Department of Energy
Washington, DC 20585

May 15, 2013

Subject: Final *Assessment of Historical Knolls Atomic Power Laboratory Waste Storage Locations Niagara Falls Storage Site FUSRAP Site* (Rev 3, May 2013).

Dear Stakeholders:

I am pleased to provide the final version of the *Assessment of Historical Knolls Atomic Power Laboratory Waste Storage Locations Niagara Falls Storage Site FUSRAP Site* (Rev 3, May 2013).

The U.S. Department of Energy (DOE) began reviewing documentation in 2011 in response to stakeholder concerns about final conditions at certain Niagara Falls Storage Site (NFSS) vicinity properties where Knolls Atomic Power Laboratory (KAPL) wastes had been temporarily stored in the 1950s. DOE solicited public comment and input after the report was released in draft form in March 2012. Stakeholders were asked to provide any additional information concerning the reviewed properties that might not be included in the DOE document collection.

This report provides a summary of available information about radiological conditions on the affected closed vicinity properties, from the initial decontamination through the assessment, post remedial action, and verification phases. The remediation work was conducted in the 1980s. DOE finds that KAPL wastes were remediated to levels that do not exceed regulatory limits and no use restrictions are required as the result of KAPL waste involvement at these properties. Land use restrictions may ultimately be needed because of other wastes but remedial action is ongoing and final site conditions are not yet known.

DOE received stakeholder comments that primarily addressed waste characterization, handling, and storage of the KAPL waste at the former Lake Ontario Ordnance Works. The comments and DOE responses are presented in a response summary, which is Attachment III of this final report. DOE will respond to comments provided at any time about conditions on the closed vicinity properties. If we receive additional information that changes our conclusions, we will amend the report.

We look forward to working with the U.S. Army Corps of Engineers Buffalo District and the citizens of Lewiston and Porter as the NFSS cleanup is completed and the site transitions back to DOE for long-term surveillance and maintenance. DOE will remain available and keep our stakeholders informed of the Department's activities during this transition.

This report was produced to respond to stakeholder questions and is not a decision document, nor does it fulfill any regulatory requirement. If you have questions or additional comments, please contact our public affairs staff by e-mail at FUSRAPInfo@lm.doe.gov.

Sincerely,

Christopher Clayton
FUSRAP Program Manager

cc:
File: NFS 000(A) (rc grand junction)
\\Sites\Niagra Falls\5-15-13 Niagra Falls KAPL Cover Letter for Report

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Assessment of Historical Knolls Atomic Power Laboratory Waste Storage Locations Niagara Falls Storage Site, FUSRAP Site Lewiston, New York

May 2013
Rev 3



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Assessment of Historical Knolls Atomic Power Laboratory Waste Storage Locations
Niagara Falls Storage Site
FUSRAP Site
Lewiston, New York

May 2013
Rev 3

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Attachment I Correspondence from Department of Energy Schenectady Naval Reactors Office to New York Department of Health

Attachment II *Nuclear Facility Historical Site Assessment for the Separations Process Research Unit (SPRU) Disposition Project, 2006* (partial report)

Attachment III Response to Stakeholder Comments

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Abbreviations

AEC	U.S. Atomic Energy Commission
ALARA	as low as reasonably achievable
BNI	Bechtel National, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm	centimeter(s)
CWM	Chemical Waste Management
DERP-FUDS	Defense Environmental Restoration Program for Formerly Used Defense Sites
DOE	U.S. Department of Energy
EM	DOE Office of Environmental Management
EPA	U.S. Environmental Protection Agency
ERDA	U.S. Energy Research and Development Administration
EU	exposure unit
FUSRAP	Formerly Utilized Sites Remedial Action Program
KAPL	Knolls Atomic Power Laboratory
LOOW	Lake Ontario Ordnance Works
LOSA	Lake Ontario Storage Area
MED	Manhattan Engineer District
MOU	memorandum of understanding
µR/hr	microroentgen(s) per hour
mR/hr	milliroentgen(s) per hour
mrem/yr	millirem(s) per year
NFSS	Niagara Falls Storage Site
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
ORAU	Oak Ridge Associated Universities
ORNL	Oak Ridge National Laboratory
pCi/g	picocurie(s) per gram
PRG	Preliminary Remediation Goal
RIR	Remedial Investigation Report
SPRU	Separations Process Research Unit
TEDE	total effective dose equivalent

TNT	trinitrotoluene
USACE	U.S. Army Corp of Engineers
VP	vicinity property

Executive Summary

Beginning in 1952, the Lake Ontario Ordnance Works (LOOW), near Lewiston, New York, began receiving low-level radioactive waste from the Knolls Atomic Power Laboratory (KAPL) located in Schenectady, New York. The waste originated from the Separations Process Research Unit (SPRU), a pilot plant that conducted laboratory-scale research on non-irradiated and slightly irradiated test specimens, for development of processes later used at other facilities on a production scale to extract uranium and plutonium from irradiated uranium. SPRU commenced operation at KAPL in 1950 (DOE 2006b).

The purpose of this report is to determine if KAPL waste residuals remain on the Niagara Falls Storage Site (NFSS) proper or the vicinity properties (VPs) in concentrations requiring the involvement of the U.S. Department of Energy's (DOE's) Office of Environmental Management (EM).

The waste stream from SPRU consisted of (1) sludge from "evaporator bottoms" (i.e., the contents remaining after liquid wastes were evaporated to reduce their volume) and (2) associated contaminated material such as protective clothing. Other waste received from KAPL consisted of combustible materials with a radioactivity of approximately 12 milliroentgens per hour from mixed fission products. The KAPL wastes were temporarily stored at various locations on the LOOW prior to being repackaged and shipped to Oak Ridge National Laboratory for permanent disposal.

According to historical process knowledge and waste profile information from remediation at the KAPL facility, the predominant radionuclide was cesium-137 (Cs-137), with minor amounts of strontium-90 (Sr-90) and americium-241 (Am-241).

DOE remediated a portion of the LOOW under the Formerly Utilized Sites Remedial Action Program (FUSRAP). Under FUSRAP, DOE found that the NFSS and 26 nearby VPs were contaminated with radiological material, including KAPL waste residuals on some of the properties.

DOE assessment, remediation, and verification processes were designed to investigate known locations where KAPL wastes were handled. Cs-137 was used as an indicator for KAPL waste, and suspected areas were investigated through the use of gamma measurements; subsurface explorations; tighter, more closely spaced surveys; and targeted analytical programs in the areas where KAPL wastes were known to have been stored or incinerated (Berger 2010). Records indicate that KAPL wastes were stored and combustibles incinerated on the NFSS proper and on VP-E', VP-H', VP-N/N' North, VP-N/N' South, and VP-X.

DOE remediated 23 of the VPs (referred to as the "completed" VPs), including the properties identified as storage or incineration locations for KAPL waste. Cesium results for the completed VPs, prior to remediation, ranged from background (less than 0.02 to 1.05 picocuries per gram (pCi/g) up to 33.0 pCi/g, and these areas were consequently remediated by DOE. The U.S. Army Corp of Engineers (USACE) was assigned responsibility to conduct remedial activities on FUSRAP sites by Congress in 1997 and will investigate the remaining three active VPs (VP-E, VP-E', and VP-G) and the NFSS proper.

During remedial investigations, USACE detected traces of Am-241 in approximately 1 percent of samples from the NFSS, and so determined that it is not a contaminant of concern. This also suggests that other transuranic elements are unlikely to be present in significant concentrations or to be widespread in the NFSS or on the vicinity properties in soils or sediment. Plutonium-239 (Pu-239) was also detected, but only in trace amounts.

If KAPL material is identified exceeding cleanup criteria on the NFSS or the VPs, the agency responsible for the KAPL-related constituents would be EM[1], which is currently remediating the SPRU facility in Schenectady, New York.

After review of the historical site documentation, DOE reports, and USACE radiological data presented in the Remedial Investigation Report and Remedial Investigation Addendum for the NFSS, DOE concludes the following:

- DOE remediated the completed VPs for unrestricted residential use, (though it is noted that the New York State Department of Health has also enforced land use restrictions on some of the completed VPs). Sample and walkover gamma scan results indicate that no wastes remain that would cause referral to USACE for further remediation. No EM involvement is required at these properties.
- For the active VPs (VP-E, VP-E', and VP-G), results of DOE's cleanup of the accessible portions of these properties indicate that KAPL waste does not remain at concentrations greater than the DOE cleanup limit:
  - Inaccessible areas were not associated with historic KAPL waste handling. Therefore, it is unlikely that KAPL waste remains on the active (i.e., the three remaining) VPs.
  - Because gamma activity was used by DOE during remediation/verification activities for excavation control, additional USACE cleanup of FUSRAP wastes on these properties will likely result in the remediation of any co-located residual KAPL wastes to acceptable levels or identification of KAPL waste that is not co-located.
  - Although USACE has not established a cleanup level for Cs-137 on the active NFSS VPs, DOE assessment and remediation data indicate that assessed Cs-137 was remediated and significant Cs-137 is unlikely to remain. Because of the low likelihood of encountering significant KAPL waste on the active NFSS VPs, no need for EM involvement is anticipated at these properties.
- USACE assessment soil sampling results on the NFSS proper indicate that KAPL waste does not exceed the DOE cleanup level for Cs-137. USACE has not established a cleanup level for Cs-137 on NFSS proper. The USACE cleanup of FUSRAP wastes on the NFSS proper will likely result in the remediation of any co-located residual KAPL wastes or identification of KAPL waste that is not co-located.

If a residential exposure scenario is used, the concentration of Cs-137 would result in a risk of $1 \times 10\ E^{-6}$ or 4.06 pCi/g (EPA 2010; this includes the ingestion of 25 percent of fruits and vegetables from a home garden). DOE's remediation limit for Cs-137 was based on pathway

[1] EM is currently responsible for the remediation of KAPL waste at the Schenectady, New York, location. If KAPL waste is identified after this action has been completed, responsibility would fall to LM for assessment and referral back to USACE.

analysis based on RESRAD computer code. The analysis determined 33 pCi/g would result in risks less than $1 \times 10\ E^{-5}$ (DOE 1988) for the same scenario. Another benchmark for protectiveness is the U.S. Nuclear Regulatory Commission's surface soil screening level for decommissioning, which is 11 pCi/g for Cs-137 (NUREG 1757 Vol. 1). Therefore, the DOE cleanup limit for the NFSS VPs does not result in unacceptable risk for an unrestricted residential use scenario. USACE found Cs-137 concentrations as high as 5.15 pCi/g on the NFSS proper (USACE 2009a), which would be within the range of acceptable risk for this exposure scenario.

USACE stated in 2009 that the subsistence farming scenario was "overly conservative" and "highly unlikely" due to the proximity to landfills, poor water quality, and low groundwater yield (USACE 2009b). Therefore, it is probable that the residential exposure assumptions are reasonably conservative for analyzing risk from Cs-137 residuals. Based on a comparison of measured Cs-137 concentrations to U.S. Environmental Protection Agency risk-based Preliminary Remediation Goals, residual Cs-137 from KAPL waste does not pose an unacceptable human health risk for an unrestricted residential land-use scenario.

The affected properties currently are zoned for industrial or commercial use. Much of the land is used for landfills. The New York State Department of Health has applied land use restrictions, which limit the use of the property to its existing use and in some cases restricts intrusive work.

On the basis of this evaluation, DOE has concluded that, although minor KAPL residuals remain, particularly Cs-137, they are less than a risk-based screening benchmark. Therefore, they do not pose an unacceptable risk and do not require further remediation.

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1.0 Introduction

The Niagara Falls Storage Site (NFSS) and associated vicinity properties (VPs) are located near the town of Lewiston, New York. The NFSS proper is a 191-acre site. The NFSS proper and the VPs combined occupy approximately 1,500 acres of the original 7,500-acre facility formerly known as the Lake Ontario Ordnance Works (LOOW) (Figure 1). Radiological waste residuals on this portion of the former LOOW are being remediated under the Formerly Utilized Sites Remedial Action Program (FUSRAP).

Federal activities at the LOOW in the 1940s and 1950s included storage and transshipment of radioactive waste and uranium scrap. Among the various materials sent to LOOW was radioactive waste from the Knolls Atomic Power Laboratory (KAPL) in Schenectady, New York. Most KAPL waste was shipped off site or remediated. To determine if any KAPL waste remains at the NFSS or VPs that requires remediation, the U.S. Department of Energy (DOE) Office of Legacy Management has evaluated data for the NFSS and VPs. Evaluation results are presented in this report.

1.1 Objective

The objective of this evaluation is to determine if KAPL waste residuals remain on the NFSS proper or the VPs. The evaluation included the following tasks:

- Review historical records to identify areas where KAPL wastes may have been handled, stored, or incinerated; and
- Review the results of assessment, post-remediation, and verification surveys to identify any areas that may need further evaluation and possible remedial action.

1.2 Background

The federal government constructed a trinitrotoluene (TNT) manufacturing facility on the LOOW in 1943. The TNT plant operated for about 9 months and was shut down. By 1944, 1,500 acres of the LOOW had been reassigned to the Manhattan Engineer District (MED) of the U.S. Army Corp of Engineers (USACE). MED used the site as an interim storage location for various wastes, including radioactive residues that resulted from the processing of uranium ore during the development of the atomic bomb. Wastes stored ranged from building and office materials to process sludge. Site ownership passed from MED to its successor agencies, the U.S. Atomic Energy Commission (AEC), the U.S. Energy Research and Development Administration, and, for the NFSS proper, DOE. The VPs are currently owned by private parties or local government.

AEC initiated FUSRAP in 1974. By 1997, DOE had remediated 23 of 26 VPs. Those 23 remediated VPs are referred to as “completed.” In 1997 Congress transferred responsibility for FUSRAP assessment and remediation to USACE, which is currently performing a Remedial Investigation/Feasibility Study of the NFSS proper. USACE will also investigate the remaining three active VPs: VP-E, VP-E' and VP-G. DOE had initiated remediation of the three active VPs but could not complete certification of the properties because of inaccessible areas and owner activities.

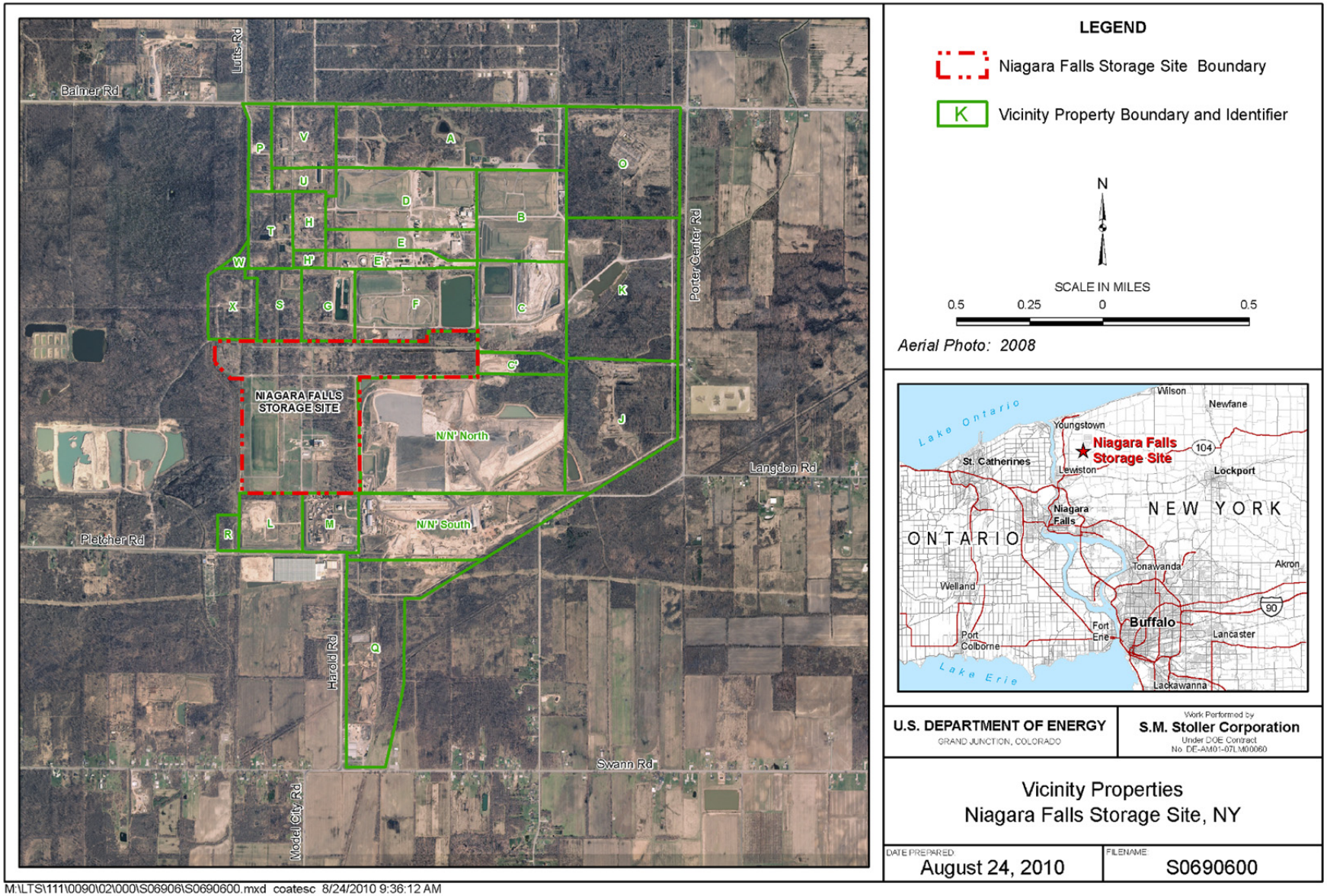


Figure 1. Vicinity Properties at the Niagara Falls Storage Site, New York

To provide a comprehensive sequence of events and previous investigations, a chronology of activities on the NFSS and the vicinity properties is provided in Table 1.

Table 1. Historical Chronology for the Niagara Falls Storage Site

Date	Event
1942	Construction of LOOW by USACE
1942–1943	TNT production
1944–1953	Interim waste storage, uranium transshipment
1952–1954	KAPL storage on LOOW beginning at Building 845-1 (VP-E')
1953–1954	Boron Isotope project at Building 401; KAPL waste moved to other locations
1954–1955	Major decontamination of properties by Hooker Chemical includes repackaging of KAPL waste and drumming of ashes from incineration of contaminated combustible waste for shipment to Oak Ridge, Tennessee
1955	Excess properties sold by AEC (approximately 1,511 acres)
1958	Last shipment of KAPL waste from LOOW to Oak Ridge, Tennessee
1958–1971	Boron production resumed
1968	U.S. General Services Administration disposed of additional 1,298 acres, leaving a 213-acre AEC-owned site (Aerospace Corp. 1982.)
October 1970	Elevated radiological contamination confirmed
April 1972–1974	AEC remediates areas exceeding 50 microroentgens per hour (μR/hr); New York State Department of Health (NYSDOH) places land use restrictions on all of the excessed properties based on State decontamination criteria of 20 μR/hr
June 1972	Radiological surveys and decontamination complete (AEC 1973)
1973	Aerial and vehicle-mounted surveys confirm remaining portions were contaminated
1975	Additional acreage sold to private parties, leaving the 191-acre NFSS proper
1971–1981	National Lead of Ohio was caretaker for the site
1978	Aerial survey by DOE using more sensitive helicopter-mounted instruments
1979	DOE commissions Battelle Columbus Laboratories to perform comprehensive surveys over the storage site and including offsite areas
1981	Bechtel National, Inc., becomes caretaker of the site and begins development of plans for additional post-remedial actions
June 1981	Remedial action and radiological surveys on VP-N/N' North (Eberline 1981)
1983–1984	Comprehensive assessments performed on all offsite properties
1983–1990	Post-remedial-action and verification surveys completed for VPs (did not include VP-E, VP-E', and VP-G, which had inaccessible areas)
1997	Congress transferred the authority for FUSRAP from DOE to USACE in the Energy, Water Development and Appropriations Act, transferring the responsibility for remediation from DOE to USACE
2007	USACE completes Remedial Investigation Report (RIR) for NFSS
2011	USACE completes the Remedial Investigation Addendum Report

This evaluation uses (1) assessment, post-remediation, and verification data acquired by DOE; (2) USACE assessment data from NFSS; (3) documentation describing historical KAPL waste handling at LOOW; and (4) process knowledge of KAPL waste from LOOW site documentation and from current remediation activities of the Separations Process Research Unit (SPRU) at the KAPL facility.

1.3 Stakeholder Roles and Responsibilities

Section 1.3.1 through Section 1.3.4 outline the roles and responsibilities of DOE, USACE, state and federal agencies, and stakeholders involved with remediation of NFSS proper and its VPs.

1.3.1 Department of Energy

FUSRAP was created in 1974. Cleanup of eligible FUSRAP sites was the responsibility of the AEC and its successor agencies, the U.S. Energy Research and Development Administration (ERDA) and then DOE, until 1997. AEC/ERDA/DOE was self-regulated and established cleanup criteria and remediation processes for FUSRAP sites (see also additional discussion in Section 2.0). Under FUSRAP, DOE was responsible for the cleanup of only radiological contamination. For remediation of the NFSS VPs, correspondence records indicate that the New York State Department of Environmental Conservation (NYSDEC), the New York State Department of Health (NYSDOH), and the U.S. Environmental Protection Agency (EPA) were kept informed and consulted during the decontamination, assessment, and remediation.

During review of the NFSS and surrounding areas, conducted in the 1970s and 1980s under the authority of DOE, properties adjacent to the NFSS that were known or suspected of having been used for storage of radioactive materials and contained radiological contamination were designated as VPs for environmental response and were assigned letter designations. As of March 1997, DOE had completed remediation of all but three VPs. DOE has responsibility for long-term surveillance of the 23 completed VPs. The NFSS and the three partially remediated VPs (VP-E, VP-E', and VP-G) are still open FUSRAP sites under the authority of USACE.

In addition to long-term surveillance and maintenance activities for the completed sites and VPs, DOE is responsible for determining if new information or changed site conditions warrant the referral of a completed site to USACE for additional assessment and, if necessary, remediation. DOE is also responsible for determining if a new site is eligible for remediation under FUSRAP.

DOE uses the following criteria to determine if a site should be referred to USACE for further assessment:

- A third-party characterization or survey reveals existing MED- or AEC-related contamination that was not previously identified.
- A review of historical records indicates the potential for existing MED/AEC contamination that was not previously identified.
- An individual with credible institutional knowledge provides information that additional MED/AEC contamination might exist that was not identified in previous assessments.

1.3.2 U.S. Army Corps of Engineers

Congress transferred responsibility for assessing and remediating FUSRAP sites from DOE to USACE in 1997. In March 1999, DOE and USACE entered into a memorandum of understanding (MOU) for the purpose of delineation, administration, and execution of FUSRAP responsibilities (DOE and USACE 1999). The MOU implements the direction of Congress that USACE has the authority to administer and execute cleanup activities at eligible FUSRAP sites pursuant to the provisions of the Energy and Water Development Appropriations Act of 1998; the Energy and Water Development Appropriations Act of 1999; the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); and the National Oil and Hazardous Substances Pollution Contingency Plan. In addition, the MOU stipulates that DOE does not have regulatory responsibility or control over the FUSRAP activities of USACE. USACE is responsible for all environmental response activities at a FUSRAP site until 2 years

after remedial action is complete, at which time DOE assumes responsibility for long-term surveillance and maintenance of the site.

USACE is responsible for the cleanup of FUSRAP wastes from the NFSS and the three active VPs that remained to be remediated when the program was transferred in 1997. Additionally, USACE is responsible for cleanup of U.S. Department of Defense-related wastes from approximately 6,500 acres of the LOOW, which includes the NFSS and VPs. The Department of Defense cleanup is being conducted under the Defense Environmental Restoration Program for Formerly Used Defense Sites (DERP-FUDS) program.

1.3.3 State and Federal Regulatory Agencies

The NYSDEC provides input and oversight of the USACE Buffalo District's ongoing FUSRAP cleanup, as well as regulatory oversight of the Modern Municipal, Inc.'s, municipal waste landfill and the Chemical Waste Management (CWM) hazardous waste landfill. These landfills occupy the majority of the 26 VPs and access to the company property restricts the access to the VPs that lie within their facilities.

NYSDOH maintains land-use controls over portions of the NFSS and VPs. These were first imposed in 1972 after initial AEC activities indicated that dose rates from stored radioactive materials were potentially hazardous to the public. These controls, in the form of use restrictions, are still in effect for several of the completed VPs and prevent the properties from development or disturbance of the surface without an acceptable plan approved by the New York State Commissioner of Health (Wallo 1980; DOE 1980a). Under these restrictions, the owner or future owner of a restricted property is responsible for performing the necessary due diligence, to ensure compliance with the restrictions, if there is a sale of the property or a change in surface conditions or land use.

EPA Region 2 provides regulatory oversight of the USACE operations and assists NYSDEC in its oversight of the municipal and hazardous waste landfill operations.

1.3.4 Stakeholders

USACE currently has a public outreach program for the LOOW and NFSS described in the *Public Involvement Plan, Former Lake Ontario Ordnance Works Site (Defense Environmental Restoration Program for Formerly Used Defense Sites) and Niagara Falls Storage Site (Formerly Utilized Sites Remedial Action Program), Lewiston and Porter, New York, for 2009–2010* (May 2009).

Stakeholders expressed questions about the possibility of KAPL residuals remaining on NFSS proper and the VPs. DOE evaluated the final site conditions and solicited input of new information from stakeholders. USACE has allowed DOE to present information to stakeholders at USACE public meetings. DOE has provided contact information to stakeholders and DOE will respond to stakeholder inquiries.

Stakeholders may contact DOE at 720-377-9672 or by E-mail at FUSRAPinfo@lm.doe.gov.

1.4 Current Site Conditions

The 191-acre NFSS proper is surrounded by a 7-foot-high chain-link fence topped with barbed wire and access is controlled by USACE. Access to the majority of the surrounding VPs is restricted to the general public by private industry site operators of the Modern Municipal landfill and CWM hazardous waste landfill, which border the NFSS to the north and east. The majority of the LOOW building structures have been removed with the exception of the concrete foundations and below-ground infrastructure.

DOE owns the NFSS proper and USACE controls land use on that property while remediation is in process. The NFSS proper contains the Interim Waste Containment Structure, which was constructed by DOE to isolate FUSRAP waste remediated from the VPs.

Current land use is industrial/commercial.

1.5 Eligibility of KAPL Residuals for FUSRAP Remediation

FUSRAP addresses wastes generated through MED/AEC activities that are on sites that are not included in another program. In the case of potential KAPL waste on the NFSS and VPs, the material is currently being remediated by the DOE Office of Environmental Management (EM) at the SPRU at the KAPL Schenectady, New York, location. Although a formal waste eligibility determination has not been conducted by USACE, responsibility for remediation of any remaining KAPL waste found on the NFSS or VPs may be covered by EM.

2.0 Regulatory Framework

The primary contaminants at Lake Ontario Storage Area (LOSA)/LOOW were uranium processing residues containing uranium-238 (U-238), uranium-235 (U-235), radium-226 (Ra-226), and other uranium daughter products. Early research of historical information identified areas known to have been involved with radioactive waste storage, including wastes received from KAPL and generated during the University of Rochester experiments. DOE developed decontamination and survey plans in accordance with the type of waste stored and the history of waste handling at the locations on the NFSS and VPs (AEC 1973; DOE 1981a). Site-specific and generic cleanup standards for the types of waste to be encountered were also generated.

2.1 Generic Cleanup Limits for Radium and Thorium

DOE remedial action activities at NFSS VPs adopted the cleanup criteria specified in the *U.S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program (FUSRAP) and Remote Facilities Management Program Sites* (DOE 1987 Rev 2 March [see Figure 4]). These guidelines are in DOE 5480.1 and in Title 40 *Code of Federal Regulations* Part 192 (40 CFR 192). They are further described in the Oak Ridge Operations documents *Radiological Guidelines for Application to DOE's Formerly Utilized Sites Remedial Action Program* (ORO-831) and *Pathways Analysis and Radiation Dose Estimates for Radioactive Residues at Formerly Utilized MED/AEC Sites* (ORO-832). These establish average concentration limits for radium and thorium in soil, and they invoke a criterion for maximum concentration, referred to as the hot spot rule.

ORO-831 also outlines the necessary process and describes the use of the term "Released for Unrestricted Use," which refers to guidelines for the amount of residual radioactive material that can remain in the decontaminated area and still allow for the use of the property. This guidance states that the basis of any cleanup criteria or guidelines for unrestricted use of a property must be sufficiently sound so that the remedial activities that meet those site-specific established criteria or guidelines would ensure that no member of the population would receive a radiation dose exceeding the specified limit at any time in the future of the site.

2.2 Derived Cesium and Uranium Residual Radioactive Material Guidelines

Cleanup guidelines for total uranium and cesium-137 (Cs-137) contamination at NFSS and NFSS VPs were established by Argonne National Laboratory in the *Derivation of Uranium and Cesium-137 Residual Radioactive Material Guidelines for the Niagara Falls Storage Site*[2] (DOE 1988). The derivation of the single-nuclide and total uranium guidelines was based on the requirement that the 50-year committed TEDE to a hypothetical individual who lives and works in the immediate vicinity of the NFSS should not exceed 100 mrem/yr following decontamination of the vicinity properties. DOE used the residual-radioactivity computer code RESRAD for the pathways analysis resulting in the cleanup criteria. Three scenarios were evaluated using the residual-radioactivity computer code model and the results indicated that the basic dose limit of 100 mrem/yr would not be exceeded within 1,000 years for either uranium or Cs-137, if soil concentrations for these radionuclides do not exceed 90 picocuries per gram (pCi/g) for total uranium and 33 pCi/g for Cs-137. These concentration values were considered to be adequately conservative and technically achievable for the remediation of the NFSS and the VPs.

2.3 Background Concentrations

Background exposure rates and baseline radionuclide concentrations were determined for surface soil by selecting 20 locations in areas surrounding the vicinity of the NFSS (DOE 1987) (Figure 2). The results indicated exposure rates ranged from 6.8 microroentgens per hour (μR/hr) to 8.8 μR/hr, a typical range for this area of New York. Concentrations of the radionuclides found in surface soils at the locations were as follows:

- Ra-226: less than 0.09 to 1.22 pCi/g
- U-238: less than 2.20 to 6.26 pCi/g
- Thorium-232 (Th-232): less than 0.18 to 1.18 pCi/g
- Cs-137: less than 0.02 to 1.05 pCi/g

Additional detail on the background sample results is provided in Table 2, which corresponds to Figure 2 locations where the samples were collected.

[2] The term Residual Radioactive Material is the title of the FUSRAP guidelines document and does not imply that the classification for contamination at NFSS and NFSS VPs is regulated under Title I of the Uranium Mill Tailings Radiation Control Act.

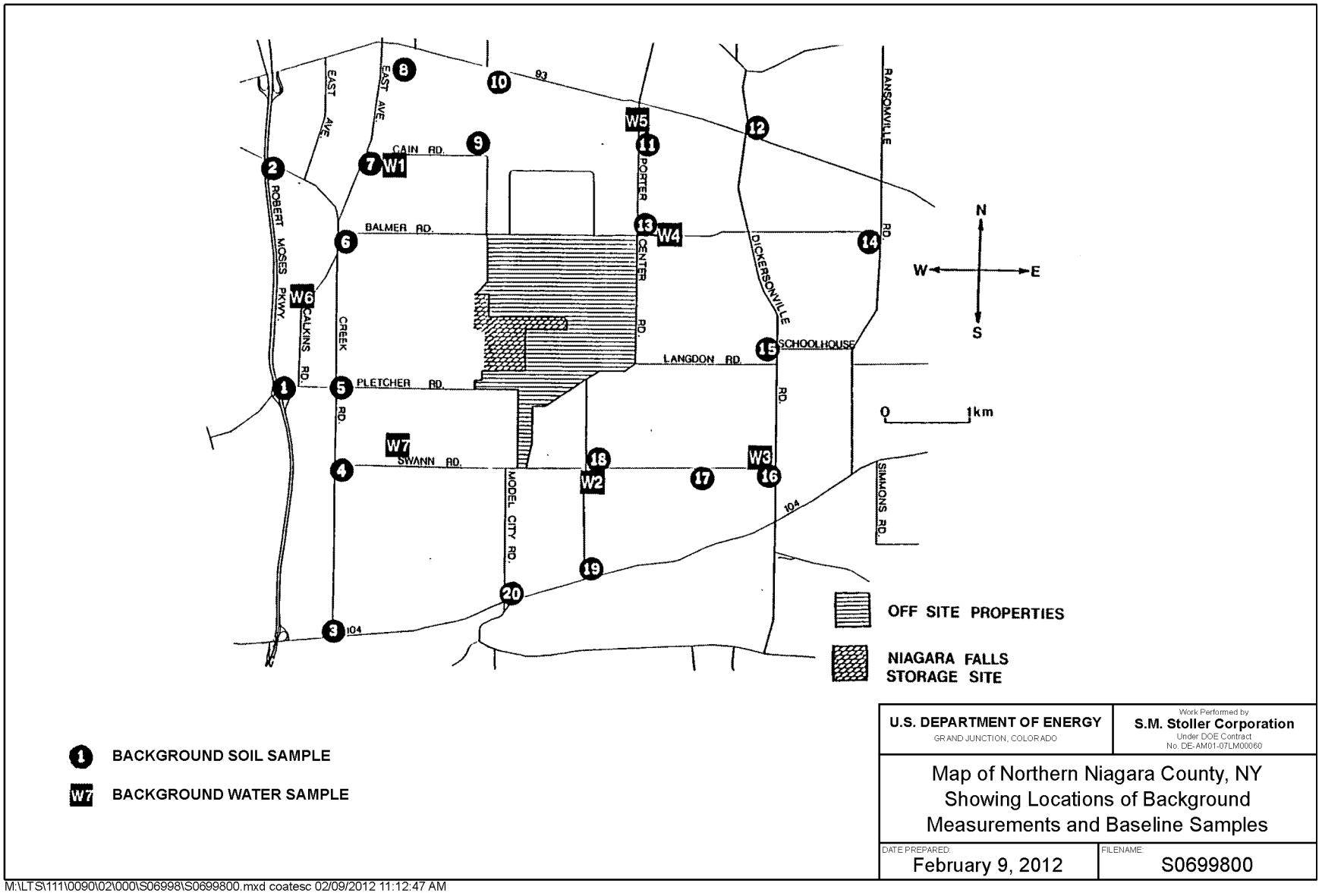


Figure 2. Map of Northern Niagara County, New York, Showing Locations of Background Measurements and Baseline Samples (Source: DOE 1987)

Table 2. Background Exposure Rates and Baseline Radionuclide Concentrations in Soil

Location	Exposure Rate[a] (µR/hr)	Radionuclide Concentrations (pCi/g)[b]				
		Ra-226	U-235	U-238	Th-232	Cs-137
1	6.8	0.74 ± 0.16	<0.19	<2.89	0.70 ± 0.46	0.29 ± 0.08
2	6.8	0.75 ± 0.19	<0.19	<3.35	<0.22	0.24 ± 0.08
3	8.3	0.71 ± 0.18	0.46 ± 0.41	<3.72	0.88 ± 0.33	0.34 ± 0.09
4	7.9	0.67 ± 0.18	<0.22	<4.10	1.18 ± 0.35	0.12 ± 0.07
5	7.3	0.70 ± 0.16	<0.17	<3.34	0.68 ± 0.24	0.14 ± 0.07
6	7.7	0.50 ± 0.15	<0.16	<2.33	0.52 ± 0.38	0.17 ± 0.09
7	7.7	0.63 ± 0.13	<0.17	<2.73	0.83 ± 0.24	0.35 ± 0.08
8	7.6	0.59 ± 0.12	<0.14	<2.20	0.54 ± 0.23	<0.02
9	7.1	0.63 ± 0.20	<0.23	<4.16	0.83 ± 0.38	0.69 ± 0.11
10	7.1	0.70 ± 0.16	<0.19	<2.98	<0.18	0.69 ± 0.10
11	6.7	<0.09	<0.19	<2.83	0.49 ± 0.31	0.48 ± 0.14
12	7.1	0.48 ± 0.13	<0.16	<2.84	0.65 ± 0.26	0.68 ± 0.10
13	6.7	0.57 ± 0.14	<0.17	<2.36	0.49 ± 0.26	0.41 ± 0.08
14	6.8	0.68 ± 0.17	<0.19	<3.24	0.67 ± 0.25	0.70 ± 0.10
15	8.2	0.65 ± 0.14	<0.17	<3.20	0.72 ± 0.35	0.23 ± 0.08
16	7.4	0.91 ± 0.17	<0.71	<3.58	0.83 ± 0.28	0.61 ± 0.09
17	7.0	0.48 ± 0.14	<0.16	<2.73	0.32 ± 0.22	0.38 ± 0.08
18	7.7	0.73 ± 0.16	<0.18	6.26 ± 9.23	<0.23	0.32 ± 0.12
19	8.8	1.22 ± 0.22	<0.23	<3.79	1.08 ± 0.49	1.05 ± 0.13
20	8.6	0.83 ± 0.17	<0.21	<3.59	0.84 ± 0.29	0.08 ± 0.07
Range	6.7 to 8.8	<0.09 to 1.22	<0.14 to 0. 71	<2.20 to 6.26	<0.18 to 1.18	<0.02 to 1.05

[a] Measured at 1 m above the surface.
[b] Errors are 2σ based on counting statistics only.
Source: DOE 1987

2.4 Administrative Limits

DOE applied the concept of ALARA to remedial activities at NFSS and NFSS VPs. Application of ALARA analysis resulted in reducing the levels of residual contamination to levels less than the TEDE limit of 100 mrem/yr.

If multiple radionuclides were present, the Sum of Ratios rule was used, where the fraction contributed by each radionuclide to its guideline would be determined and the sum of the fraction would not exceed 1. If the fraction exceeded 1, further evaluation would be needed on that area.

3.0 Historical Shipment Records

At the request of NYSDOH personnel in 2005, the EM office in Schenectady, New York, provided information on KAPL radioactive waste shipped to the LOOW and eventually repackaged and shipped from LOOW to Oak Ridge, Tennessee. The following attachments to this report provide more history and include the NYSDOH information on SPRU and the KAPL shipments:

- Attachment I: Correspondence from Department of Energy Schenectady Naval Reactors Office to New York Department of Health
- Attachment II: *Nuclear Facility Historical Site Assessment for the Separations Process Research Unit (SPRU) Disposition Project, 2006* (partial report)

The shipping information in Attachment I provides general information about the amounts and types of containers but does not provide sufficient detail to establish that all material received at LOOW was eventually shipped to Oak Ridge or to determine what amount of waste might remain at the prior storage locations.

3.1 Shipments Received

Records indicate that six shipments were made from the Schenectady operation to LOOW between January 1952 and September 1954. Attachment I provides a detailed account of the shipments received, including the number and types of containers, as well as descriptions of the material.

3.2 Shipments to Oak Ridge, Tennessee

Records indicate that a total of eight shipments involving a total of 14 boxcars were made from LOSA to Oak Ridge National Laboratory (ORNL) from January through June of 1958. A summary of the shipments is included in Attachment I.

4.0 Locations of Storage and Incineration

Primary sources of information about the history of KAPL storage and incineration on the NFSS and NFSS VPs include reports of previous investigations and remediation prepared by AEC and DOE during the early 1970s to the late 1980s. Documentation of KAPL waste shipments was provided to NYSDOH by the DOE KAPL office (DOE 2005). The waste was stored first at Building 845-1 on VP-E', then relocated to the Baker Smith Shops area and to the Sewage Treatment Plant area on VP-X and Building 401. There were additional locations of storage, including VP-N/N' North and South. Incineration of the combustible portion of KAPL waste was reported to have occurred on VP-N/N' North at the old incinerator building and on VP-H' on a pad along the east boundary adjacent to VP-E' (Aerospace Corp. 1982).

Table 3 and Figure 3 summarize and illustrate the historical locations of KAPL storage and incineration on the NFSS and VPs.

Table 3. KAPL Waste Storage Areas and Map Locations

Map Loc.	Building Number	Building Name	Building Location	Material Stored
1	401 (401-1)	Boiler House NFSS (Power Area)	NFSS (Building removed by USACE 2011)	KAPL Waste
2	419 (611-1)	Incinerator Building	VP-N/N' South (Area northeast of curve in R St.)	Ashes from KAPL waste[a]
3	443	Welding Shop	NFSS (Baker Smith Shops)	L-30 drums/ KAPL
4	444	Storage Building	NFSS (Baker Smith Shops)	L-30 drums/KAPL
5	445	Pipe Shop	NFSS (Baker Smith Shops)	L-30 drums/KAPL
6	446	Lord Electric Shop	VP-X (east of West Patrol Rd.)	KAPL waste
7	447	Tool House	VP-X (east of West Patrol Rd.)	KAPL waste
8	448	Paint Shop	VP-X (east of West Patrol Rd.)	KAPL waste
9	460 (718-1)	Locomotive Shop area	VP-N/N' North (south of O St., east of Castle Garden Rd., and west of Vine St.)	Possible KAPL storage
10	458 (707-5)	Change House	VP-N/N' North (north of Locomotive Shops area)	Possible KAPL incineration
11	845-1	Compressor House area	VP-E' (north of M St.)	KAPL waste
12, 13	Not Known	Concrete Pads	VP-H' (near the east boundary with VP-E')	KAPL waste incineration

[a] Not verified but inferred from documentation.
Source: Aerospace Corp. 1982

5.0 Waste Characteristics and Handling

History on the storage locations, types of waste, and its characteristics was utilized during the planning and designing of the assessment and remediation that took place during the early decontamination efforts on the LOOW (AEC 1973, DOE 1981a). Assessment, remediation, and verification of KAPL storage locations utilized Cs-137 as the indicator constituent of KAPL waste in determining the extent of the waste and during confirmation of remediation efforts.

Approximately 700,000 pounds of contaminated waste in 16 boxcars was shipped from KAPL to LOSA through September 1952. The shipments included 675 boxes and 394 drums of slurry packaged in carbon steel and stainless steel drums. The stainless steel drums would have been

used to package the more corrosive waste. The waste was temporarily stored at several locations at LOSA/LOOW prior to repackaging and shipment to ORNL for final disposal.

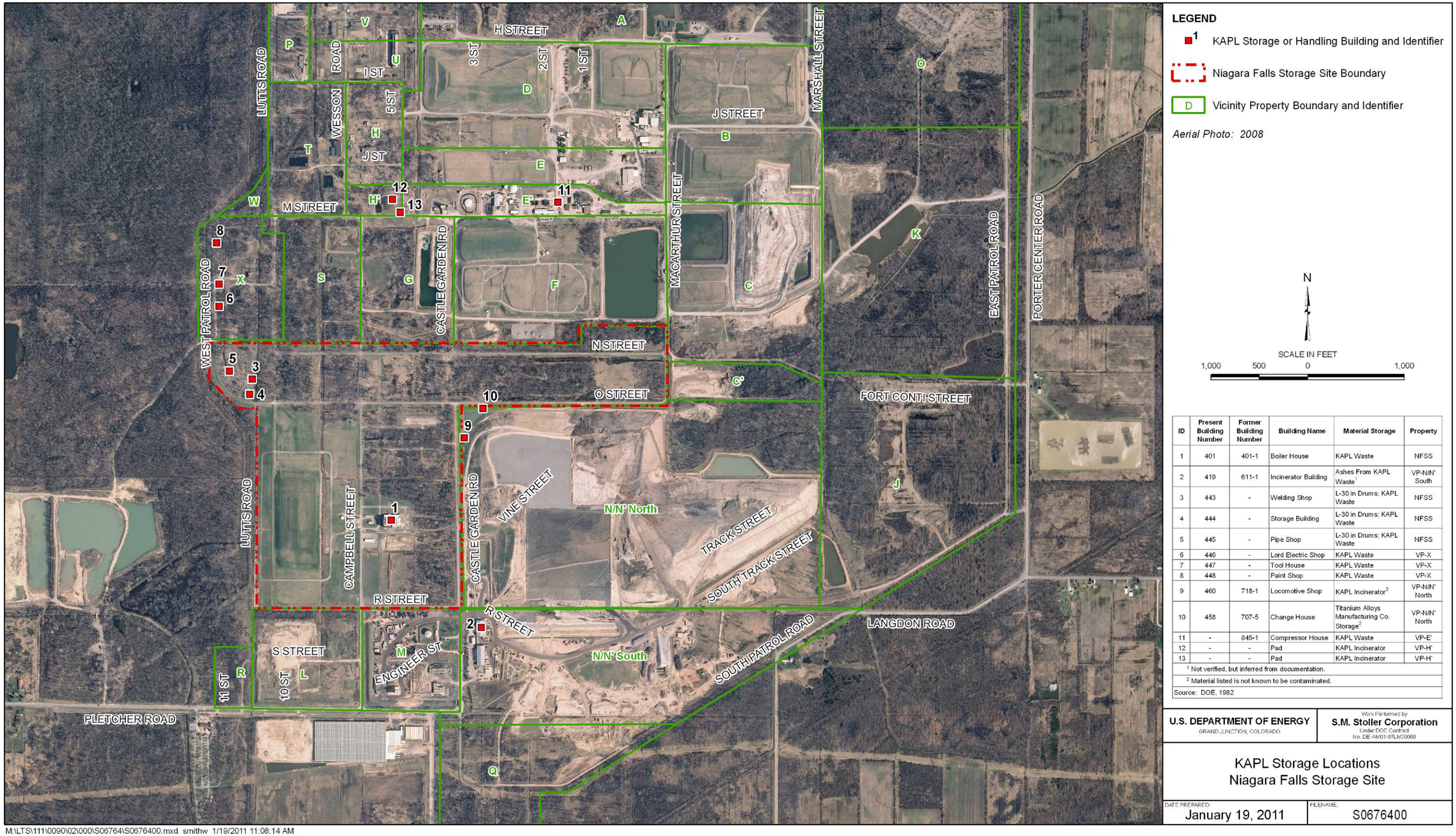
KAPL wastes consisted of the following types of waste:

- **Miscellaneous scrap:** Composed of materials contaminated with low-level fission products, such as air filters, glass, metals, wood, and all materials that could not be bailed.
- **Baled materials:** Composed of dry waste (such as paper, rags, floor sweepings, gloves, lagging, and so on) contaminated with low-level fission products.
- **Solid waste:** Composed of higher levels of fission products, including both miscellaneous scrap and bailed materials.
- **Plutonium waste:** Composed of all materials contaminated with plutonium. This type of waste was placed into 1-gallon paint cans and sealed into 55-gallon drums.
- **Slurry:** Composed of evaporator bottom sludge, neutralized and contaminated with higher levels of fission products.
- **Oils:** Composed of degreasing fluid and cutting oils, contaminated with low-level fission products.

The 394 drums of slurry waste contained fission products as well as some residual plutonium. This slurry would have accounted for most of the radioactivity in the KAPL waste received at LOSA/LOOW (DOE 2005).

Process knowledge of how the waste was generated and the characteristics of the waste can be partially derived from the KAPL Schenectady Operations document, which is Attachment II of this report. Waste at the Schenectady operations was reduced through evaporation in large stainless steel vats at Building H2. The slurry was generated when the evaporators were cleaned. Constituents of the slurry is documented as containing a mix of Cs-137, Sr-90, Pu-239, and Am-241. The exact amount of each constituent is not well documented, but radioactivity in curies was estimated based on an analysis of the waste prior to shipment to LOSA/LOOW. Analytical results from the waste characterization were published by the EM SPRU Project Office (DOE 2006c).

In the 2006 SPRU report, DOE established that Cs-137 is a valid surrogate for locating KAPL material, primarily because (1) Cs-137 is the predominant radionuclide and (2) concentrations of other radionuclides are much lower than the Cs-137 concentrations (DOE 2006c). As an example, in a sample set of 115 Pu-239/240 results and more than 300 Cs-137 results, the average Pu-239/240 concentration was about 0.2 pCi/g, while the average Cs-137 concentration was 21 pCi/g or approximately 2 orders of magnitude greater. The maximum Pu-239/240 result was 6.7 pCi/g. The SPRU Derived Concentration Guideline Level for Pu-239/240 under a "subsistence farmer scenario" is 13.3 pCi/g. There is no statistical rigor in this analysis, and the Cs-137 to Pu-239/240 ratios in the sample set were not constant, but it illustrates that Pu-239/240 concentrations are much less than Cs-137 concentrations and are therefore less than a risk-based guideline set for the KAPL facility.



ID	Present Building Number	Former Building Number	Building Name	Material Storage	Property
1	401	401-1	Boiler House	KAPL Waste	NFSS
2	419	611-1	Incinerator Building	Ashes From KAPL Waste[1]	VP-N/N' South
3	443	-	Welding Shop	L-30 in Drums; KAPL Waste	NFSS
4	444	-	Storage Building	L-30 in Drums; KAPL Waste	NFSS
5	445	-	Pipe Shop	L-30 in Drums; KAPL Waste	NFSS
6	446	-	Lord Electric Shop	KAPL Waste	VP-X
7	447	-	Tool House	KAPL Waste	VP-X
8	448	-	Paint Shop	KAPL Waste	VP-X
9	460	718-1	Locomotive Shop	KAPL Incinerator[3]	VP-N/N' North
10	458	707-5	Change House	Titanium Alloys Manufacturing Co. Storage[2]	VP-N/N' North
11	-	845-1	Compressor House	KAPL Waste	VP-E'
12	-	-	Pad	KAPL Incinerator	VP-H'
13	-	-	Pad	KAPL Incinerator	VP-H'

[1] Not verified, but inferred from documentation.
[2] Material listed is not known to be contaminated.
Source: DOE, 1982

U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION, COLORADO

Work Performed by
S.M. Stoller Corporation
Under DOE Contract No. DE-AM01-07LM00060

KAPL Storage Locations
Niagara Falls Storage Site

DATE PREPARED: January 19, 2011
FILENAME: S0676400

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Figure 3. KAPL Storage Locations at the Niagara Falls Storage Site

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5.1 Fission-Related Curies

Sample analysis of the KAPL slurry waste indicates an average of 3.4 curies (mixed fission product) per 130 gallons of slurry, or 0.026 curie per gallon. This supports the following calculation of total fission-related curies in the KAPL slurry waste:

394 slurry drums × 60 gal/drum = 23,640 gallons of slurry[3]
23,640 gallons of slurry × 0.026 curie per gallon = 614.64 curies

The curie content of the boxes is based on an assumed average dose rate of 12 milliroentgens per hour (mR/hr) for the boxes, which were assumed to be entirely mixed fission products. This supports the following calculation for the total curie content:

675 boxes × 12 mR/hr per box = 8,100 mR/hr = 8.1 R/hr

If 8.3 R/hr = 1 curie of activity, then: 8.1 R/hr = 0.98 curie

Assuming 614.64 curies total in the slurry drums and 0.98 curies in the boxes, then the total for the shipment to LOSA is approximately 615.62 curies.

