalization Basin that serves as a replacement for the Equalization Basin. The Equalization Tank will be removed as part of Phase 1 decommissioning activities.

Old Warehouse Slab. The Old Warehouse was a pre-engineered steel building with three sections. The main warehouse section was 80 feet by 144 feet by approximately 21 feet high at the roof peak. A 38 feet by 42 feet by 15 feet high room was attached to the north end of the building that housed a radiological counting facility. A double-wide office trailer was located on a concrete foundation wall at the south end of the building. The Old Warehouse was removed down to its concrete floor slab at grade in May 2007. The Old Warehouse slab will be removed as part of Phase 1 decommissioning activities.

South Waste Tank Farm Test Tower. The South Waste Tank Farm Test Tower is a pre-engineered structure erected as a stack of modules including ladders, handrails, and grating. The exterior "skin" is fabric. The South Tower is 16 feet by 16 feet by 48 feet high. It will be removed during Phase 1 decommissioning. (A North Tower also had been present; it was removed to its foundation in October 2006.)

Road-Salt and Sand Shed. The Road-Salt and Sand Shed is a storage bin and a sand stall resting on asphalt pavement. It is constructed with a wooden frame covered with galvanized steel siding. This facility will be removed during work to achieve the interim end state. The slab will be removed as part of Phase 1 decommissioning activities.

LLW Rail Packaging and Staging Area. The LLW Rail Packaging and Staging Area covers approximately 27,000 square feet east of and adjacent to the railroad tracks at the south end of WMA 6. The area contains two eight-inch-thick reinforced concrete pads and another section covered with crushed limestone. The concrete pads will be removed during Phase 1 decommissioning activities.

WMA 6 is known to have a significant amount of buried infrastructure in its northern portion, including wastewater lines that connected the Process Building with the Old Sewage Treatment Facility, the New Sewage Treatment Facility, sludge ponds and equalization tanks/basin, and the WMA 2 water treatment facilities.

F.2 Physical Setting

The WMA 6 area is a long, narrow waste management area that is oriented northwest to southeast. It is bordered by WMA 10 to the west, WMA 1 and 2 to the north, WMA 12 and 7 to the east, and WMA 9 to the south. WMA 6 is bisected by Erdman Brook; north of the stream is the north plateau, and south of the stream is the south plateau.

The topography of the WMA 6 area has been significantly reworked as part of site activities, which have included the construction of several buildings, the installation of a railroad line along the length of WMA 6, the construction of buried infrastructure including storm sewers and sewage lines, and the construction of several holding ponds.

A significant portion of WMA 6 is currently covered by hardstands, roads, the railroad bed, and concrete pads/building foundations. The balance is grass-covered.

The northern half of WMA 6 is underlain by the sand and gravel unit which overlies the Lavery till. In general, groundwater in the sand and gravel unit flows to the northeast across the north plateau although there probably is also localized discharge to Erdman Brook. The Lavery till has low permeability but groundwater does flow vertically downward through this unit recharging the underlying Kent Recessional Sequence.

The weathered Lavery till is exposed at the surface in the southern half of WMA 6. Groundwater in the weathered Lavery till flows to the northeast across the south plateau with likely discharge to Erdman Brook.

WMA 6 is drained by Erdman Brook via ditches that run parallel to the railway line.

F.3 Area History

Figure F.3 shows the WMA 6 area in 1962, prior to site development. At this time the WMA 6 area was bifurcated by a public road, there was a residence within its boundaries, and a portion of it was farmed.

Figure F.4 shows the WMA 6 area in 1966, after site development had begun. WMA 6 was affected primarily by the completion of a road connecting the main plant area with the NDA/SDA, the installation of the railway, and the construction of the demineralizer sludge ponds, cooling towers and old sewage treatment plant in the northern portion of WMA 6.

Figure F.5 shows the WMA 6 area in 1968. The primary change is the expansion of hardstand/open storage/staging areas west of the WMA 7 area within the southern end of WMA 6.

Figure F.6 shows the WMA 6 area in 1977. Nothing of significance had changed since 1968 other than a lessening of activity at the south end of WMA 6.

Figure F.7 shows the WMA 6 area in 1984. There were no significant changes from 1977.

Figure F.8 shows the WMA 6 area in 1995. There were significant changes between 1984 and 1995, including the construction of additional hardstands, the Sewage Treatment Facility, the construction of the Equalization Basin, and various other smaller supporting facilities in the northern area of WMA 6.

Figure F.9 shows the WMA 6 area in 2007, without much change since 1995.

F.4 Known and Suspected Releases

Several portions of WMA 6 have been affected by known or suspected releases. The two Demineralizer Sludge Ponds and the New Cooling Tower basin are known to have been impacted by radioactivity. In addition, portions of the Sewage Treatment Plant may contain radioactivity concentrations above background from sewage sludge which tends to concentrate naturally occurring radionuclides.

Actions were taken to find and repair a suspected sewage line leak for the line connecting the Process Building with the Old Sewage Treatment Facility, but when excavation of the line neared the south side of the Process Building, radiation levels from soil contamination hampered the project. Direct radiation levels of several mR/h were measured on containers of sludge removed from the Old Sewage Treatment Plant for disposal in the 1980s. The wastewater lines connecting the Process Building with the Old Sewage Treatment Facility may have contamination associated with adjacent soils.

The Old Sewage Treatment Plant outfall drainage channel extends approximately 650 feet to the south from its discharge culvert near the Old Warehouse Slab, flowing into the first culvert under the Railroad tracks on the south plateau. In the 1960s and 1970s, the Old Sewage Treatment Facility experienced several contamination events, some of which were expressed as radioactivity increases in the treated effluent.

A 1982 gamma radiation survey of the Old Sewage Treatment Plant drainage channel showed levels three feet above the surface ranging from 110 to 500 μR/h on a section of the channel that extended approximately 200 feet south of the discharge culvert. The contaminated portion of the area was about 15 feet wide and 600 feet long, the northern 200 feet of which exhibited significant contamination in sediments represented by an 800 pCi/g Cs-137 sample result from the channel sediments, and up to 1 mR/hr near the surface of the drainage channel. The sediment layer was estimated to be at least a foot thick. In order to prevent further contaminant transport downstream, a new drainage channel was excavated to the west of the contaminated channel, and the spoil was placed over the old channel. At least three feet of soil covers the old drainage channel sediment.

Surface soil contamination resulting from air deposition is also likely present in WMA 6 due to historical stack releases from the Process Building. This contamination would likely be more pronounced for areas in closer proximity to the Process Building.

F.5 Existing Data

Existing data sets for this area include:

- In 1982, static direct exposure readings were collected across the WVDP premises (WVNS 1982). All of WMA 6 was covered by these measurements on a 10-m grid. Figure F.10 shows these results color-coded by the exposure readings encountered, with the data overlain on a 1977 aerial photograph. Interpretation of these data in the vicinity of the Process Building is complicated by possible shine impacts. These data suggest surface contamination in the northern portion of WMA 6, extending south to the Old Warehouse, and then a line of contamination likely associated with the old sewage treatment drainage channel that runs parallel to the Rail Spur for some distance. These data also indicate smaller, more localized areas of surface contamination in the southeastern corner of WMA 6 associated with hardstands and staging areas servicing WMA 7 and WMA 9.

- In 1990 and 1991, a second static direct exposure measurement program was conducted across the WVDP premises (WVNS 1992). In the case of WMA 6, this effort provided systematic coverage of a portion of the WMA 6 area on a 10-m grid. This data collection used different instrumentation and protocols than the 1982 study, so the results are not quantitatively comparable. As with the 1982 data set, interpretation of these data around the Process Building is complicated by the potential for shine impacts. Figure F.11 shows these results overlain on a 1995 aerial photograph. These data confirm the original 1982 direct measurement program findings north of the Old Warehouse, but did not identify the spur of contaminated soils in the old sewage treatment discharge channel, presumably because the old discharge channel had been backfilled with several feet of clean fill.

- There are very little soil sampling data for WMA 6 available within ELIMS, except adjacent to the Process Building along the WMA 1 boundary. Figure F.12 shows the locations of surface samples and soil bores. With the exception of soil bore GP10208 which was completed in 2008, all other sampling was done in 1993. Figure F.12 also shows the Cs-137 and Sr-90 results for surface samples for the locations where surface samples were collected. In general, activity concentrations decreased as one moves south in WMA 6; some of the samples in the north had surface soil activity concentrations that exceeded the surface soil CG_w. All three soil bores in the northern portion of WMA 6 adjacent to WMA 1 had contamination present at depths greater than 1 m. The two soil bores in the middle and southern portion of WMA 6 and the soil bore adjacent to WMA 12 and WMA 2 did not. Table F.1 identifies the number of locations analyzed for each of the 18 primary radionuclides of interest (ROI).

- There are also limited groundwater data for WMA 6 within ELIMS. Figure F.13 shows locations with groundwater results color-coded by Sr-90 activity concentrations. Figure F.14 shows the same for tritium. The detection limits for Sr-90 and tritium varied widely among ELIMS samples. 10 pCi/L and 500 pCi/L were selected as thresholds for Sr-90and tritium, respectively, because based on ELIMS data results above these activity concentrations were consistently above method detection limits and so indicative of contamination impacts rather than simply measurement error.

The highest groundwater contamination was in the northernmost portion of WMA 6, immediately down gradient of the presumed 1968 Process Building subsurface release. In addition there were low level elevated Sr-90 results along the WMA 2 border, with the Process Building the presumed source.

The tritium above-background activity concentrations identified in Figure F.14 just east of the Railway Spur were in the early 1990s and appeared to be transitory. There are only two groundwater samples with Sr-90 results for this same location, both from the early 1990s. For both samples, the Sr-90 results were around 30 pCi/L, indicating definite Sr-90 impacts. There is a fairly continuous set of gross beta information for this location that appears to indicate on-going elevated gross beta levels over the years, presumably associated with Sr-90 impacts. This location is directly east of the Old Sewage Treatment Plant outfall channel discharge culvert; contamination associated with discharges from that culvert may be the source of the groundwater impacts.

The cluster of groundwater sampling locations immediately south of the Sewage Treatment Plant did have what appeared to be very low level gross beta above-background activity concentrations in the early 1990s along with some tritium results that were marginally detectable and above background conditions. Any groundwater impacts in this vicinity would presumably be from Sewage Treatment Plant activities.

F.6 Planned Phase 1 DP Activities

For a more complete description of planned Phase 1 DP activities, see the Phase 1 DP, Section 3.1 and Section 7.7.

The New Cooling Tower will be removed down to its underground structure prior to the initiation of Phase 1 decommissioning activities.

The Sewage Treatment Plant, the South Waste Tank Farm Test Tower, the two Demineralizer Sludge Ponds, the Equalization Basin, the Equalization Tank, and the remaining concrete floor slabs, foundations, and hardstands will be removed.

The Phase 1 work does not include the Rail Spur.

F.7 Conceptual Site Model

WMA 6 potentially has impacts from a variety of releases. Some of these are surface, and some are subsurface. In addition, surface soil reworking in specific areas of WMA 6 has possibly resulted in buried contamination. Specifically:

- WMA 6 surface soils were likely affected by the 1968 airborne releases of radioactivity from the Process Building stack in WMA 1. These impacts would have originally been greatest proximal to the Process Building and decreased as one moved south in WMA 6. Since 1968, however, there has been significant surface soil reworking in the northern portion of WMA 6. These activities could have removed contaminated soil layers, buried those layers under clean backfill, and/or redistributed/mixed contamination in surface and near surface soils.

- Activities and buried infrastructure associated with the Old Sewage Treatment Facility are known to have resulted in significant soil contamination that likely remains and that may be buried. The exact location of these infrastructure footprints is currently unknown.

- The original old sewage treatment plant discharge channel that traversed the central portion of WMA 6 was contaminated and then buried with clean soil. Buried contamination likely remains associated with that original footprint. There are indications that there may low level groundwater impacts associated with this contamination as well.

- Subsurface releases from the Process Building have impacted subsurface soils and groundwater in WMA 6 along the WMA 1 boundary. The lateral extent of these impacts is currently unknown.

- GPBG0408, a "background" soil bore completed adjacent to the WMA 6 boundary within WMA 10 just south of the New Warehouse and the Sewage Treatment Plant encountered tritium soil contamination at a depth of approximately five feet. While the exact source is unknown and tritium was the only radionuclide above background, it does raise potential subsurface concerns for this area, assuming that the original release point was within WMA 6 and not WMA 10. The cluster of wells directly south of the Sewage Treatment Plant showed some indications of elevated gross beta and tritium activity above background levels in the 1990s. The soils and groundwater data suggest that there is the potential for very low level impacts of soils/groundwater in this vicinity.

- Sediments within the Demineralizer Sludge Ponds are known to be contaminated, although the depth of contamination is not known.

- There is evidence of low levels of contamination in the sediments for the ditch that currently drains WMA 10 in a southeasterly fashion along the Rail Spur before connecting with Erdman Brook.

Because the Old Warehouse pre-dates the 1968 airborne releases of radioactivity from the Process Building stack, the assumption is that soils beneath the Old Warehouse slab are un-impacted.

Figure F.15 shows the current Conceptual Site Model (CSM) for surface and near surface WMA 6 soils. Figure F.16 shows the same for soils deeper than 1 m. Particularly for subsurface soils, the CSM is based on very little data and is primarily conjecture at this stage. Figures F.15 and F.16 also show the footprints of the planned deep excavations for WMA 1 and WMA 2. Note that the planned excavations for WMA 1 and WMA 2 extend into portions of the northern part of WMA 6.

F.8 WMA 6-Specific Characterization Goals

- Evaluate Appropriateness of the Current List of Radionuclides of Interest (ROI)
- Verify Absence of Additional ROI
- Determine Extent of Surface Contamination
- Identify the Presence/Absence of Buried Contamination
- Identify Soil Waste Stream Characteristics
- Develop an Inventory of Buried Infrastructure
- Obtain Data to Support Phase 2 Planning

F.9 CSAP Pre-Remediation Data Collection and Associated Decision-Making

CSAP pre-remediation data collection will consist of a number of components described in more detail below.

F.9.1 Buried Infrastructure

The footprint of buried infrastructure will be identified and mapped. Buried infrastructure that may exist or is known to exist within WMA 6 includes wastewater lines associated with the Old Sewage Treatment Plant, wastewater lines associated with the new Sewage Treatment Plant, storm sewer lines, and water supply lines. **[required]**

F.9.2 Gamma Walkover Survey Data

The purpose of performing a gamma walkover survey of the WMA 6 area is to identify the level and extent of surface contamination. This includes both general trends in average activity concentrations pertinent to the surface soil CG_w requirement, as well as the identification of isolated, more-elevated anomalies that might be indicative of discrete releases and/or surface soil CG_{emc} concerns.

A complete (100%) logged gamma walkover survey (GWS) will be conducted for accessible areas within WMA 6. Examples of areas that would not be accessible are areas where standing water is present in wetlands, existing building footprints, and building pads. Based on the GWS results, surface soil within WMA 6 will be divided into three categories: (1) surface soils where GWS indicates possible surface soil CG_w exceedances; (2) surface soils where GWS indicate impacts, but those impacts are not expected to exceed surface soil CG_w standards; and (3) surface soils where there is no indication of impacts above background conditions. The purpose of this data collection is to provide insights into the spatial distribution of surface contamination, and to guide subsequent soil sampling. **[required]**

F.9.3 Surface Soil Sampling

Surface soil sampling will be used to address areas inaccessible to GWS data collection, to resolve hot spots identified by the GWS data, and to evaluate the presence, absence, and/or extent of surface contamination above surface soil CG_w requirements based on GWS results.

- **Wetlands.** It is possible that standing water will be present in wetlands that prevent GWS data collection from those areas. Soil sampling will be required for wetland footprints and for any other areas where standing water prevents the collection of GWS data.

  For every area where standing water or saturated soil conditions prevent GWS data collection, systematic soil sampling will take place. At least one and at most five sampling locations will be selected per area. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. In the case where an area has more than one location, locations will be selected so that each representative area does not overlap and provides systematic coverage of the area of interest. If a wetland area is less than 200 m^2 in size, one 5-point composite will be formed to be representative of the wetland's area. **[contingent]**

- **Hot Spots.** If GWS data indicate the presence of contamination that possibly exceeds "hot spot" (CG_{cmc}) standards or an isolated elevated area is identified that appears indicative of a discrete release, the location of concern will be sampled with a biased sample. If biased samples are collected from a particular location, they will be collected from two depth intervals: 0-15 cm, and 0-1 m. In the case of surface soils, each biased sample will be a composite sample formed from five increments systematically distributed over the area of interest. The 0-15 cm samples will be analyzed for the 12 radionuclides of potential interest in addition to the 18 ROI. One down-hole gamma scan will be conducted from each biased location. The purpose of these samples is to resolve GWS anomalies, evaluate the appropriateness of the current ROI list, and verify the absence of additional ROI. **[contingent]**

- **CG_w Sampling.** Surface soil sampling may be conducted after the GWS to further clarify results, with the level and nature of sampling dependent on GWS results. If GWS results indicate no evidence of contamination impacts above background levels, no additional surface soil sampling will be required other than to address areas too wet to perform a gamma walkover survey. Based on historical direct gamma measurements, the areas most likely to have contamination exceeding surface soil CG_w requirements are along the boundary between WMA 6 and WMA 1.

    - If GWS results indicate contamination impacts above background levels but that surface soil contaminant levels exceeding surface soil CG_w requirements are unlikely, a minimum of five surface soil sample locations will be identified and sampled that target the areas with the highest gross activity levels. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap. The purpose is to document the maximum activity concentrations present in surface soils within WMA 6. **[contingent]**

    - If GWS results indicate surface soil contaminant levels exceeding surface soil CG_w requirements likely exist, one sampling location will be selected at the highest gross activity level to confirm surface soil CG_w exceedances and another set of sampling locations will be identified to spatially bound the extent of contamination (i.e., along the boundary of what is considered likely above surface soil CG_w requirements). Two samples will be collected from the location targeting high gross activity levels, one representative of a 0-15 cm depth interval, and one representative of a 0-1 m depth interval. One sample will be collected from each location intended to laterally bound contamination, representative of a 0-15 cm depth interval. Each sample will be a 5-increment composite formed to be representative of a 200 m^2 area. In addition, the location targeting high gross activity levels will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. Locations will be selected so that each representative area does not overlap. The purpose is to document surface soil CG_w requirement exceedances and bound the lateral extent of contamination. **[contingent]**

- If GWS results indicate areas with surface soil contamination impacts but it is unclear whether surface soil CG_w requirement exceedances are present, at most five sampling locations will be selected that systematically cover the areas of interest. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap. The purpose is to resolve the question of whether surface soil CG_w requirement exceedances exist for areas where GWS results are ambiguous. **[contingent]**

- If any 0-15 cm interval yields a sample result indicating a surface soil CG_w requirements exceedance and that sample location is not laterally bounded either by existing sampling locations with results less than surface soil CG_w requirements or by GWS data that clearly indicate contamination is not a concern, additional sampling locations will be selected so that the contamination encountered is spatially bounded. Sampling to laterally bound contamination may extend, if necessary, into WMA 10 and/or WMA 12. The purpose is to laterally bound contamination that is above CG_w requirements. **[contingent]**

F.9.4 Subsurface Soil Sampling

The purpose of subsurface soil sampling within WMA 6 is to determine presence and vertical extent of contamination impacts above background levels. There are several areas within WMA 6 that have specific subsurface soil contamination concerns that are discussed below. These include subsurface soils associated with the boundaries with WMA 1 and WMA 2, the two Demineralizer Sludge Ponds, the New Sewage Treatment Plant, and the original footprint of the Old Sewage Treatment Plant discharge ditch.

- Systematic subsurface sampling along the northern boundary of WMA 6 will take place as part of WMA 1 and WMA 2 pre-remediation CSAP activities; that sampling may extend into WMA 6 as necessary to laterally bound contamination that may be encountered. WMA 1 and 2 data collection activities are described in the Appendices A and B, respectively.

- A minimum of two soil cores will be collected from each of the two Demineralizer Sludge Ponds to a minimum depth of 3 m. Samples will be collected representative of each 1 m interval. The soil bores will be scanned vertically with down-hole static readings every 15 cm. The purpose of this data collection is to determine the likely depth of contamination associated with the sludge ponds. **[required]**

- If Demineralizer Sludge Pond soil cores encounter contamination in the 2-3 m depth interval, sampling will continue deeper until contamination is vertically bounded and samples yield results consistent with background conditions. The purpose of this data collection is to vertically bound subsurface contamination that might be encountered. **[contingent]**

- Four soil cores will be collected around the New Sewage Treatment Plant. These cores will extend 1 m into the Lavery Till. They will be scanned vertically with down-hole static readings every 50 cm. One soil sample will be formed representative of each 1 m depth, starting with the 1-2 m interval. The last sample will be representative of Lavery Till conditions to a depth of 1 m into the till. Three groundwater samples will be collected from each bore, one from the water table surface, one from the zone immediately above the Lavery Till, and one midway between the water table and the

Lavery Till. The purpose of this data collection is to determine the presence of subsurface contamination in the vicinity of the Sewage Treatment Plant and to provide background information on the Lavery Till. **[required]**

- If any of the four New Sewage Treatment Plant soil cores encounters contamination above background conditions at depths below 1 m, then additional core locations will be selected to laterally bound the contamination encountered. If the contamination appears to be associated with the movement of contaminated groundwater, bounding bores will be placed on a triangular grid with a 30-m spacing and sampling will continue until contamination is bounded. If contamination appears to be associated with contaminated soil layers in the vadose zone, bounding bore placement will be driven by the location, the nature of the contamination, and by the nature of the suspected release. In this case soil core separation will likely be less than 30 m. The purpose of this data collection is to laterally bound subsurface contamination that might be encountered. **[contingent]**

- Three trenching locations will be selected along the WMA 6 drainage ditch. The trenches will be separated by approximately 20 m to provide coverage for the stretch of the channel that was reported to have been contaminated. The purpose of the trenching is to identify subsurface contamination associated with the original sewage discharge channel. Trenching will be orthogonal to the orientation of the current ditch, and will be from a west to east direction starting at the ditch. Trenching will continue eastward for a minimum of 6 m or until there is no further evidence of contamination deeper than 1 m. Trenching will be to a minimum depth of 2 m, or to a depth such that there is no further evidence of contamination. Soils will be screened for elevated activity as trenching progresses. A minimum of three soil samples will be collected from each trench, one from the start of the trench targeting soils at a depth of approximately 1.5 m from soils believed to be unimpacted based on gross activity data, one from soils that exhibit the highest levels of gross activity, or from soils that appear to be representative of the original sewage discharge channel if no evidence of elevated activity is observed, and one from soils on the western edge of the trench from a depth of approximately 1.5 meters from soils believe to be unimpacted based on gross activity data. If significant contamination is identified by gross activity measurements, a fourth sample will be required from soils at the bottom of the trench beneath the zone where contamination was identified to verify background conditions. **[required]**

- If all three trenches identify contamination, then trenching will continue down the length of the original sewage discharge channel until the channel either terminates or until background soils are encountered. Trench spacing will be approximately 20 m. Sampling will be conducted as previously described. **[contingent]**

- If any 0-15 cm surface soil sample result indicates contamination impacts above background levels and there was not a 0-1 m sample collected from that location, a 0-1 m sample will be collected from that location following the protocols used for the original 0-15 cm surface soil sample. In addition, each soil location will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. **[contingent]**

- If a surface soil sample indicates contamination impacts above background levels for the 0-1 m depth interval, an additional sample from a depth of 1-2 m will be collected and analyzed from that location. This process will continue until the vertical extent of contamination above background is bounded. One down-hole gamma scan will be conducted from each soil location requiring deeper investigation with a static reading taken every 15 cm vertically. The purpose of these samples is to define the vertical extent of contamination. **[contingent]**

F.9.5 Drainage Feature Sampling

WMA 6 contains three distinct drainage features, the current WMA 6 drainage ditch, the reach of Erdman Brook that passes through WMA 6, and a drainage ditch the feeds Erdman Brook from the south (Figure F.1). For drainage features within WMA 6, the surface soil CG_w requirements apply. Surface drainage feature sampling will be conducted to determine ditch sediment contamination status relative to surface soil CG_w requirements. Surface drainage features will be sampled as follows:

- Discrete samples representing a 0-15 cm depth interval will be collected from ditch sediments. In WMA 6, the three drainage features have a combined length of approximately 360 m. Samples will be systematic located using a random start, separated by 30 m. **[required]**

- If any 0-15 cm sample result indicates contamination impacts above background levels and a 0-1 m sample was not also collected, a 0-1 m sample will be collected from that location following the protocols used for the original 0-15 cm sample. **[contingent]**

- If a sample indicates contamination impacts above background levels for the 0-1 m depth interval, an additional sample from a depth of 1-2 m will be collected and analyzed from that location. This will be repeated, as necessary, until the vertical extent of contamination impact is bounded at that location. **[contingent]**

F.9.6 Buried Infrastructure Soil Sampling

Soils associated with buried infrastructure within WMA 6 will be sampled to determine their contamination status.

- Three locations along the each piece of buried infrastructure within WMA 6 will be trenched. These locations will be selected to maximize the possibility that contamination will be encountered (e.g., locations where historical or current GWS data indicate surface contamination exists). During excavation, exposed soils will be monitored by scans for evidence of elevated gross activity. The purpose of this sampling is to evaluate the presence of contamination associated with buried infrastructure. **[required]**

    - If elevated readings are encountered below a depth of 1 m, soils exhibiting the highest levels of gross activity will be sampled and analyzed.

    - If elevated readings are not encountered below a depth of 1 m, a sample representative of soils deeper than 1 m will be collected. In the case of infrastructure that did not carry waste or wastewater, the sample will be from soils immediately above the line. In the case of infrastructure that did carry waste or wastewater, the sample will be from soils immediately beneath the line.

- If contamination above background conditions is encountered at any selected location, trenching will continue to depth until background conditions are observed. An additional

sample will be collected from the base of the trench to verify background conditions. The purpose is to vertically bound observed contamination. **[contingent]**

- If buried infrastructure soil sampling identifies contamination impacts greater than background, biased sampling will continue following the line until at least two consecutive locations yield soil samples below surface soil CG_w requirements. Location spacing will be based on engineering judgment, including the geometry of the line, the level of contamination encountered, and surface evidence of contamination. The purpose of this sampling is to bound the extent of contamination associated with buried infrastructure, as necessary. **[contingent]**

F.9.7 Additional Contingencies

Sampling and/or GWS data may indicate that contamination exists or extends beneath surfaces currently covered by existing structures, concrete, asphalt, or gravel. In this case, "surface soil" will be defined as soil immediately beneath the cover. If sampling or GWS data indicate that contamination may exist beneath existing structures (e.g., existing buildings, building pads, or hardstand areas), then sampling locations will be offset along the foundation/hardstand edge to determine contamination extent. The purpose of the offset is to allow safe acquisition of data. Data collection through building pads and hardstands in WMA 6 will not be required as part of this effort.

F.9.8 Required Laboratory Analyses

All samples will be submitted for analysis of all 18 ROI.

A select portion of the samples as described above may be analyzed for the additional 12 radionuclides of potential interest. If these sample results indicate the presence of the one or more of those radionuclides at levels of potential significance, then the balance of samples from WMA 6 will also be analyzed for the additional radionuclides that were identified.

Table F.2 summarizes the required sample numbers and the estimated number of contingency samples for WMA 6.

This sampling plan assumes that quick turn-around analyses are available for Sr-90 and Cs-137 and that soil samples will be screened for Sr-90 and Cs-137 prior to being analyzed for the balance of the ROI. Based on these screening data, contingency sampling requirements as described above may be undertaken without the benefit of the remaining analyses.

F.9.9 Decision-Making Summary

A summary of decision-making based on the WMA 6 data is as follows:

- For each piece of buried infrastructure of concern that is identified, three biased locations will be selected, excavation conducted to expose the line, and a soil sample formed from soils most likely contaminated. If contamination is encountered above CG requirements, sampling will continue along these lines until it is bounded.

- Systematic sampling will be selected from the footprint of drainage features from the 0-15 cm interval. Discrete soil samples will be collected. If any of these exceed the CG requirement, then sampling will continue to depth to vertically bound contamination.

- If the GWS identifies a surface soil anomaly that potentially exceeds the CG_{emc}, that location will be sampled and analyzed.

- Subsurface sampling will be conducted within the footprints of the Demineralization Sludge Ponds. If contamination is encountered above background conditions, the depth of these bores will be extended until there is no evidence of contamination above background conditions.

- Subsurface sampling will be conducted around the current Sewage Treatment Plant and extend vertically into the Lavery Till. If contamination is encountered above background conditions, additional cores will be collected to bound the lateral extent of contamination.

- Trenching will be conducted in the footprint of the old sewage discharge channel. If contamination is encountered, trenching will continue down the length of the original ditch until either the ditch terminates or background conditions are observed.

- The WMA 6 surface soil area classification as contained in Figure F.15 will be adjusted based on GWS results. These adjustments may affect systematic sample number requirements and will affect the placement of the initial round of systematic surface soil sample locations.

- Depending on the outcome of the first round of systematic surface soil sampling, additional systematic soil sample locations will be selected to further laterally bound contamination extent.

- If any 0-1 m soil interval encounters contamination above CG requirements, additional deeper 1 m interval soil samples will be required for that location to determine vertical extent of contamination. If additional vertical samples are required, vertical sampling will continue until background conditions are observed.

Table F.1 Historical Data Analyses

Nuclide	# of Surface Soil Locations	# of Subsurface Soil Locations	# of Sediment Locations
Am-241	0	3	0
C-14	0	1	0
Cm-243	0	1	0
Cm-244	0	1	0
Cs-137	9	6	3
I-129	0	1	0
Np-237	0	1	0
Pu-238	0	3	0
Pu-239	0	3	0
Pu-240	0	3	0
Pu-241	0	3	0
Sr-90	9	6	3
Tc-99	0	1	0
U-232	0	1	0
U-233	0	1	0
U-234	0	1	0
U-235	0	1	0
U-238	0	1	0

Table F.2 Sample Number Estimates

	Required	Contingent	Total
Systematic Sediment Samples (0-15 cm)	21	3	24
Systematic Sediment Samples (0-1 m)	0	6	6
Biased Sediment Samples (0-15 cm)	0	0	0
Biased Sediment Samples (0-1 m)	0	0	0
Systematic Surface Soil Samples (0-15 cm)	12	12	24
Systematic Surface Soil Samples (0-1 m)	12	12	24
Biased Surface Soil Samples (0-15 cm)	0	6	6
Biased Surface Soil Samples (0-1 m)	0	6	6
Systematic Subsurface Soil Samples (1-m intervals)	52	0	52
Biased Subsurface Soil Samples (1-m intervals)	0	12	12
Buried Infrastructure Soil Samples	12	12	24
Discrete Groundwater Samples	12	0	12
Total:	109	69	178

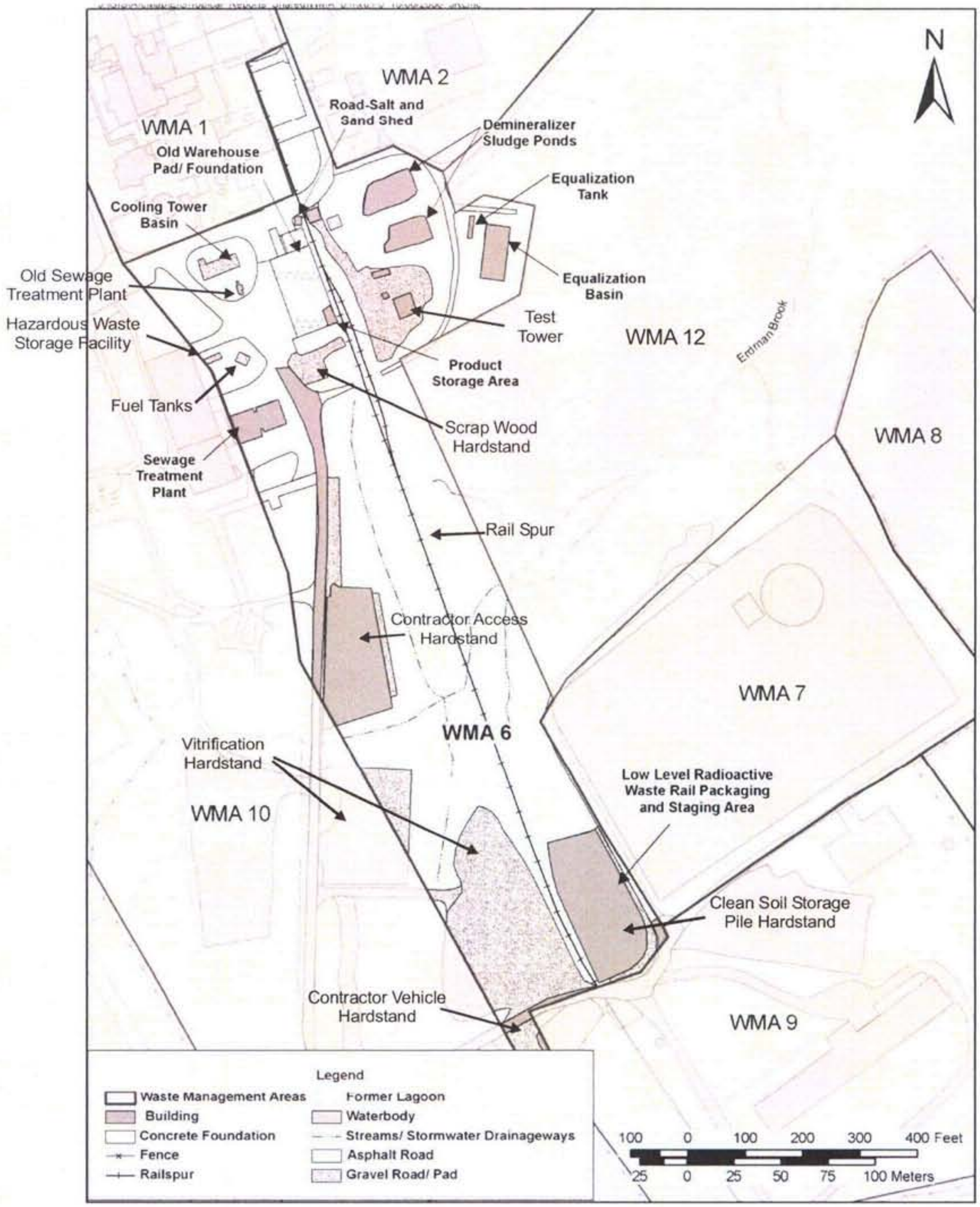

Figure F.1 WMA 6 (adapted from Phase 1 DP, Figure 3-38)