5.2 Plutonium-Related Curies

The estimated curies activity of plutonium is based on sample analysis that indicates an average of 0.025 gram of plutonium per drum of slurry. This supports the following calculation of the total grams of plutonium contained in the KAPL slurry waste:

394 slurry drums × 0.025 g/drum = 9.85 g total plutonium

Note: Assuming that the plutonium was all Pu-239, the amount in curies can be calculated as follows: 9.85 g times the conversion factor to curies (0.065) would equal a total of 0.640 curie of Pu-239 (www.ieer.org/clssroom/unitconv.html).

Total plutonium, as indicated by the estimated amount provided in curies and in grams, was a very small fraction of the waste stored at the LOSA/LOOW facilities and was less likely to have had contact with the environment due to its secondary containment (i.e., packed into 1-gallon cans packed inside 55-gallon drums) that were specially marked. No plutonium-bearing waste or unmarked waste was incinerated (Aerospace Corp. 1982).

6.0 Review of Remedial Activities

The following sections discuss the assessment, remediation, and verification for the locations where KAPL wastes were stored or incinerated. This information has been assembled from the 1970 through early 1990 investigations by DOE on the VPs and from current information on the NFSS proper from the USACE Remedial Investigation Report (RIR) completed in 2007

[3] The answers to these equations as presented in the reference materials were incorrect. 394 × 60 equals 23,640 (not 17,700) gallons of slurry, and 3.4 divided by 130 equals 0.026 curie per gallon (not 0.083 curie per gallon).

(USACE 2007b) and field work for the USACE Remedial Investigation Addendum (USACE 2009a). Figures and tables referenced in the following sections are located at the end of the report (prior to the attachments) and reflect information from the specific known areas where KAPL wastes were handled.

6.1 NFSS

In support of the RIR and RIR Addendum, a Baseline Risk Assessment was performed that divided the NFSS proper into 18 physical exposure units (EUs) (Figure 5). An EU is the geographic area in which a receptor is assumed to work or live and where a receptor may be exposed to site-related constituents. The EUs provide a geographical framework for the determination of the site-related constituents (USACE 2007a). USACE established background values for the area that were used in establishing tolerance limits for the radionuclides of concern (USACE 2007b). Analytical results provided by USACE in its 2007 RIR for the NFSS proper have identified radionuclides of concern for the EUs and identified locations where Cs-137 is elevated above the upper tolerance limit of 0.34 pCi/g in soil (established during the Baseline Risk Assessment). USACE identified Cs-137 results for the NFSS are presented on Figure 5. These analytical results were also reviewed for Am-241 as an indicator of other transuranic elements. Out of a total of 768 Am-241 results, only 9 were detections. This indicates that (1) Am-241 is not a contaminant of concern for the NFSS and (2) other transuranic radioisotopes, such as Pu-239/240, are unlikely to be present at significant concentrations in soils and sediments.

Cesium detect outliers were identified. They ranged from 0.817 pCi/g to 6.26 pCi/g and were scattered throughout primarily the areas of EU-1 and EU-13. The upper tolerance limit established by USACE is only slightly above the DOE-established background values (DOE 1987) for the area. However, USACE has not yet established Applicable or Relevant and Appropriate Requirements for the site and no cleanup criteria has been formalized.

The following areas within the NFSS are briefly discussed in relation to past DOE activities and other events.

6.1.1 Baker Smith Shops Area (NFSS Proper), EU-1

The Baker Smith Shops area consists of Buildings 443, 444, and 445 located south of VP-X on the NFSS (Figure 5 and Figure 7). The area is secured by a fence and is bounded by West Patrol road to the west and the West Drainage Ditch on the east. USACE has designated this area EU-1 in their remedial investigation. The area was originally accessed by rail and two railroad off-loading/loading platforms that straddled the boundary between VP-X to the north and the Baker Smith Shops to the south. The off-loading platforms and tracks have been removed, leaving only the ballast.

The Baker Smith Shops area was a temporary storage location for KAPL wastes as well as L-30 residues in drums. Plans by the U.S. Navy in the 1950s to convert the Boiler House (Building 401, located east of the area) to a boron-10 plant caused the KAPL wastes to be moved in late 1953 from the Boiler House to the Baker Smith Shops area (Figure 7) prior to being shipped to ORNL (Aerospace Corp. 1982). Some documentation suggests drums of waste material were stored outside near the pumping station, which is also known as Building 435 of

the Sewage Treatment Plant (Figure 8). However, most historical sources suggest that the only buildings used for drums storage were those marked on the Hooker Electrochemical Company Chart in the Baker Smith Shops area (i.e., Buildings 443, 444, 445).

Building 444 burned to the ground prior to early assessment and remediation, leaving only a concrete pad. During a 1970 assessment survey, the concrete pad was found to be contaminated (1 to 60 mR/hr). The assessment survey found several areas in the vicinity with gamma activities greater than 70 mR/hr where Cs-137 was detected. These areas were later remediated during decontamination efforts in the 1970s. Cs-137 was identified again on the site in a 1978 aerial survey (DOE Report ORNL/TM-7004) and a separate 1979 radiological survey (DOE Report WAMD-010).

Low levels of actinium, protactinium, lead, radium, thorium, and uranium have also been detected in soil analytical results from EU-1 by USACE (USACE 2007b) in lesser amounts than the Cs-137. This confirms the older waste profile information, in which Cs-137 was the most abundant fission-related contaminant detected. The analytical results do indicate that any significant amount of KAPL waste was removed during the earlier decontamination by DOE. Residual outliers on the NFSS will be investigated under the current USACE program.

6.1.2 Power Area (Boiler House) Building 401, EU-13

Building 401 (formerly known as Building 401-1) was located east of the Interim Waste Containment Structure on the NFSS storage site, within EU-13 (Figure 5 and Figure 6). KAPL waste was temporarily stored in this building prior to being sent to the Baker Smith Shops area in 1953. The Boiler House structure has been removed by USACE under their Remedial Investigation/Feasibility Study activities in 2011. This document can be reviewed online at the USACE web site for NFSS as part of the December 2007 Remedial Investigation (http://www.lrb.usace.army.mil).

During the 1971 decontamination effort, Building 401 area was decontaminated to background levels (stated as less than 63 mR/hr). However, during the 2007 USACE investigation, outliers of Cs-137 in the general area of Building 401 were identified. These findings will be addressed during the Feasibility Study for the balance of the plant.

A review of DOE information about this area indicates no evidence of KAPL existing in quantities that exceed established DOE guidelines.

6.2 Vicinity Property-X

6.2.1 Buildings 446, 447, and 448

VP-X is a completed VP located north of the Baker Smith Shops area (EU-1). DOE certified the VP-X property meets FUSRAP cleanup criteria and officially closed the offsite property during its verification survey in late 1980s. The property is currently owned by the Town of Lewiston. Buildings 446, 447, and 448 no longer remain and were located west of a former Sewage Treatment Plant (Figure 8) along West Patrol Road. During the 1950s some amounts of KAPL wastes were stored here prior to being moved either to the Baker Smith Shops area or the area of Building 421. In 1957, the Baker Smith Shops buildings were in disrepair and without adequate

fire protection, prompting the removal of KAPL wastes to a location known as the Thaw House adjacent to Building 421 located on the NFSS proper, the silo used to store K-65 residues[4].

An assessment survey of VP-X was performed by DOE in July and August 1983 (ORAU 1984b). Soil samples were analyzed for Ra-226, U-235, U-238, Cs-137, and Th-232. Gamma exposure rates and surface soil results are provided for the areas surrounding the buildings in Table 4 of this report. In addition, the assessment survey included a gamma scan of 100 percent of the property and subsurface soil surveying and sampling on 40-meter grid spacing. Results of the assessment identified three areas of general contamination exceeding criteria near the pumping station of the Sewage Treatment Plant and along the south-central portion of the site (Table 4). Other small areas with elevated radionuclide concentrations met the concentration guideline averaged over 100 meters squared. Areas in the vicinity of the buildings where KAPL waste might have been stored were included in the survey but no anomalies were identified during the assessment.

During the 1980s remedial action, DOE decontaminated and backfilled 14 areas on VP-X. Based on the elevated readings, the decontamination work concentrated on the areas in the vicinity for the Sewage Treatment Plant area buildings (Figure 8) and along the southern boundary of VP-X in the vicinity of the former offloading platforms. After remediation Ra-226 results were less than 5 pCi/g.

Prior to the remedial action, elevated gamma activities were found in ash material. After the material removal, verification survey crews found that gamma activities were not elevated. Some naturally occurring material (slag) or wollastonite might remain on the site. Verification sample results for these areas on VP-X are provided in Table 5.

Based on this review of the assessment/remedial and verification survey results, VP-X has been decontaminated to levels within the established DOE guidelines.

6.3 Vicinity Property-N/N' North

VP-N/N' north is located east of the NFSS and is a completed VP. DOE certified this property meets FUSRAP cleanup criteria. The property is currently owned by Modern Landfill, Inc., and is operated as a solid waste landfill.

6.3.1 Building 460 (718-1) Locomotive Shop and Building 458 (707-5) Change House

Building 458 (707-5) and Building 460 (718-1) were located in the northwest corner of the completed VP-N/N' North inside the triangle formed by Vine Street, Castle Garden Road, and O Street. KAPL waste was either (1) stored in or near these buildings or (2) incinerated on a concrete pad south of Building 458 (707-5), known as the Change House (Figure 9).

Data from an early 1971 assessment (AEC 1973) is shown in Figure 10 which illustrates the areas surveyed and decontaminated as part of the initial VP-N/N' North assessment. Elevated

[4] Records show that in the same timeframe as the move to the Thaw House, 38,500 cubic feet of waste (350,000 pounds) located in buildings 446 and 448 was shipped to Oak Ridge Disposal Grounds. This shipment could have been the same waste, based on the quantity and the timing of the move, which might indicate that the move to the Thaw House never took place.

exposure rates were detected midway along Vine Street, east of the Locomotive Shop. Direct readings in the vicinity of the Locomotive Shop (Building 460) were less than 40 μR/hr and in the vicinity of the Change House (Building 458 [707-5]) were less than 20 μR/hr.

These areas were reassessed and remediated in June 1981 because of the expansion of the Modern Landfill solid waste landfill and the need to remove the impacted areas. A triangular area bordered by Castle Garden Road on the west, O Street on the north, and Vine Street on the southeast (Figure 11) was remediated through a joint remedial action agreement between DOE and Modern Landfill (which allowed access for the Post Remedial Actions in 1985 [DOE 1989]). The remedial action and radiological surveys targeted areas identified during the initial 1970s decontamination in an effort to remove Ra-226 and Cs-137 bearing material from the surface of the approximate 19-acre triangle and along Castle Garden road (Eberline 1981).

Results of the remedial activities performed during 1985 within the triangle are presented in Table 6. Coordinates for the locations correspond with the grid illustrated in Figure 11. Cs-137, Sr-90, and the Cs/Sr ratios were elevated at three locations. The locations are associated with the area of the Locomotive Shop. While all three results were elevated, they were still below the DOE guideline of 33 pCi/g for Cs-137. Location E+02,1+62 had the highest Cs-137 concentration at 24 ± 2 pCi/g.

Based on this review of assessment and remedial activities, VP-N/N' North has been decontaminated to levels within the established guidelines including all FUSRAP related wastes and any KAPL wastes that may have been co-located with it.

Verification surveys on VP-N/N' North included sampling of several small areas of elevated gamma activity at areas that were remediated reducing the gamma activity to background levels. Further remediation and followup gamma monitoring at other locations on the VP confirmed the remedial action resulted in all soil areas meeting the cleanup standards (ORAU 1990).

6.4 Vicinity Property-N/N' South

VP-N/N' South is located east of the NFSS and Castle Garden Road and is directly below VP-N/N' North. DOE certified this property meets FUSRAP cleanup criteria. The property is currently owned by Modern Landfill for use as a solid waste landfill.

6.4.1 Building 419 Incinerator Building

Building 419 (Building 611-1) was located on VP-N/N' South, in an area south of the curve of R Street (Figure 12). KAPL combustible waste, properly labeled and less than the criteria of 6 mR/hr, might have been incinerated at this location. AEC at the time instructed Hooker Chemical to burn the low-level combustible wastes and then barrel the ashes to reduce volume for shipping the waste to ORNL for disposal.

This area was included in the 1971−1972 decontamination effort. Figure 12, Figure 13, and Figure 14 present the direct gamma exposure rate results for the 1971 assessment over the former incinerator building area. Although the area was remediated, elevated radiation levels were still detected by the mobile scan performed by DOE in 1980 (DOE 1980b). Surface soil contamination was identified again in the 1984 comprehensive survey (ORAU 1984a). The

major contaminant was Ra-226 and (to a lesser extent) U-238, indicating the contamination was from uranium processing residues. Smaller amounts of Cs-137, U-235, and Th-232 were also detected in several samples. Subsurface sampling and results indicated that the contamination was limited to the top 25 centimeters (cm) of soil in roughly a 200-square-meter area in the vicinity of the old incinerator. Table 7 provides the gamma exposure rate and analytical results data for the surface soil samples that were collected from that area as part of the assessment.

A comprehensive survey of VP-N/N' South was conducted during August 1984 (ORAU 1984a). The incinerator area was located in the northwest corner of the property and was used by Hooker Chemical to burn the low-level combustible waste containers. Aerial photographs show that the incinerator existed until late 1963. VP-N/N' South was decontaminated through an agreement between DOE and Modern Landfill. One location exceeded 15 pCi/g for subsurface soil, and the 100-square-meters average was 6 pCi/g. One location met the hot spot criteria at 40 pCi/g. There is no information as to whether these locations were attributed to Ra-226 or Cs-137, but Ra-226 was considered the primary contaminant on the site during the decontamination.

Verification activities identified only two isolated locations of elevated surface activity (in the area of Track Street) not associated with the incinerator area, and these were reduced to background exposure rates through sampling. Table 8 provides the analytical results for soil samples collected as part of the verification survey.

VP-N/N' South has been decontaminated to levels that are less than the established guidelines for the removal of any FUSRAP-related wastes, as well as any co-located KAPL wastes. Small amounts of Cs-137, U-235, and Th-232 were detected during the comprehensive assessment but were limited to the top 25 cm of soil. Verification data did not include cesium because the post-remediation survey resulted in meeting the cleanup guidelines (DOE 1986a), which meant that cesium analyses were not necessary as part of the verification survey.

6.5 Vicinity Property-E'

Chemical Waste Management (CWM) owns VP-E and VP-E', which are north of the NFSS (Figure 1 and Figure 15) north of M Street. CWM uses the area for treatment and processing of chemical wastes. VP-E' has been only partially remediated so it remains an open VP. USACE plans to complete remediation on that VP in the future. CWM controls access to the property.

As part of previous 1971 remediation activities (Figure 16), VP-E' was divided into four identified areas of elevated readings (Figure 17). Area 1 was north of the three buildings used to store KAPL wastes. Of the three buildings, Building 845-1 was the initial location for the storage of KAPL wastes. The two other buildings were identified by the reports as concrete pads within the Compressor House area.

6.5.1 Building 845-1 Compressor House Area

The first shipment of KAPL waste was received from Schenectady and stored in a 41-ft by 96-ft blockhouse designated Building 845-1 on VP-E'. Building 845-1 is located 20 feet north from M Street within the Compressor House area. KAPL wastes possibly were stored at the Compressor House prior to being incinerated, and wastes that could not be incinerated were shipped to the Baker Smith Shops area. Later shipments were stored in two wooden buildings

(illustrated on Figure 15) that were adjacent to Building 845-1 and in the Boiler House (Building 401) located south of VP-E' on the NFSS proper.

After the 1971 decontamination effort, several large areas remained in the range of 20 µR/hr to 50 µR/hr. Figure 16 and Figure 17 illustrate the results of the decontamination effort. In the areas along M Street near the location of Building 845-1, a few spotty areas above 20 µR/hr remained, which were attributed to naturally occurring radioactivity in the roadbed slag (AEC 1973; Aerospace Corp. 1982).

A comprehensive radiological survey was conducted in 1982 that included surface radiation scans, measurements of direct radiation levels, and analyses of soil and water samples from the surface and subsurface. A separate assessment performed around the same time was based on a 20-meter grid covering both VP-E' and VP-H'. The 20-meter grid was developed and subdivided into 5-meter-spacing over two areas on VP-E' where prior radiological surveys and histories of site usage indicated a higher potential for radiological contamination (Cole and Berger 1982). Ground-penetrating radar was also utilized to detect anomalies in the subsurface that might suggest radioactive residues or burials. Ground-penetrating radar did not identify any evidence of anomalies in the subsurface. Surface survey results identified U-238 and Ra-226 in small areas exceeding the criteria of 40 pCi/g (for U-238) and 5 pCi/g (for Ra-226) on the property. Results of the assessment are presented in Table 9 and Table 10 for the areas of concern where KAPL waste was stored.

No significant radiation levels were detected in the buildings. Walkover surveys identified several drains in the vicinity of old concrete foundations where radioactive materials were stored that indicated elevated radiation levels, but no radionuclides were identified from the residues taken from the drain. Radiation readings were generally higher along the rail spur, and attempts to identify the source with soil sampling indicated the material was either in or below the ballast (Cole and Berger 1982).

Following final remediation, gamma exposure rates at 1 meter above the surface ranged from 7 µR/hr to 17 µR/hr; the higher levels were in the vicinity of unremediated areas beneath the access road and the PCB storage tanks. Table 9 and Table 10 include the analytical data from the remediation and assessment of VP-E' including the 5-meter grid area results for direct radiation readings only. The main concern on VP-E' was residual contamination beneath PCB storage tanks and on the access road, where small plaster-like chips of lead cake were identified.

Verification surveys performed in 1985 and 1986 on VP-E' identified gamma anomalies on sections 1, 2, and 4 of the property (Figure 15). Surveys did not indicate radiological contamination in the vicinity of the buildings that were used for storage of KAPL waste. Verification gamma survey and analytical results from surface soil samples are presented in Table 11. Verification data did not include Cs-137 as an analyte for the surface soil sampling because no indications were found during the comprehensive assessment, and gamma activities were at or below background levels in the non-affected or remediated areas.

Based on this review of the assessment, remedial, and verification results, the accessible portions of VP-E' have been decontaminated to levels within the established guidelines in order to remove any FUSRAP related wastes and any KAPL wastes that may have been co-located with it. Since VP- E, E’ and G have not been completed, they remain to be evaluated by USACE. The remaining soils on these VP’s, including beneath the concrete pads, and the drains on VP- E’,

will need further evaluation as part of the USACE investigation and remediation. The USACE has already removed and properly disposed an abandoned waste drum from VP-G as part of their RI/FS activities.

6.6 Vicinity Property-H'

VP-H' is located along the west boundary of VP-E' and north of M Street (Figure 3 and Figure 19). The property is owned by CWM, which restricts access to the site. There is no record or evidence of contaminated waste burials on VP-H'. However, waste incineration was performed on concrete pads along the eastern boundary of the site.

The 1970s assessments identified radiation levels of 20–50 μR/hr near the concrete pads. Decontamination of the property required the removal of 1–3 feet of soil comprising 35,000 cubic feet, and the area was not backfilled (AEC 1973). Post-decontamination radium soil concentrations were listed as less than 1 pCi/g.

A 1978 aerial survey was conducted over the entire LOOW and did not identify any anomalous gamma radiation levels on VP-H'. A preliminary assessment was performed over properties VP-H' and VP-E' in 1982 (Cole and Berger 1982) and was followed up by a comprehensive assessment over VP-H' in 1983 (ORAU 1983b). Soil and sediment samples were analyzed and reviewed for Cs-137, U-235, U-238, and other gamma emitters. Several samples in the vicinity of the pads contained high Cs-137 concentrations (13.8 pCi/g to 33 pCi/g) and were consequently analyzed for Sr-90, because the presence of elevated Cs-137 was an indicator of possible KAPL wastes or University of Rochester wastes. One of the samples that had high Ra-226 and U-238 levels was also analyzed for Pu-239 (results 0.3 ± 0.26 pCi/g) and cobalt-60 (Co-60) (results 13.3 pCi/g). Figure 18 and Figure 19 illustrate the gamma measurement locations and the two locations near the pads where additional sample analysis was performed. Results for cesium, strontium, and plutonium were below the DOE established guidelines. However, results of a walkover gamma scan and analysis of biased surface soil samples indicated numerous isolated areas of Ra-226 in the soils well in excess of the 5 pCi/g cleanup criterion. Several samples also contained U-238 concentrations greater than cleanup criteria (Figure 19, Table 12, and Table 13). DOE subsequently remediated the areas on VP-H'.

A verification survey was performed over VP-H' in 1983 and 1984 (ORAU 1989). Table 14 shows the results of soil samples collected from the site and Table 15 presents data from samples of the cinder ash material from the site. Contact exposure rates in the area of the black cinder material ranged as high as 84 μR/hr. A sample of this material contained 220 pCi/g of Ra-226 and 37 pCi/g of U-238. Additional excavation was performed over the area and subsequent survey results indicated the area conformed to the DOE FUSRAP cleanup criteria.

Information reviewed for VP-H' indicates a low potential for remaining KAPL waste. At the time of the verification, all concentrations were found to be within the FUSRAP guidelines for the NFSS VPs. However, additional information concerning Ra-226 results submitted to DOE in 2004 may result in further coordination between DOE and USACE concerning additional assessment and remediation.

7.0 Future Land Use and Protectiveness Summary

This analysis is intended to indicate whether residual KAPL waste remains on the NFSS proper and NFSS VPs at concentrations that would require investigation and, if necessary, remediation.

To evaluate the protectiveness of remediated NFSS VPs to future occupants, assumptions are needed for future land use. Land use assumptions will determine the exposure scenarios that are reasonable for future occupants (EPA 1995). Future land use is an important factor used in developing site cleanup levels.

7.1 Land Use

Most of the NFSS VPs are privately owned and zoned for industrial/commercial applications. This land use can be assumed to persist for longer than Cs-137 residuals would remain above background levels.[5] Therefore, a reasonable exposure scenario would be for a site worker who spends 40 hours per week and 50 weeks per year on the surface of the site. This worker would not eat food grown on the site (produce, cereal grains, fish, and meat) or drink site groundwater. Other pathways such as direct radiation, dermal absorption, and dust inhalation may be plausible.

Land use restrictions were placed into effect by NYSDOH beginning in 1972 and were restated under the NYSDOH Commissioners orders issued in 2004. They remain in effect for the vicinity properties and drainages (NYSDOH 2004). These restrictions are summarized below:

- The property shall not be developed or used for industrial, commercial, or residential purposes. Any existing use can continue but not be expanded or broadened.
- The property may be used for recreational purposes if the owner takes adequate precautions and persons only make intermittent or occasional recreational use of the land.
- Five days written notice to NYSDOH is required for a proposed sale, transfer, or conveyance of the property.
- All restrictions will continue until NYSDOH determines radiation levels are safe.
- Decontamination by other than an official agency will require application and approval of an acceptable plan by NYSDOH.
- In some instances, such as the Town of Lewiston property (VP-X), no deliberate or intentional movement, displacement, or excavation of soil is permitted unless there is an acceptable plan approved by NYSDOH.

There may be more specific requirements for each property for each of the offsite properties. These requirements can be accessed by contacting NYSDOH. Because of all of these land-use restrictions, a residential or subsistence farming scenario is not likely and unreasonable.

This is consistent with USACE findings regarding a subsistence farmer exposure scenario:

> It should be noted that the subsistence farmer land use scenario was evaluated in the (human health risk assessment) as an overly conservative worst case. This scenario is highly unlikely due to the proximity of the site to surrounding landfills and the poor yield and quality of on-site groundwater resources (USACE 2007b).

[5] A Cs-137 occurrence of 5 pCi/g in 2007 would decay to less than 1 pCi/g in less than 90 years.

Historical site information and remediation data indicate that KAPL activities mostly occurred on the developed portion of the NFSS VPs in areas that can reasonably be anticipated to remain in industrial use.

7.2 Protectiveness

Preliminary Remediation Goals (PRGs) were developed by EPA for radionuclides under different exposure scenarios. The default PRGs correspond to a risk of 1×10^{-6} (or an excess cancer risk of 1 in 1,000,000). EPA's "acceptable" risk range (40 CFR 300) is between 1×10^{-6} and 1×10^{-4} (excess cancer risk of 1 in 10,000).

The default PRG for Cs-137 in residential soils (which includes ingestion of 25 percent of fruits and vegetables from a home garden) is 4.02 pCi/g (EPA 2010). The DOE remediation limit for Cs-137, based on pathway analysis, was 33 pCi/g (DOE 1988). This is approximately an order of magnitude higher than the default PRG and would result in risks on the order of 1×10^{-5} for residential soil—the midpoint of the acceptable risk range.

The U.S. Nuclear Regulatory Commission's surface soil screening level for decommissioning (to meet a dose limit of 25 mrem/year, unrestricted use) of 11 pCi/g Cs-137 provides another comparison as a benchmark for protectiveness, for which to compare site-related Cs-137 levels (NUREG 1757 Vol. 1).

DOE analyses for Cs-137 indicate that concentrations in the mid-1980s were generally less than 2 pCi/g. Residual Cs-137 levels would be about one half the levels found in the 1980s because the half-life of Cs-137 is 30.2 years. Cs-137 concentrations are less than the PRG of 4.02 pCi/g for residential soil, indicating that potential risks from Cs-137 residues on the completed NFSS VPs would be within the acceptable risk range established by EPA for unrestricted residential use.

USACE found Cs-137 concentrations as high as 5.15 pCi/g on the NFSS proper (USACE 2009b). Sample locations were biased to areas with elevated gamma activities. The USACE data set consisted of 1,087 Cs-137 results, of which 24 exceeded the upper bound of background (0.8 pCi/g) established by DOE (DOE 1987). Cs-137 occurrences also appear to be sporadic, limited in extent, and correspond to PRGs within the acceptable risk range for residential soil. On the basis of comparison of measured Cs-137 concentrations to EPA risk-based PRGs, residual KAPL waste would not pose an unacceptable human health risk for a residential land-use scenario.

8.0 Conclusions

This evaluation has determined that KAPL contaminants were removed during remedial activities at the former LOOW as either co-located or comingled with other radionuclides. Process knowledge and field observations establish that Cs-137 is the predominant radionuclide in the KAPL waste stream. Cs-137, a strong gamma emitter, was used as an indicator for remediation of KAPL waste. Other radionuclides were present in much lower relative concentrations and were likely also removed during remediation of the VPs.

In comparing the measured Cs-137 concentrations to EPA risk-based PRGs, any remaining residual KAPL waste (mainly Cs-137) on the NFSS and offsite VPs does not pose an unacceptable human health risk for a residential land-use scenario. Risk to industrial workers would be lower.

The following conclusions are provided:

- Remediation of the completed NFSS VPs resulted in removal of FUSRAP and KAPL wastes to levels that permit unrestricted residential use of those properties. Sample and walkover gamma scan results indicate that no wastes remain that would cause referral to USACE for further remediation. No EM involvement is required at these properties.
- For the active VPs (VP-E, VP-E', and VP-G), results of DOE's cleanup of the accessible portions of these properties indicate that KAPL waste does not remain at concentrations greater than the DOE cleanup limit.
  - — Inaccessible areas were not associated with historic KAPL waste handling. Therefore, it is unlikely that KAPL waste remains on the active VPs.
  - — Because gamma activity is used for excavation control, additional USACE cleanup of FUSRAP wastes on these properties will likely result in the remediation of any co-located residual KAPL wastes to acceptable levels or identification of KAPL waste that is not co-located.
  - — Although USACE has not established a cleanup level for Cs-137 on the active NFSS VPs, DOE remediation data indicate that significant Cs-137 concentrations are unlikely to remain. Because of the low likelihood of encountering significant KAPL waste on the active NFSS VPs, no need for EM involvement is anticipated at these properties.
- USACE soil sampling results on the NFSS proper indicate that KAPL waste does not exceed the DOE cleanup level for Cs-137. USACE has not established a cleanup level for Cs-137 on NFSS proper. Because gamma activity will be used for excavation control, the USACE cleanup of FUSRAP wastes on the NFSS proper will likely result in the remediation of any co-located residual KAPL wastes or identification of KAPL waste that is not co-located.

EM involvement will be necessary only if there is identification of KAPL-related materials that exceed[6] either (1) the DOE cleanup limit on completed VPs or (2) the USACE cleanup limit on NFSS proper or the active VPs, and if those materials are not co-located with FUSRAP waste.

9.0 Recommendations

DOE should coordinate with USACE as they proceed with the evaluation, remedy selection, and remediation of the NFSS proper and active VPs. DOE will address any KAPL waste residuals that cannot be remediated by USACE.

No further action is needed to address KAPL waste on the completed VPs.

[6] DOE will be responsible even after EM's Schenectady cleanup is complete.

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Tetra Tech, Inc., 2006. *Waste Acceptance Package for Drum Number 1 Generated at Niagara Falls Storage Site*, prepared by Tetra Tech, Inc., Collinsville, Illinois, for the U.S. Army Corps of Engineers Buffalo District, May.

USACE (U.S. Army Corps of Engineers), 2002. *Final Gamma Walkover Survey Report, Lewiston-Porter School Property Youngstown, New York*, prepared by Science Applications International Corporation (SAIC), February.

USACE (U.S. Army Corps of Engineers) 2007a. *Baseline Risk Assessment Report for the Niagara Falls Storage Site*, Buffalo, NY, December.

USACE (U.S. Army Corps of Engineers), 2007b. *Remedial Investigation Report for the Niagara Falls Storage Site*, Science Applications International Corporation (SAIC), December.

USACE (U.S. Army Corps of Engineers), 2009a. *Niagara Falls Storage Site Remedial Investigation Report Addendum, Fact Sheet*, June.

USACE (U.S. Army Corps of Engineers), 2009b. Feasibility Study Work Plan for the Niagara Falls Storage Site, Final, December.

USACE (U.S. Army Corps of Engineers), 2011. *NFSS Remedial Investigation Report Addendum*, prepared by Science Applications International Corporation, Columbus, Ohio, for USACE Buffalo District, April.

Wallo, A., 1980. Correspondence from Andrew Wallo, The Aerospace Corporation, to William E. Mott, DOE, concerning the NYSDOH Commissioner's April 1972 land use restrictions on 1,511 acres of former LOOW, August 11; (see Attachment I).

DOE 5480.1a 40CFR Part 192

Residual Contamination Guidelines for Formerly Utilized Sites And Remote Facilities Management Program Sites

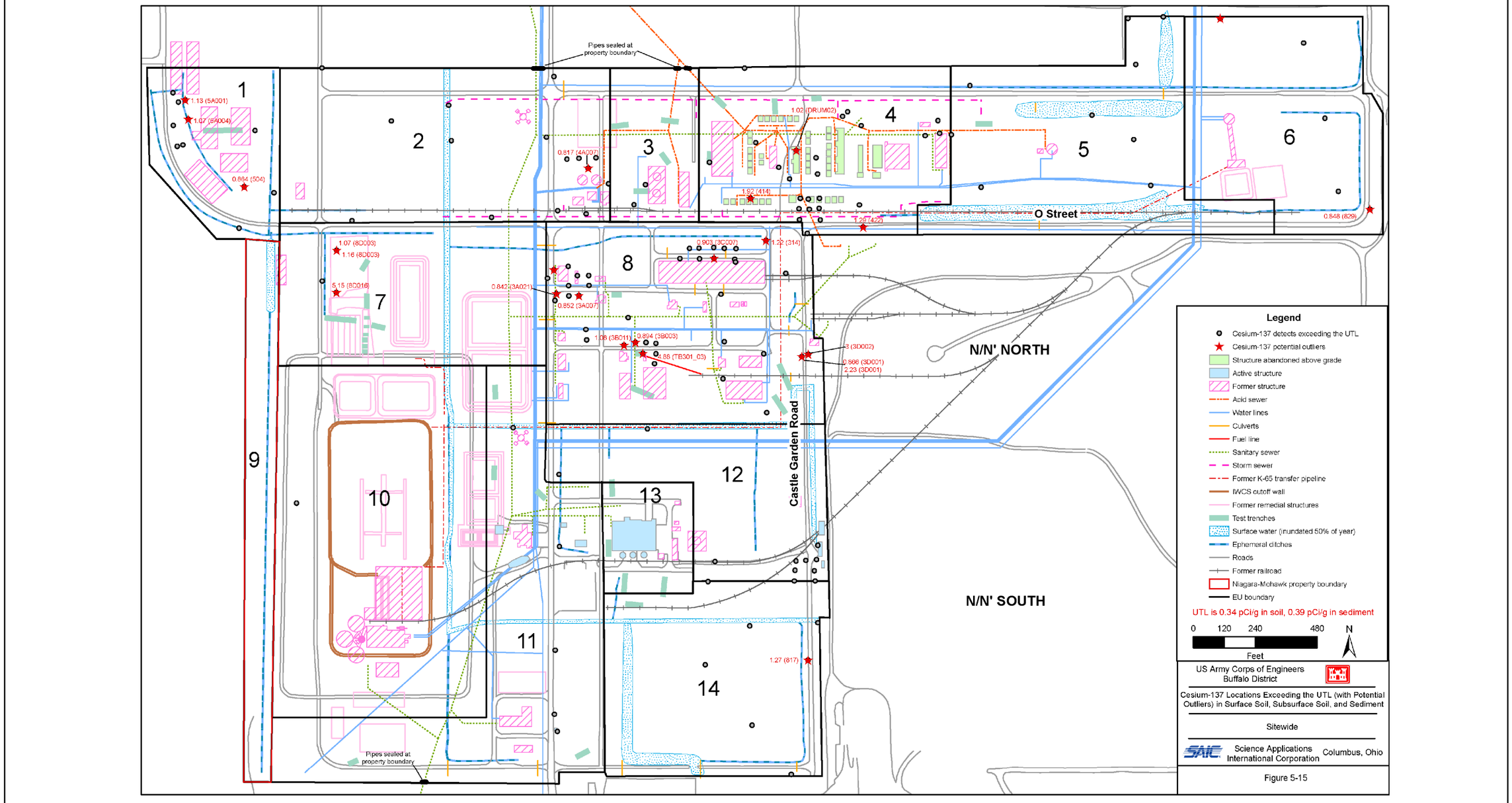
The following guidelines represent the maximum residual contamination limits for unrestricted use of land and structures contaminated with radionuclides related to the nuclear fuel cycle at FUSRAP and remote SFMP sites. A site specific analysis will be prepared for each site prior to determining residual contamination guidelines for a specific site. It is the policy of DOE to decontaminate sites to contamination levels at or below the limits and in a manner consistent with DOE's as-low-as-reasonably achievable (ALARA) policy on a site specific basis. Site specific guidelines and ALARA policy will be determined by DOE on a site specific basis and an ALARA report filed on completion of remedial action at a site. Existing state and federal standards will be applied for water protection. Residual contamination limits for other nuclides will be developed when required using the same methodology[1] as was used for those represented here.

1. Soil (Land) Guidelines (Maximum limits for Unrestricted Use)

Radionuclide	Criteria[2, 3, 4] (pCi/g above background)
U-Natural[5]	75
U-238[6]	150
U-234[6]	150
Th-230[7]	15
Ra-226	5 pCi/g averaged over the first 15cm of soil below the surface; 15pCi/g when averaged over 15cm of thick soil layers more than 15cm below the surface and less than 1.5m below the surface
U-235[6]	140
Pa-231	40
AC-227	190
Th-232	15
Am-241	60
Pu-241[8]	2400
Pu-238, 239, 240	300
Cs-137	80
Sr-90	300
H-3 (pCi/ml soil moisture)	5,200

1. Described in ORO-831 and ORO-832
2. In the event of occurrence of mixtures of radionuclides, the fraction contributed by each radionuclide to its guideline shall be determined, and the sum of these fractions shall not exceed 1. There are two special cases for which this rule must be modified:
   a) If Ra-226 is present, then the fraction for Ra-226 should not be included in the sum if the Ra-226 concentration is less than or equal to the Th-230 concentration. If the Ra-226 concentration exceeds the Thorium 2320 concentration, then the sum shall be evaluated by replacing the Ra-226 concentration by the difference between the Ra-226 and Th-230 concentrations.
   b) If Ac-227 is present, then the same rule given in (a) for Ra-226 relative to Th-230 applies for Ac-227 relative to Pa-231.
3. Except for RA-226, these guidelines represent unrestricted use residual concentrations above background averaged across any 15cm thick layer to any depth and over any contiguous 100m2 surface area. The same conditions prevail for Ra-226 except for soil layers beneath 1.5m; beneath 1.5m, the allowable Ra-226 concentration may be affected by site-specific conditions and must be evaluated accordingly.
4. Localized concentrations in excess of these guidelines are allowable provided that the average over $100m^2$ is not exceeded. However, DOE ALARA policy will be considered on a site specific basis when dealing with elevated localized concentrations.
5. A curie of natural uranium means the sum of $3.7x10^{10}$ disintegrations per second (dis/s) over any 15cm thick layers from U-238 plus $3.7X10^{10}$ dis/s from U-234 plus $1.7X10^{9}$ dis/s from U-235. One curie of natural uranium is equivalent to 3,000 kilograms or 6,600 pounds of natural uranium.
6. Assumes no other uranium isotopes are present
7. The Th-230 guideline is 15 pCi/g to account for ingrowth of Ra-226 as the Th-230 decays. Ra-226 is a limiting radionuclide because its decay product is Rn-222 gas.
8. The Pu-241 guideline was derived from the Am-241 concentration.

Figure 4. Residual Contamination Guidelines for Formerly Utilized Sites and Remote Facilities Management Program Sites



Source: USACE 2007 RI

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Figure 5. USACE 2007 Remedial Investigation Illustrating EUs and Cesium Results

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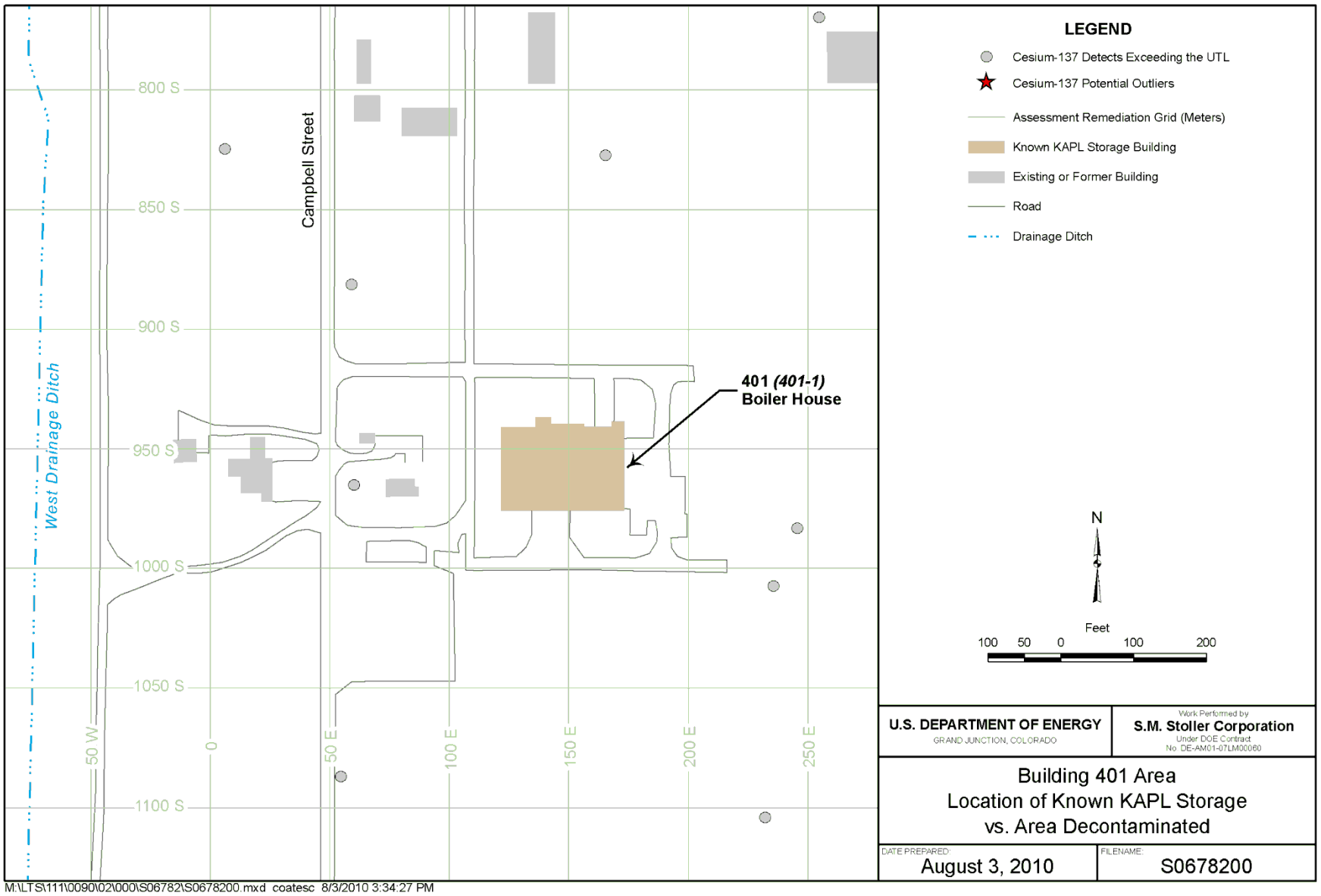

Figure 6. Building 401 Area Location of Known KAPL Storage vs. Area Decontaminated
(Source: USACE 2007b)

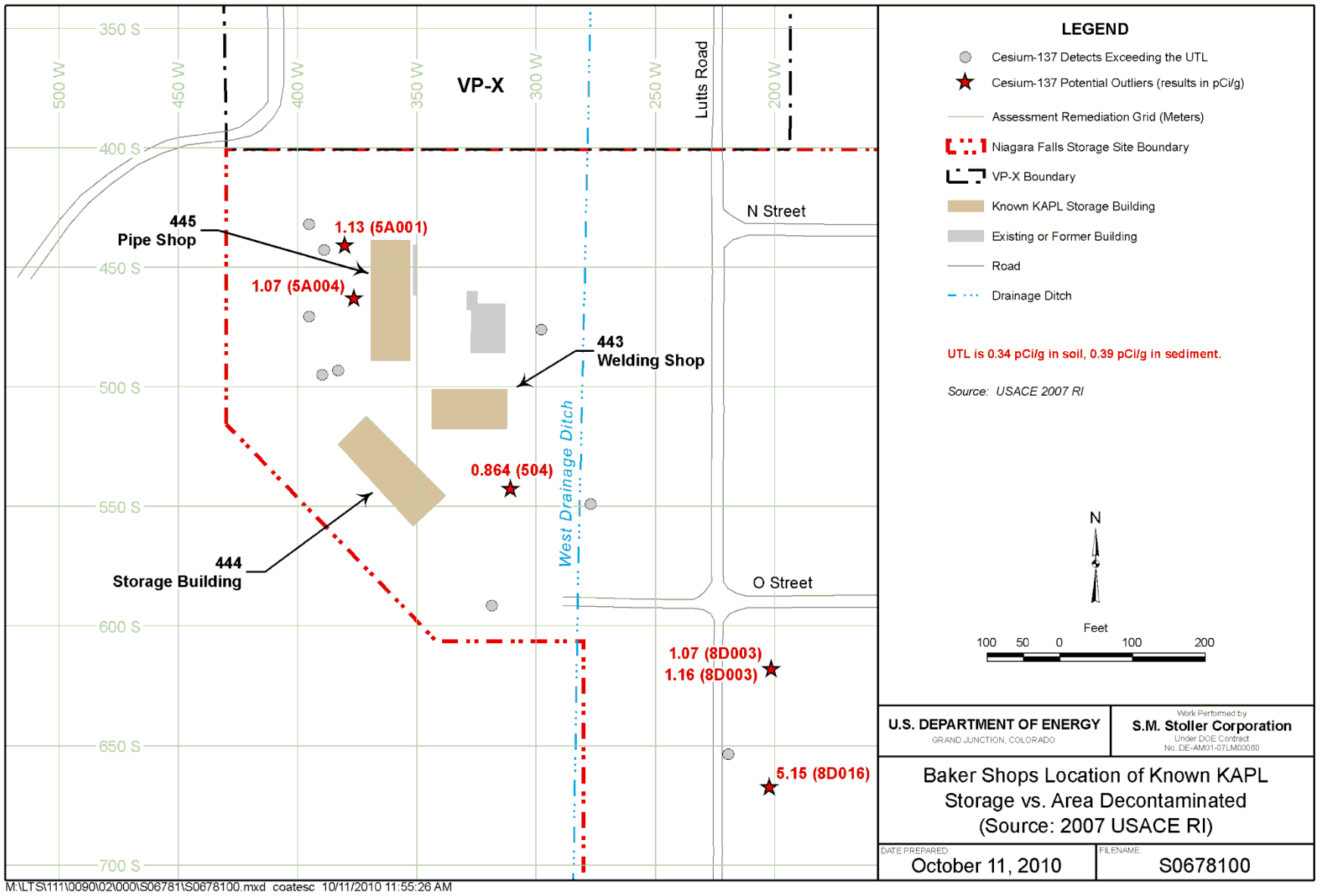

Figure 7. Baker Smith Shops Location of Known KAPL Storage vs. Area Decontaminated (Source: USACE 2007b)

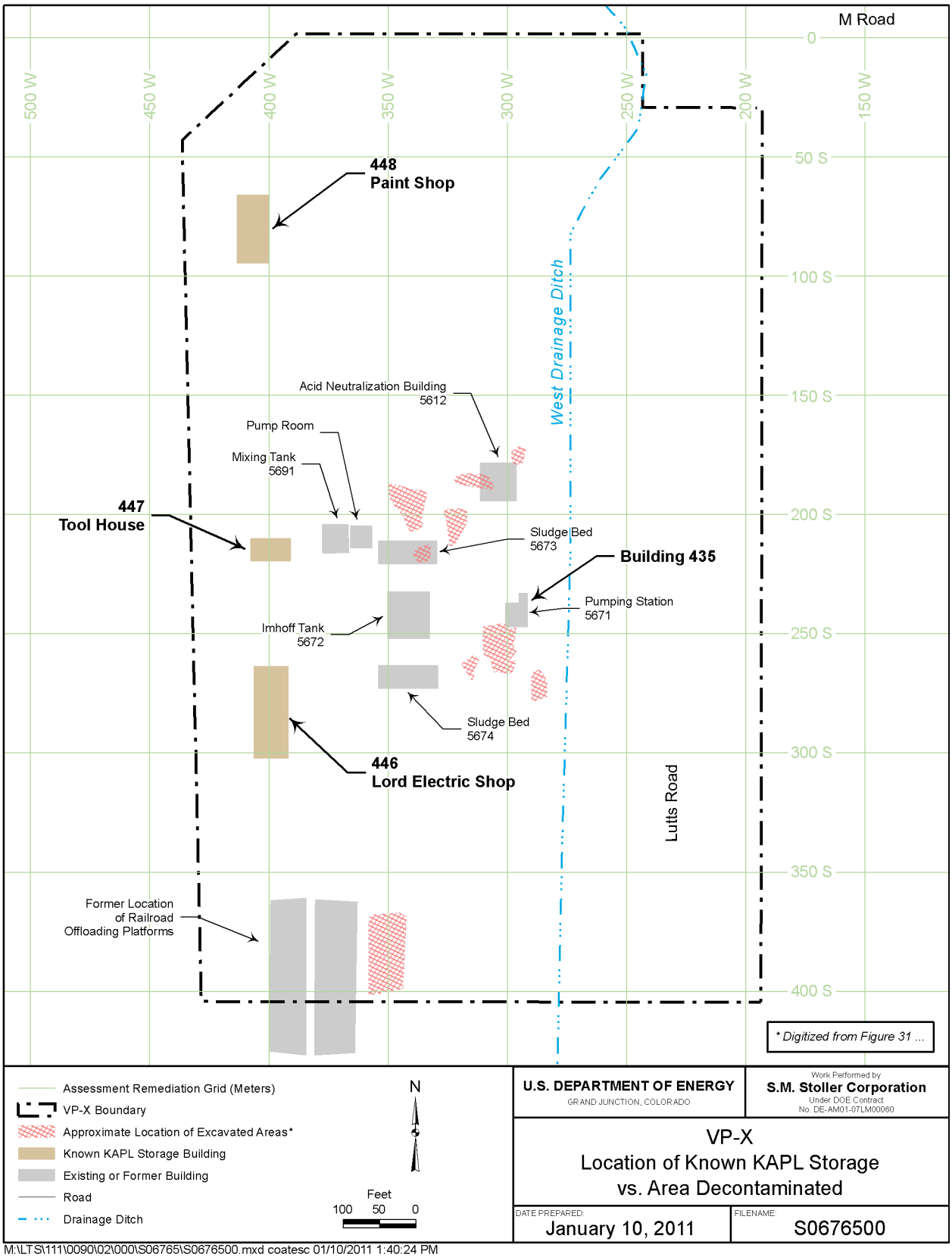

Figure 8. VP-X Location of Known KAPL Storage vs. Area Decontaminated (Source: DOE 1986a)

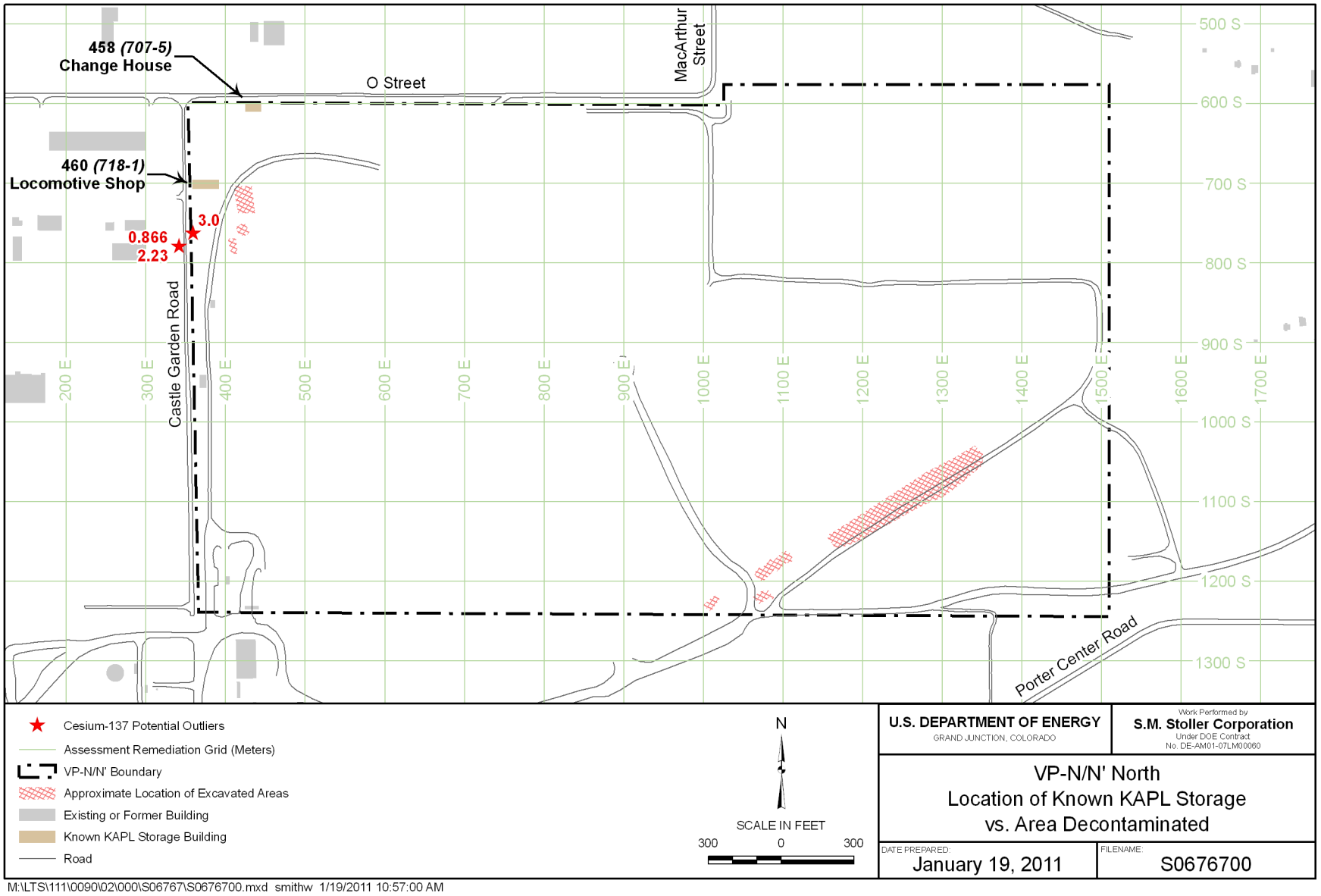

Figure 9. VP-N/N' North Location of Known KAPL Storage vs. Area Decontaminated (Source: DOE 1989)