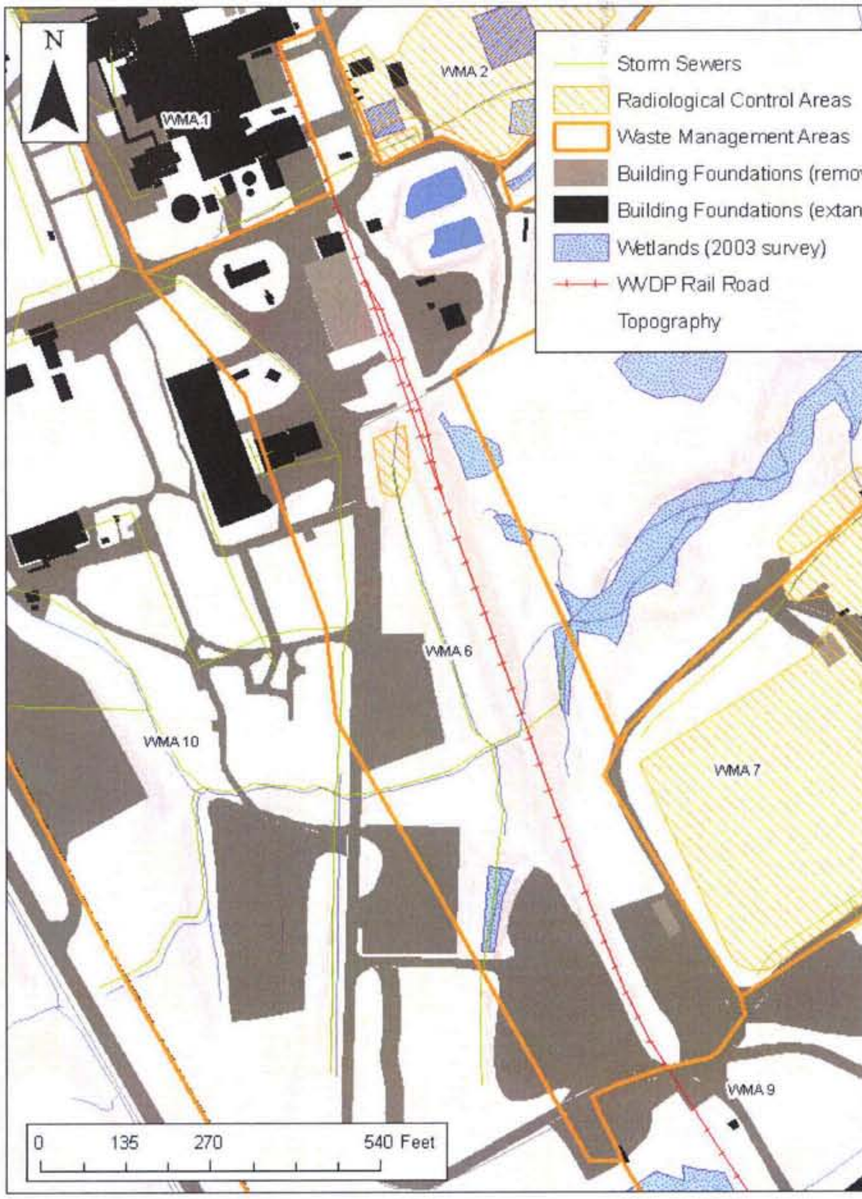

Figure F.2 WMA 6 with Topography

Figure F.3 WMA 6 Aerial Photograph from 1962

Figure F.4 WMA 6 Aerial Photograph from 1966

Figure F.5 WMA 6 Aerial Photograph from 1968

Figure F.6 WMA 6 Aerial Photograph from 1977

Figure F.7 WMA 6 Aerial Photograph from 1984

Figure F.8 WMA 6 Aerial Photograph from 1995

Figure F.9 WMA 6 Aerial Photograph from 2007

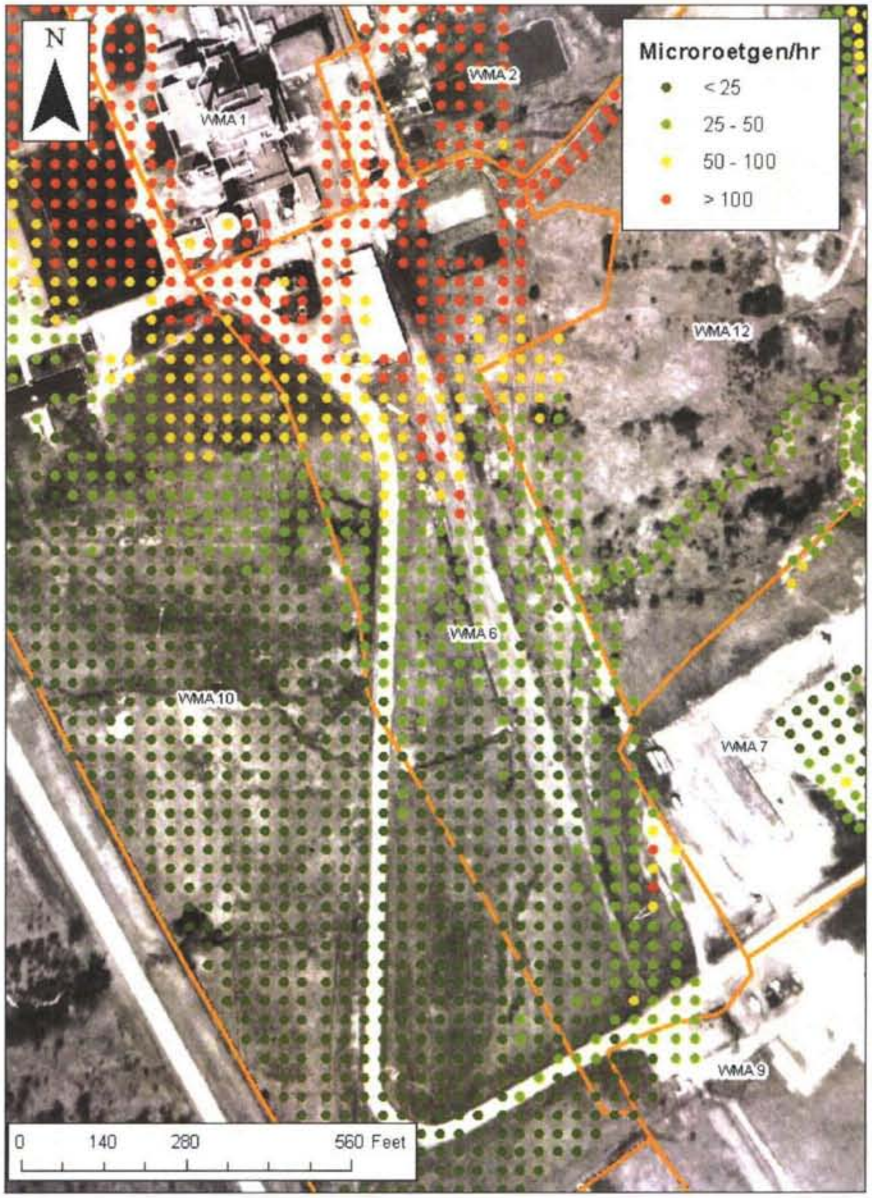

Figure F.10 WMA 6 1982 Direct Gamma Survey Results

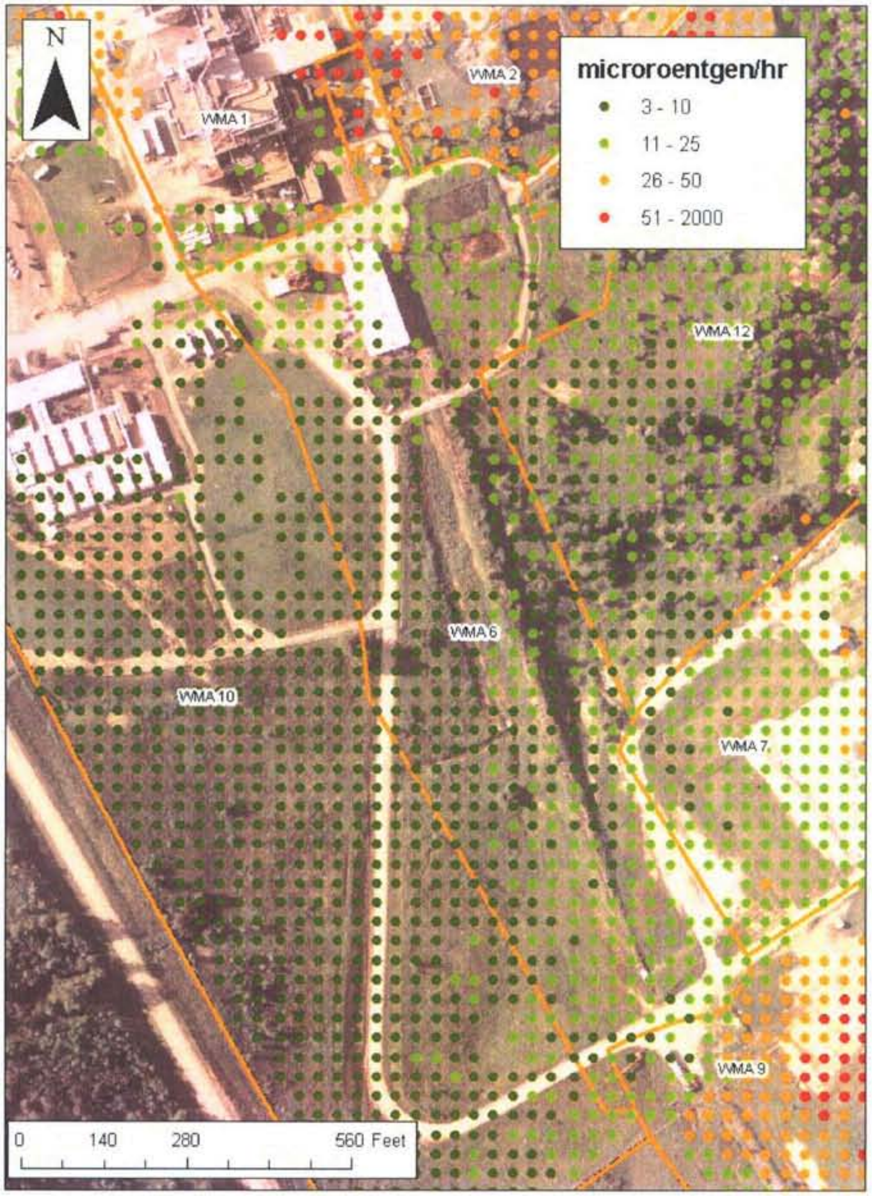

Figure F.11 WMA 6 1990 - 1991 Direct Gamma Survey Results

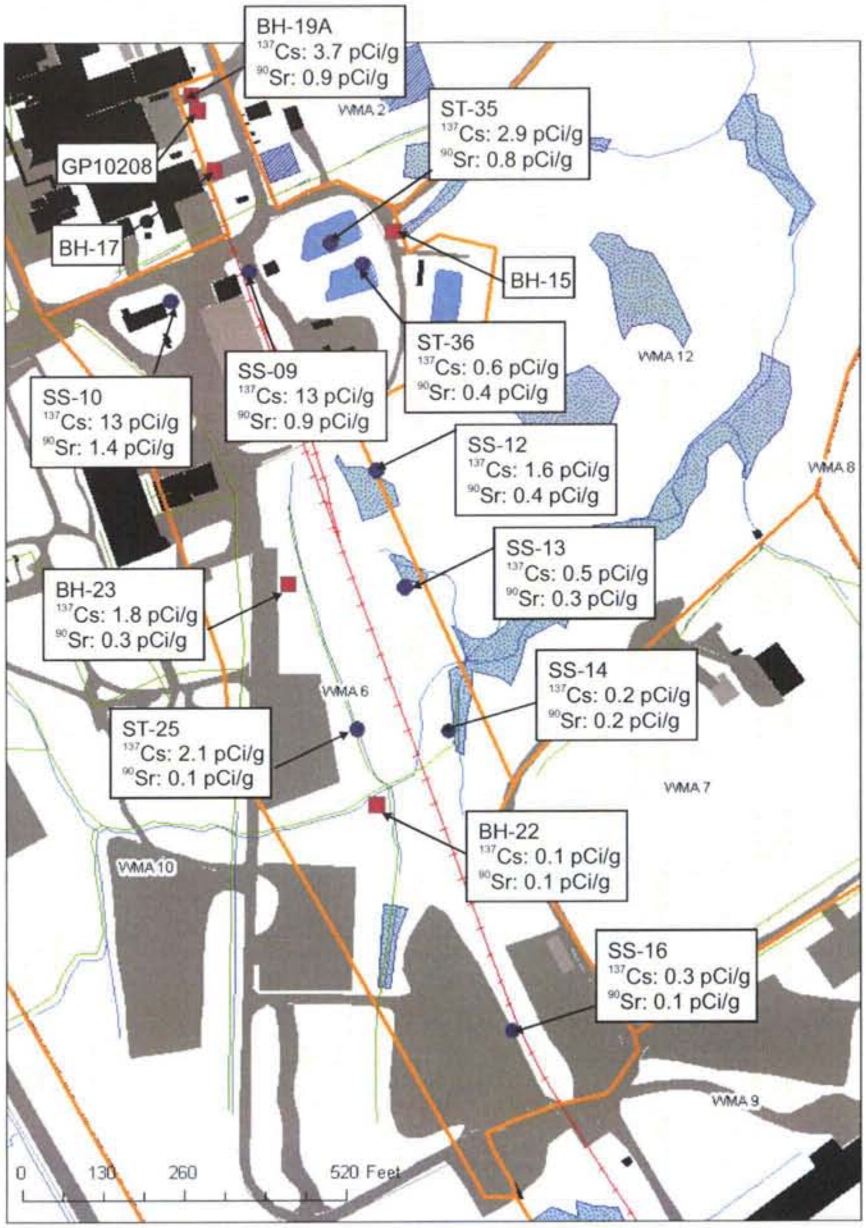

Figure F.12 WMA 6 Historical Surface Sampling Results

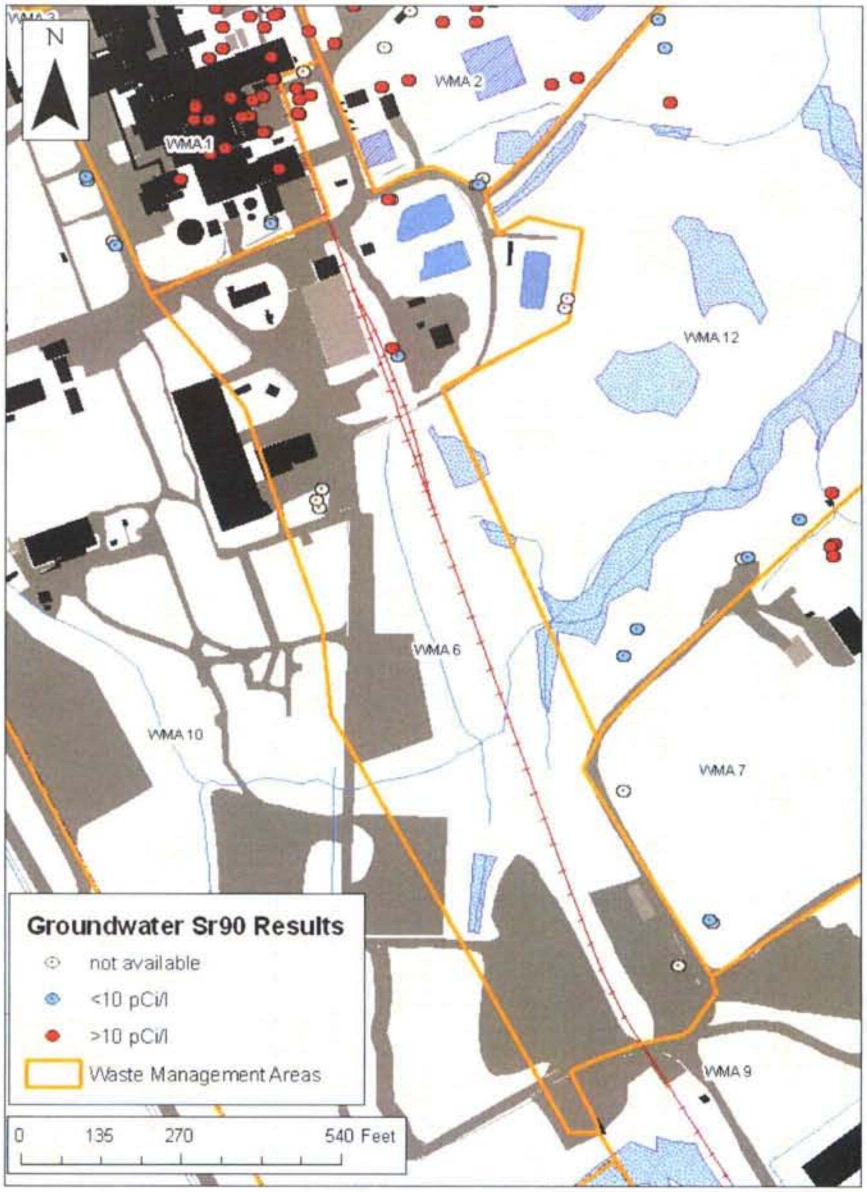

Figure F.13 WMA 6 Historical Groundwater Sr-90 Results

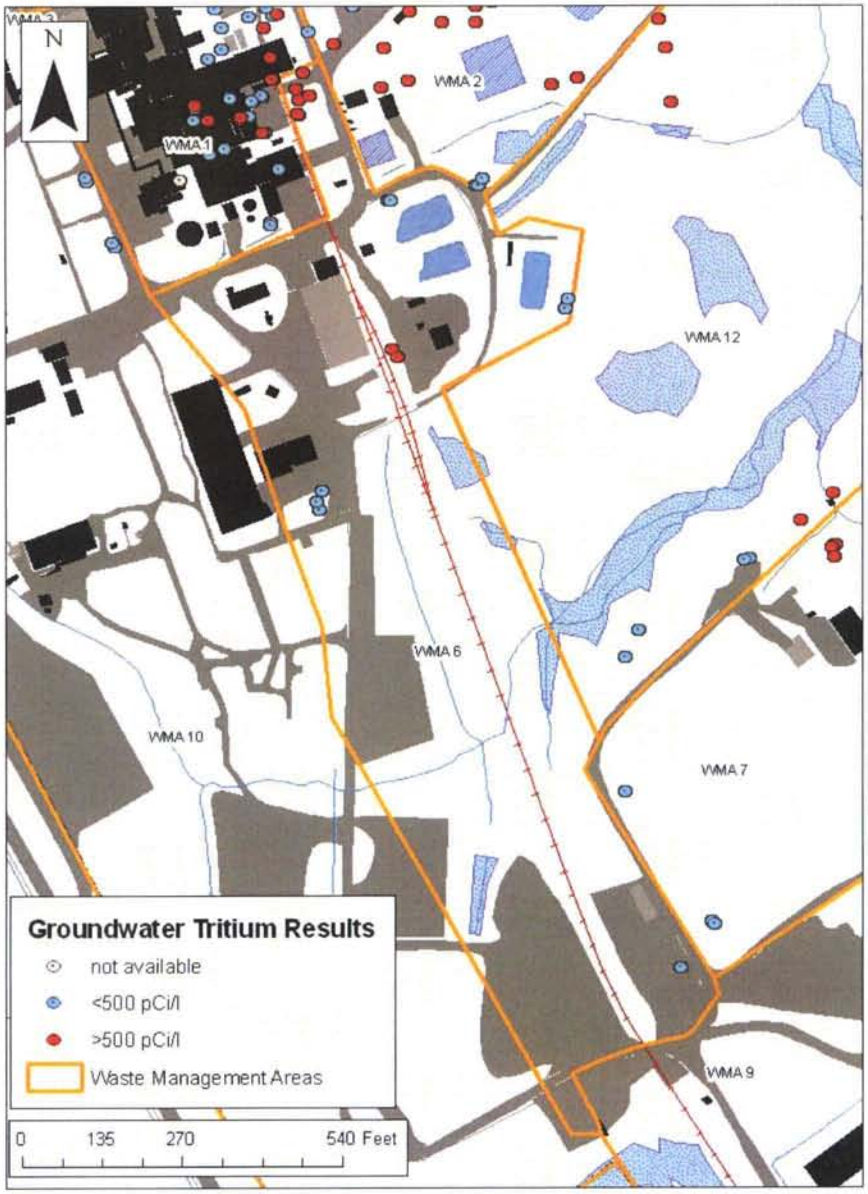

Figure F.14 WMA 6 Historical Groundwater Tritium Results

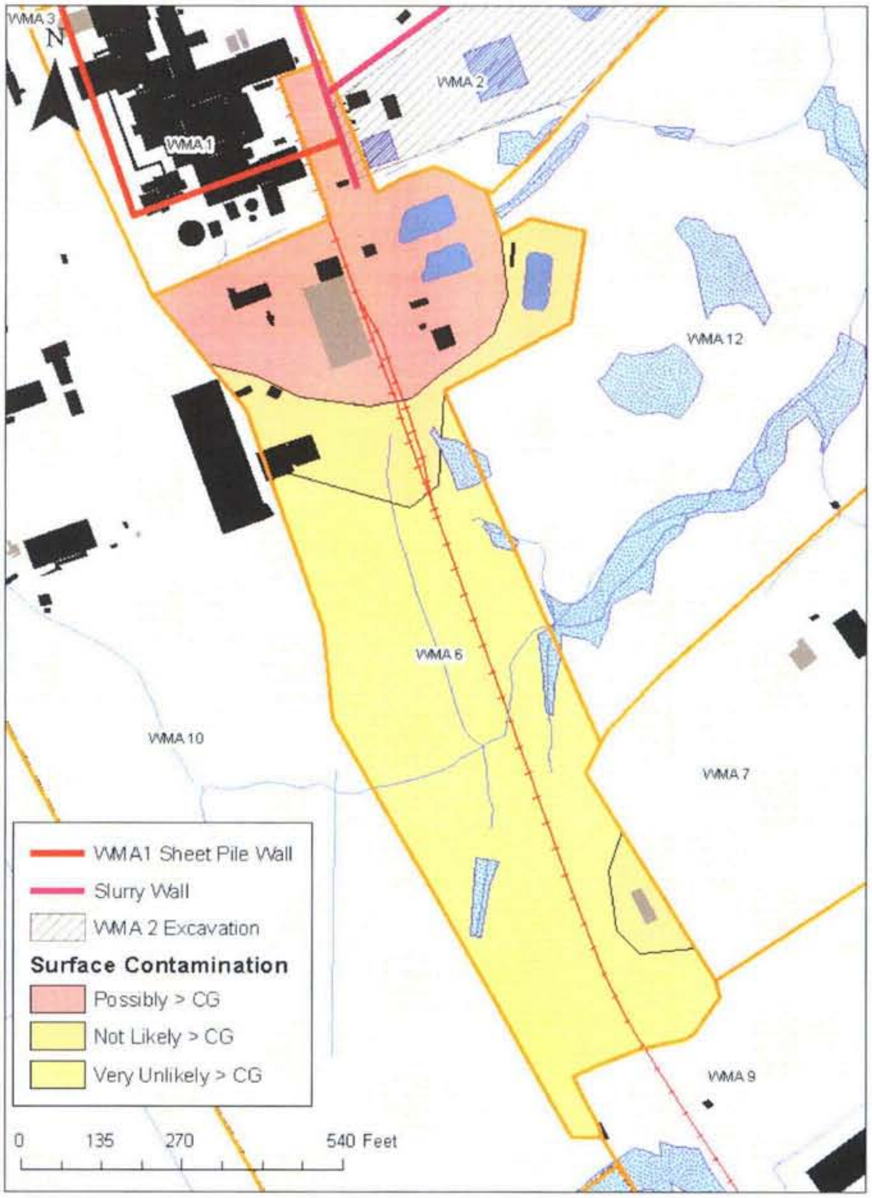

Figure F.15 WMA 6 Initial Surface CSM

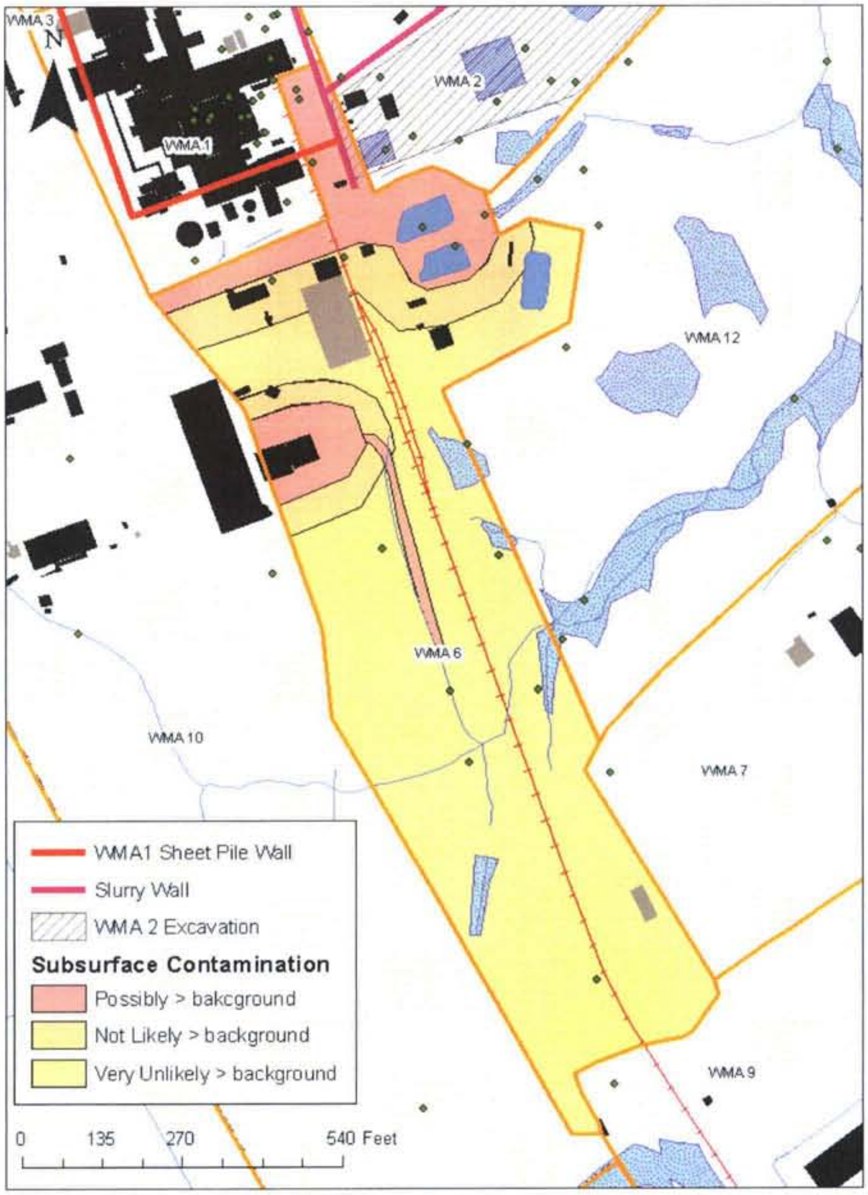

Figure F.16 WMA 6 Initial Subsurface CSM

APPENDIX G

WMA 7 PRE-REMEDIATION DATA COLLECTION

G.1 Background

Waste Management Area 7 (WMA 7) is approximately 8 acres in size and contains the NDA and ancillary structures (see Figures G.1 and G.2 for maps). The NDA was operated by NFS under license from the NRC for disposal of solid radioactive waste exceeding 200 mrem/h from fuel reprocessing operations.

The NDA is divisible into three distinct areas (Figure G.3): (1) the NFS Waste Disposal Area, which is a U-shaped area containing Deep Disposal Holes and Shallow Special Holes; (2) the WVDP Disposal Trenches and Caissons; and (3) the area occupied by the Interceptor Trench project.

Other structures and facilities include the Liquid Pretreatment System, the NDA Hardstand, an Inactive Plant Water Line, a Leachate Transfer Line, a Former Lagoon located beneath the former Interim Waste Storage Facility floor slab, a Groundwater Barrier Wall, and a Geomembrane Cover.

Descriptions of the various features of the NDA follow, and are taken from the Phase 1 DP, Section 3.1.2:

NFS Deep Disposal Holes. Approximately 100 NFS Deep Disposal Holes are located in the eastern portion of the U-shaped NFS Waste Disposal Area.

About 6,600 cubic feet of leached cladding from reprocessed fuel, also known as hulls, are buried in these holes. The hulls were contained in 30-gallon steel drums stacked three abreast in the holes. Three of these drums contain irradiated, un-reprocessed fuel with damaged cladding from the N-Reactor at the Hanford Site. The Deep Disposal Holes also contain LLW generated during fuel reprocessing.

Most of these holes are 2.7 feet by 6.5 feet by 50 to 70 feet deep.

NFS Shallow Special Holes. Approximately 230 NFS Shallow Special Holes are located in the northern and western portions of the U-shaped NFS Waste Disposal Area.

At least 22 1,000-gallon tanks containing a mixture of spent n-dodecane and tributyl phosphate in absorbent material were disposed in several of these Shallow Special Holes during the late 1960s and the early 1970s. Eight of these tanks in Special Holes 10 and 11 were believed to be the source of n-dodecane and tributyl phosphate detected in a nearby monitoring well on November 1983.

The Shallow Special Holes are typically about 20 feet deep, with various lengths and widths; most are about 12 feet wide and 20 to 30 feet long. The length and width of each hole varied according to the quantity of waste requiring disposal at each disposal event, and the dimensions of large waste items such as failed equipment. Miscellaneous wastes, other than leached hulls or related spent fuel debris, were packaged in several types of containers, including steel drums, wooden crates, and cardboard boxes.

The following actions were taken by the WVDP between October 1985 and May 1987 to mitigate the migration of the n-dodecane and tributyl phosphate from Special Holes 10 and 11:

- The eight 1,000-gallon tanks containing the n-dodecane/tributyl phosphate contaminated absorbents were removed.
- The tanks were size-reduced, contaminated absorbents and soils were removed, and all waste was packaged for disposal.
- Liquid n-dodecane and tributyl phosphate was removed and solidified into a qualified waste form suitable for disposal.
- Special Holes 10 and 11 were backfilled.
- Approximately 9,700 cubic feet of packaged contaminated soil, contaminated absorbents, size-reduced tanks, and solidified n-dodecane and tributyl phosphate were generated during this removal activity.

WVDP Trenches. Twelve WVDP Trenches are present; most of these trenches are in the parcel of land located inside the U-shaped NFS Waste Disposal Area.

The WVDP Trenches contain approximately 200,000 cubic feet of LLW resulting from decontamination activities performed between 1982 and 1986.

The trenches are typically about 30 feet deep and about 15 feet wide. The lengths vary from 30 feet to 250 feet. Trenches 9 and 11 have composite liners and caps. All other WVDP Trenches are capped with clay.

WVDP Caissons. Four WVDP Caissons were constructed by the WVDP near the eastern and southern corners of the NDA. The caissons are steel-lined concrete cylindrical vaults.

WVDP disposal records indicate approximately 823 cubic feet of waste in drums was placed in Caisson 1. The WVDP disposal records do not indicate that any waste was placed in the other three caissons.

The WVDP Caissons are seven feet in diameter and 60 feet deep, finished so that the top of the caissons were even with the ground surface. The caissons are plugged with concrete for shielding and covered with a plastic shield to prevent rainwater infiltration.

Interceptor Trench and Liquid Pretreatment System. The Interceptor Trench and associated Liquid Pretreatment System were installed after groundwater contaminated with tributyl phosphate, n-dodecane, and several radionuclides was detected in a well in the NDA. The purpose of the project was to intercept potentially contaminated groundwater migrating from the NDA.

The Interceptor Trench is located on the northeast and northwest boundaries of the NFS Waste Disposal Area. The base of the trench extends to a minimum of one foot below the interface of the weathered Lavery till with the unweathered Lavery till. The trench is drained by a drainpipe that directs accumulated water to a collection sump. The collection sump has a submersible pump to transfer groundwater to the Liquid Pretreatment System. As of 2008, no groundwater has ever been transferred to the Liquid Pretreatment System.

Liquid that collects in the sump is routinely sampled, analyzed, and transferred to the Low Level Waste Treatment Facility in WMA 2 for treatment and release. Treated wastewater is discharged from Lagoon 3 in WMA 2 to Erdman Brook through an SPDES permitted outfall.

The Liquid Pretreatment System consists of seven tanks made of carbon steel: one 5,000-gallon holding tank, two 1,000 gallon pre-filtration holding tanks, two 700-gallon tanks containing granular activated carbon, and two 1,000-gallon post-filtration holding tanks. The granular activated carbon tanks are housed in a wooden shed 12 feet long by 10 feet wide. The other five tanks are located in a Quonset-style building.

NDA Hardstand. The NDA Hardstand is located near the southeast corner of the NDA.

It was an interim storage area where radioactive waste was staged before being disposed. The NDA Hardstand is radiologically contaminated.

The NDA Hardstand originally was a three-sided structure with cinder block walls, located on a sloped pad of crushed rock 20 feet wide and 20 feet long. The block walls were removed down to crushed rock pad in September 2006. The crushed rock pad will be removed during Phase 1 decommissioning.

Inactive Plant Water Line. A buried eight-inch diameter cast iron water line from the plant runs along the southwestern border of the NDA.

The Plant Water Line was formerly used to supply clean water from the reservoirs to the Process Building, but was taken out of service in 1986 and capped with cement.

Leachate Transfer Line. The Leachate Transfer Line is a two-inch diameter buried polyvinylchloride pipeline that runs along the northeast and northwest sides of the NDA, continues northward across WMA 6, and terminates at Lagoon 2 in WMA 2. The total length of the line is 4,000 feet.

The Leachate Transfer Line has two sections. The section of the line described above is currently used to transfer groundwater from the NDA Interceptor Trench sump to Lagoon 2. There also is an inactive section of the line that runs from the SDA lagoons to the Interceptor Trench sump; the two ends of this section are capped. This section was originally used to transfer liquids from the SDA lagoons via a pump house next to the NDA Hardstand to Lagoon 1.

Former Lagoon. This lagoon, formerly used by NFS for collecting surface water runoff, was located beneath the former Interim Waste Storage Facility floor slab in the northeastern portion of the NDA. Around 1972 it was filled with radiologically contaminated soil from cleanup after a HEPA filter was dropped at the NDA during disposal operations.

The Interim Waste Storage Facility floor slab was removed in May 2008 as required for the planned installation of the Geomembrane Cover over the NDA; the Geomembrane Cover was installed in the fall of 2008.

Groundwater Barrier Wall. In July 2008, a subsurface groundwater barrier wall was installed on the southwest and southeast sides of the NDA to minimize groundwater migration into the NFS Waste Disposal Area. This barrier wall is a soil-bentonite slurry wall with a maximum hydraulic conductivity of 1E-07 cm/s that is keyed at least five feet into the underlying unweathered Lavery till. The slurry wall is approximately 850 feet long, three feet wide, and is 15 to 20 feet deep.

Geomembrane Cover. In the fall of 2008 the NDA was covered with XR-5, an ethylene inter-polymer alloy geomembrane, to limit infiltration of precipitation into the NFS Waste Disposal Area. During installation of the XR-5 geomembrane, imported backfill was placed on the surface of the NDA and the surface was graded to form a suitable foundation for the geomembrane.

G.2 Physical Setting

The WMA 7 area is located on the south plateau, and is bounded by WMA 12 to the north, WMA 6 to the west, WMA 9 to the south, and WMA 8 to the east.

The WMA 7 area was originally relatively flat and farmed prior to site development. After site development began, the majority of the WMA 7 area was used for the NDA, or for NDA support activities, with the surface reworked several times over the years. In its current configuration, the WMA 7 area includes the capped NDA, a groundwater barrier wall that wraps around the west and south boundary of the NDA, a groundwater interceptor drain that wraps around the north and eastern ends of the NDA, various support facilities immediately above the NDA for leachate collection, and the NDA Hardstand in the southeastern portion of the area.

The WMA 7 area is drained by two drainage features, one running along the eastern boundary in a northerly direction, and the second that runs along the northern boundary in an easterly direction. Both features eventually drain into Erdman Brook.

The WMA 7 area is underlain by the weathered and unweathered Lavery Till. The weathered Lavery Till allows some groundwater movement. Groundwater within the weathered Lavery Till flows to the northeast, following the surface topography.

The unweathered Lavery Till is a relatively impermeable unit. Groundwater flows vertically through the unweathered Lavery Till to the Kent Recessional Sequence.

Within the unweathered Lavery Till there is a layer known as the Kent Recessional Sequence that is more permeable and that does transport groundwater. Groundwater within the Kent Recessional Sequence, in general, moves to the northeast, discharging to Buttermilk Creek. Subsurface features associated with the NDA extend through the weathered Lavery Till into the unweathered Lavery Till, but do not penetrate the Kent Recessional Sequence.

Figure G.4 shows a west-to-east cross-section of the subsurface through the NDA.

G.3 Area History

Figure G.5 shows the WMA 7 area in 1962, before site development. The area at that time was farmed.

Figure G.6 shows the WMA 7 area in 1966. The area had already been largely cleared, although from this photograph it is not possible to determine its use.

Figure G.7 shows the WMA 7 area in 1968. Area development has continued, with the footprint of the NDA now fairly well-defined.

Figure G.8 shows the WMA 7 area in 1977. The NDA Hardstand is visible in the southeast corner of WMA 7 and in use. There also appears to be temporary storage along the western edge of the NDA.

Figure G.9 shows the WMA 7 area in 1984. At this point in time the NDA was largely covered and re-vegetated, with the exception of the center of the NDA. In this photograph a structure is visible towards the north end of the NDA and activity is visible in the WVDP disposal area.

Figure G.10 shows the WMA 7 area in 1995. The area is now completely re-vegetated.

Figure G.11 shows the WMA 7 area in 2007 before the placement of the NDA Geomembrane Cover. The SDA's geomembrane cover is visible.

G.4 Known and Suspected Releases

The buried waste in the NDA is known to contain a large amount of radioactivity which has been estimated to total approximately 229,000 curies in 2011 (Phase 1 DP, Table 2-20).

The NDA Hardstand area (formerly used as a radioactive waste container storage and staging area) is known to be contaminated and is currently roped off as a radiological controlled area. The source of contamination was presumably releases from containers.

A drainage area adjacent to the NDA is believed to contain contaminated soil below contouring fill. The swale between the SDA and the NDA has been historically contaminated, presumably from spills during waste burial operations by NFS, and after SDA closure, during leachate control activities. During the NDA tank removal and subsurface control period in the 1980s and 1990s, the swale area was re-contoured to prevent erosion. An unknown amount of low-level radioactive contamination remains in that area, evidenced by continuing elevated radioactive contaminant indicators in surface water immediately downstream. The swale area averages approximately 30 feet wide running 300 feet north along the drainage from the NDA Hardstand. Based upon observations during radiation surveys in 1982, the contamination appeared to have permeated porous fill in the swale channel. Gamma readings in that area were five to seven times background, not inconsistent with observed downstream gross beta contamination. Surface soil contamination is still occasionally noted in that area.

Surface soil contamination above background levels is likely in the immediate vicinity of the NDA associated with air deposition of contaminants associated with original waste placement activities.

G.5 Existing Data

Existing data sets for this area include:

- Extensive historical record searches and modeling have been used to determine the activity contents of the NDA (WVNS 1982).

- In 1982 static direct exposure readings were collected across the WVDP premises (WVNS 1992). Only a small portion of WMA 7 was covered by these measurements on a 10-m grid. Figure G.12 shows these results color-coded by the exposure readings encountered, with the data overlain on a 1977 aerial photograph. The data indicate elevated surface contamination associated with the two WMA 7 drainage features.

- In 1990 and 1991 a second static direct exposure measurement program was conducted across the WVDP premises (WVNS 1992). In the case of WMA 7, this effort provided systematic coverage of its entire area on a 10-m grid. This data collection used different instrumentation and protocols than the 1982 study, so the results are not quantitatively comparable. Figure G.13 shows these results overlain on a 1995 aerial photograph.

- There are very little soil sampling data for WMA 7 available within ELIMS. In 1993 two surface samples were collected and two soil cores were obtained. Figure G.14 shows the Cs-137 and Sr-90 results for surface samples from these locations. The locations in the northeastern corner showed Cs-137 and Sr-90 impacts. None of the samples were in locations where one would expect to see the highest levels of impacts, based on the historical gamma measurements. Table G.1 identifies the number of locations analyzed for each of the 18 primary radionuclides of interest.

- There is a fair amount of historical groundwater sampling data available for WMA 7 within ELIMS. Figure G.15 shows groundwater sampling locations color-coded by historical Sr-90 results. Figure G.16 shows the same for tritium results. In both cases the various wells displayed are screened in different geological units. The detection limits for Sr-90 and tritium varied widely among ELIMS samples. 10 pCi/L and 500 pCi/L were selected as thresholds for Sr-90 and tritium, respectively, because based on ELIMS data results above these activity concentrations were consistently above method detection limits and so indicative of contamination impacts rather than simply measurement error.

As is evident from these two figures, there have been groundwater impacts in the vicinity of WMA 7, particularly to the north and northwest. Contaminated groundwater in this area is shallow and likely discharges via wetlands, ditches, and seeps to Erdman Brook, which runs along the north edge of WMA 7 and is fed by two drainage features originating within WMA 7.

G.6 Planned Phase 1 DP Activities

The remaining gravel pad associated with the NDA Hardstand will be removed along with the top two feet of soil (see Phase 1 DP, Section 3.1 and Section 7.8).

Phase 1 will not address the NDA itself and the associated Interceptor Trench.

G.7 Conceptual Site Model

Historical activities within the WMA 7 footprint have almost exclusively been associated with the NDA. One would expect to find surface soil contamination impacts outside the NDA Geomembrane Cover resulting from dust deposition and discrete spills and leaks during NDA and SDA operation (the SDA is immediately adjacent to the east). It is likely contamination would be more concentrated in drainage features and around the NDA hardstand. Historical gamma measurements support these assumptions.

Because of the significant amount of soil reworking and re-contouring that has occurred within WMA 7 over the years, it is possible that buried contamination exists, particularly along the northeastern and eastern edges of WMA 7 and potentially associated with buried infrastructure backfill that is present at the site. In addition, contaminated leachate/groundwater associated with the NDA has likely contaminated subsurface soils adjacent to and downgradient from the NDA.

Figure G.17 shows the current Conceptual Site Model (CSM) for surface and near surface WMA 7 soils. The portion of the WMA 7 area covered under the NDA Geomembrane Cover is not within the Phase 1 scope of activities.

G.8 WMA 7-Specific Characterization Goals

- Evaluate Appropriateness of the Current List of Radionuclides of Interest (ROI).
- Verify Absence of Additional ROI.
- Explore the Possibility of Surrogate ROI.
- Determine Extent of Surface Contamination.
- Identify the Presence/Absence of Buried Contamination.
- Identify Soil Waste Stream Characteristics.
- Develop an Inventory of Buried Infrastructure.
- Obtain Data to Support Phase 2 Planning.

G.9 CSAP Pre-Remediation Data Collection and Associated Decision-Making

CSAP pre-remediation data collection will consist of a number of components described in more detail below. Data collection will only take place in those portions of WMA 7 that are not covered by the NDA geomembrane cover.

G.9.1 Buried Infrastructure

The footprint of buried infrastructure will be identified and mapped. The focus would be on buried infrastructure that has footprints outside the NDA geomembrane cover. **[required]**

G.9.2 Gamma Walkover Survey Data

The purpose of performing a gamma walkover survey of the WMA 7 area is to identify the level and extent of surface contamination. This includes both general trends in average activity concentrations pertinent to the CG_w requirement, as well as the identification of isolated, more-elevated anomalies that might be indicative of discrete releases and/or CG_{emc} concerns.

A complete (100%) logged gamma walkover survey (GWS) will be conducted for accessible areas within WMA 7, with the exception of the NDA capped area. Examples of areas that would not be accessible (besides the capped area) are areas where standing water is present in wetlands.

This is most likely to occur in the northeastern corner of WMA 7. Based on the GWS results, surface soil within WMA 7 will be divided into three categories: (1) surface soils where GWS indicates possible surface soil CG_w exceedances; (2) surface soils where GWS indicate impacts, but those impacts are not expected to exceed surface soil CG_w standards; and (3) surface soils where there is no indication of impacts above background conditions. The purpose of this data collection is to provide insights into the spatial distribution of surface contamination, and to guide subsequent soil sampling. **[required]**

G.9.3 Surface Soil Sampling

Surface soil sampling will be used to address areas inaccessible to GWS data collection, to resolve hot spots identified by the GWS data, and to evaluate the presence, absence, and/or extent of surface contamination above CG_w requirements based on GWS results.

- **Wetlands.** It is possible that standing water will be present in wetlands that prevent GWS data collection from those areas. The most likely place for this to occur is along the eastern boundary of WMA 7. Soil sampling will be required for wetland footprints and for any other areas where standing water prevents the collection of GWS data.

  For every area where standing water or saturated soil conditions prevent GWS data collection, systematic soil sampling will take place. At least one and at most five sampling locations will be selected per area. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. In the case where an area has more than one location, locations will be selected so that each representative area does not overlap and provides systematic coverage of the area of interest. If a wetland area is less than 200 m^2 in size, one 5-point composite will be formed to be representative of the wetland's area. **[contingent]**

- **Hot Spots.** If GWS data indicate the presence of contamination that possibly exceeds "hot spot" (CG_{emc}) standards or an isolated elevated area is identified that appears indicative of a discrete release, the location of concern will be sampled with a biased sample. If biased samples are collected from a particular location, they will be collected from two depth intervals: 0-15 cm, and 0-1 m. In the case of surface soils, each biased sample will be a composite sample formed from 5 increments systematically distributed over the area of interest. The 0-15 cm samples will be analyzed for the 12 radionuclides of potential interest in addition to the 18 ROI. One down-hole gamma scan will be conducted from each biased location. The purpose of these samples is to resolve GWS anomalies, evaluate the appropriateness of the current ROI list, and verify the absence of additional ROI. **[contingent]**

- **CG_w Sampling.** Surface soil sampling may be conducted after the GWS to further clarify results, with the level and nature of sampling dependent on GWS results. If GWS results indicate no evidence of contamination impacts above background levels, no additional surface soil sampling will be required other than to address areas too wet to perform a gamma walkover survey. Based on historical direct gamma measurements, the areas most likely to have contamination exceeding surface soil CG_w requirements are along the boundary between WMA 7 and WMA 8.

  - If GWS results indicate contamination impacts above background levels but that surface soil contaminant levels exceeding CG_w requirements are unlikely, a minimum of five surface soil sample locations will be identified and sampled that target the areas with the highest gross activity levels. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap. The purpose is to document the maximum activity concentrations present in surface soils within WMA 7. **[contingent]**

  - If GWS results indicate surface soil contaminant levels exceeding CG_w requirements likely exist, one sampling location will be selected at the highest gross activity level to confirm CG_w exceedances and another set of sampling locations will be identified to spatially bound the extent of contamination (i.e., along the boundary of what is considered likely above CG_w requirements). Two samples will be collected from the location targeting high gross activity levels, one representative of a 0-15 cm depth interval, and one representative of a 0-1 m depth interval. One sample will be collected from each location intended to laterally bound contamination, representative of a 0-15 cm depth interval. Each sample will be a 5-increment composite formed to be representative of a 200 m^2 area. In addition, the location targeting high gross activity levels will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. Locations will be selected so that each representative area does not overlap. The purpose is to document CG_w requirement exceedances and bound the lateral extent of contamination. **[contingent]**

- If GWS results indicate areas with surface soil contamination impacts but it is unclear whether CG_w requirement exceedances are present, at most five sampling locations will be selected that systematically cover the areas of interest. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap. The purpose is to resolve the question of whether CG_w requirement exceedances exist for areas where GWS results are ambiguous. **[contingent]**

- If any 0-15 cm interval yields a sample result indicating a CG_w requirements exceedance and that sample location is not laterally bounded either by existing sampling locations with results less than CG_w requirements or by GWS data that clearly indicate contamination is not a concern, additional sampling locations will be selected so that the contamination encountered is spatially bounded. Sampling to laterally bound contamination will not compromise the NDA geomembrane cover or extend into WMA 8, but may extend, if necessary, into WMA 12 and/or WMA 6. The purpose is to laterally bound contamination that is above CG_w requirements. **[contingent]**

G.9.4 Subsurface Soil Sampling

The purpose of subsurface soil sampling within WMA 7 is to determine presence and vertical extent of contamination impacts above background levels.

- If any 0-15 cm surface soil sample result indicates contamination impacts above background levels and there was not a 0-1 m sample collected from that location, a 0-1 m sample will be collected from that location following the protocols used for the original 0-15 cm surface soil sample. In addition, each soil location will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. **[contingent]**

- If a surface soil sample indicates contamination impacts above background levels for the 0-1 m depth interval, an additional sample from a depth of 1-2 m will be collected and analyzed from that location. This process will continue until the vertical extent of contamination above background is bounded. One down-hole gamma scan will be conducted from each soil location requiring deeper investigation with a static reading taken every 15 cm vertically. The purpose of these samples is to define the vertical extent of contamination. **[contingent]**

G.9.5 Drainage Feature Sampling

WMA 7 contains two distinct drainage features, one along the eastern boundary of the NDA and a second along the northern boundary. For drainage features within WMA 7, the surface soil CG_w requirements apply. Surface drainage feature sampling will be conducted to determine ditch sediment contamination status relative to surface soil CG_w requirements. Surface drainage features will be sampled as follows:

- Discrete samples representing a 0-15 cm depth interval will be collected from ditch sediments. In addition, ditch sampling along the eastern boundary will include samples representing a 0-1 m depth interval. In WMA 7, the two ditches have a combined length of approximately 90 m. Samples will be systematic located using a random start, separated by 30 m. **[required]**

- If any 0-15 cm sample result indicates contamination impacts above background levels and a 0-1 m sample was not also collected, a 0-1 m sample will be collected from that location following the protocols used for the original 0-15 cm sample. **[contingent]**

- If a sample indicates contamination impacts above background levels for the 0-1 m depth interval, an additional sample from a depth of 1-2 m will be collected and analyzed from that location. This will be repeated, as necessary, until the vertical extent of contamination impact is bounded at that location. **[contingent]**

- The two WMA 7 drainage features combine to feed Erdman Brook in WMA 12. If ditch contamination above surface soil CG_w requirements is encountered that extends to the boundary with WMA 12, sampling will continue with a 30 m spacing into WMA 12 following the drainage feature until contamination above surface soil CG_w requirements is bounded or the portion of Erdman Brook is encountered where sediment CG requirements apply. **[contingent]**

G.9.6 Buried Infrastructure Soil Sampling

Soils associated with buried infrastructure within WMA 7 will be sampled to determine their contamination status.

- Three locations along the each piece of buried infrastructure within WMA 7 but outside the NDA geomembrane cover will be selected for soil excavation. These locations will be selected to maximize the possibility that contamination will be encountered (e.g., locations where historical or current GWS data indicate surface contamination exists). During excavation, exposed soils will be monitored by scans for evidence of elevated gross activity. The purpose of this sampling is to evaluate the presence of contamination associated with buried infrastructure. **[required]**
    - If elevated readings are encountered below a depth of 1 m, soils exhibiting the highest levels of gross activity will be sampled and analyzed.
    - If elevated readings are not encountered below a depth of 1 m, a sample representative of soils deeper than 1 m will be collected. In the case of infrastructure that did not carry waste, the sample will be from soils immediately above the line. In the case of infrastructure that did carry waste, the sample will be from soils immediately beneath the line.
- If contamination above background conditions is encountered at any selected location, trenching will continue to depth until background conditions are observed. An additional

sample will be collected from the base of the trench to verify background conditions. The purpose is to vertically bound observed contamination. **[contingent]**

- If additional buried infrastructure of potential concern is identified, a minimum of at least one soil sample from at least one biased location will collected following the protocols already described for each buried infrastructure line identified that is of potential concern. Infrastructure of potential concern is infrastructure that either carried waste or was installed after 1968. Examples of the type of additional buried infrastructure that might be encountered are water supply lines, gas lines, electrical lines, telecommunication lines, etc. The purpose of this sampling is to evaluate the presence of contamination associated with buried infrastructure. **[contingent]**

- If buried infrastructure soil sampling identifies contamination impacts greater than background, biased sampling will continue following the line until at least two consecutive locations yield soil samples below surface soil CG_w requirements. Location spacing will be based on engineering judgment, including the geometry of the line, the level of contamination encountered, and surface evidence of contamination. The purpose of this sampling is to bound the extent of contamination associated with buried infrastructure, as necessary. **[contingent]**

G.9.7 Additional Contingencies

Sampling and/or GWS data may indicate that contamination exists or extends beneath surfaces currently covered by existing structures, concrete, asphalt, or gravel. In this case, "surface soil" will be defined as soil immediately beneath the cover. If sampling or GWS data indicate that contamination may exist beneath existing structures (e.g., the NDA geomembrane cover or the hardstand area), then sampling locations will be offset along the foundation/hardstand edge to determine contamination extent. The purpose of the offset is to allow safe acquisition of data. Data collection through the NDA geomembrane cover or through hardstands in WMA 7 will not be required as part of this effort.

G.9.8 Required Laboratory Analyses

All samples will be submitted for analysis of all 18 ROI.

A select portion of the samples as described above may be analyzed for the additional 12 radionuclides of potential interest. If these sample results indicate the presence of the one or more of those radionuclides at levels of potential significance, then the balance of samples from WMA 7 will also be analyzed for the additional radionuclides that were identified.

Table G.2 summarizes the required sample numbers and the estimated number of contingency samples for WMA 7.

This sampling plan assumes that quick turn-around analyses are available for Sr-90 and Cs-137 and that soil samples will be screened for Sr-90 and Cs-137 prior to being analyzed for the balance of the ROI. Based on these screening data, contingency sampling requirements as described above may be undertaken without the benefit of the remaining analyses.

G.9.9 Decision-Making Summary

A summary of decision-making based on the WMA 7 data is as follows:

- If buried infrastructure of concern in addition to the Interceptor Trench and Leachate Transfer Line is identified, then biased locations will be selected, excavation conducted to expose the trench/line, and at least one biased sampled collected. If contamination is encountered above CG_w requirements, sampling will continue along the trench/lines until it is bounded.

- Backfill associated with the Interceptor Trench and Leachate Transfer Line will be sampled. If contamination is encountered above CG_w requirements, sampling will continue along the trench/line until contamination is bounded.

- The WMA 7 surface soil area classification as contained in Figure G.17 will be adjusted based on GWS results. These adjustments may affect systematic sample number requirements and will affect the placement of the initial round of systematic sample locations.

- Additional surface soil sampling may be required to laterally bound contamination above surface soil CG_w requirements.

- If any 0-1 m soil interval encounters contamination above CG_w requirements, additional deeper 1 m interval soil samples will be required for that location to determine vertical extent of contamination. If additional vertical samples are required, vertical sampling will continue until background activity concentrations are observed.

- Based on the GWS results, locations from the two drainage features will be selected for sampling.

- If any drainage feature sample encounters contamination above CG_w requirements, additional systematic sampling from the ditch feature will be required to further define the extent of contamination in the drainage feature.

Table G.1 Historical Data Analyses

Nuclide	# of Surface Soil Locations	# of Subsurface Soil Locations	# of Sediment Locations
Am-241	1	2	1
C-14	0	0	0
Cm-243	0	0	0
Cm-244	0	0	0
Cs-137	4	2	1
I-129	0	0	0
Np-237	0	0	0
Pu-238	1	2	1
Pu-239	1	2	1
Pu-240	1	2	1
Pu-241	1	2	1
Sr-90	4	2	1
Tc-99	0	0	0
U-232	1	2	1
U-233	1	2	1
U-234	1	2	1
U-235	1	2	1
U-238	1	2	1

Table G.2 Sample Number Estimates

	Required	Contingent	Total
Systematic Sediment Samples (0-15 cm)	0	6	6
Systematic Sediment Samples (0-1 m)	0	0	0
Biased Sediment Samples (0-15 cm)	2	6	8
Biased Sediment Samples (0-1 m)	0	0	0
Systematic Surface Soil Samples (0-15 cm)	7	5	12
Systematic Surface Soil Samples (0-1 m)	7	5	12
Biased Surface Soil Samples (0-15 cm)	0	6	6
Biased Surface Soil Samples (0-1 m)	0	6	6
Systematic Subsurface Soil Samples (1-m intervals)	0	6	6
Biased Subsurface Soil Samples (1-m intervals)	0	3	3
Buried Infrastructure Soil Samples	6	6	12
Total:	22	49	71

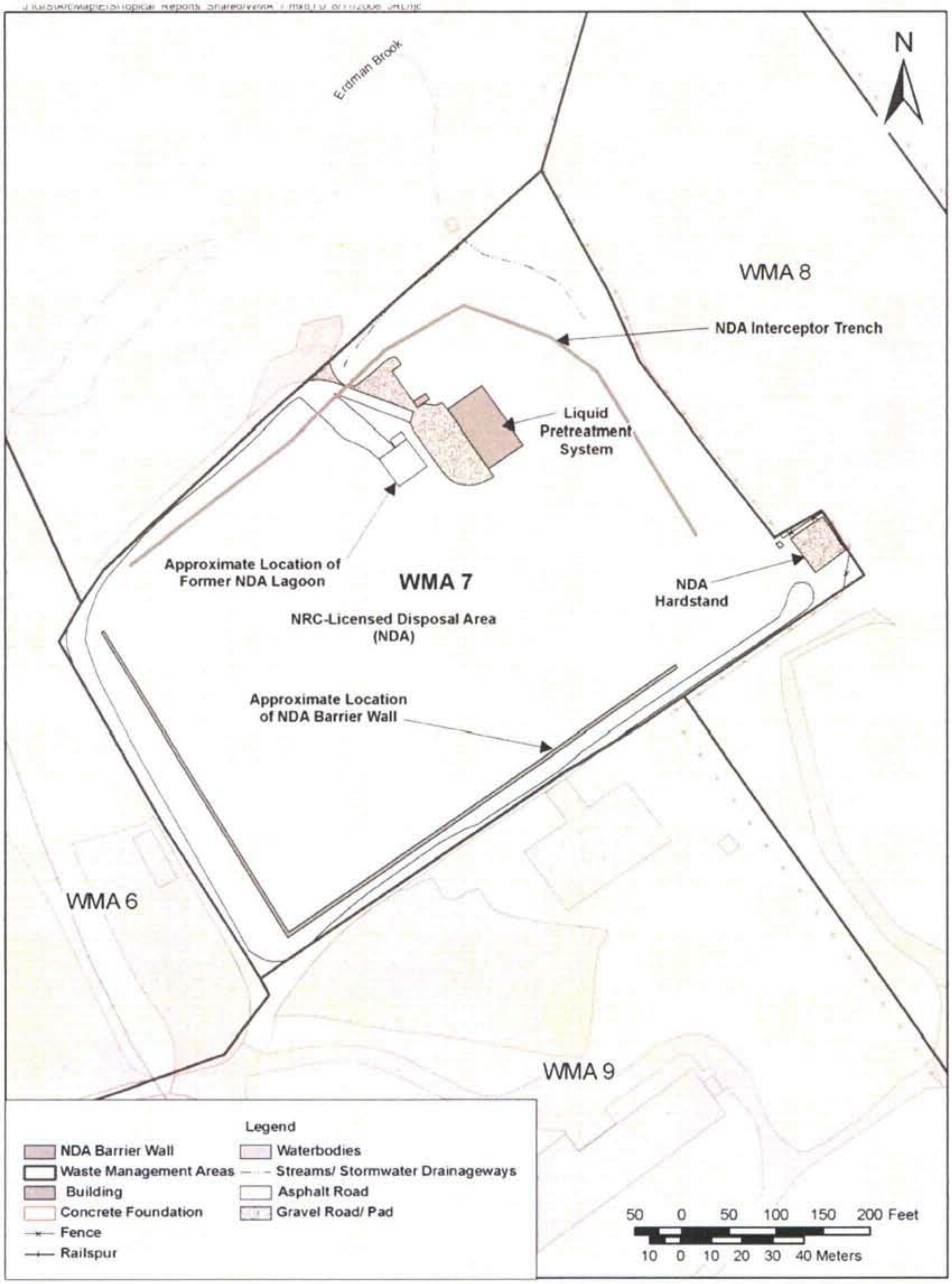

Figure G.1 WMA 7 (from Phase 1 DP, Figure 3-41)

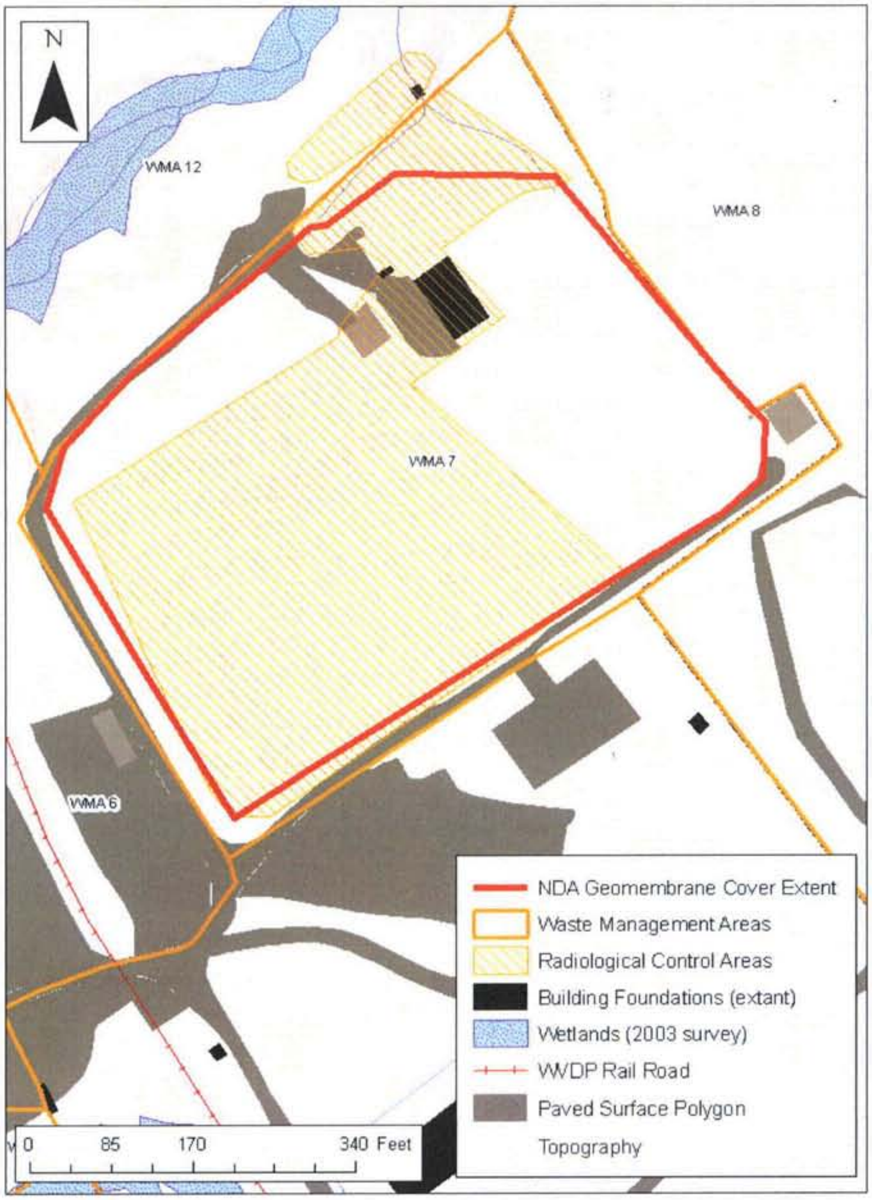

Figure G.2 WMA 7 with Topography

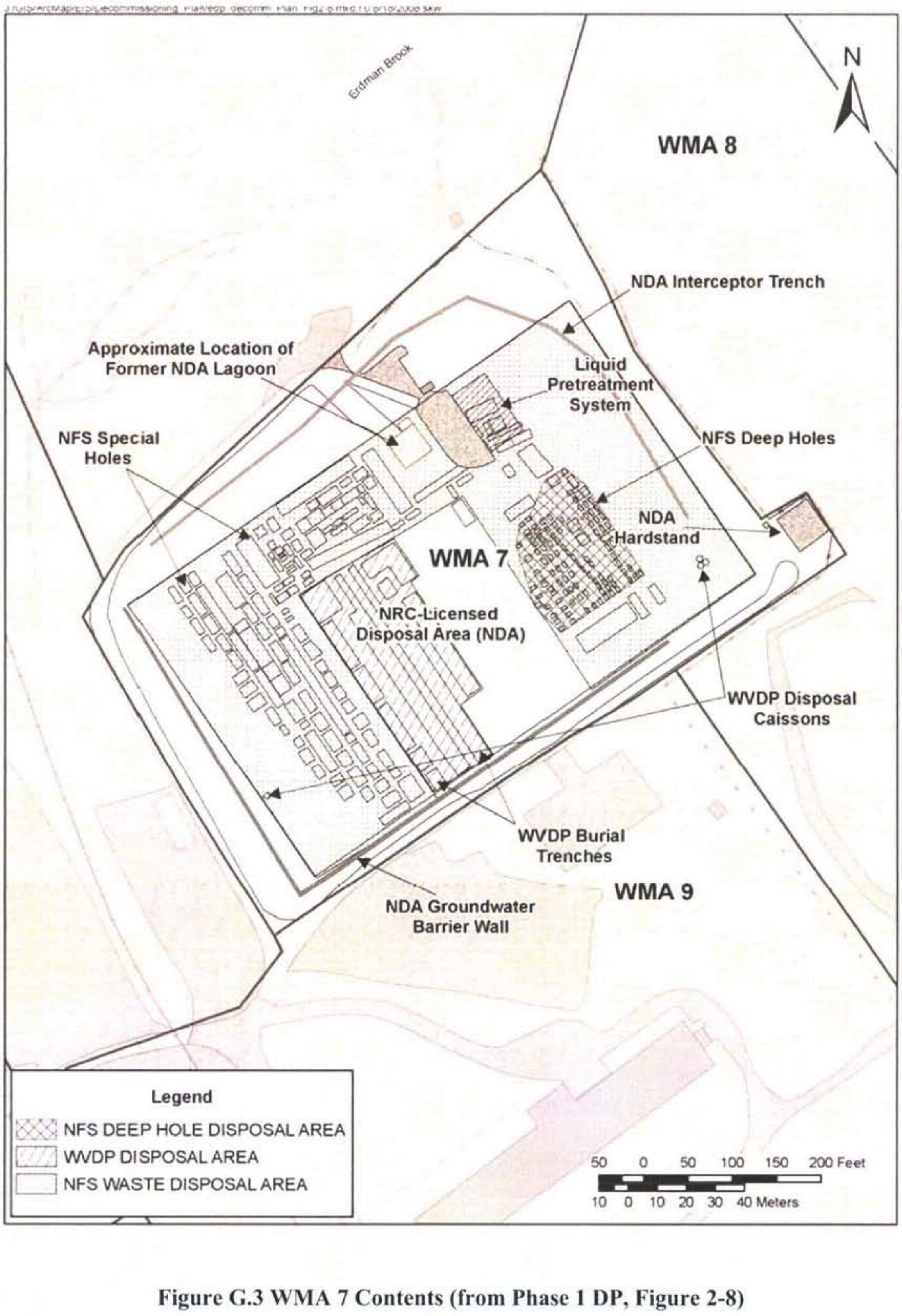

Figure G.3 WMA 7 Contents (from Phase 1 DP, Figure 2-8)

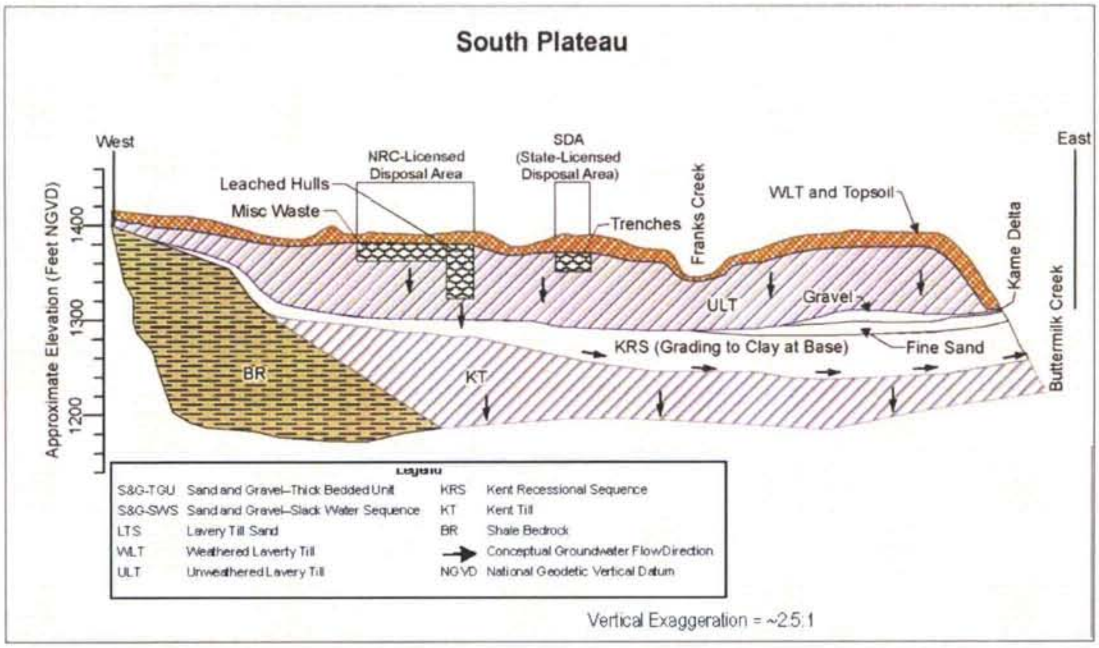

Figure G.4 Subsurface Cross-Section of WMA 7 Area (from Phase 1 DP, Figure 3-7)

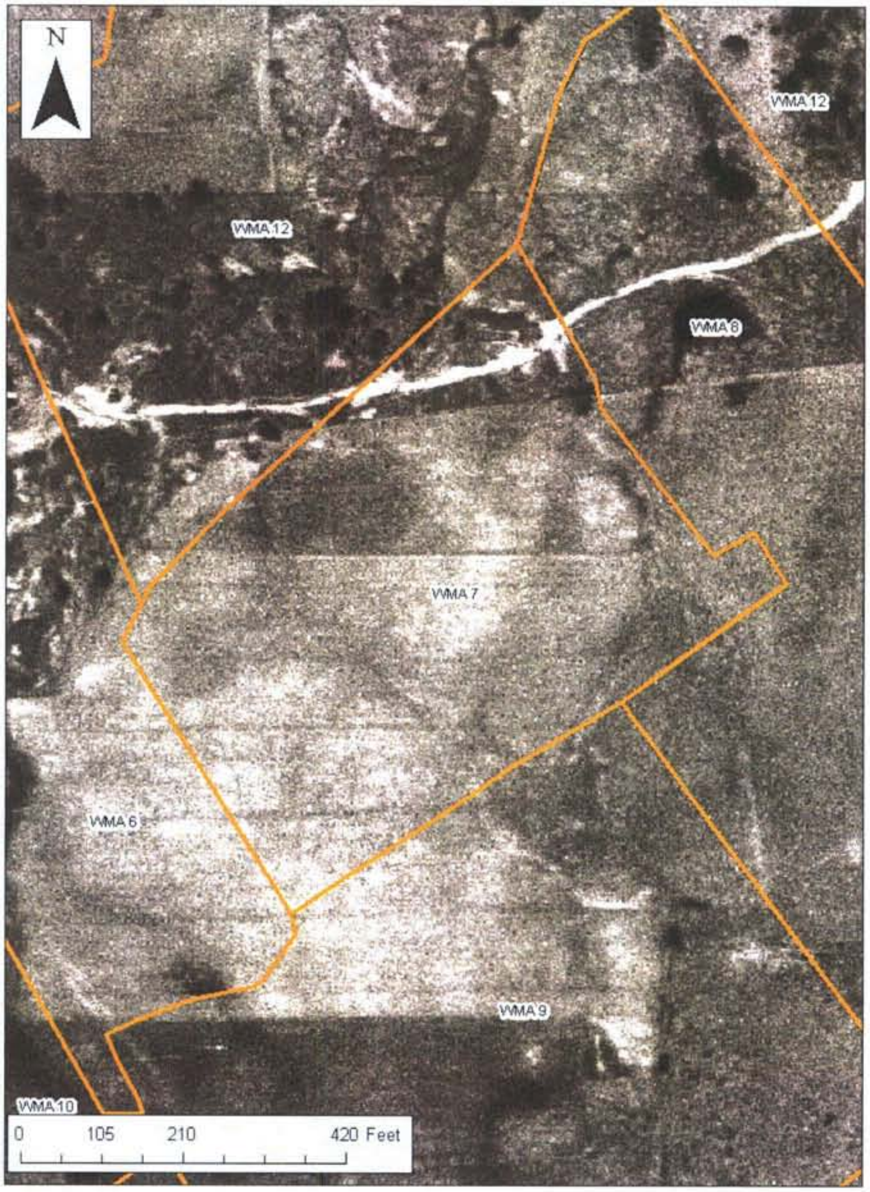

Figure G.5 WMA 7 Aerial Photograph from 1962

Figure G.6 WMA 7 Aerial Photograph from 1966

Figure G.7 WMA 7 Aerial Photograph from 1968

Figure G.8 WMA 7 Aerial Photograph from 1977

Figure G.9 WMA 7 Aerial Photograph from 1984

Figure G.10 WMA 7 Aerial Photograph from 1995

Figure G.11 Aerial Photograph from 2007

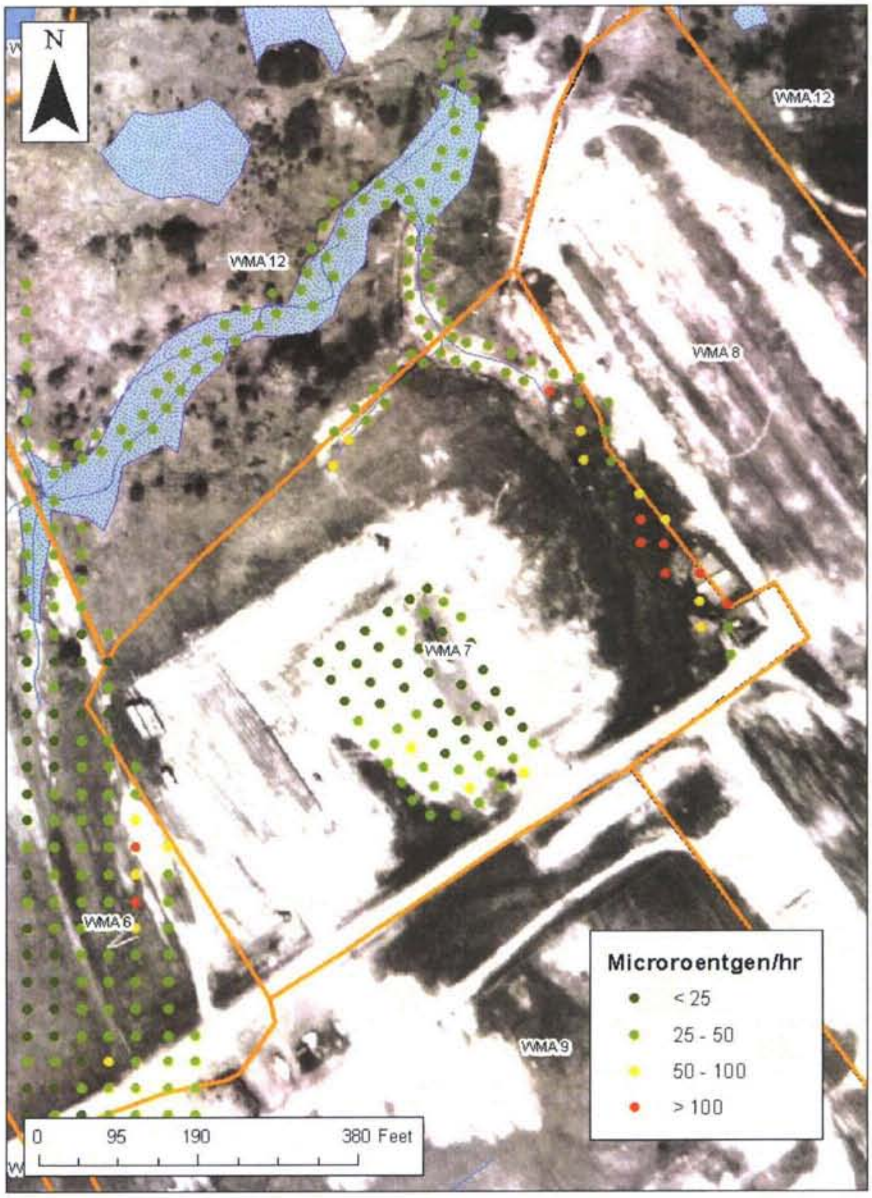

Figure G.12 WMA 7 1982 Direct Gamma Measurement Results

Figure G.13 WMA 7 1990-1991 Direct Gamma Measurement Results

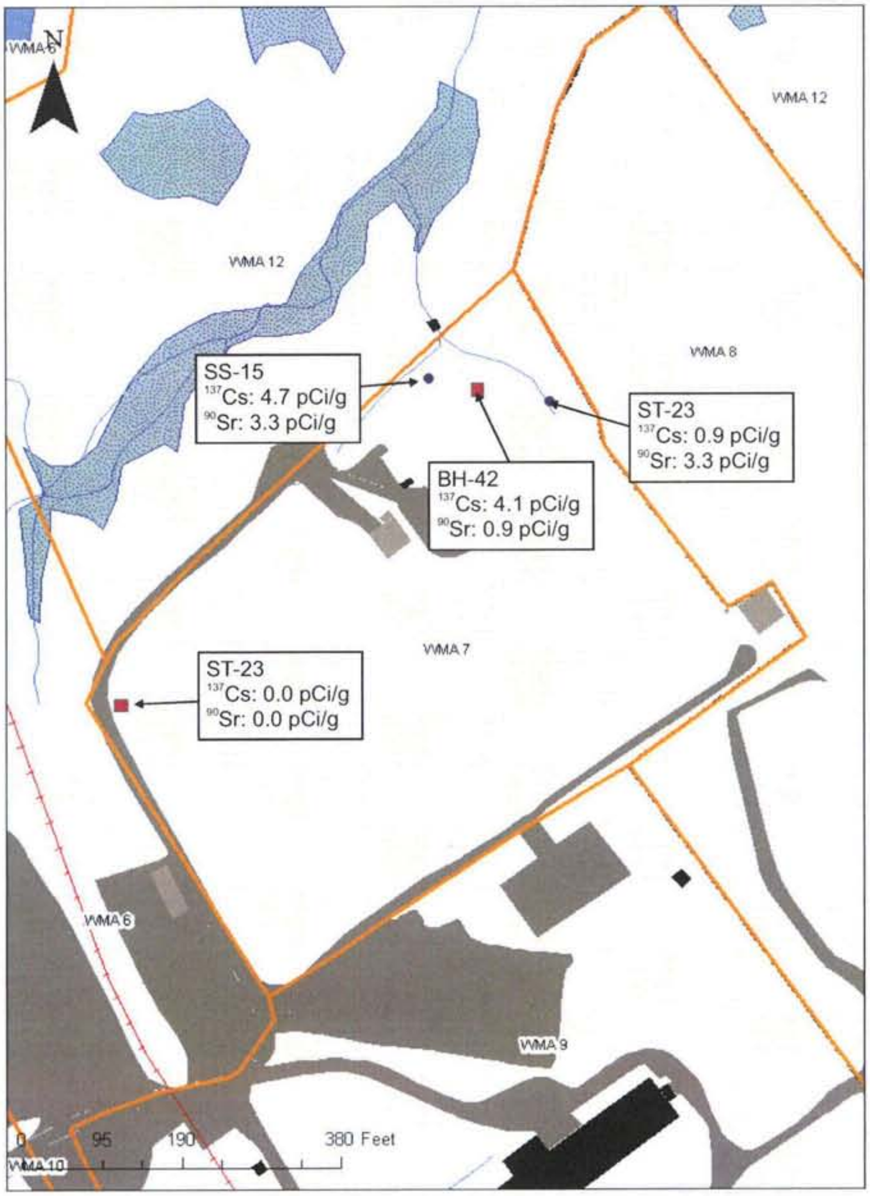

Figure G.14 WMA 7 Historical Surface Sampling Results

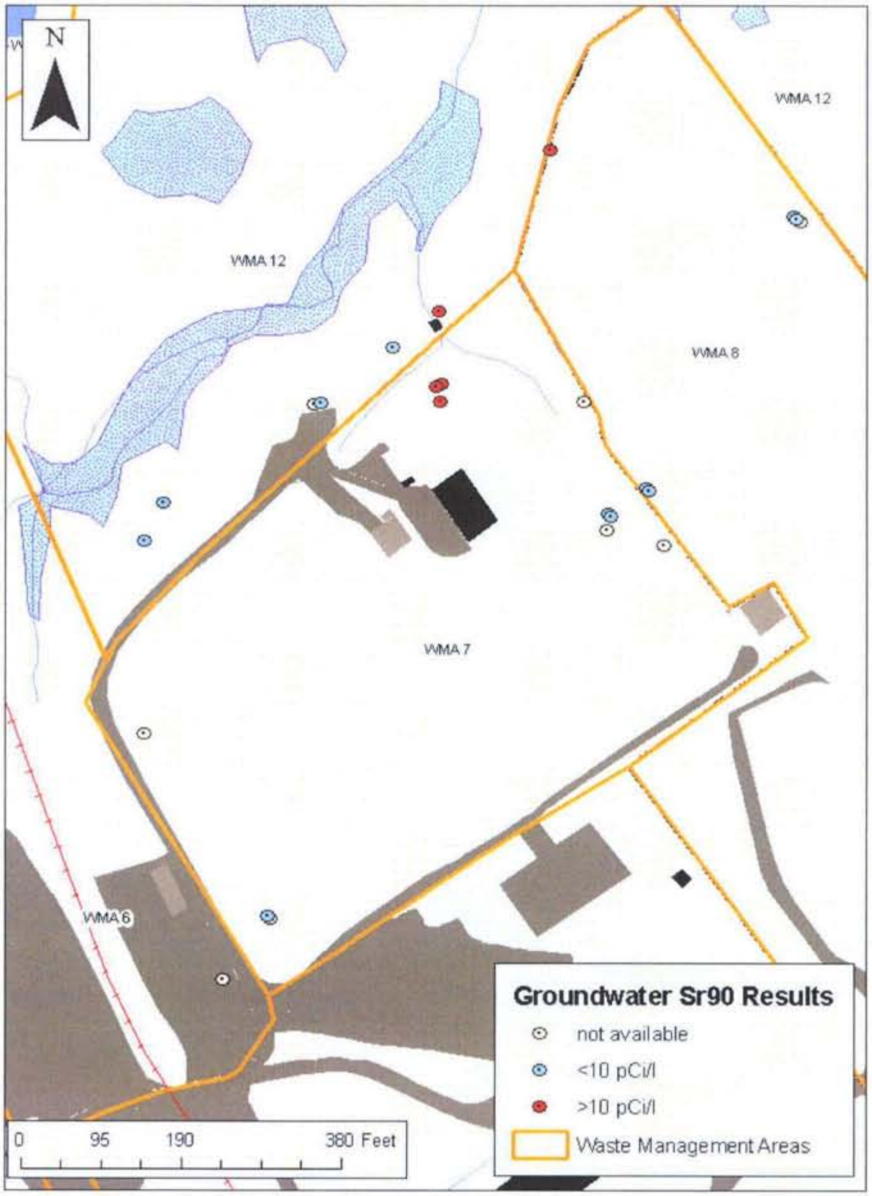

Figure G.15 WMA 7 Historical Groundwater Sr-90 Results

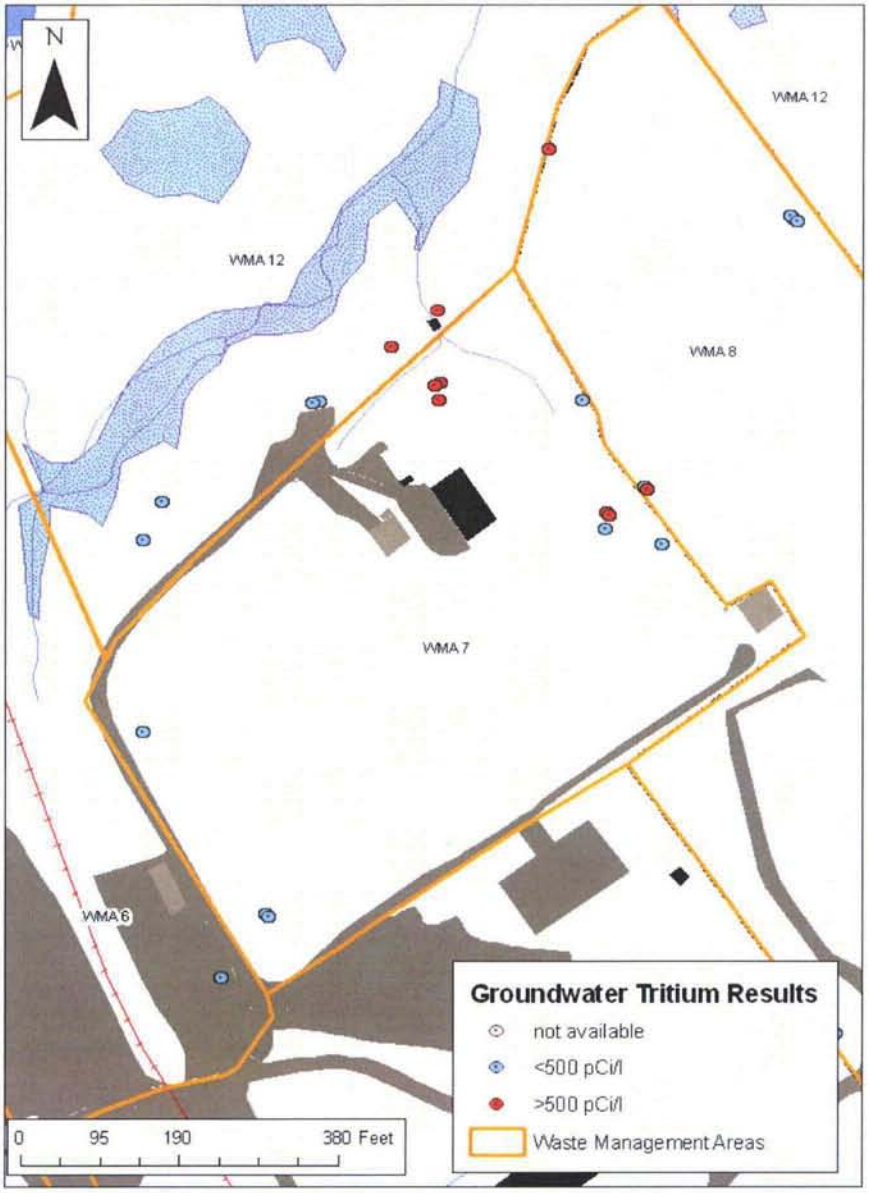

Figure G.16 WMA 7 Historical Groundwater Tritium Results

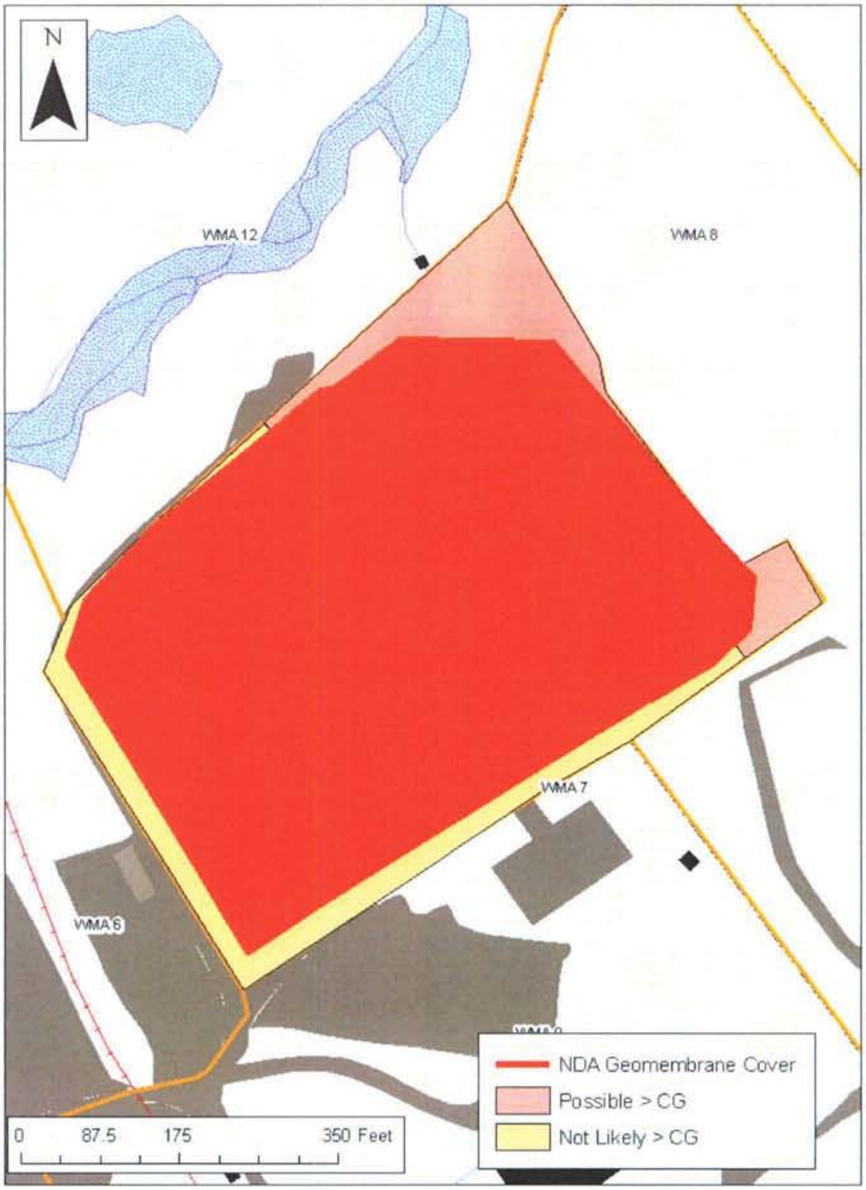

Figure G.17 Initial WMA 7 Surface Soil CSM

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APPENDIX H

WMA 9 PRE-REMEDIATION DATA COLLECTION

H.1 Background

The Waste Management Area 9 (WMA 9) is approximately 12 acres in size and contains the Drum Cell, Subcontractor Maintenance Area, and NDA Trench Soil Container Area (see Figures H.1 and H.2 for maps). The descriptions below are taken from the Phase 1 DP, Section 3.1.2.