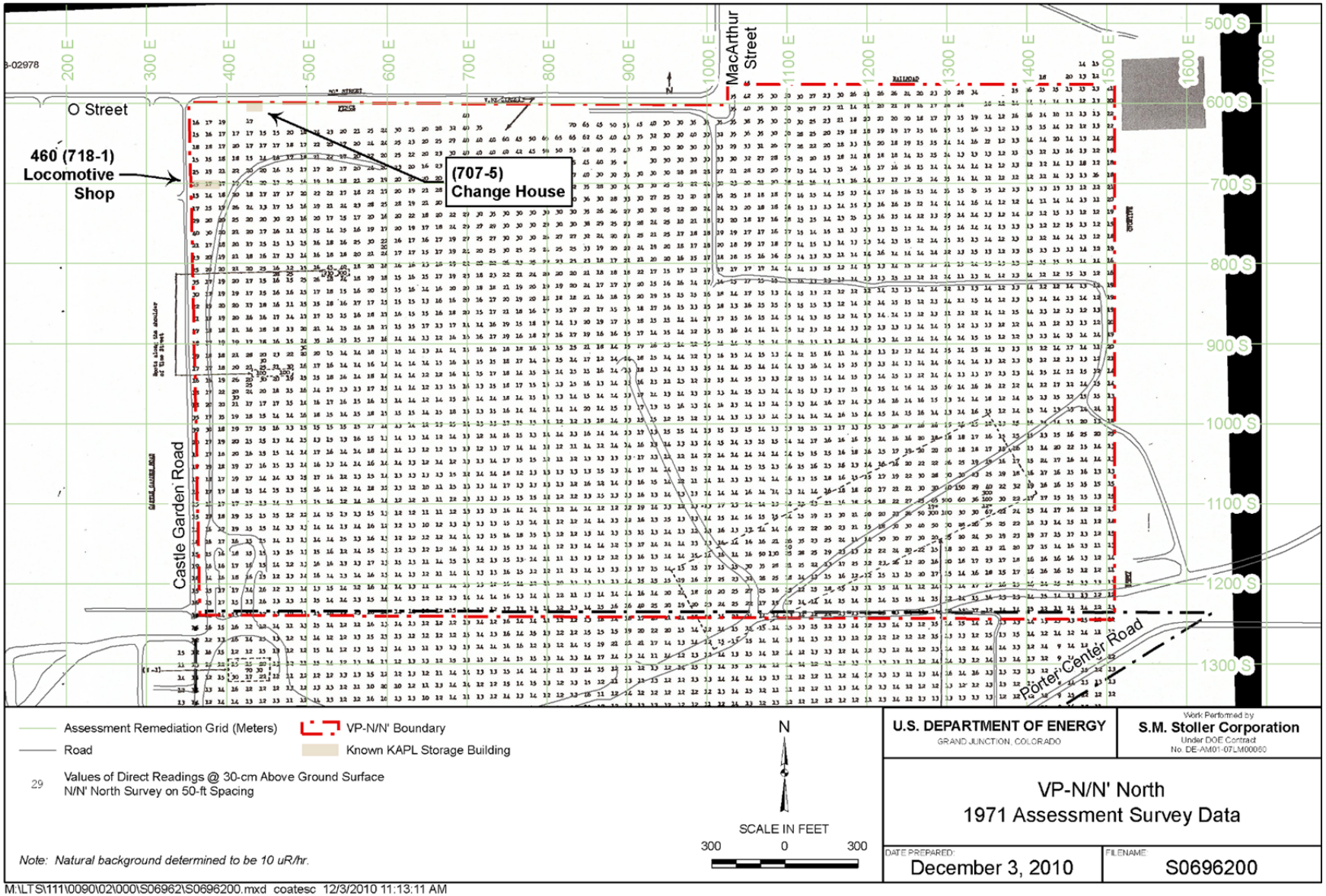

Figure 10. VP-N/N' North 1971 Assessment Survey Data
(Source: AEC 1973)

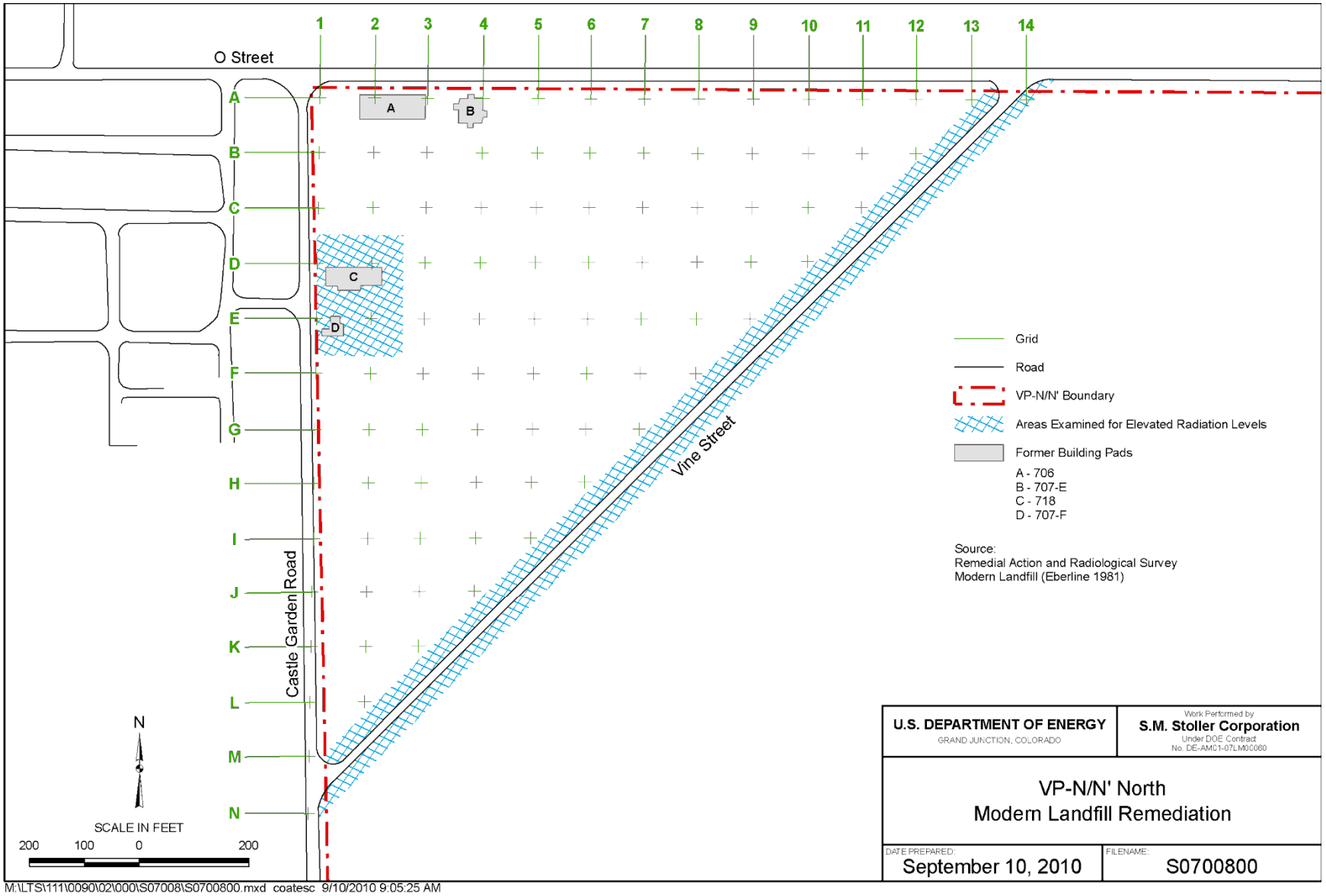

Figure 11. VP-N/N' North—Modern Landfill Remediation
(Source: Eberline 1981) (See Table 6 for data)

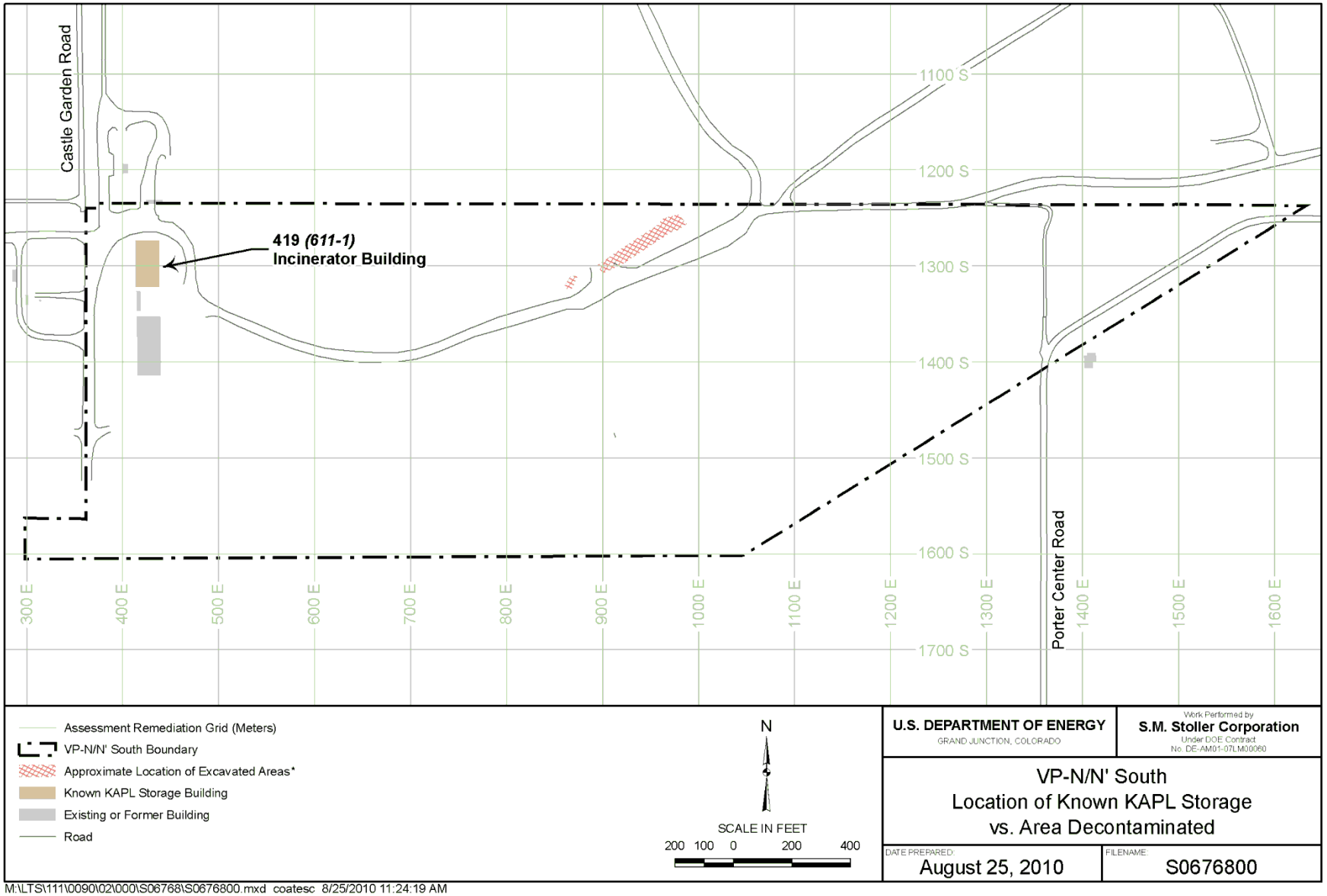

Figure 12. VP-N/N' South—Location of Known KAPL Storage vs. Area Decontaminated (Source: DOE 1986a)

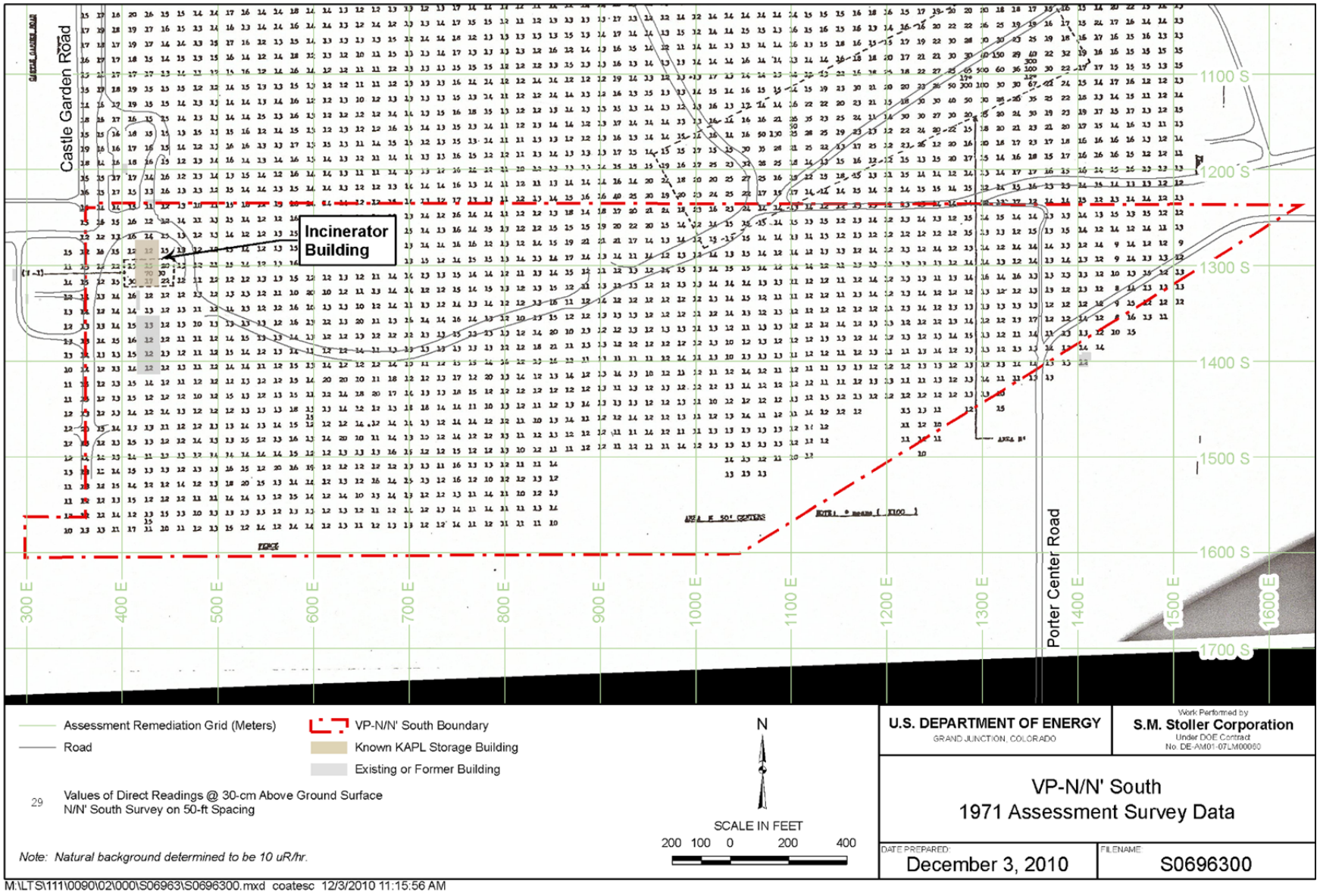

Figure 13. VP-N/N' South—1971 Assessment Survey Data
(Source: AEC 1973)

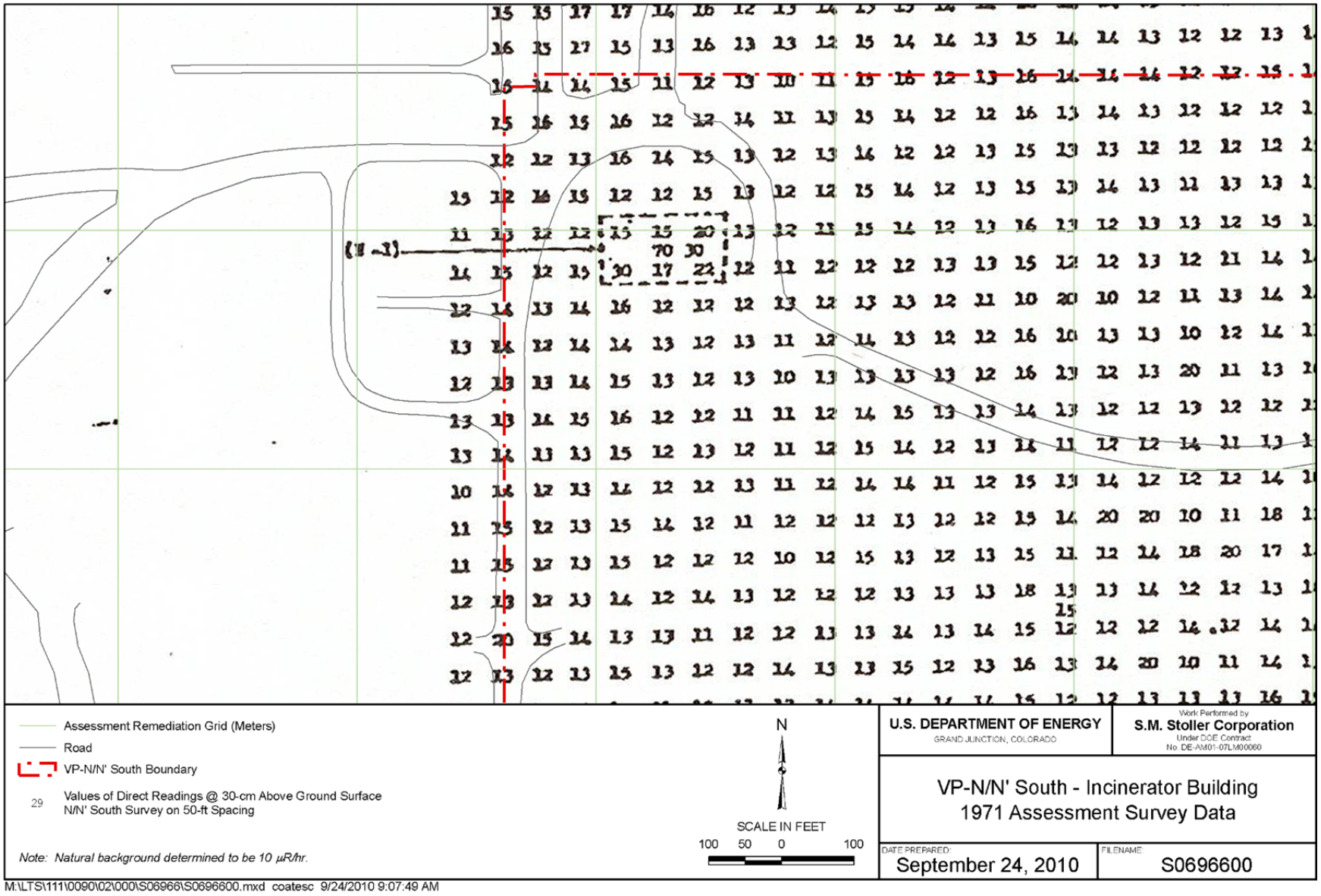

Figure 14. VP-N/N' South—Incinerator Building 1971 Assessment Survey Data (Source: AEC 1973)

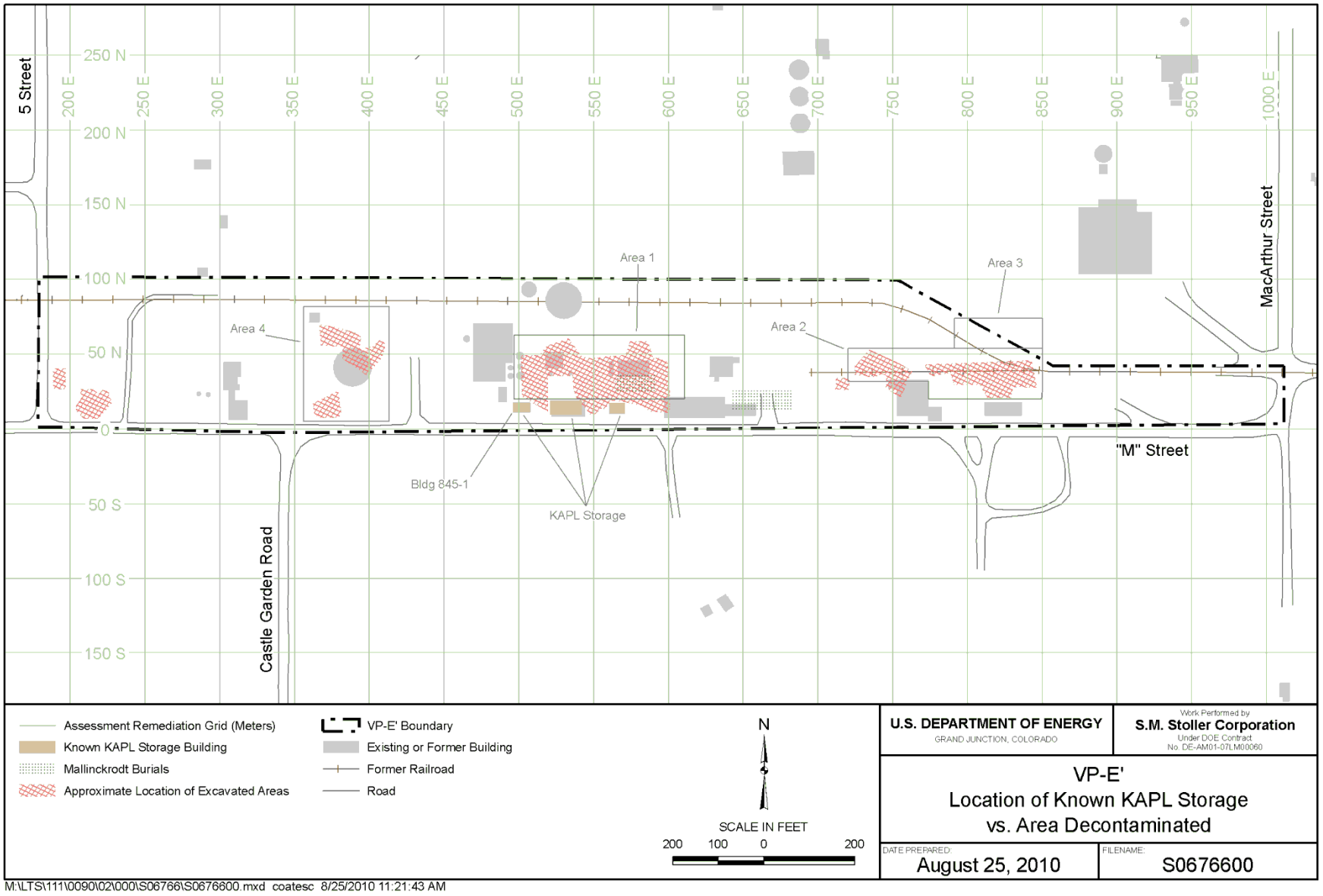

Figure 15. VP-E' Location of Known KAPL Storage vs. Area Decontaminated (Source: DOE 1986a)

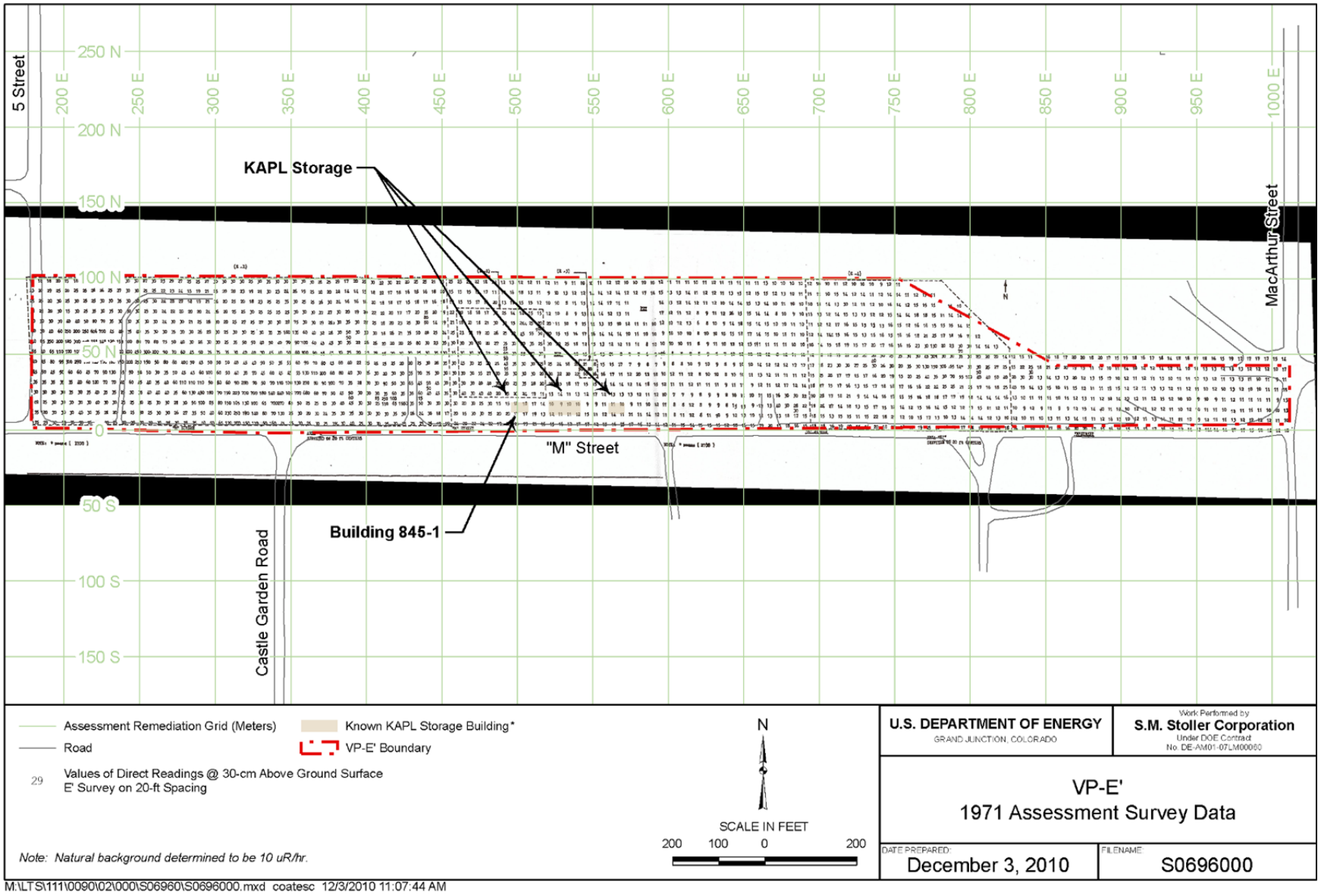

Figure 16. VP-E' 1971 Assessment Survey Data
(Source: AEC 1973)

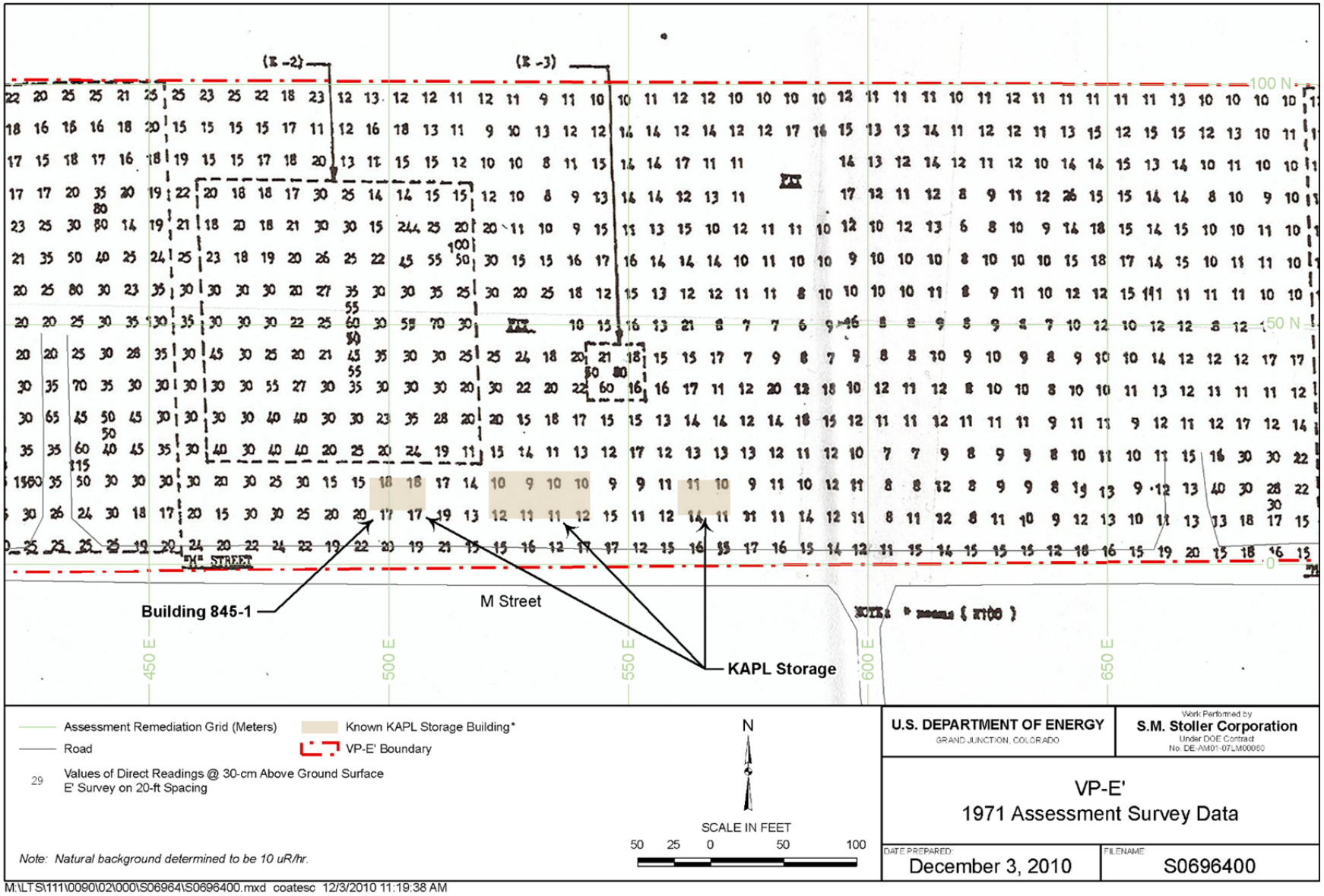

Figure 17. VP-E' 1971 Assessment Survey Data (Close-Up)
(Source: AEC 1973)

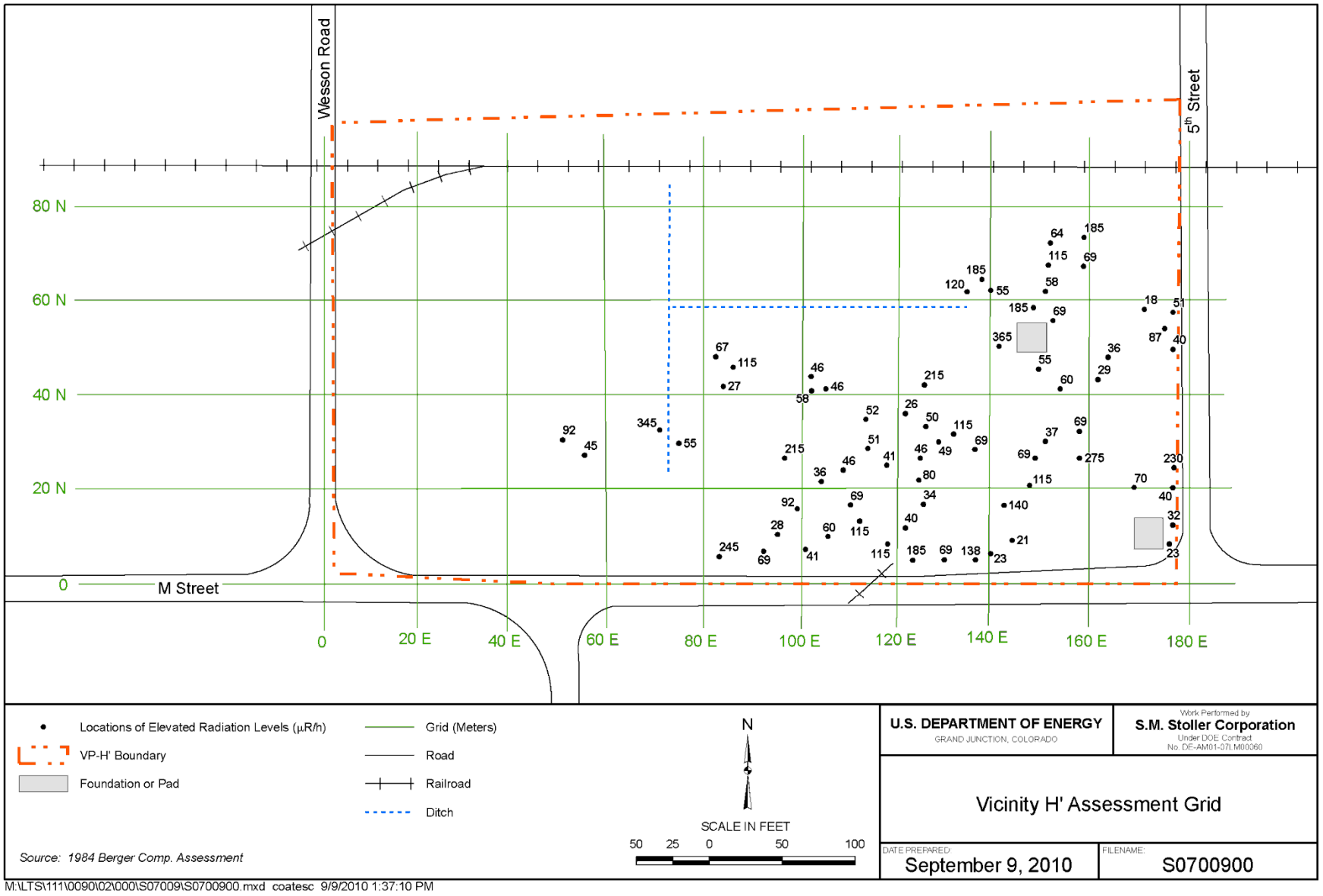

Figure 18. VP-H' Assessment Grid

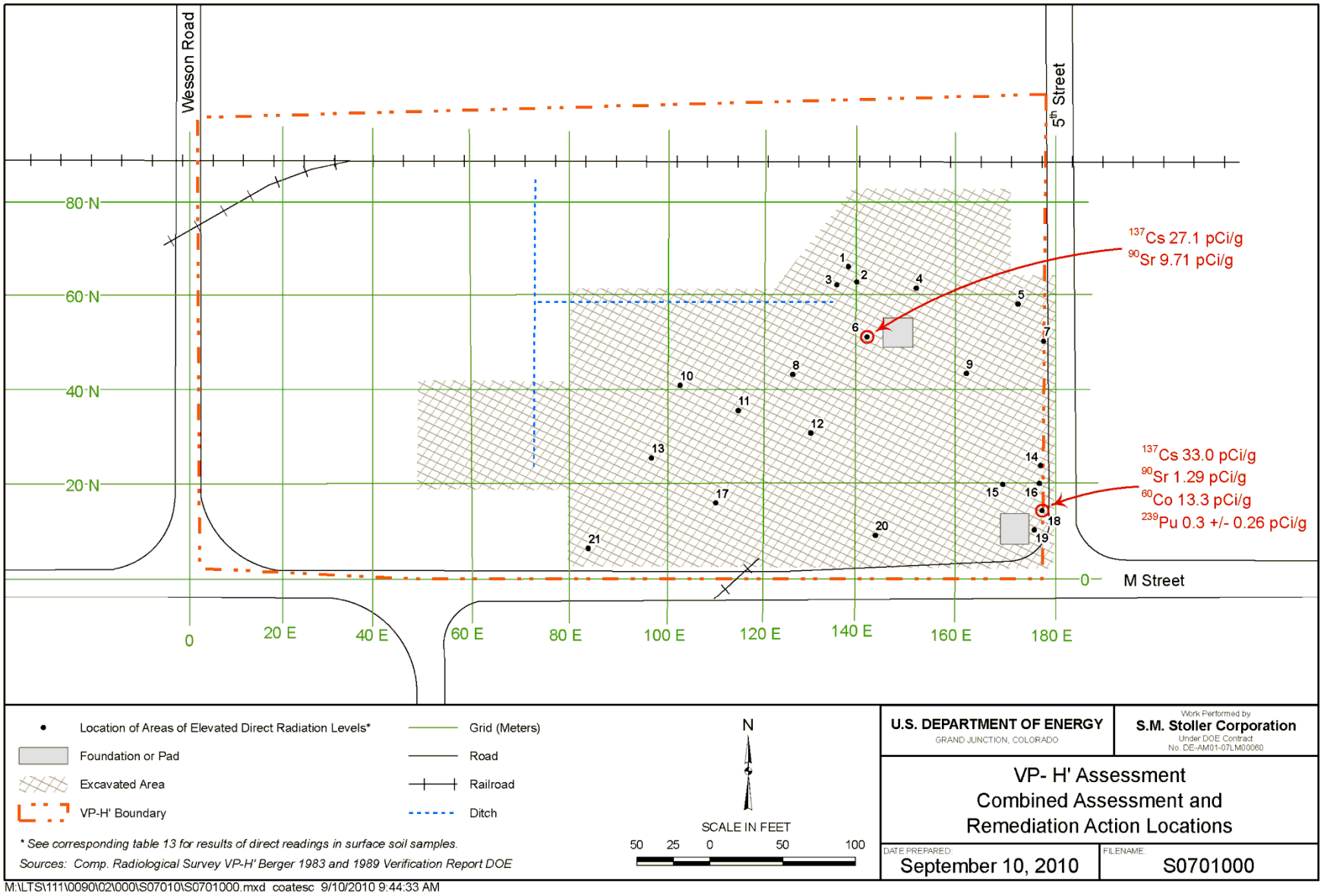

Figure 19. VP-H' Assessment: Combined Assessment and Remediation Action Locations

Table 4. VP-X Assessment Survey Data

VP-X Direct Radiation Levels Systematically Measured at 40-m grid intervals					VP-X Radionuclide Concentrations in Surface Soil Samples Collected at 40-m Grid Intervals				
Grid Coordinates		1 m Above Surface	Surface Exposure Rates	1 cm Above Surface	Ra-226	U-235	U-238	Cs-137	Th-232
South	West	(µR/hr)	(µR/hr)	(µrad/hr)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)
0	360	6	6	6	0.54 ± 0.19	0.33 (.40)	<0.63	0.81 ± 0.11	<0.12
40	360	8	8	38	0.89 ± 0.20	<0.27	1.32 ± 1.19	<0.04	1.13 ± 0.35
40	400	8	9	12	0.98 ± 0.25	<1.29	<0.88	0.75 ± 0.16	0.90 ± 0.40
80	360	8	8	9	0.83 ± 0.23	<0.19	2.00 ± 1.64	<0.04	0.87 ± 0.36
80	400	8	8	9	0.88 ± 0.38	<0.30	2.03 ± 3.28	0.10 ± 0.09	1.04 ± 0.39
120	360	8	8	8	0.78 ± 0.19	<0.15	1.16 ± 0.77	0.35 ± 0.88	1.33 ± 0.44
120	400	8	8	21	0.98 ± 0.21	<0.16	1.07 ± 0.75	<0.04	0.78 ± 0.28
160	360	8	9	24	1.34 ± 0.34	<0.37	<1.14	0.63 ± 0.14	1.68 ± 0.71
160	400	8	8	19	0.84 ± 0.24	<0.25	<0.30	0.47 ± 0.09	0.85 ± 0.30
200	360	9	9	28	1.28 ± 0.31	<0.32	1.93 ± 1.50	0.78 ± 0.14	1.13 ± 0.42
200	400	7	7	11	0.95 ± 0.25	<0.24	0.25 ± 1.73	0.90 ± 0.13	0.58 ± 0.32
240	360	8	9	9	0.90 ± 0.30	<0.21	<0.75	0.39 ± 0.10	0.91 ± 0.48
240	400	7	8	26	0.48 ± 0.14	<0.23	2.20 ± 0.92	,0.04	1.14 ± 0.52
280	360	7	7	11	0.43 ± 0.18	<0.13	0.55 ± 0.66	0.26 ± 0.08	0.41± 0.24
280	400	8	7	32	0.61 ± 0.26	<0.23	1.84 ± 1.49	<0.04	1.07 ± 0.47
320	360	8	8	27	0.56 ± 0.30	<0.20	1.80 ± 1.06	0.87 ± 0.13	0.73 ± 0.35
320	400	9	9	22	0.78 ± 0.21	<0.21	1.38 ± 1.54	0.15 ± 0.07	0.93 ± 0.30
360	360	12	13	29	3.06 ± 0.36	<0.38	4.97 ± 1.39	0.59 ± 0.11	1.10 ± 0.37
360	400	9	9	29	1.33 ± 0.28	<0.22	<0.72	0.84 ± 0.13	0.90 ± 0.40
400	360	12	10	17	0.93 ± 0.19	<0.25	2.62 ± 1.33	0.18 ± 0.08	0.94 ± 0.29
400	400	10	10	40	1.01 ± 0.31	<0.24	6.92 ± 2.25	0.18 ± 0.12	1.11 ± 0.35

Source: (ORAU 1984b) Comprehensive Assessment YP-X)
Note: µrad/hr = microrads per hour

Table 5. VP-X Verification Data

Location		Depth	Radionuclide Concentrations (pCi/g)		
N	W	(m)	Ra-226	U-238	Th-232
610	432	Surface	1.5 ± 0.3[a]	1.0 ± 2.6	0.8 ± 0.9
631	344	Surface	0.9 ± 0.2	0.9 ± 1.4	1.0 ± 0.5
658	409	Surface	1.0 ± 0.3	1.7 ± 1.3	0.9 ± 0.3
658	409	0.2–0.4	0.7 ± 0.2	3.8 ± 0.8	1.0 ± 0.3
699	375	Surface	0.6 ± 0.3	1.5 ± 2.1	1.0 ± 0.4
729	459	Surface	0.6 ± 0.2	2.1 ±1.0	0.7 ± 0.3
735	395	Surface	1.3 ± 0.3	4.1 ± 2.1	1.2 ± 0.4
735	395	0.2–0.4	0.9 ± 0.2	1.4 ± 0.5	0.9 ± 0.5
759	368	Surface	1.4 ± 0.5	2.6 ±1.8	0.7 ± 0.3

[a] Uncertainties represent the 95-percent confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6–10 percent have not been propagated into these data.

Source: ORAU 1989

Table 6. Results of Remedial Action at the VP-N/N' North Modern Landfill
Concentrations (pCi/g)

Grid Location	Ra-226	K-40	Cs-137	Sr-90	Cs-137/Sr-90
C + 77, 1 + 77	<2.5	12 ± 3	0.5 ± 0.1		
C + 77, 1 + 92	<2.5	13 ± 3	0.9 ± 0.1		
C + 92, 1 + 77	<2.5	15 ± 3	1.3 ± 0.1	0.1 ± 0.05	13
C + 92, 1 + 92	3 ± 1	17 ± 3	<0.5		
D + 57, 1 +47	4 ± 1	13 ± 3	4 ± 1	0.7 ± 0.1	5.7
D + 72, 1 + 47	3 ± 1	17 ± 3	4 ± 1		
D + 87, 1 + 32	2 ± 1	20 ± 3	6 ± 1	4.0 ± 0.4	1.5
D + 87, 1 + 47	<2.5	9 ± 2	2 ± 1		
D + 87, 1 + 62	2 ± 1	11 ± 2	9 ± 1	0.7 ± 0.1	13
E + 00, 2 + 00	<2.5	20 ± 3	5 ± 1	1.2 ± 0.1	4.2
E + 02, 1 + 32	<2.5	8 ± 2	<0.5		
E + 02, 1 + 47	<2.5	14 ± 2	1.8 ± 0.2		
E + 02, 1 + 62	3 ± 1	15 ± 3	24 ± 2	7.5 ± 0.8	3.2
E + 02, 1 + 77	<2.5	22 ± 3	<0.5		
E + 17, 1 + 32	<2.5	8 ± 2	17 ± 2	3.5 ± 0.4	4.9
E + 17, 1 + 47	<2.5	9 ± 2	<0.5		
E + 17, 1 + 62	<2.5	13 ± 2	4 ± 1	4 ± 1	1.5
E + 17, 1 + 77	<2.5	2 ± 3	2 ± 1		
E + 32, 1 + 62	<2.5	12 ± 2	3 ± 1		
E + 32, 1 + 67	<2.5	17 ± 3	4 ± 1	0.2 ± 0.03	20
G + 62, 7 + 37			1.4 ± 0.2	0.1 ± 0.1	14
H + 00, 7 + 00			2.8 ± 0.4	0.1 ± 0.03	28
H + 40, G + 35			1.8 ± 0.2	0.2 ± 0.04	9
J + 00, 4 + 90			2 ± 1	0.1 ± 0.1	20
J + 92, 3 + 92			1 ± 0.2	0.2 ± 0.04	5

Source: Eberline 1981
Note: Figure 11 shows approximate grid locations.