Drum Cell. The Drum Cell was built in 1987 to store radioactive waste solidified in cement and packaged in square 71-gallon drums. It is a pre-engineered metal building 375 feet long, 60 feet wide, and 26 feet high. The facility consists of a base pad, concrete shield walls, remote waste handling equipment, container storage areas, and a control room within the weather structure. The base pad consists of concrete blocks set on a layer of compacted crushed stone, underlain by geotextile fabric and compacted clay. Concrete curbs to support the drum stacks lie on top of the base pad. All of the drums stored in the Drum Cell were removed in 2007 and disposed of at offsite LLW disposal facilities. The Drum Cell will be removed during Phase 1 of the proposed decommissioning.

Subcontractor Maintenance Area. The Subcontractor Maintenance Area (also known as the Contractor Vehicle Hardstand) is a compacted gravel pad measuring approximately 20 feet by 30 feet located in the northwest corner of WMA 9. Prior to 1991, it was used by construction subcontractors to clean asphalt paving equipment with diesel fuel. In November 1991, the area was remediated by removing the upper six inches of soil and replacing it with clean gravel. The removed soil was tested for Toxicity Characteristic Leaching Procedure parameters and found to be nonhazardous solid waste. Since 1991, the area has been used as a staging area for heavy equipment and construction materials (stone, gravel). The gravel pad will be removed during Phase 1 of the proposed decommissioning.

NDA Trench Soil Container Area. The NDA Trench Soil Container Area (comprising the NDA Roll-Off Hardstand and the Empty Waste Container Hardstand) is a gravel pad storage area located on the north side of WMA 9. It was used to store roll-off containers containing soil excavated during the installation of the NDA Interceptor Trench (located in WMA 7), which was completed in 1990. The containers were covered with tarps to prevent infiltration of precipitation and their rear gates were equipped with rubber gaskets to prevent discharge of any soil or liquid. The roll-off containers and their contained soil have been removed and disposed of offsite. The gravel pad will be removed during Phase 1 of the proposed decommissioning.

H.2 Physical Setting

WMA 9 is primarily flat and located on the south plateau. It is bordered to the southeast and southwest by wetlands. It is bordered to the west by the WVDP premises fence line, WMA 6, and WMA 10, to the north by WMA 6 and WMA 7, to the east by WMA 8, and to the south by the WVDP premises fence line. The railroad spur servicing the site runs through the western end of WMA 9. Approximately 2.6 acres of WMA 9 is composed of hardstands, roads, or railroad bed.

WMA 9 is underlain by the Lavery Till, a relatively impermeable unit.

WMA 9 is currently drained by three distinct drainage ditches trending from the northwest to the southeast where they feed Franks Creek. These include one running along the eastern side of the railway, one connecting with the southwest side of the Drum Cell facility, and one running parallel to the northeast side of WMA 9.

H.3 Area History

Figure H.3 shows WMA 9 in 1962, prior to site development. Prior to site development, the northern portion of WMA 9 was farmed. The southern portion was a shrubby area drained by the western reaches of Franks Creek.

Figure H.4 shows WMA 9 in 1966, after development of the site had begun. When the site was established, the drainage features of WMA 9 were altered so that the drainage was aligned with the fence line along the south side of WMA 9. The railroad was installed by the mid 1960s, and the northern portion of WMA 9 was cleared and used for open storage.

Figure H.5 shows WMA 9 in 1968, with an active open storage area visible adjacent to WMA 9's boundary with WMA 6 and WMA 7.

Figure H.6 shows WMA 9 in 1977. A cleared area in the southeastern portion of WMA 9 was connected to the SDA area via an access road.

Figure H.7 shows WMA 9 in 1984. By this time the SDA was covered; a road providing access from the SDA to the southern portion of WMA 9 was present.

Figure H.8 shows WMA 9 in 1995. The Drum Cell facility is in place, and the hardstand areas to the north have been changed to match their present configuration. To the south, the access road from the SDA was present.

Figure H.9 shows WMA 9 in 2007. The SDA has been capped.

H.4 Known and Suspected Releases

The Drum Cell – the only building in WMA 9 and is to be removed during Phase 1. The Drum Cell is expected to contain only low levels of residual radioactivity, if any.

There are no known significant releases within WMA 9. However, there may have been contaminated soil releases as part of the NDA interceptor trench work, and surface soils may have been contaminated by dust during the placement of wastes in the NDA and SDA.

H.5 Existing Data

Existing data sets for this area include:

- In 1982 static direct exposure readings were collected across the WVDP premises (WVNS 1982). Only a very small portion of WMA 9 was covered by these measurements on a 10-m grid. Figure H.10 shows these results color-coded by the exposure readings encountered, with the data overlain on a 1977 aerial photograph. The data suggest a slight impact along the railway line. The impacts likely extend into WMA 9.

- In 1990 and 1991 a second static direct exposure measurement program was conducted across the WVDP premises (WVNS 1992). In the case of WMA 9, this effort provided systematic coverage of its entire area on a 10-m grid. This data collection used different instrumentation and protocols than the 1982 study, so the results are not quantitatively comparable. Figure H.11 shows these results overlain on a 1995 aerial photograph. These data show marked elevated readings surrounding the Drum Cell. Given what was stored in the Drum Cell in this time frame, these readings may reflect shine from the building itself rather than elevated activity levels in the ground surface.

- There are very little sampling data for WMA 9 available within ELIMS. In 1993 two surface samples were collected pertinent to WMA 9, one in the extreme northwest corner of WMA 9 and the second in the extreme southeast corner of WMA 9. Figure H.12 shows the Cs-137 and Sr-90 results for these two samples. Both samples showed low level Sr-90 impacts; although there was some evidence of Cs-137 as well, the Sr-90 were more significant from the perspective of surface soil CG_w requirements. Neither sample was placed in a location where one would expect to find contamination. Table H.1 identifies the number of samples analyzed for each of the 18 primary radionuclides of interest (ROI).

- There are limited groundwater data for WMA 9 available within ELIMS. Figure H.13 shows groundwater sampling locations color-coded by historical Sr-90 results. Figure H.14 shows groundwater sampling locations color-coded by historical tritium results. The detection limits for Sr-90 and tritium varied widely among ELIMS samples. 10 pCi/L and 500 pCi/L were selected as thresholds for Sr-90 and tritium, respectively, because based on ELIMS data results above these activity concentrations were consistently above method detection limits and so indicative of contamination impacts rather than simply measurement error. In neither case was there significant evidence of groundwater impacts.

H.6 Planned Phase 1 DP Activities

The Drum Cell, the Subcontractor Maintenance Area hardstand, and the NDA Trench Soil Container Area hardstand will be removed during Phase 1 (see Phase 1 DP, Section 3.1 and Section 7.10).

H.7 Conceptual Site Model

Historical WMA 9 site activities have primarily included open land surface storage and storage of cement solidified radioactive waste in steel drums within the Drum Cell. Although no significant releases have been reported for this area, it is possible that there were releases associated with storage activities. These would likely have been low level releases, and would have been confined to surface soils. There is the possibility that the construction of the current configuration of hardstands might have buried surface contamination that existed prior to their construction. There is also the possibility that contamination may have found its way into the surface drainage features that drain the WMA 9 area into Franks Creek.

The only buried infrastructure expected within the WMA 9 area would be associated with electrical lines. Subsurface soil contamination associated with these lines is not considered a significant concern since there is little historical evidence of significant surface soil impacts.

Figure H.15 shows the current CSM for WMA 9 surface soils.

H.8 WMA 9-Specific Characterization Goals

- Evaluate Appropriateness of the Current List of Radionuclides of Interest (ROI).
- Explore the Possibility of Surrogate ROI.
- Determine Extent of Surface Contamination.
- Identify the Presence/Absence of Buried Contamination.
- Identify Soil Waste Stream Characteristics.
- Obtain Data to Support Phase 2 Planning.

H.9 CSAP Pre-Remediation Data Collection and Associated Decision-Making

CSAP pre-remediation data collection will consist of a number of components described in more detail below.

H.9.1 Gamma Walkover Survey Data

The purpose of performing a gamma walkover survey of the WMA 9 area is to identify the level and extent of surface contamination. This includes both general trends in average activity concentrations pertinent to the CG_w requirement, as well as the identification of isolated, more-elevated anomalies that might be indicative of discrete releases and/or CG_{emc} concerns.

A complete (100%) logged gamma walkover survey (GWS) will be conducted for accessible areas within WMA 9. Examples of areas that would not be accessible are areas where standing water is present in wetlands and the footprints of existing buildings. Based on the GWS results, surface soil within WMA 9 will be divided into three categories: (1) surface soils where GWS indicates possible surface soil CG_w exceedances; (2) surface soils where GWS indicate impacts, but those impacts are not expected to exceed surface soil CG_w standards; and (3) surface soils where there is no indication of impacts above background conditions. The purpose of this data collection is to provide insights into the spatial distribution of surface contamination, and to guide subsequent soil sampling. **[required]**

H.9.2 Surface Soil Sampling

Surface soil sampling will be used to address areas inaccessible to GWS data collection, to resolve hot spots identified by the GWS data, and to evaluate the presence, absence, and/or extent of surface contamination above CG_w requirements based on GWS results.

- **Wetlands.** It is possible that standing water will be present in wetlands that prevent GWS data collection from those areas. The most likely place for this occurring is along the western bank of the railway line. Soil sampling will be required for wetland footprints and for any other areas where standing water prevents the collection of GWS data.

  For every area where standing water or saturated soil conditions prevent GWS data collection, systematic soil sampling will take place. At least one and at most five sampling locations will be selected per area. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. In the case where an area has more than one location, locations will be selected so that each representative area does not overlap and provides systematic coverage of the area of interest. If a wetland area is less than 200 m^2 in size, one 5-point composite will be formed to be representative of the wetland's area. **[contingent]**

- **Hot Spots.** If GWS data indicate the presence of contamination that possibly exceeds "hot spot" (CG_{emc}) standards or an isolated elevated area is identified that appears indicative of a discrete release, the location of concern will be sampled with a biased sample. If biased samples are collected from a particular location, they will be collected from two depth intervals: 0-15 cm, and 0-1 m. Each biased sample will be a composite sample formed from 5 increments systematically distributed over the area of interest. The 0-15 cm samples will be analyzed for the 12 radionuclides of potential interest in addition to the 18 ROI. One down-hole gamma scan will be conducted from each biased location. The purpose of these samples is to resolve GWS anomalies, evaluate the appropriateness of the current ROI list, and verify the absence of additional ROI. **[contingent]**

- **CG_w Sampling.** Surface soil sampling may be conducted after the GWS to further clarify results, with the level and nature of sampling dependent on GWS results. If GWS results indicate no evidence of contamination impacts above background levels, no additional surface soil sampling will be required other than to address areas too wet to perform a gamma walkover survey. Based on historical direct gamma measurements, the areas most likely to have contamination exceeding surface soil CG_w requirements are along the boundary between WMA 10 and WMA 1, 3, and 5.

    - If GWS results indicate contamination impacts above background levels but that surface soil contaminant levels exceeding CG_w requirements are unlikely, a minimum of five surface soil sample locations will be identified and sampled that target the areas with the highest gross activity levels. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap. The purpose is to document the maximum activity concentrations present in surface soils within WMA 9. **[contingent]**

- If GWS results indicate surface soil contaminant levels exceeding CG_w requirements likely exist, one sampling location will be selected at the highest gross activity level to confirm CG_w exceedances and another set of sampling locations will be identified to spatially bound the extent of contamination (i.e., along the boundary of what is considered likely above CG_w requirements). Two samples will be collected from the location targeting high gross activity levels, one representative of a 0-15 cm depth interval, and one representative of a 0-1 m depth interval. One sample will be collected from each location intended to laterally bound contamination, representative of a 0-15 cm depth interval. Each sample will be a 5-increment composite formed to be representative of a 200 m^2 area. In addition, the location targeting high gross activity levels will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. Locations will be selected so that each representative area does not overlap. The purpose is to document CG_w requirement exceedances and bound the lateral extent of contamination. **[contingent]**

- If GWS results indicate areas with surface soil contamination impacts but it is unclear whether CG_w requirement exceedances are present, at most five sampling locations will be selected that systematically cover the areas of interest. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap. The purpose is to resolve the question of whether CG_w requirement exceedances exist for areas where GWS results are ambiguous. **[contingent]**

- If any 0-15 cm interval yields a sample result indicating a CG_w requirements exceedance and that sample location is not laterally bounded either by existing sampling locations with results less than CG_w requirements or by GWS data that clearly indicate contamination is not a concern, additional sampling locations will be selected so that the contamination encountered is spatially bounded. The purpose is to laterally bound contamination that is above CG_w requirements. **[contingent]**

H.9.3 Subsurface Soil Sampling

The purpose of subsurface soil sampling within WMA 9 is to determine presence and vertical extent of contamination impacts above background levels.

- If any 0-15 cm surface soil sample result indicates contamination impacts above background levels and there was not a 0-1 m sample collected from that location, a 0-1 m sample will be collected from that location following the protocols used for the original 0-15 cm surface soil sample. In addition, each soil location will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. **[contingent]**

- If a surface soil sample indicates contamination impacts above background levels for the 0-1 m depth interval, an additional sample from a depth of 1-2 m will be collected and analyzed from that location. This process will continue until the vertical extent of contamination above background is bounded. One down-hole gamma scan will be conducted from each soil location requiring deeper investigation with a static reading taken every 15 cm vertically. The purpose of these samples is to define the vertical extent of contamination. **[contingent]**

H.9.4 Drainage Feature Sampling

WMA 9 contains three distinct drainage features. For drainage features within WMA 9, the surface soil CG_w requirements apply. Surface drainage feature sampling will be conducted to determine ditch sediment contamination status relative to surface soil CG_w requirements. Surface drainage features will be sampled as follows:

- Discrete samples representing a 0-15 cm depth interval will be collected from ditch sediments. In WMA 9, the three ditches have a combined length of approximately 420 m. Samples will be systematic located using a random start, separated by 30 m. **[required]**

- If any 0-15 cm sample result indicates contamination impacts above background levels, a 0-1 m sample will be collected from that location following the protocols used for the original 0-15 cm sample. **[contingent]**

- If a sample indicates contamination impacts above background levels for the 0-1 m depth interval, an additional sample from a depth of 1-2 m will be collected and analyzed from that location. This will be repeated, as necessary, until the vertical extent of contamination impact is bounded at that location. **[contingent]**

H.9.5 Required Laboratory Analyses

All samples will be submitted for analysis of all 18 ROI.

A select portion of the samples as described above will be analyzed for the additional 12 radionuclides of potential interest. If these sample results indicate the presence of the one or more of those radionuclides at levels of potential significance, then the balance of samples from WMA 9 will also be analyzed for the additional radionuclides that were identified.

Table H.2 summarizes the required sample numbers and the estimated number of contingency samples for WMA 9.

This sampling plan assumes that quick turn-around analyses are available for Sr-90 and Cs-137 and that soil samples will be screened for Sr-90 and Cs-137 prior to being analyzed for the balance of the ROI. Based on these screening data, contingency sampling requirements as described above may be undertaken without the benefit of the remaining analyses.

H.9.6 Decision-Making Summary

A summary of decision-making based on the WMA 9 data is as follows:

- The WMA 9 surface soil area classification as contained in Figure H.15 will be adjusted based on GWS results. These adjustments may affect sample number requirements and will affect the placement of the initial round of soil sample locations.

- Depending on the outcome of the 1st round of hardstand soil sampling, additional soil sample locations will be selected to further laterally bound contamination extent.

- If any 0-1 m soil interval encounters contamination above background levels, additional deeper 1 m interval soil samples will be required for that location to determine vertical extent of contamination. If additional vertical samples are required, vertical sampling will continue until background conditions are observed.

Table H.1 Historical Data Analyses

Nuclide	# of Surface Soil Locations	# of Subsurface Soil Locations	# of Sediment Locations
Am-241	1	0	0
C-14	0	0	0
Cm-243	0	0	0
Cm-244	0	0	0
Cs-137	2	0	0
I-129	0	0	0
Np-237	0	0	0
Pu-238	1	0	0
Pu-239	1	0	0
Pu-240	1	0	0
Pu-241	1	0	0
Sr-90	2	0	0
Tc-99	0	0	0
U-232	1	0	0
U-233	1	0	0
U-234	1	0	0
U-235	1	0	0
U-238	1	0	0

Table H.2 Sample Number Estimates

	Required	Contingent	Total
Systematic Sediment Samples (0-15 cm)	14	0	14
Systematic Sediment Samples (0-1 m)	0	0	0
Biased Sediment Samples (0-15 cm)	0	0	0
Biased Sediment Samples (0-1 m)	0	0	0
Systematic Surface Soil Samples (0-15 cm)	6	6	12
Systematic Surface Soil Samples (0-1 m)	6	6	12
Biased Surface Soil Samples (0-15 cm)	0	6	6
Biased Surface Soil Samples (0-1 m)	0	6	6
Systematic Subsurface Soil Samples (1-m intervals)	0	3	3
Biased Subsurface Soil Samples (1-m intervals)	0	4	4
Buried Infrastructure Soil Samples	0	0	0
Total:	26	31	57

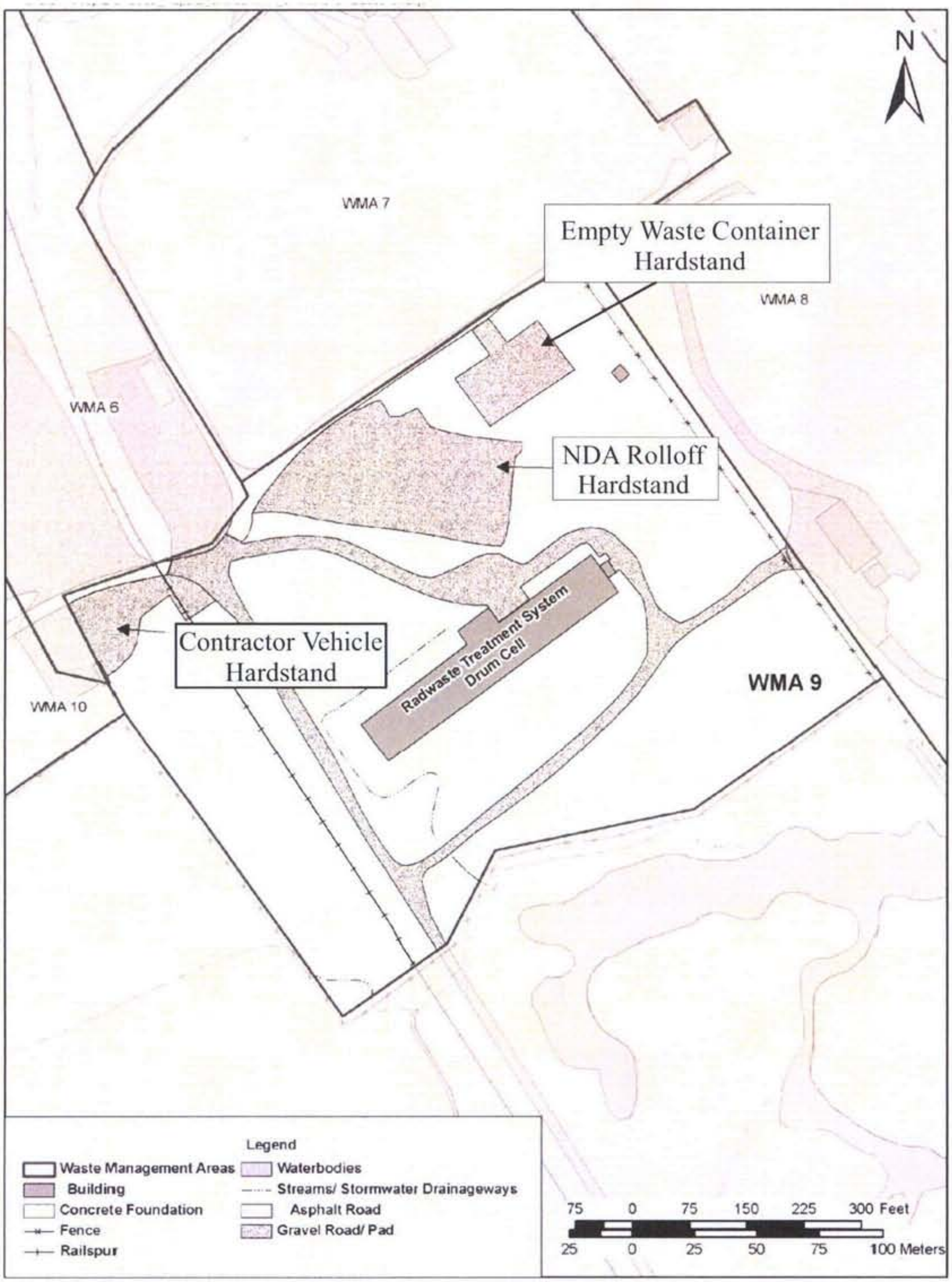

Figure H.1 WMA 9

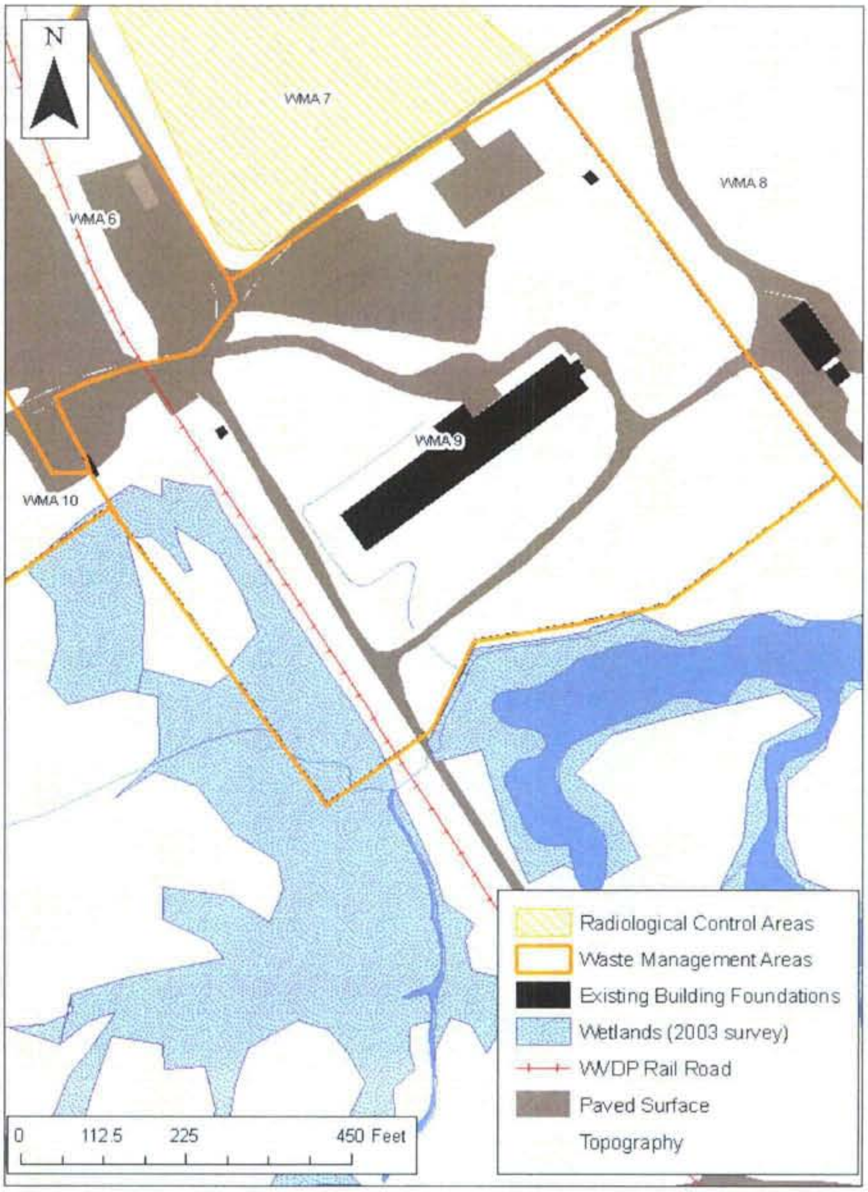

Figure H.2 WMA 9 with Topography

Figure H.3 WMA 9 Aerial Photo from 1962

Figure H.4 WMA 9 Aerial Photo from 1966

Figure H.5 WMA 9 Aerial Photo from 1968

Figure H.6 WMA 9Aerial Photo from 1977

Figure H.7 WMA 9 Aerial Photo from 1984

Figure H.8 WMA 9 Aerial Photo from 1995

Figure H.9 WMA 9 Aerial Photo from 2007

Figure H.10 WMA 9 1982 Direct Gamma Measurements

Figure H.11 WMA 9 1990-1991 Direct Gamma Measurements

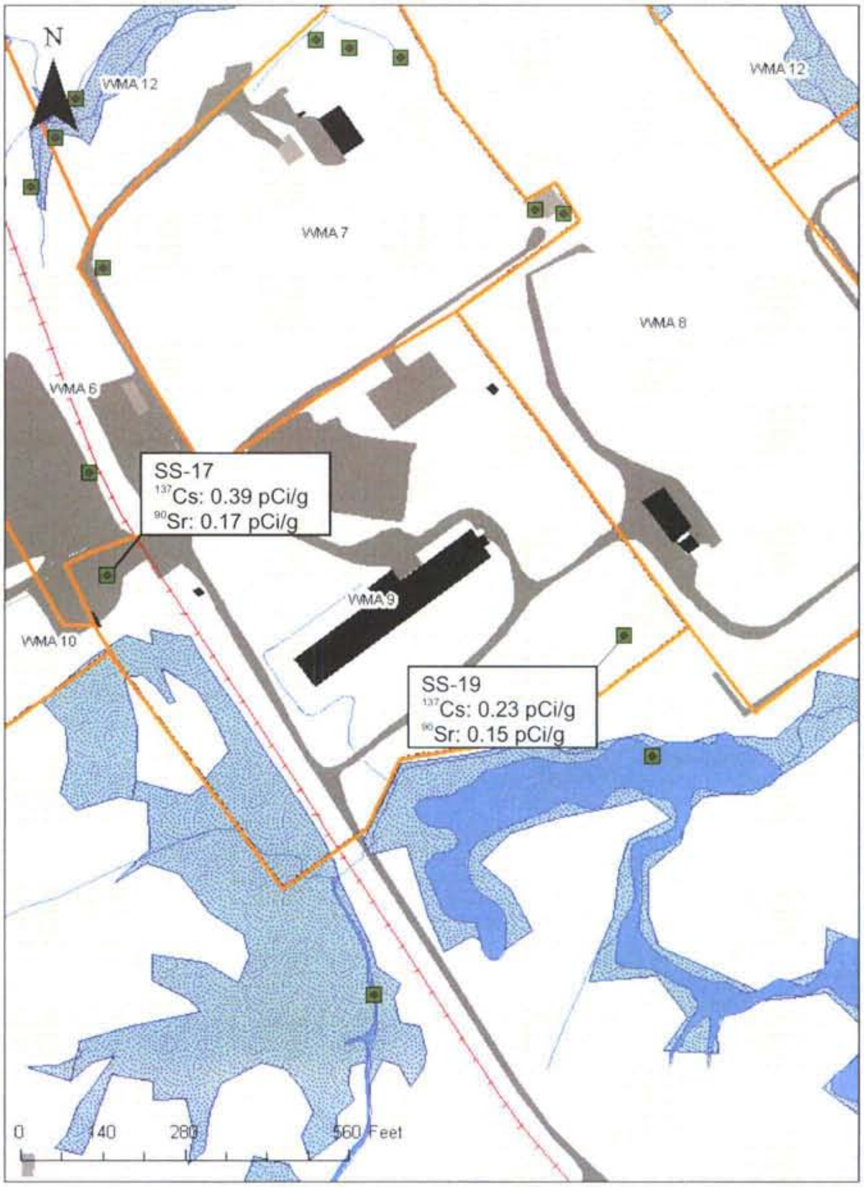

Figure H.12 WMA 9 1993 Surface Sampling Results

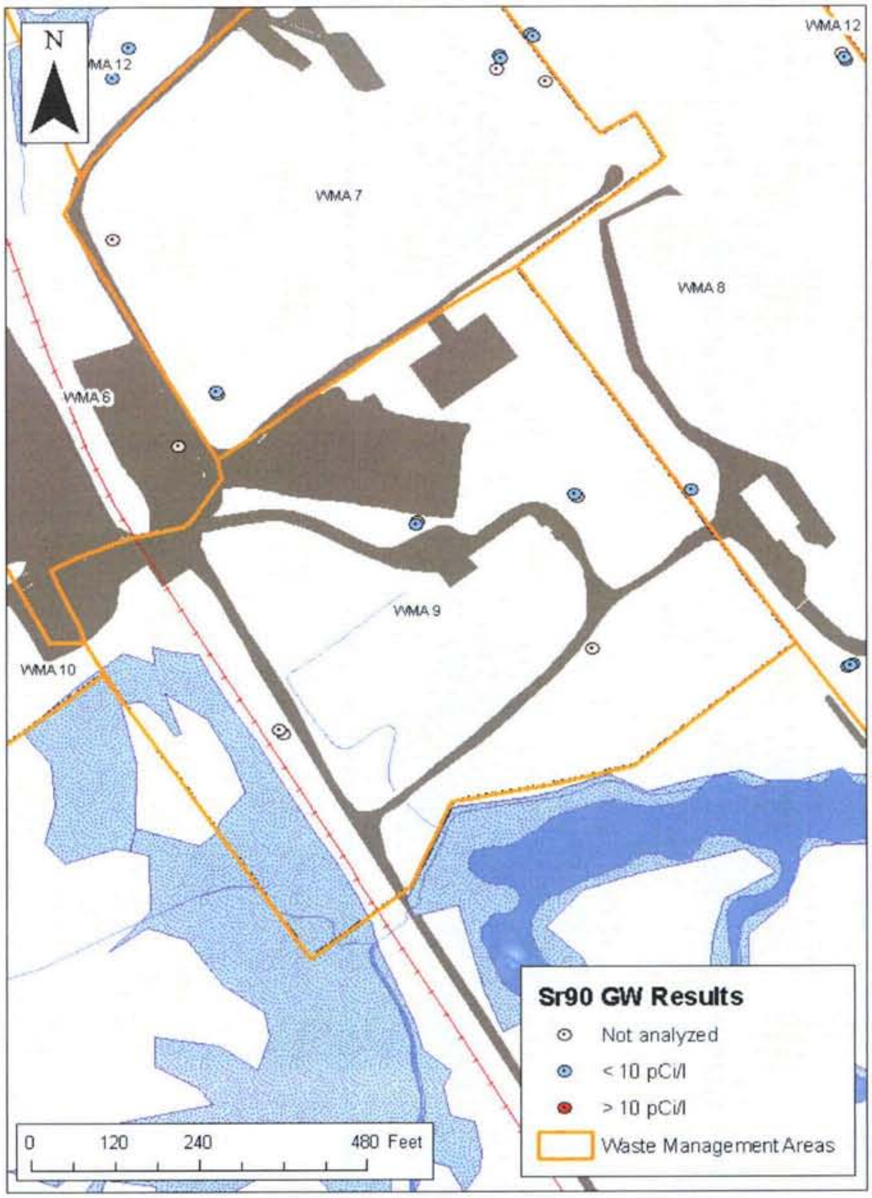

Figure H.13 Historical Groundwater Sr-90 Results

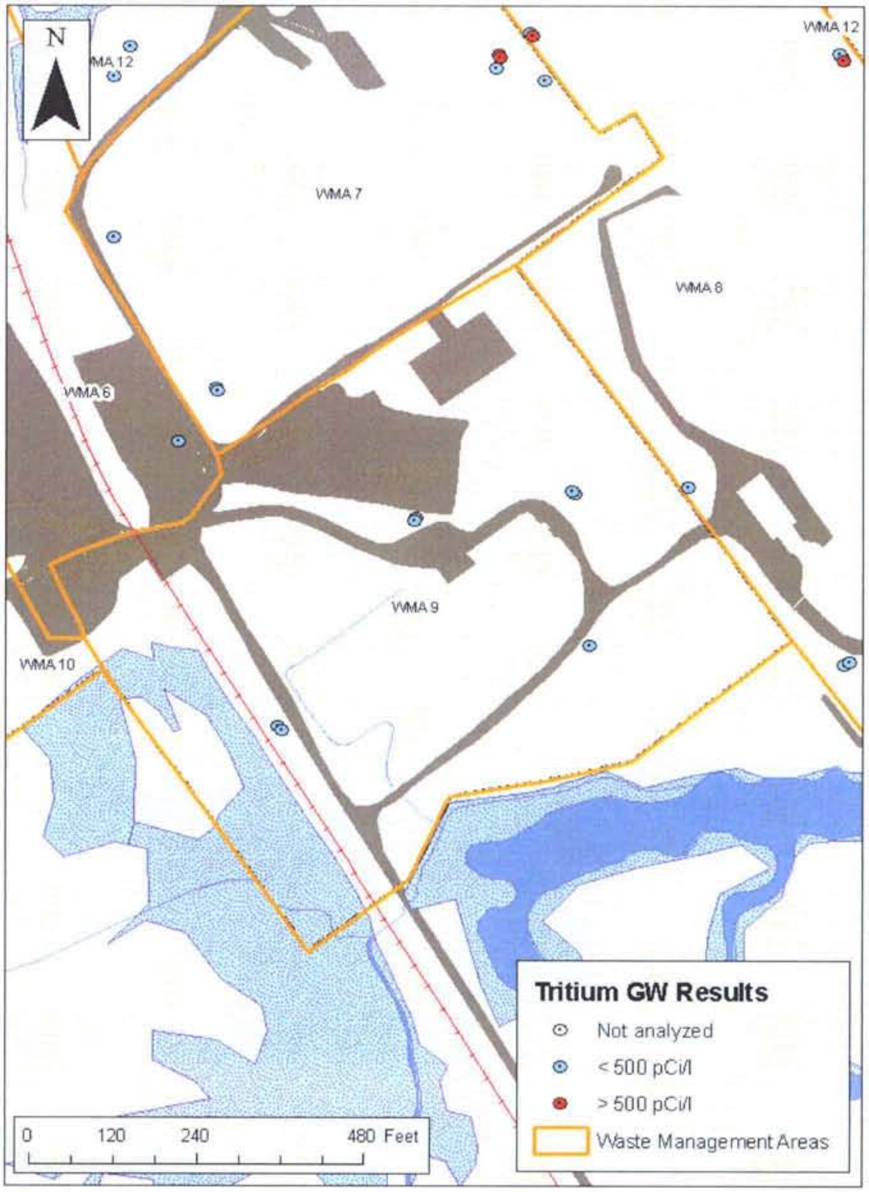

Figure H.14 Historical Groundwater Tritium Results

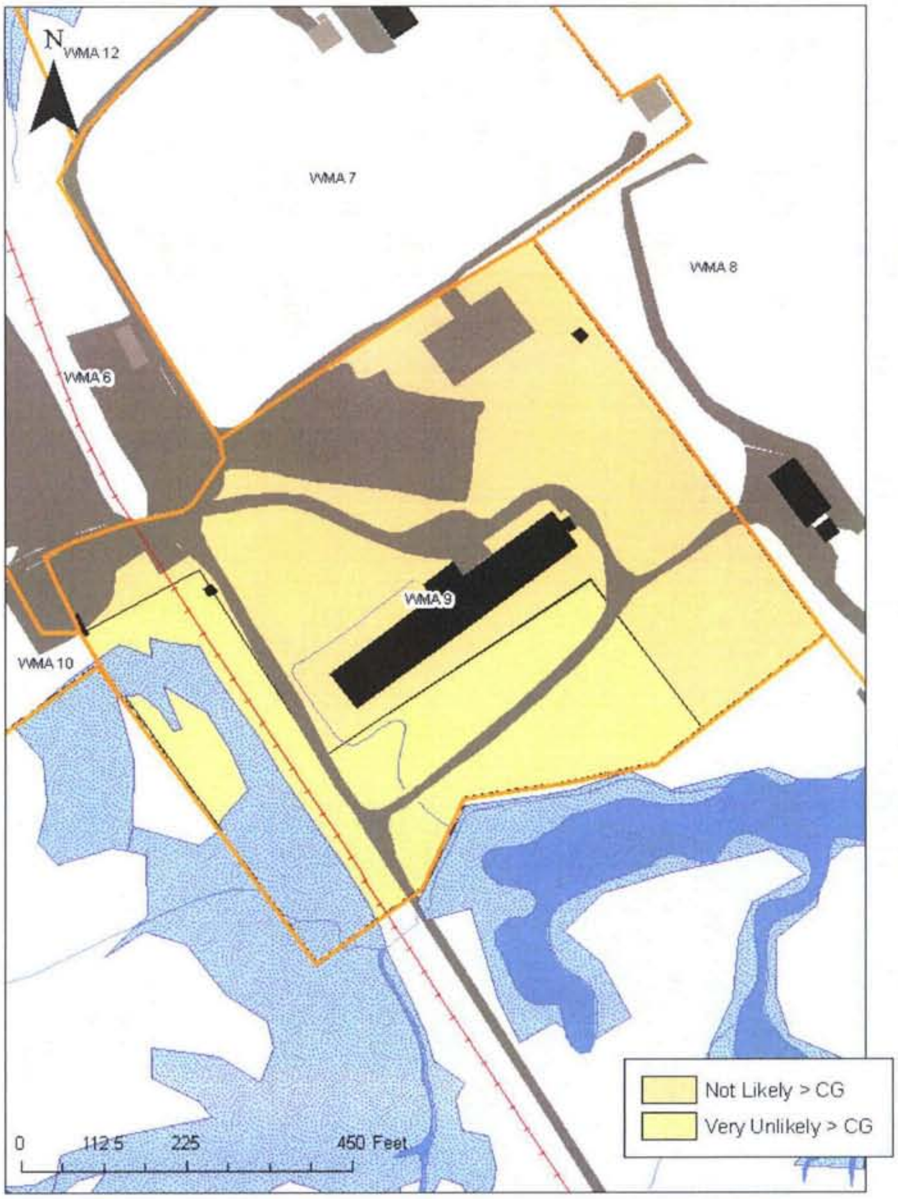

Figure H.15 WMA 9 Surface Soil CSM

APPENDIX I

WMA 10 PRE-REMEDIATION DATA COLLECTION

I.1 Background

Waste Management Area 10 (WMA 10) is approximately 30 acres in size and contains support and service facilities (see Figures I.1 and I.2 for map).

WMA 10 includes: (1) the Administration Building, (2) the Expanded Laboratory, (3) the New Warehouse, (4) the Security Gatehouse, (5) the Meteorological Tower, (6) the Main Parking Lot, and (7) the South Parking Lot. In addition, concrete slabs and foundations from several removed structures remain in place, along with the Former Waste Management Storage Area and various hardstands. The descriptions below are taken from the Phase 1 DP, Section 3.1.2.

Administration Building. The Administration Building is a single-story structure 130 feet long and 40 feet wide, 10 feet high at the eaves, and 11.7 feet high at the peak. The concrete base is nine inches thick. Construction materials include the concrete foundation, wood frame, metal siding, and metal roofing. The Administration Building was built during the 1960s. Trailers were added beginning in 1982 and removed in 2005. An addition to the west side of the building was added during the early 1980s; the addition is approximately 94 feet long and 30 feet wide with a concrete base six inches thick. The Administration Building will be removed to grade during the work to achieve the interim end state.

Meteorological Tower. The Meteorological Tower is located south of the Administration Building. Constructed of steel, it stands approximately 200 feet high on a concrete foundation. It has three main support columns with interior trusses and is anchored with five support cables. A stand-by generator and electrical boxes rest on a concrete pad.

Security Gatehouse and Fences. The main Security Gatehouse is located adjacent to the Administration Building. It was constructed in 1963. The gatehouse is 34 feet long, 20 feet wide, and nine feet high at the edge of the roof. Construction materials include a concrete foundation, concrete block walls, a concrete slab floor, and a built-up roof with metal deck.

A steel security fence surrounds the WVDP, the SDA, and miscellaneous other locations, including parts of WMA 10. It is made of galvanized chain link with galvanized steel pipe posts, with a spacing of 10 feet. The fence is seven feet high with a total length of 4.7 miles. Three strands of barbed wire are stretched across the top of the fence. Figure I.1 shows the location of the fence along the border of WMA 10.

Expanded Laboratory. The Expanded Laboratory is located south of the Administration Building. It was constructed during the early 1990s. The laboratory is 92 feet long and 50 feet wide, and consists of eight one-story modular units supported by 72 concrete piers. It was manufactured from light wood framing, metal roofing, and siding. An addition, 20 feet wide and 50 feet long on a concrete foundation wall, was built on the east side of the laboratory. This facility will be removed to grade during the work to achieve the interim end state.

New Warehouse. The New Warehouse was built during the 1980s and is located east of the Administration Building. It is a pre-engineered steel building, 80 feet wide, 250 feet long, and 21.5 feet high at the roof peak, resting on about 40 concrete piers and a poured concrete foundation wall. The concrete floor is underlain with a gravel base.

Former Waste Management Storage Area. This area is a lay-down area associated with the New Warehouse.

Parking Lots and Roadways. Two parking lots are located off Rock Springs Road: the Main Parking Lot and the South Parking Lot. The Main Parking Lot has a total paved surface area of 180,000 square feet and is covered with asphalt underlain with gravel. The South Parking Lot with approximately 80,000 square feet of parking area is also paved with asphalt. A guardrail approximately 1,200 feet long borders the lot along its southern, eastern and western sides. Roadways are constructed of a stone sub-base approximately eight-inches thick, covered with asphalt approximately four-inches thick. The total area of pavement or gravel surface within WMA 10 is approximately 11 acres.

Buried Infrastructure. Storm drainage from WMA 10 is carried by underground storm sewer lines to discharge points outside the WMA 10 boundary. Buried utilities also provide a pathway for storm drainage.

I.2 Physical Setting

WMA 10 is relatively flat. WMA 10 is bordered to the west by the WVDP premises fence line, to the north by WMA 5, to the east by WMA 3, WMA 1, WMA 6, and WMA 9, and to the south by the WVDP premises fence line. A significant portion of WMA 10's surface area (11 acres) is covered by concrete, asphalt, or gravel as part of roads, parking lots, and hardstands. There are only a few structures with relatively small footprints within WMA 10. The balance of WMA 10 is vegetated. WMA 10 is divided into a portion that is on the north plateau and a portion that is on the south plateau, with Erdman Brook the divider.

A relatively small portion of WMA 10 in the north has surface drainage captured by a storm sewer system that directs it north and off-premises. The majority of surface drainage from WMA 10 falls in Erdman Brook's watershed and is captured by Erdman Brook, which passes west to east through the center of WMA 10.

The northern half of WMA 10 is underlain by the sand and gravel unit which overlies the Lavery till. In general, groundwater in the sand and gravel unit flows to the northeast across the north plateau although there probably is also localized discharge to Erdman Brook. The Lavery till has low permeability but groundwater does flow vertically downward through this unit recharging the underlying Kent Recessional Sequence.

The weathered Lavery till is exposed at the surface in the southern half of WMA 10. Groundwater in the weathered Lavery till flows to the northeast across the south plateau with likely discharge to Erdman Brook.

The majority of WMA 10's surface has been reworked since 1981.

I.3 Area History

Figure I.3 shows WMA 10 in 1962, prior to site development. As can be seen in this photograph, much of the WMA 10 area was farmed and/or farmsteads. A public road passed north-south through the southeastern portion of WMA 10.

Figure I.4 shows WMA 10 in 1966, after construction of the Nuclear Fuel Services nuclear fuel reprocessing facility. The farmsteads had been removed, and the Administration Building and associated parking lot were present in the northern portion of WMA 10. The road that had originally passed through the southeastern portion of WMA 10 had been reworked.

Figure I.5 shows WMA 10 in 1968.

Figure I.6 shows WMA 10 in 1977. As can be seen in this photograph, there is no visual evidence of significant landscape alterations since the 1966 aerial photograph.

Figure I.7 shows WMA 10 in 1984, after establishment of the WVDP. Trailers had been added to the Administration Building, along with some unpaved roadways and what appears to be some surface reworking immediately south of the Administration Building.

Figure I.8 shows WMA 10 in 1995. Almost the entire surface area of WMA 10 has been affected by site activities.

Figure I.9 shows WMA 10 in 2007. There has been additional surface reworking for portions of WMA 10 since 1995.

I.4 Known and Suspected Releases

There are no known or suspected contamination releases that originated within the WMA 10 area.

None of the facilities constructed within WMA 10 were believed to have been impacted by site radioactivity as of 2008.

Surface soils have likely been impacted, to some degree, by radionuclides resulting in Cs-137 above background levels in surface soils. Deposition would be expected to be more pronounced in the north eastern areas of WMA 10 close to the Process Building where the1968 stack release took place.

Soils associated with drainage features within WMA 10 are known to contain elevated levels of site contaminants. The impacts are likely due to erosion, runoff, and subsequent deposition in drainage features.

I.5 Existing Data

Existing data sets for this area include:

- In 1982, static direct exposure readings were collected across the WVDP premises (WVNS 1982). Most of WMA 10 was covered by these measurements on a 10-m grid. Figure I.10 shows these results color-coded by the exposure readings encountered, with the data overlain on a 1977 aerial photograph. These data show very distinct spatial trends associated with gross activity, ranging from near background or at background conditions at the southern end of WMA 10 to significantly elevated activity levels in the northeastern corner adjacent to the Process Building. These patterns may have been associated with patterns in surface soil contamination, or may have been associated with shine from facility buildings; however, they are patterns that are potentially indicative of soil contamination and are consistent with what would have been expected from air deposition resulting from stack releases.

- In 1990 and 1991, a second static direct exposure measurement program was conducted across the WVDP premises (WVNS 1992). In the case of WMA 10, this effort provided systematic coverage on a 10-m grid, with the exception of the northern portion of WMA 10. This data collection used different instrumentation/protocols than the 1982 study, so the results are not quantitatively comparable. Figure I.11 shows these results overlain on a 1984 aerial photograph. The patterns of gross activity values match those observed in 1982.

- There have been two soil sampling activities in WMA 10 (Figure I.12) that resulted in sample results contained in ELIMS. In 1993, soil samples were collected from four locations; three locations were surface samples only and one location was sampled to depth. In 2008, three additional locations were sampled as part of a subsurface background study; at each location, soil samples were retrieved from depths greater than one meter. Table I.1 identifies the number of samples analyzed for each of the 18 primary radionuclides of interest (ROI) from these two sampling programs. The 1993 sampling program only included Am-241, Cs-137, Sr-90, the plutonium isotopes, and the uranium isotopes. The 2008 background sampling program addressed all 18 ROI. Neither sampling program collected surface samples from the northeastern portion of WMA 10, which is the portion most likely affected by contamination.

All Cs-137 results were less than one pCi/g and all Sr-90 results were non-detects. These results are not surprising because surface samples were not collected in areas most likely to have been impacted by site activities. Of the four subsurface cores (one from 1993 and three from the 2008 background study), one sample from a depth of 5 to 7 ft from GPBG0408 reported elevated gross beta and tritium concentrations above background conditions. While these values were not high, they were indicative of impacts. Tritium is the most mobile site contaminant, and while not one of the 18 ROI, tritium does serve as a marker of subsurface site impacts. GPBG0408 is immediately adjacent to WMA 6, along the eastern edge of WMA 10.

- There were eleven groundwater sampling locations on the perimeter of WMA 10, including three along its boundary with WMA 1, that have historical sample results in ELIMS. Figure I.13 shows Sr-90 results from these programs with locations color-coded by whether activity concentrations were ever observed greater than 10 pCi/L. Figure I.14 shows the same type of map for tritium, with locations color-coded by whether activity concentrations were ever observed greater than 500 pCi/L. The detection limits for Sr-90 and tritium varied widely among ELIMS samples. 10 pCi/L and 500 pCi/L were selected as thresholds for Sr-90 and tritium, respectively, because based on ELIMS data results above these activity concentrations were consistently above method detection limits and so indicative of contamination impacts rather than simply measurement error. There was some evidence of groundwater impacts along the boundary with WMA 1.

I.6 Planned Phase 1 DP Activities

A number of existing structures will be removed down to their slabs either prior to Phase 1 DP activities or as part of the Phase 1 activities (see Phase 1 DP, Section 3.1 and Section 7.10).

These include:

- the New Warehouse
- the Vitrification Cold Lab and Expanded ELAB along with adjacent supporting structures
- the former Waste Management Area
- the Administration Building
- the Changing Facility
- the Vit Hill trailers and adjacent supporting facilities, and
- the Diesel Fuel Building

These buildings were not impacted by on-site activities and are not expected to be contaminated. As part of the slab removal process, the top 2 feet of soil are expected to be removed along with the slabs.

Phase 1 will not address the Meteorological Tower and the Security Gatehouse.

I.7 Conceptual Site Model

None of the buildings within the WMA 10 boundary are believed to have been impacted by radioactive contamination. Soil surfaces that were exposed at the time of the 1968 airborne releases would have been impacted to some degree. The majority of WMA 10 was exposed soil surface at that time. Since then there has been significant reworking of WMA 10 surface soils, including paving activities. Consequently, there is the potential for surface soil contamination above background conditions for exposed soils, and also the possibility of contamination beneath existing pavement and clean fill material. The highest concentrations would likely be along the northeastern edge of WMA 10 along WMA 1, closest to the original 1968 airborne releases, and in the footprint of surface drainage features present within WMA 10.

The only structure present in 1968 was the Administration Building and the Security Gatehouse. There is the possibility of contaminated soils underneath building foundations built after 1968. The most likely facilities where this would be the case are the New Warehouse, the former

Contractor Fabrication Shop, and the Vit Hill trailer pads, whose footprints fall within elevated gross activity identified by the 1982 direct gamma survey.

There also is the possibility of low level contamination associated with storm water sewers present in WMA 10 at depths greater than 1 m. This contamination may have been introduced when the present storm water configuration was installed due to the use of contaminated soils as backfill material, and/or from leakage from the system. If contaminated fill material is present, it is most likely to be associated with the northernmost portion (within WMA 10) of the storm sewer system since this is where historical surface soil contamination would have been the greatest.

Finally, one background soil core within WMA 10 along its border with WMA 6 encountered elevated tritium in soils at a depth of 5 to 7 feet. This is most likely due to subsurface contamination extending from WMA 6. The soil core location was approximately 55 m south/southwest of the current sewage treatment facility.

Figure I.15 shows the current Conceptual Site Model (CSM) for surface and near surface WMA 10 soils. As depicted on the figure, soil contamination, if it exists, is most likely to be found in the northeastern portion of WMA 10.

I.8 WMA 10-Specific Characterization Goals

- Evaluate Appropriateness of the Current List of Radionuclides of Interest (ROI)
- Explore the Possibility of Surrogate ROI
- Determine Extent of Surface Contamination
- Develop an Inventory of Buried Infrastructure
- Identify the Presence/Absence of Buried Contamination
- Identify Soil Waste Stream Characteristics
- Establish Site-Specific Performance for On-Site and Field-Based Analytical Methods
- Obtain Data to Support Phase 2 Planning

I.9 CSAP Pre-Remediation Data Collection and Associated Decision-Making

CSAP pre-remediation data collection will consist of a number of components described in more detail below.

I.9.1 Buried Infrastructure

The footprint of buried infrastructure will be identified and mapped. Buried infrastructure of particular interest for WMA 10 is infrastructure that would have been installed after 1968, and so potentially might have involved the use of contaminated soils as backfill. An example is the current storm water sewer system. **[required]**

I.9.2 Gamma Walkover Survey Data

The purpose of performing a gamma walkover survey of the WMA 10 area is to identify the level and extent of surface contamination. This includes both general trends in average activity concentrations pertinent to the CG_w requirement, as well as the identification of isolated, more-elevated anomalies that might be indicative of discrete releases and/or CG_{emc} concerns.

A complete (100%) logged gamma walkover survey (GWS) will be conducted for accessible areas within WMA 10 including paved areas. Examples of areas that would not be accessible are areas where standing water is present in wetlands or ponds and the footprints of existing buildings. Based on the GWS results, surface soil areas within WMA 10 will be divided into three categories: (1) surface soils where GWS indicates possible surface soil CG_w exceedances; (2) surface soils where GWS indicate impacts, but those impacts are not expected to exceed surface soil CG_w standards; and (3) surface soils where there is no indication of impacts above background conditions. The purpose of this data collection is to provide insights into the spatial distribution of surface contamination, and to guide subsequent soil sampling. **[required]**

I.9.3 Surface Soil Sampling

Surface soil sampling will be used to address areas inaccessible to GWS data collection, to resolve hot spots identified by the GWS data, and to evaluate the presence, absence, and/or extent of surface contamination above CG_w requirements based on GWS results.

- **Wetlands.** It is possible that standing water will be present in wetlands that prevent GWS data collection from those areas. Consequently, soil sampling will be required for wetland footprints and for any other areas where standing water prevents the collection of GWS data.

  For every area where standing water or saturated soil conditions prevent GWS data collection, systematic soil sampling will take place. At least one and at most five sampling locations will be selected per area. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. In the case where an area has more than one location, locations will be selected so that each representative area does not overlap and provides systematic coverage of the area of interest. If a wetland area is less than 200 m^2 in size, one 5-point composite will be formed to be representative of the wetland's area. **[contingent]**

- **Hot Spots.** If GWS data indicate the presence of contamination that possibly exceeds "hot spot" (CG_{cmc}) standards or an isolated elevated area is identified that appears indicative of a discrete release, the location of concern will be sampled with a biased sample. If biased samples are collected from a particular location, they will be collected from two depth intervals: 0-15 cm, and 0-1 m. Each biased sample will be a composite sample formed from 5 increments systematically distributed over the area of interest. The 0-15 cm samples will be analyzed for the 12 radionuclides of potential interest in addition to the 18 ROI. One down-hole gamma scan will be conducted from each biased location. The purpose of these samples is to resolve GWS anomalies, evaluate the appropriateness of the current ROI list, and verify the absence of additional ROI. **[contingent]**

- **CG_w Sampling.** Surface soil sampling may be conducted after the GWS to further clarify results, with the level and nature of sampling dependent on GWS results. If GWS results indicate no evidence of contamination impacts above background levels, no additional surface soil sampling will be required other than to address areas too wet to perform a gamma walkover survey.

- If GWS results indicate contamination impacts above background levels but that surface soil contaminant levels exceeding CG_w requirements are unlikely, a minimum of five surface soil sample locations will be identified and sampled that target the areas with the highest gross activity levels. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap. The purpose is to document the maximum activity concentrations present in surface soils within WMA 10. **[contingent]**

- If GWS results indicate surface soil contaminant levels exceeding CG_w requirements likely exist, one sampling location will be selected at the highest gross activity level to confirm CG_w exceedances and another set of sampling locations will be identified to spatially bound the extent of contamination (i.e., along the boundary of what is considered likely above CG_w requirements). Two samples will be collected from the location targeting high gross activity levels, one representative of a 0-15 cm depth interval, and one representative of a 0-1 m depth interval. One sample will be collected from each location intended to laterally bound contamination, representative of a 0-15 cm depth interval. Each sample will be a 5-increment composite formed to be representative of a 200 m^2 area. In addition, the location targeting high gross activity levels will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. Locations will be selected so that each representative area does not overlap. The purpose is to document CG_w requirement exceedances and bound the lateral extent of contamination. **[contingent]**

- If GWS results indicate areas with surface soil contamination impacts but it is unclear whether CG_w requirement exceedances are present, at most five sampling locations will be selected that systematically cover the areas of interest. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap. The purpose is to resolve the question of whether CG_w requirement exceedances exist for areas where GWS results are ambiguous. **[contingent]**

- If any 0-15 cm interval yields a sample result indicating a CG_w requirements exceedance and that sample location is not laterally bounded either by existing sampling locations with results less than CG_w requirements or by GWS data that clearly indicate contamination is not a concern, additional sampling locations will be selected so that the contamination encountered is spatially bounded. The purpose is to laterally bound contamination that is above CG_w requirements. **[contingent]**

I.9.4 Subsurface Soil Sampling

The purpose of subsurface soil sampling within WMA 10 is to determine presence and vertical extent of contamination impacts above background levels.

- If any 0-15 cm surface soil sample result indicates contamination impacts above background levels and there was not a 0-1 m sample collected from that location, a 0-1 m sample will be collected from that location following the protocols used for the original 0-15 cm surface soil sample. In addition, each soil location will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. **[contingent]**

- If a surface soil sample indicates contamination impacts above background levels for the 0-1 m depth interval, an additional sample from a depth of 1-2 m will be collected and analyzed from that location. This process will continue until the vertical extent of contamination above background is bounded. One down-hole gamma scan will be conducted from each soil location requiring deeper investigation with a static reading taken every 15 cm vertically. The purpose of these samples is to define the vertical extent of contamination. **[contingent]**

I.9.5 Drainage Feature Sampling

Portions of WMA 10 include surface drainage features (i.e., ditches). For drainage features within WMA 10, the surface soil CG_w requirements apply. Surface drainage feature sampling will be conducted to determine ditch sediment contamination status relative to surface soil CG requirements. Surface drainage features will be sampled as follows:

- Discrete samples representing a 0-15 cm depth interval will be collected from ditch sediments for those ditches that have potential contamination concerns. In the case of WMA 10, this is about a 90 m stretch of Erdman Brook extending from the WAM 6 boundary westward to where the brook bifurcates into two feeder streams. Samples will be systematic located using a random start, separated by 30 m. **[required]**

- If any 0-15 cm sample result indicates contamination impacts above background levels, a 0-1 m sample will be collected from that location following the protocols used for the original 0-15 cm sample. **[contingent]**

- If a sample indicates contamination impacts above background levels for the 0-1 m depth interval, an additional sample from a depth of 1-2 m will be collected and analyzed from that location. This will be repeated, as necessary, until the vertical extent of contamination impact is bounded at that location. **[contingent]**

- If the eastern-most ditch sampling point indicates contamination above the surface soil CG_w requirement, systematic sampling will continue eastward following the ditch with a 30 m spacing until results are below the surface soil CG_w.

I.9.6 Buried Infrastructure Soil Sampling

Soils associated with buried infrastructure within WMA 10 will be sampled to determine their contamination status.

- For a minimum of five selected locations along the main storm sewer line within WMA 10, excavation will take place to expose the line. These locations will be selected to maximize the possibility that contamination will be encountered (e.g., locations where historical or current GWS data indicate surface contamination exists). During excavation, exposed soils will be monitored by scans for evidence of elevated gross activity. The purpose of this sampling is to evaluate the presence of contamination associated with buried infrastructure. **[required]**

- o If elevated readings are encountered below a depth of 1 m, soils exhibiting the highest levels of gross activity will be sampled and analyzed.

- o If elevated readings are not encountered below a depth of 1 m, a sample representative of soils deeper than 1 m but above the storm sewer line will be obtained.

- If contamination above background conditions is encountered at any selected location, trenching will continue to depth until background conditions are observed. An additional sample will be collected from the base of the trench to verify background conditions. The purpose is to vertically bound observed contamination. **[contingent]**

- If additional buried infrastructure of potential concern is identified, a minimum of at least one soil sample from at least one biased location will collected following the protocols described for the main storm sewer line for each buried infrastructure line identified that is of potential concern. Infrastructure of potential concern is infrastructure that either carried waste or was installed after 1968. Examples of the type of additional buried infrastructure that might be encountered are water supply lines, gas lines, electrical lines, telecommunication lines, etc. The purpose of this sampling is to evaluate the presence of contamination associated with buried infrastructure. **[contingent]**

- If buried infrastructure soil sampling identifies contamination impacts greater than background, biased sampling will continue following the line away from the WMA 1, 3, and 5, until at least two consecutive locations yield soil samples below surface soil CG_w requirements. Location spacing will be based on engineering judgment, including the geometry of the line, the distance from WMA 1, 3, and 5, the level of contamination encountered, and surface evidence of contamination. The purpose of this sampling is to bound the extent of contamination associated with buried infrastructure, as necessary. **[contingent]**

I.9.7 Additional Contingencies

Sampling and/or GWS data may indicate that contamination exists or extends beneath surfaces currently covered by existing structures, concrete, asphalt, or gravel. In this case, "surface soil" will be defined as soil immediately beneath the cover. If sampling or GWS data indicate that contamination may exist beneath existing structures (e.g., the Administration Building, Security Gatehouse, or hardstand areas), then sampling locations will be offset along the foundation/hardstand edge to determine contamination extent. The purpose of the offset is to allow safe acquisition of data. Data collection through the floors of existing buildings or through hardstands in WMA 10 will not be required as part of this effort.

WMA 10 abuts up to several other areas that have the potential for subsurface soil contamination concern at depths greater than one meter (e.g., WMA 1). Sampling efforts associated with those areas may result in soil core collection that extends into WMA 10 as necessary.

I.9.8 Required Laboratory Analyses

All samples will be submitted for analysis of all 18 ROI.

A select portion of the samples as described above will be analyzed for the additional 12 radionuclides of potential interest. If these sample results indicate the presence of the one or more of those radionuclides at levels of potential significance, then the balance of samples from WMA 10 will also be analyzed for the additional radionuclides that were identified.

Table I.2 summarizes the required sample numbers and the estimated number of contingency samples for WMA 10.

This sampling plan assumes that quick turn-around analyses are available for Sr-90 and Cs-137 and that soil samples will be screened for Sr-90 and Cs-137 prior to being analyzed for the balance of the ROI. Based on these screening data, contingency sampling requirements as described above may be undertaken without the benefit of the remaining analyses.

I.9.9 Decision-Making Summary

A summary of decision-making based on the WMA 10 data is as follows:

- If buried infrastructure of concern is identified (in addition to the main storm sewer line), then biased locations will be selected, excavation conducted to expose the line, and at least one biased sampled collected. If contamination is encountered above surface soil CG_w requirements, sampling will continue along these lines until it is bounded.

- Backfill associated with the main storm sewer line will be sampled. If contamination is encountered above surface soil CG_w requirements, sampling will continue along the main line until contamination is bounded.

- The WMA 10 surface soil area classification as contained in Figure I.15 will be adjusted based on GWS results. These adjustments may affect systematic sample number requirements and will affect the placement of the initial round of systematic sample locations.

- Depending on the outcome of the first round of systematic soil sampling, additional systematic soil sample locations will be selected to further laterally bound contamination extent.

- If contamination above background levels is encountered in any 0-1 m soil interval, additional deeper 1-m interval soil samples will be required for that location to determine vertical extent of contamination. If additional vertical samples are required, vertical sampling will continue until background conditions are observed.

Table I.1 Historical Data Analyses

Nuclide	# of Surface Soil Locations	# of Subsurface Soil Locations	# of Sediment Locations
Am-241	3	4	0
C-14	0	3	0
Cm-243	0	3	0
Cm-244	0	3	0
Cs-137	4	4	0
I-129	0	3	0
Np-237	0	3	0
Pu-238	3	4	0
Pu-239	3	4	0
Pu-240	3	4	0
Pu-241	3	4	0
Sr-90	4	4	0
Tc-99	0	3	0
U-232	3	4	0
U-233	3	4	0
U-234	3	4	0
U-235	3	4	0
U-238	3	4	0

Table I.2 Sample Number Estimates

	Required	Contingent	Total
Systematic Sediment Samples (0-15 cm)	3	3	6
Systematic Sediment Samples (0-1 m)	0	2	2
Biased Sediment Samples (0-15 cm)	0	0	0
Biased Sediment Samples (0-1 m)	0	0	0
Systematic Surface Soil Samples (0-15 cm)	5	15	20
Systematic Surface Soil Samples (0-1 m)	5	15	20
Biased Surface Soil Samples (0-15 cm)	0	6	6
Biased Surface Soil Samples (0-1 m)	0	6	6
Systematic Subsurface Soil Samples (1-m intervals)	0	5	5
Biased Subsurface Soil Samples (1-m intervals)	0	3	3
Buried Infrastructure Soil Samples	5	6	11
Total:	18	61	79

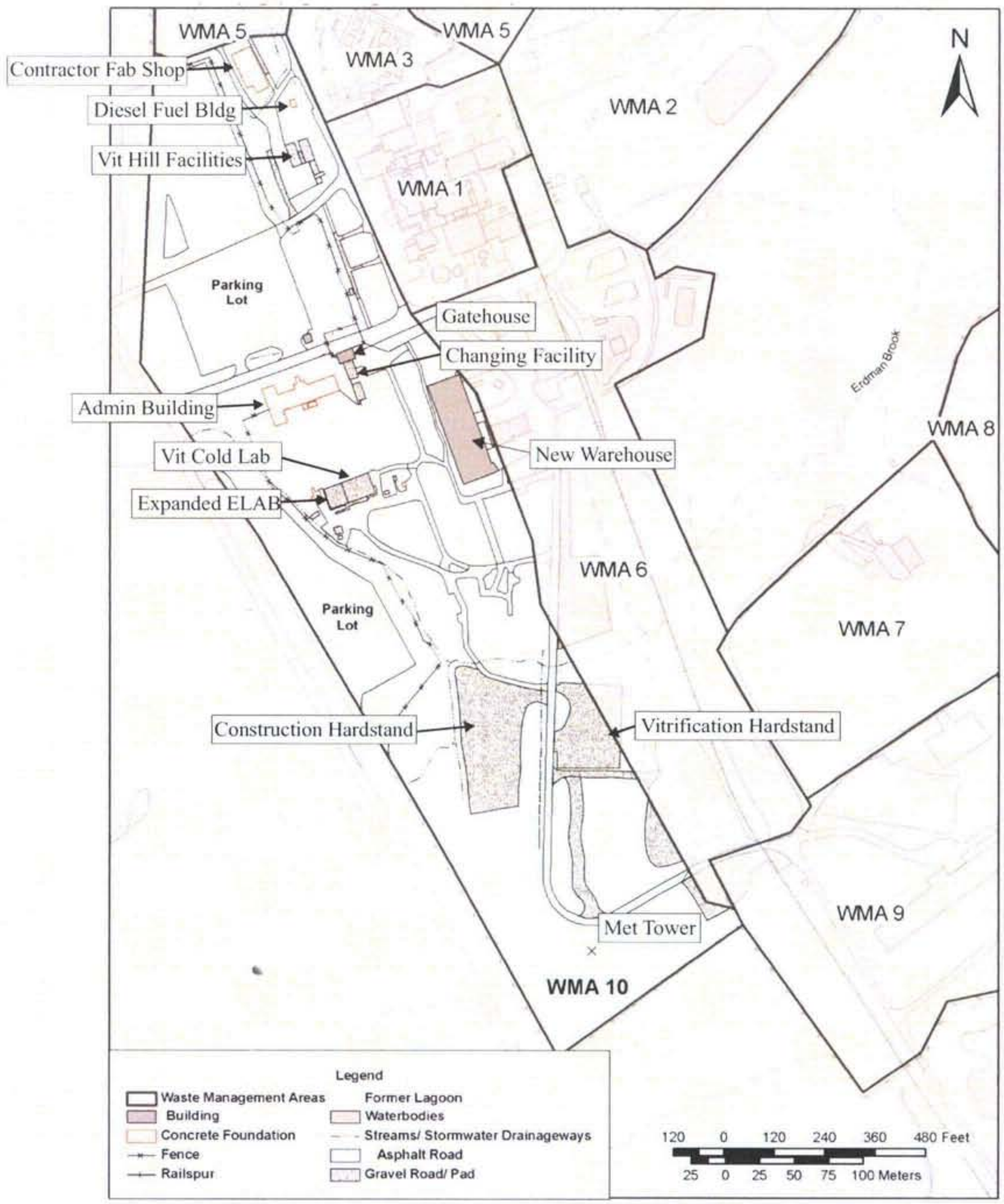

Figure I.1 WMA 10 (adapted from Phase 1 DP, Figure 3-43)