Table 7. VP-N/N' South Results of Old Incinerator Area Assessment

VP-N/N' South Direct Radiation Levels Systematically Measured at 10-m Grid Intervals, Old Incinerator Area					Radionuclide Concentrations in Surface Soil Samples Collected at 10-m Grid Intervals, Old Incinerator Area			
Grid Coordinates		1 m Above Surface	Surface Exposure Rates	1 cm Above Surface	Ra-226	U-235	U-238	Cs-137
East	South	(µR/hr)	(µR/hr)	(µrad/hr)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)
100	0	11	12	62	0.57 ± 0.19a	<0.24	<2.94	0.18 ± 0.09
100	10	11	11	52	0.54 ± 0.22	<0.24	<2.50	<0.05
100	20	13	15	86	2.20 ± 0.28	<0.24	<4.87	0.09 ± 0.04
100	30	11	12	86	0.52 ± 0.28	<0.25	<4.07	0.46 ± 0.16
100	40	11	11	61	0.52 ± 0.20	<0.24	<1.89	0.30 ± 0.10
100	50	11	11	98	<0.13	<0.24	5.69 ± 8.91	0.71 ± 0.07
100	60	11	10	68	0.54 ± 0.02	<0.24	<3.80	0.12 ± 0.10
100	70	11	11	61	0.72 ± 0.30	<0.26	<4.15	0.17 ± 0.14
100	80	11	11	68	0.71 ± 0.18	<0.24	<4.09	0.08 ± 0.09
100	90	11	11	55	0.84 ± 0.22	<0.24	<4.05	0.09 ± 0.09
100	100	11	11	70	0.57 ± 0.25	<0.24	5.32 ± 8.36	0.17 ± 1.10
110	0	15	16	110	0.67 ± 0.30	<0.24	<4.19	<0.04
110	10	15	17	100	0.61 ± 0.18	<0.24	<2.49	0.15 ± 0.10
110	20	11	10	72	0.61 ± 0.18	<0.24	<2.49	0.10 ± 0.11
110	30	10	10	64	0.62 ± 0.11	<0.24	<3.83	<0.03
110	40	11	11	53	0.60 ± 0.19	<0.24	5.46 ± 7.96	0.17 ± 0.12
110	50	11	11	62	0.47 ± 0.18	<0.24	<3.28	<0.04
110	60	11	11	70	0.71 ± 0.18	<0.24	<2.73	0.10 ± 0.12
110	70	(There is no 70)			0.66 ± 0.21	<0.24	<3.84	0.17 ± 0.08
110	80	11	11	75	0.58 ± 0.19	<0.24	<4.45	0.07 ± 0.08
110	90	12	11	62	0.82 ± 0.24	<0.24	<4.71	0.29 ± 0.07
110	100	11	12	69	0.75 ± 0.11	<0.24	<3.49	0.27 ± 0.08
120	0	12	13	82	0.61 ± 0.11	<0.24	<3.83	<0.04
120	10	12	12	68	0.85 ± 0.42	<0.24	<3.34	0.19 ± 0.13
120	20	11	10	53	0.55 ± 0.20	<0.24	<3.26	0.06 ± 0.07
120	30	11	11	62	<0.14	<0.24	<1.89	<0.03

Table 7 (continued). VP-N/N' South Results of Old Incinerator Area Assessment

VP-N/N' South Direct Radiation Levels Systematically Measured at 10-m Grid Intervals, Old Incinerator Area					Radionuclide Concentrations in Surface Soil Samples Collected at 10-m Grid Intervals, Old Incinerator Area			
Grid Coordinates		1 m Above Surface	Surface Exposure Rates	1 cm Above Surface	Ra-226	U-235	U-238	Cs-137
East	South	(µR/hr)	(µR/hr)	(µrad/hr)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)
120	40	11	11	65	0.51 ± 0.07	<0.24	<4.06	<0.03
120	50	11	12	81	0.59 ± 0.30	<0.24	<4.64	<0.04
120	60	11	12	64	0.42 ± 0.21	<0.24	<4.11	0.50 ± 0.13
120	70	12	12	91	0.74 ± 0.24	<0.28	<5.35	0.40 ± 0.17
120	80	12	12	81	0.42 ± 0.20	<0.24	<5.19	0.08 ± 0.08
120	90	12	12	87	0.47 ± 0.18	<0.25	<3.17	0.06 ± 0.10
130	0	11	11	78	0.54 ± 0.20	<0.24	<4.75	0.05 ± 0.09
130	10	10	11	72	0.33 ± 0.21	<0.24	<3.95	0.51 ± 0.11
130	20	10	11	59	0.53 ± 0.15	<0.24	<2.88	0.11 ± 0.07
130	30	10	11	78	0.74 ± 0.18	<0.24	<3.06	0.12 ± 0.09
130	40	11	11	62	0.41 ± 0.15	<0.24	<3.02	<0.03
130	50	12	12	64	0.63 ± 0.28	<0.24	<4.29	0.27 ± 0.11
130	60	11	11	75	0.62 ± 0.20	0.18 ± 0.42	<4.64	0.23 ± 0.11
130	70	12	12	86	0.64 ± 0.26	<0.24	<3.62	0.40 ± 0.12
130	80	12	12	66	0.69 ± 0.22	<0.24	<5.05	0.39 ± 0.15
130	90	12	12	81	0.84 ± 0.24	<0.24	<4.25	0.42 ± 0.13
140	0	12	12	75	0.57 ± 0.19	<0.24	<3.78	<0.03
140	10	11	11	65	0.46 ± 0.22	<0.25	<2.91	0.29 ± 0.15
140	20	10	11	72	0.52 ± 0.24	<0.24	7.86 ± 8.36	0.05 ± 0.08
140	30	11	11	61	0.65 ± 0.24	<0.24	6.04 ± 12.29	<0.02
140	40	12	12	83	0.55 ± 0.11	<0.24	<3.60	<0.04
140	50	12	12	62	0.96 ± 0.37	<0.24	<5.41	0.51 ± 0.14
140	60	12	11	68	0.59 ± 0.20	<0.24	<4.20	0.25 ± 0.10
140	70	12	12	78	0.48 ± 0.21	<0.24	<4.26	0.27 ± 0.13
140	80	11	11	66	0.59 ± 0.17	<0.24	<4.64	0.29 ± 0.12
140	90	12	12	79	0.83 ± 0.27	<0.24	<4.23	<0.03
150	0	12	11	60	0.49 ± 0.16	<0.24	<3.57	0.41 ± 0.11

Table 7 (continued). VP-N/N' South Results of Old Incinerator Area Assessment

VP-N/N' South Direct Radiation Levels Systematically Measured at 10-m Grid Intervals, Old Incinerator Area					Radionuclide Concentrations in Surface Soil Samples Collected at 10-m Grid Intervals, Old Incinerator Area			
Grid Coordinates		1 m Above Surface	Surface Exposure Rates	1 cm Above Surface	Ra-226	U-235	U-238	Cs-137
East	South	(μR/hr)	(μR/hr)	(μrad/hr)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)
150	10	11	11	90	0.64 ± 0.23	<0.24	<3.92	0.61 ± 0.13
150	20	11	11	66	0.56 ± 0.20	<0.24	<2.34	<0.03
150	30	12	12	83	0.53 ± 0.15	<0.24	<3.58	<0.03
150	40	15	15	120	5.19 ± 0.50	<0.24	<5.47	0.67 ± 0.15
150	50	11	11	62	0.59 ± 0.19	<0.24	<3.63	0.25 ± 0.11
150	60	11	11	72	0.54 ± 0.23	<0.24	<2.19	0.11 ± 0.11
150	70	11	12	95	0.51 ± 0.18	<0.24	<3.92	0.09 ± 0.10
150	80	11	12	53	0.63 ± 0.24	<0.24	<4.20	<0.03
150	90	11	12	66	0.61 ± 0.21	<0.24	<3.80	0.28 ± 0.13
160	0	11	11	73	0.63 ± 0.24	<0.24	<3.86	<0.04
160	10	11	11	42	0.46 ± 0.27	<0.24	<3.23	0.53 ± 0.11
160	20	11	12	74	1.04 ± 0.29	0.20 ± 0.89	<5.12	0.51 ± 0.12
160	30	13	13	120	6.61 ± 0.60	1.67 ± 1.06	19.9 ± 0.5	1.11 ± 0.10
160	40	12	12	74	2.24 ± 0.34	<0.24	<5.82	0.89 ± 0.19
160	50	11	12	73	1.29 ± 0.29	<0.24	<4.79	0.78 ± 0.16
160	60	12	11	65	0.68 ± 0.21	<0.24	<2.45	0.11 ± 0.08
160	70	11	12	62	0.58 ± 0.21	<0.24	<4.04	0.20 ± 0.011
160	80	11	11	85	<0.16	<0.24	<3.21	0.13 ± 0.10
160	90	11	11	53	0.50 ± 0.16	<0.22	<3.15	0.33 ± 0.11
170	0	11	11	62	0.82 ± 0.21	<0.24	<3.14	0.45 ± 0.13
170	10	11	11	48	0.51 ± 0.18	<0.24	<3.39	0.57 ± 0.14
170	20	12	11	53	0.60 ± 0.39	<0.24	5.41 ± 9.02	0.95 ± 0.17
170	30	39	93	320	12.8 ± 0.8	1.47 ± 1.47	20.2 ± 0.5	1.48 ± 0.26
170	40	12	12	74	0.69 ± 0.24	<0.24	8.08 ± 11.25	0.35 ± 0.14
170	50	12	11	88	0.84 ± 0.22	<0.24	<3.82	0.32 ± 0.10
170	60	11	11	75	0.53 ± 0.20	<0.24	<4.02	0.23 ± 0.10
170	70	11	11	88	0.67 ± 0.22	<0.24	<4.51	0.06 ± 0.09
170	80	11	11	90	0.49 ± 0.18a	<0.24	<3.57	0.31 ± 0.13
170	90	11	11	73	0.64 ± 0.16	<0.24	<3.44	0.16 ± 0.09
180	0	11	11	62	0.60 ± 0.23	<0.24	<3.27	0.47 ± 0.15
180	10	11	11	62	1.30 ± 0.24	<0.24	<4.48	0.70 ± 0.12
180	20	12	12	42	0.66 ± 0.21	<0.24	<4.21	0.34 ± 0.17
180	30	13	12	64	1.10 ± 0.26	<0.24	<4.67	0.4 ± 0.14
180	40	12	12	83	0.54 ± 0.27	<0.24	<5.05	0.40 ± 0.16

Table 7 (continued). VP-N/N' South Results of Old Incinerator Area Assessment

VP-N/N' South Direct Radiation Levels Systematically Measured at 10-m Grid Intervals, Old Incinerator Area					Radionuclide Concentrations in Surface Soil Samples Collected at 10-m Grid Intervals, Old Incinerator Area			
Grid Coordinates		1 m Above Surface	Surface Exposure Rates	1 cm Above Surface	Ra-226	U-235	U-238	Cs-137
East	South	(μR/hr)	(μR/hr)	(μrad/hr)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)
180	50	11	11	82	0.65 ± 0.19	<0.24	<4.46	0.19 ± 0.11
180	60	11	11	69	0.68 ± 0.23	<0.24	<3.58	0.19 ± 0.16
180	70	12	11	77	0.58 ± 0.20	<0.24	<3.58	0.45 ± 0.12
180	80	11	11	83	0.42 ± 0.23	<0.24	<5.67	0.59 ± 0.13
180	90	11	11	83	0.52 ± 0.19	<0.24	<4.37	0.21 ± 0.08
190	0	11	12	70	0.45 ± 0.23	<0.24	<2.89	<0.03
190	10	11	12	72	0.72 ± 0.20	<0.24	<4.65	0.14 ± 0.08
190	20	11	11	81	0.87 ± 0.26	<0.24	<4.01	0.55 ± 0.15
190	30	11	11	62	0.49 ± 0.17	<0.24	<2.54	0.28 ± 0.09
190	40	12	12	99	0.55 ± 0.28	<0.25	<4.26	0.36 ± 0.10
190	50	12	12	85	0.62 ± 0.20	<0.24	<3.36	0.37 ± 0.12
190	60	12	11	87	0.60 ± 0.22	<0.24	<2.99	<0.04
190	70	11	12	77	0.47 ± 0.21	<0.24	<2.98	0.21 ± 0.10
190	80	11	12	75	0.50 ± 0.024	<0.24	<2.35	0.17 ± 0.09
190	90	(There is no 90)						
200	0	11	12	62	0.55 ± 0.20	<0.24	<3.96	0.06 ± 0.07
200	10	11	12	73	0.46 ± 0.22	<0.24	<4.30	0.20 ± 0.11
200	20	11	11	72	6.61 ± 0.50	<.024	<6.04	0.46 ± 0.14
200	30	11	11	68	0.48 ± 0.19	<0.24	<2.46	0.52 ± 0.11
200	40	11	12	79	0.85 ± 0.20	<0.24	<5.02	0.40 ± 0.13
200	50	11	11	64	<0.16	<0.24	<3.23	0.41 ± 0.12
200	60	11	12	73	0.53 ± 0.22	<0.24	<0.64	0.21 ± 0.08

Source: ORAU 1983c

Table 8. VP-N/N' South Verification Survey Data

Location		Depth (m)	Radionuclide Concentrations (pCi/g)		
S	E		Ra-226	U-238	Th-232
2188	3873	Surface	1.4 ± 0.3	2.3 ± 1.8	1.5 ± 0.6
2215	3803	Surface	1.3 ± 0.4	3.5 ± 2.4	0.7 ± 0.5
2219	3844	0.3–0.45	1.0 ± 0.3	1.2 ±1.1	1.2 ± 0.3
2235	3750	Surface	0.8 ± 0.2	0.6 ± 1.1	1.3 ± 0.4
2240	3845	Surface	1.0 ± 0.2	1.4 ± 1.5	0.8 ± 0.5
2275	3688	Surface	1.4 ± 0.3	1.6 ± 1.9	1.3 ± 0.4
2278	3763	0.3–0.45	0.9 ± 0.4	<1.0	1.2 ± 0.4
2293	3755	Surface	1.1 ± 0.3	1.3 ± 1.8	1.1 ± 0.5
2303	3683	0.3–0.45	0.9 ± 0.2	0.6 ± 1.2	1.3 ± 0.5
2315	3644	Surface	1.0 ± 0.2	1.2 ± 1.4	1.0 ± 0.3
2315	3710	Surface	1.1 ± 0.2	1.2 ± 1.6	1.0 ± 0.5
2365	3503	0.6–0.75	0.9 ± 0.2	<0.6	0.9 ± 0.5
2369	3513	0.3–0.45	0.9 ± 0.3	12.4 ± 1.8	2.3 ± 0.6
2370	3531	Surface	1.8 ± 0.3	3.3 ± 1.1	1.3 ± 0.5
2381	3488	Surface	0.8 ± 0.4	5.9 ± 2.4	1.7 ± 0.9
2393	3495	Surface	1.2 ± 0.3	13.3 ± 3.1	2.3 ± 0.6

[a] Uncertainties represent the 95-percent confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6–10 percent have not been propagated into these data.

Source: ORAU 1989

Table 9. VP-E' Assessment Summary Table

VP-E' Direct Radiation Levels Systematically Measured at 20-m Grid Intervals Assessment Data					Radionuclide Concentrations in Surface Soil Samples Collected at 20-m Grid Intervals				
Grid Coordinates		1 m Above Surface	Surface Exposure Rates	1 cm Above Surface	Ra-226	U-235	U-238	Th-232	Cs-137
North	East	(µR/hr)	(µR/hr)	(µrad/hr)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)
0	500	7.2	7.2	29					
0	520	6.8	7.2	31					
0	540	6.4	7.2	35					
0	560	6.4	6.8	37					
0	580	6.6	6.8	40					
0	600	5.2	5.6	19					
0	620	5.9	5.0	27					
0	640	5.0	4.7	38					
0	660	6.6	5.9	20					
20	500	8.0	8.1	43					
20	520	7.2	7.2	46					
20	540	5.2	5.4	45					
20	560	4.8	5	43					
20	580	5.4	5.2	37					
20	600	a	a	a					
20	620	a	a	a					
20	640	5.7	5.4	26					
20	660	5.0	5.4	32					
40	500	5.7	5.7	31					
40	520	5.0	5.2	19					
40	540	7.4	8.8	51					
40	560	5.2	5.9	32					
40	580	a	a	a					
40	600	a	a	a					
40	620	5.2	5.2	33					
40	640	5.7	7.2	45					
40	660	6.2	6.8	31					
-4 b	500				0.74 ± 0.16	0.13 ± 0.06	<3.26	0.57 ± 0.22	<0.03
-4 b	520				1.06 ± 0.19	0.14 ± 0.06	<4.39	0.95 ± 0.30	<0.03
-4 b	540				0.74 ± 0.13	0.09 ± 0.06	<2.55	0.48 ± 0.23	<0.02
-4 b	560				0.71 ± 0.14	0.12 ± 0.06	<2.55	0.67 ± 0.19	<0.02
-4 b	580				0.97 ± 0.17	0.12 ± 0.07	<3.02	0.60 ± 0.24	<0.03

Table 9 (continued). VP-E' Assessment Summary Table

VP-E' Direct Radiation Levels Systematically Measured at 20-m Grid Intervals Assessment Data					Radionuclide Concentrations in Surface Soil Samples Collected at 20-m Grid Intervals				
Grid Coordinates		1 m Above Surface	Surface Exposure Rates	1 cm Above Surface	Ra-226	U-235	U-238	Th-232	Cs-137
North	East	(µR/hr)	(µR/hr)	(µrad/hr)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)
3	602				0.74 ± 0.14	<0.13	<2.84	0.55 ± 0.21	0.02 ± 0.05
-5 b	620				0.72 ± 0.16	<0.13	5.43 ± 9.73	0.60 ± 0.20	0.02 ± 0.06
-5 b	640				0.53 ± 0.13	<0.12	<2.69	0.59 ± 0.22	<0.02
-5 b	660				0.64 ± 0.14	<0.13	<3.12	0.42 ± 0.30	0.04 ± 0.06
20	500				1.50 ± 0.19	0.18 ± 0.28	<3.15	0.48 ± 0.23	0.09 ± 0.05
20	520				0.64 ± 0.14	<0.11	5.08 ± 6.38	0.50 ± 0.17	0.06 ± 0.04
20	540				---	---	---	---	---
20	560				---	---	---	---	---
20	580				---	---	---	---	---
20	600				---	---	---	---	---
20	620				---	---	---	---	---
20	640				---	---	---	---	---
20	660				---	---	---	---	---
40	500				0.74 ± 0.24	<0.15	<2.91	0.49 ± 0.31	<0.03
40	520				2.48 ± 0.26	<0.19	<4.77	0.68 ± 0.33	0.16 ± 0.07
40	540				0.96 ± 0.16	<0.11	<2.45	0.34 ± 0.25	0.07 ± 0.09
40	560				---	---	---	---	---
40	580				---	---	---	---	---
40	600				---	---	---	---	---
40	620				---	---	---	---	---
40	640				---	---	---	---	---
40	660				1.14 ± 0.18	<0.14	<3.19	0.80 ± 0.26	0.04 ± 0.07

Source: ORAU 1983a

Table 10. VP-E' Direct Readings from North of KAPL Storage, 5-m Grid of Area

Grid Coordinates		Gamma Exposure Rates at 1 m Above Surface	Gamma Exposure Rates at the Surface	Beta-Gamma Dose Rates at 1 cm Above Surface
North	**East**	**(μR/hr)**	**(μR/hr)**	**(μrad/hr)**
Area 1				
20	540	5.2	5.4	45
	545	5.4	5.0	32
	550	5.9	5.4	32
	555	5.4	5.4	27
	560	4.8	5.0	43
	565	6	5.4	32
	570	5.4	5.7	33
	575	5.7	5.6	37
	580	5.4	5.2	37
	585	5.2	5.0	16
	590	4.4	4.4	32
	595	5.4	5.4	31
25	540	6.2	6.2	29
	545	6.2	6.0	31
	550	5.4	5.9	21
	555	5.4	5.4	31
	560	4.8	5.0	27
	565	5.0	5.0	22
	570	5.4	4.6	31
	575	5.0	5.0	35
	580	4.6	4.8	32
	585	5.0	5.4	27
	590	5.0	4.6	24
	595	5.0	5.0	22
	600	4.6	4.4	31
	605	4.8	4.4	16
	610	5.0	4.8	40
30	540	6.2	7.2	38
	545	6.0	6.6	26
	550	5.6	5.9	27
	555	5.0	4.6	22
	560	5.4	4.6	26
	565	5.6	5.4	26
	570	5.2	5.2	16
	575	5.6	5.2	21
	580	5.4	5.0	19
	585	5.0	4.6	37
	590	5.2	4.6	32
	595	5.2	5.2	32
	600	5.6	5.7	27
30	605	4.4	4.8	21
	610	5.0	5.0	32

Table 10 (continued). VP-E' Direct Readings from North of KAPL Storage, 5-m Grid of Area

Grid Coordinates		Gamma Exposure Rates at 1 m Above Surface	Gamma Exposure Rates at the Surface	Beta-Gamma Dose Rates at 1 cm Above Surface
North	**East**	**(µR/hr)**	**(µR/hr)**	**(µrad/hr)**
35	540	6.8	6.2	40
	545	6.8	6.2	40
	550	6.0	6.8	33
	555	5.0	5.0	22
	560	5.4	5.7	32
	565	5.4	5.2	27
	570	5.4	5.7	31
	575	6.6	7.2	43
	580	5.2	5.4	27
	585	5.7	6.0	35
	590	6.2	7.0	37
	595	5.4	5.7	22
	600	5.6	5.7	27
	605	5.7	7.0	26
	610	5.2	5.0	29
40	540	7.4	8.8	51
	545	7.2	6.6	29
	550	8.6	8.8	38
	555	5.7	5.4	24
	560	5.2	5.9	32

Source: ORAU 1983a

Table 11. VP-E' Verification Summary Table

Location		Radionuclide Concentrations (pCi/g)		
N	**E**	**Ra-226**	**U-238**	**Th-232**
Section 1				
1974	1437	22.5 ± 3.7	<5.9	2.1 ± 0.2
1974	1437	2.0 ± 0.3	1.5 ± 0.9	0.6 ± 0.6
	(after further remediation)			
1992	1403	2.2 ± 0.5	1.6 ± 2.5	0.7 ± 0.5
1993	1444	16.2 ± 0.8	6.1 ± 2.8	1.3 ± 0.8
2000	1442	6.0 ± 0.5	3.4 ± 2.5	0.9 ± 0.3
2012	1393	3.2 ± 0.4	4.8 ± 3.8	1.1 ± 0.4
2073	1344	25.7 ± 1.1	2.8 ± 3.0	0.8 ± 0.8
2073	1344	13.6 ± 0.6	5.0 ± 0.6	1.2 ± 0.5
	(after further remediation)			
2100	1340	1.8 ± 0.3	3.4 ± 0.8	0.8 ± 0.5
Section 2				
2035	1943	6.3 ± 0.7	<1.4	0.8 ± 0.4
2134	2072	2.5 ± 0.4	<0.8	0.9 ± 0.5
2259	2072	20.6 ± 0.8	<10.5	1.2 ± 0.6
2279	2085	1.3 ± 0.3	2.6 ± 2.1	1.1 ± 0.4
Section 3				
2034	2169	115 ± 2	6.6 ± 2.5	1.9 ± 1.3
2039	2168	156 ± 3	35.0 ± 9.3	<1.0
2039	2170	258 ± 3	<33	<1.1
2093	2185	8.0 ± 0.7	18.3 ± 2.8	0.8 ± 0.6
2093	2223	13.8 ± 0.7	2.0 ± 1.4	0.9 ± 0.4
2107	2174	2.2 ± 0.4	1.3 ± 1.7	0.5 ± 0.4
Section 4				
2024	3463	1.0 ± 0.3	<0.8	1.0 ± 0.3
2029	3456	1110 ± 10	<7.9	<2.4
2029	3456	0.7 ± 0.2	<3.9	0.9 ± 0.3
(after further remediation)				
2034	3467	1.2 ± 0.2	<0.6	1.0 ± 0.4
2044	3445	0.8 ± 0.3	1.1 ± 1.1	0.8 ± 0.5
2056	3505	2.0 ± 0.3	1.4 ± 1.6	0.7 ± 0.6
2067	3167	0.6 ± 0.2	0.7 ± 1.1	0.7 ± 0.3
2082	3424	1.2 ± 0.2	1.3 ± 1.3	1.3 ± 0.6

Source: ORAU 1990

Table 12. VP-H' Assessment Data (Direct Readings of Surface Soils)

Grid Location	Direct Reading Measurements			Surface Soil Samples				
	Gamma Exposure Rates at 1 m Above the Surface	Gamma Exposure Rates at the Surface	Beta-Gamma Dose Rates at the Surface	Radionuclide Concentrations (pCi/g)				
	(µR/hr)	(µR/hr)	(µrad/hr)	Ra-226	U-235	U-238	Th-232	Cs-137
80N, 80E	7.2	7.2	35	0.64 ± 0.17	0.45 ± 0.45	<2.66	0.77 ± 0.31	0.35 ± 0.09
80N, 100E	8.0	7.4	23	0.68 ± 0.21	<0.18	<2.54	<0.20	0.42 ± 0.11
80N, 120E	6.8	7.2	29	0.71 ± 0.16	<0.21	<2.64	0.84 ± 0.34	0.64 ± 0.10
80N, 140E	7.7	7.7	38	0.71 ± 0.19	<0.22	<3.94	0.61 ± 0.34	0.67 ± 0.15
80N, 160E	7.4	7.2	25	0.87 ± 0.18	<0.21	<3.68	<0.22	0.49 ± 0.10
80N, 178E	7.3	8.6	37	1.40 ± 0.39	<0.33	<4.06	<0.26	0.99 ± 0.21

Source: ORAU 1983b

Table 13. VP-H′ Selected Assessment Data

Sample[a]	Grid Location	Radionuclide Concentrations (pCi/g)[b]				
		Ra-226	U-235	U-238[f]	Th-232	Cs-137
B1	64N, 139E	278 ± 4[c]	11.7 ± 5.2	228 ± 97	<1.31	8.32 ± 0.96
B2	63N, 140E	2.14 ± 0.43	66.0 ± 3.0	1480 ± 50	<0.26	0.56 ± 0.21
B3	63N, 137E	167 ± 2	13.7 ± 3.4	202 ± 51	<0.68	3.48 ± 0.44
B4	62N, 152E	53.9 ± 1.1	3.16 ± 1.76	43.8 ± 30.3	<0.42	1.44 ± 0.25
B5	58N, 172E	11.6 ± 0.5	0.84 ± 0.92	<6.46	<0.28	0.17 ± 0.13
B6	52N, 141E[d]	1750 ± 10	<8.24	450 ± 220	<3.48	27.1 ± 2.3
B7	51N, 178E	17 ± 0.6	1.02 ± 0.98	<7.20	<0.26	0.66 ± 0.16
B8	45N, 126E	835 ± 5	<3.57	<11.0	<1.53	13.8 ± 1.0
B9	44N, 162E	18.5 ±0.9	<0.81	<11.1	<0.43	0.70 ± 0.22
B10	41N, 101E	110 ± 2	2.93 ± 2.68	<16.3	<0.54	2.63 ± 0.39
B11	35N, 115E	22.8 ± 0.7	1.13 ± 1.10	<7.96	<0.30	0.58 ± 0.16
B12	30N, 130E	123 ± 3	3.06 ± 4.03	<7.02	<0.90	1.98 ± 0.52
B13	26N, 96E	470 ± 5	<3.89	<9.14	<1.55	7.45 ± 0.93
B14	23N, 177E	501 ± 5	<3.81	<12.5	<1.62	7.22 ± 1.13
B15	20N, 170E	141 ± 2	<1.96	<4.64	<0.87	<0.23
B16	20N, 177E	11.9 ± 0.5	<0.45	<6.17	<0.22	0.83 ± 0.16
B17	17N, 110E	219 ± 3	<2.60	<8.47	<1.12	3.64 ± 0.83
B18	14N, 178E[e]	330 ± 3	7.73 ± 4.59	134 ± 68	<1.10	33.0 ± 0.7
B19	10N, 175E	18.9 ± 0.6	0.85 ± 1.02	<7.32	<0.25	0.74 ± 0.16
B20	10N, 145E	38.9 ± 0.9	<0.75	28.2 ± 23.0	0.69 ± 0.67	0.60 ± 0.20
B21	7N, 83E	958 ± 7	<5.29	<17.0	<2.22	15.1 ± 1.5

[a] Locations on Figure 20.
[b] Analytical for locations on Figure 20.
[c] Errors are 2σ based on counting statistics.
[d] This sample also contained 9.71 ± 0.75 pCi/g of Sr-90 and 0.30 ± 0.26 pCi/g of Pu-239.
[e] This sample also contained 13.3 ± 1.3 pCi/g of Co-60 and 1.29 ± 0.36 pCi/g of Sr-90.
[f] Large minimum detectable activities and relative errors are the result of high continuum count rates resulting from high levels of Ra-226 in these samples.

Table 14. VP-H' Verification Survey Data

Property	Sample ID	Grid Location	Analysis By	Radionuclide Concentration (pCi/g)[a]		
				Ra-226	U-238	Th-232
H'	102	N 2020, E1130	BNI[b]	0.6 ± 0.2	<MDA[c]	0.4 ± 0.4
			ORAU[d]	1.4 ± 0.4	1.7 ± 1.3	1.2 ± 0.5
	105	N2020, 1200	BNI	1.1 ± 0.2	2.5 ± 2.2	1.6 ± 0.4
			ORAU	0.9 ± 0.3	2.1 ± 1.5	1.3 ± 0.6
	117	N2030, E1230	BNI	1.0 ± 0.2	<MDA	0.9 ± 0.4
			ORAU	0.9 ± 0.2	1.7 ± 1.4	1.1 ± 0.04
	146	N2070, E1050	BNI	1.1 ± 0.2	1.3 ± 1.8	1.0 ± 0.04
			ORAU	1.3 ± 0.2	1.8 ± 1.4	1.2 ± 0.5
	346	N2070, E1110	BNI	1.2 ± 0.4	<MDA	1.6 ± 0.4
			ORAU	2.1 ± 0.4	1.7 ± 2.8	1.1 ± 0.7
	325	N2130, E1010	BNI	0.7 ± 0.2	<MDA	0.6 ± 0.2
			ORAU	0.9 ± 0.3	1.9 ± 0.8	1.1 ± 0.3
	28	N2130, E1230	BNI	1.0 ± 0.2	3.2 ± 3.6	1.0 ± 0.4
			ORAU	0.9 ± 0.2	1.9 ± 0.8	1.1 ± 0.3

[a] Uncertainties represent the 95 percent confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10 percent have not been propagated into these data.
[b] Bechtel National, Inc. (BNI)
[c] minimum detectable amount (MDA)
[d] Oak Ridge Associated Universities

Source: ORAU 1989

Table 15. VP-H' Cinder Removal Data

Location		Radionuclide Concentration (pCi/g)		
N	**E**	**Ra-226**	**U-238**	**Th-232**
1937	1125	1.4 ± 0.3	1.4 ± 1.6	0.7 ± 0.3
1940	1122	1.2 ± 0.2	1.6 ± 0.9	1.1 ± 0.4
1940	1128	1.1 ± 0.3	1.6 ± 1.2	1.2 ± 0.4
1943	1125	0.5 ± 0.3	0.6 ± 1.7	0.6 ± 0.3

Source: ORAU 1989

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Attachment I

Correspondence from Department of Energy Schenectady Naval Reactors Office to New York Department of Health

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Department of Energy
Schenectady Naval Reactors Office
Post Office Box 1069
Schenectady, New York 12301-1069

REC&SD:DAD05-27

AUG 1 0 2005

Mr. Stephen Gavitt
Assistant Bureau Director
Bureau of Environmental Radiation Protection
New York State Department of Health
547 River Street
Troy, New York 12180-2166

Dear Mr. Gavitt:

Subject: **KAPL RADIOACTIVE WASTE INFORMATION RELATED TO THE LAKE ONTARIO ORDNANCE WORKS**

In our telephone conversation of July 8, 2005, you requested information and available documents on Knolls Atomic Power Laboratory (KAPL) radioactive waste that was stored at the Lake Ontario Ordnance Works (LOOW) during the 1950s. In particular, you were interested in any records documenting that the KAPL waste was shipped from LOOW to Oak Ridge. I have attached the documents we have located that are responsive to your request.

For background, from 1952 to 1954, KAPL shipped radioactive waste to LOOW as directed by the Atomic Energy Commission (AEC) and later the Department of Energy. The limited records available from this period indicate that a large portion of the KAPL waste from this time period was associated with the Separations Process Research Unit (SPRU), an AEC pilot plant for developing methods for extracting fissionable material from irradiated uranium.

These documents provide information on the number and types of radioactive waste containers sent to LOOW. Several of these documents also provide information on the subsequent shipment of the KAPL waste at LOOW to Oak Ridge in 1958. The information in the documents indicates that the large majority of the radioactivity in the waste was fission product radioactivity. Of all the waste shipped from KAPL, only a small fraction of the containers had waste containing residual separated plutonium associated with SPRU work, which was a very small fraction of the total radioactivity.

In addition to the documents themselves, I have attached a brief summary sheet for each document commenting on the significance of that document to your request. If you have any questions on the attached information, please contact my office.

Sincerely,

ORIGINAL SIGNED BY

J. Hughes Robillard, Director
Radiological/Environmental Controls
and Safety Division

Attachments:

(1) USAEC Schenectady Operations Office Letter (Batza) to KAPL (Perleberg), dated October 13, 1954, "KAPL Radioactive Waste Presently Stored at LOSA"

(2) KAPL letter (Perleberg) to USAEC Schenectady Operations Office (Anderson), dated October 26, 1954, "KAPL Radioactive Waste at LOSA"

(3) KAPL letter (Manieri to Collins) dated December 2, 1954, "Estimated Curies Activity Shipped from LOAS from KAPL"

(4) KAPL letter (Manieri) to Oak Ridge National Laboratory (Witkowski), dated January 29, 1958, "Radioactive Waste Shipment from Model City, New York"

(5) Hooker Electrochemical Company letter (Seager) to KAPL (Manieri), dated February 14, 1958, "Radioactive Waste Shipment from Model City, New York"

(6) Hooker Electrochemical Company letter (Seager) to Oak Ridge National Laboratory (Witkowski), dated June 26, 1958, "Radioactive Waste Shipment from Model City, New York"

(7) KAPL letter (Manieri) to Virginia Military Institute (Morgan), dated August 18, 1961, "Data on KAPL's Radioactive Waste Disposal"

(8) Paper on LOOW Waste from KAPL files, date unknown

AUG 1 0 2005

bcc: Michelle Rhodes, USACE
W. N. Perry, DOE-Oak Ridge
S. B. Feinberg, DOE-SPRU

Attachment (1)

USAEC Schenectady Operations Office Letter (Batza) to KAPL (Perleberg), dated October 13, 1954, "KAPL Radioactive Waste Presently Stored at LOSA"

KAPL sent radioactive waste to LOOW (also known as Lake Ontario Storage Area or LOSA) from January 22, 1952 to September 9, 1954. This USAEC Schenectady Operations Office letter addressed to KAPL states that a memorandum was received by Oak Ridge stating that future storage of KAPL waste at LOOW would not be permitted. It also stated that it was necessary for Oak Ridge to take steps to reduce to a minimum the hazard potential of materials presently stored at the Niagara Falls site. KAPL was requested to provide information on the waste shipments made to LOOW. Attachment 2 is the response to this request.

UNITED STATES
ATOMIC ENERGY COMMISSION
SCHENECTADY, NEW YORK

ADDRESS REPLY TO:
THE MANAGER
U. S. ATOMIC ENERGY COMMISSION
P. O. BOX 1069
SCHENECTADY, NEW YORK
AND REFER TO:

TAD:AAB

RECEIVED
OCT 14 1954
C. N. PERLEBERG

October 13, 1954

General Electric Company
Knolls Atomic Power Laboratory
Schenectady, New York

Attention: Mr. C. N. Perleberg

Subject: KAPL RADIOACTIVE WASTE PRESENTLY STORED AT LOSA

Gentlemen:

A memorandum has been received from Oak Ridge advising this office that future storage of KAPL waste at LOSA would not be permitted. This memo indicated that it is necessary for Oak Ridge to take steps to reduce to a minimum the hazard potential of materials presently stored at the Niagara Falls site.

It was requested that specific information concerning the amounts and specifications of each of the waste shipments made to LOSA be furnished as soon as possible. It would be appreciated greatly if you would forward this data if it is available.

Very truly yours,

A. A. Batza, Chief
SF Accountability and
Special Materials Branch

RECEIVED
OCT 15 1954
UTILITIES UNIT

Attachment (2)

KAPL Letter (Perleberg) to USAEC Schenectady Operations Office (Anderson), dated October 26, 1954, "KAPL Radioactive Waste at LOSA"

This letter is the KAPL response to the AEC request in Attachment (1).

Seven shipments were made to LOOW between January 22, 1952 and September 9, 1954. It is stated in the letter that KAPL did not keep a log of the items listing the contents of each container in detail. However, the number and type of boxes or drums are listed.

October 26, 1954

Mr. J. D. Anderson, Manager
Schenectady Operations Office
U. S. Atomic Energy Commission
Knolls Atomic Power Laboratory
Schenectady, N. Y.

Attention: Mr. A. A. Batza

Subject: KAPL Radioactive Waste at LOSA.

Dear Sir:

Complying with your request of October 13 there is attached a list of the items which have been shipped to LOSA since January 1952 when the first shipment was made according to our records. We have not kept a log of the items showing the contents of each container in detail.

If an inventory is desired, it should be taken from the markings on the containers at LOSA. At the time of shipment, each container is so labeled, along with the radiation level. The latter will be lower now in cases of short half-life contamination.

Very truly yours,

C. N. Perleberg, Manager
MAINTENANCE & UTILITIES SUB-SECTION

CNP/RFW/meh
Attach.

bcc: ES Collins
RF Wyer

The following material was shipped to LOSA on January 22, 1952:

2	1½ x 1½ x 2 ft. waste boxes
1	2 x 2 x 2 waste box
1	2 x 2 x 8 ft. waste box
1	4 x 6 x 12 waste box
202	4 x 4 x 4 waste boxes
31	30 gal. s/s drums
61	55 gal. s/s drums
99	70 gal. s/s drums
217	55 gal. c/s drums
9	275 gal. storage tanks

The following material was shipped to LOSA on October 16, 1952:

26	4 x 4 x 4 boxes containing plastic tubing, contaminated clothing and rubbers, assorted pieces of steel, galvanized copper, and stainless steel pipe and contaminated concrete, dirt and paper ashes
9	boxes pipe
6	boxes ashes
5	boxes metal dust work
2	boxes machinery
84	boxes baled paper, scrap glass-fiber and CWS filters, scrap metal, glass dirt, ashes, rubbers and clothing
6	bales honeycomb
29	bales CWS filters
15	bales paper
7	bales scrap

The following contaminated waste material was shipped starting August 27, 1953:

97	4 x 4 x 4 boxes misc. contaminated waste material
13	pallets of contaminated baled paper
2	boxes 42 x 26 x 26 contaminated waste material
1	box 89 x 26 x 48 misc. contaminated waste material
1	box 50 x 34 x 36 misc. contaminated waste material
1	box 66 x 30 x 46 misc. contaminated waste material
38	pallets, 4 ballels per pallet, of liquid contaminated waste material
26	pallets contaminated filters
21	boxes assorted sizes of misc. contaminated waste material
2	pallets (5 gal. cans) contaminated waste material
22	pallets (55 gal. drums) contaminated slurry
1	pallet (15 gal. drums) contaminated liquid waste material
96	drums liquid contaminated waste

The following material was shipped to LOSA April 16, 1954:

80	4 x 4 x 4 boxes misc. contaminated waste material
16	boxes 4 x 4 x 4 containing baled paper
42	boxes misc. contaminated waste

The following material was shipped to LOSA April 23, 1954:

38 boxes 4 x 4 x 4 misc. contaminated waste material

The following material was shipped to LOSA June 4, 1954:

36 4 x 4 x 4 misc. contaminated waste material
6 pallets, four 55 gal. drums each pallet, contaminated oil
12 boxes baled paper
3 boxes filters
7 4 x 4 x 4 misc. scrap

The following material was shipped to LOSA September 9, 1954:

14 pallets, 4 ballels per pallet, contaminated waste material
39 boxes 4 x 4 x 4 misc. contaminated waste material
2 boxes 4 x 2 misc. contaminated waste material
1 box 6 x 6 misc. contaminated waste material
17 boxes 4 x 2 CWS filters
1 box 6 x 6 x 8 containing desk and tools from HML
1 box 6 x 4 x 8 containing 1 bench, tools, and misc. items from HML

Attachment (3)

KAPL Internal Letter (Manieri to Collins) dated December 2, 1954, "Estimated Curies Activity Shipped from LOAS from KAPL"

This internal letter provides the estimated curies of waste shipped to LOOW. (Note that the letter uses the acronym LOAS for LOSA.) It was estimated that 408.08 Ci of MFP and 0.63 Ci of Pu was shipped.

In the SPRU pilot plant, irradiated uranium from Hanford was dissolved and processed to extract plutonium and uranium. The resulting liquid waste was processed by evaporation to concentrate most of the radioactivity in a slurry form. This radioactive slurry would contain fission product radioactivity as well as some residual plutonium not extracted by the SPRU process. This slurry would have accounted for most of the radioactivity in the KAPL waste. Thus, this 1954 KAPL curie estimate was primarily based on the amount of slurry shipped and samples of the slurry material. The curie content of the boxes was based on an assumed average dose rate of 12 mr/hr on the box. The curie content of the boxes is assumed to be entirely mixed fission products.

RECEIVED
DEC 3 1954
UTILITIES UNIT

December 2, 1954

W.S. Collins
E-1 Basement
KAPL

SUBJECT: ESTIMATED CURIES ACTIVITY SHIPPED LOAS FROM KAPL

Approximately 700,000 lbs. of contaminated waste in 16 box cars have been shipped to LOAS since September, 1952.

The above shipment included approximately 675 boxes and 394 slurry drums.

Sample analysis indicates an average of 3.4 curies (mixed fission product) per 150 gallons of slurry or .023 curies per gallon.

394 slurry drums X 50 gal/drum = 17,700 gal. of slurry.

.023 curies/gal. X 17,700 gal. slurry = 407.1 curies of mixed fission product.

Assume an average of 12 mr/hr. per box. 675 boxes x 12 mr/hr = 8100 mr/hr.

8.3 R/hr. = 1 curie activity
8.1 R/hr. = 0.98 curie activity
8.3 R/hr.

Assume - 407.10 in slurry drum
0.98 in waste boxes
408.08 curies (mixed fission product)

Estimated curies activity of Plutonium. Sample analysis indicates an average of 0.025 gram Plutonium per drum.

394 drums x .025 g/drums = 9.85 g/total pu.

1.4×10^{11} = d/m/g of pu.

$1.4 \times 10^{11} \times 9.85 = 1.38 \times 10^{12}$ d/m/394 drums

$\frac{1.33 \times 10^{12}}{2.2 \times 10^{12}}$ = 0.63 curies pu/394 drums
d/m/curies

	407.10	in slurry drums
	0.98	in waste boxes
	408.08	curies (mixed fission products)
	0.63	curies pu/394 drums
Total curies activity	408.71	

The above report is based on assumption and also on sample analysis of the slurry.

D.A. Manieri, Foreman

UTILITIES OPERATIONS SUB-UNIT
KAPL

DAM:sjp

cc: RF Wyer
CH Perleberg
WH Truran
File

Attachment (4)

KAPL Letter (Manieri) to Oak Ridge National Laboratory (Witkowski), dated January 29, 1958, "Radioactive Waste Shipment from Model City, New York"

This letter discusses a shipment of three railcars of KAPL radioactive waste from LOOW to Oak Ridge National Laboratory scheduled for January 31, 1958. This letter also states that Hooker Electrochemical Company personnel are planning to incinerate KAPL's combustible waste now in storage at Model City. The ashes and miscellaneous non-combustible materials were to be packaged to meet I.C.C. regulation and included in the next shipment to Oak Ridge. Attachments 5, 7, and 8 indicate this plan was followed.

A listing of the containers, contents, dose rates and weights in each box car is provided. Six different categories of contents are described in this listing. One of these categories is described as "Pu waste" composed of all materials contaminated with Pu. This type of waste was put into one gallon cans and then into drums. The remaining five waste categories included primarily fission product radioactivity. One of the three railcars on this list was ATMX 208. There was a note under the packing list for this railcar stating that 16 additional pallets would be loaded into this railcar. The packing list in the document forwarded to SNR by Mr. Gavitt also was for the ATMX 208 railcar. This second list included more material than in the list in the attached document and apparently includes the additional waste material indicated in the note.

It is noteworthy that only 5 of the 134 pallets and none of the boxes listed in this shipment were Pu waste. This is consistent with only a small fraction of the KAPL waste material being plutonium contaminated waste. Furthermore, the description of the plutonium contaminated waste indicates that it was double encapsulated, first in paint cans and then in drums. This material would have been less likely to leak during storage than the more highly radioactive, semi-liquid "slurry" waste which was not noted as being double encapsulated.

This letter, along with some of the subsequent letters, indicates that KAPL was aware of the shipment of KAPL waste from LOOW to Oak Ridge and played some role in assisting with arrangements for that transfer.

GENERAL ELECTRIC

Knolls Atomic Power Laboratory
Schenectady, New York

January 29, 1958

Mr. E.J. Witkowski
Oak Ridge National Laboratory
Oak Ridge, Tennessee

Gentlemen:

Subject: Radioactive Waste Shipment from Model City, New York

Confirming our telephone conversation of January 29, 1958 attached is a list of items which Hooker Electrochemical Company is including in the three (3) carload shipments of radioactive waste material scheduled for shipment on January 31, 1958.

Mr. F.W. Malone, Chief AEC Niagara Falls Branch will advise you by phone exactly what day the shipment will leave Model City, New York. In addition, he will make arrangements to route the waste shipment to the Y-12 siding on the L & N railroad as per your request.

In the very near future (six to eight weeks) the Hooker Electrochemical Company personnel are planning to incinerate KAPL's combustible waste now in storage at Model City, New York. The ashes and the misc. non-combustible materials will be packaged to meet I.C.C. regulation and be included in the next waste shipment to Oak Ridge.

As in the past, a list of materials including dose rates, description and weights that will be put into each box car will be forwarded to you with our shipping documents. In addition, an itemized list of materials will be tacked inside of each box car shipped to assure for continued safe handling of our loadings and for your guidance at Oak Ridge burial grounds.

KAPL and the Hooker Electrochemical Co. appreciate your cooperation and trust that this shipment will run as smoothly as the past operations. If Oak Ridge has any questions regarding the plan or schedule, please do not hesitate to advise this section.

Very truly yours,

D A Manieri

D.A. Manieri, Foreman
Radioactive Waste
OPERATION & MAINTENANCE

DAM/cmp
Attachment

Distribution
W.F. Trolenberg - SCO
[illegible] - KAPL
[illegible] - AEC,D.C.
[illegible] - KAPL
B. Ball - SCO
[illegible] Schoen - Oak Ridge CO
L. Cherubin - KAPL
[illegible] - Oak Ridge CO
F.W. Malone AEC Niagara [illegible]
J.D. Sweeney Hooker [illegible]
J. Hanner Hooker [illegible]

Radioactive Waste Material
In Box Cars for Disposal
AT
OAK RIDGE NATIONAL LABORATORY

Car #ATMX 207

Qty	Containers	Material	Max. Dose Rate	Max. Weight
9 Pallets	65 gal. s/s drum	Slurry	50 mr/hr.	2800#/pallet
2 "	55 " " "	"	50 "	2000 "
1 "	55 " " "	"	100 "	1000 "
1 "	55 " " "	"	80 "	1000 "
1 "	55 " " "	"	95 "	2000 "
1 "	55 " c/s "	PU	40 "	1000 "
3 "	65 " s/s "	Slurry	20 "	2800 "
6 "	55 " " "	"	40 "	2000 "
24 "	55 " " "	"	80 "	2000 "

Car #ATMX 209

9 Pallets	55 gal. c/s drum	Cont. oils	10 mr/hr.	2000#/pallet
8 "	55 " s/s "	Slurry	120 "	2000 "
6 "	65 " " "	"	90 "	2800 "
4 "	55 " c/s "	Solid Waste	200 "	1000 "
4 "	55 " " "	PU	10 "	1000 "
4 "	55 " " "	Oils	6 "	2000 "
2 "	55 " s/s "	Slurry	50 "	2000 "
2 "	65 " c/s "	Cont. ashes	6 "	2000 "
4 "	55 " s/s "	Slurry	180 "	2000 "
5 "	55 " c/s "	Solid Waste	150 "	1000 2

Car #ATMX 208

5 Pallets	65 gal s/s drum	Slurry	20 mr/hr.	2800#/pallet
4 "	55 " c/s "	Oils	10 "	2000 "
11 "	55 " s/s "	Slurry	500 "	2000 "
4 Boxes	4' x 3' x 2'	Misc. Scrap	6 "	300#/box
1 Pallet	55 gal. c/s drum	Solid Waste	3000 "	1000#/pallet
1 "	55 " s/s "	Slurry	800 "	2000 "
2 "	65 " c/s "	Misc. Waste	30 "	2000 "
4 "	30 " s/s "	Slurry	40 "	1500 "

Note: 16 additional pallets of drums will be loaded and monitored into this car by the Hooker Electrochemical Co. personnel.

Monitoring Results:
External radiation

Car ATMX 207) 10 mr/hr. at 12 ft. from outer surface of box car - 10 mr/hr. at 5 ft.
Car ATMX 209) at ends of box car.

Car ATMX 208 - Will be monitored by Hooker personnel when loading is completed

Identification

Since some of this material has been in storage since 1952, we have re-surveyed and color coded radiation readings on each container for your guidance.

Yellow - L - indicates maximum reading 50 mr/hr.

Blue - M - indicates maximum reading 200 mr/hr.

Red - H - indicates maximum reading 1000 mr/hr.

Readings greater than 1 R/hr. have been identified in Red by the actual radiation readings on container.

All containers are palletized and banded four to a pallet.

Materials:

Miscellaneous Scrap is composed of materials contaminated with low level fission products, such as air filter, glass, metals, wood and all materials that cannot be baled.

Baled Materials are complosed of dry waste, such as paper, rags, floor sweepings, gloves, lagging, etc., contaminated with low level fission products

Solid Waste is composed of high level fission products and includes both miscellaneous scrap and baled materials

PU Waste is composed of all materials contaminated with PU. This type of waste is put in one gallon cans and then into drums.

Slurry is composed of evaporator bottoms, neutralized and contaminated with high level fission products.

Oils are composed of degreasing fluid and cutting oils, contaminated with low level fission products.

DAM/[illegible]

Attachment (5)

Hooker Electrochemical Company Letter (Seager) to KAPL (Manieri), dated February 14, 1958, "Radioactive Waste Shipment from Model City, New York"

This letter discusses the Bill of Materials for shipment for the 4th rail car. It also states that burning of the Schenectady waste material is scheduled to start February 19.

A listing of the containers, contents, dose rates and weights in the box car is provided. There was no "Pu waste" listed in this railcar shipment. The Hooker letter comments that the "results" from this railcar are quite a bit higher than previous readings. This apparently refers to the fact that both the average radiation level on individual pallets as well as the railcar are higher than those listed for the three railcars in the previous shipment. This is unsurprising as this railcar contained mostly pallets of the highly radioactive slurry.

It is believed that the "HESL personnel" mentioned in this letter are from the AEC Health and Safety Laboratory in New York City.

HOOKER ELECTROCHEMICAL COMPANY
NIAGARA FALLS
NEW YORK
Contract No. AT-(30-1)-1524

February 14, 1958

D. A. Manieri
Foreman, Radioactive Waste Material
Knolls Atomic Power Laboratory
Schenectady, New York

Subject: RADIOACTIVE WASTE SHIPMENT FROM MODEL CITY, NEW YORK

Dear Don:

The enclosed Bill of Material shows the results for our fourth car. This was quite a bit higher than we found on previous readings.

The burning of Schenectady waste material is scheduled to start February 19. HESL personnel are due here Tuesday the 18th to lay out the project. Everything should be ready Wednesday. Come up if you can.

Regards,

Paul Seager

Paul Seager
Plant 31

PS:jc
Enclosure

L. Manieri

February 14, 1958

RADIOACTIVE WASTE MATERIAL IN BOX CAR-SAL 10063

ITEMS	DESCRIPTION	MATERIALS	MAX. DOSE RATE	MAX. WEIGHT
4-Pallets	65 gal-c/s Capsules	U. Residue	5 mr/hr	1000#/pallet
4-Pallets	55 gal-c/s Drums	Oils	10 mr/hr	2000#/pallet
2-Pallets	65 gal-s/s Drums	Slurry	10 mr/hr	2800#/pallet
3-Pallets	35 gal-s/s Drums	Slurry	10 mr/hr	1000#/pallet
1-Pallet	20 gal-s/s Drums	Slurry	10 mr/hr	500#/pallet
4-Pallets	55 gal-s/s Drums	Slurry	150 mr/hr	2000#/pallet
1-Pallet	55 gal-s/s Drums	Slurry	250 mr/hr	2000#/pallet
3-Pallets	55 gal-s/s Drums	Slurry	300 mr/hr	2000#/pallet
4-Pallets	55 gal-s/s Drums	Slurry	510 mr/hr	2000#/pallet
1-Pallet	65 gal-c/s Capsule 35 gal-s/s Inside	Slurry	10 mr/hr	1000#/pallet
1-Pallet	65 gal-c/s Capsule	KAPL Waste & Gaps Inside	200 mr/hr	2000#/pallet
2-Pallets	55 gal-c/s	KAPL Waste	450 mr/hr	2000#/pallet
1-Pallet	55 gal-c/s	KAPL Waste	1 R/hr	2000#/pallet
1-Pallet	55 gal-c/s	KAPL Waste	3 R/hr	2000#/pallet
1-Pallet	55 gal-c/s	KAPL Waste	7 R/hr	2000#/pallet
1-Pallet	55 gal-s/s & c/s	Slurry & Oil	200 mr/hr	2000#/pallet
5 Boxes	4' x 3' x 2'	Misc. Scrap	10 mr/hr	300#/Box
3 Boxes	4' x 3' x 2'	Filters	110 mr/hr	300#/Box

Identification:

All Drums have been re-surveyed and identified as follows:

Yellow "L" indicates Maximum reading of 50 mr/hr
Blue "M" " " " " 200 mr/hr
Red "H" " " " " 1000 mr/hr

Drums are Palletized and banded four to a Pallet.

Material:

Solid Waste - Composed of high level mixed fission product and includes miscellaneous scrap.

Slurry - Composed of high level mixed fission product from evaporator bottoms from KAPL Liquid Waste Process.

Pu - Composed of all materials contaminated with Plutonium or Thorium. This type of waste is packaged into 1 gallon paint cans, and placed into carbon steel drums.