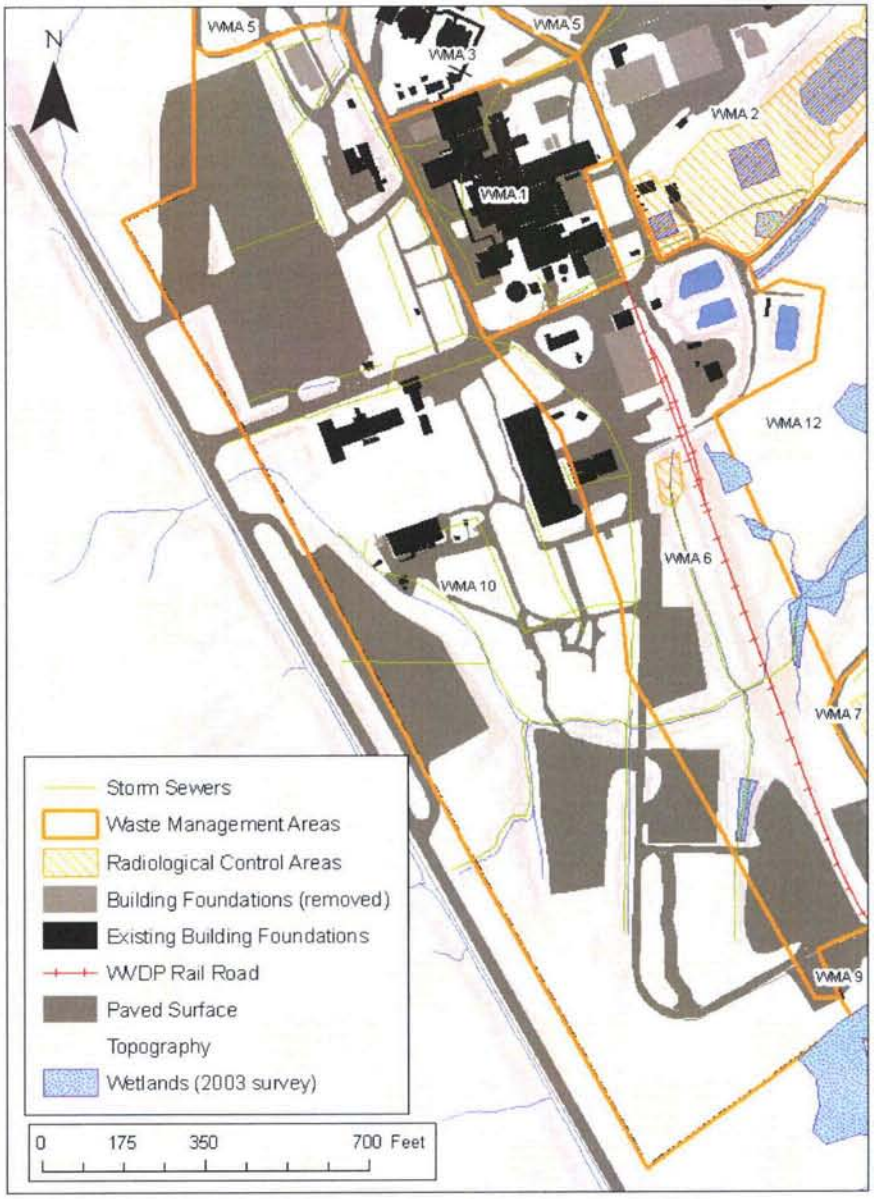

Figure I.2 WMA 10 with Topography

Figure I.3 WMA 10 Aerial Photograph from 1962

Figure I.4 WMA 10 Aerial Photograph from 1966

Figure I.5 WMA 10 Aerial Photograph from 1968

Figure I.6 WMA 10 Aerial Photograph from 1977

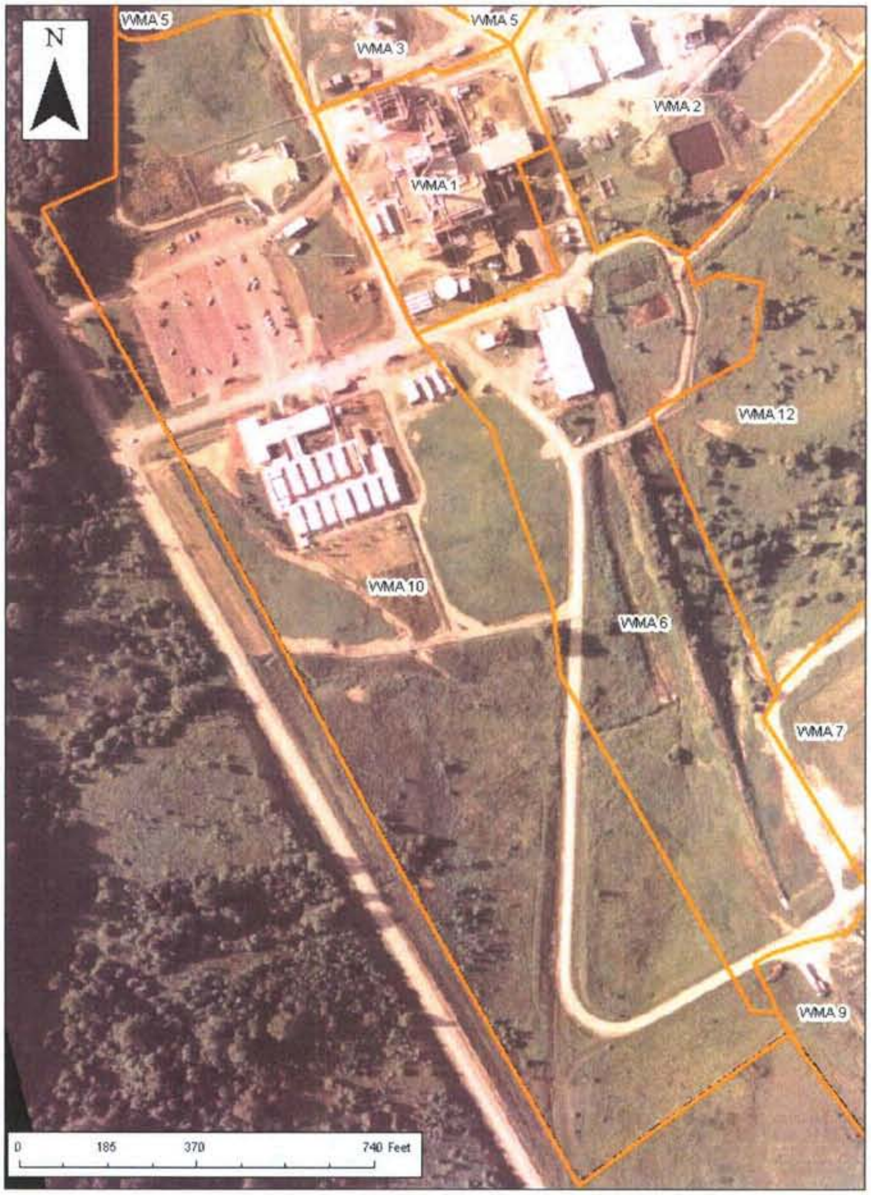

Figure I.7 WMA 10 Aerial Photograph from 1984

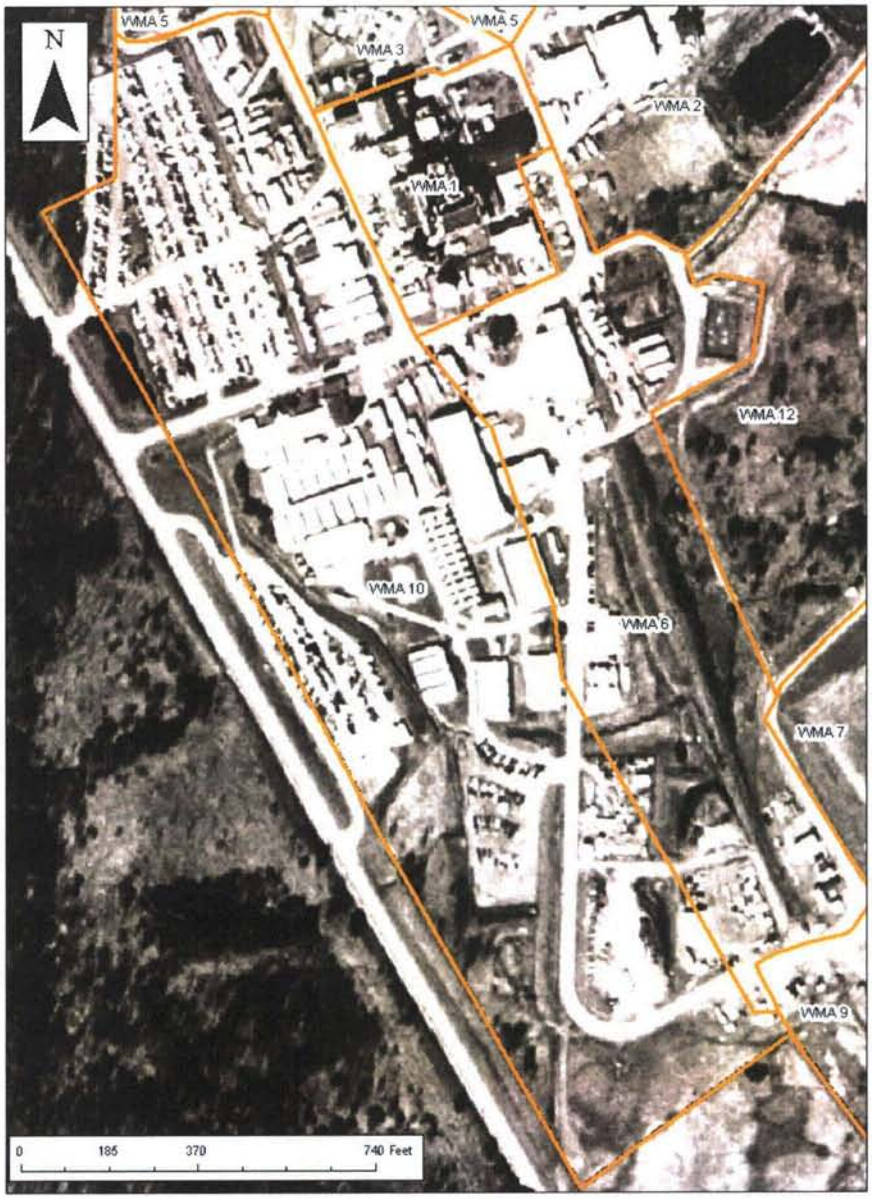

Figure I.8 WMA 10 Aerial Photograph from 1995

Figure I.9 WMA 10 Aerial Photograph from 2007

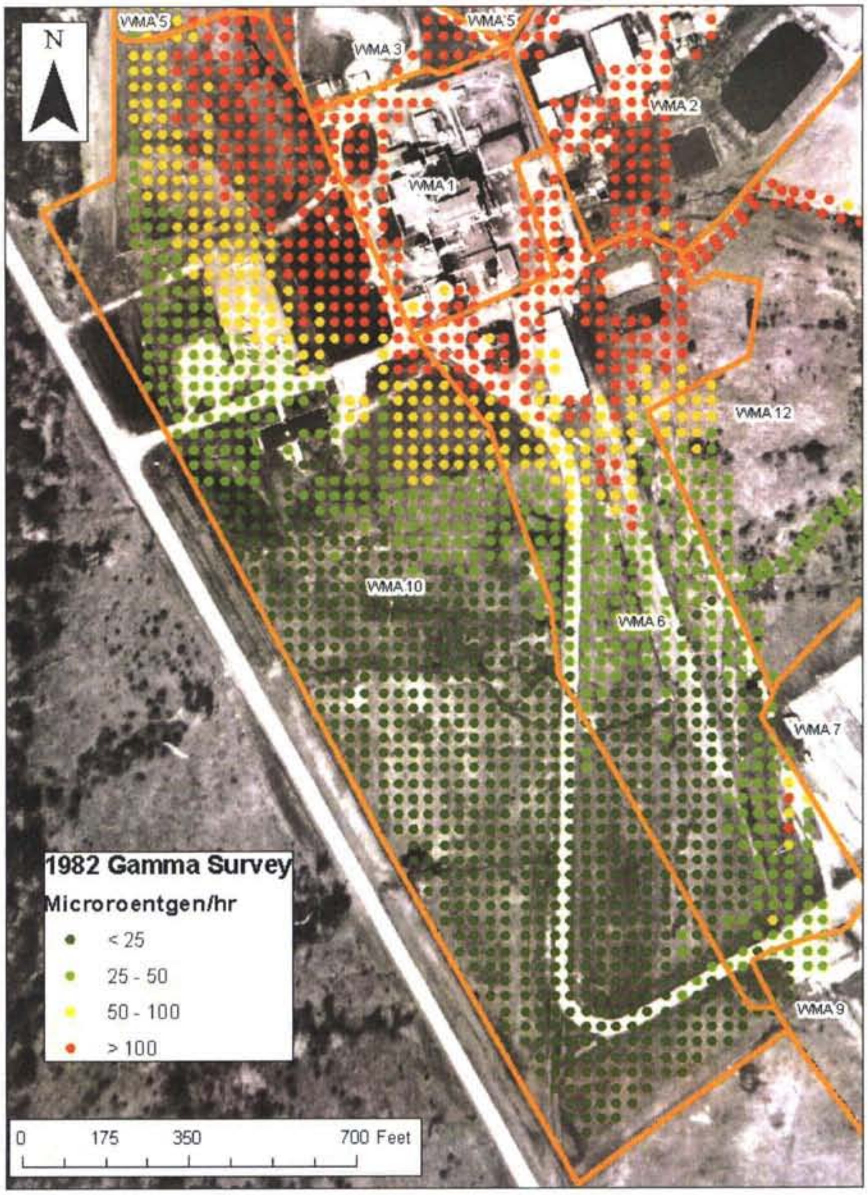

Figure I.10 WMA 10 1982 Direct Gamma Measurement Survey

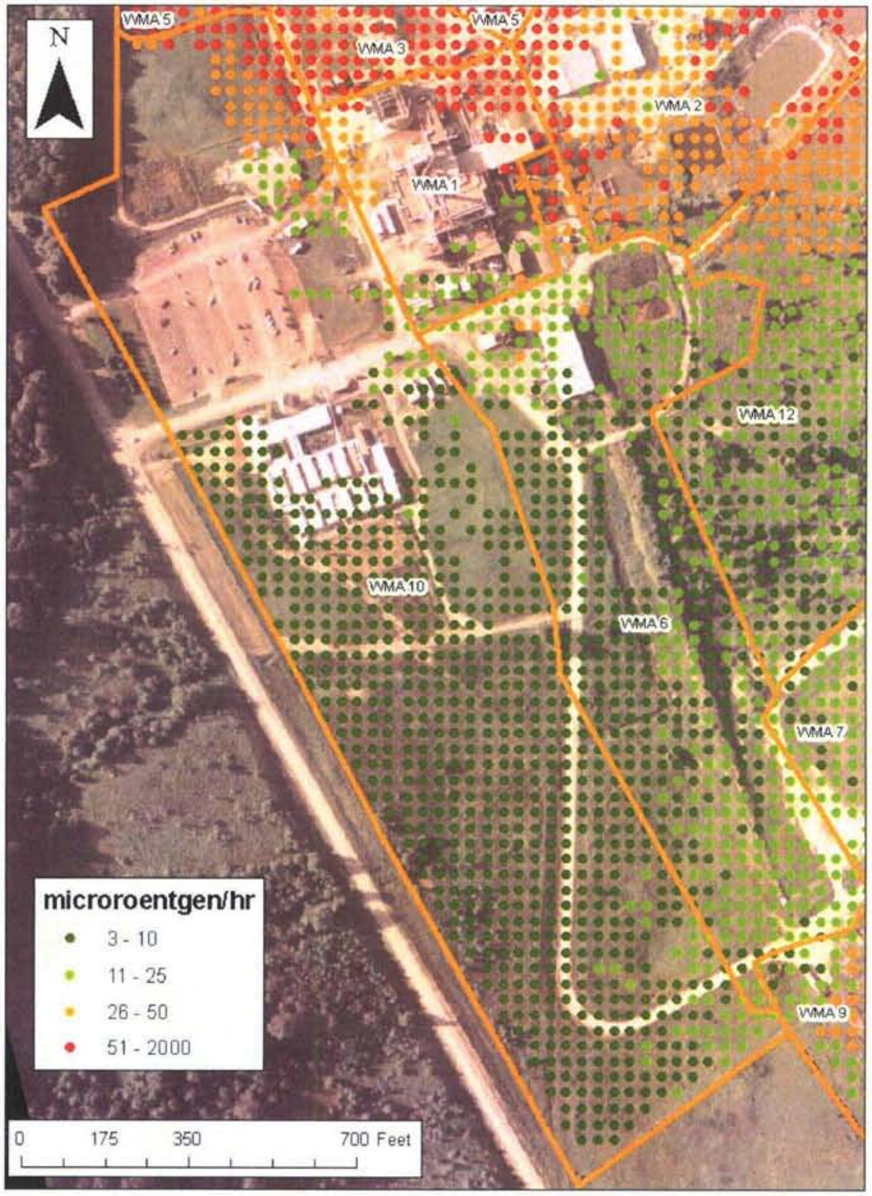

Figure I.11 WMA 10 1990-1991 Direct Gamma Measurement Survey

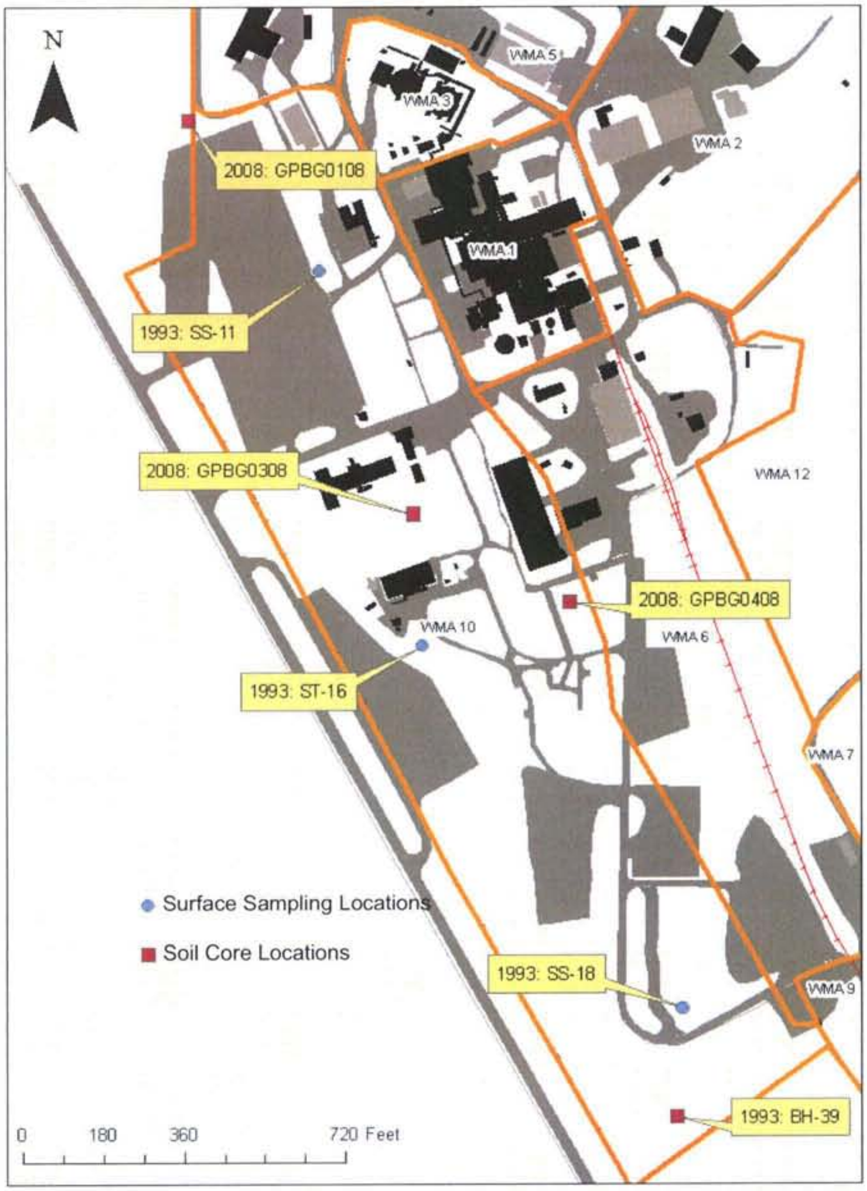

Figure I.12 WMA 10 Soil Sampling Locations

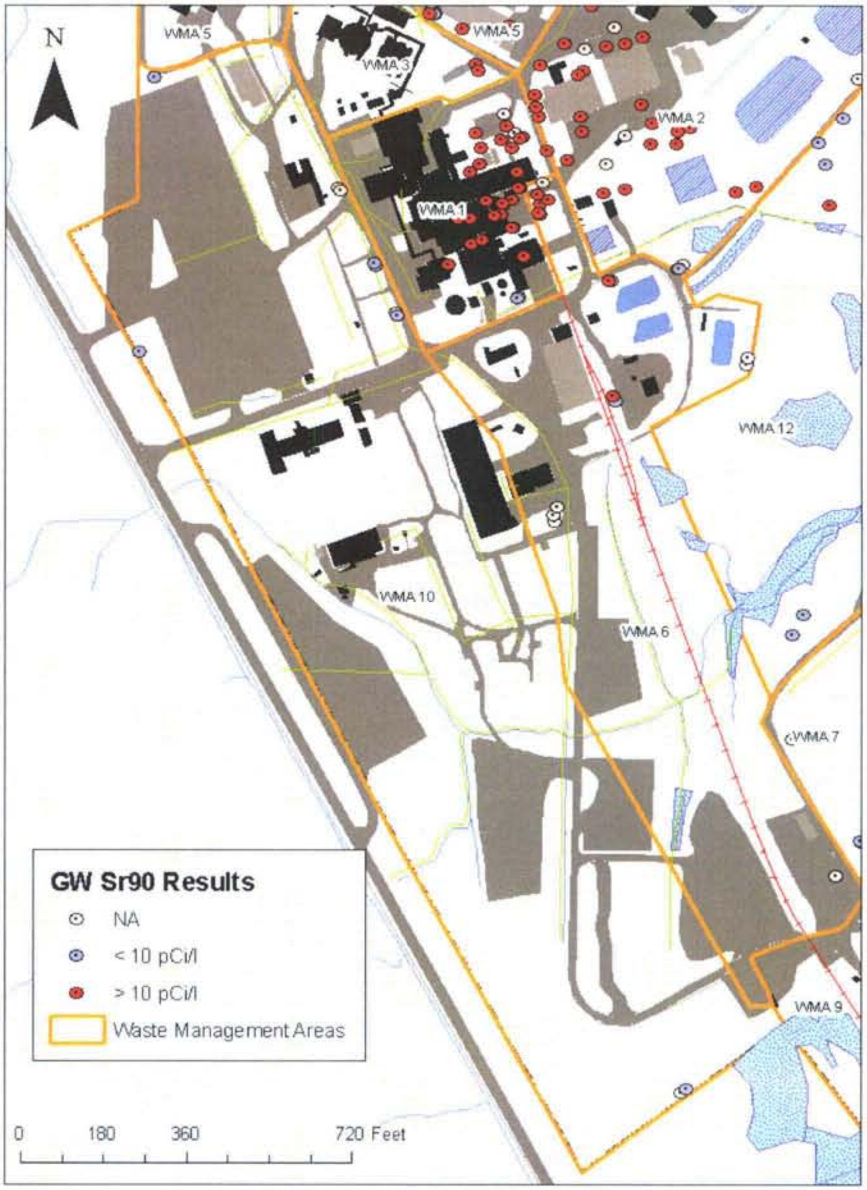

Figure I.13 WMA 10 Sr-90 Groundwater Results

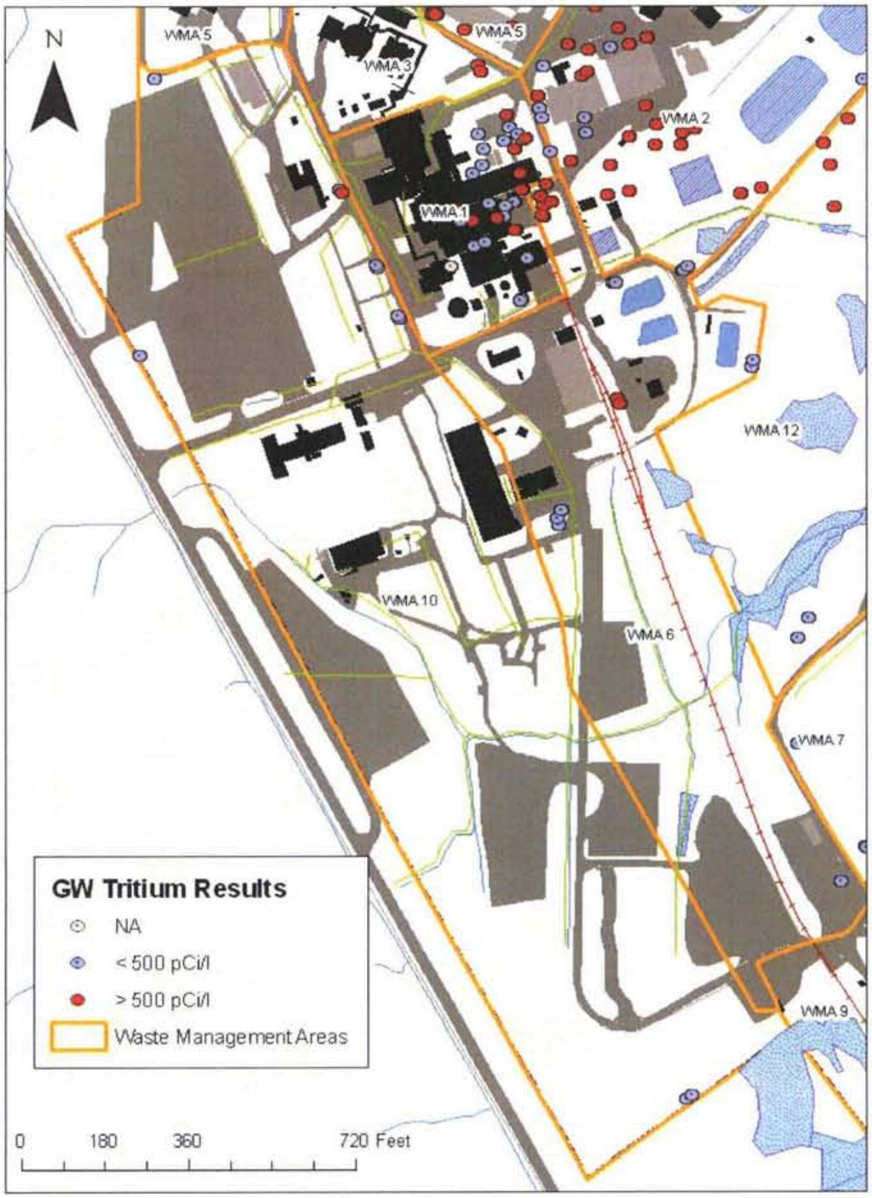

Figure I.14 WMA 10 Tritium Groundwater Results

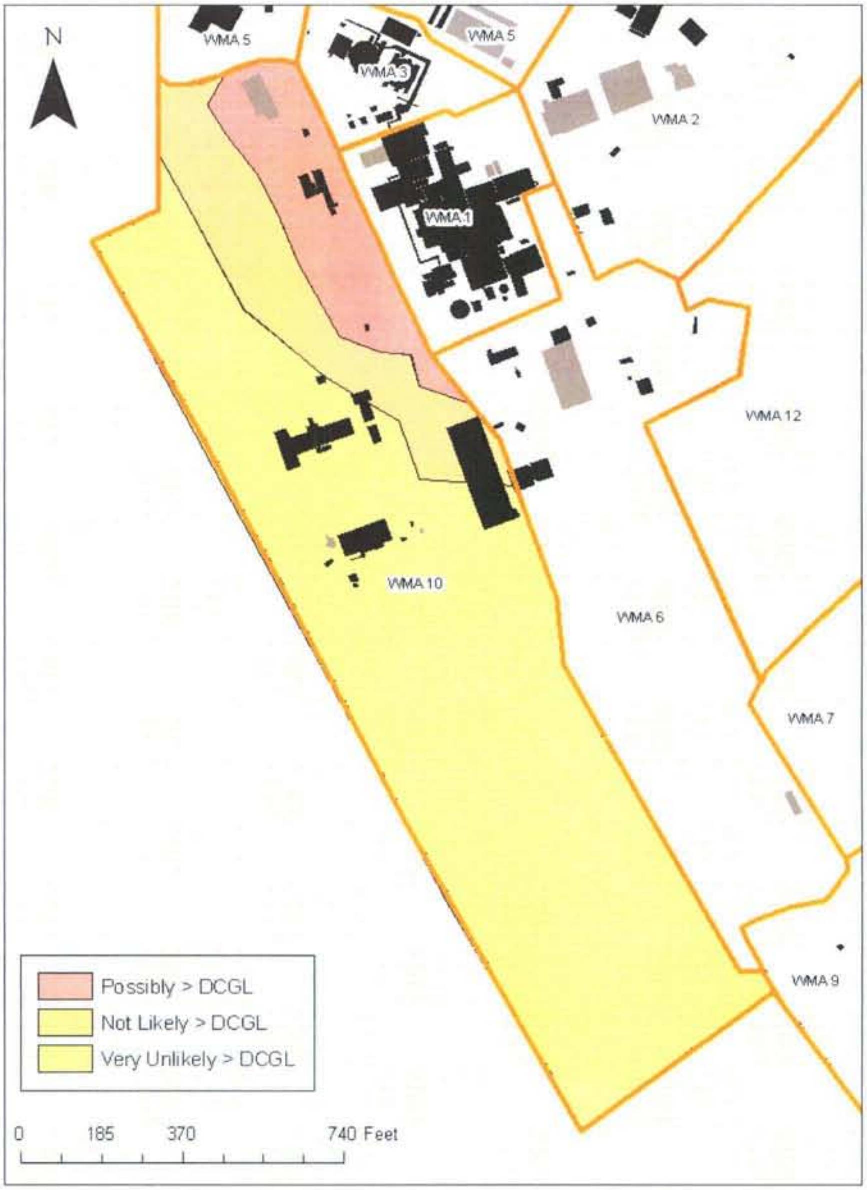

Figure I.15 Initial WMA 10 Surface Soil CSM

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APPENDIX J

WMA 12 PRE-REMEDIATION DATA COLLECTION

J.1 Background

Waste Management Area 12 (WMA 12) is approximately 42 acres in size and contains the balance of the WVDP premises not included in one of the other WMAs (see Figure J.1 for map).

J.2 Physical Setting

WMA 12 is primarily located on the south plateau. It is bounded to the east by the WVDP fence line, to the north by WMA 2, to the west by WMA 6, and to the south by WMA 7, WMA 8, and the WVDP fence line.

WMA 12 is vegetated. Its primary topographical features are associated with Erdman Brook and Franks Creek. Both streams incise fairly deep gullies into the land surface, and are fed by intermittent drainage features scattered across WMA 12. Erdman Brook and Franks Creek are two of the primary drainage features within the WVDP premises.

The WMA 12 area is underlain by the weathered and unweathered Lavery Till. The weathered Lavery Till allows some groundwater movement. The unweathered Lavery Till is an impermeable unit. The two streambeds are incised into the Lavery Till. Groundwater within the weathered Lavery Till predominately discharges to the two streams. Within the unweathered Lavery Till there is a layer known as the Kent Recessional Series that is more permeable and that does transport groundwater. Groundwater within the Kent Recessional Series, in general, moves to the west/northwest.

WMA 12 does not have any significant man-made features currently. As will be discussed in the section on the historical air photo analysis, WMA12 has been relatively undisturbed by Nuclear Fuel Services (NFS), NYSERDA, or WVDP activities.

J.3 Area History

WMA 12 was not used for any structural purposes during the lifespan of the NFS and WVDP activities; however, WMA 12 supported NFS and WVDP operations. Both NFS and the WVDP discharged untreated (pre-1971) and treated (post-1971) low-level wastewater to Erdman Brook and Franks Creek in WMA 12.

Figure J.2 shows WMA 12 in 1962 prior to site development. At this time a significant fraction of WMA 12 was wooded, with the balance appearing to have been farmed.

Figure J.3 shows WMA 12 in 1966. At this stage the adjacent WMA 2 lagoons were actively being used. A soils push-out area is visible that extends from WMA 2 into WMA 12. This push-out area is of significance because it corresponds to elevated direct gamma readings collected in 1990-1991.

Figure J.4 shows a 2007 aerial photo of the WMA 12 area. The push-out area is still visible as a grass-covered area adjacent to WMA 2.

J.4 Known and Suspected Releases

There are no known or suspected releases within the WMA 12 footprint. However, soils within WMA 12 potentially would have been impacted by air deposition, and drainage features within WMA 12 (including the streambeds and banks of Erdman Brook and Franks Creek) potentially would have been affected by the deposition of radionuclide contamination from surface water sediment transport mechanisms. There is also evidence that contaminated soils/sediments from WMA 2 may have been pushed by construction or maintenance activities into WMA 12 at some point in the past based on historical direct gamma readings and historical air photographs.

On the east side of WMA 12, it is possible that historical activities in WMA 7 resulted in contaminated soils being displaced into drainage features that crossed into WMA 12.

In addition, effluent discharges have taken place periodically to Erdman Brook through the Lagoon 3 permitted outfall. Of particular historical note were the relatively large releases that took place during NFS operations, such as in 1969 when 108 curies of gross beta activity were released (WVDP-EIS-006). Other releases of significance include discharges of SDA trench leachate before LLWTF operation began in 1972 that are described in NFS quarterly reports, the releases through the permitted sanitary outfall when a sewer line near Tank 7D-13 failed (WVDP-220), and surface water runoff from the NDA and SDA over the years.

Within WMA 2, Lagoons 2 and 3 are unlined. While currently operated with relatively low liquid levels, historically (e.g., during NFS operation) liquid levels could have been higher and resulted in the movement of contaminated groundwater through the subsurface with discharge via seeps to Erdman Brook.

Finally, small amounts of permitted activity continue to be released into Erdman Brook/Franks Creek through batch releases from Lagoon 3.

J.5 Existing Data

Existing data sets for this area include:

- In 1982 static direct exposure readings were collected across the WVDP premises. Within WMA 12 these focused on Erdman Brook and Franks Creek (WVNS 1982). Figure J.5 shows these results color-coded by the exposure readings encountered. These data show very distinct spatial trends associated with gross activity impacts in surface soils/sediments, ranging from near background or at background conditions at the eastern end of Franks Creek to significantly elevated activity levels in Erdman Brook alongside and downstream of WMA 2 and its lagoons.

- In 1990 and 1991 a second static direct exposure measurement program was conducted across the WVDP premises (WVNS 1992). In the case of WMA 12, this effort provided systematic coverage of its area on a 10-m grid. Unlike the 1982 program, this data collection did not target the streambeds specifically and it used different instrumentation/protocols than the 1982 study, so the results are not quantitatively comparable. However, the 1990-1991 data collection effort did provide insights into surface soil contamination across the WMA 12 area (Figure J.6). Surface soil impacts are evident in soils along the western portion of WMA 12. These impacts appear to fade to background conditions towards the eastern side of WMA 12.

- There have been several soil/sediment sampling activities in WMA 12 resulting in datasets contained in ELIMS. Environmental monitoring via soil/sediment sampling has taken place since 1991 to the present at location SNSP0006. In 1993, sediment samples from Erdman Brook and Franks Creek were collected (ST series locations in Figure J.7), as well as a handful of surface soil samples along the perimeter of WMA 12 (SS series locations in Figure J.7). Table J.1 identifies the number of samples analyzed for each of the 18 primary radionuclides of interest (ROI). As is clear from Table J.1, the majority of sample results pertain to Cs-137 and Sr-90, with very little coverage for some of the other ROI. Figure J.8 shows the locations of subsurface soil cores in the vicinity of WMA 12; as is clear from this figure, very little subsurface data exists that is pertinent to WMA 12. The spatial distribution of surface Cs-137 as identified by historical samples is shown in Figure J.9. Figure J.10 shows the Sr-90 results for these same samples.

  The limited Cs-137 data that are available are, in general, consistent with the historical direct reading data for this area. The same spatial pattern observed in direct readings for Erdman Brook is replicated in sediment samples, with the highest Cs-137 activity concentrations occurring at the northern fence line and coincident with the highest direct readings. Erdman Brook sediment Cs-137 activity concentrations drop as one moves up the stream channel, mirroring the direct exposure readings.

- A hot spot was identified in 1990 about 75 feet below the confluence of Erdman Brook and Franks Creek. As described in the footnote on page 4-49 of the Phase 1 DP, in 1990, a sample from a hot spot in Erdman Brook that measured 3000 μR/h during the ground-level survey showed 0.01 μCi/g (10,000 pCi/g) Cs-137. This was a screening analysis that may have been performed on a wet sample; it was not validated. This area of localized contamination was described as about six inches by six inches located one meter from the edge of the water. Limited investigation indicated that the contamination extended more than seven inches below the streambed surface. (WVDP-EIS-007, Appendix C)

- There are sixteen historical groundwater sampling locations within WMA 12 (Figure J.11) that have historical sample results within ELIMS. These include eight along the WMA 2 border on the north side of WMA 12, and another six along the WMA 7/WMA 8 border on the south side of WMA 12. The detection limits for Sr-90 and tritium varied widely among ELIMS samples. 10 pCi/L and 500 pCi/L were selected as thresholds for Sr-90 and tritium, respectively, because based on ELIMS data results above these activity concentrations were consistently above method detection limits and so indicative of contamination impacts rather than simply measurement error.

  All of the groundwater sampling locations along the WMA 2 boundary show tritium impacts, and most show low levels of Sr-90 as well (although not all were analyzed for Sr-90). In general Sr-90 activity concentrations increase as one moves east along the border. Likely sources of this contamination are the lagoons and the north plateau groundwater plume. Along the southern boundary, one well, WNNDADR, had elevated Sr-90 impacts. Groundwater movement within WMA 12 is likely controlled by surface topography and Franks Creek and Erdman Brook. In general one would expect groundwater to move from the northern and southern boundaries towards the center of the WMA, and from west to east.

J.6 Planned Phase 1 DP Activities

There are no planned Phase 1 decommissioning activities for WMA 12.

J.7 Conceptual Site Model

Based on the available information, the conceptual site model (CSM) for WMA 12 is as follows. No environmental releases of contamination within WMA 12 are believed to have occurred. However, environmental media within WMA 12 have been affected to some degree by releases elsewhere at the WVDP site. This has resulted in surface soil contamination for at least portions of WMA 12 (as evidenced by historical direct gamma surveys and limited soil samples), potential subsurface contamination along the northeastern boundary of WMA 12 along WMA 2, and also in more significant streambed sediment contamination resulting in releases of contaminated water from the Lagoon 3 discharge weir. In the case of the latter, Erdman Brook has the bulk of these impacts. The impacts increase as one moves downstream to the WVDP fence line, likely due to historical releases from WMA 2. Contamination in stream sediments is significant enough that eastern portions of Erdman Brook have been designated radiological control areas by WVDP (see Figure J.1)

In addition, historical activities within WMA 7 may have led to the release of contaminated soils into drainage features that crossed into WMA 12. The radiological control area defined for WMA 7 does currently extend into WMA 12 (see Figure J.1).

Because there have not been significant historical soil disturbance activities for the majority of WMA 12, buried contamination is not expected to be present in most of the area. The exceptions to this is an area immediately adjacent to WMA 2 that appears to have been a push-out area active in 1960s, and that exhibited elevated gamma readings in 1990-1991. Any soil contamination present is expected to be limited to surface soils (i.e., top one meter of soils) with the possible exception of soils immediately adjacent to WMA 2 along the historical waste storage lagoons. Also, within WMA 2, Lagoons 2 and 3 are unlined. Contaminated groundwater may have migrated through the subsurface with discharge via seeps to Erdman Brook, potentially contaminating subsurface soils between the boundary of WMA 2 and Erdman Brook along the footprints of Lagoons 2 and 3.

The data collection plans for WMA 12, as described below, do not explicitly address the possibility of buried contamination that is overlain by clean soils. The only areas where this is believed to be a plausible possibility are along the boundary with WMA 2, resulting from activities within WMA 2. Soil sampling to depth will also be taking place in WMA 2 along the boundary with WMA 12 to address this possibility. If buried contamination that extends into WMA 12 is encountered as part of that effort, sampling will continue into WMA 12 until it is spatially bounded.

Because both Erdman Brook and Franks Creek are primarily eroding features in this area of the site, one would not expect to see sediment contamination extending more than one meter into the subsurface. One would expect to find "bathtub ring" contamination along banks deposited by high flows that mobilize and transport contaminated soils and sediments.

The limited historical groundwater data available for WMA 12 show low level tritium and Sr-90 impacts, predominately along the border with WMA 2, and to a lesser degree along the border with WMA 7. Groundwater flow from the boundaries is likely inwards towards the center of WMA 12, with discharges likely occurring to Erdman Brook and Franks Creek.

There are no surface soil historical samples within WMA 12 that exceed surface soil CG_w requirements. However, two surface soil samples (SS-08 and SS-04) come close, and may have exceeded a Sum of Ratios (SOR) of unity if all 18 ROI had been analyzed. In addition, some of the most elevated areas identified by direct exposure readings were not sampled. Based on the existing data, Figure J.12 indicates where contamination is expected to possibly exist above Phase 1 CG_w standards in soils, where measurable impacts are not likely to be above CG_w standards, and where contamination is very unlikely to be above CG_w standards.

There is historical evidence of sediments exceeding sediment CG_w requirements. Figure J.13 shows the portions of Erdman Brook and Franks Creek where sediment CG requirements apply and the likelihood that contamination might be present above sediment CG_w requirements. Based on the very limited data available, Cs-137 appears to be the primary concern in WMA 12 soils and sediments, followed by Sr-90.

J.8 WMA 12-Specific Characterization Goals

- Evaluate appropriateness of the current list of ROI
- Verify absence of additional ROI
- Determine extent of surface contamination
- Determine level and extent of sediment contamination
- Identify soil waste stream characteristics
- Obtain data to support Phase 2 planning
- Determine contamination status of various gullies and seeps that feed Erdman Brook and Franks Creek

J.9 CSAP Pre-Remediation Data Collection and Associated Decision-Making

CSAP pre-remediation data collection will consist of a number of components described in more detail below.

J.9.1 Gamma Walkover Survey Data

The purpose of performing a gamma walkover survey of the WMA 12 area is to identify the level and extent of surface contamination. This includes both general trends in average activity concentrations pertinent to the CG_w requirement, as well as the identification of isolated, more-elevated anomalies that might be indicative of discrete releases and/or CG_{emc} concerns.

A complete (100%) logged gamma walkover survey (GWS) will be conducted for accessible areas within WMA 12 including exposed soils/sediments associated with Erdman Brook and Franks Creek. Examples of areas that would not be accessible are areas where standing water is present in wetlands or ponds. Based on the GWS results, surface soil and sediment areas within WMA 12 will be divided into three categories: (1) surface soils/sediments where GWS indicates possible CG_w exceedances; (2) surface soils/sediments where GWS indicate impacts, but those impacts are not expected to exceed CG_w standards; and (3) surface soils/sediments where there is no indication of impacts above background conditions. The purpose of this data collection is to provide insights into the spatial distribution of surface contamination, and to guide subsequent soil/sediment sampling. **[required]**

J.9.2 Surface Soil Sampling

Surface soil sampling will be used to address areas inaccessible to GWS data collection, to resolve hot spots identified by the GWS data, and to evaluate the presence, absence, and/or extent of surface contamination above CG_w requirements based on GWS results.

- **Wetlands.** It is possible that standing water will be present in the wetlands that prevent GWS data collection from those areas. Consequently, soil/sediment sampling will be required for pond footprints and for any other areas where standing water prevents the collection of GWS data.

  For every area where standing water or saturated soil conditions prevent GWS data collection, systematic soil sampling will take place. At least one and at most five sampling locations will be selected per area. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. In the case where an area has more than one location, locations will be selected so that each representative area does not overlap and provides systematic coverage of the area of interest. If a ponded area is less than 200 m^2 in size, one 5-point composite will be formed to be representative of the pond's area. **[contingent]**

- **Hot Spots.** If GWS data indicate the presence of contamination that possibly exceeds "hot spot" (CG_{emc}) standards or an isolated elevated area is identified that appears indicative of a discrete release, the location of concern will be sampled with a biased sample. If biased samples are collected from a particular location (soil or sediment), they will be collected from two depth intervals: 0-15 cm, and 0-1 m. In the case of surface soils, each biased sample will be a composite sample formed from 5 increments systematically distributed over the area of interest. In the case of sediments, each biased sample will be a discrete sample. The 0-15 cm samples will be analyzed for the 12 radionuclides of potential interest in addition to the 18 ROI. In the case of surface soils, one down-hole gamma scan will be conducted from each biased location. The purpose of these samples is to resolve GWS anomalies, evaluate the appropriateness of the current ROI list, and verify the absence of additional ROI. **[contingent]**

- **CG_w Sampling.** Surface soil sampling may be conducted after the GWS to further clarify results, with the level and nature of sampling dependent on GWS results. If GWS results indicate no evidence of contamination impacts above background levels, no additional surface soil sampling will be required other than to address areas too wet to perform a gamma walkover survey. Based on historical direct gamma measurements, the area most likely to have contamination exceeding surface soil CG_w requirements is along the WMA 2 border.

  - If GWS results indicate contamination impacts above background levels but that surface soil contaminant levels exceeding CG_w requirements are unlikely, a minimum of five surface soil sample locations will be identified and sampled that target the areas with the highest gross activity levels. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap.

The purpose is to document the maximum activity concentrations present in surface soils within WMA 12. **[contingent]**

- If GWS results indicate surface soil contaminant levels exceeding CG_w requirements likely exist, one sampling location will be selected at the highest gross activity level to confirm CG_w exceedances and another set of sampling locations will be identified to spatially bound the extent of contamination (i.e., along the boundary of what is considered likely above CG_w requirements). Two samples will be collected from the location targeting high gross activity levels, one representative of a 0-15 cm depth interval, and one representative of a 0-1 m depth interval. One sample will be collected from each location intended to laterally bound contamination, representative of a 0-15 cm depth interval. Each sample will be a 5-increment composite formed to be representative of a 200 m^2 area. In addition, the location targeting high gross activity levels will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. Locations will be selected so that each representative area does not overlap. The purpose is to document CG_w requirement exceedances and bound the lateral extent of contamination. **[contingent]**

- If GWS results indicate areas with surface soil contamination impacts but it is unclear whether CG_w requirement exceedances are present, at most five sampling locations will be selected that systematically cover the areas of interest. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap. The purpose is to resolve the question of whether CG_w requirement exceedances exist for areas where GWS results are ambiguous. **[contingent]**

- If any 0-15 cm interval yields a sample result indicating a CG_w requirements exceedance and that sample location is not laterally bounded either by existing sampling locations with results less than CG_w requirements or by GWS data that clearly indicate contamination is not a concern, additional sampling locations will be selected so that the contamination encountered is spatially bounded. The purpose is to laterally bound contamination that is above CG_w requirements. **[contingent]**

J.9.3 Subsurface Soil Sampling

The purpose of subsurface soil sampling within WMA 12 is to determine the vertical extent of contamination impacts above background levels.

- If any 0-15 cm surface soil sample result indicates contamination impacts above background levels and there was not a 0-1 m sample collected from that location, a 0-1 m sample will be collected from that location following the protocols used for the original 0-15 cm surface soil sample. In addition, each soil location will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. **[contingent]**

- If a surface soil sample indicates contamination impacts above background levels for the 0-1 m depth interval, an additional sample from a depth of 1-2 m will be collected and analyzed from that location. This process will continue until the vertical extent of contamination above background is bounded. One down-hole gamma scan will be conducted from each soil location requiring deeper investigation with a static reading taken every 15 cm vertically. The purpose of these samples is to define the vertical extent of contamination. **[contingent]**

J.9.4 Sediment Sampling

The purpose of sediment sampling within WMA 12 is to determine the presence and lateral extent of contamination above sediment CG_w requirements, and the vertical extent of sediment contamination impacts above background levels, for those portions of Erdman Brook and Franks Creek where the sediment CG requirements apply. The areas shaded as part of the sediment CSM in Figure J.13 indicate the portions of Erdman Brook and Franks Creek to which sediment CG requirements apply. For all other portions of Erdman Brook and Franks Creek, and any other drainage feature in WMA 12, the surface soil CG requirements apply.