Oils - Ashes - Contaminated with low level mixed fission products.

U Residue - Uranium residue, formerly packaged in 5 gal. can, packed in 65 gal. c/s capsules.

Filters - Spun glass air filters packed in wooden boxes.

Gaps - Cesium and strontium gaps capsuled in 65 gal. c/s drums.

Continued.....

Monitoring Results:

External Radiation

30 mr/hr at 12 ft. from outer surface of sides.

[illegible] mr/hr at 5 ft. from ends of box car.

Paul Seager

Paul Seager

jc

Attachment (6)

Hooker Electrochemical Company Letter (Seager) to Oak Ridge National Laboratory (Witkowski) dated June 26, 1958, "Radioactive Waste Shipment from Model City, New York"

This letter discusses Bills of Materials for a two rail car shipment on or about June 26. The contents in each box car is provided. The box cars only contained wood boxes, and no "Pu waste" is listed.

RECEIVED
JUL 16 1958
D. A. MANIERI

Contract No. AT-(30-1)-1524

June 26, 1958

Mr. E. J. Witkowski
Oak Ridge National Laboratory
Oak Ridge, Tennessee

Subject: Radioactive Waste Shipment From Model City, New York

Dear Sir:

Enclosed are the Bills of Materials for cars ATMX 208 & 209 which will be shipped on or about June 26. The radiation monitoring results are noted and the cars are placarded.

A copy of this Bill of Material is being sent to D. Manieri at KAPL for his records.

Very truly yours,

Paul Seager

Paul Seager
Design Engineer
P-31

PS:km
cc: D.A. Manieri KAPL
F.W. Malone NF-AEC
J.D. Sweeney HEC
P. Seager HEC

Contract No. AT-(30-1)-1524

June 26, 1958

RADIOACTIVE WASTE MATERIAL
IN BOX CAR ATMX 209
DISPOSAL AT ORNL

ITEMS	DESCRIPTION	MATERIALS	MAX. WEIGHT
30 Boxes	Wood	Misc. Scrap	750 #/Box

Total 30 Boxes

Estimated weight of car load 22,500#

Monitoring Results:

Containers should not exceed 200 mr/hr

External Radiation

10 mr/hr at 12 ft. from outer surface of box car sides.

10 mr/hr at 5 ft. from ends of box car.

Paul Seager
Paul Seager
Design Engineer
Plant - 31

km

Contract No. AT-(30-1)-1524

June 26, 1958

RADIOACTIVE WASTE MATERIAL
IN BOX CAR ATMX 208
DISPOSAL AT ORNL

ITEMS	DESCRIPTION	MATERIALS	MAX. WEIGHT
47 Boxes	Wood	Misc. Scrap	750 #/Box

Total 47 Boxes

Estimated weight of car load 35,250#

Monitoring Results:

Containers should not exceed 200 mr/hr

External Radiation

10 mr/hr at 12 ft. from outer surface of box car sides.

10 mr/hr at 5 ft. from ends of box car.

Paul Seager

Paul Seager
Design Engineer
Plant - 31

km

Attachment (7)

KAPL Letter (Manieri) to Virginia Military Institute (Morgan) dated August 18, 1961, "Data on KAPL's Radioactive Waste Disposal"

From the first and last paragraphs of this letter, it appears that the addressee and a Mr. Costello were working on a technical paper and had requested information on all KAPL waste shipments up to the time of the letter. The KAPL reply indicated that the first shipment of KAPL waste to LOOW for storage started in 1952, and that the first shipment from KAPL to Oak Ridge was in 1955. The letter listed the dates, number of railcars, and volume of KAPL waste sent to Oak Ridge in FY 1958 both from KAPL and from LOOW. This list included six shipments and a total of 11 railcars for the waste sent from LOOW to Oak Ridge National Laboratory as follows:

Date	Freight Cars Shipped	Volume (cubic feet)
January 30, 1958	3	9,186
April 30, 1958	2	6,124
May 7, 1958	2	6,124
May 14, 1958	1	3,062
May 19, 1958	1	3,062
May 29, 1958	2	6,124

However, this list does not appear to include the shipment of one rail car in February 1958 shown in Attachment (5) and the shipment of two rail cars in June 1958 shown in Attachment (6). With these additional shipments, there would be a total of eight shipments and 14 rail cars.

This letter also notes that KAPL assisted in packaging and shipping of the waste from LOOW to Oak Ridge National Laboratory. To the author's (Manieri's) knowledge the Hooker Electrochemical Company under the direction of the AEC New York Operations Office, incinerated all of KAPL's combustible waste. The letter also states: "The ashes with the noncombustible materials were packaged and are included in the 1958 FY shipment to Oak Ridge National Laboratory for permanent burial."

This 1961 letter, coming three years after the 1958 shipments from LOOW to Oak Ridge, appears to reflect the understanding of the KAPL personnel involved that the shipment of KAPL waste from LOOW to Oak Ridge had in fact been completed.

August 18, 1961

Virginia Military Institute
Lexington, Virginia

Attention: Mr. J. M. Morgan, Jr.

Subject: Data on KAPL's Radioactive Waste Disposal

Gentlemen:

In reference to your letter dated August 10, 1961 requesting the gross volume of low and intermediate level solid waste packaged and shipped off site from the Knolls Atomic Power Laboratory since the late 1940's, our records reveal that the first shipment from KAPL to A.E.C. for temporary storage was made on October 16, 1952. The first shipment of KAPL Radioactive Waste to Oak Ridge National Laboratory for permanent burial was made on March 17, 1953.

During Fiscal Year 1958, the following waste shipments were made to Oak Ridge National Laboratory for permanent burial.

Date	Freight Cars Shipped	From	To	Volume Cu. Ft.
Nov. 1, 1957	3	KAPL	ORNL	10,534
May 5, 1958	3	KAPL	ORNL	8,040
Jun. 30, 1958	3	LORA	ORNL	9,186
Apr. 30, 1958	2	LORA	ORNL	6,124
May 7, 1958	2	LORA	ORNL	6,124
May 14, 1958	1	LORA	ORNL	3,062
May 19, 1958	1	LORA	ORNL	3,062
May 29, 1958	2	LORA	ORNL	6,124
			Total	52,256

In 1958, I had the opportunity to visit LORA at Model City, New York to assist in packaging and shipping of KAPL's waste material. To my knowledge, The Linde Electrochemical Company personnel, under the direction of the New York Operation Office, incinerated all of KAPL's combustible waste. The cubic with the noncombustible materials were packaged and are included in the 1958 FY shipment to Oak Ridge National Laboratory for permanent burial.

To complete waste shipment data for Fiscal Year 1961, the following waste material was shipped to Oak Ridge National Laboratory for permanent burial.

Date	Freight Cars Shipped	From	To	Volume Cu. Ft.
Sept. 1960	12	KAFL	ORNL	21,500
Apr. 1961	5	KAFL	ORNL	14,006
			Total	35,506

Attached is a sketch of our standardized palletized 4' x 4' x 8' ply wood boxes, for which Bureau of Explosive Permit No. 1120 has been obtained and which is utilized for packaging most combustible and noncombustible waste generated at the Laboratory.

The second sketch is a palletized 4' x 4' x 8' concrete container for which we are now in the process of obtaining an I.C.C. Bureau of Explosive permit. This container, when shielded with earth and capped with concrete, will be utilized to package and ship our intermediate and high level radioactive waste material that is generated at the Laboratory.

We hope that the above information will assist you and Mr. D. C. Costello in preparing your paper at Chalk River, Canada. If we can be of further assistance in this matter, please do not hesitate to notify this section.

Very truly yours,

D. A. Manieri, Foreman
Radioactive Wastes
OPERATION & MAINTENANCE

DAMang

cc: B. M. Ball
B. J. Feinberg
L. J. Chambin
D. C. Costello - AEC - Washington

Attachment (8)

Paper on LOOW Waste from KAPL Files, date unknown

This undated and unsigned document was found in the files of an engineer who worked on radioactive waste from the 1950s through the 1980s. The date or reason it was created is not known. This document states that 8 shipments and 14 box cars of waste were shipped from LOOW to Oak Ridge. This total is consistent with the of shipments and railcars listed in Attachment (7) supplemented by the additional shipments documented in Attachments (5) and (6). It also provides additional indication that cognizant KAPL personnel understood that all of the KAPL waste stored at LOOW was shipped to Oak Ridge in 1958.

LOOW

CONTAINERS	7 Shipments (1952-54) SHIPPED TO LOOW FROM KAPL	8 Shipments - 14 Box Cars (1958) SHIPPED FROM LOOW TO OAK RIDGE
Bales - combustible	57	12 4' x 3' x 2' Wood Boxes
Pallets - combustible	91	346 Wood Boxes
Misc. wood boxes	184	Combustibles incinerated
Boxes - Wood 1½' x 1½' x 2'	2	during 1952-1958 - Ash
Boxes - Wood 2' x 2' x 2'	1	packaged in 70 or 55
Boxes - Wood 2' x 2' x 8'	1	gallon drums.
Boxes - Wood 4' x 6' x 12'	1	
Boxes - Wood 4' x 4' x 4'	541	
Boxes - Wood 42" x 26" x 26"	2	
Boxes - Wood - 89" x 26" x 48"	1	
Boxes - Wood - 50" x 34" x 36"	1	
Boxes - Wood - 66" x 30" x 46"	1	
Boxes - Wood - 4' x 2'	2	
Boxes - Wood - 6' x 6'	1	
Boxes - Wood - Filters	17	
Boxes - Wood - 6' x 6' x 8'	1	
Boxes - Wood - 6' x 4' x 8'	1	
Drums - 30 Gal.	31	32
Drums - 55 Gal.	486	580
Drums - 65/70 Gal.	99	345
Drums - 5 Gal.	2 Pallets	May have been repackaged
Drums - 15 Gal.	1 Pallet	May have been repackaged
275 Gal. Storage Tanks	9	May have been decontaminated and reused.

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Attachment II

Nuclear Facility Historical Site Assessment for the Separations Process Research Unit (SPRU) Disposition Project, 2006
(partial report)

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EM U.S. Department of Energy
Office Of Environmental Management

Nuclear Facility Historical Site Assessment for the Separations Process Research Unit (SPRU) Disposition Project

April 2006

Prepared for
U.S. Department of Energy
Office of Environmental Management
SPRU Project Office

Prepared by
Environmental Resource Group, LLC

Contract Number: DE-AM09-03SR22289
Task Number: DE-AT09-03SR22377

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1.0 ACRONYMS AND GLOSSARY

UNITS OF MEASURE

centi	hundred, or hundredth part
Ci	Curie
Ci/ml	Curie per milliliter
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
cpm corr	corrected counts per minute
CW	closed window
dpm	disintegrations per minute
F	Fahrenheit
ft	foot, feet
ft^2	square feet
ft^3	cubic feet
g	gram
gal	gallon, gallons
gpm	gallons per minute
HP	horsepower
hr	hour
in	inch(es)
in^2	square inch(es)
kg	kilogram
kilo	thousand
l	liter
MDA	minimum detectible activity
micro	millionth
milli	thousandth
min	minute
ml	milliliter
mR	milliRoentgen
mrad	millirad
mRem	milliRem
mRep	milliRoentgen equivalent physical
nano	thousand millionth
pCi	picoCurie
pico	one trillionth (10^{-12}) part
ppm	parts per million
psig	pounds per square inch gauge
R	Roentgen
rad	radiation absorbed dose
Rem	Roentgen equivalent man
Rep	Roentgen equivalent physical
sq ft	square feet (foot)
µCi	microCurie
µCi/cc	microCurie per cubic centimeter
µCi/ml	microCurie per milliliter
µg	microgram

ACRONYMS

Ag	silver
Al	aluminum
Am	americium
App.	appendix
B	boron
Ba	barium
BCE	batch count extraction
Be	beryllium
Bi	bismuth
BKC	Blaw-Knox Company
C	carbon
C-(six digit number)	correspondence referenced
Ca	calcium
CCTF	Corrosion Coolant Test Facilities
Cd	cadmium
Ce	cerium
CFR	Code of Federal Regulations
Cl	chlorine
Co	cobalt

corr	corrected [cpm]
Cr	chromium
Cs	cesium
Cu	copper
CW	closed window
DAC	derived air concentration
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
Eu	europium
F	fluorine
Fe	iron
FPCE	Full Core Physics Experiment
FY	fiscal year
GE	General Electric
GM	Geiger-Mueller (detector)
H	hydrogen
HEPA	high efficiency particulate air (filter)
Hg	mercury
HP	horsepower
HSA	historical site assessment
I	iodine
I-(six digit number)	interview referenced
K	potassium
KAPL	Knolls Atomic Power Laboratory
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
Mg	magnesium
Mn	manganese
MPC	Maximum Permissible Concentration
MPC_a	Maximum Permissible Concentration for air
N	nitrogen
Na	sodium
Nb	niobium
Ni	nickel
NNSA	National Nuclear Security Administration
NRC	Nuclear Regulatory Commission
NYSDEC	New York State Department of Environmental Conservation
OW	open window
P	phosphorous
p.	page
Pa	protactinium
Pb	lead
PCB	polychlorinated biphenyls
pp.	pages
Pr	praseodymium
Pu	plutonium
PUREX	plutonium uranium extraction
R-(six digit number)	report reference
Ra	radium
radiac	radioactive detection, identification, and computation
RCRA	Resource Conservation and Recovery Act
REDOX	reduction-oxidation
RML	Radioactive Materials Laboratory
RMP	radiation work permit
Rn	radon
Ru	ruthenium
RWP	radiological work permit
S	sulfur
Si	silicon
S&M	surveillance and maintenance
SPRU	Separations Process Research Unit
Sr	strontium
SWMU	solid waste management unit
TBP	tributyl phosphate
Th	thorium
Ti	titanium
TRU	transuranic
U	uranium
USGS	United States Geological Survey
V-(six digit number)	videotape reference
WBS	work breakdown structure
Y	yttrium
Zn	zinc
Zr	zirconium

GLOSSARY

actinide(s). A group of elements that are very dense, radioactive metals. The elements are actinium, thorium, protactinium, uranium, neptunium, plutonium, americium, curium, berkelium, californium, einsteinium, fermium, mendelevium, nobelium, and lawrencium.

accessible. In this historical site assessment, the term accessible is used to describe areas in Buildings G2, H2, and the pipe tunnels that can be entered without dosimetry, protective clothing, respirators, or supplied clean air. See also "inaccessible."

alpha. A particle emitted from the nucleus of an atom that contains two protons and two neutrons.

aquiclude. A subsurface rock, soil, or sediment unit that does not yield useful quantities of water.

background radiation. Radiation from: (1) naturally occurring radioactive materials which have not been technologically enhanced; (2) cosmic sources; (3) global fallout as it exists in the environment (such as from the testing of nuclear explosive devices); (4) radon and its progeny in concentrations or levels existing in buildings or the environment which have not been elevated as a result of current or prior activities; and (5) consumer products containing nominal amounts of radioactive material or producing nominal amounts of radiation (DOE-STD-1098-99, *Radiological Control* [Change Notice No. 1, June 2004]). Background radiation is typically less than 10 microrad per hour.

beta. A beta is a high-speed particle, identical to an electron, that is emitted from the nucleus of an atom.

cell. A shielded enclosure within a structure where hazardous processes can be remotely controlled and carried out. Cells are typically constructed of thick concrete walls to isolate radioactive materials, and fission products that have high gamma radiation emissions.

closed window (CW). The position that the "sleeve" of a Geiger-Mueller (GM) detector must be in to cover the detector and filter out beta radiation, allowing only gamma and x-ray radiation to be measured.

contamination area. One type of radiologically contaminated area. Others are "radiation area," "high radiation area," "very high radiation area," or "high contamination area." Entry into these areas requires workers to have special training, protective clothing, and a radiological work permit. A contamination area is an area where removable contamination levels (disintegrations per minute/100 cm^2) exceed or are likely to exceed the listed values in Table 2-2 of DOE-STD-1098-99, *Radiological Control* (Change Notice No. 1, June 2004), but less than or equal to 100 times the Table 2-2 values.

corrected counts per minute (cpm corr or ccpm). Counts per minute measured less the average background radiation count. Counts per minute may also be corrected for decay.

crud. A buildup of radiological precipitates in piping or other fluid system components in bends, elbows, tanks, etc.

Curie. A Curie is a measure of radioactivity based on the observed decay rate of approximately 1 gram of radium. The Curie was named in honor of Pierre and Marie Curie, pioneers in the study of radiation. One Curie of radioactive material has 37 billion atomic transformations (disintegrations) in 1 second. It is defined as the number of nuclear transformations occurring per minute. One Curie = 2.22×10^{12} disintegrations per minute.

decommissioning. The process of closing and securing a nuclear facility or nuclear materials storage facility to provide adequate protection from radiation exposure and to isolate radioactive contamination from the human environment.

decontamination. The removal of a chemical, biological, or radiological contaminant from, or neutralizing its potential effect on, a person, object or environment by washing, chemical action,

mechanical cleaning, or other techniques. Decontamination may also include treatment and disposal of wastes generated during decontamination efforts.

derived air concentration (DAC). For the radionuclides listed in Appendix A of 10 CFR 835, the airborne concentration that equals the annual limit on intake (ALI) divided by the volume of air breathed by an average worker for a working year of 2000 hours (assuming a breathing volume of 2,400 cubic meters). For radionuclides listed in Appendix C of 10 CFR 835, the air immersion DACs were calculated for a continuous, non-shielded exposure via immersion in a semi-infinite atmospheric cloud. The values are based upon the derived airborne concentration found in Table 1 of the *U. S. Environmental Protection Agency's Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, published September 1988 (DOE-STD-1098-99, *Radiological Control* [Change Notice No. 1, June 2004]).

exponential notation. The following exponential notations are examples of those used in this document.

$1 \times 10^{4} = 10{,}000$
$1 \times 10^{2} = 100$
$1 \times 10^{0} = 1$
$1 \times 10^{-2} = 0.01$
$1 \times 10^{-4} = 0.0001$

facilon. A durable fiberglass reinforced plastic sheeting material commonly used in radiological contamination controls.

fission product. A usually radioactive isotope produced as a result of the fission of a massive atom such as U-235. The REDOX and PUREX runs for the separation of plutonium and uranium from fission products by solvent extraction were tested in the SPRU Building G2.

fixed contamination. Radioactivity remaining on a surface after repeated decontamination attempts fail to significantly reduce the contamination level.

gamma. Gamma rays are electromagnetic waves or photons emitted from the nucleus (center) of an atom.

high-level radioactive waste. During the years of SPRU research (and for the purposes of this historical site assessment) high-level radioactive waste referred to the liquid waste produced in the G2 process pilot plant that measured 0.05 microCuries or greater per liter. Low-level radioactive waste (less than 0.05 microCuries per liter) included contaminated waste from the laundry and incinerator scrubber. The chemistry laboratories also produced primarily low-level radioactive liquid waste. These high- and low-level waste definitions were used to distinguish waste streams at the time of SPRU operations and do not correspond to present DOE definitions of high- and low-level waste (R-001949, p. 36).

high radiation area. One type of radiologically contaminated area. Others include “radiation area,” “very high radiation area,” “contamination area,” or “high contamination area.” Entry into these areas requires workers to have special training, protective clothing, and a radiological work permit. A high radiation area is an area with dose rates greater than 100 milliRems in one hour 30 centimeters from the source or from any surface through which the ionizing radiation penetrates. Areas at licensee facilities must be posted as “high radiation areas,” and access into these areas is maintained under strict control (DOE-STD-1098-99, *Radiological Control* [Change Notice No. 1, June 2004]).

inaccessible. In this historical site assessment, the term inaccessible is used to describe areas in Buildings G2, H2, and the Pipe Tunnels that cannot be entered without dosimetry, protective clothing, and in some cases, respirators or supplied clean air. See also “accessible.”

interceptor. An interceptor is a plumbing trap that collects particulates and solids in a piping system.

low-level radioactive waste. During the years of SPRU research (and for the purposes of this historical site assessment) low-level radioactive waste (less than 0.05 microCuries per liter) included contaminated waste from the laundry and incinerator scrubber. The chemistry laboratories also produced primarily low-level radioactive liquid waste. High-level radioactive waste refers to the liquid waste produced in the G2 process pilot plant that was 0.05 microCuries or greater per liter. These high- and low-level waste definitions were used to distinguish waste streams at the time of SPRU operations and do not correspond to present DOE definitions of high- and low-level waste (R-001949, p. 36). (See definition of ***radioactive waste***.)

MPCa (Maximum permissible concentration for air)**.** MPCa is the concentration of a radioisotope in air that would lead to an annual dose of 5 Rem due to inhalation of that isotope. This unit was replaced by the derived air concentration (DAC).

non-process areas (versus process areas). Non-process areas are the areas in G2 that were not used to chemically separate plutonium from uranium. The non-process areas are currently accessible.

open window (OW). The position that the "sleeve" of a GM detector must be in to expose the detector. Beta, gamma, and x-ray radiation are measured with an "open window."

picoCurie. A picoCurie is one one-trillionth (1/1,000,000,000,000) of a Curie.

plenum. An air-filled space in a structure that receives air from a blower for distribution (as in a ventilation system).

process areas (versus non-process areas). The SPRU process area (about 7,500 square feet [R-001949, p. 64]) is inaccessible and includes Cells Nos. 1, 2, 3, 4, and 5; Cell Access Corridor, Process and Hot Tunnels, Upper and Lower Sampling Aisles, and the Pipe and Motor Generator Room. These areas were used to chemically separate plutonium from uranium.

protective storage mode. Protection storage mode is a non-operating status with continuing surveillance and monitoring.

PUREX. PUREX is a uranium and plutonium extraction process using a solvent, tributyl phosphate (TBP). SPRU was a PUREX pilot plant.

rad, radiation absorbed dose. The rad is a unit for measuring energy absorbed in any material. Absorbed dose results from energy being deposited by the radiation. It is defined for any material and applies to all types of radiation. It is a measurement of absorbed dose but does not take into account the potential biological effects that different types of radiation have on the human body. Greater than 100 rad must be imparted in a short period over a substantial portion of the body before most individuals will show significant clinical symptoms.

radiac (radioactive detection, identification, and computation)**.** The term refers to the detection and measurement of the intensity of emitted nuclear radiation.

radiation. Radiation is energy in transit in the form of high-speed particles and electromagnetic waves. Electromagnetic waves make up visible light, radio and television waves, ultraviolet, and microwaves, with a large spectrum of energies. These examples of electromagnetic waves do not cause ionizations of atoms because they do not carry enough energy to separate molecules or remove electrons from atoms.

radiation area. One type of radiologically contaminated area. Others include "high radiation area," "very high radiation area," "contamination area," or "high contamination area." Entry into these areas requires workers to have special training, protective clothing, and a radiological work permit. A radiation area is any area with radiation levels greater than 5 milliRems in one hour at 30 centimeters from the source or from any surface through which the radiation penetrates (DOE-STD-1098-99, *Radiological Control* [Change Notice No. 1, June 2004]).

radioactive waste. During SPRU operations, high-level radioactive liquid waste was defined as 0.05 microCuries or more per liter and low-level radioactive waste was defined as less than 0.05 microCuries per liter. Note: These are not current DOE definitions of high and low-level radioactive waste. Per DOE Manual 435.1-1, *Radioactive Waste Management Manual,* (July 9, 1999), high-level waste is the highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations, and other highly radioactive material that is determined, consistent with existing law, to require permanent isolation. Low-level radioactive waste is radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material, or naturally occurring radioactive material.

radiological work permit (RWP). Permit that identifies radiological conditions, establishes worker protection and monitoring requirements, and contains specific approvals for radiological work activities. The radiological work permit is an administrative process for planning and controlling radiological work and informing workers of the radiological conditions (DOE-STD-1098-99, CN1, June 2004).

REDOX (reduction-oxidation). REDOX was a chemical extraction process for separating uranium and plutonium from mixed fission products. SPRU was a REDOX pilot plant. A full-scale REDOX plant was built at the Hanford site in Richland, Washington.

Rem, Roentgen equivalent man. The Rem is a unit for measuring the biological effects of radiation on the human body. It is the most commonly used unit for dose reporting. The Rem takes into account the absorbed dose and the biological effects of different types of radiation. It is a measurement of biological dose equivalence. This unit applies to both internal and external doses.

removable contamination. Radioactivity that can be transferred from a surface to an absorbent material, such as filter paper or cotton swabs, by rubbing with moderate pressure and swabbing an area of at least 100 square centimeters.

Rep, Roentgen equivalent physical. The Rep is an obsolete unit of absorbed radiation dose equal to the absorption of 93 ergs of energy per gram. This is equivalent to 0.93 rad. The definition was made because a dose of 1 rep of beta rays was considered biologically equivalent to a dose of 1 Roentgen of x-rays.

Roentgen. The Roentgen is a unit for measuring ionization caused by gamma/x-rays in air. Therefore, it does not relate to the biological effects of radiation on the human body. It is a measurement of exposure.

SI prefixes. SI stands for "Système International d'Unités," or the international system of units. SI prefixes refer to the way many units are broken down into smaller units or expressed as multiples, using standard metric prefixes. Examples include a millirad (mrad) is 10^{-3} rad, a microRem (μRem) is 10^{-6} Rem, a nanogram is 10^{-9} grams, and a picoCurie is 10^{-12} Curies.

slug. A slug is a lump, disk, or cylinder of metal. During SPRU pilot tests, metal slugs (smaller than 6 inches in diameter) containing uranium and encased in aluminum were separated into plutonium and uranium.

surficial. Surficial means of or pertaining to a surface, especially the land surface: a surficial geologic deposit.

surveillance and maintenance. Periodic inspections and maintenance of structures, systems, and equipment necessary for the satisfactory containment of contamination to protect workers, the public, and the environment.

TBP/diluent. Solvent extraction is a process to recover, purify, or separate metals during liquid extraction. Solvent extraction refers to a process that transfers one or more components between two immiscible (or nearly immiscible) liquid phases. Many solvents can extract uranium, plutonium, or

thorium from acid solutions. One of these solvents is tri-n-butyl phosphate (TBP). The TBP is always diluted in an organic matrix, or diluent, to improve the physical characteristics of the organic phase.

Transuranic (TRU). Transuranics are elements heavier than uranium (e.g., plutonium) with half-lives greater than 20 years and concentrations of more than 100 nanoCuries per gram of waste. All transuranics are man-made alpha-emitters. SPRU operations involved TRU elements.

work breakdown structure (WBS). A deliverable-oriented grouping of project elements that organizes and defines the total scope of the project. Each descending level represents an increasingly detailed definition of a project component. Project components may be products or services. The WBS reflects the way in which project costs and data will be summarized and eventually reported.

2 EXECUTIVE SUMMARY

The *Nuclear Facility Historical Site Assessment for the Separations Process Research Unit (SPRU) Disposition Project* documents the identification, collection, organization, cataloguing, review, and analysis of available information for the SPRU Disposition Project. The SPRU facilities occupy approximately 5 acres on the Knolls Atomic Power Laboratory (KAPL) property in Niskayuna, New York. KAPL is owned by the U.S. government and operated by the U.S. Department of Energy (DOE) Office of Naval Reactors, Schenectady Naval Reactors, and their contractor, KAPL, Inc., a Lockheed Martin Company.

The SPRU Disposition Project includes both the SPRU nuclear facilities and land areas. The land areas are addressed in a separate historical site assessment.

The SPRU facilities were constructed to research the separation of plutonium and uranium from radioactive material encased in aluminum, known as slugs. SPRU operated between February 1950 and October 1953, when research activities ceased following successful development of the reduction oxidation (REDOX) and plutonium uranium extraction (PUREX) processes subsequently used by Hanford and the Savannah River Sites. The research was performed on a laboratory scale; SPRU was never a production plant. Decommissioning of SPRU began in October 1953 and continued through the 1990s. All SPRU facilities are under surveillance and maintenance.

This report organizes and compiles information for the following SPRU facilities:

- Building G2 – contains laboratories, hot cells, separations process testing equipment, and the pipe tunnels in G2
- Building H2 – contains equipment and tanks for liquid waste processing and includes the H2 Pipe Tunnel and H1 Cooling Towers
- Tunnels – contain piping, utilities, and equipment in each building and also connect Buildings G2 and H2 and Buildings G1 and E1
- Tank Farm – contains subsurface tank vaults and tanks along the eastern side of Building H2 for storing liquid waste.

In addition to summarizing the historical documentation, this historical site assessment addresses whether areas are impacted or not impacted by radioactive contamination, the contamination sources, the likelihood of contamination migration, threats to human health, and further characterization needs.

Impacted versus Non-impacted

The SPRU facilities are considered impacted by radioactive contamination above background levels. H2 and G2 have high to very high radiation and contamination areas based on survey data, guidance, and definitions provided in DOE-STD-1098-99, *Radiological Control*, as well as low radiation and contamination areas. The Tunnels and Tank Farm are both considered high radiation and contamination areas.

Sources of Contamination

SPRU processes were a contributor to the contamination in each of the facilities. The SPRU facility decontamination and decommissioning events through at least 1966 also generated radioactive waste. However, non-SPRU KAPL activities in G2, H2, the Tunnels, and the Tank Farm after SPRU decommissioning continued to contaminate these areas. Building H2 was used for waste management at least until 2001, when a new waste management facility at E11 became operational. The Tunnel piping is still used to transport liquid waste.

Likelihood of Contamination Migration

The Tank Farm vaults pose the highest potential for contamination migration relative to the other SPRU facilities. Contaminated water from unknown sources around H2 is collected in the H2 footer drains and treated in the Hillside Drain System. Buildings G2 and H2 are concrete structures with contaminated concrete and abandoned equipment and no evidence of migration from inside the buildings. If the facilities are demolished, a risk of releases to the air and soil exists. There is evidence of prior water seepage into the G2-H2 Tunnel as well as radioactive sludge in the north tunnel sump. There is no evidence that other SPRU areas are probable contamination pathways to the environment.

Natural events such as earthquakes, flooding, fire, or human accident scenarios have the possibility of altering the physical conditions reported in this historical site assessment, including the likelihood of contamination migrating to the environment.

Threat to Human Health

The SPRU facilities are identified and managed as radiological control areas with specific area access restricted as appropriate. Human health risk to the public and current workers is as low as reasonable achievable and is considered negligible. The greatest risk to human health is estimated to be for workers should demolition of the facilities occur, although the risk is considered manageable.

Further Characterization Needs

The Tunnels and the piping in the Tunnels potentially require additional characterization prior to demolition activities. There is little information regarding contamination in the Tunnels and piping. There were interview references to pipes being nearly full of sludge and other references indicating the pipes were flushed to remove residual sludge. Two H2 areas recommended for further characterization include the Hopper Cells and the Pipe Tunnel. The accessible areas of Building G2 were surveyed in 2004, and the Tank Farm tanks and vaults were characterized during the 1989 and 1998 surveys.

The conditions summarized above are based on historical site assessment information and assessments and are relevant only for the near future. Under current conditions and surveillance and maintenance activities, SPRU-related contamination is contained within the facilities, equipment, tanks, piping, and managed in the Hillside Drain System.

3 HISTORICAL SITE ASSESSMENT PURPOSE

The purpose of a historical site assessment is to determine and document the status of a site or facility following the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* guidance that resulted from U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and U.S. Nuclear Regulatory Commission (NRC) concurrence on an approach to conducting radiation surveys and investigations at potentially contaminated sites. This historical site assessment documents an investigation to collect existing information describing the Separations Process Research Unit (SPRU) facility history from the start of site activities to the present.

The SPRU Disposition Project is being implemented under DOE Manual 413.3-1, *Project Management for the Acquisition of Capital Assets*. The DOE Manual 413.3-1 applies to all DOE projects with an expected budget in excess of $5 million, and establishes a capital acquisition management system that organizes projects into four phases with associated "Critical Decisions." Information in the historical site assessment will provide input into the Critical Decision-1 package titled "Approve Alternative Selection and Cost Range." An Integrated Project Team of individuals with diverse backgrounds will provide input to and review of key decisions throughout all phases of the SPRU Disposition Project.

3.1 Historical Site Assessment Scope

The following SPRU facilities are addressed in this historical site assessment, and are shown in Figure 3-1. SPRU facilities addressed in this historical site assessment and the associated work breakdown structure (WBS) designation are listed and described in Table 3-1.

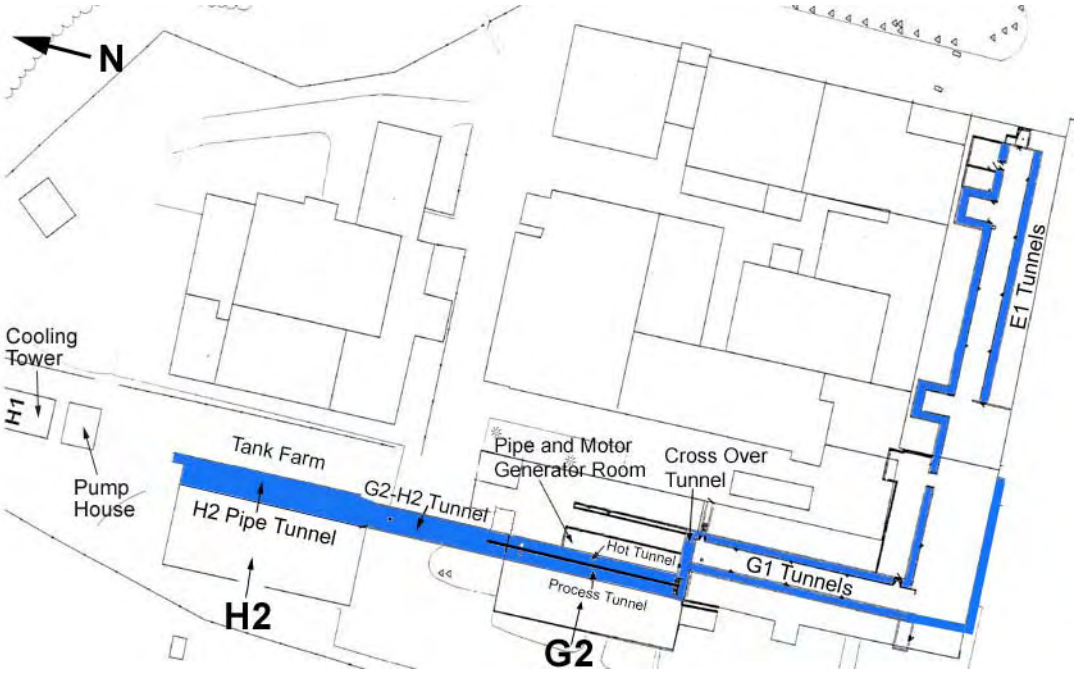


Figure 3-1. Structures in the Historical Site Assessment Scope (2004)

Table 3-1. SPRU Areas within the Scope of the Historical Site Assessment and Associated WBS

Historical Site Assessment Section and Scope	SPRU Facility and WBS	Areas Included in WBS
Section 7, G2 and G2 Pipe Tunnels Current Conditions Scope: G2 –laboratories, hot cells, separations process testing equipment, and the G2 Tunnels	G2 and G2 Pipe Tunnels WBS 1.4.8.10.2.2	G2 structure and contents; pipes; processing tanks Soil immediately adjacent to and below building Soil contaminated by discharges from building Stack and foundation G3 facility remnants
Section 8, H2, H1, and H2 Pipe Tunnel Current Conditions Scope: H2 - used for liquid and solid waste processing, H1 Cooling Tower, the Pipe Tunnel inside H2, and the Tank Enclosures * (but not the tanks)	H2 and Tank Enclosures WBS 1.4.8.10.2.3	H2 structure and contents; pipes; processing tanks; and Tank Enclosures H2 Pipe Tunnel Soil immediately adjacent to and below building Soil contaminated by building discharges including the hillside Stack and foundation Demolition of decontaminated Tank Enclosures H1 Cooling Tower Cooling Tower Pump House
Section 9, Tunnels Current Conditions Scope: Tunnels in and connecting G2 and H2 and between G2 and KAPL buildings G1 and E1	Tunnel Cleanout WBS 1.4.8.10.2.4	Pipes that are in G1 and E1 Tunnels Pipes that are in the G2-H2 Tunnel Decontamination of E1 and G1 Tunnels
Section 10, Tank Farm Current Conditions Scope: Tank Farm - a subsurface concrete-enclosed series of tanks along the east side of H2 used for storing liquid waste	Tank Enclosure Cleanout WBS 1.4.8.10.2.5	Six 10,000-gallon waste tanks and one 5,000-gallon waste tank adjacent to H2 Tank contents (tank heels, sludge, liquids, etc.) Piping (and contents) connecting the tanks with H2 Soil above and below the Tank Enclosures Decontamination of Tank Enclosures

* Tank Enclosures is the WBS term for Tank Vaults

The following areas in the proximity of the SPRU facilities are not included in this historical site assessment and are addressed in the *Land Areas Historical Site Assessment for the SPRU Disposition Project.*

- Upper Level Land Area
  - Soils and groundwater underlying and surrounding the SPRU Facility Area
- North Field Land Area
  - Former Slurry Drum Storage Area
- Lower Level Land Area
  - Lower Level Parking Lot
  - Railroad Staging Area
  - K4 and Laundry Lines
  - K5 Retention Basin
  - K6 and K7 Storage Pads (demolished and removed)
  - J3 Cold Incinerator
  - J4 and J5 Sand Filter Bed Area

3.2 SPRU Background

The SPRU nuclear facilities are located on the Knolls Atomic Power Laboratory (KAPL) site in Niskayuna, New York, and managed by the DOE Office of Environmental Management. KAPL is owned by the U.S. government and operated by the U.S. DOE Office of Naval Reactors, Schenectady Naval Reactors, and their contractor, KAPL, Inc., a Lockheed Martin Company. The KAPL mission is envisioned to continue past the 2014 time frame estimated for SPRU cleanup. Therefore, the anticipated SPRU future land use, or end state, is consistent with DOE's continued mission.

Construction began in 1947 under a contract between the General Electric Company (GE) and the Atomic Energy Commission. Originally, the site mission had a dual purpose: design and development of nuclear-powered reactors and conduct of pilot tests on chemical processes to separate plutonium and uranium from radioactive material encased in aluminum. The SPRU facilities were constructed to address the latter mission on a laboratory scale; SPRU was never a production plant (R-001546)[1].

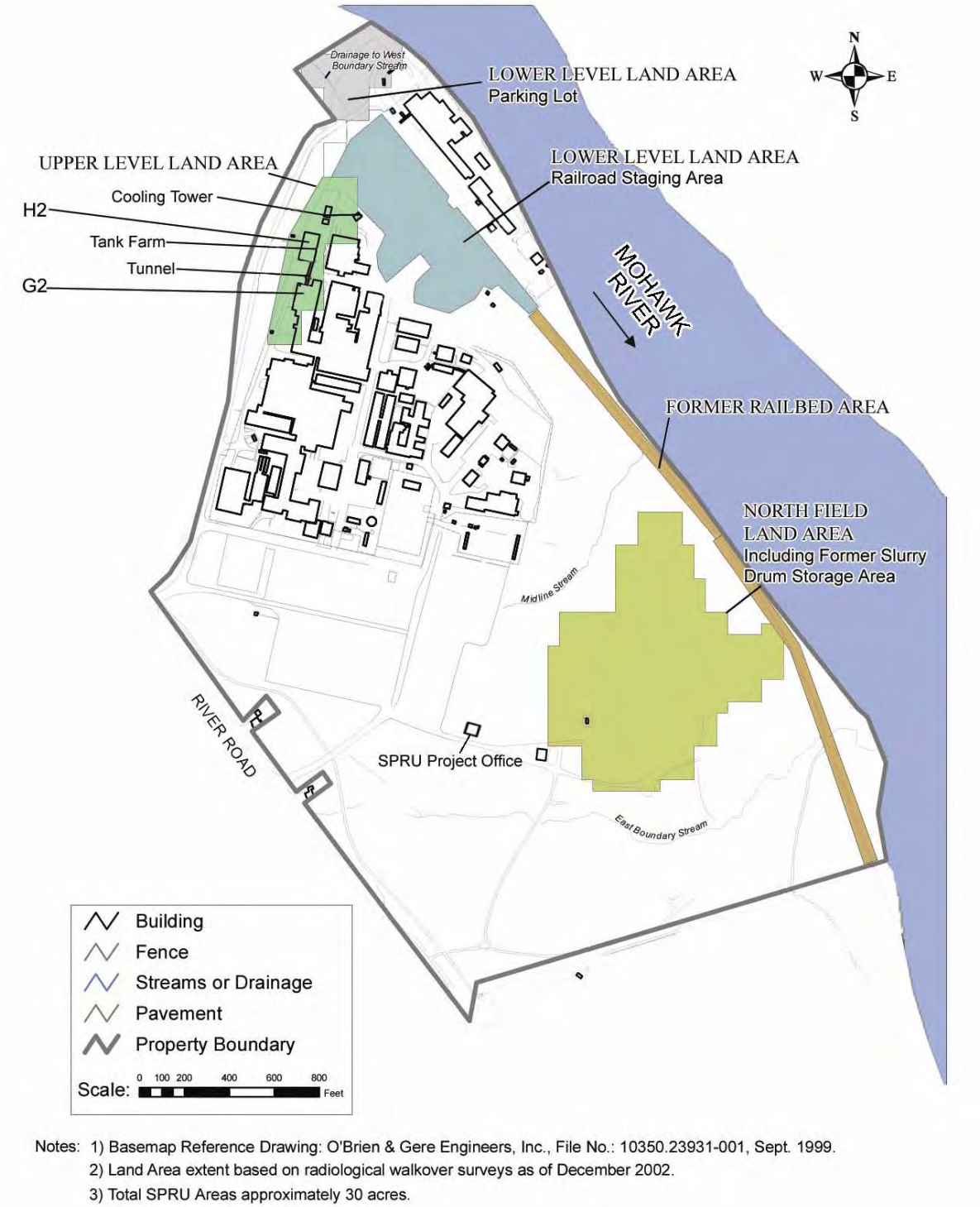
SPRU operated between February 1950 and October 1953, when research activities ceased following successful development of the reduction oxidation (REDOX) and plutonium uranium extraction (PUREX) processes subsequently used by Hanford and the Savannah River Site (R-000255). Decommissioning of SPRU continued through the 1990s; storage tanks were drained and flushed and steam, gas, and electrical services were shut down. The high efficiency particulate air (HEPA)-filtered exhaust system remained operational to maintain the buildings at a constant negative pressure. From the mid-1950s to the early 1990s, portions of Building G2 were modified and used by KAPL office workers and laboratory personnel (R-000255). Building H2 and the Tank Farm were partially shut down, but some areas remained in use for SPRU decommissioning activities and other KAPL waste management functions.

Section 6, SPRU Facility History, provides a comprehensive history.

[1] References in this historical site assessment are noted with parenthetical numbers that are listed in Appendix A, References.

4 PROPERTY IDENTIFICATION

The SPRU Disposition Project nuclear facilities are on the KAPL site in eastern New York State, approximately 2 miles east of the City of Schenectady. KAPL is located along River Road, on the south bank of the Mohawk River. The SPRU facilities are shown in Figure 4-1 and listed in Table 4-1.



Notes: 1) Basemap Reference Drawing: O'Brien & Gere Engineers, Inc., File No.: 10350.23931-001, Sept. 1999.
2) Land Area extent based on radiological walkover surveys as of December 2002.
3) Total SPRU Areas approximately 30 acres.

Figure 4-1. SPRU Disposition Project Areas

Table 4-1. SPRU Disposition Project Areas

Nuclear Facility Historical Site Assessment for the SPRU Disposition Project Scope
Building G2 *Building H2* *H2 Tank Farm* *Pipe Tunnels* *Hi Cooling Tower* *Cooling Tower Pump House*
Land Areas Historical Site Assessment for the SPRU Disposition Project Scope
Upper Level Land Area - Soils and groundwater underlying and surrounding the SPRU Facilities *North Field Land Area* - Former Slurry Drum Storage Area *Lower Level Land Area* - Lower Level Parking Lot - Railroad Staging Area - K4 and Laundry Lines - K5 Retention Basin - K6 and K7 Storage Pads (demolished and removed) - J3 Cold Incinerator - J4 and J5 Sand Filter Bed Areas

Neither the KAPL site nor the SPRU Disposition Project areas are on EPA's National Priorities List (C-000536, C-000537). In 1998, the New York State Department of Environmental Conservation (NYSDEC) completed a *Resource Conservation and Recovery Act* (*RCRA) Facility Assessment, Preliminary Review – Visual Site Inspection Report of KAPL*, and included SPRU Disposition Project areas (R-001546).

The solid waste management units (SWMUs) listed in Table 4-2 are within the scope of the *Nuclear Facility Historical Site Assessment for the SPRU Disposition Project.* The SWMUs were formerly listed in the KAPL Part 373 NYSDEC Permit #4-4224-00024/00001, and are now included in the *U.S. DOE SPRU RCRA Hazardous Waste Part A Permit Application*, dated February 1, 2004. The SPRU site EPA ID number is NYR 000 096 859. Soil and groundwater near these SWMUs are being characterized in accordance with work plans approved by NYSDEC.

Table 4-2. SPRU Facility Solid Waste Management Units

Name	SWMU Number	Description	Notes
H2 Tank Farm	SWMU-031	One 5,000-gallon and six 10,000-gallon stainless steel storage tanks in seven underground concrete vaults on the east side of H2	
SPRU Tank 527	SWMU-058	200-gallon stainless steel tank in G2 Cell 3	No further action per KAPL Site Permit.
SPRU Tank 531	SWMU-059	500-gallon stainless steel tank in the East Bay of G2 Cell No. 5	No further action per KAPL Site Permit.
SPRU Tank 532	SWMU-060	400-gallon stainless steel tank in the East Bay of G2 Cell No. 5	No further action per KAPL Site Permit.
SPRU Tank 534	SWMU-061	750-gallon stainless steel tank in the East Bay of G2 Cell No. 5	No further action per KAPL Site Permit.
SPRU Tank 551	SWMU-062	75-gallon stainless steel tank in the East Bay of G2 Cell No. 5	No further action per KAPL Site Permit.
SPRU Tank 536	SWMU-063	100-gallon stainless steel tank in the East Bay of G2 Cell No. 5	No further action per KAPL Site Permit.
SPRU Tank 316	SWMU-064	1,000-gallon stainless steel tank in the south end of G2 Cell No. 5	No further action per KAPL Site Permit.
Pipe Tunnels	SWMU-057	Tunnels located in and connecting the basement of G2 and H2	Inactive
H2 Processing Facility	SWMU-030	Waste Treatment Facility	Inactive

Source: U.S. DOE SPRU RCRA Hazardous Waste Part A Permit Application, dated February 1, 2004. EPA ID number is NYR 000 096 859.

4.1 Physical Characteristics

SPRU-related areas occupy approximately 30 acres of the 170-acre KAPL site. The SPRU facilities described in this historical site assessment occupy approximately 5 acres. The remaining 25 acres consist of the Lower Level and North Field Land Areas, which will be addressed in a *Land Areas Historical Site Assessment for the SPRU Disposition Project*.

Figure 4-2 shows the location of KAPL relative to its regional setting. The SPRU Project Office is located at 2425 River Road, Niskayuna, New York, 12309. The KAPL site and SPRU facilities are located on a bluff overlooking the southern bank of the Mohawk River. Surface elevations at the site range between approximately 330 feet above mean sea level at the top of the bluff to 230 feet on the lower portions of the site along the river. Figure 4-3 shows the KAPL property relative to its location in the Niskayuna area.

4.2 Environmental Setting

In the eastern portion of New York State near SPRU, the Mohawk River flows from west to east toward its confluence with the Hudson River approximately 15 miles downstream. The Mohawk River drains the southern portion of the Adirondack Mountains to the northwest and portions of the Catskill Mountains to the south. Median monthly discharge from the Mohawk River ranges between 2,000 and 10,000 cubic feet per second (USGS, 1996). Average annual precipitation near the site is 38 inches per year and average runoff is 18 inches per year. Surface water from the KAPL property drains to the northeast into the Mohawk River by way of three ephemeral streams: the East and West Boundary streams and the Midline Stream.

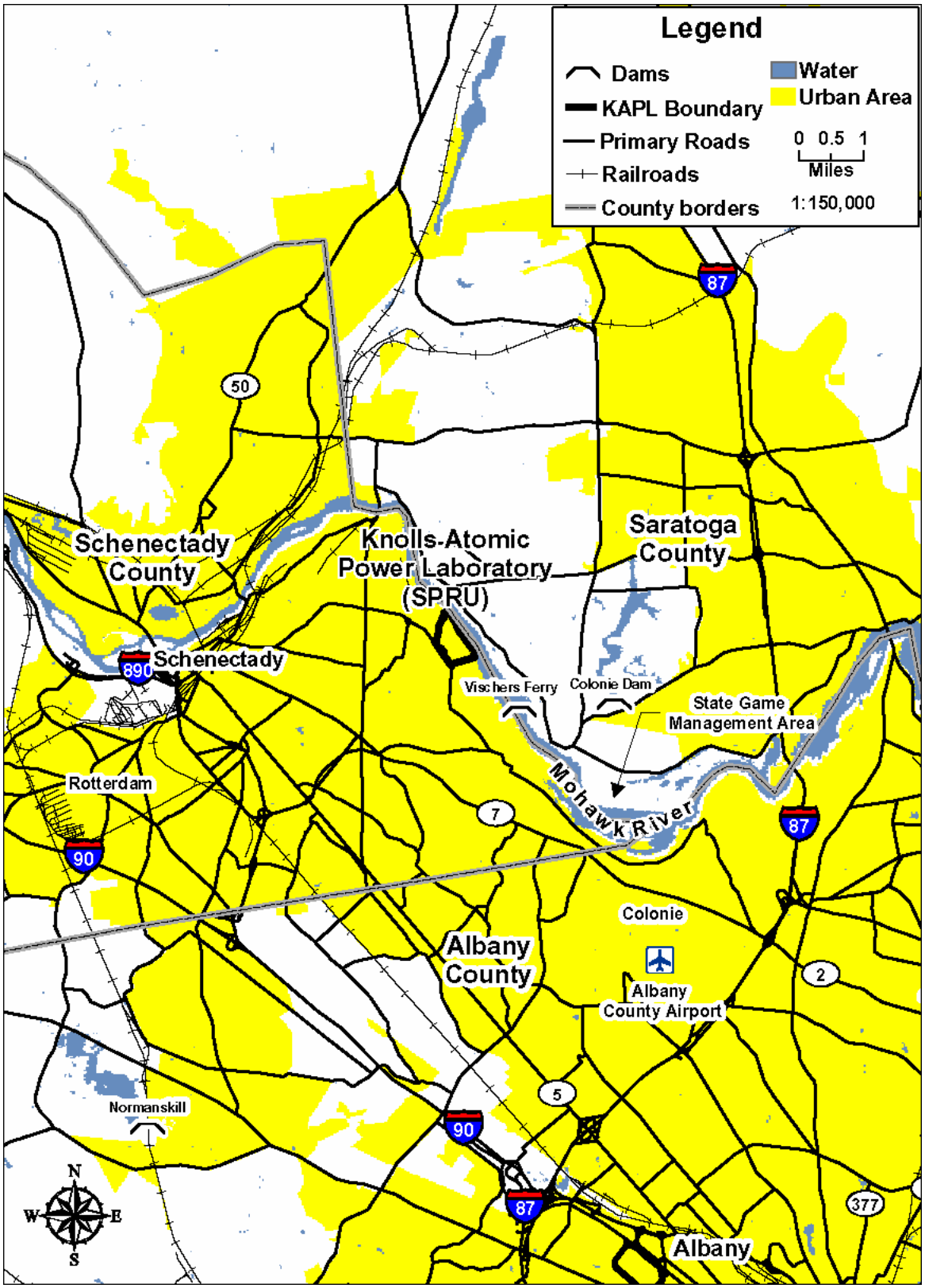


Figure 4-2. SPRU Area Map (2004)

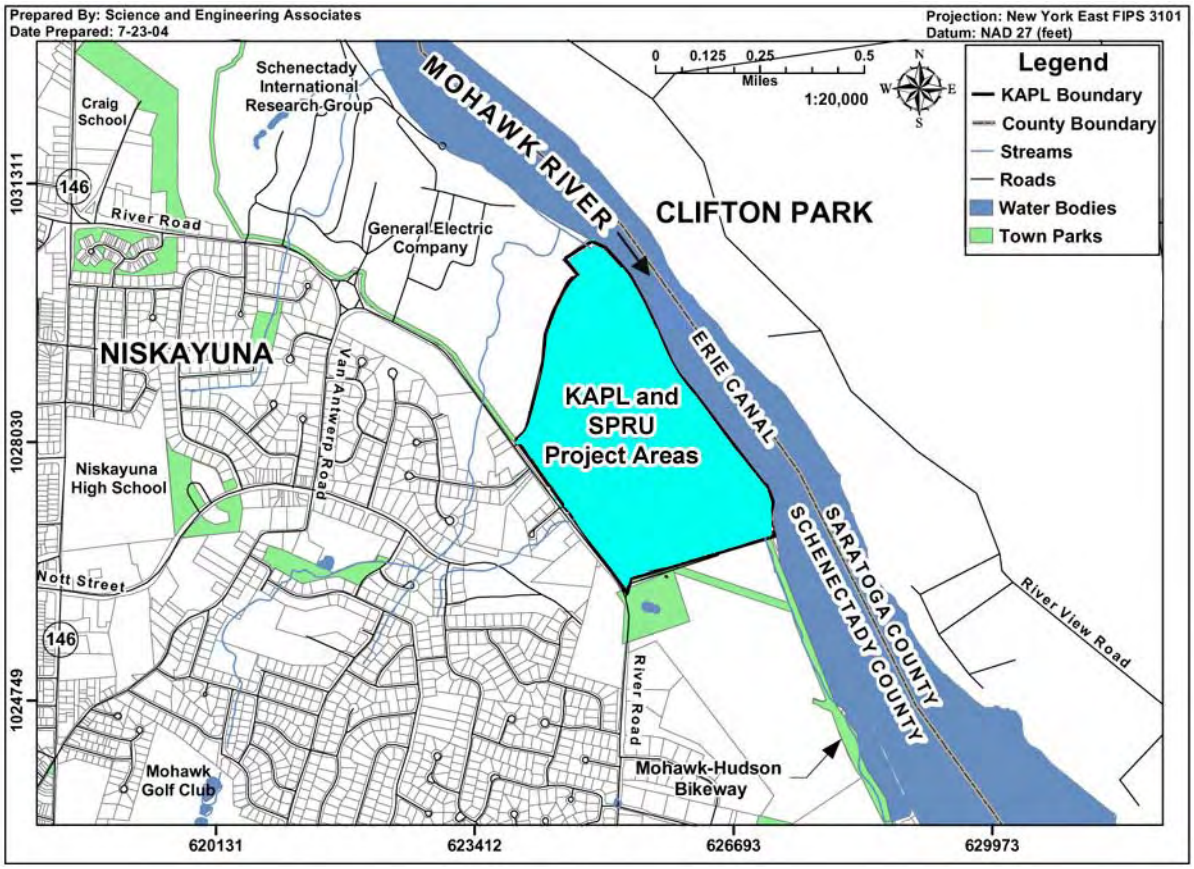


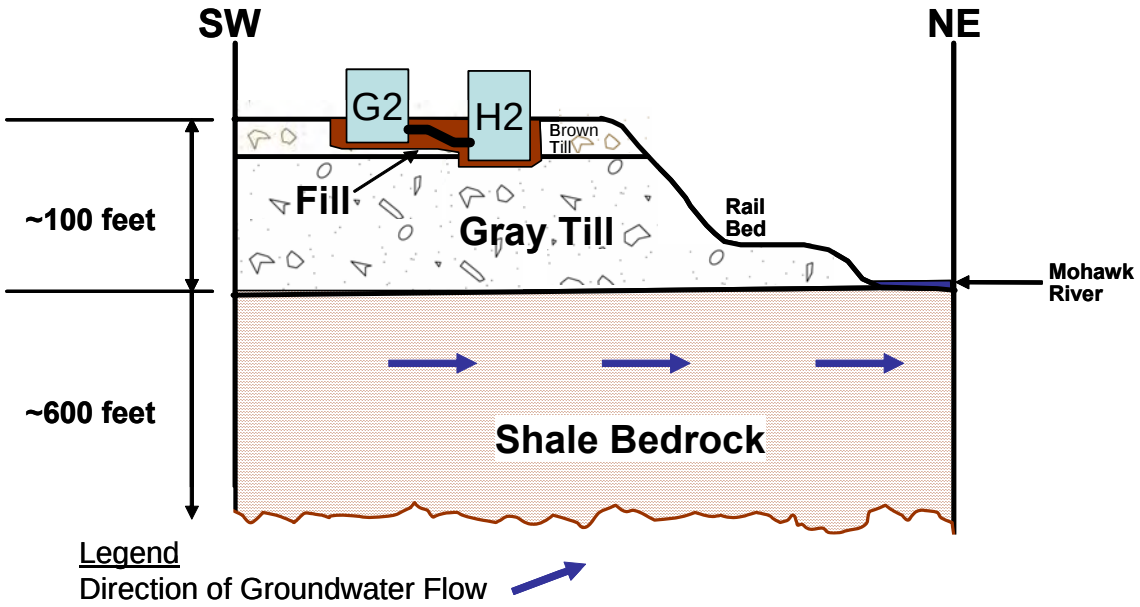
Figure 4-3. SPRU Vicinity Map (2004)

Surficial deposits at KAPL consist of tightly compacted glacial till up to 70 feet thick that acts as an aquiclude, minimizing the downward infiltration of water. The till thins toward the Mohawk River, where it is absent or up to a maximum of 10 feet thick. Glacial lake deposits of silt and fine sand are present at the surface in isolated areas on the KAPL site (R-000159, pp. 4-8). The surficial glacial deposits are underlain by bedrock consisting predominantly of Ordovician Schenectady Formation shale, with some interbedded siltstone that is up to 600 feet thick. The bedrock typically has low porosity and impermeability (R-000159, pp. 4-6).

Shallow, perched groundwater is encountered intermittently in the glacial till and lake deposits and, when found, is not laterally continuous. Where present, it is encountered between 5 and 10 feet below grade, with a general flow direction to the north or northeast (R-000159). Groundwater within the underlying bedrock is found locally within fractures and bedding planes and is not laterally continuous. Where encountered, the water table in the shale bedrock is approximately 70 feet below grade, and groundwater flow is generally to the north or northeast toward the Mohawk River (R-000159), moving at less than 5 to 10 feet per year (R-002032, p. 8). There are no aquifers suitable for development under the site because of the dense glacial till and low-permeability shale bedrock (R-002032).

Locally, shallow north and northeasterly perched groundwater flow patterns are perturbed at the KAPL site by streams, topography, and artificial fill for building and piping around G2, H2, and the tunnels (Figure 4-4) (R-000431). The G2 and H2 foundations extend to depths of 12 and 30 feet below grade, respectively. Shallow groundwater flows preferentially through the more permeable backfill around the tunnels, piping corridors, and buildings.

Shallow, perched groundwater flow is also locally affected by footing drains that were installed along the exterior of the H2 foundation. Between 1983 and 2001, an average of 79,000 gallons of water per year discharged from the footing drains to a hillside collection sump west of the building (R-000432, pp. 10, 11). Water continues to discharge to the hillside sump and it is actively collected, monitored, and treated before being released to the storm water system (C-002100).



Schematic Stratigraphic Cross Section
(Not to Scale)

R-000159, based on information from ERM-Northeast, 1992, *Final Report – Hydrogeologic Evaluation of the Knolls Atomic Power Laboratory – Knolls Site*, July 8, 1992.

Figure 4-4. SPRU Groundwater Schematic (2004)

4.3 Adjacent Land Use

Figure 4-5 shows land use in the areas adjacent to SPRU. SPRU is located within KAPL property, which occupies a strip of land along the southern bank of the Mohawk River. The area has been used for research and development since the late 1940s. GE continues to operate a research and development facility northwest of KAPL, and the Schenectady International Research Group is located further to the northwest along the river.

To the southeast of the SPRU facilities, on the KAPL property, is a research and development facility dedicated to support of the United States Naval Nuclear Propulsion Program. KAPL facilities include administrative offices; chemistry, physics, radioactive materials laboratories; engineering offices; computer facilities; machine shops; a sewage pumping station; a boiler house; oil storage facilities; cooling tower; and RCRA-permitted hazardous and mixed waste storage and treatment facilities.

Outside the KAPL boundaries, to the southwest, land use consists of medium- to high-density residential housing in Niskayuna, New York. To the southeast is the closed municipal landfill and Niskayuna recreational land consisting of hiking trails and a bike path. To the northeast, the Mohawk River is under the jurisdiction of the Canal Corporation. Across the Mohawk River is low-density residential housing in the Town of Clifton Park.

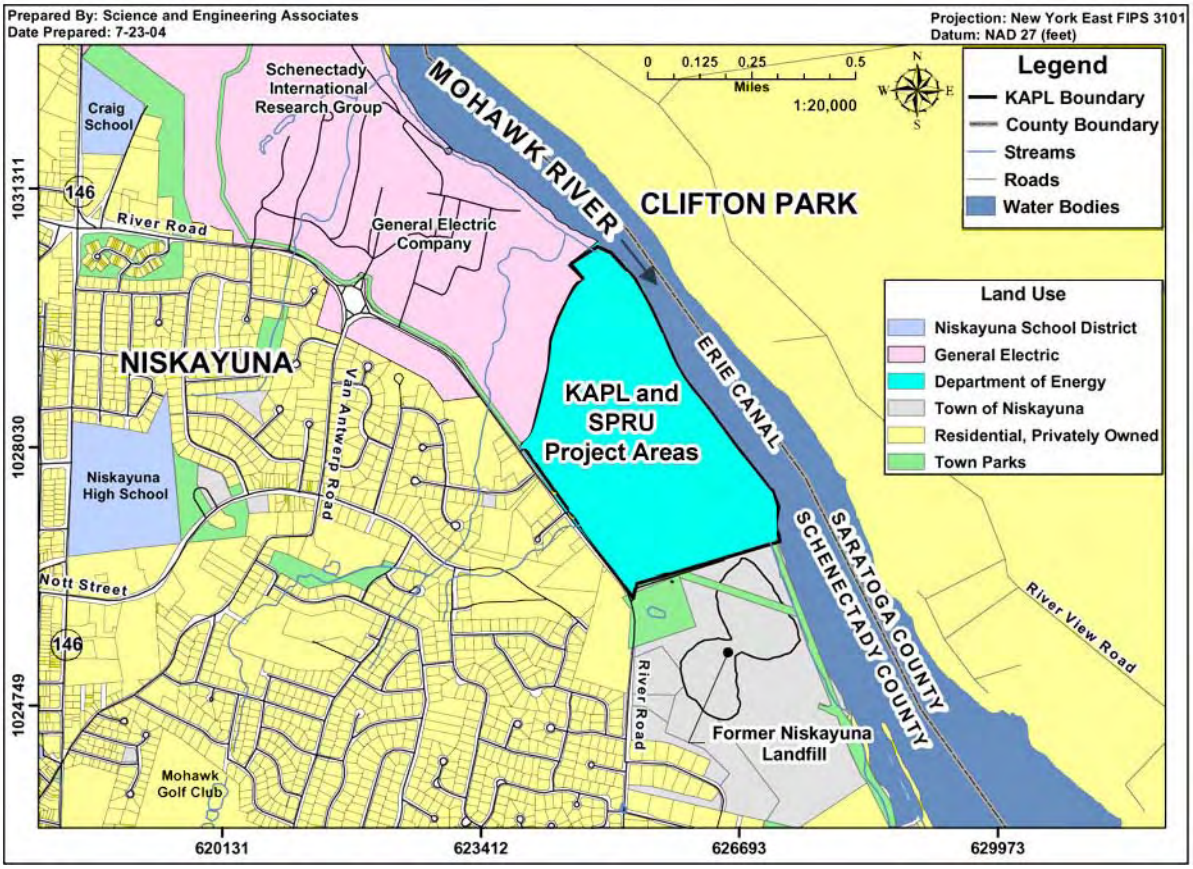


Figure 4-5. SPRU Disposition Project Surrounding Area Land Use (2004)

5 HISTORICAL SITE ASSESSMENT METHODOLOGY

Information for the *Nuclear Facility Historical Site Assessment for the SPRU Disposition Project* was compiled and reviewed following the methodology presented in the DOE Statement of Work dated September 12, 2003, and the approach outlined in MARSSIM. A project team with expertise in nuclear engineering and health physics, civil and mechanical engineering, waste management facilities, environmental remediation, and historical site assessment development conducted the historical research and report preparation. Site visits were made to observe existing conditions in SPRU facilities and to interview knowledgeable people. The following types of information were reviewed:

- Historical documents including SPRU Disposition Project correspondence and operational records from KAPL, SPRU, and other DOE sites' libraries and files
- Radiological survey data
- Technical drawings
- Property assessments
- Photographs and video documentation of the building interiors
- Interviews with past and current employees.

5.1 Documents Reviewed

The project team screened a list of approximately 3,000 documents for potential relevance to the *Nuclear Facility Historical Site Assessment for the SPRU Disposition Project*. Of these, approximately 1000 documents were reviewed for information pertinent to the assessment; more than 160 documents were pertinent references for this document. In addition, 13 videotapes, more than 2,000 drawings or maps, and approximately 680 historical photographs were researched and reviewed for input into this document. Current photographs of the interior and exterior of Buildings G2 and H2 are included in this document.

Documents reviewed included correspondence, radiological surveys, sampling data, permits, authorizations, and SPRU facility records from the time of construction to the present. The videotapes recorded historical inspections and radiological surveys that occurred in the SPRU facilities during the 1989 inspections of Building H2, Building G2 process areas and tunnels, the G1 and G2-H2 unnels, and the 1998 Tank Farm inspection. The drawings and maps, specifically engineering drawings such as blueprints and site plats and plots, provided information concerning the chronology of construction, historical research activities, and post-closure modifications to the SPRU facilities. (Note: as-built drawings for the SPRU facilities do not exist.) Historical photographs provided documentation of the construction process and current building configurations.

5.2 Site Visits

Project team personnel toured the following SPRU-related areas of KAPL and interiors of Buildings G2 and H2 to observe, assess, and document conditions:

- Tour of Upper and Lower Areas, March 12, 2004
- Tour of the interior of G2, exterior of H2 and G2, March 19, 2004
- Tour of the interior of G2, exterior of H2 and G2, April 13, 2004
- Tour of the interior of G2, exterior of H2 and G2, April 14, 2004
- Tour of the interior of G2, exterior of H2 and G2, and Land Areas, April 26, 2004
- Tour of the interiors of G2 and H2, May 11, 2004.

5.3 Personal Interviews

Project team personnel conducted interviews with former and current KAPL employees. Interview notes are recorded and archived with SPRU reference documents.

5.4 Radiological Contamination

After compiling information and data from available sources, the project team analyzed the information to determine whether SPRU facility areas were impacted or non-impacted, the level and type of contamination, the potential for contamination releases to the environment, and additional characterization needs.

Current radiological conditions in SPRU facility areas are derived from the most recent radiological survey data available. However, past radiological surveys targeted specific areas and no single survey covered all the SPRU facility areas. The primary radiological surveys used to show current conditions are as follows:

- 1989 (most of G2, H2, Tank Farm Vaults and Tanks, and some Tunnel areas)
- 1998 (Tank Farm Vault inspection)
- 2004 (accessible areas).

Historical site assessment drawings showing current radiological conditions are provided in Sections 7, 8, 9, and 10. Tables in Sections 7, 8, 9, and 10 include data from other historical survey events as appropriate.

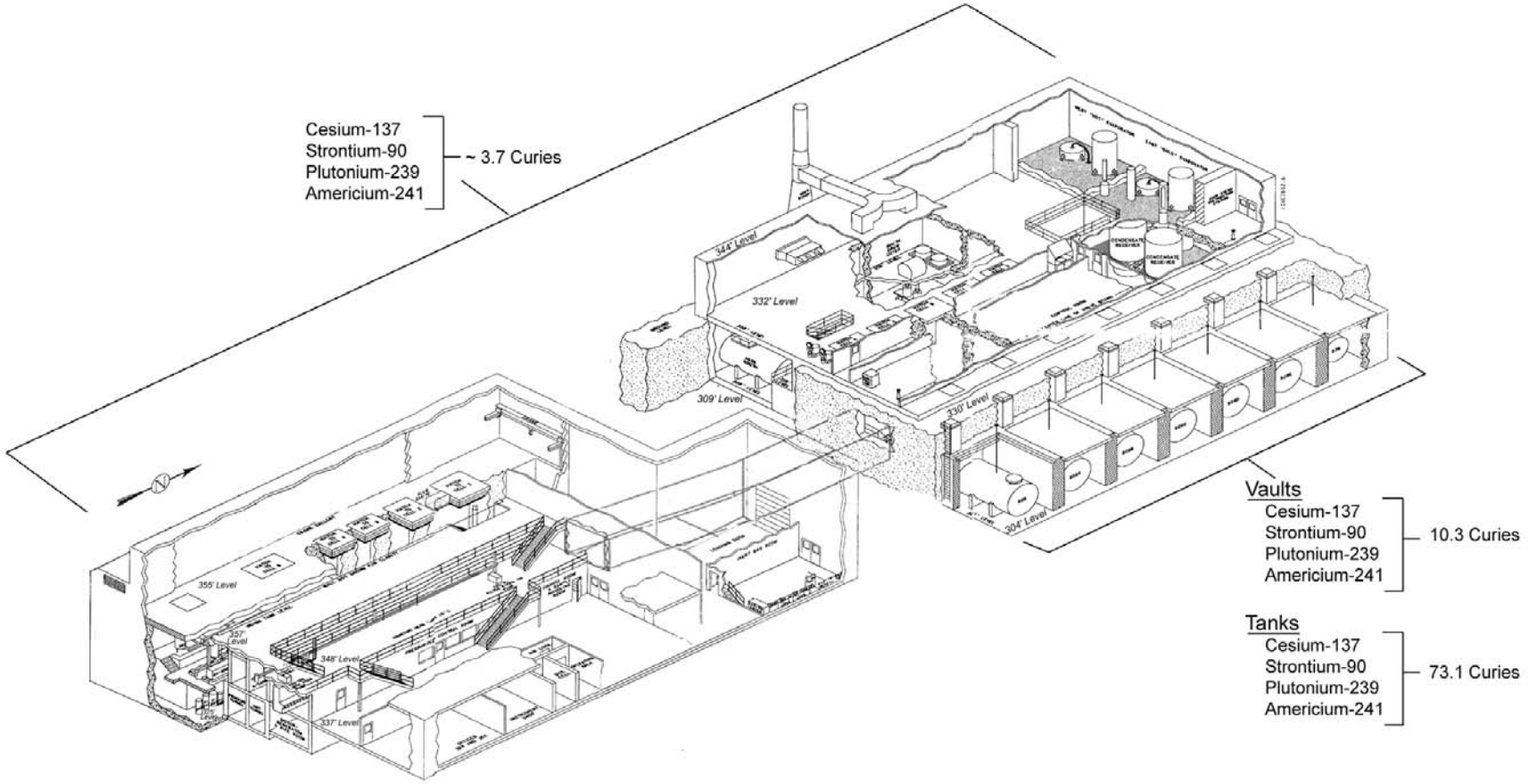
SPRU radionuclide distribution was calculated for the 1989 survey report, *Preliminary Evaluation of the Status of the Separations Process Research Unit* (R-001949), dated 1992. The estimated total residual SPRU radioactivity as presented on Figure 5-1 is 87 Curies (R-001949, Appendix C). It should be noted that there are inconsistencies and uncertainties identified in the *Preliminary Evaluation of the Status of the Separations Process Research Unit* report regarding the total amount and distribution of radioactivity in SPRU facilities.

For the Tank Farm tanks and vaults, "due to uncertainty in the calibration and actual locations of the detectors used for the radiation measurements, and in the density of the residue in the tanks, the uncertainty in the curie content (83.4) is estimated to be a factor of 2" (R-001949, p. C-3).

The Curie content of the rest of G2 and H2 Building complex is approximately 3.7 Curies. The values provided for the remainder of the G2 and H2 Building complex are very approximate values based on limited general area radiation level surveys which are not intended for Curie content estimates (R-001949, p. C-3).

The *Preliminary Evaluation of the Status of the Separations Process Research Unit* report further analyzes radiation amount and distribution as follows:

- "The quantities of radioactivity remaining are estimated to be in the range of 10 curies of plutonium and 80 curies of long-lived mixed fission products, principally strontium-90 and cesium-137; these estimates could vary by a factor of two (2)" (R-001949, p. 6).
- "The estimated total residual SPRU radioactivity is about 10 curies of plutonium and 77 curies of long-lived mixed fission products, principally strontium-90 and cesium-137; these estimates could vary by a factor of 2" (R-001949, p. 110).



Source: Preliminary Evaluation of the status of the Separations Process Research Unit (SPRU) October 1992, Appendix C (R-001949)

Note: Representation of building interior is not to scale.

Figure 5-1. SPRU Radiological Contamination Distribution (1992)

The DOE-STD-1098-99, *Radiological Control* (Change Notice No. 1, June 2004), provides criteria for defining radiation areas, contamination areas, and posting radiological controls. The project teams used this Standard as guidance for evaluating SPRU survey data and designating radiation and contamination areas on drawings showing current radiological conditions. Table 5-1 defines radiation areas and contamination areas according to the Standard.

Table 5-1. DOE-STD-1098-99 Criteria for Radiation and Contamination Areas

Area	Criteria	Required Posting	Posting and Protection
Radiation Area	Radiation levels could result in an individual receiving > 0.005 Rem in 1 hour at 30 cm	"CAUTION, RADIATION AREA" [see 835.603(a)]	"RWP[1] AND PERSONNEL DOSIMETER REQUIRED FOR ENTRY"
High Radiation Area	Radiation levels could result in an individual receiving > 0.1 Rem in 1 hour at 30 cm	"CAUTION" or "DANGER," "HIGH RADIATION AREA" [see 835.603(b)]	"PERSONNEL DOSIMETER, SUPPLEMENTAL DOSIMETER, AND RWP REQUIRED FOR ENTRY"*
Very High Radiation Area	Radiation levels could result in an individual receiving > 500 rad in 1 hour at 100 cm	"GRAVE DANGER, VERY HIGH RADIATION AREA" [see 835.603(c)]	"SPECIAL CONTROLS REQUIRED FOR ENTRY"*
Contamination Area	Removable contamination levels (dpm/100 cm^2) > Table 2-2 values[1] but less than or equal to 100 x Table 2-2 values	"CAUTION, CONTAMINATION AREA" [see 835.603(e)]	"RWP AND PROTECTIVE CLOTHING REQUIRED FOR ENTRY"
High Contamination Area	Removable contamination levels (dpm/100 cm^2) > 100 x Table 2-2 values[2]	"CAUTION" or "DANGER," "HIGH CONTAMINATION AREA" [see 835.603(f)]	"RWP AND PROTECTIVE CLOTHING REQUIRED FOR ENTRY"
Airborne Radioactivity Area	Airborne concentrations (µCi/ml) above background: 1) are > the applicable DAC[3] values[2]; or 2) could result in an individual (without respirator) receiving an intake > 12 DAC-hrs in a week	"CAUTION" or "DANGER," AIRBORNE RADIOACTIVITY AREA" [see 835.603(d)]	"RWP AND PROTECTIVE CLOTHING REQUIRED FOR ENTRY"

* Source: DOE-STD-1098-99, Radiological Control, June 2004. Table 2-2 refers to the Table 2-2 Summary of Surface Contamination Values [see 835 Appendix D] in DOE-STD-1098-99.

Notes: 1 RWP – radiological work permit
2 Levels exceed or are likely to exceed the listed values
3 DAC – derived air concentration

5.5 Chemical Analysis

Asbestos, polychlorinated biphenyls (PCBs), and other chemical surveys have not been performed in the SPRU facility areas. However, hazardous properties were common with the building materials, equipment, and other materials commonly used in the late 1940s and early 1950s. SPRU documentation does not include site characterization for these hazardous properties. The *Nuclear Facility Historical Site Assessment for the SPRU Disposition Project* recognizes the potential for chemical hazards but cannot identify current chemical conditions. If sample collection reveals concentrations of asbestos-containing building materials, PCBs, or heavy metals (e.g., lead, mercury, and copper) in excess of applicable regulatory thresholds, mitigation measures during decommissioning activities will be required.

The following is a partial list of potential asbestos-containing building materials, PCBs, and heavy metals associated with materials and equipment discussed in records reviewed and/or observed onsite:

- Asbestos-containing building materials are found in an estimated 3,000 product types manufactured primarily between 1940 and the present in the United States (www.epa.gov). Equipment and materials in SPRU associated with asbestos-containing building materials include fireproofing, ventilation materials, piping and other insulation, arc shields, steam flange gaskets, transite paneling, floor tile, exterior asbestos corrugated material, and mastic.
- PCBs are found in equipment, oil, and paint products manufactured primarily between 1929 and 1977 in the United States. More than 1.5 billion pounds were manufactured prior to cessation of production in 1977 (www.epa.gov). Remaining materials and equipment associated with SPRU research activities during this period include light ballasts, remnant oil products (e.g., ventilation system for dust control, spindle oil, electrical equipment), and painted surfaces.
- Heavy metals (e.g., mercury and lead) are found on painted surfaces and various equipment onsite. Electrical equipment remaining onsite include switches and relays and wiring. Other equipment onsite includes piping, meters, fluorescent lamps, and batteries. Lead shielding is abundant in the SPRU facilities.
- Unidentified sealants and plastic wall materials that may require special handling for removal (e.g., asbestos-containing materials, volatile organic compounds, etc.) were also used. For example, one reference described a sprayed, strippable film, which was applied to the internal surfaces to prevent adhesion of radioactive contamination to the building structure. The chemical constituents of this material were not revealed in documents reviewed (R-001949, p. 67).

6 SPRU FACILITY HISTORY

In May 1946, GE entered into a prime contract with the Atomic Energy Commission Production Division to operate the Hanford Engineering Works in Richland, Washington, and to build and operate a laboratory that would become KAPL. The Hanford program involved operating natural uranium-fueled reactors to produce plutonium, with KAPL providing Hanford technical and scientific support in designing and developing nuclear power reactors. In early 1947, the Atomic Energy Commission launched an urgent program to provide production facilities to recover plutonium and uranium from irradiated fuel. The Hanford fuel recovery plan was based on a solvent extraction process known as REDOX (reduction-oxidation) (R-000427). GE Hanford was requested to provide a full-scale REDOX plant at the Hanford site in Richland, Washington by late 1949, and in December 1947, requested a REDOX pilot plant to research the process.

SPRU Buildings G2 and H2, the connecting tunnels, and adjacent Tank Farm were constructed between 1947 and 1949 to perform pilot-scale tests on chemical separation processes (R-000255). Radioactive REDOX processing commenced in June 1950. In October 1950, the Atomic Energy Commission requested that SPRU be used to support DuPont in developing a fuel recovery plant at the Savannah River Plant in South Carolina, and by December, SPRU terminated REDOX testing and started modifications to support PUREX research. PUREX work at SPRU was terminated in June 1953. The SPRU plant decommissioning began in October 1953 (R-000427). Table 6-1 provides a chronological overview of events associated with SPRU.

Table 6-1. SPRU Timeline

Date	Noteworthy Event
May 1946	Atomic Energy Commission awarded General Electric the prime contract.
August 1947	Construction commenced.
December 1947	REDOX pilot plant construction requested by General Electric Hanford.
February 1948	Blaw-Knox (subcontractor) hired to design pilot plant.
June 1948	Pilot plant was named Separations Process Research Unit (SPRU).
July 1949	Pre-operational testing began.
February 1950	Non-radioactive REDOX runs initiated.
June 1950	Radioactive REDOX runs initiated.
October 1950	Atomic Energy Commission SPRU pilot plant supports DuPont in developing the PUREX process.
December 1950	REDOX testing terminated and PUREX modifications began. Between June and December 1950, 54 REDOX separation process runs were performed.
February 1951	First PUREX run initiated.
June 1953	PUREX work terminated.
October 1953	SPRU decommissioning activities began to close and secure the SPRU research facilities to provide adequate protection from radiation exposure and to isolate radioactive contamination from the human environment. Decontamination, deactivation, and decommissioning activities included: • Flushing out all tanks with nitric acid and water • Steam, gas, and electrical services shut down • Fuses removed from electrical disconnect switches • Inlet air dampers to the cell areas were closed • HEPA-filtered exhaust ventilation left operational to maintain facility at negative pressure to control airflow into these areas and to monitor discharges. (R-001949, p. 5)

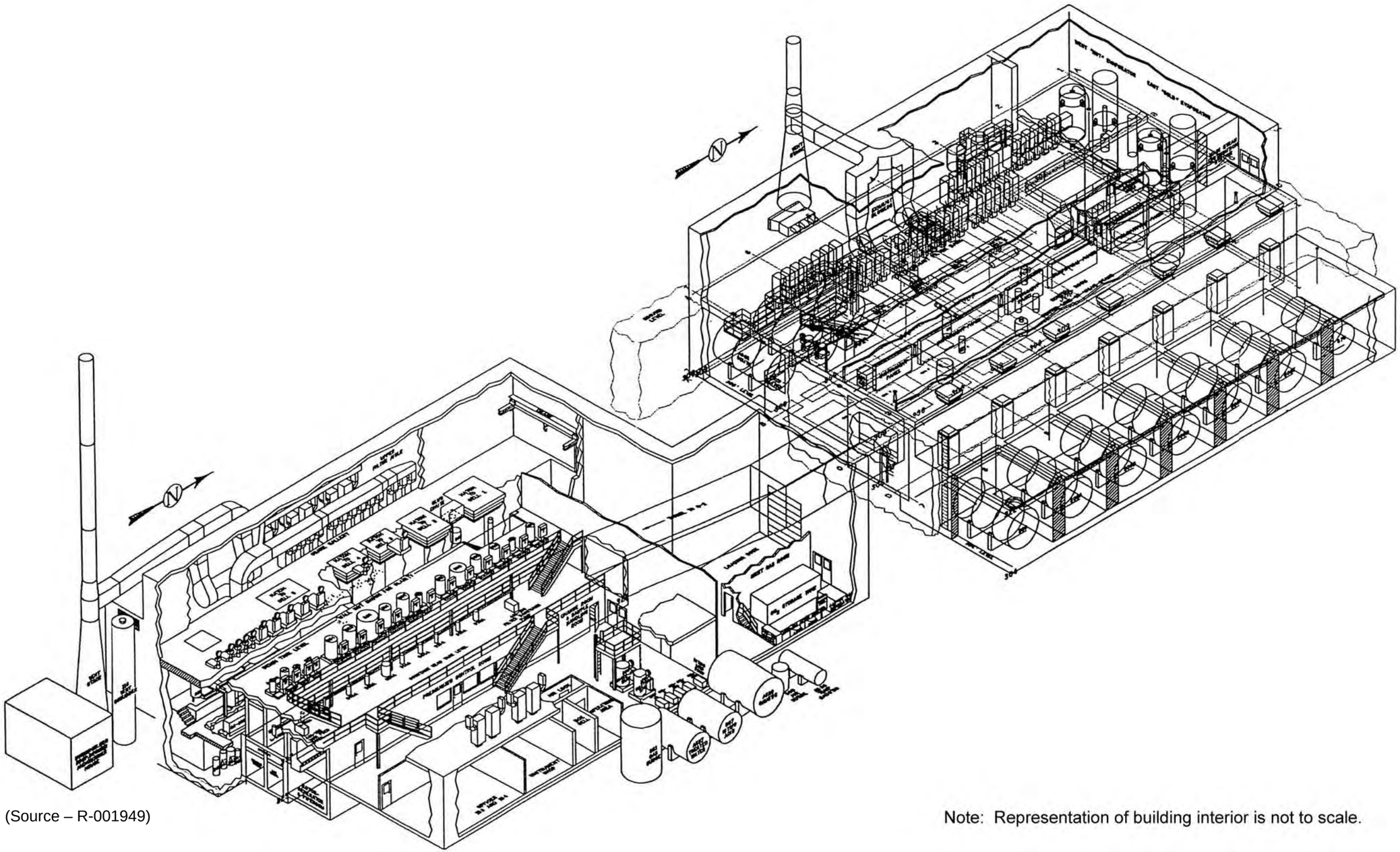
Date	Noteworthy Event
1954 - 1960s	Several G2 areas were decontaminated and converted to office, laboratory, and library space. H2 waste treatment continued. Building H2 waste incinerator was shut down. SPRU ventilation stack was moved to the Radioactive Materials Laboratory. Remaining SPRU waste was removed from Tank Vaults and processed (1965). Significant decontamination and modifications were performed in Building H2 (1966). Use of Building H2 evaporators was discontinued.
1970s	Waste baler moved from L7 to Building H2. Facilities Deactivation Program initiated (1977). Reuse water system operational (1977). Use of Tank Vaults for Radioactive Materials Laboratory waste and water collected from Building G2/H2 Pipe Tunnel sump discontinued (1978). Building F5 (Slurry Drum Storage) removed (1978). Routine entry into several SPRU areas discontinued.
1980s	G3 Pump House and Scrubber Stack removed (1986). Comprehensive SPRU physical inspection and radiological surveys conducted, including Subsurface Penetrating Underground Detector (SPUD) surveys (1989). New Hillside Water System put on line (1989).
1990s	Current SPRU Maintenance and Surveillance Program initiated (1990). Memo of understanding between DOE and Naval Reactors signed, establishing roles and responsibilities for decommissioning SPRU (September 1992).
1998	SPRU Tank Vaults inspected.

Reference: Separations Process Research Unit (SPRU) History and Current Status, April 1998 (R-000255).

REDOX and PUREX processes performed in G2 generated waste that moved through the G2-H2 Pipe Tunnel and was treated in H2. Interconnectivity also included:

- Building H2 nitrogen was supplied from G2, and G2 cooling water came from H2 (C-000461).
- Uranium solution was concentrated and drummed in H2 and returned to G2 for reuse (C-000461).
- The carbon dioxide fire fighting system storage tanks and controls were located in G2.
- A separate header connected to a storage tank in H2, but the main control valve and panel was located in G2 (C-000476).
- The H2 compressed air header originated at the main header in G2, and valve and filter controls were located in G2 (C-000476).
- Alarm and intercom systems of both buildings were interconnected. Any alarm in H2 simultaneously set off in G2 (C-000476).
- The buildings were established as a material balance area for accountability (C-000476).
- G2 personnel supported H2 activities and vice versa (C-000475).

An isometric drawing of the 1949 G2 and H2 configuration is provided in Figure 6-1.



(Source – R-001949)

Note: Representation of building interior is not to scale.

Figure 6-1. G2-H2 Isometric Drawing, 1949 Configuration

6.1 Building G2 History

The SPRU pilot plant was used for research in Building G2 between 1950 and 1953 to test chemical processes for separating plutonium and uranium from radioactive material encased in aluminum, called slugs. REDOX chemical test runs were performed until the end of 1950, and PUREX test runs until mid-1953 when the technique was successfully exported for use at Hanford and the Savannah River Site (R-000255). Separated plutonium was transferred to the Los Alamos National Laboratory (C-000469).

REDOX and PUREX Process Summary

The following narrative and figures describe the processes that occurred during SPRU operations. More detailed information on the REDOX and PUREX chemical processes and G2 equipment used for the processes is available in the October 1992, *Preliminary Evaluation of the Status of the Separation Process Research Unit (SPRU)* report (R-001949) and in the following Appendix B drawings.

Drawing No. 2828-92-2, Flow Diagram, March 29, 1948
Drawing No. 2828-92-3, Flow Diagram, June 29, 1948
Drawing No. 2828-92-4, Flow Diagram, May 8, 1948
Drawing No. 2828-92-5, Flow Diagram, March 17, 1948
Drawing No. 2828-92-6, Flow Diagram, May 17, 1948
Drawing No. 2828-92-7, Flow Diagram, June 29, 1948
Drawing No. 2828-92-8, Flow Diagram, May 8, 1948.

SPRU REDOX runs started in 1950, and the program was completed at the end of the year. The DuPont Company believed that mixer-settlers would be adopted for the PUREX process planned for the Savannah River Plant it was building, so during 1951, associated studies were conducted at the SPRU pilot plant. A series of demonstration runs were performed during the first half of 1952, and alternate PUREX processes were studied and further head-process refinements were developed in the second half of 1952 and the first half of 1953 (R-000472).

Separations were accomplished in equipment located in concrete-shielded G2 cells. Many variations were tested, but the general process is diagrammed in Figure 6-2 and summarized as follows:

(1) Dissolution of slugs (Cell No. 2)

- Slugs were dropped into the dissolver.
- The aluminum slug jacket was dissolved, and the dissolved aluminum transferred to waste storage areas.
- Irradiated uranium metal was dissolved for subsequent processing.

(2) Head-end separation (Cell No. 1)

- Prior to solvent extraction, the slug solution was processed, including precipitation and centrifugation to remove specific fission products.

(3) Feed preparation (Cell No. 1)

- The slug solution (hot feed) was chemically adjusted to meet solvent extraction process requirements (1AF stream – aqueous feed).
- Reagent streams (cold feed) were chemically adjusted at the Weigh Tank level to meet solvent extraction process requirements (1AX stream – organic extraction reagent; 1AS stream – aqueous scrubbing reagent).

(4) Chemically adjusted hot feed (1AF) and cold feed (1AX and 1AS) streams were processed through the solvent extraction units. The extraction process consisted of three cycles:

- First extraction cycle: Uranium and plutonium were separated from the radioactive fission products and each other:
  - In Cell No. 3 (the 1A bank), the 1AF aqueous feed, the 1AX organic extraction reagent, and 1AS aqueous scrubbing reagent streams were continuously contacted, resulting in the 1AP organic product stream containing uranium and plutonium and the 1AW aqueous waste stream containing fission products.
  - In Cell No. 4 (the 1B bank), the 1AP organic product stream was contacted with the 1BS organic reagent and 1BX aqueous reagent streams in a continuous manner, resulting in the 1BP aqueous product stream containing the plutonium and the 1BU organic product stream containing the uranium.
  - In Cell No. 5A (the 1C bank), the 1BU organic product stream was contacted with the 1CX aqueous reagent stream, resulting in the 1CW organic waste stream containing low-level fission products and the 1CU scrubbed aqueous product stream containing uranium.
- The second plutonium extraction cycle involved additional removal of residual fission products from the recovered plutonium using either the solvent extraction method (described here) or the ion-exchange method.
  - In the 1BP concentrating system, the 1BP aqueous product stream from the 1B bank was chemically adjusted, resulting in the 2AF feed stream.
  - In the 2A bank (Cell No. 5D), the 2AF feed stream was contacted with the 2AS aqueous reagent and 2AX organic reagent streams in a continuous manner, resulting in the 2AW aqueous waste stream containing low-level fission products and the 2AP organic stream containing the plutonium.
  - In the 2B bank (Cell No. 5C), the 2AP organic stream was contacted with the 2BX aqueous reagent stream, resulting in the 2BW organic waste stream containing low-level fission products and the 2BP aqueous product stream containing the plutonium.
- The second uranium extraction cycle involved additional removal of residual fission products of recovered uranium using the solvent extraction method.
  - In the 1CU concentrating system, the 1CU scrubbed aqueous product stream from the 1C bank was chemically adjusted, resulting in the 1DF feed stream.
  - In the 1D bank (Cell No. 5B), the 1DF feed stream was contacted with the 1DX organic reagent and 1DS aqueous reagent streams in a continuous manner, resulting in the 1DU organic stream containing uranium and the 1DW aqueous waste stream containing low-level fission products.
  - In the 1E bank (Cell No. 5C), the 1DU organic stream was contacted with the 1EX aqueous reagent stream, resulting in the 1EW organic waste stream containing low-level fission products and the 1EU scrubbed aqueous product stream containing the uranium.

Organic waste streams from the PUREX process were washed for reuse in the solvent extraction process. The aqueous waste solutions were transferred to Building H2 for concentration and storage.

The processes performed in G2 involved both radioactive and chemical constituents. Tables 6-2 and 6-3 summarize the hazardous and radioactive materials that were, or are, present in Buildings G2 and H2, the tunnels, and the Tank Farm.

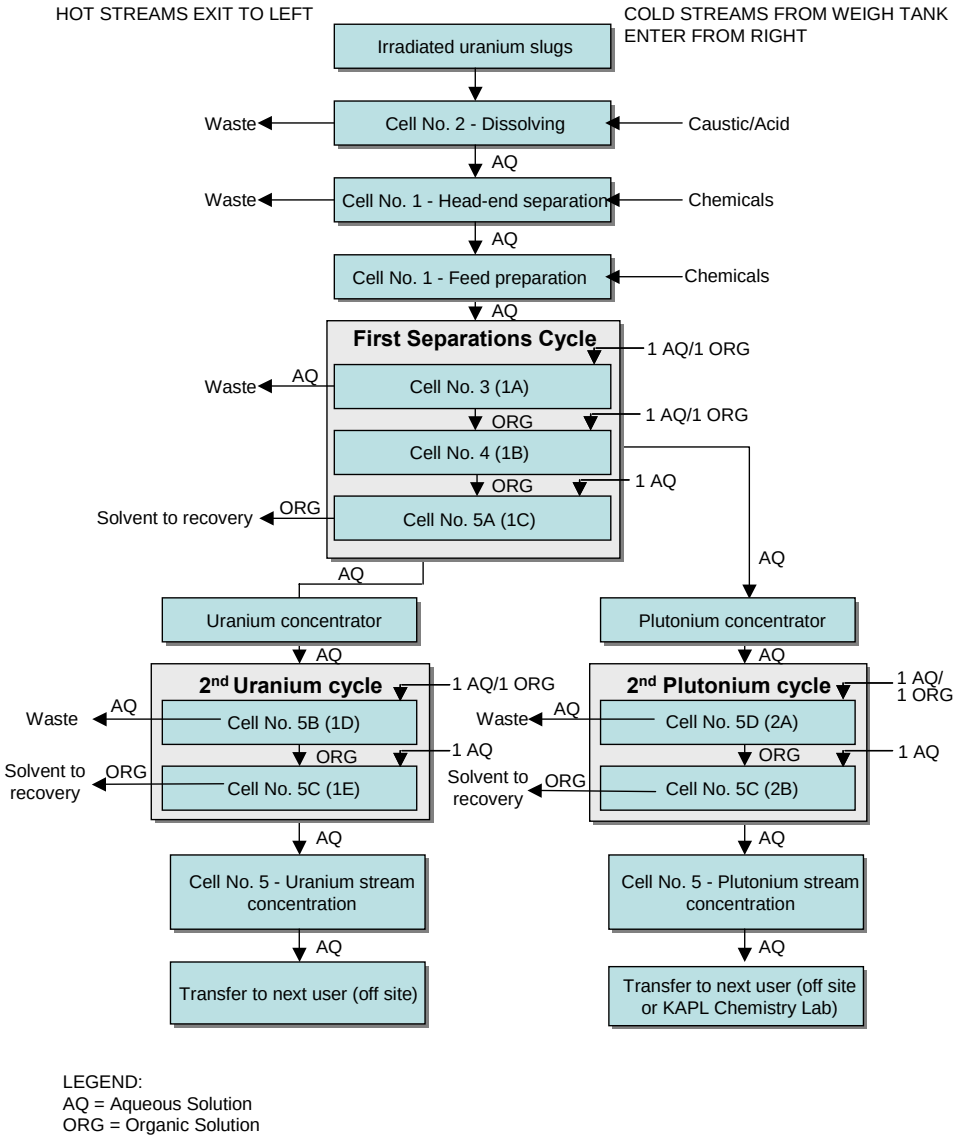


Figure 6-2. G2 Separations Process Summary

Table 6-2. SPRU Radioactive Constituents based on Historical Radiological Surveys

Radionuclide (half-life)		
Am-241 (430 yrs)	Pr (isotope unknown)	Th-231 (26 hours)
Ba-137m (2.6 minutes)	Pu-238 (88 yrs)	Th-234 (24 days)
Cs-134 (2.1 yrs)	Pu-239 (24,000 yrs)	U-234 (240,000 yrs)
Cs-137 (30 yrs)	Pu-240 (6,500 yrs)	U-235 (700 million yrs)
Eu-154 (8.8 yrs)	Pu-241 (14 yrs)	U-238 (4.5 billion yrs)
Eu-155 (5 yrs)	Ra-226 (1,600 yrs)	Y-90 (64 hours)
H-3 (12 yrs)	Sr-90 (29 yrs)	
Pa-234m (1.2 minutes)	Thorium (isotope unknown)	

Section 5.5, Chemical Analysis, provides general information about the chemicals that may be present in the SPRU facilities. Table 6-3 summarizes the hazardous materials associated with SPRU or subsequent processes.

Table 6-3. SPRU-Related Hazardous Constituents and Products

Chemical/Compound/Product	Description and Reference
Acetone	Control valve cleaning following degreasing using CCl_4 and acetone (R-000009, p. 1).
Acidified methyl isobutyl ketone	Unknown (R-001949).
Aluminum (Al)	Detected in 1965, Tank Farm Vault. See aluminum nitrate and aluminum oxide below (R-000026, p. 1, R-000048, p. 34).
Aluminum nitrate Al $(NO_3)_3$	Used in uranium transfer. REDOX only (R-000026, p. 1).
Aluminum oxide, Alumina (Al_2O_3)	Nitric acid solution, ultrasene, and a slurry of Al_2O_3 in water and in acid were used as decontaminating agents for small pieces of equipment such as the caps of sample bases and the interface liquid level floats from the 1C bank (located in Cell No. 5A) (R-000048, p. 34).
Ammonium bifluoride (NH_4HF_2)	Tank decontamination Cell No. 1 (R-000046, pp. 63, 65).
Amsco (Product)	Purchased from the American Spirits Company, possibly used as a diluting agent and as a calibrating fluid or solvent (C-000493, p. 2).
Bismuth (Bi(III))	Laboratory studies. Retention of iodine in process solutions by mercuric salts was studied as a way to hold iodine in solution during various steps of the bismuth phosphate process according to a document dated 1953. It was not clear from the reference whether this activity was associated with SPRU processes in Buildings G2 or H2 (R-000025, p. 1).
Cadmium (Cd)	Elevated concentration noted during 1998 Tank Farm Vault inspection. Vault #509C had the greatest concentration. Vaults 509D and 505 did not have detectable concentrations (R-000025).
Calcium (Ca)	Detected in 1965, Tank Farm Vault. See calcium hypochlorite below (R-000034, p. 82).
Calcium hypochlorite $(Ca(ClO))_2$	Perchloron. Prevents algae growth in cooling tower. Also used in internal tank decontamination (R-000034, p. 82).
Carbon tetrachloride (CCl_4)	Control valve degreasing (R-000009, p. 1).
Cerium (Ce)	Rare earth found in 1BP (located in Cell No. 4) (R-000048, p. 29).
Copper (Cu)	Detected in 1965, Tank Farm Vault. Laboratory studies involving complexing agents tried included copper (Cu(II)). It was not clear from the reference whether this activity was associated with SPRU processes in Buildings G2 or H2. Also, possible result of copper piping deterioration (R-000025).
Floor sealant (Product)	Unknown constituents. The sealant was described generally as a combustible material.
Hexone	Used in SPRU. Open air burning in 1958 proposed. Hexone distilled (relatively free of radioactivity), then proposed to ship to Hanford (C-001957). REDOX process Cell No. 5 - flammable solvent (R-001949, p. 9; R-002087, p. 21).
Hydrocarbons	Back-up generators, pumps/motors, tar, grease.
Hydrofloric acid (HF)	Reacts with solvents and metals. Decontamination of tanks in Cell No. 1 (R-000046, p. 65).