- One discrete surface sediment sample will be collected to a depth of 15 cm from a biased location in the vicinity of the confluence of Erdman Brook and Franks Creek. The location will be selected based on GWS data. Its location will be selected so that it targets the location most likely to contain significant contamination. Besides the 18 ROI it will also be analyzed for the 12 radionuclides of potential interest. The purpose of this sample is to evaluate the the appropriateness of the current ROI list and to verify the absence of additional ROI. **[required]**

- Systematic sediment sampling will focus on those portions of Erdman Brook considered most likely (based on GWS and historical sampling) to potentially have contamination above the CG_w requirements for sediments. Figure J.13 shows the portions of Erdman Brook and Franks Creek where the sediment CG requirements apply and the portion of Erdman Brook that possibly has contamination above sediment CG_w requirements based on historical information; these footprints may change based on GWS data collection. If the footprints change significantly, the number of samples described below may also change. The goal is to have one sample per 30 m stretch of streambed. A minimum of three samples per each stream stretch will be required regardless of how long the finalized stretches are. Seven composite samples currently are expected from the eastern portion of Erdman Brook that is of concern (approximately 30 m between samples). It is not expected that Franks Creek will require this sampling. Each composite sample will be from a depth of 0-15 cm, and will be formed from three soil/sediment increments. The first increment will be from the center line of the streambed. The other two increments will be from the either side of the banks/streambed, randomly placed between the stream center line and three meters orthogonal to the stream center line. The purpose of this sampling is to determine the level and extent of sediment contamination above the sediment CG_w requirement. **[required]**

- Historical direct gamma measurements did not identify significant contamination in Franks Creek sediments. Consequently only one sediment sample will be collected from Franks Creek. This sample will be biased in its selection, based on GWS data. If GWS data do not identify an obvious biased location, then the sample will be drawn from a portion of the streambed where deposition appears to have taken place. The sample will be a composite sample collected from a depth of 0-15 cm, and will be formed from three increments as described in the previous bullet. The purpose of this sampling is to determine whether contamination above sediment CG_w requirements is potentially present in Franks Creek sediments. **[required]**

- If the results from the Erdman Brook and/or Franks Creek sampling effort indicate sediment CG_w exceedances that stretch into the area of the creek designated as unlikely or very unlikely to have contamination above sediment CG_w requirements, systematic sampling of those remaining stretches of the creeks where sediment CG requirements apply will be conducted with a spacing of one sample per 30 meters using the same increment composite sampling protocols previously described for Erdman Brook. The purpose of this sampling is to determine the level and extent of sediment contamination. **[contingent]**

- If any 0-15 cm sediment sample result indicates contamination impacts above background levels, a 0-1 m sample will be collected from that location following the protocols used for the original 0-15 cm sediment sample. **[contingent]**

- If a sediment sample indicates contamination impacts above background levels for the 0-1 m depth interval, an additional sample from a depth of 1-2 m will be collected and analyzed from that location. This will be repeated, as necessary, until the vertical extent of contamination impact is bounded at that location. **[contingent]**

J.9.5 Drainage Feature Sampling

Figure J.13 identifies those portions of Erdman Brook and Franks Creek where sediment CG requirements apply. For the remaining portions of these streams within the WVDP premises as well as other drainage features surface soil CG requirements apply. Some of these features lie in areas of WMA 12 where contamination concerns are not significant (e.g. the far eastern end of Franks Creek). There are other portions, however, where contamination impacts are likely. These include the western end of Erdman Brook and the ditches feeding Erdman Brook from the north and from WMA 7.

- Discrete samples representing a 0-15 cm depth interval will be collected from ditch sediments for those ditches that have potential contamination concerns. Samples will be systematic located using a random start, separated by 30 m for those ditch portions that are more than 30 m in length. **[required]**

- If any 0-15 cm sample result indicates contamination impacts above background levels, a 0-1 m sample will be collected from that location following the protocols used for the original 0-15 cm sample. **[contingent]**

- If a sample indicates contamination impacts above background levels for the 0-1 m depth interval, an additional sample from a depth of 1-2 m will be collected and analyzed from that location. This will be repeated, as necessary, until the vertical extent of contamination impact is bounded at that location. **[contingent]**

J.9.6 Required Laboratory Analyses

All samples will be submitted for analysis of all 18 ROI.

A select portion of the samples as described above will be analyzed for the additional 12 radionuclides of potential interest. If these sample results indicate the presence of the one or more of those radionuclides at levels of potential significance, then the balance of samples from WMA 12 will also be analyzed for the additional radionuclides that were identified.

Table J.2 summarizes the required sample numbers and the estimated number of contingency samples for WMA 12.

This sampling plan assumes that quick turn-around analyses are available for Sr-90 and Cs-137 and that soil samples will be screened for Sr-90 and Cs-137 prior to being analyzed for the balance of the ROI. Based on these screening data, contingency sampling requirements as described above may be undertaken without the benefit of the remaining analyses.

J.9.7 Decision-Making Summary

A summary of decision-making based on the WMA 12 data is as follows:

- If GWS indicate anomalies are present, biased samples will be selected to target those anomalies.

- If biased sample results for the 0-1 m depth interval indicate contamination impacts above background, an additional sample from that location representing the depth interval 1-2 m will be collected and this process repeated until contamination is vertically bounded.

- The WMA 12 surface soil area classification as contained in Figure J.12, and the sediment classification as contained in Figure J.13, will be adjusted based on GWS results. These adjustments may affect systematic sample number requirements, particularly for sediments.

- If the results from the biased sediment sample taken from the confluence of Franks Creek and Erdman Brook indicate one or more of the twelve radionuclides of potential interest are a concern, then the analyte list for all remaining samples from this area will be modified to include those contaminants.

- If systematic sediment samples from Erdman Brook indicate contamination near to or above sediment CG_w levels at the boundary of the area of concern being sampled, systematic sampling will be extended to the balance of Erdman Brook within the WVDP premises.

- If the biased sample from Franks Creek indicates contamination near to or above sediment CG_w requirements, systematic sampling will be conducted along the balance of Franks Creek within the WVDP premises.

- If systematic surface soil samples exceed sediment CG_w requirements, sampling will continue to depth until the encountered contamination is vertically bounded, and sampling will continue laterally until contamination is laterally bounded.

Table J.1 Historical Data Analyses

Nuclide	# of Surface Soil Locations	# of Subsurface Soil Locations	# of Sediment Locations
Am-241	1	2	9
C-14	0	1	0
Cm-243	0	1	0
Cm-244	0	1	0
Cs-137	8	3	11
I-129	1	1	0
Np-237	0	1	0
Pu-238	1	2	8
Pu-239	1	2	8
Pu-240	1	2	8
Pu-241	1	2	7
Sr-90	8	3	11
Tc-99	0	1	0
U-232	1	2	8
U-233	1	2	8
U-234	1	2	8
U-235	1	2	8
U-238	1	2	8

Table J.2 Sample Number Estimates

	Required	Contingent	Total
Systematic Sediment Samples (0-15 cm)	31	10	41
Systematic Sediment Samples (0-1 m)	0	20	20
Biased Sediment Samples (0-15 cm)	0	3	3
Biased Sediment Samples (0-1 m)	0	3	3
Systematic Surface Soil Samples (0-15 cm)	7	10	17
Systematic Surface Soil Samples (0-1 m)	0	10	10
Biased Surface Soil Samples (0-15 cm)	0	5	5
Biased Surface Soil Samples (0-1 m)	0	5	5
Systematic Subsurface Soil Samples (1-m intervals)	0	2	2
Biased Subsurface Soil Samples (1-m intervals)	0	1	1
Total:	38	69	107

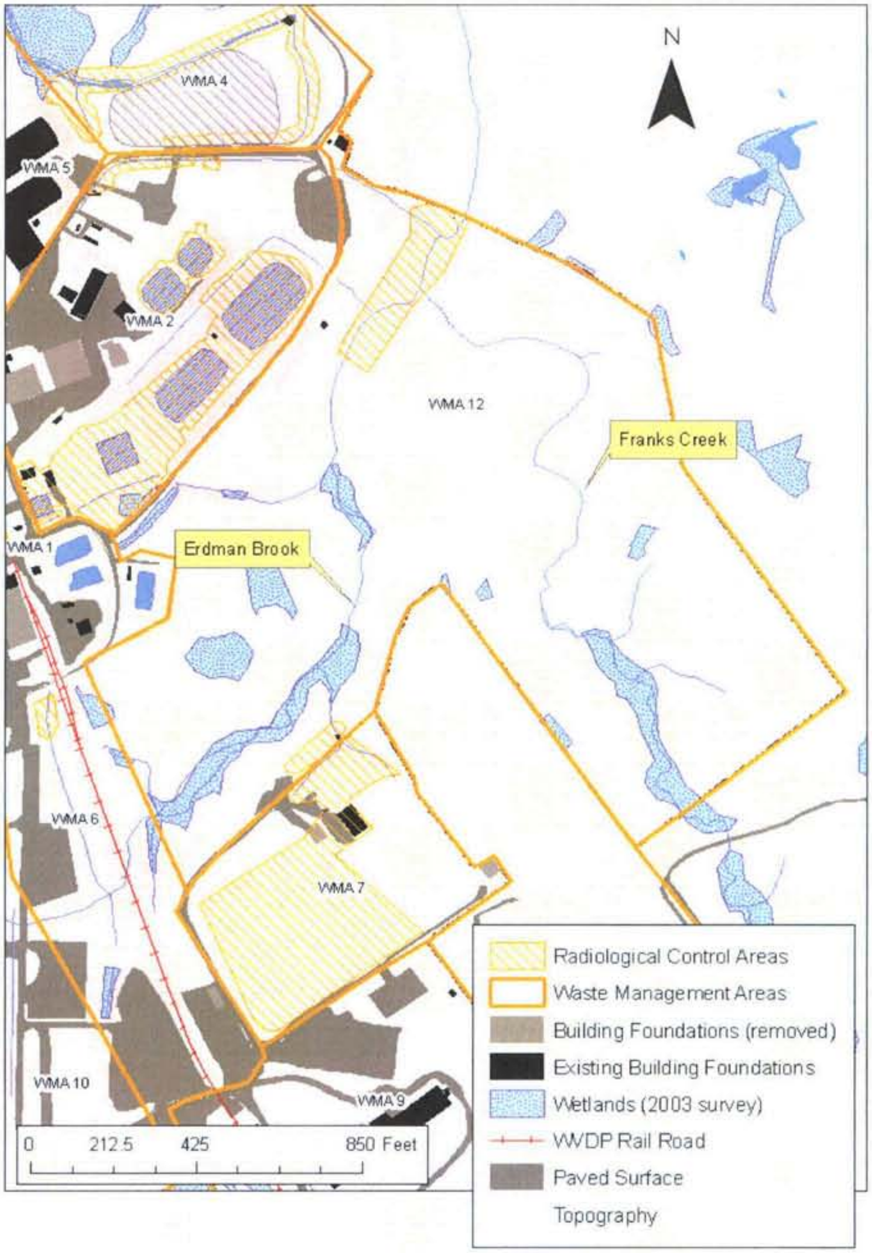

Figure J.1 WMA 12

Figure J.2 WMA 12 Aerial Photograph from 1962

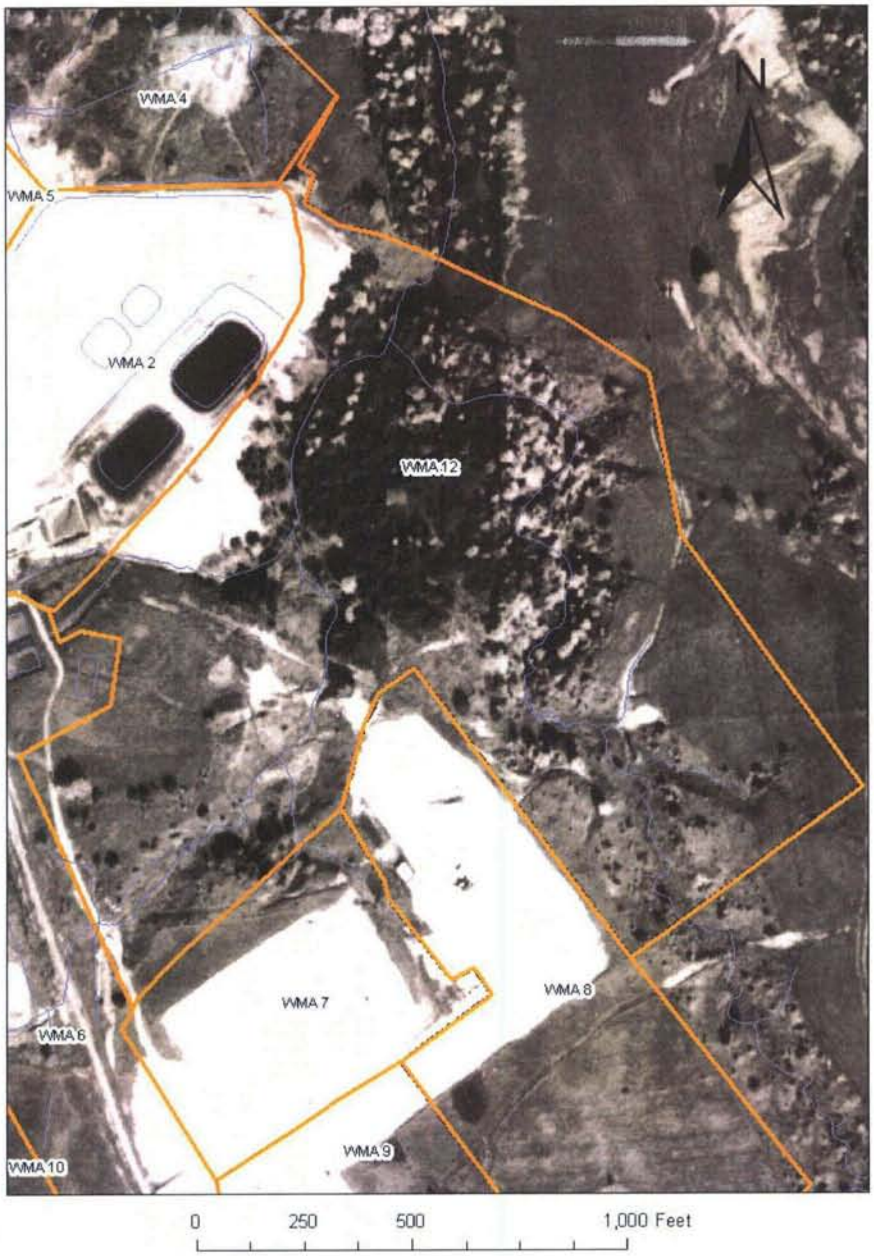

Figure J.3 WMA 12 Aerial Photograph from 1966

Figure J.4 WMA 12 2007 Aerial Photo

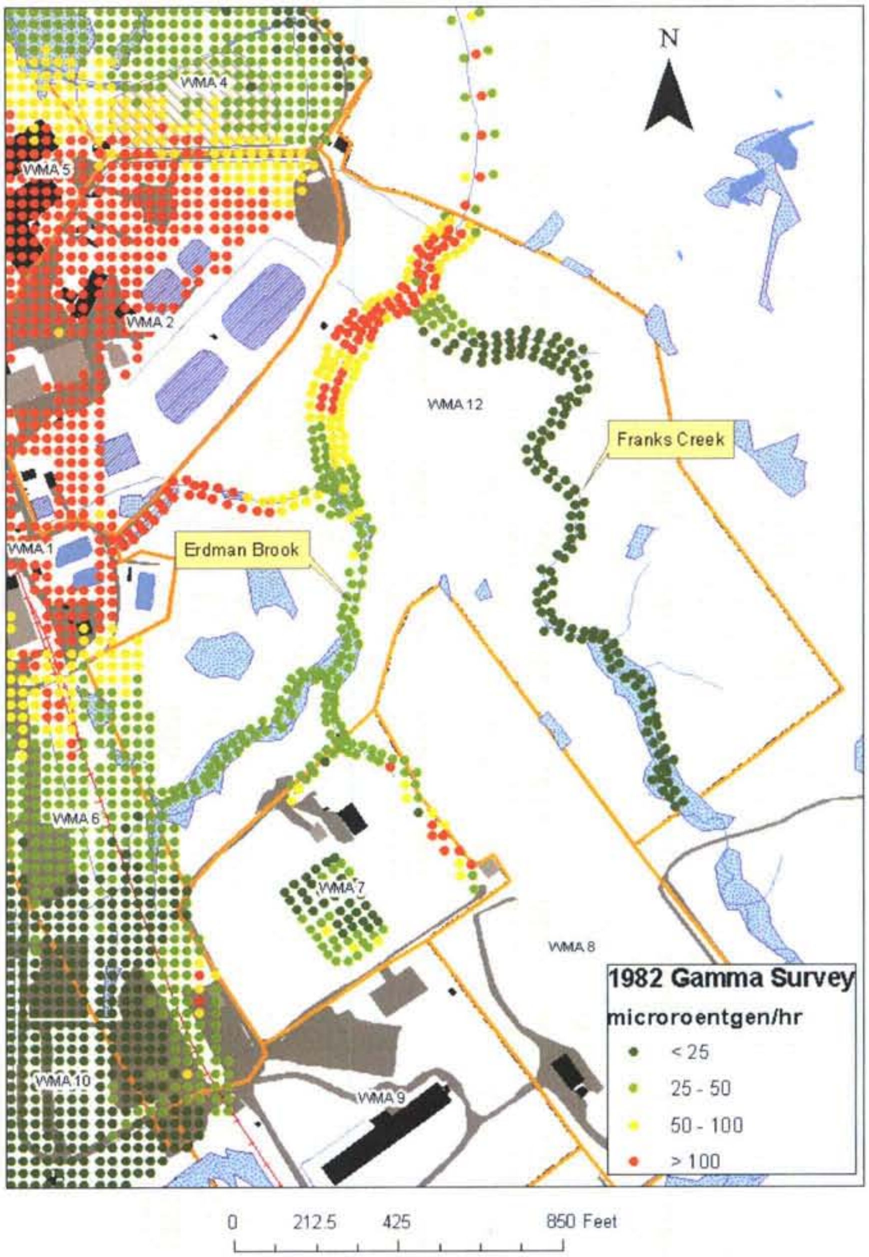

Figure J.5 1982 WMA 12 Direct Gamma Exposure Measurement Results

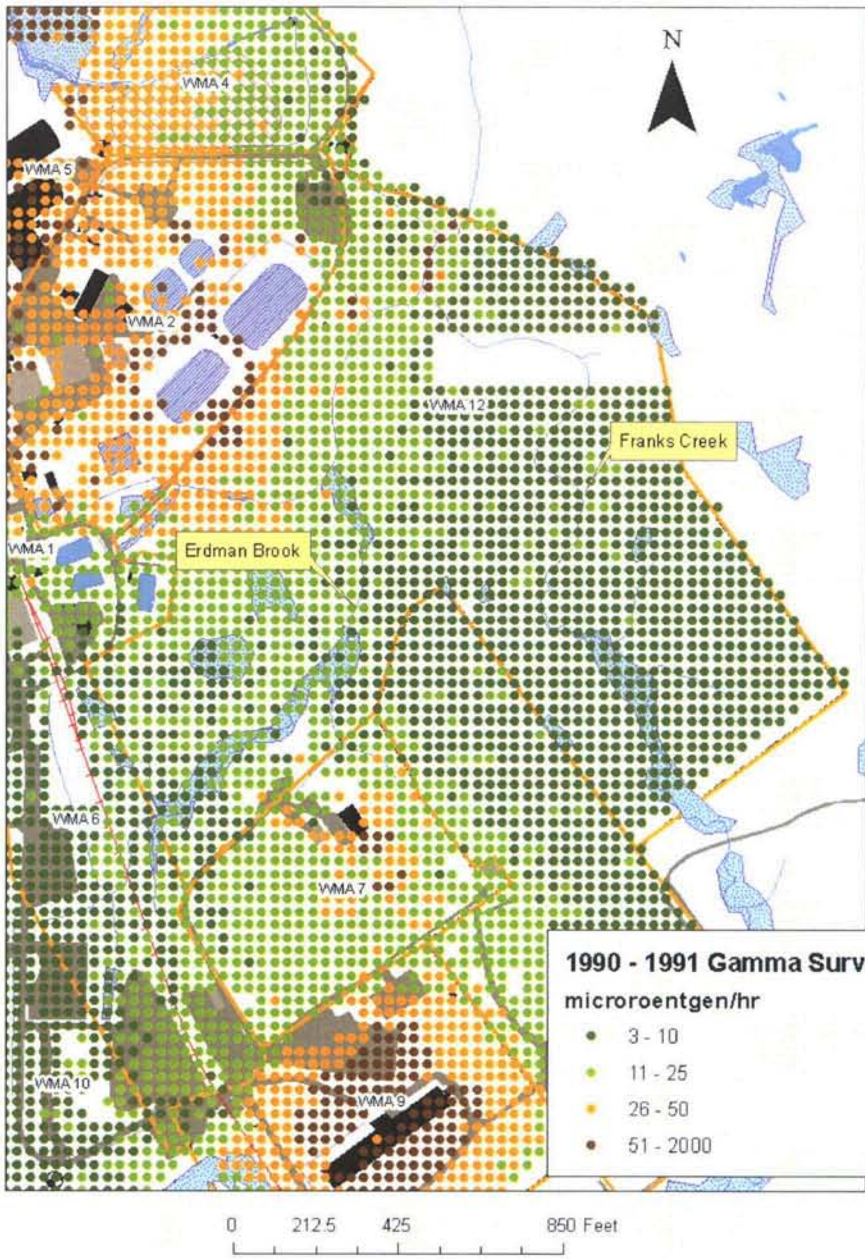

Figure J.6 WMA 12 1990 – 1991 Direct Gamma Exposure Measurement Results

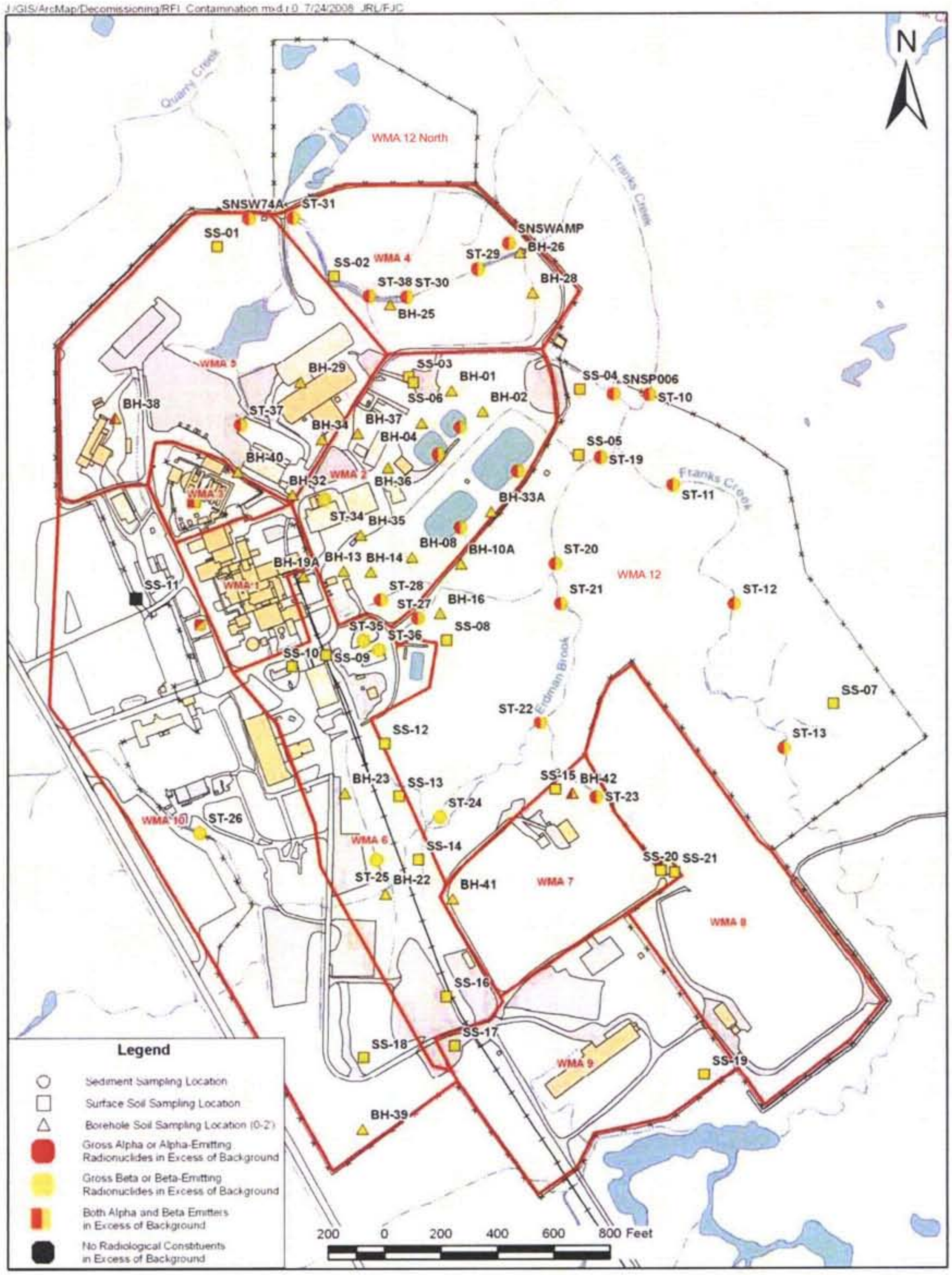

Figure J.7 WMA 12 Historical Surface Sampling Locations (Phase 1 DP Fig 4-6)

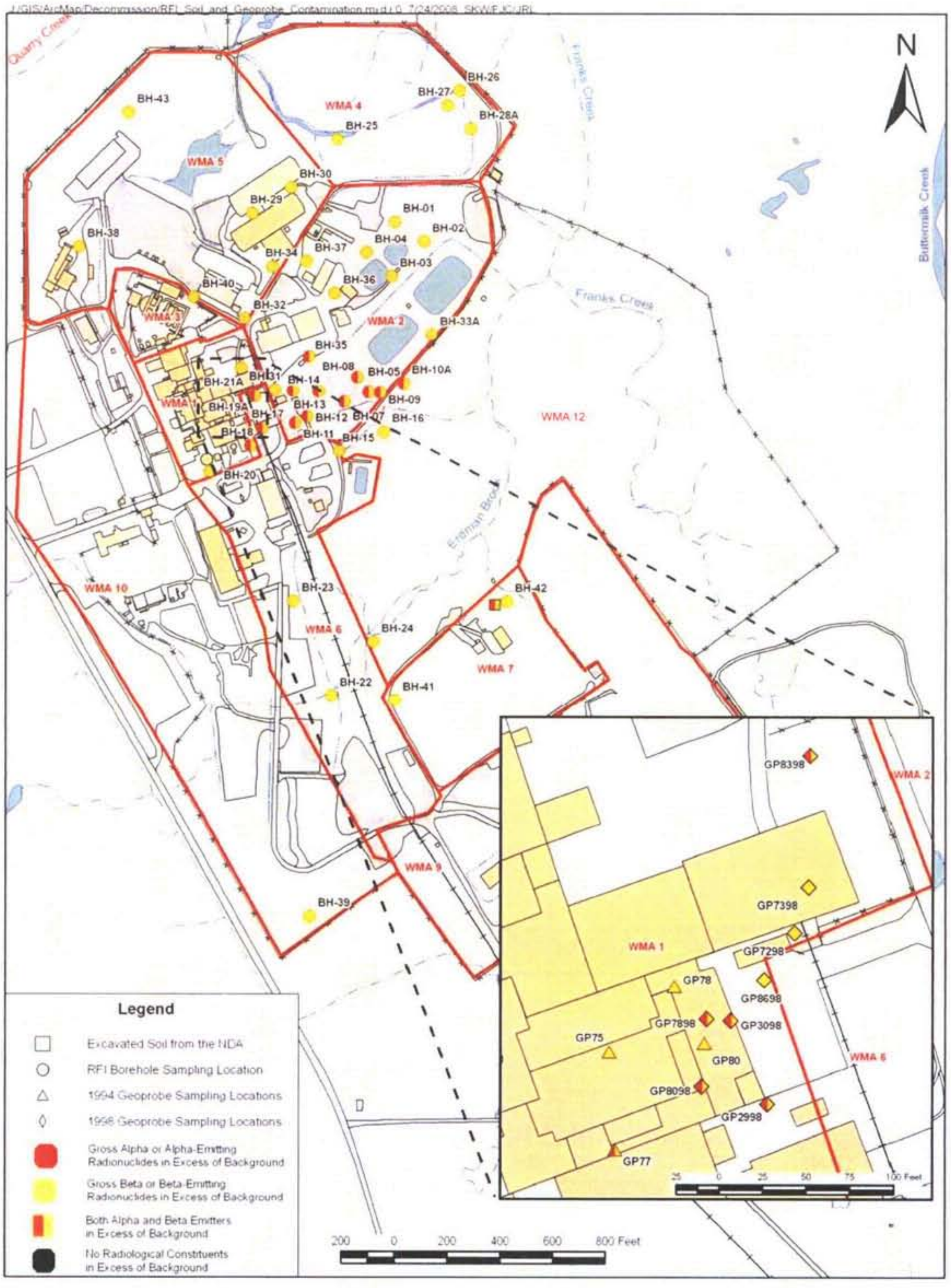

Figure J.8 WMA 12 Historical Subsurface Sampling Locations (Phase 1 DP Fig 4-7)