Chemical/Compound/Product	Description and Reference
Iodine (I)	Cake wash, radio-iodine analysis. The iodine balance in the PUREX head-end was described as a method for radio-iodine analysis based on extraction and carrier precipitation and was used for dissolver and hot feed solutions (R-000026, p. 1).
Iron (Fe)	Detected in 1965, Tank Farm Vault. Associated with the second Pu cycle. Iron powder was used in SPRU. Hanford report Hw-22086 reported that sponge iron is satisfactory for use in REDOX plant for making ferrous sulfamate (R-000039, C-000493).
Kerosene (Product)	Amsco (a diluent) and ultrasene kerosene (R-000001, p. 7).
Lead (Pb)	Flooring, plating, paint (lead-based). Lead shields were placed around the flange connections at the top of the simmer tank and the centrifuge agitator shaft to reduce the radiation level. Also, final degradation of radioactive materials. Laboratory studies (R-000046, p. 58).
Magnesium (Mg)	Detected in 1965, Tank Farm Vault. See discussion of magnesium oxide below (R-000001, p. 3).
Magnesium oxide (MgO)	Cake. Magnesium oxide (MnO_2) was used during centrifuging (R-000001, p. 3).
Manganese (Mn)	Elevated concentration noted during 1998 Tank Farm Vault Inspection and detected in 1965. Vault 509D had the greatest concentration. See discussion manganese dioxide, manganese nitrate, sodium permanganate and potassium permanganate below (R-000026, p. 3).
Manganese dioxide (MnO_2)	Cake in the centrifuge (R-000026, p. 3).
Manganese nitrate ($Mn(NO_3)_2$)	Added with permanganate as a part of the head-end treatment in Runs 1-7, July 1952, KAPL 785. Discussed as general use in process (R-000026, p. 3).
Manganese (II) (Mn(II))	Formed by the radiation-induced decomposition of the MnO_2 cake in the centrifuge (R-000041).
Mercury (Hg, Hg (II))	Elevated concentration noted during 1998 Tank Farm Vault inspection. Vaults 509B and 509C had the greatest concentrations. Air sparging/iodine laboratory studies. It was not clear from the air sparging reference whether or not this activity was associated with SPRU processes in Buildings G2 or H2. Equipment may also contain as follows: meters, fluorescent lamps, batteries, switches & relays, vacuum gauges/tubes, thermostats, mercoid switches, thermowells, thermocouples, thermometers (R-000025, p. 1; C-000031, p. 3).
Niobium (Nb)	Detected in 1965, Tank Farm Vault. Nb-Zr decontamination. Used in centrifugation (Cell No. 1). Following the completion of the PUREX runs, the pilot plant was reportedly used from at least December 1953 through March 1954 to prepare source material for another project, which was concerned with the isolation of radioactive Nb-Zr (R-000014, p. 2; R-000001, p. 3).
Nitric Acid (HNO_3)	Used for decontamination of Cell No. 1 (R-002087, p. 26).
Nitrogen gas	Nitrogen was blown through service lines to displace water in the vessel hosting jackets prior to the entry of steam in order to prevent steam hammering. Nitrogen is not likely to remain in G2 (C-000503, R-001949).
Oil (Product)	Spindle oil, pump oil, motor oil, oil to suppress dust. May contain PCBs or other constituents (R-001949, p. 49; R-002087, p. 21).
Oxalic acid $(COOH)_2$	Tank decontamination Cell No. 1 (R-000046, pp. 63, 65).
Permanganate (MnO_4)	Water treatment, head-end step. Added with manganese nitrate as a part of the head-end treatment in Runs 1-7, July 1952, KAPL 785. Sodium permanganate was substituted for potassium permanganate to take advantage of greater solubility and ease of solution (R-000049).
Peroxide	Peroxide preparation, second Pu cycle, to concentrate Pu solution. The elute is precipitated with peroxide. Sulfamic acid introduced as a part of a flush process. Additional steps described included mention of chemicals as follows: a sulfate wash of the resin and elution with nitric acid plus sulfamic acid produced an elute, which was precipitated with peroxide prior to shipment to Los Alamos (June 1952) in the second Pu cycle, which resulted in concentration of the plutonium solution (R-000038, p. 1).
Potassium permanganate ($KMnO_4$)	Sodium permanganate was substituted for potassium permanganate to take advantage of greater solubility and ease of solution (R-000049).
Ruthenium (Ru)	Scrubber contaminant. Approximately 3 percent of the ruthenium (Ru) was found in the scrubber. What was described as a "major portion of ruthenium" was evolved in the simmer tank and plated out on the walls of the tank (R-000026, pp. 3, 4; R-000046, p. 58).
Shop Coolant D-3 (Product)	Unidentified coolant. Possibly ethylene glycol or similar.
Silica	Entrained silica particles heavily laden with Zr and Nb accounted for most of excess activity in runs 18 and 19 resulting in low gamma decontamination factor of the uranium streams. Postulated that the silica particles resulted from dissolution of slug jacket loading material (R-000049).
Silicon (Si)	Detected in 1965, Tank Farm Vault (R-000049).

Chemical/Compound/Product	Description and Reference
Silver (Ag, Ag (II))	Elevated concentration noted during 1998 Tank Farm Vault Inspection. Vaults 509B and 509C had the greatest concentration. It was not clear from the reference whether this activity was associated with SPRU processes in Buildings G2 or H2. Complexing agents tried included silver Ag (I) (R-000025, p. 1).
Sodium (Na)	Detected in 1965, Tank Farm Vault. See discussion of sodium carbonate, sodium hydroxide, and other sodium compounds below (R-000026, p. 1).
Sodium carbonate (Na_2CO_3)	Washing agent (decontamination solvent) (R-000026, p. 1).
Sodium chloride	Unknown (R-001949).
Sodium citrate ($C_6H_5Na_3O_7$)	Decontamination of Cell No. 1. Cake Dissolving: Originally the procedure was discussed whereby the solid material was to be sent directly to storage in mild steel tanks without further concentration and with little or no neutralization. Sodium citrate and nitric acid (solvents) were considered and several tests were made (R-000046, pp. 50, 63, 65).
Sodium dichromate	Corrosion prevention in cooling towers south of G2 and adjacent to H2. Sodium dichromate was added to the basin to reduce the amount of corrosion in pipes (R-000034, p. 82).
Sodium hydroxide (NaOH)	Used to adjust the pH evaporation. Washing agent (decontamination solvent). Discharge to Mohawk River. Reacts with w/solvents and acids. NaOH spray is a part of the G2 cleaning process. Decontamination of Cell No. 1 (R-001949).
Sodium nitrate ($NaNO_2$)	Sodium nitrate ($NaNO_2$) was used in the second uranium run (November 1952-January 1953) to treat the feed mixture. Sodium nitrate was also added to manganese dioxide (MnO_2) particles as they passed through the centrifuge to the feed during the plutonium valence adjustment, resulting in a deterioration of the Nb-Zr decontamination. By product of nitric acid + solvent + metal. Part of flush in second Pu cycle run with Na_2SO_4 and Fe (NO_3) (R-000047, p. 2; R-000047, p. 3).
Sodium permanganate ($NaMnO_4$)	Sodium permanganate was substituted for potassium permanganate to take advantage of greater solubility and ease of solution (R-000049; R-000001, p. 4).
Sodium sulfate (Na_2SO_4)	Cold 2AF mixture with Fe (NO_3) and $NaNO_2$ second Pu cycle.
Sulfamic acid (NH_2SO_3H)	Part of flush process. Ion exchange for second plutonium sequence additive (R-000001, p. 13).
Tributyl phosphate (TBP)	At least some needed to be butanol free, of the purest grade to avoid possible formation of nitration products (C-000493).
Trisodium phosphate (Na_3PO_4)	Decontamination of cells (R-000046, p. 67).
Ultrasene	Type of kerosene that replaced Amsco (a diluent) because of flash point. Closed-cup flash point of ultrasene is 160 degrees F, approximately 15 degrees higher than Amsco (R-000049).
Versene	Ethylene diamine tetracetic acid. Chelating agent used to control metal ions over a broad pH range in aqueous systems.
Zinc (Zn (II))	Elevated concentration noted during 1998 Tank Farm Vault inspection. Vault #509C had the greatest concentration. Laboratory studies involving retention of iodine in process solutions by mercuric salts. It was not clear from the reference whether this activity was associated with SPRU processes in Buildings G2 or H2. Complexing agents tried included Zn (II) (R-000025, p. 1).
Zirconium (Zr)	Detected in 1965, Tank Farm Vault. Head-end step during SPRU (R-000001, p. 3).

Decontamination activities performed after SPRU test runs were completed are summarized in Table 6-4, Building G2 Decommissioning Activities Summary.

Periodic inspections of G2 were conducted after SPRU decommissioning (R-000025). Between May 1989 and October 1989, three inspections were conducted on the Lower and Upper Sample Aisles, Cell No. 5 complex, Cell Access Aisle, Pump Room, and Cells No. 1, 2, 3, and 4 (R-001949, p. 82). Between May 10, 1989 and June 15, 1989, the Upper and Lower Sample Aisles; Cell 1, 2, 3, 4, and 5; and the Cell Access Aisle, Motor Generator Room, and Pump Room were entered. The Crossover Tunnel, G1 West Tunnel, G2 Process Tunnel, G2 Hot Tunnel, and the G2-H2 Tunnel also were inspected (R-001949, p. 88). The October 1992 document, *Preliminary Evaluation of the Status of the Separation Process Research Unit (SPRU),* reports results of the inspections (R-001949).

Table 6-4. Building G2 Decommissioning Activities Summary

Date	G2 Decommissioning Activity
1953	Process cell inlet dampers were closed (R-001949, p. 3), however HEPA filtered exhaust system was left operational and running to maintain the facilities at negative pressure (R-000255). Removed fuses from electrical disconnect switches. Shut down electrical, steam, and gas services. Blanked-off cell open process lines. Flushed processing tanks and pipelines with nitric acid and water, except those normally containing organic solvents. Cells No. 3 and 4 tanks were flushed sufficiently to permit entry, but Cell No. 3, 527 (IAW) tank remained highly contaminated. Cell No. 5 tanks did not emit significant dose rates, but had internal contamination (reported after 1953 R-002036, p. 17) (R-000059, p. 7). Cells No. 3 and 4 cleanups included replaced cell covers, flushed and emptied equipment, and locked door completed. Cell No. 5 "greenhouse," disassembled and discarded as waste. This eliminated the worst G2 plutonium contamination source and Cell No. 5 decontamination completed. The greenhouse was an enclosure around concentrator units in Cell No. 5. (C-000486). Crane Gallery surplus equipment removal and decontamination completed. Filter aisle(s) general cleanup completed. Lower Sample Aisle decontamination completed. Aboveground storage tanks on the east side of G2 contained treated water, caustic material (50 percent sodium hydroxide [NaOH]), and acid material (60 percent nitric acid [HNO_3]) (R-001935, p. 5). The tanks were removed and reused at West Milton.
1954	Blanked-off vents, cut piping, and disconnected electrical service in banks 1A and 1B; mixer-settler banks (with exception of 1A in Cell No. 3 and 1B in Cell No. 4) remained in G2 as of February 1954. DC circuits formerly used to operate mixer-settler banks disconnected. Ventilation system installed to maintain a negative pressure between cells and other areas of Building G2. Cells No. 3 and 4 mixer/settlers removed. Fuses removed from process equipment circuits except for sump pumps; other electrical equipment remained as per original drawings. Cell No. 4 1B bank removed (however, the summary document reviewed did not contain 1B bank disposal or decontamination information (R-001935, p. 8). Cells No. 1, 2, 3, 4, and 5 air supply shut off by closing Crane Gallery dampers. Vents leading to bank 1C were also blanked-off.
1959	Equipment moved in office space areas behind a barrier wall near cell areas.
Mid-sixties	Curies quantities of plutonium and mixed fission products disposed, leaving residual contamination on floor, walls, overhanging pipes, process tanks and in-process pipes and tanks (R-000155, p. 1). Process lines isolated. Contaminated solid waste packaged and shipped for off-site disposal (R-001949, pp. 5, 6). Gross contamination from floor and equipment surfaces, loose equipment and debris, and liquid and sludge process tanks removed. Loose contamination was removed from floor and equipment surfaces. Movable equipment and loose debris were removed. Liquids and sludge were removed from process tanks. G2 ventilation stack was removed and relocated to another site at KAPL (R-000255).
1970s 1980s	A ventilation system reverse flow occurred in either the late 1970s or early 1980s, contaminating previously decontaminated areas such as sample aisles (I-000418). In 1977, a KAPL Facilities Deactivation Program was initiated; use of the SPRU Tank Farm was discontinued and routine entry into the SPRU facilities was no longer allowed. In the mid- to late-1980s, the G3 pump house and scrubber stack were removed and the radioactive laundry line between H2 and K4 (the radioactive laundry) was removed (R-000255). KAPL performed a comprehensive physical inspection and radiological survey of the SPRU buildings and a new Hillside Drain system was put online.
1999	Autoclave test in room G2-174 dismantled (C-001950, p. 1). G1/G2 test functions relocated to facilities (C-001950, p. 1).

Waste Management

Liquid waste generated during SPRU research activities was sent to H2 for treatment. Radioactive solid waste produced by SPRU research activities included combustible waste, incinerator ash, evaporator sludge, and contaminated equipment and miscellaneous materials. Miscellaneous radioactive material items such as decontamination materials (mops, rags, etc.), paper used as floor covering, protective clothing, air system filters, floor sweepings, and tools that could not be effectively cleaned to acceptable levels was collected, segregated, packaged, and stored until disposed off site (R-001949).

During SPRU research activities, two incinerators were used at KAPL. The Cold Incinerator (Unregulated Incinerator) was located in the KAPL Building J-3 Lower Level. The Hot Incinerator, also referred to as the Pilot Incinerator, was located on the north side of Building F1, east of H2.

The Cold Incinerator was used to dispose of uncontaminated combustible waste, consistent with the industrial and municipal practices of the time. The waste was primarily from offices and laboratories and consisted of materials such as paper scrap, cardboard, and plastic. Although waste segregation programs ensured that waste burned in the Cold Incinerator came from areas that were not producing contaminated waste, low-level radioactive waste was inadvertently burned in a few instances. Even when properly segregated wastes were burned, naturally occurring radionuclide concentrated in the ash. As a result, Cold Incinerator ash usually contained detectable radioactivity. Although ash radioactivity was very low, the ash was disposed as radioactive waste (R-001949).

Hot Incinerator development began in March 1949, with burning tests of non-radioactive waste beginning in February 1950. Incineration began in February 1951, following tests and modifications. The incinerator operated in a partial vacuum to ensure that exhausted radioactive materials passed through the scrubber and filter. The Hot Incinerator was placed in standby status, dismantled, and removed by August 1952. During the months the Hot Incinerator was operated, approximately 20,000 pounds of low-level radioactive combustible waste were burned. Incinerated solid waste was shipped to the Lake Ontario Ordnance Works until 1954, stored until 1958, and then shipped to Oak Ridge National Laboratory for disposal (R-001949).

Building G2 Post-1953

Use of SPRU facilities for REDOX and PUREX research was terminated in June 1953. Shortly afterwards, the Control Room, portions of the constant head tank levels, the Rotameter Room, and change rooms were converted to a machine shop, test areas, drafting rooms, engineering and scientific offices, and library space for KAPL research (R-000155, pp. 1, 2). Documentation and evidence of other G2 activities and modifications from the mid-1950s to the early 1990s for KAPL activities included:

- A letter dated December 11, 1953 stating, “Most of the equipment described is still in use, although some of it was devoted purely to REDOX work and has since been either dismantled or modified. At the present time, the pilot plant is being used to prepare source material for another project that is concerned with the isolation of radioactive zirconium-niobium. This work was scheduled to be suspended in the early part of March 1954” (R-000472).
- A wastewater concentrator in the north end of Building G2 listed as KAPL SWMU-026 (R-002170) consisted of two 50-gallon wastewater accumulation tanks (one polyethylene, the other stainless steel), a steam- and electric-heated stainless steel 55-gallon wastewater concentrator drum, two overflow collection tanks (one stainless steel, the other polyethylene), and several secondary containment structures. The wastewater concentrator unit operated in the mid-1980s, to concentrate non-hazardous Corrosion Coolant Test Facilities (CCTF – a Naval Reactors facility) wastewater. SWMU-026 is no longer listed on the RCRA permit.
- The Experimental Engineering Laboratory utilized G2 areas modified after 1954, including the truck well and storage area that became the autoclave area. In 1999, a turnover report outlined

KAPL activities to be moved to another KAPL facility and listed equipment that would remain, to be dispositioned with G2 (C-001950).

- In 1961, either the Lower or Upper Filter Room was converted to a KAPL laundry facility (references do not specify which) (C-000106, pp. 1-2).
- KAPL used the Lower Filter Area as a welding school in 1976 (R-002085, p. 4).

6.2 Building H2 History

Building H2 was the SPRU waste processing facility constructed to store and process radioactive liquid waste from the G2 process pilot plant and operated from July 1949 to October 1953. It processed waste generated in G2 that was sent to H2 through drain lines in the tunnels and in drums. Drums permitted settling of solids so that the supernatant only was decanted into the H2 waste disposal system, and permitted oil removal (C-000450). It also processed waste from the laundry, hot incinerator scrubber, and from other site laboratories conducting research.

During this time, H2 processed large quantities of liquid waste. For example, in the first three quarters of fiscal year (FY) 1952, 2,705,000 gallons of radioactive liquid waste was processed (R-000505). A March 16, 1950 letter stated, "At the present time we are receiving approximately 2,500 gallons a day of waste from G-1, E-1, and G-2 buildings" (C-000460). A plan to send waste from Building F to Building H using disposable hoses rather running a new drain line was also considered (C-000470). On January 31, 1952, a KAPL letter was issued stating that the additions of drain lines were no longer allowed without approval from the person responsible for H2 waste management. The letter expressed concern that non-radioactive waste was being sent to H2 and being processed at an unnecessarily high cost, and that the quantities of waste being sent to H2 were overloading H2's capacity (C-000451). A KAPL instruction was issued stating that new waste lines into H2 must be approved, including new tie-in lines to existing drain headers and that non-routine (frequency of less than once per day), large (greater than 500 gallons) waste volumes must also be approved before waste could be sent to H2 (C-000452). Instructions were also given to personnel in E1, G1, and the Radioactive Materials Laboratory (C-000448), E-2 (C-000454), and G2 (C-00449) on how to transport waste drums to H2.

As more waste was sent to H2, internal procedures were developed to help manage the volume. In May 1952, a letter stated that casks (drums) brought to H2 for treatment must be tagged with the contents and the source (C-000454). In another memo, H2 operators expressed concern about the presence of tributyl phosphate in the laboratory wastes, and requested that tributyl phosphate not be poured into the sinks, "except for extremely small amounts where the total amount discarded will not be in excess of 5-10 ml per laboratory per day" (R-000447).

Building H2 was exhausted through glass wool and HEPA filters and released through a 60-foot high exhaust stack.

In 1953, SPRU decommissioning began. H2 tanks and lines were flushed with nitric acid and water. HEPA filtered exhaust ventilation systems remained operational to maintain negative pressure in the facility. The H2 incinerator was shut down in 1954.

Between July and December 1963, the following Building H2 changes were initiated:

- A small temporary ion exchange filter system for processing waste evaporator distillate before release to the sewer system was installed (R-001993, p. 3).
- The east and west evaporator systems were decontaminated and a new evaporator heat exchanger and slurry pump installed (R-001993, p. 3).
- The Slurry Drum Facility was built on the north side of H2 after 1963 to manage slurry drums.

- Two K5 30,000-gallon retention pits were reactivated for diverting Building H2 process steam condensate water and evaporator distillate, providing an additional control point for Building H2 liquid effluent (R-001993, p. 3).
- Preparations began for installing a separate controlled drainage line from the Radioactive Materials Laboratory to Building H2 to isolate Radioactive Materials Laboratory wastes from the low-level large volume wastes generated by other KAPL activities (R-001993, p. 4).

Radioactive liquid waste that was stored in the underground Tank Farm was disposed in 1964 and 1965. More than 20,000 gallons of waste was processed and disposed off-site. Waste processing methods included packaging evaporated liquid and solidified slurry with absorbent material in concrete-shielded drums and pumping and solidification of liquid directly with cement and/or absorbent material in large volume steel tanks. The solidified waste and containers were transported for off-site burial in reusable concrete-shielded or lead-shielded shipping containers (R-001949, I-000422).

Additional Building H2 cleanup performed in 1966 included:

- Removing loose contamination from floor and equipment surfaces
- Isolating process lines
- Removing movable equipment and loose debris
- Removing liquid and sludge from process tanks
- Relocating 332-foot level condenser cooling water supply and return pipes and concrete curbs surrounding the duct penetrations in the 332-foot level floor (R-002108, pp. 18-19)
- Packaging and shipping contaminated waste for off-site disposal (I-000422).

The 1966 cleanup also entailed removing 14 steel filter boxes, numbered 12 to 25, located in two banks toward the south end of the 332-foot level. In July 1966, contamination was found on top of the filter boxes in the area where a barrel had exploded several years previously. The average reading was 30 milliRem per hour beta-gamma (C-000427). Removing the filter boxes involved removing or relocating and sealing ductwork servicing the filter boxes, relocating the vent header line condenser to the 319-foot level, and removing vent header ductwork.

The neutralizer cells reportedly were taken out of service in 1984 (I-000426).

Throughout the post-SPRU period, radiological incident reports and other documentation indicate radioactive contamination in H2 from both SPRU and non-SPRU program use (I-000422). On June 13, 1986, radioactivity measuring 1,000 counts per minute was found on one strand of a mop head. The mop was used to dry mop the 332-foot level work area only. Preliminary isotopic analysis indicated gamma activity from cesium-137 and cesium-134 (C-000860, Attachment 1, Radiological History for H2). Similarly, floor sweepings of an area in Building H2 surveyed on December 3, 1987 showed 3,000 counts per minute beta-gamma radioactivity. Isotopic analysis of the contaminated debris showed fission product activity typical of contamination found in Radioactive Materials Laboratory waste that is approximately 3 to 7 years old (C-000860, Attachment 1, Radiological History for H2). On January 13, 1988, while performing routine housekeeping on the 332-foot level of Building H2, a radioactive waste processor accumulated debris, including a bolt, on a dust mop from a fixed contamination area under the south exhaust fan. The bolt and floor debris were surveyed. The bolt measured 300 counts per minute fixed beta-gamma and no detectable alpha. The floor debris measured 1,000 counts per minute beta-gamma and no detectable alpha. The primary isotope identified on the bolt and in the debris was cesium-137. The bolt apparently vibrated loose from the base of the fan belt guard, releasing formerly fixed contamination (C-000860, Attachment 1, Radiological History for H2).

The 309-foot level North Hopper Cell was last accessed in 1989. The dose rate at that time was 10 milliRem per hour with a limit of 2 hours restricted personnel access into the room (R-001836).

The 319-foot level former RW Cell was last accessed in 1979, when the dose rate was 10 milliRem per hour with a limit of 2 hours restricted personnel access into the room (R-001836).

6.3 Tunnel History

Between 1950 and 1954, SPRU facilities and KAPL laboratories in buildings E1, E2, E3, E4, D3, D4, and G1 managed liquid waste using drain lines that traversed the tunnels to the H2 waste management process equipment (R-001949). Treated process liquids were returned to E1, G1, D4, and Radioactive Material Laboratory laboratories through pipes in the H2, G2, and G1 Tunnels (R-000255, p. 13).

Following SPRU decommissioning, pipes and equipment were generally drained and flushed with nitric acid and water for decontamination. Some pipes were cut, capped, or turned off with a valve (R-00156, p. G-79). However, no specific records indicate which pipes were cleaned or modified.

In 1964, 20 pounds of mercury present for an indefinite period in the G1 Tunnel were removed from the floors (C-000860, Attachment 3).

During or shortly after the SPRU research activities ended, p-traps and vents were installed in E1 and G1 laboratory drains to collect chemicals such as heavy metals and mercury. Although not specifically documented, the p-traps and vents were disconnected possibly in the late 1970s (I-000421).

The Radioactive Materials Laboratory radioactive liquid waste reuse system was activated in 1977, using the SPRU tunnels to transport liquid waste from the Radioactive Materials Laboratory and the D, E, and G buildings to H2 for treatment and processing. This is a "closed loop" system that treats wastewater in ion exchange resin columns in H2 and returns clean water to the laboratories.

Sometime in the 1980s, it was reported that liquid waste from the Radioactive Materials Laboratory was not reaching H2; apparently the pipes were clogged enough that liquid input to the system did not reach H2. The system was flushed with water in an attempt to clean it out, but eventually an eighteen-inch section of pipe outside the G1 West Tunnel was replaced (I-000422). When this pipe was replaced, it was noted to be approximately 90 percent full of solids and sludge (I-000421).

In 2001, drain lines from the D, E, and G building complex were rerouted to a waste management facility in building E11. Only the Radioactive Materials Laboratory continues to use the H2 radioactive liquid waste reuse system.

The E1 laboratory liquid waste originally went through the E1 tunnels, the G1 tunnel, and the G2 Hot Tunnel to H2. Most original tunnel piping and equipment remains in the E1 tunnels. G1 laboratory liquid waste went from the G1 tunnels to the G2 Hot Tunnel to H2.

In order to lower the dose rates in the work area above the tunnel ceiling, lead shielding was added in the 1990s to the two interceptors in the eastern portion of the E1 Tunnel below Room E135 (C-000298, p. 1; C-000637). The interceptors are 30-gallon drums with a sump pump.

After SPRU operations ended in 1953, at least two contamination events occurred in the E1 and G1 East tunnels. Water infiltrated the E1 and G1 Tunnels in the late 1980s and early 1990s. The E1 interceptors overflowed due to pump failure, filling the sump with water and sludge and highly contaminating the E1 tunnel and sumps. Secondly, until 2001, the E1 and G1 laboratories continued using the tunnel system to H2. In the late 1990s, the E1 Tunnel piping was flushed (I-000422). In 2001, the D, E, and G building complex drain lines were rerouted to a new waste management facility in building E11.

The Crossover Tunnel managed G2 waste and processing liquids and other laboratory waste. In 1983, an interceptor tank connected to the Radioactive Materials Laboratory reuse system overflowed in the Crossover Tunnel. The interceptor was subsequently by-passed (R-000114, p. 2).

The G2-H2 Tunnel transported liquid waste and process liquids from G2 process areas and other buildings to the H2 liquid waste process and storage areas. The G2-H2 Tunnel connects the G2 Hot and Process Tunnels on the south to the H2 Pipe Tunnel on the north (C-000014, p. 6).

In 1976, the G2-H2 Tunnel sump was connected to one of the three 10,000-gallon storage tanks on the lower level of H2 (C-000142). Following the 1989 inspection, KAPL addressed G2-H2 Tunnel water infiltration (C-000196) by installing a plastic hose that pumped water from the tunnel floor sump to processing equipment in the H2 lower level, preventing water buildup on the tunnel floor. Concrete slab hatchway leaks were caulked and the floor was grouted (C-000196).

During the 1989 inspection, the sump at the north end of the tunnel was observed to be highly radioactive (1-Rem per hour) and contained sludge (R-001949). During the 1980s, sludge was cleaned out of the same sump (I-000422). The source of inflow to the sump is unknown. It is speculated the seepage in the north end of the tunnel could be the source, or that the interconnectivity of the SPRU sumps with the G2-H2 sump being the low point in the system is the cause.

Reportedly, the G2-H2 Tunnel was periodically flooded to reduce worker radiation doses (I-000422). Watermarks in the flat portion of the tunnel are consistent with a 1-foot lip at the south end of the tunnel, adjacent to the H2 Tunnel and Building H2 connection. G2-H2 Tunnel water seepage to surrounding soil was not known to occur and watermarks were not attributed to tunnel pipe leaks (C-000997, p. 1).

6.4 Tank Farm History

Following SPRU decommissioning in 1953, Tank Farm use continued for storage of liquid waste until 1978 (R-000255, p. 3). The first comprehensive cleanout of the tanks occurred in 1965, when SPRU and other KAPL waste in the tanks was removed and disposed of off-site (R-000056, p. 1).

In the 1965 cleanout, radioactive SPRU liquid waste stored from 1954 in Tank Farm Tanks 505 and 509A and in H2 Neutralizer Cell No. 4, Tank 320, was removed. The 22,550 gallons of waste consisted of "2,377 Curies of activity (fission products), 903 Kg of depleted uranium, and 539 grams of plutonium" (C-000118, p. 1).

Between March and October 1978, the Tank Farm tanks were emptied of all liquid waste. Letter A0-6191-606, Contaminated Liquid Waste Disposal, H2 Tank Farm, Request for Concept Approval, outlined the method proposed for disposing of an estimated 26,915 gallons of contaminated liquid waste stored in the H2 Tank Farm. Liquid from the tanks was to be transferred to the south tank, A525-A, using remotely operated steam adductors. The liquid was then to be pumped from the A525-A tank using an installed evaporator feed pump and temporary piping to the pump discharge line, and then run through the pipe chase to the temporary volumetric filler located at the 332-foot level of H2. From the volumetric filler, the liquid waste was to be solidified and sealed in 55-gallon drums and shipped for disposal to the Chem Nuclear Facility located in Barnwell, South Carolina (C-002033, pp. 1-2, 4-5; C-002052, p. 2).

There have been no Tank Farm construction modifications except for addition of a surveillance camera in each Tank Farm vault for monitoring groundwater infiltration and plastic piping to allow for vault draining following the 1989 inspection (R-001949).

Water infiltration into the Tank Farm vaults has been a continuous problem. Water leaked into the tank vaults as early as 1952, in "considerable" quantities. Concern was expressed because the water had to be processed through the evaporators, causing them to run at near capacity (C-000458). Draining accumulated water and maintaining dry vaults was recommended and implemented in 1956 as a groundwater contamination preventative measure (R-000057, pp. 3-8; C-000063, pp. 2-3; C-000067, p. 1).

In 1952, a drainage tile system designed to alleviate rainwater seepage was installed above the Tank Farm vaults. The tile sections connect at the 320 foot elevation to the main drainage system, which runs parallel to the east side of the Tank Farm, along the north side of H2, and down an embankment to a concrete catch basin. The catch basin drains to the storm sewer, but also overflows to the drainage ditch along the east side of the road to the lower level (R-000057, pp. 3-8, C-000063, pp. 2-3).

Table 6-5 presents the approximate amount of water on vault floors in 2000 and historically (R-001304, Attachment 1, p. 8).

Table 6-5. Estimated Water Present on Vault Floors from 1978 to 2000 (Gallons)

Vault	1978(1)	1989(2)	1998(3)	2000(4)
505	375	60	25	N/A
509A	6,000	275	4,500	7,907
509B	1,325	315	50	N/A
509C	8,145	20	20	N/A
509D	2,375	0	0	N/A
509E	8,250	2,650	800	1,482
578	970	0	0	N/A

(1) 1978 values from ES-RJC-9803, Historical Review of Tritium Concentrations in Knolls Site Samples, November 11, 1998; there was no tarp over the Tank Farm at this time.
(2) 1989 volumes are totals of volumes pumped prior to the inspection plus residual volumes estimated by visual observation during inspection.
(3) 1998 volumes estimated from visual observation during the inspection.
(4) 2000 volumes pumped from April to August 2000; only vaults 509E and 509A were pumped at this time.

In the spring of 1952, four test wells were drilled around the Tank Farm in response to concerns about the potential soil and groundwater contamination near H2 and the Tank Farm. Test wells No. 1 (35.9 feet deep) and No. 2 (134.5 feet deep) were drilled approximately 7 feet north of the Tank Farm, approximately 10 feet apart. Test Well No. 3 (35.9 feet deep) was drilled east of the Tank Farm in the 509C Vault area. Test Well No. 4 (32.9 feet deep) was drilled approximately 5 feet south of the Tank Farm. Well tests (in particular from Well No. 1) between 1952 and 1956 suggested some leaking or seepage of radioactive liquids from Tank Farm vaults and possible seepage from the H2 tunnel. The Tank Farm vaults were determined to be the most probable groundwater contamination source.

Additional sampling from sample points No. 1 and No. 4 indicated gross beta activity in the range of less than or equal to 4.2×10^{-9} to $(1.41 \pm 0.88) \times 10^{-8}$ microCuries per milliliter and gross gamma activity in the range of less than or equal to 1.8×10^{-8} to $(3.15 \pm 2.22) \times 10^{-8}$ microCuries per milliliter. Strontium-90 was identified in these samples. Gross alpha analysis indicated all samples to be less than or equal to 10^{-9} microCuries per milliliter (R-000057, pp. 3-8; C-000063, p. 1; C-000154, Table 1 and Figure 1). Core boring samples obtained near the Tank Farm in 1974 failed to demonstrate discernible levels of ground contamination (C-000445).

In 1983, a tarp intended to divert water from the Tank Farm area to the H2 Hillside Drain system was installed over the Tank Farm (R-001304, Attachment 1, p. 7). Following the 1989 inspection, a new plastic tarp was installed over the Tank Farm and covered with gravel. The second tarp was still in place in 1997 (C-000396, p. 4). Plans to periodically pump down the vaults following the 1989 inspection were abandoned and the vaults were not pumped down before the 1998 inspection. Vaults 509A and 509E were pumped intermittently from April to August 2000 (R-001304, Attachment 1, p. 16), after which KAPL planned to pump down the Tank Farm vaults at least every 3 years (R-001304, Attachment 1, p. 8).

Tank and Vault 505 Contamination History

Table 6-6 describes the radiological history resulting from the vault and tank inspections and the resulting radiological survey and analysis findings. Table 6-7 summarizes 505 Tank and Vault chemical history.

Table 6-6. Tank and Vault 505 Radiological History

Date	Area	Visual Impressions	Summary Findings (Reference)
6/1/1963	505 Tank	Volume of waste = 11,000 gallons (Note: R-002047, p. 4, suggests tank overflow into the vaults during the past)	Radiochemical analysis identified: Plutonium (accountability) – 81 g, Plutonium (observed) – 11 g Uranium (accountability) – 308 kg, Uranium (observed) – 181 kg Cs-137 (observed) – 377 Ci, Sr-90 (observed) – 354 Ci (R-000115, p. 4)
4/1/1965	505 Tank	Volume of waste = 8,250 gallons	Unknown method of identification: Pu – 9 g, Depleted Uranium – 136 kg, Cs-137 – 283 Ci, Sr-90 – 266 Ci (C-000118, attachment b, p. 2)
12/1971	505 Vault	None	General radiation in cell: 1 Rem/hr – 2 Rem/hr beta 100 mRem/hr – 150 mRem/hr gamma (R-000385, Table 4)
12/1971	505 Tank	Volume of sludge heel – 300 gallons	Concentration of tank contents: 1 x 10^3 pCi/gal alpha 1x 10^8 pCi/gal beta-gamma (R-000385, Table 4)
Unclear; possibly 1965; letter from 1977 or 1978 considers results current	505 Tank	Approximate volume = 250 gallons (Cs-137 observed in gamma spectra Gross beta expressed as equivalent Sr-Y-90)	Radiochemical results (µCi/ml): (2.33 ± 0.02) x 10^{-3} gamma; (2.62 ± 0.04) x 10^{-3} beta; (7.83 ± 0.48) x 10^{-5} alpha; (3.1 ± 1.0) x 10^{-6} tritium Spectrographic chemical analysis (ppm in liquid waste with error of ± 2): Na – 115; Ca – 70; U – 1200; Ba – <6; Mg – 25; Ni – 115; Si – 55; Al – 55; B – <0.3; Fe – 225; Zr – 25; Cu – 3; Mn – 7; Be – <0.03; Cr – 8; Pb – 5; Nb – 3; P – 280; Ti – <1 (C-002033, encl. pp. 1-2; C-002049, attachment)
9/12/1989	505 Vault	Vault structurally sound Piping and pipe fittings in vault sound Residual water covers vault floor to maximum depth ¼ inch at drainage channel; dirt, dust, and debris visible beneath clear water; waterproofing material from walls visible at various locations on floor Tar-like substance (believed to be sealant applied to ceiling) present on portions of ceiling, walls, floor, and outer tank and piping; less in this vault than noted in other vaults Streaks of water on west and south walls with actual water drops or sheeting on west wall; condensation appears to be cause of water, similar to what was observed in 509B Vault Water lines on vault walls and tank to about 5 feet above floor; no water was pumped from this vault prior to inspection Air flow into vault during inspection > 26 ft^3/min; normally no air flow	Gamma readings range from <1 mRem/hr 1 foot below ceiling to 114 mRem/hr at 304-foot level Beta and gamma readings range from <100 mRem/hr 1 foot below ceiling to 400 mRem/hr at 304-foot level Data indicate contamination contribution from sludge heel in tank Reading from tool elbow which rubbed against south wall about 12 feet from floor had no detectable contamination by direct probe; tool head and camera housing, which came into contact with west end of tank, read 4,200 cpm above background beta-gamma by direct probe Floor contamination measured by radiation levels taken from 409 detergent-dampened rag: 0.3 mRem/hr open window and 0.2 mRem/hr closed window with RO-2 radiac; Q-tips swiped on rag read 3,400 cpm above background beta-gamma and 20 cpm alpha Vault surface radionuclide distribution and Ci content: Cs-137 – 88.7%, 0.80 Ci content, 0.0092 g Pu-239 – 0.6%, 5.4x10^{-3} Ci content, 0.087 g Am-241 – 0.1%, 9x10^{-4} Ci content, 0.0002 g Sr-90 – 10.6%, 0.096 Ci content, 0.7x10^{-3} g Vault sump sample radionuclide analysis results (µCi/ml) (pre-inspection samples collected from existing lines connected to common header in H2, 309-foot level):

Date	Area	Visual Impressions	Summary Findings (Reference)
			No information due to blockage in lines (new lines subsequently installed) (C-000203, Part I, pp. 18-19)

Table 6-7. Tank and Vault 505 Chemical History

Date	Area	Summary Findings (Reference)
Unknown (prior to 3/17/1965)	505 Tank	X-ray fluorescence identified in g/gal: U – 13.7, Cr – 1.7, Mn – 0.57, Fe – 1.2, Ni – 0.20, Pb – 0.04, Al – not given, Si – not given (R-000115, p. 3)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	505 Tank	Spectrographic chemical analysis (ppm in liquid waste with error of ± 2): Na – 115; Ca – 70; U – 1200; Ba – <6; Mg – 25; Ni – 115; Si – 55; Al – 55; B – <0.3; Fe – 225; Zr – 25; Cu – 3; Mn – 7; Be – <0.03; Cr – 8; Pb – 5; Nb – 3; P – 280; Ti – <1 (C-002033, encl. pp. 1-2; C-002049, attach.)

Tank and Vault 509A Contamination History

Table 6-8 describes the radiological history resulting from 509A Tank and Vault inspections including visual observations and summarized radiological survey and analysis findings. Table 6-9 summarizes 509A Tank chemical history.

Table 6-8. Tank and Vault 509A Radiological History

Date	Area	Visual Impressions	Summary Findings (Reference)
6/1/1963	509A Tank	Volume of waste = 11,000 gallons (Note: R-002047, p. 4, suggests there was past Tank overflow into the Vaults)	Radiochemical analysis identified: Pu (observed) – 464 g, U (observed) – 611 kg Cs-137 (observed) – 636 Ci Sr-90 (observed) – 704 Ci (C-000118, attach. b, p. 2; R-000115, p. 4)
4/1/1965	509A Tank	Volume of waste = 1,350 gallons	Unknown method of identification: Pu – 452 g, Depleted U – 604 kg, Cs-137 – 520 Ci, Sr-90 – 520 Ci (C-000118, attach. b, p. 2)
12/1971	509A Vault	None	General radiation in cell: 1 Rem/hr – 2 Rem/hr beta 100 mRem/hr – 150 mRem/hr gamma (R-000385, Table 4)
12/1971	509A Tank	Volume of sludge heel = 350 gallons	Concentration of Tank contents: 1 x 10^4 pCi/gal alpha 1x 10^8 pCi/gal beta-gamma (R-000385, Table 4)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	509A Tank	Approximate volume = 5,775 gallons (Cs-137 observed in gamma spectra Gross beta expressed as equivalent Sr-Y-90)	Radiochemical results (µCi/ml): (2.19 ± 0.05) x 10^{-4} gamma; (3.04 ± 0.04) x 10^{-3} beta; (4.11 ± 0.37) x 10^{-6} alpha; (4.7 ± 0.7) x 10^{-6} tritium (C-002033, encl. pp. 1-2; C-002049, attachment)
9/12/1989	505 Vault	Vault structurally sound Piping and pipe fittings in vault sound Residual water covers vault floor to maximum depth ¼ inch at drainage channel; dirt, dust, and debris visible beneath clear water; waterproofing material from walls visible at various locations on floor. Tar-like substance (believed to be sealant applied to ceiling) present on	Gamma readings range from <1 mRem/hr 1 foot below ceiling to 114 mRem/hr at 304-foot level Beta and gamma readings range from <100 mRem/hr 1 foot below ceiling to 400 mRem/hr at 304-foot level Data indicate contamination contribution from sludge heel in tank Reading from tool elbow which rubbed against south wall about 12 feet from floor had no detectable contamination by direct probe; tool head and camera housing, which came into contact with west end of tank, read 4,200 cpm above

Date	Area	Visual Impressions	Summary Findings (Reference)
		portions of ceiling, walls, floor, and outer tank and piping; less in this vault than noted in other vaults Streaks of water on west and south walls with actual water drops or sheeting on west wall; condensation appears to be cause of water, similar to what was observed in 509B Vault Water lines on vault walls and tank to about 5 feet above floor; no water was pumped from this vault prior to inspection Air flow into vault during inspection > 26 ft^3/min; normally no air flow	background beta-gamma by direct probe Floor contamination measured by radiation levels taken from 409 detergent-dampened rag: 0.3 mRem/hr open window and 0.2 mRem/hr closed window with RO-2 radiac; Q-tips swiped on rag read 3,400 cpm above background beta-gamma and 20 cpm alpha Vault surface radionuclide distribution and Curie content: Cs-137 – 88.7%, 0.80 Ci content, 0.0092 g Pu-239 – 0.6%, $5.4x10^{-3}$ Ci content, 0.087 g Am-241 – 0.1%, $0.9x10^{-3}$ Ci content, 0.0002 g Sr-90 – 10.6%, 0.096 Ci content, $0.7x10^{-3}$ g Vault sump sample radionuclide analysis results (µCi/ml) (pre-inspection samples collected from existing lines connected to common header in H2, 309-foot level): No information due to blockage in lines (new lines subsequently installed) (C-000203, Part I, pp. 18-19)

Table 6-9. Tank 509A Chemical History

Date	Area	Summary Findings (Reference)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	509A Tank	Spectrographic chemical analysis (ppm in liquid waste with error of ± 2): Na – 350; Ca – 45; U – <20; Ba – 10; Mg – 35; Ni – 10; Si – 10; Al – 2; B – 4; Fe – 10; Zr – 1; Cu – 0.5; Mn – 1; Be – <0.01; Cr – 0.7; Pb – <0.6; Nb – 0.4; P – 10; Ti – <0.4 (C-002033, encl. pp. 1-2; C-002049, attachment)

Tank and Vault 509B Contamination History

Table 10-9 describes the radiological history resulting from 509B Tank and Vault inspections, including visual observations and summarized radiological survey and analysis findings. Table 6-11 summarizes 509B Tank chemical history.

Table 6-10. Tank and Vault 509B Radiological History

Date	Area	Visual Impressions	Summary Findings (Reference)
12/1971	509B Vault	None	General radiation in cell: 1 Rem/hr – 2.5 Rem/hr beta 100 mRem/hr – 150 mRem/hr gamma (R-000385, Table 4)
12/1971	509B Tank	Volume of sludge heel = 250 gallons	Concentration of tank contents: 1×10^4 pCi/gal alpha $1x\ 10^7$ pCi/gal beta-gamma (R-000385, Table 4)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	509B Tank	Approximate volume = 1,150 gallons (Cs-137 observed in gamma spectra Gross beta expressed as equivalent Sr-Y-90)	Radiochemical results (µCi/ml): $(7.56 \pm 0.22) \times 10^{-5}$ gamma; $(1.46 \pm 0.02) \times 10^{-3}$ beta; $(2.04 \pm 0.10) \times 10^{-5}$ alpha; $(3.4 \pm 1.0) \times 10^{-6}$ tritium (C-002033, encl. pp. 1-2; C-002049, attach.)
9/11/1989	509B Vault	Vault structurally sound Piping and pipe fittings in vault sound	Gamma readings range from 3 mRem/hr 1 foot below vault ceiling to 35 mRem/hr at the 307-foot level

Date	Area	Visual Impressions	Summary Findings (Reference)
		Ranges from film to approximately ½ inch water (near drainage channel leading to sump) over floor; clear water; dirt, concrete dust, and debris visible through water Tar-like substance (believed to be sealant applied to ceiling) present on portions of ceiling, walls, floor, and outer tank and piping Streaks of water on west and south walls; west wall appeared to be damp believed to be significant condensation Several water lines on tank and walls up to approximately 6.5 feet from floor; darkest water line at approximately 18 inches from floor; inconsistent with 295 gallons removed from Vault sump prior to inspection (would have been to less than 3 inches) Cement waterproofing material installed on lower 3 feet of walls not readily apparent Air flow into vault during inspection > 69 ft^3/min; normally no air flow	Beta and gamma readings range from <100 mRem/hr 1 foot below vault ceiling to 300 mRem/hr at the 307-foot level Data indicate contamination contribution from sludge heel in tank Reading from tool elbow which contacted south wall near ladder about 12 feet from floor was 800 cpm beta-gamma by direct probe; reading from tool head and camera housing was 30,000 cpm beta-gamma by direct probe and 2.4 mRem/hr open window with RO-2 radiac Floor contamination samples from a 409 detergent-dampened rag measured with an RO-2 radiac: 2.2 mRem/hr open window and 0.6 mRem/hr closed window; Q-tips swiped on rag read 10,000 cpm beta-gamma and 30 cpm alpha Vault surface radionuclide distribution and Curie content: Cs-137 – 36.2%, 0.74 Ci content, 0.0086 g Pu-239 – 27.8%, 0.57 Ci content, 9.2 g Am-241 – 2.7%, $5.5x10^{-3}$ Ci content, 0.017 g Sr-90 – 33.3%, 0.68 Ci content, $5.0x10^{-3}$ g Vault sump sample radionuclide analysis results (µCi/ml) (pre-inspection samples collected from existing lines connected to common header in H2, 309-foot level): Cs-137 – $5.1x10^{-3}$ filtrate, $4.9x10^{-5}$ in crud Pu total – $2.5x10^{-5}$ filtrate, $2.0x10^{-5}$ in crud U-234 – $9.1x10^{-5}$ filtrate, not detected in crud U-238 – $1.0x10^{-4}$ filtrate, not detected in crud Sr-90 – $2.8x10^{-3}$ filtrate, $6.7x10^{-6}$ crud Tritium – filtrate not analyzed, crud not analyzed (C-000203, Part I, pp. 10-11)

Table 6-11. Tank 509B Chemical History

Date	Area	Summary Findings (Reference)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	509B Tank	Spectrographic chemical analysis (ppm in liquid waste with error of ± 2): Na – 500; Ca – 20; U – 20; Ba – 7; Mg – 6; Ni – 3; Si – 3; Al – 2.5; B – 1.5; Fe – 0.8; Zr – 0.6; Cu – 0.4; Mn – 0.15; Be – 0.01; Cr – <0.5; Pb – <0.6; Nb – <0.4; P – <10; Ti – <0.4 (C-002033, enclosure pp. 1-2; C-002049, attachment)

Tank and Vault 509C Contamination History

Table 6-12 describes the radiological history resulting from 509C Tank and Vault inspections, including visual observations and summarized radiological survey and analysis findings. Table 6-13 outlines 509C Tank chemical history.

Table 6-12. Tank and Vault 509C Radiological History

Date	Area	Visual Impressions	Summary Findings (Reference)
12/1971	509C Vault	None	General radiation in cell: 5 Rem/hr beta 250 mRem/hr gamma (R-000385, Table 4)

Date	Area	Visual Impressions	Summary Findings (Reference)
12/1971	509C Tank	Volume of sludge heel = 200 gallons	Concentration of tank contents: 1 x 10^4 pCi/gal alpha 1x 10^7 pCi/gal beta-gamma (R-000385, Table 4)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	509C Tank	Approximate volume = 8,145 gallons (Cs-137 observed in gamma spectra Gross beta expressed as equivalent Sr-Y-90)	Radiochemical results (µCi/ml): (4.24 ± 0.07) x 10^{-4} gamma; (4.69 ± 0.05) x 10^{-3} beta; (1.47 ± 0.08) x 10^{-5} alpha; (1.6 ± 1.0) x 10^{-6} tritium (C-002033, encl. pp. 1-2; C-002049, attach.)
9/8/1989	509C Vault	Vault structurally sound Piping and pipe fittings in vault sound Ranges from film to approximately ½ inch water (near drainage channel leading to sump) over floor; clear water; dirt, concrete dust, and debris, as well as cement waterproofing material from walls, visible through water Tar-like substance (believed to be sealant applied to ceiling) present on portions of ceiling, walls, floor, and outer tank and piping; one location of tar on piping above tank is discolored and water (from ceiling above) drips off tar at the rate of 1 drop per minute Streaks of water on west and south walls; streaks begin high on walls and end on floor, appear to be moist Water line evident on walls and Tank 18 inches above floor Air flow into vault during inspection > 160 ft^3/min; normally no air flow	Gamma readings range from 7 mRem/hr 1 foot below vault ceiling to 74 mRem/hr at the 307-foot level Beta and gamma readings range from <100 mRem/hr 1 foot below vault ceiling to 300 mRem/hr at the 307-foot level Data indicate contamination contribution from sludge heel in tank Reading from tool elbow which contacted south wall about 12 feet from floor was 200 cpm beta-gamma on a large area wipe; reading from camera which was in contact with west end of tank was 7,500 cpm beta-gamma and 400 cpm alpha Floor contamination samples from a 409 detergent-dampened rag measured with an RO-2 radiac: 0.5 mRem/hr open window and <0.2 mRem/hr closed window; Q-tips swiped on rag read 3,000 cpm above background beta-gamma Vault surface radionuclide distribution and Curie content: Cs-137 – 82.8%, 1.1 Ci content, 0.013 g Pu-239 – 0.8%, 0.011 Ci content, 0.18 g Am-241 – 0.1%, 1.3x10^{-3} Ci content, 0.0004 g Sr-90 – 16.4%, 0.22 Ci content, 1.6x10^{-3} g Vault sump sample radionuclide analysis results (µCi/ml) (pre-inspection samples collected from existing lines connected to common header in H2, 309-foot level): Cs-137 – 1.1x10^{-3} filtrate, 1.9x10^{-5} in crud Pu total – 1.9x10^{-5} filtrate, 8.7x10^{-5} in crud U-234 – 2.3x10^{-4} filtrate, not detected in crud U-238 – 2.4x10^{-4} filtrate, not detected in crud Sr-90 – 3.6x10^{-3} filtrate, 1.5x10^{-4} crud Tritium – filtrate not analyzed, crud not analyzed (C-000203, Part I, pp. 12-13)

Table 6-13. Tank and Vault 509C Chemical History

Date	Area	Summary Findings (References)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	509C Tank	Spectrographic chemical analysis (ppm in liquid waste with error of ± 2): Na – 280; Ca – 100; U – 30; Ba – <2; Mg – 20; Ni – 2; Si – 7; Al – 0.6; B – 1.5; Fe – 1.7; Zr – <0.3; Cu – 0.15; Mn – 0.15; Be – <0.007; Cr – <0.5; Pb – <0.6; Nb – <0.4; P – <10; Ti – <0.4 (C-002033, encl. pp. 1-2; C-002049, attach.)
Unknown (The document reporting results is dated 2/21/1990.)	509C Tank	Shotgun swab sample analysis (metals) results given in net concentration per gram of waste (ppm): Arsenic – 166 Lead – 10,536 Barium – 68,600 Selenium – 207 Cadmium – 65 Silver – 105 Chromium – 3,474 Mercury – 217 (C-000201, p. 2)

Tank and Vault 509D Contamination History

Table 6-14 describes the radiological history from 509D Tank and Vault inspections, including visual observations and summarized radiological survey and analysis findings. Table 6-15 summarizes 509D Tank chemical history.