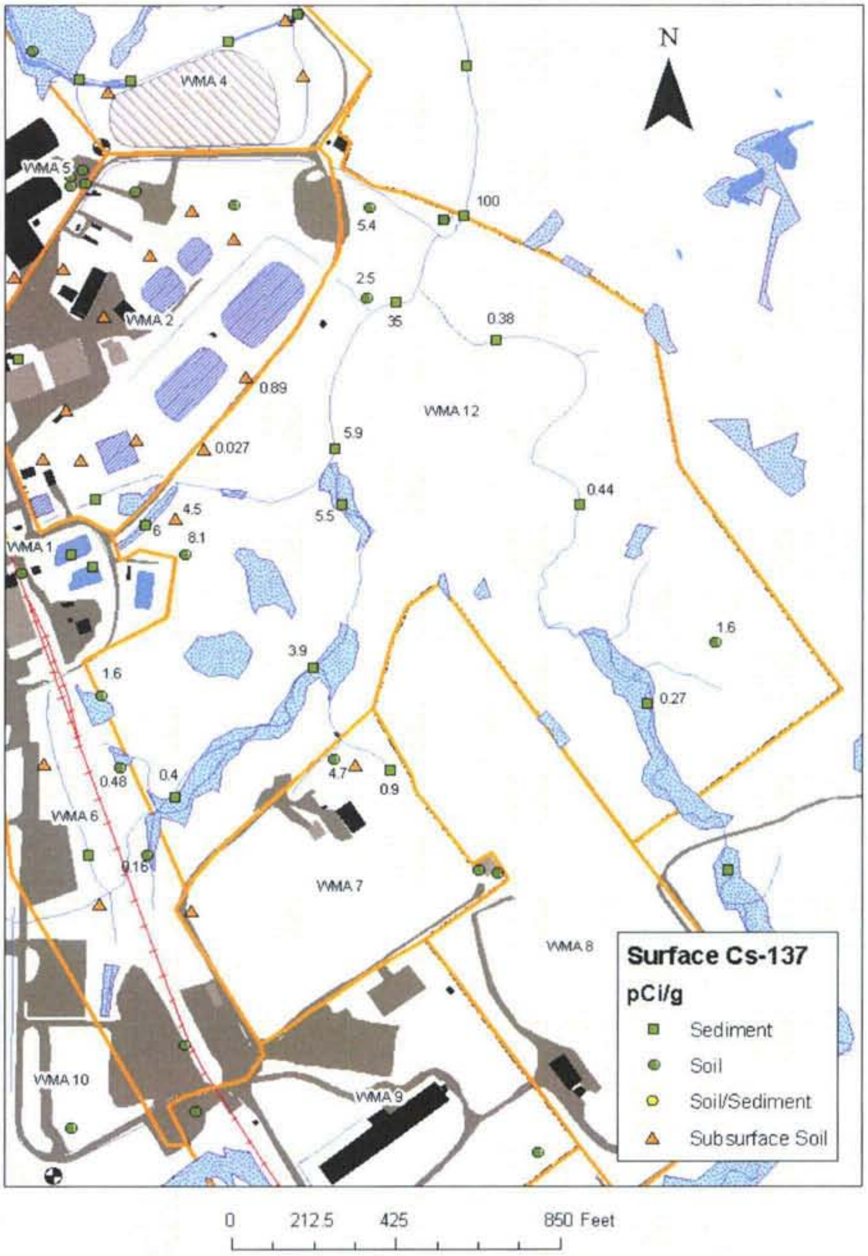

Figure J.9 WMA 12 Surface Cs-137 Activity Concentrations

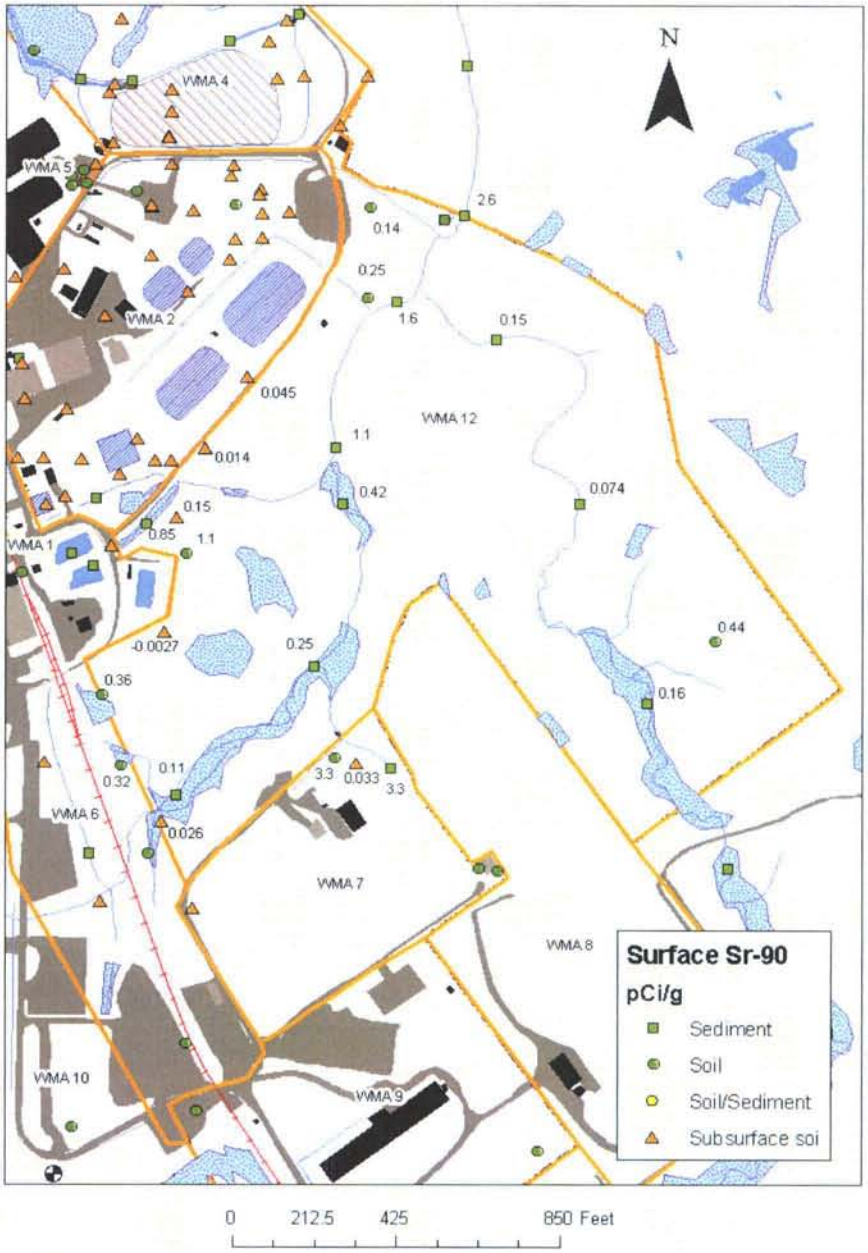

Figure J.10 WMA 12 Surface Sr-90 Activity Concentrations

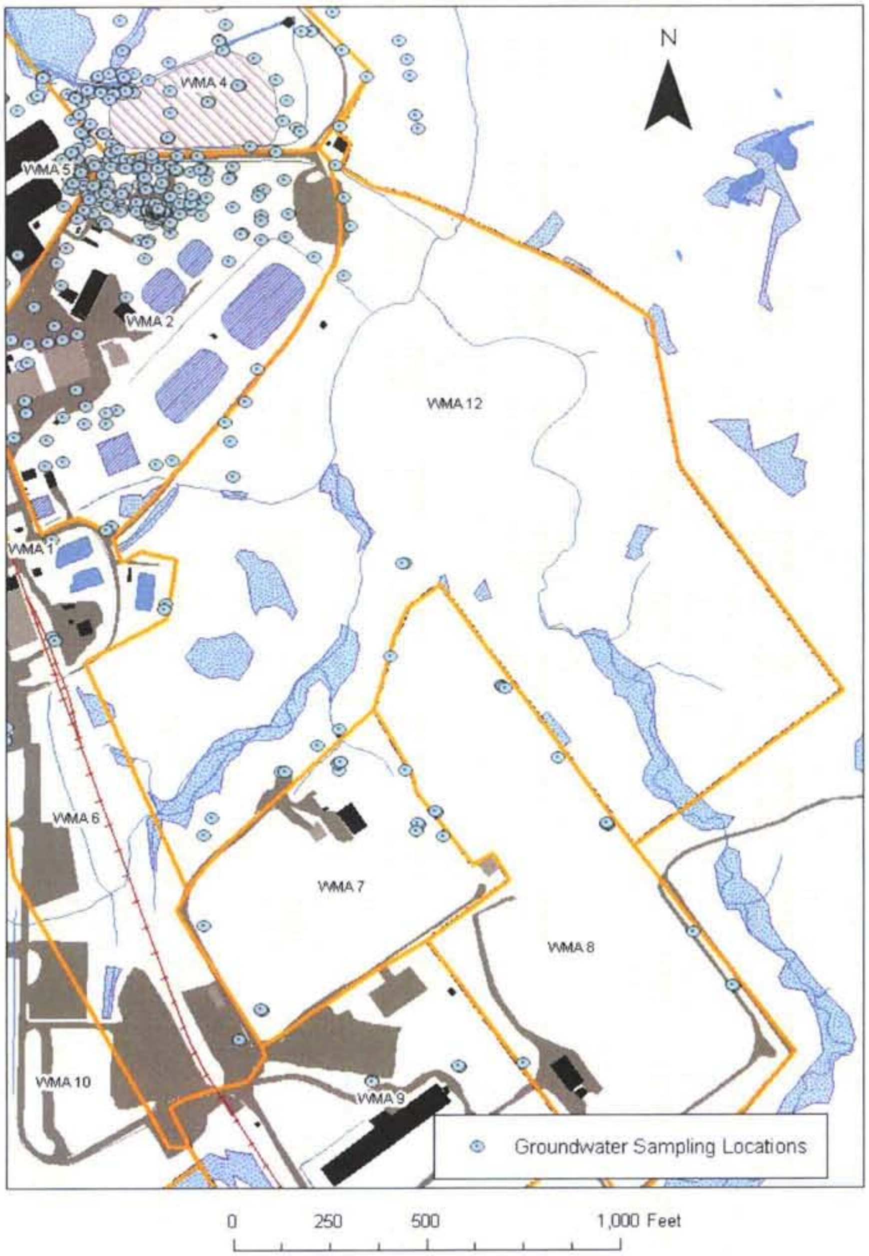

Figure J.11 WMA 12 Historical Groundwater Sampling Locations

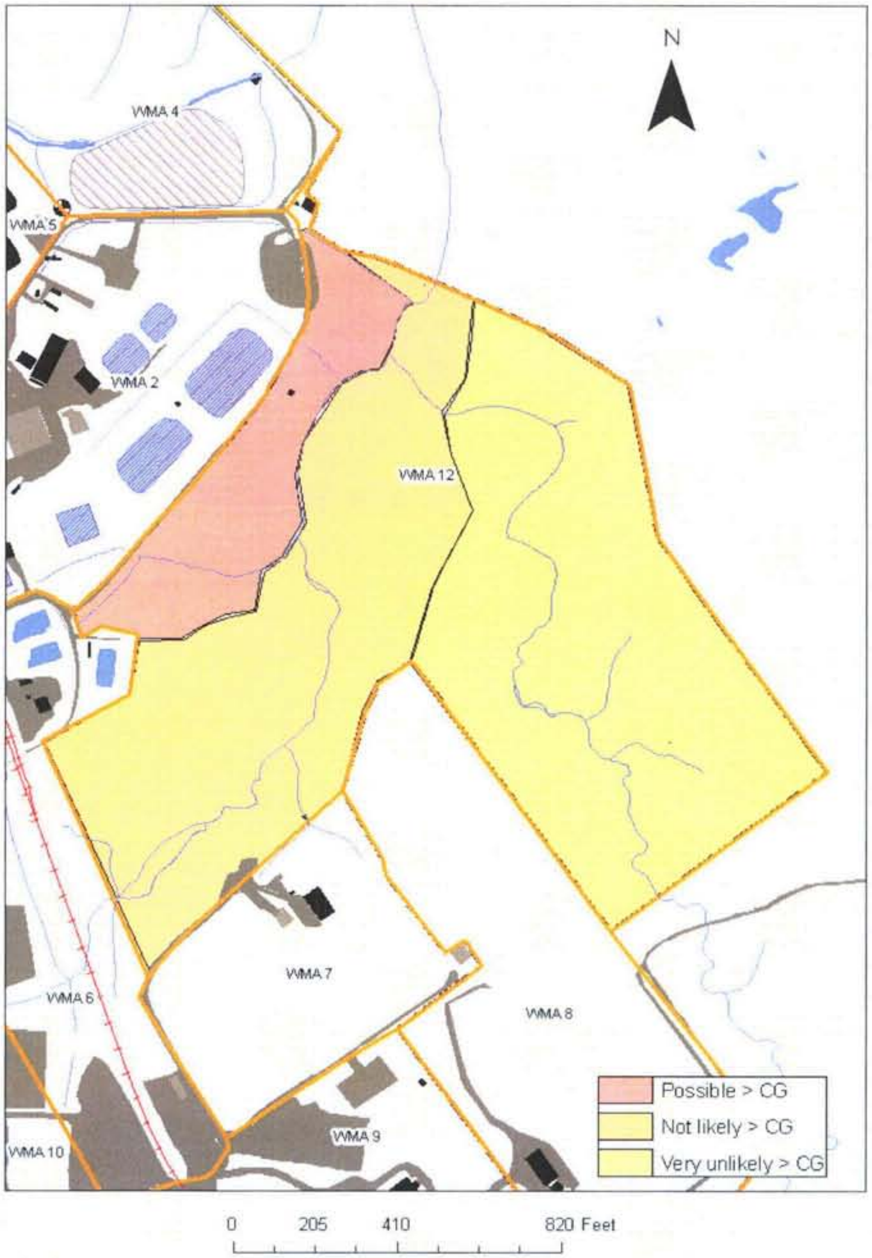

Figure J.12 WMA 12 Initial WMA 12 Surface Soil CSM

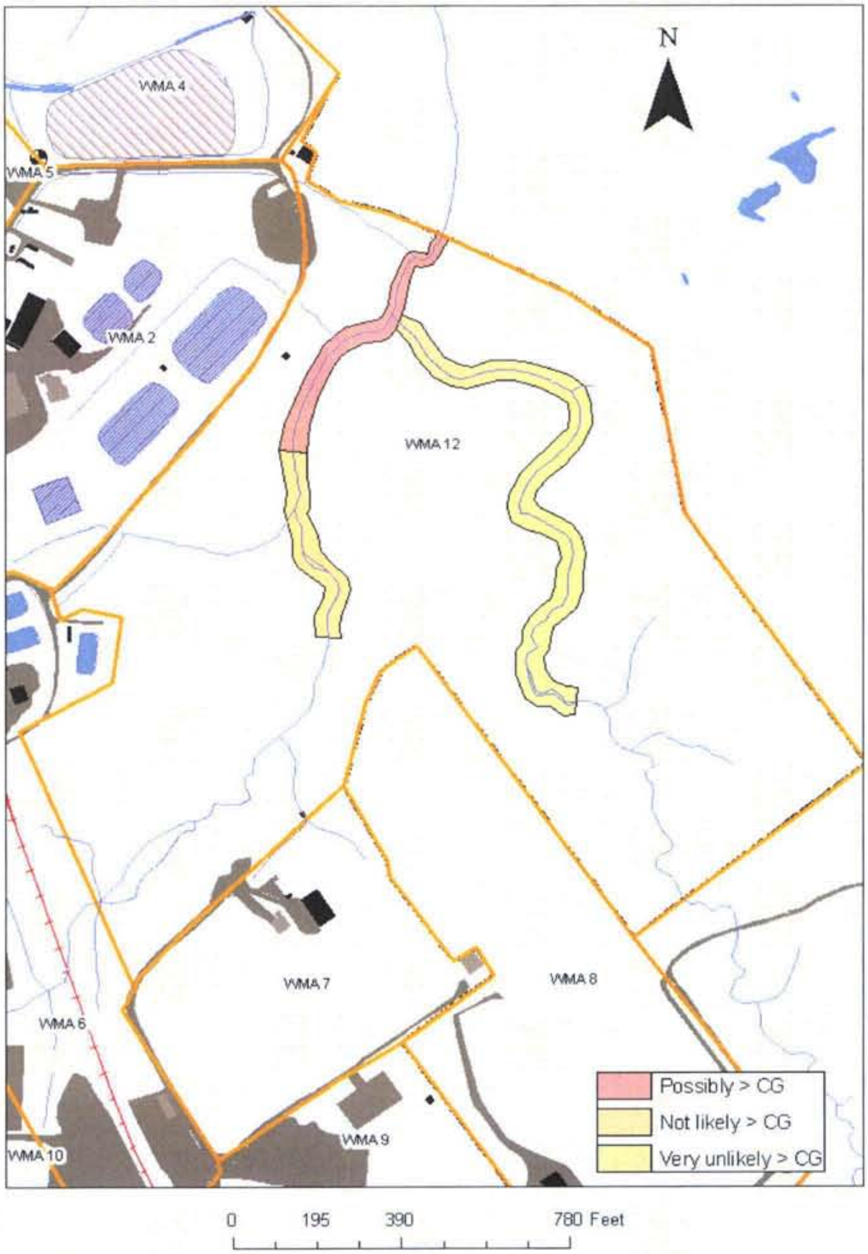

Figure J.13 WMA 12 Initial Sediment CSM

APPENDIX K

WMA 12 NORTH PRE-REMEDIATION DATA COLLECTION

K.1 Background

Waste Management Area 12 North (WMA 12 North) is approximately 7 acres in size (see Figure K.1 for map).

K.2 Physical Setting

WMA 12 North is located on the north plateau. It is bounded to the west, north, and east by the WVDP fence line and to the south by WMA 4.

WMA 12 North is vegetated. A significant portion of its surface is a wetland that is oriented along a southwest to northeast axis and is approximately 1.6 acres in size. A portion of this area has standing water for most of the year. Surface drainage is towards the southeast where a drainage ditch connects with another drainage ditch from WMA 5 that then empties off-premises to the north into Quarry Creek.

The subsurface of WMA 12 North is comprised of the sand and gravel unit, a relatively permeable unit that carries groundwater, which overlays the Lavery Till, a relatively impermeable unit that is a barrier to vertical groundwater flow. Because there has been no intrusive sampling within the boundaries of WMA 12 North, the thickness of the sand and gravel unit in this area is not known. Groundwater likely flows to the northwest, north, and northeast following surface topography, discharging to seeps along Quarry Creek to the north, Franks Creek to the east, and/or to the wetlands/surface drainage features within WMA 12 North.

There are no facilities in WMA 12 North.

K.3 Area History

WMA 12 North was not used for any structural purposes during the lifespan of the NFS reprocessing activities on-site or for any known WVDP-related activities. As will be discussed later in this section, there is evidence that portions of the surface have been reworked, although the reason is unclear.

Figure K.2 shows WMA 12 North in 1962 prior to NFS development. At this time WMA 12 North was grassland and woodland.

Figure K.3 shows WMA 12 North in 1966. A road leads into WMA 12 North from the southwest and terminates in what appears to be a cleared area. The purpose of the clearing is not known. Based on the fact that in later years ponds are present, this may have been a soils borrow area to support construction on the main NFS site.

Figure K.4 shows WMA 12 North in 1968. The clearing is more defined than in 1966, as is the entry road from the southwest.

Figure K.5 shows WMA 12 North in 1977. Ponds with standing water are present that were not in existence in 1968. The ponds are located in the previously cleared areas.

Figure K.6 shows WMA 12 North in 1984. In this photograph, ponds with standing water are clearly visible.

Figure K.7 shows WMA 12 North in 1995. There is no visible change in WMA 12 North since 1984.

Figure K.8 shows WMA 12 North in 2007. There is no visible change in WMA 12 North since 1995.

K.4 Known and Suspected Releases

There are no known or suspected releases within the WMA 12 North footprint.

The soils within WMA 12 North potentially would have been impacted by air deposition of radionuclide contaminants released by Process Building activities in WMA 1(in particular the cesium prong resulting from the 1968 stack release).

K.5 Existing Data

Existing data sets for this area include:

- Direct measurement gamma surveys were conducted over portions of the WVDP premises in 1982 and 1990-1991; however, no direct measurement gamma data were collected for the WMA 12 North area.

- There has been no sediment or soil sampling from within the WMA 12 North footprint available in the ELIMS database.

- There has been no groundwater data collection from within the WMA 12 North footprint that is reported in the ELIMS database.

K.6 Planned Phase 1 DP Activities

There are no planned Phase 1 decommissioning activities for WMA 12 North.

K.7 Conceptual Site Model

Based on the very limited available information, the conceptual site model (CSM) for WMA 12 North is as follows. No environmental releases of contamination within WMA 12 North are believed to have occurred. However, environmental media within WMA 12 North likely have been affected to some degree by releases elsewhere on the WVDP premises. These include air deposition contamination on surface soils, most likely along the western and southern portions of WMA 12 North since these were in closest proximity to WMA 1, and potential reworking of that contamination by erosional processes in the vicinity of WMA 12 North.

Pond sediments may be of concern since these ponds would have served as a settling basin for contaminated soils eroded from surrounding surface soils. The ponds appear to have been present for forty years.

Figure K.9 shows the current CSM for surface and near surface soils. Figure K.10 shows the CSM for soils deeper than 1 m. The assumption is that it is unlikely that there is soil contamination deeper than one meter within WMA 12 North. The assumption also is that there are no significant groundwater impacts within WMA 12 North; the most likely source of groundwater contamination would have been migration associated with the north plateau groundwater plume. 2008 characterization activities to the south in adjacent WMA 4 did not identify plume impacts as far north as WMA 12 North.

K.8 WMA 12 North-Specific Characterization Goals

- Evaluate appropriateness of the current list of Radionuclides of Interest (ROI)
- Determine level and extent of surface contamination
- Determine level and extent of sediment contamination
- Identify soil waste stream characteristics
- Obtain data to support Phase 2 planning

K.9 CSAP Pre-Remediation Data Collection and Associated Decision-Making

CSAP pre-remediation data collection will consist of a number of components described in more detail below.

K.9.1 Gamma Walkover Survey Data

The purpose of performing a gamma walkover survey of the WMA 12 North area is to identify the level and extent of surface contamination. This includes both general trends in average activity concentrations pertinent to the CG_w requirement, as well as the identification of isolated, more-elevated anomalies that might be indicative of discrete releases and/or CG_{emc} concerns.

A complete (100%) logged gamma walkover survey (GWS) will be conducted for WMA 12 North for accessible areas. Examples of areas that would not be accessible are areas where standing water is present in wetlands or ponds. Based on the GWS results, surface soils within WMA 12 North will be divided into three categories: (1) surface soils where GWS indicates possible surface soil CG_w exceedances; (2) surface soils where GWS indicate impacts, but those impacts are not expected to exceed surface soil CG_w standards; and (3) surface soils where there is no indication of impacts above background conditions. The purpose of this data collection is to provide insights into the spatial distribution of surface contamination, and to guide subsequent soil sampling. **[required]**

K.9.2 Surface Soil Sampling

Surface soil sampling will be used to address areas inaccessible to GWS data collection, to resolve hot spots identified by the GWS data, and to evaluate the presence, absence, and/or extent of surface contamination above CG_w requirements based on GWS results.

- **Wetlands.** It is highly likely that standing water will be present in the ponds/wetlands that prevent GWS data collection from those areas. Consequently, soil/sediment sampling will be required for pond footprints and for any other areas where standing water prevents the collection of GWS data.

  For every area where standing water or saturated soil conditions prevent GWS data collection, systematic soil sampling will take place. At least one and at most five sampling locations will be selected per area. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. In the case where an area has more than one location, locations will be selected so that each representative area does not overlap and provides systematic coverage of the area of interest. If a ponded area is less than 200 m^2 in size, one 5-point composite will be formed to be representative of the pond's area. **[contingent]**

- **Hot Spots**. If GWS data indicate the presence of contamination that possibly exceeds "hot spot" (CG_{emc}) standards or an isolated elevated area is identified that appears indicative of a discrete release, then the location of concern will be sampled with a biased sample. If biased samples are collected from a particular location, they will be collected from two depth intervals: 0-15 cm, and 0-1 m. Sufficient soil mass will be collected to allow for the analysis of all 18 ROI. In the case of surface soils, each biased sample will be a composite sample formed from five increments systematically distributed over the area of interest. The exception to this are hot spots identified in ditch footprints – in these cases the biased samples will be discrete. All samples will be analyzed for all 18 ROI. One down-hole gamma scan will be conducted from each soil biased location with static measurements taken every 15 cm. The purpose of these samples is to resolve GWS anomalies and evaluate the appropriateness of the current ROI list. **[contingent]**

- **CG_w Sampling.** Surface soil sampling may be conducted after the GWS to further clarify results, with the level and nature of sampling dependent on GWS results. If GWS results indicate no evidence of contamination impacts above background levels, no additional surface soil sampling will be required other than to address areas too wet to perform a gamma walkover survey.

    - If GWS results indicate contamination impacts above background levels but that surface soil contaminant levels exceeding CG_w requirements are unlikely, a minimum of five surface soil sample locations will be identified and sampled that target the areas with the highest gross activity levels. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap. The purpose is to document the maximum activity concentrations present in surface soils within WMA 12 North. **[contingent]**

    - If GWS results indicate surface soil contaminant levels exceeding CG_w requirements likely exist, one sampling location will be selected at the highest gross activity level to confirm CG_w exceedances and another set of sampling locations will be identified to spatially bound the extent of contamination (i.e., along the boundary of what is considered likely above CG_w requirements). Two samples will be collected from the location targeting high gross activity levels, one representative of a 0-15 cm depth interval, and one representative of a 0-1 m depth interval. One sample will be collected from each location intended to laterally bound contamination, representative of a 0-15 cm depth interval. Each sample will be a 5-increment composite formed to be representative of a 200 m^2 area. In addition, the location targeting high gross activity levels will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. Locations will be selected so that each representative area does not overlap. The purpose is to document CG_w

requirement exceedances and bound the lateral extent of contamination. **[contingent]**

- If GWS results indicate areas with surface soil contamination impacts but it is unclear whether CG_w requirement exceedances are present, at most five sampling locations will be selected that systematically cover the areas of interest. One sample will be collected from each location representative of a 0-15 cm depth interval. The sample will be a 5-increment composite formed to be representative of a 200 m^2 area. Locations will be selected so that each representative area does not overlap. The purpose is to resolve the question of whether CG_w requirement exceedances exist for areas where GWS results are ambiguous. **[contingent]**

- If any 0-15 cm interval yields a sample result indicating a CG_w requirements exceedance and that sample location is not laterally bounded either by existing sampling locations with results less than CG_w requirements or by GWS data that clearly indicate contamination is not a concern, additional sampling locations will be selected so that the contamination encountered is spatially bounded. The purpose is to laterally bound contamination that is above CG_w requirements. **[contingent]**

K.9.3 Subsurface Soil Sampling

The purpose of subsurface soil sampling within WMA 12 North is to determine the vertical extent of contamination impacts above background levels.

- If any 0-15 cm surface soil sample result indicates contamination impacts above background levels and there was not a 0-1 m sample collected from that location, a 0-1 m sample will be collected from that location following the protocols used for the original 0-15 cm surface soil sample. In addition, each soil location will have one down-hole gamma scan conducted at the center of the location with static measurements taken every 15 cm. **[contingent]**

- If a surface soil sample indicates contamination impacts above background levels for the 0-1 m depth interval, an additional sample from a depth of 1-2 m will be collected and analyzed from that location. This process will continue until the vertical extent of contamination above background is bounded. One down-hole gamma scan will be conducted from each soil location requiring deeper investigation with a static reading taken every 15 cm vertically. The purpose of these samples is to define the vertical extent of contamination. **[contingent]**

K.9.4 Required Laboratory Analyses

All samples will be submitted for analysis of all 18 ROI. No samples will require analysis of the twelve potential radionuclides of concern.

Table K.1 summarizes the number of required samples and the estimated number of contingency samples for WMA 12 North.

This sampling plan assumes that quick turn-around analyses (within 48 hours) are available for Sr-90 and Cs-137 and that soil samples will be screened for Sr-90 and Cs-137 prior to being analyzed for the balance of the ROI. Based on these screening data, contingency sampling requirements as described above may be undertaken without the benefit of the remaining analyses.

K.9.5 Decision-Making Summary

A summary of decision-making based on the WMA 12 North data is as follows:

- If GWS indicate anomalies are present, biased samples will be selected to target those anomalies.
- The WMA 12 North surface soil area classification as contained in Figure K.9 will be adjusted based on GWS results. These adjustments may affect systematic sample number requirements.
- If the GWS data identify areas likely exceeding CG_w requirements, one sample will be placed to verify contamination and another set of surface soil samples used to laterally

bound contamination. Additional locations may be selected, as necessary, to laterally bound contamination extent.

- If GWS data indicate impacts exist but that it is unlikely that contamination exceeds CG_w requirements, five biased locations will be selected based on GWS data to verify this conclusion.

- If GWS data identify areas where contamination impacts exist but CG_w compliance is unclear, at most five systematic surface soil samples will be allocated to each area to verify contamination status.

- If a portion of the WMA 12 North area is too wet to conduct a GWS, at most five systematic sampling locations will be selected per area to evaluate the presence of contamination above CG_w requirements.

- If sample results from 0-15 cm intervals are above background and there was not a 0-1 m sample collected for that location, a 0-1 m sample will be collected and analyzed.

- If sample results for the 0-1 m depth interval are above background, an additional sample from that location representing the depth interval 1-2 m will be collected and this process repeated until contamination is vertically bounded.

- If a surface soil sample indicates contamination above CG_w requirements and that location is not bounded either by GWS data that indicate conditions are clearly below CG_w requirements or other surface soil sample locations that indicate activity concentrations below CG_w requirements, then additional surface soil sampling locations will be selected to bound the contamination encountered.

Table K.1 Sample Number Estimates

	Required	Contingent	Total
Systematic Sediment Samples (0-15 cm)	14	0	14
Systematic Sediment Samples (0-1 m)	0	0	0
Biased Sediment Samples (0-15 cm)	0	0	0
Biased Sediment Samples (0-1 m)	0	0	0
Systematic Surface Soil Samples (0-15 cm)	5	10	15
Systematic Surface Soil Samples (0-1 m)	0	4	4
Biased Surface Soil Samples (0-15 cm)	0	3	3
Biased Surface Soil Samples (0-1 m)	0	3	3
Systematic Subsurface Soil Samples (1-m intervals)	0	0	0
Biased Subsurface Soil Samples (1-m intervals)	0	0	0
Total:	19	20	39

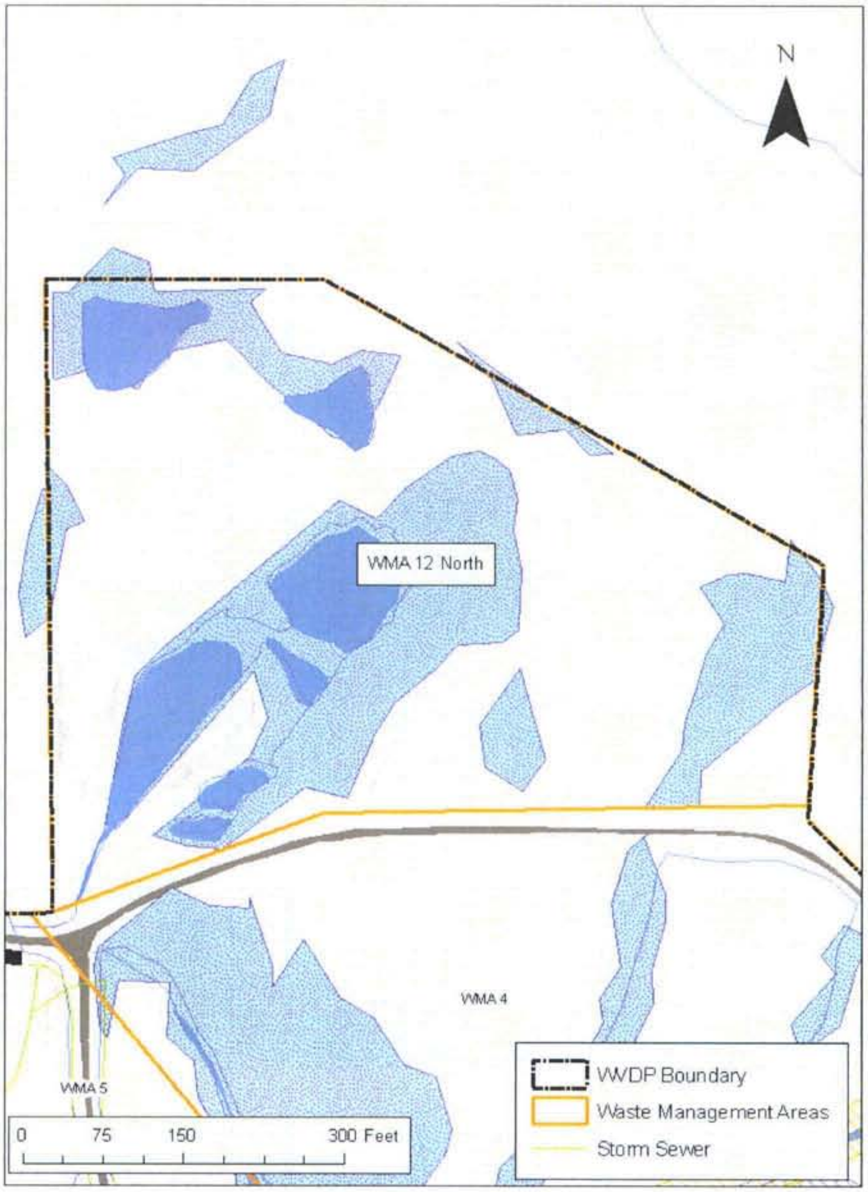

Figure K.1 WMA 12 North

Figure K.2 WMA 12 North Aerial Photograph from 1962

Figure K.3 WMA 12 North Aerial Photograph from 1966

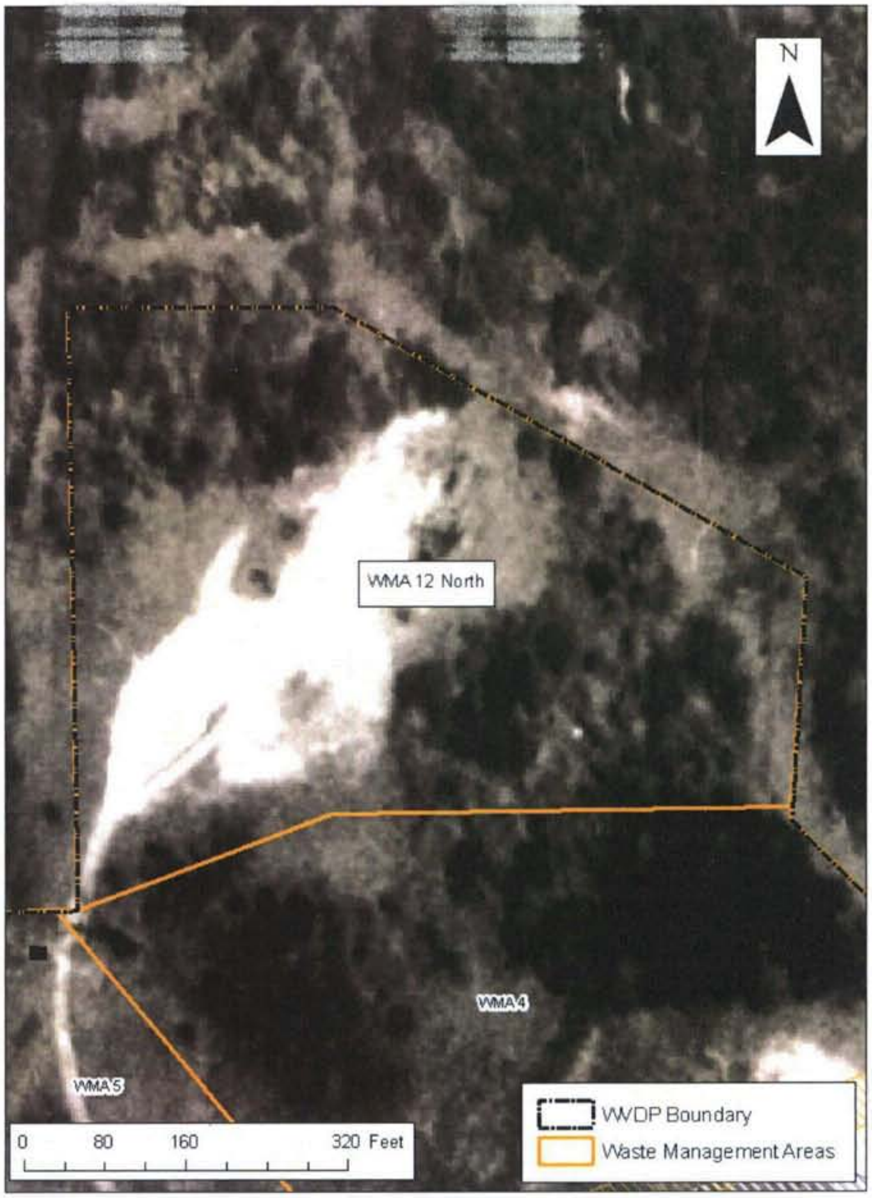

Figure K.4 WMA 12 North Aerial Photograph from 1968

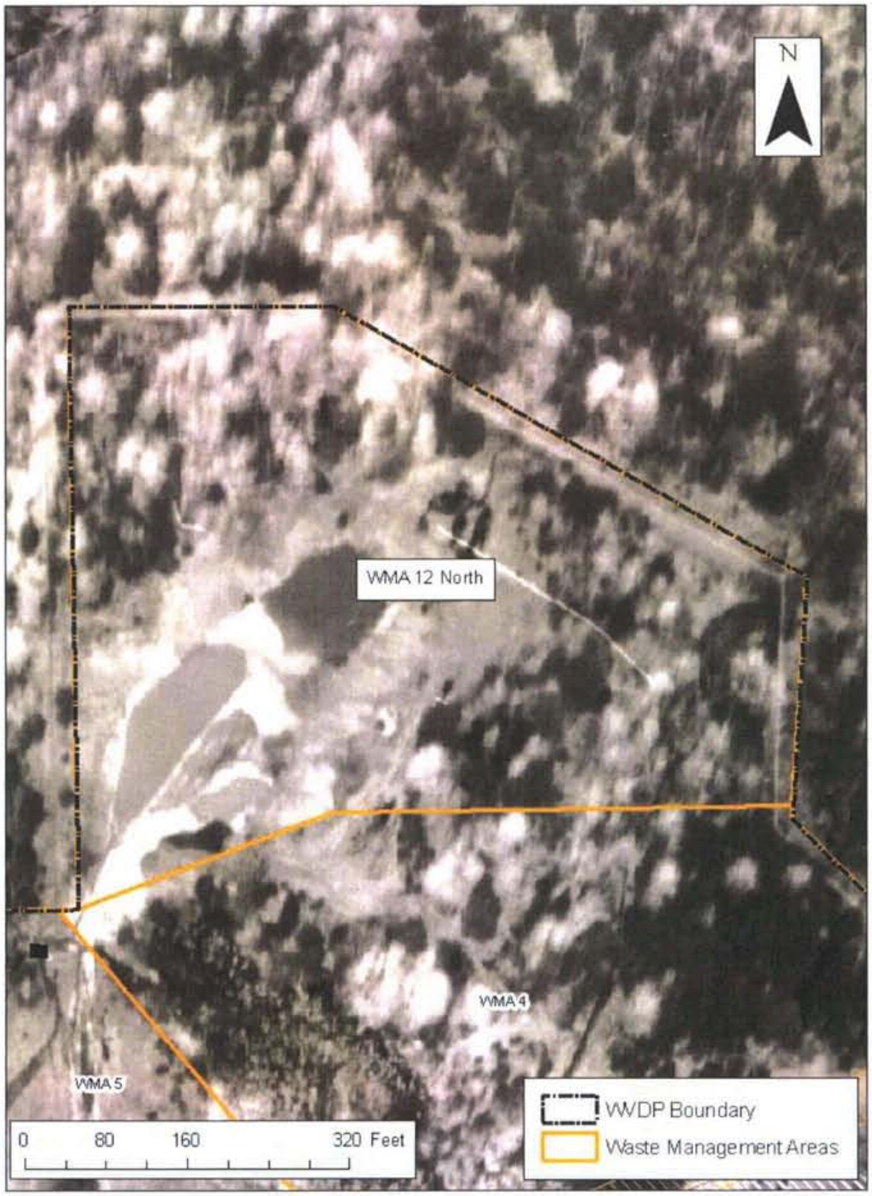

Figure K.5 WMA 12 North Aerial Photograph from 1977

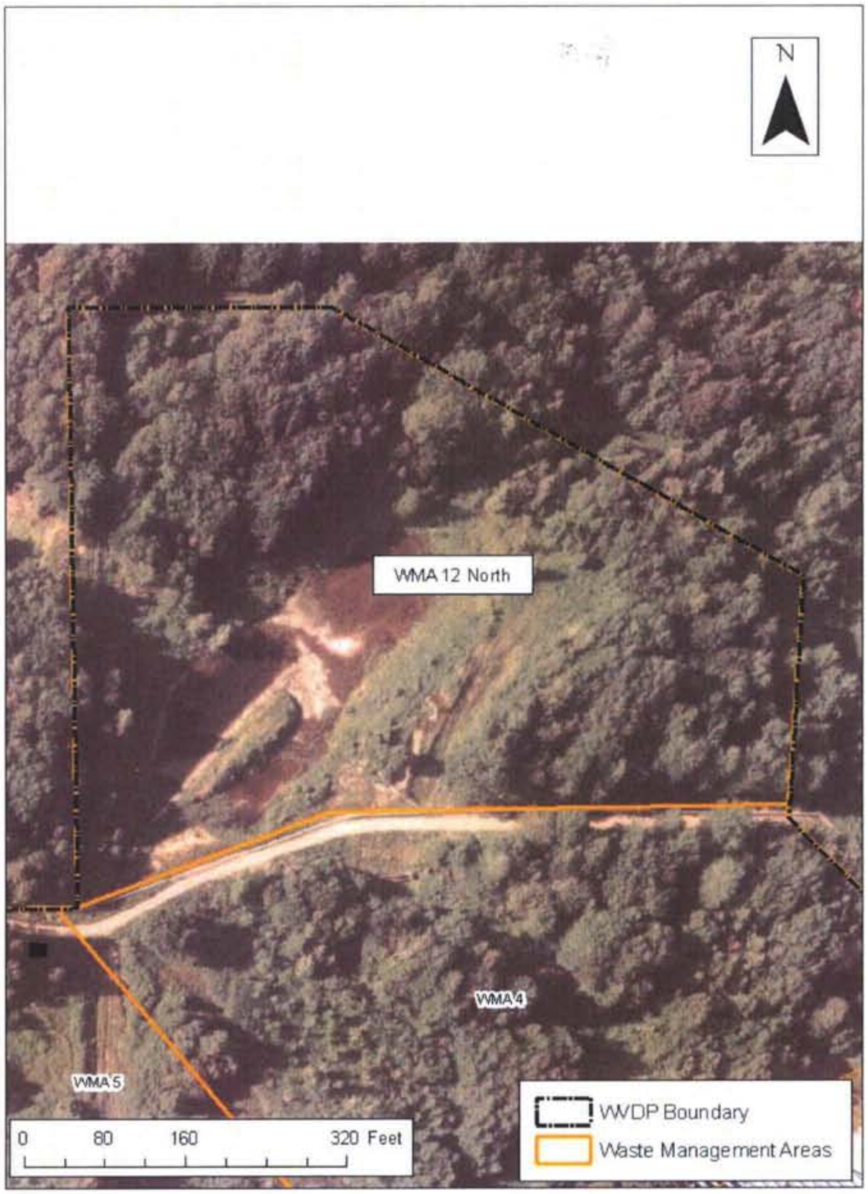

Figure K.6 WMA 12 North Aerial Photograph from 1984

Figure K.7 WMA 12 North Aerial Photograph from 1995

Figure K.8 WMA 12 North Aerial Photograph from 2007

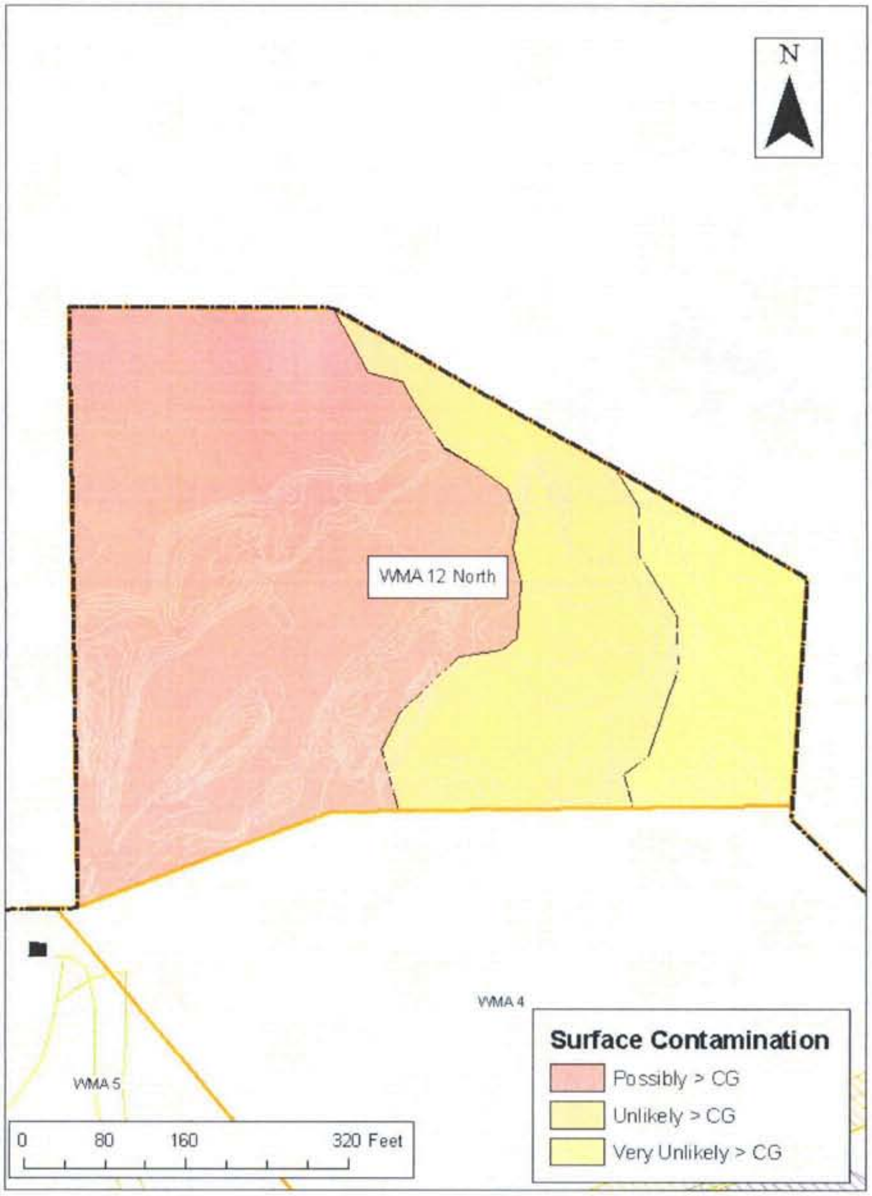

Figure K.9 Initial WMA 12 North Surface Soil CSM

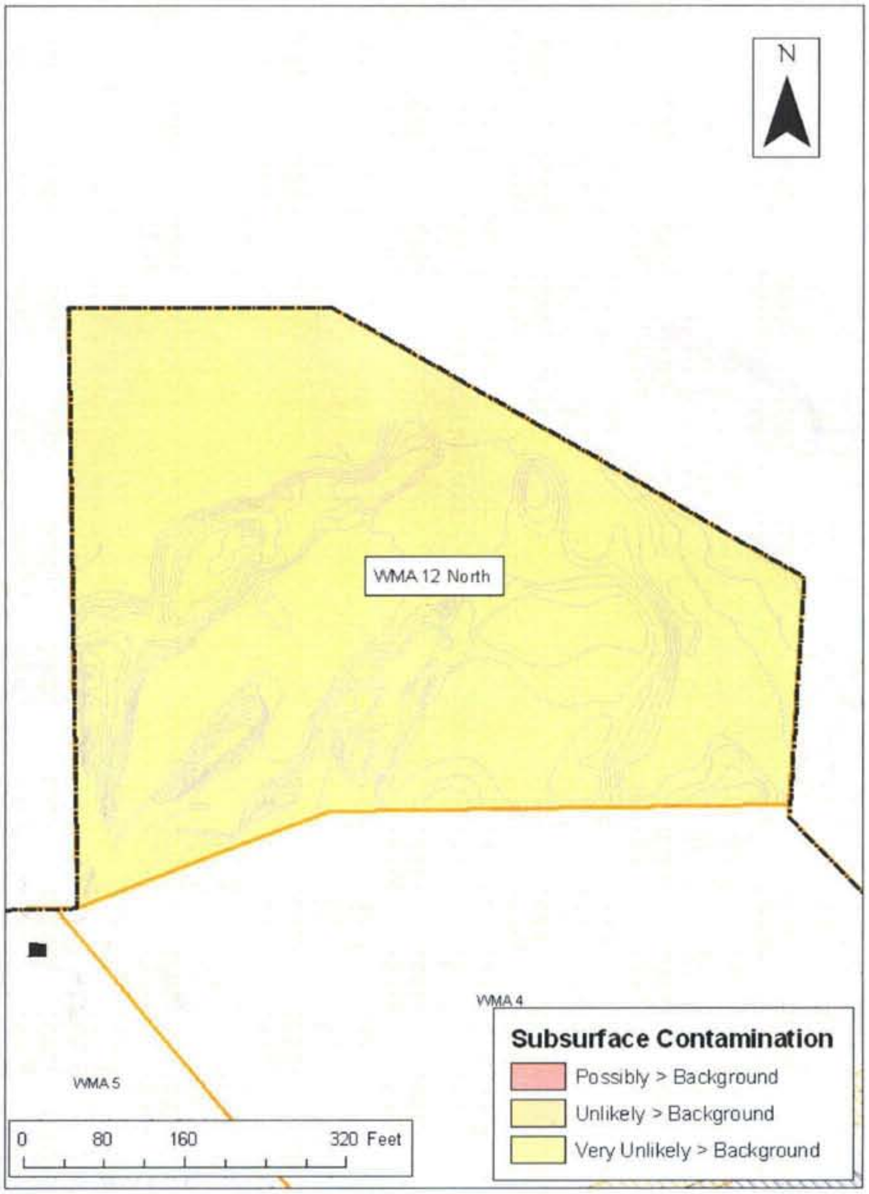

Figure K.10 Initial WMA 12 North Subsurface Soil CSM