Table 6-14. Tank and Vault 509D Radiological History

Date	Area	Visual Impressions	Summary Findings (Reference)
12/1971	509D Vault	None	General radiation in cell: 400 mRem/hr – 1 Rem/hr beta 15 mRem/hr – 35 mRem/hr gamma (R-000385, Table 4)
12/1971	509D Tank	Volume of sludge heel = 300 gallons	Concentration of tank contents: 1 x 10^4 pCi/gal alpha 1x 10^7 pCi/gal beta-gamma (R-000385, Table 4)
Unclear; possibly 1965; letter from 1977 or 1978 considers results current	509D Tank	Approximate volume = 2,375 gallons (Cs-137 observed in gamma spectra Gross beta expressed as equivalent Sr-Y-90)	Radiochemical results (µCi/ml): (7.92 ± 0.22) x 10^{-5} gamma; (6.52 ± 0.10) x 10^{-4} beta; (4.66 ± 0.31) x 10^{-6} alpha; (6.1 ± 1.1) x 10^{-6} tritium (C-002033, encl. pp. 1-2; C-002049, attach.)
9/6/1989 – 9/7/1989	509D Vault	Vault structurally sound Piping and pipe fittings in vault sound Some grind marks noted on tank (evidently from original construction) No active water leakage noted; stalactites hanging from ceiling; vertical stains on walls; several horizontal lines on tank and walls at common elevations indicating standing water in the past at different levels up to 5 feet above floor Tar-like substance (believed to be sealant applied to ceiling) present on portions of ceiling, walls, floor, and outer tank and piping; one location of tar on piping above tank is discolored and water (from ceiling above) drips off tar at the rate of 1 drop per minute Floor of vault covered with approximately 1/8" to ¼" of dirt, dust, and debris With exception of horizontal water lines, this vault is similar in appearance to 509E and 578 Vaults Air flow into vault during inspection > 160 ft^3/min; normally no air flow	Gamma readings range from <1 mRem/hr at the 331-foot level to 12 mRem/hr at the 310-foot level Beta and gamma readings range from <100 mRem/hr at the 331-foot level to 100 mRem/hr at the 306-foot level Data indicate contamination contribution from sludge heel in tank Floor contamination samples from a 409 detergent-dampened rag read 200 cpm above background beta-gamma with no detectable alpha Vault surface radionuclide distribution and Curie content: Cs-137 – 46.6%, 0.072 Ci content, 8.3x10^{-4} g Pu-239 – None detected Am-241 – None detected Sr-90 – 53.4%, 0.083 Ci content, 0.61x10^{-3} g Vault sump sample radionuclide analysis results (µCi/ml) (pre-inspection samples collected from existing lines connected to common header in H2, 309-foot level): Cs-137 – 1.5x10^{-1} filtrate, 7.9x10^{-3} in crud Pu total – 5.0x10^{-5} filtrate, 3.1x10^{-5} in crud U-234 – 5.8x10^{-4} filtrate, not detected in crud U-238 – 5.9x10^{-4} filtrate, not detected in crud Sr-90 – 1.4x10^{-2} filtrate, 3.6x10^{-4} crud Tritium – filtrate not analyzed, crud not analyzed (C-000203, Part I, pp. 14-15)

Table 6-15. Tank and Vault 509D Chemical History

Date	Area	Summary Findings (Reference)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	509D Tank	Spectrographic chemical analysis (ppm in liquid waste with error of ± 2): Na – 310; Ca – 30; U – <15; Ba – 3; Mg – 10; Ni – 8; Si – 8; Al – 1.2; B – 8; Fe – 2; Zr – <0.3; Cu – 0.15; Mn – 0.4; Be – <0.007; Cr – 0.3; Pb – <0.6; Nb – <0.4; P – 25; Ti – <0.4 (C-002033, enclosure pp. 1-2; C-002049, attachment)

Date	Area	Summary Findings (Reference)
Unknown (the document reporting results is dated 2/21/1990)	509D Tank	Shotgun swab sample analysis (metals) results given in net concentration per gram of waste (ppm): Arsenic – 92 Barium – 19,100 Cadmium – 90 Chromium – 3,904 Lead – 4,116 Selenium – 66 Silver – 79 Mercury – 1,400 (C-000201, p. 2)

Tank and Vault 509E Contamination History

Table 6-16 describes the radiological history from 509E Tank and Vault inspections, including visual observations and summarized radiological survey and analysis findings. Table 6-17 summarizes 509E Tank chemical history.

Table 6-16. Tank and Vault 509E Radiological History

Date	Area	Visual Impressions	Summary Findings (Reference)
12/1971	509E Vault	None	General radiation in cell: 370 mRem/hr beta 175 mRem/hr gamma (R-000385, Table 4)
12/1971	509E Tank	Volume of sludge heel = 400 gallons	Concentration of tank contents: 1 x 10^4 pCi/gal alpha 1x 10^7 pCi/gal beta-gamma (R-000385, Table 4)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	509E Tank	Approximate volume = 8,250 gallons (Cs-137, Cs-134 observed in gamma spectra Gross beta expressed as equivalent Sr-Y-90)	Radiochemical results (µCi/ml): (3.36 ± 0.02) x 10^{-2} gamma; (2.69 ± 0.04) x 10^{-2} beta; (3.7 ± [unreadable]) x 10^{-7} alpha; (1.6 ± 0.12) x 10^{-5} tritium (C-002033, encl. pp. 1-2; C-002049, attach.)
9/5/1989	509E Vault	Vault structurally sound Piping and pipe fittings in vault sound Water leaking into vault from at least two locations in ceiling at rate of one drop every 10-15 seconds; vault floor is damp; two stalactites noted on ceiling, 4 to 6 inches long, located where water is leaking in; believed to be tar-like substance with yellowish color possibly from dissolved minerals associated with leakage Tar-like substance (believed to be sealant applied to ceiling) present on portions of ceiling, walls, floor, and outer tank and piping Floor of vault covered with approximately 1/8" of dirt, concrete dust, and debris; remains of cement waterproofing from walls on floor Air flow into vault during inspection > 160 ft^3/min; normally no air flow	Gamma readings range from 11 mRem/hr 1 foot below the ceiling to 69 mRem/hr 1 foot above the floor Beta and gamma readings range from <100 mRem/hr 1 foot below the ceiling to 200 mRem/hr 1 foot above the floor Data indicate contamination contribution from sludge heel in tank Floor contamination samples from a 409 detergent-dampened rag read 3.5 mRem/hr open window and 0.2 mRem/hr closed window with an RO-2 ionization chamber detector; calculated to be greater than 70,000 cpm beta-gamma Vault surface radionuclide distribution and Curie content: Cs-137 – 78.8%, 0.64 Ci content, 0.0074 g Pu-239 – 6.3%, 0.051 Ci content, 0.82 g Am-241 – 0.6%, 4.9x10^{-3} Ci content, 0.0014 g Sr-90 – 14.2%, 0.12 Ci content, 0.88x10^{-3} g Vault sump sample radionuclide analysis results (µCi/ml) (pre-inspection samples collected from existing lines connected to common header in H2, 309-foot level): Cs-137 – 7.6x10^{-3} filtrate, 7.1x10^{-5} crud Pu total – 1.0x10^{-5} filtrate, 2.5x10^{-5} crud U-234 – 1.0x10^{-5} filtrate, not detected in crud U-238 – 5.2x10^{-6} filtrate, not detected in crud Sr-90 – 2.9x10^{-3} filtrate, 5.9x10^{-5} crud Tritium - <2.6x10^{-7} filtrate, crud not analyzed (C-000203, Part I, pp. 16-17)

Table 6-17. Tank and Vault 509E Chemical Analysis History

Date	Area	Summary Findings (Reference)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	509E Tank	Spectrographic chemical analysis (ppm in liquid waste with error of ± 2): Na – 265; Ca – 80; U – <15; Ba – <2; Mg – 10; Ni – 2; Si – 15; Al – 2.5; B – 4; Fe – 8; Zr – <0.3; Cu – 0.4; Mn – 2; Be – <0.007; Cr – 0.7; Pb – 0.7; Nb – <0.4; P – 40; Ti – 1.3 (C-002033, encl. pp. 1-2; C-002049, attach.)

Tank and Vault 578 Contamination History

Table 6-18 describes the radiological history from 578 Tank and Vault inspections, including visual observations and summarized radiological survey and analysis findings. Table 6-19 summarizes 578 Tank chemical history.

Table 6-18. Tank and Vault 578 Radiological History

Date	Area	Visual Impressions	Summary Findings (Reference)
12/1971	578 Vault	None	General radiation in cell: 2 Rem/hr – 3 Rem/hr beta 150 mRem/hr gamma (R-000385, Table 4)
12/1971	578 Tank	Volume of sludge heel – 100 gallons	Concentration of tank contents: 1 x 10^4 pCi/gal alpha 1x 10^7 pCi/gal beta-gamma (R-000385, Table 4)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	578 Tank	Approximate volume = 970 gallons (Cs-137, Cs-134, Co-60 observed in gamma spectra Gross beta expressed as equivalent Sr-Y-90)	Radiochemical results (µCi/ml): (1.09 ± 0.01) x 10^{-3} gamma; (9.15 ± 0.07) x 10^{-3} beta; (1.03 ± 0.05) x 10^{-4} alpha; (1.1 ± 0.02) x 10^{-4} tritium (C-002033, encl. pp. 1-2; C-002049, attach.)
8/30/1989 – 8/31/1989	578 Vault	Vault structurally sound Piping and pipe fittings in vault structurally sound No active water leakage noted Floor damp Sump connected to vault empty (prior to inspection) Tar-like substance (believed to be sealant applied to ceiling) present on portions of ceiling, walls, floor, and outer tank and piping Floor of vault covered with approximately 1/16" mixture of dirt, concrete dust, debris Cement water proofing material installed on lower 3 foot of walls appears to have fallen off and is visible on floor Air flow into vault through hatch opening provided drying effect during inspection (air flow during inspection ~ 28 ft^3/min); normally no air flow	RO-7-ID: Gamma readings range from 8 mRem/hr 1 foot below vault ceiling to 52 mRem/hr 1 foot above vault floor RO-7-IM: Beta and gamma readings range from <100 mRem/hr 1 foot below vault ceiling to 500 mRem/hr 1 foot above vault floor Data indicate contamination contribution from sludge heel in tank RO-2 radiac: Readings on walls range from 300 cpm beta-gamma, 50 cpm alpha at 12 feet from floor to 18,000 cpm beta-gamma, 1,600 cpm alpha at 1 to 2 feet from floor (readings taken of swipes from inspection equipment which came into contact with walls at these locations only) RO-2 radiac: Floor contamination measured by radiation levels taken from cotton swab: 0.6 mRem/hr open window and 0.2 mRem/hr closed window Vault surface radionuclide distribution and Curie content: Cs-137 – 65.2%, 1.1 Ci content, 0.013 g Pu-239 – 4.5%, 0.077 Ci content, 1.2 g Am-241 – 0.4%, 6.7x10^{-3} Ci content, 0.002 g Sr-90 – 29.9%, 0.51 Ci content, 3.7x10^{-3} g

Date	Area	Visual Impressions	Summary Findings (Reference)
		Blank flanges removed from two pipes (flanges hanging from pipe ends with studs and nuts attached) extending from west wall	(C-000203, Part I, pp. 5-7)

Table 6-19. Tank and Vault 578 Chemical Analysis History

Date	Area	Summary Findings (Reference)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	578 Tank	Spectrographic chemical analysis (ppm in liquid waste with error of ± 2): Na – 285; Ca – 45; U – <15; Ba – <2; Mg – 25; Ni – 12; Si – 15; Al – 6; B – 6; Fe – 20; Zr – 1.5; Cu – 0.8; Mn – 0.8; Be – <0.007; Cr – 1.7; Pb – 1.5; Nb – 0.3; P – 15; Ti – 0.4 (C-002033, encl. pp. 1-2; C-002049, attach.)
Unknown (The document reporting results is dated 2/21/1990)	578 Tank	Shotgun swab sample analysis (metals) results given in net concentration per gram of waste (ppm): Arsenic – 94 Barium – 3,005 Cadmium – 81 Chromium – 2,004 Lead – 2,726 Selenium – 123 Silver – 115 Mercury – 1,210 (C-000201, p. 2)

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Attachment III

Response to Stakeholder Comments

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Assessment of Historical Knolls Atomic Power Laboratory (KAPL) Waste Storage Locations Niagara Falls Storage Site, FUSRAP Site, Lewiston, New York, February 2012

Response to Comments and Identification of Responsive Documents

Correspondence 1, dated 4/04/2012: Please find attached comments regarding, "Assessment of Historical Knolls Atomic Power Laboratory Waste Storage Locations, Niagara Falls Storage Site, Lewiston, NY", February 2012. The above-referenced Assessment understates the types and amounts of nuclear reprocessing waste sent to the NFSS and Vicinity Properties. Please accept the following comments.

Comment 1: Following discussion with yourself [Christopher Clayton, Project Manager, DOE] and Mr. Bob Darr [S.M. Stoller Corporation] and Mr. Joey Gillespie [S.M. Stoller Corporation] at the USACE Public Workshop on March 28, 2012, it became clear that the assessment carried out to date was based on limited historical data. Significantly more data exists, which I shall forward to Mr. Gillespie for his review, along with further detailed comments.

Response 1*: DOE appreciates any additional information on remediated sites. We continue to add new information to the permanent site collections. We relied on final decision documents for the majority of data used to prepare the assessment report and gave less weight to documents that presented preliminary or interim findings or discussions that were not relevant to the purpose of the report. We acknowledge that there are significantly-more historical data on the site than was reviewed in the process of writing the assessment report; however, the document concentrated on final data found in final decision documents (i.e. Record of Decision and Final Remedial Action and Verification documents) that had bearing on the purpose of the report. The purpose of the report was to determine whether residual contamination from the* Separation Process Research Unit (SPRU) *waste stream at KAPL remained at the former Lake Ontario Ordinance Works (LOOW). DOE reviewed the historical locations for interim storage of the KAPL waste on the former LOOW; data from the DOE assessment, remediation, and verification of those areas; and more recent process knowledge from the cleanup of the KAPL waste in Schenectady, New York, to determine if the historical storage locations were adequately assessed and remediated. DOE also reviewed the USACE assessment of the Niagara Falls Storage Site (NFSS) and concluded that the USACE data are sufficient to demonstrate that KAPL residuals are not present in areas that have not yet been remediated at this site.*

Comment 2: The report findings appear to be based on the assumption that the predominant radionuclide in the KAPL wastes sent to the NFSS is Cesium-137 (Cs-137) with minor amounts of Strontium-90 (Sr-90) and Americium-241 (Am-241). However, this assumption is incorrect.

Response 2: *The report findings were based on assessment and remediation data from the LOOW, process knowledge of historical Schenectady SPRU operations, and waste profile information from remediation at the former LOOW and KAPL facilities. Documentation indicates that Sr-90, Am-241, and plutonium-239 (Pu-239) concentrations were significantly lower than Cs-137 concentrations. Therefore, DOE believes that Cs-137 is a valid surrogate for Sr-90, Am-241, and Pu-239 contamination in environmental media at the former LOOW. This finding is in accordance with Multi-Agency Radiation Survey and Site Investigation Manual (MARSIMM) guidance, August 2000, Section 4.3.2, "DCGLs and the Use of Surrogate*

Measurements," which states:

> *For sites with multiple contaminants, it may be possible to measure just one of the contaminants and still demonstrate compliance for all of the contaminants present through the use of surrogate measurements. Both time and resources can be saved if the analysis of one radionuclide is simpler than the analysis of the other. For example, using the measured ^{137}Cs concentration as a surrogate for ^{90}Sr reduces the analytical costs because wet chemistry separations do not have to be performed for ^{90}Sr on every sample. In using one radionuclide to measure the presence of others, a sufficient number of measurements, spatially separated throughout the survey unit, should be made to establish a "consistent" ratio. The number of measurements needed to determine the ratio is selected using the Data Quality Objectives (DQO) Process and based on the chemical, physical, and radiological characteristics of the nuclides and the site."*

DOE finds support for this approach in two additional reports: Radiological Characterization Report for SPRU Outside Areas Executive summary E5*, last paragraph, "Use of Radionuclide Surrogates," and June 1981* Remedial Action and Radiological Surveys Conducted on Modern Landfill, Inc. Lewiston, NY*, page 11 and top of page 12. Both reports refer to the use of Cs-137 during remediation as a surrogate for other contaminants.*

Comment 3: The processing of irradiated uranium at the KAPL SPRU facility produced mixed fission product waste containing approximately equal amounts of Cesium-137 and Strontium-90. Review of historical SPRU process documentation confirms that there was no separation of Cesium-137 and Strontium-90, with respect to the mixed fission product waste.

Response 3: *It is true that Cs-137 and Sr-90 were not separated from the KAPL waste stream. Cesium and strontium were not the objects of recovery; only the uranium and plutonium were. However, KAPL reports indicate that the SPRU waste, which was created by digestion of irradiated uranium contained in aluminum casts did not contain equal amounts of individual fission products. The* Land Area Historical Site Assessment for the SPRU Disposition Project *(DOE 2006) presents the analytical data collected during the Schenectady characterization efforts. Analytical results for Cs-137 indicated that concentrations were in all cases greater than the concentrations of Sr-90 and other radionuclides in surface soils. This statement agrees with the results of assessment and verification surveys by DOE at LOOW. The DOE assessment report for Vicinity Property H′(ORAU 1983) notes that concentrations of Cs-137 ranged from 27.1 to 33 pCi/g, and concentrations of Sr-90 ranged from 1.29 to 9.71 pCi/g. See also Appendix 12-A of the USACE NFSS Remedial Investigation Report Addendum (USACE 2011) for radiological survey results. Cesium was by far the most prevalent radionuclide. Data from the Baseline Risk Assessment and the Human Health Risk Assessment (SAIC 2007, Section 3) show that Sr-90 was detected much less frequently and at much lower concentrations, such that analysis using RESRAD did not identify Sr-90 as a radionuclide of potential concern for the NFSS. DOE considers the NFSS portion of the former LOOW a worst-case scenario for the LOOW, since most of the KAPL waste storage occurred there.*

Comment 4: Waste profile information from the remediation of the SPRU facility reflects the preferential adherence of Cesium-137 to surface soils at the KAPL site, not the absence of Strontium-90 in the mixed fission product waste stream.

Response 4: *See response to comment 3. The adsorptive affinity of the radionuclides may be germane to the distribution of radionuclides where the KAPL material was introduced into the soils at LOOW. However, the assessment, post-remediation, and verification analytical results at the NFSS and the vicinity properties establish that Sr-90 concentrations are far lower at former KAPL storage locations than Cs-137 concentrations, as discussed in response to comments 2 and 5.*

Comment 5: Given that the disposal and storage of KAPL wastes on the NFSS and associated Vicinity Properties would be expected to result in both Cesium-137 and Strontium-90 contamination, why has Cesium-137 been identified as a contaminant of concern for the NFSS but not Strontium-90? The answer seems to be a lack of analyses. Please consider the following:

> An investigative survey of the NFSS, performed by ORAU in 1986 and 1987 identified areas of elevated Cesium-137 up to 838 pCi/g, but not Strontium-90. No Strontium analyses were performed on the samples.
>
> Review of the radiological survey reports, prepared by ORAU in support of the DOE Formerly Utilized Sites Remedial Action Program reveals that only a very small fraction of survey samples, containing elevated Cesium-137, were analyzed for Strontium-90. Note Strontium-90 was detected up to 111 pCi/g.
>
> No Strontium-90 analyses were performed for verification survey samples.
>
> Similarly, for the USACE's NFSS *Remedial Investigation* and *Remedial Investigation Addendum*, Strontium-90 analyses were extremely limited and added as an after-thought, only after Cesium-137 had been identified as a radionuclide of concern for the NFSS.

Response 5: *Please provide a complete reference location of the analytical results by ORAU in 1986 and 1987. Also please provide a complete reference for the Sr-90 detection.*

*DOE assessment and remediation surveys were based on process knowledge of storage areas on the NFSS and vicinity properties, prior survey observations during the initial decontaminations, and waste characterization. This process information supported the use of Cs-137 as a surrogate for the remediation of strontium and other associated low-detection, lower-risk radionuclides from the vicinity properties. Surveys of former storage areas on the LOOW found that Cs-137 levels were higher than Sr-90 levels from biased sample locations (*Remedial Action and Radiological Surveys Conducted at Property Owned by Modern Landfill, Inc.*, Eberline 1981, pages 11 and 12). Therefore, it is likely that if remediation was adequate to reduce Cs-137 levels to less than the cleanup standard the concentrations of strontium and other low-risk radionuclides were also less than the standards on the vicinity properties. Verification analysis for strontium would have only been necessary if cesium had been detected in significant concentrations during the verification survey.*

USACE arrived independently at the same conclusion through a risk-based screening of analytical results, citing weight of evidence. The 2007 Human Health Risk Assessment and Screening Level Ecological Risk Assessment *(SAIC 2007) were performed as part of the Baseline Risk Assessment for the NFSS. Results from sample analyses were used to determine if the analytes detected were of sufficient quantity and concentration to become radionuclides of concern (ROC). Sections 5.2 and 5.3 of the report explain the criteria for determining an ROC for a site. Through evaluation of the analytical database using RESRAD, ROCs were defined on the basis of total risk by medium and then by specific risk from a radionuclide of potential concern. To be identified as an ROC, the excess lifetime cancer risk for any radionuclide must exceed 1×10^{-4} in a specific medium for a given receptor. Analytical results indicated that Sr-90 concentrations were not high enough or were not detected with sufficient frequency for the analyte to become a radionuclide of potential concern.*

In addition, the USACE enhanced the Environmental Surveillance Program in 2008 to include analysis of strontium-90, plutonium, technetium, and tritium in three groundwater monitoring wells at NFSS. Two sets of results from these additional analyses are presented in Table 9-1 and 9-2 of the 2011 Remedial Investigation Report Addendum. None of these radionuclides were detected in samples from these 3 wells.

Furthermore, in the Fall of 2010, all groundwater, surface water, and sediment samples obtained as part of the Environmental Surveillance program were analyzed for strontium-90, in addition to other radiological parameters. This is explained in the May 2011 fact sheet, available on-line at:

http://www.lrb.usace.army.mil/Portals/45/docs/FUSRAP/NFSS/Environmental/nfss-fs-envsurvenhancements-2011-03.pdf

Results from these analyses are found in the annual Environmental Surveillance Technical Memoranda for 2010 and 2011, also on-line:

http://www.lrb.usace.army.mil/Missions/HTRW/FUSRAP/NiagaraFallsStorageSite.aspx

In summary, the analytical results from the RI, RI Addendum, and ESP indicate that strontium-90 is rarely detected in site media, and if detected, shows low concentrations well below any regulatory criteria, and does not pose a risk to human health and the environment.

Comment-response #6:

Comment 6: In the early 1990s the NFSS environmental surveillance program identified and investigated elevated beta contamination in groundwater. Radium, thorium, uranium and potassium were all eliminated as the source of the beta contamination.

In the Remedial Investigation USACE detected beta contamination in groundwater on Modern at:

236 pCi/L in well MW-17 (gross beta)
497 pCi/L in well SP-2M (gross beta)
372 pCi/L in well PZ-8D (dissolved beta)
2,340 pCi/L in well W-11 (total beta)

The NFSS and Modern were both used to store and dispose of KAPL waste. And the groundwater on both the NFSS and Modern show elevated gross beta. Review of SPRU analytical data appended to the Assessment reveals Strontium-90 and Tritium (beta) contamination of groundwater.

Response 6: *USACE will address groundwater quality at the NFSS during the feasibility study for the groundwater operable unit(OU), after surface remediation is complete. During the FS process for the groundwater OU, if USACE determines that specific isotopic analyses levels in groundwater exceed regulatory limits, USACE will address the contamination.*

As in Response 5, additional analysis of NFSS groundwater monitoring samples for strontium-90 and other radioisotopes will be performed. The USACE will be evaluating the nature and extent of groundwater contamination using isotopic specific analyses, not gross beta results. The USACE Buffalo District currently has enough isotopic analyses to evaluate the nature and extent of groundwater impacts on NFSS and will not be relying on gross beta analysis to make these determinations. Gross beta may be indicative of the presence of naturally occurring radionuclide constituents such as potassium-40, for example.

Comment 7: The remediation work at the KAPL SPRU facility also raises the question of whether Cesium-137 should be used as an indicator of Strontium-90 and other KAPL waste contaminants. Cesium-137 has been found to adhere strongly to soil, whereas other contaminants, such as Strontium-90, migrate much more easily and have been found in groundwater. The apparent lack of Strontium-90 on the NFSS and Vicinity Properties is likely to be due to a failure to target locations where strontium exists, since Cesium-137 and Strontium-90 would only be co-located in the securely contained KAPL wastes, not in the areas of spills and ground disposal.

Response 7: *The statement that the apparent lack of Sr-90 is likely due to a failure to target locations where Sr-90 exists assumes that DOE investigated only contaminated areas. Also it assumes that strontium would only be co-located in secure containment and not in disposal areas and areas of spills. Initial FUSRAP investigations adhered to existing DOE and U.S. Nuclear Regulatory Commission guidance. Survey design was based the assumption that a site was contaminated in its entirety until negative sampling and survey data proved otherwise. Site-specific survey plans described limits and standards, data requirements, instrument selection, sampling schemes, analytes, and other project parameters and specifications based on process knowledge, waste characteristics, and historical information about each site in particular. Initial surveys included systematic sampling of the affected areas at the site and areas with no apparent contamination and were supplemented with biased sampling in areas with elevated gamma activity, including the incineration areas on VPs N/N' and H'. Analytical results from work by the USACE indicated very limited detection of Sr in any of the media addressed. DOE concludes that both USACE and the early DOE work arrived at the same conclusion that Sr and Cs were together in the KAPL waste and that the Cs was an adequate surrogate for removing the waste.*

Please refer also to information regarding additional Sr-90 analysis for recent Environmental Surveillance sampling provided in Response 5.

Comment 8: The NFSS *Remedial Investigation* located several abandoned chemical drums on the NFSS and Vicinity Property G. One drum contained elevated uranium and traces of

Americium-241, which pointed to it being part of the SPRU wastes sent to the site from KAPL. This type of waste was not reviewed in the current assessment. Discrepancies also exist between the number of drums of mixed fission product waste quoted in the review, compared with the actual number sent to the site.

The DOE review should encompass all of the types and quantities of KAPL wastes stored and disposed of at the NFSS and the NFSS Vicinity properties.

Response 8: *See Response to Comment 1. Determining discrepancies in shipments of drums or addressing the findings by the USACE was not the purpose of the report. The purpose of the assessment report was to determine if residual contamination from the KAPL waste stream remained at the former LOOW as shown by final radiological conditions. The report accomplished this by examining the results of historical investigations of KAPL waste storage and handling locations and comparing those results to the results of the DOE cleanup during the 1970s and 1980s at those locations and across the entire site to determine if all locations were adequately remediated. The Drum contents were determined by the USACE certified lab to be natural and not enriched Uranium which is not characteristic of KAPL enriched wastes. Americium 241 was detected in minor amounts and the origin within the drum is unknown. However, Americium was determined not to be an Radionuclide Of Concern (ROC) by the USACE due to the limited detections and concentrations on the NFSS.*

Vicinity Property G is still an active Vicinity Property and will be addressed by the USACE.

Correspondence 2, dated 4/04/2012:

Comment 9: I am attaching a 1958 monograph by D. A. Manieri and W. H. Truran, "Radioactive Waste Disposal at Knolls Atomic Power Laboratory", which contradicts the characterization of the KAPL wastes sent to LOOW as low level. Page 2 of the document describes high level and intermediate solid wastes being canned and drummed and high level liquid waste being processed to produce drummed slurry. The term low level waste only applies to boxed solid waste and liquid waste which was released to the sewer at KAPL.

In summary, high level solid waste is packaged in aluminum tubing containers and placed within lead casks. Intermediate level solid waste is packaged in 55 gallon carbon steel drums (page 6).

Note, the monograph does not specify the type of drums to be used for radioactive slurry from the processing of high level liquid waste, but documentation (which I will send) consistently shows stainless steel drums were used, probably because the slurry was more aggressive than the solid waste.

The September/October/November 1951 Waste Disposal progress Report for KAPL records an overall average radiation level of 1,190 mr/hr per slurry drum.

Document – radioactive waste disposal at KAPL March 1958.

Response 9: *The 1958 monograph is specific to waste-handling practices at the Knolls location in Schenectady and does not discuss any shipments to the LOOW, other than it was being evaluated as a storage location for all low-level and combustible waste. This corroborates information from DOE staff at KAPL in Schenectady, New York, that only low-level waste was*

sent to LOOW. DOE's Land Area Historical Site Assessment for the Separation Process Research Unit (SPRU) Disposition Project *(DOE 2006) states that all high-level waste remained at the KAPL facility in underground tanks until a permitted disposal facility became available. The objective of the 1958 monograph was to describe the waste-handling and waste disposal practices developed at the KAPL Schenectady facility as an example for industry. It emphasizes the extensive safety and protective measures necessary for handling and disposing of different levels of radioactive wastes.*

The aluminum cladding was evaluated as a shipping method prior to 1954, to ensure safe shipment of uranium slugs to locations for separation. This shipping evaluation led the SPRU to separate the uranium and plutonium from its shipping container by dissolving the aluminum from around the uranium and then separating it out. All high-level (solid and liquid) waste from the process was stored at the KAPL facility in underground tanks adjacent to Building H2 from the shutdown in 1954 until October 1964 (1965 GE to USAEC SNR Manager Correspondence), when the waste was finally processed and shipped to a Kentucky disposal facility. Separated plutonium was shipped to Los Alamos National Laboratory. The quantity of plutonium was very small because the project was a pilot-scale effort. All low-level wastes had been shipped for temporary storage at the LOOW until final disposition in 1958 at Oak Ridge.

Correspondence 3, dated 4/05/2012:

Comment 10: Please find attached a report re. the first shipment of KAPL wastes sent to LOOW. The report refers to stainless steel slurry drums. In addition to the 191 stainless steel slurry drums received at LOOW, the shipment included 217 carbon steel drums.

Response 10: *The document is Scan 0106, a waste shipment report. It mentions stainless steel slurry drums. The document will be added to the references section of the assessment report.*

Comment 11: On page 12 of "Assessment of Historical Knolls Atomic power Laboratory Waste Storage Locations, NFSS FUSRAP Site, Lewiston New York", February 2012, only the drums of slurry sent to LOOW (394 drums in total) are addressed. The radioactive content of wastes sent in carbon steel drums (intermediate solid waste according to the 1958 Manieri and Truran monograph) is not addressed.

Response 11: *Radiation survey and analytical results from the early assessment and remediation of the vicinity properties does not support the receipt of any intermediate-level or high-level waste from the KAPL facility at the LOOW. This is also supported by analytical data from ongoing work performed by USACE at the main holding areas on the NFSS.*

Comment 12: Particular concern was expressed about the carbon steel drums, because they deteriorated more than the stainless steel drums.(see attached) The contents of the carbon steel drums has not been addressed.

Documents – scan 0010_KAPL waste disposal letter
– scan 0106_waste ship report
– scan 0107_liq waste disp memos

Response 12: *The Background and Resurvey Report (Aerospace Corporation 1982) discusses the deterioration of the buildings and the weathering of the containers, which necessitated moving the waste from location to location within the Baker Smith Shops area (NFSS proper, currently being addressed by USACE) until final repackaging and shipment to Oak Ridge in 1958. If the contents of the containers had leaked it would have been detected during subsequent investigations and remedial actions as reflected in the final conditions at the vicinity properties and as determined by the USACE work on the NFSS.*

Correspondence 4, dated 4/05/2012:

Comment 13: As discussed at the March 28, 2012 USACE NFSS public workshop, please find attached an AEC trip report from 1960. The report references photographs of the 512 acres of AEC land at the NFSS. Slides 9, 10, 11 and 12 refer to Schenectady wastes. I would very much like to see all 36 color slides, if you manage to locate them.

Document – scan 0108_boron plant trip report

Response 13: *DOE searched readily accessible LM record holdings and could not locate the trip report or the photos associated with it. DOE also performed a search of index materials for the potential Records Group 326 AEC/MED accessions at the NARA facility in Atlanta based on research of records associated with the NFSS/LOOW and the Boron Plant but was not successful in locating the trip report. It may be located at DOE Headquarters archives in Washington.*

If a trip report, correspondence, or draft document was not considered pertinent to determining site eligibility or to supporting remediation or verification activities, FUSRAP staff would not have copied it into FUSRAP records. The trip report likely was retained by the contractor for the Boron Plant or was sent to the National Archives as a historical record. DOE believes that the assessment of site records to determine whether KAPL residuals remain at the former LOOW must focus on final radiological conditions; therefore, the DOE research concentrated on records of LOOW assessment, remediation, and verification performed by DOE in the 1970s, 1980s, and current findings on the NFSS by USACE.

Correspondence 5, dated 4/11/2012:

Comment 14: Please find attached the waste profile for the contents of an abandoned drum found on the NFSS during the 1999 - 2003 USACE NFSS Remedial Investigation field work. Analysis of the drum contents reveals high levels of uranium and a small amount of americium-241. Historical documentation records that KAPL waste sent to LOOW included drums of uranium residue. The recent DOE review of KAPL wastes does not reference this discovery.

Document – NFSS waste profile drum 1

Response 14: *See Responses 1 and 8 describing the purpose of the KAPL assessment report. The assessment report will be revised to discuss this finding by the USACE-Buffalo district, and the report will be added to the bibliography. Analytical results for the drum identified as "Drum1-2451" are reported in Table 4-3 of the USACE 2007 RIR for the NFSS.*

Please see Response 8.

Correspondence 6, dated 4/11/2012:

Comment 15: The USACE Remedial Investigation Report Addendum contains several KAPL historical documents, including waste manifests for KAPL wastes sent to Oak Ridge from LOOW. See Appendix 12A.

Review of the shipment manifests for KAPL waste sent from LOOW reveal no boxes of combustible waste left LOOW. The fact that no combustible waste left the site, leads to the conclusion that all combustible KAPL waste, including plutonium contaminated waste, must have been burnt on the LOOW site. I'm attaching the documents which detail the burning operation and the difficulties encountered by Hooker personnel in identifying plutonium contaminated packages.

There was clearly intent to identify and ship plutonium contaminated waste to Oak Ridge, but the waste manifests contradict this. KAPL personnel confirm that all of the combustible waste was burnt at LOOW.

Documents – scan 0013_burn KAPL waste conf notes
– scan 0014_Pu in waste letter
– scan 0015_disp unmarked packages conf notes

Response 15: *The historical record states KAPL combustible wastes that were properly labeled and did not exceed 6 mR/h were incinerated at two locations from 1952 to 1958, and the ashes were packaged in 70 or 55 gallon drums and stored for later shipment to Oak Ridge for disposal.*

As further detailed in the commenter's scanned reports, there was a specific procedure in the April 7, 1958, conference notes (Scan 0015). The notes state that, if labeling was not legible or if the combustible materials exceeded 6 mR/h, then the materials were not incinerated but shipped to Oak Ridge (refer to Attachment 8 of the 2005 correspondence from DOE to the New York Department of Health, Attachment I of the assessment report). Attachment 8 lists 12 4 ft × 3 ft × 2 ft wood boxes and 346 wood boxes that were sent from LOOW to Oak Ridge. The list also includes drums of ashes stored since the incineration had started.

Correspondence 7, dated 4/13/2012:

Comment 16: Surface soil cesium-137 contamination, up to 59,000 pCi/g was identified on the NFSS prior to remediation. It is not known what levels of cesium-137 were present on VP H' prior to the first AEC clean up in 1972. However, cesium up to 33 pCi/g was still present in 1983.

It is concerning that surface soil from a Vicinity Property, VP H', known to be associated with KAPL waste disposal was removed from that Vicinity Property PRIOR to DOE remediation. The reported use of the soil was as top soil in domestic yards in Lewiston and at a school in Niagara Falls.

Please find the attached memo which documents the report of soil removal, prior to remediation. Is there a record of DOE follow up on the reported removal of soil from VP H'? The SCA

employee's statement is supported by documentation of radium-226 and cesium-137 being detected in top soil at Love Canal, (99th Street School).

Document – scan 0109_E'H' survey update

Response 16: *Please provide the source of the 59,000 pCi/g Cs-137 concentration.*

Cesium in concentrations up to 33 pCi/g was still present in 1983. DOE performed additional remediation of this area in 1986 (DOE 1986), and based on the gamma surveys during verification, cesium activity did not exceed cleanup criteria established for the vicinity properties (ORAU 1989).

There is no evidence of contaminated waste burial on the Vicinity Property H′ prior to 1972. However, scrap metal storage and waste incineration operations were performed on a pad on the eastern portion of the site prior to 1954 (Location and Delineation of Radioactivity Mathieson Navy Area, 1954). A 1971 decontamination survey did identify radiation levels of 20-50 µR/h on this portion of the property (AEC 1973). As part of the 1971 decontamination effort, approximately 35,000 cubic feet of contaminated soil and material was removed from H′ (excavating from 10 to 30 feet deep), which could potentially explain the scattered low or shallow depressions observed south of the railroad tracks during the 1983 Comprehensive Radiological Survey by Oak Ridge Associated Universities (ORAU 1983). This soil was stockpiled adjacent to the current IWCS location.

A 1972 aerial survey of the entire LOOW and surrounding areas by EG&G did not identify significant gamma radiation levels on VP-H′ (AEC 1972) or the surrounding areas. A mobile scan van survey by Oak Ridge in 1980 did confirm above-background radiation levels along M Street, Wesson Road, and 5th Street. The radiation levels were attributed to slag used as bedding material for the roads (ORAU 1981).

An additional report in 1981 provides information on follow-up surveys at the 93rd Street School, 99th Street School, 66th Street School, Niagara Falls Catholic School, and the south section of Love Canal (ORNL 1981). Results indicated that several locations in Niagara Falls contain areas of low-level contamination (15–20 times background) that were once or are presently covered with asphalt and have a bedding of slag (cyclowollastonite). The report also discusses elevated Cs-137 (8.4 and 15 pCi/g) found in a depression near where runoff had accumulated on the asphalt at the 99th Street School site. The Cs-137 could not be associated with other potential waste streams in the area and was determined through further analysis to be associated with fallout from nuclear testing from the cold war era. Soils were rumored to have been transported from the LOOW to the 99th Street School to cover chemical waste pits; however, this rumor was later refuted by the excavator, who stated that the soils excavated from the pits were used to backfill the pits.

DOE does not believe there is KAPL waste at these locations, and State officials have not presented DOE with information to support an assertion that KAPL material was removed from LOOW to these locations.

Correspondence 8, dated 4/13/2012:

Comment 17: Reference the February 2012 Report, "Assessment of Historical Knolls Atomic power Laboratory Waste Storage Locations Niagara Falls Storage Site, FUSRAP Site Lewiston, New York", please note that KAPL contamination on Modern property N/N' North is underestimated on page 19 of the report.

Response 17: *Please see the report titled* Post Remedial Action Survey, Property of Modern Landfill Inc., Former LOOW Site, Lewiston, NY *(ORAU 1981). Appendix D, page D-6, states: "In Summary, portions of the Modern Landfill property at the former LOOW site are contaminated with low-level residues consisting of cesium-137, strontium-90, and naturally occurring radionuclides. Although this contamination is capable of producing slight radiation exposures to persons on this property, these exposures are well within the scientifically based guidelines, and risks to such persons are negligible."*

Comment 18: Elevated cesium-137 up to 1,025 pCi/g was detected in biased surface soil samples, after the Eberline remediation, (69 pCi/g after subsequent soil removal) See pages 8 and 9 and table 4. Limited analysis also revealed the presence of strontium-90 contamination, which would not be detected by gamma surveillance. The underestimation of cesium-137 and the failure to recognize Sr-90 as a contaminant of concern with respect to KAPL waste on the NFSS and Vicinity Properties are both significant oversights in the report.

Document – NY 17-8

Response 18: *A summary of the Post Remedial Action Survey for Modern Landfill (ORAU 1981) will be added to the Modern Landfill section in the assessment report following the discussion on the Eberline work. Page 12 of the 1981 Eberline document concerning the Modern landfill Post Remedial Activities states: "In all cases results of samples analyzed for ^{137}Cs and ^{90}Sr were lower than guidelines adopted by the Department of Energy for cesium and strontium soil concentrations associated with FUSRAP.*

Correspondence 9, dated 4/20/2012:

Comment 19: Many thanks. I do have a couple of questions for USACE on more recent KAPL waste detections, before I can complete my review: I'll follow up with USACE as soon as possible and copy you. It would be helpful for the public to better understand the process by which reports such as the KAPL report are written and reviewed. Please answer the following questions for me.

How was information used in the report gathered?

Was the draft KAPL report reviewed by other agencies, outside DOE, before being released to the public for comment in mid-February, 2012?

If so, which agencies were given access to the KAPL report and when?
How long was the period of internal review for the KAPL report?

Reference the documentation I already submitted, has DOE managed to track down the slides showing KAPL waste stored on the NFSS in late 1960? According to the records, KAPL waste

shipments to Oak Ridge began and ended in 1958, so KAPL waste left on the NFSS in 1960 would have remained on site and likely been incorporated into the IWCS.

I appreciate the offer of a comprehensive response to all my comments and questions, but it would be far more useful, if DOE answered those questions it has answers to and responded to those comments it is able to respond to, as we progress. Two way dialogue is far more effective and helps build public confidence in an open and transparent DOE.

Response 19: *In a message dated 4/25/2012 4:25:41 P.M. Central Daylight Time, FUSRAPinfo@lm.doe.gov writes:*

Ann, thanks for including us in your communications with USACE. To answer your first question, we reviewed historical site documentation available in the DOE Legacy Management Considered Sites Database (CSD) and Considered Sites Library (CSL), as well as research into files at the NARA facility in Atlanta. We also reviewed the USACE Remedial Investigation Report and Remedial Investigation Addendum for the NFSS.

The draft KAPL report was offered for review to the DOE Office of Environmental Management Schenectady office, EPA, USACE, NY Department of Health, and the NY Department of Environmental Compliance. After an internal and interagency review of approximately 3 to 4 months, DOE addressed and incorporated comments from the reviewers, and released it to the public in February 2012.

In reference to the 1960 trip report you provided, so far we have not been able to find the slides associated with the trip report or the trip report itself in our CSD or CSL. We are continuing our search for these slides in other potential document collections and repositories, but it might help us locate them if you could tell us the source from which you obtained the trip report. If we can narrow down the collections to search, we will have a better chance of locating the slides. We are also researching definitive information on post-1958 KAPL waste shipments.

We will try to answer your individual questions and respond to your comments as we are able; however, some of the questions and comments are interrelated, and we will best be able to respond to them collectively.

Correspondence 10, dated 4/26/2012:

Comment 20: Thank you. Have you been able to locate the groundwater investigation carried out for DOE in the early 1990's, as part of the NFSS environmental surveillance program? The detection of elevated gross beta in the lower groundwater led to an investigation to identify the cause. Radium, thorium, uranium and potassium 40 were all eliminated as the cause of the beta contamination. At the time, the potential presence of beta emitting radioisotopes from KAPL was not considered., at least not according to the information made public.

I'm attaching a copy of the Community LOOW Project report. Appendix H contains a list of reference document related to KAPL wastes at LOOW. Please check whether you have all the documents listed.

Document – CLP final report Sept. 08

Response 20: *DOE will need to review existing records for information about a groundwater investigation carried out for DOE in the early 1990s. However, DOE could provide a more accurate response given more information about the document or a specific title, date, or reference to the document.*

LM reviewed Appendix H of the September 2008 Community LOOW Project Report during preparation of the assessment report. The references are primarily correspondence and memos to file, which may or may not be in our records, depending on relevance to the eligibility, assessment, remediation, or verification of the properties.

Please see information provided in Responses 5 and 6.

Correspondence 11, dated 5/03/2012:

Comment 21: Bob, NUMEC division of Atlantic Richfield operated the Boron-10 isotopic separation plant at Model City out of Niagara Falls for the US Atomic Energy Commission through the Oak Ridge Operations Office.

Regarding the reported transportation of soil off VP H', have you found any record of DOE follow up?

Response 21: *See response 16 for discussion of the 1972 aerial survey and follow-up ground survey of NFSS and surrounding properties.*

Correspondence 12, dated 6/14/2012:

Comment 22: The 1960 trip report came from a private collector, who had connections to the Boron-10 plant. I'm surprised DOE has not yet managed to locate the report with associated photographs and slides: these were important documents, relevant to the future use of the AEC portion of the LOOW site. The documents must be available in one of the DOE archives.

The trip report documents the presence of KAPL wastes in 1960, more than a year after all of the KAPL wastes were reportedly sent to Oak Ridge. The presence of plutonium and fission products in the KAPL wastes is a source of ongoing concern to the surrounding community, so a record of plutonium and fission product wastes being left behind on the LOOW site, after the 1958 remediation requires detailed follow up.

Which available locations has DOE searched to date? Has DOE reviewed the Oak Ridge records with respect to KAPL wastes sent there from LOOW? What do these records show with respect to the quantities and timing of KAPL wastes sent to Oak Ridge from LOOW?

Response 22: *See response 13. DOE has looked at current holdings within our readily accessible records and at the NARA collection in Atlanta, which is publically available. DOE was not able to locate the 1960 trip report or its images at our known records locations. In order to locate this document we may need to broaden our search to the DOE Headquarters records. However, trip reports were not always copied to FUSRAP collections because they did not represent either final site conditions or supporting data for final site decisions. DOE is aware that some of its collections are incomplete and is continually searching for pertinent eligibility or remedial actions records at other records centers.*

Correspondence 13, 6/14/2012:

Comment 23: Reference your report, "Assessment of historical Knolls Atomic Power Laboratory Waste Storage Locations Niagara Falls Storage Site, FUSRAP Site, Lewiston, New York, February 2012, paragraph 3.2 on page 11 states that KAPL waste was shipped from LOSA (LOOW) from 1958 to 1960. However, the referenced summary in Attachment I, shows all 8 shipments (14 boxcars) occurred between January 1958 and June 1958. Please explain why the report refers to waste shipment between 1958 and 1960.

Response 23: *Text in paragraph 3.2 on page 11 of the report has been changed to indicate that all KAPL waste was shipped in 1958, as shown in Attachment I.*

Correspondence 14, dated 6/20/2012:

Comment 24: Since no additional record of KAPL waste shipment from LOOW to Oak Ridge has been identified, should we assume the KAPL wastes identified in the 1960 trip report remained on the NFSS?

Response 24: *DOE feels that the 1960 trip report by itself is insufficient to conclude that KAPL waste was stored on the NFSS after 1958. The description of the areas photographed on page 2, item 4, references the "Baker-Smith" area and describes it as "contaminated warehouses" but makes no reference to any waste being present. The captions for photos 10, 11, and 12 also describe the "Baker-Smith" areas and provide the associated building numbers for those warehouses. Based on the parenthetical statements in the other photo captions, the Army Schenectady waste description in parentheses appears to identify what waste stream had been stored in those buildings, although we haven't determined why it is described as "Army" Schenectady waste (we could find no connection between the Army and the AEC KAPL operation). There was a Schenectady Army Depot at that time, but we have not found any evidence that it was involved in any atomic energy activities. Caption 9, "Railroad Tract," (Schenectady waste in grassless area) also appears to be an identification of what had been stored at that location or is referring to residual soil contamination.*

The USACE Remedial Investigation Report (USACE 2007) notes that KAPL residues were originally stored near a railroad spur and were later relocated to the identified buildings prior to being shipped to Oak Ridge for disposal.

The preponderance of information states that all of the KAPL waste was shipped to Oak Ridge in 1958. DOE believe that, without further documentation, the weight of evidence indicates that all packaged KAPL waste was shipped offsite in 1958. No definitive data are available to establish or suggest that KAPL waste remained at the NFSS, including the limited information offered in the 1960 trip report. USACE and DOE data indicate that no KAPL contaminants remain on the NFSS proper or the completed VPs in concentrations that exceed regulatory limits.

We are continuing to look for any additional information, including the color slides you brought to our attention, and we are preparing additional responses to your other questions. However, the 1960 trip report would not have been considered a record that would be retained by the AEC and likely wouldn't have been included in the official record. Only final decision documents and the supporting data for those documents are retained as official records. Correspondence,

contracts, photos, and other historical documentation are typically sent on to NARA for evaluation for inclusion into the historical record, which is separate from the records that DOE maintains. We are continuing to follow up with NARA to determine if the trip report and slides are in their collection. In addition to responding directly to your questions, we will update the KAPL report based on any new information we identify, and we will attach pertinent new documents to the report.

Attached to this e-mail is an excerpt from the 1982 background and resurvey recommendations report on what is now the NFSS conducted for DOE by the Aerospace Corporation of Washington, DC, which contains information concerning the disposition of the KAPL wastes (Aerospace Corporation 1982). The full document is not yet available for public release, but we will post it to the FUSRAP Considered Sites Database when we receive approval for the posting. Below is a copy of the appropriate section of the USACE Remedial Investigation Report (USACE 2007) for your reference.

2007 USACE Remedial Investigation Report, pages 1–9:

> *Other Wastes. In the period from 1952 to 1954, wastes generated at the Knolls Atomic Power Laboratory (KAPL) were shipped to the NFSS. Records indicate that the shipments consisted of approximately 700,000 pounds of contaminated wastes including 676 wooden boxes and 394 slurry drums. The contaminated materials included combustible and noncombustible solids stored in wooden crates and processing wastes stored in 55-gallon drums. The processing wastes contained some residual plutonium and fission product radioactivity (Cs-137, Sr-90) from a low-level processing plant at Schenectady. It is estimated that 408 Ci of mixed fission products and 0.63 Ci of plutonium were shipped to the site during this time period. The KAPL residues were originally stored near a railroad spur north of NFSS. Later, the wastes were moved to Buildings 443, 444, 445, 446, 447 and 448 in the Baker-Smith area. Some of the waste was also stored in Building 401. These materials were transferred to the Oak Ridge Burial grounds during the late 1950's and most of the storage buildings were later destroyed (EA 1998).*

Correspondence 15, dated 7/17/2012:

Comment 25: The 1960 trip report indicates that that not all KAPL waste packages were sent to Oak Ridge. Further indication that KAPL wastes remained at the NFSS after 1958 is given in the 1995 annual environmental surveillance report for the NFSS (158-96-009. Rev 0, ESTM 1995-NFSS).

"Residues stored in the WCS originated from sites other than NFSS. The WCS also contains contaminated rubble, uranium metal billets, combustibles stored in wooden crates, processing wastes stored in drums and contaminated soils and wastes excavated from onsite and offsite areas."

page 2, paragraph 2.

Combustibles stored in wooden crates is unique to KAPL wastes. Note, plutonium contaminated crates of combustibles were supposed to be shipped to Oak Ridge, but there is no record of crates of combustibles being shipped there from the NFSS/LOOW site. Review of the LOOW KAPL waste shipment manifests will confirm this.

Response 25: *The reference to residues stored in the WCS from the 1995 annual environmental report is correct. DOE stockpiled the waste removed during the remediation of the vicinity properties in the area of the current IWCS prior to the actual construction of the waste containment structure. This material did come from the vicinity properties with a history of storage of KAPL waste, however, the stockpile of materials at the site of the future IWCS was scanned and found to be within regulatory limits prior to being placed into the constructed cell. A radiation survey of the spoils pile indicated a maximum reading of 3.5 mr/hr at 3 feet above the surface of the pile. In addition soil samples of the pile indicated only uranium and radium to be of significance (National Lead Company of Ohio 1977). However, these wastes represent a very small percentage of the waste in the IWCS and are minimal in risk compared to the other residues within the IWCS.*

During the time of KAPL storage, combustibles stored in wooden crates would not be characteristic of only one waste stream and therefore is not unique to KAPL wastes. All KAPL combustibles were incinerated if they met the established criteria prior the 1958 shipment and the ashes containerized and shipped along with the other shipments to Oak Ridge. Crates and other KAPL combustibles were only incinerated if they met the criteria of <6 mR/hr and were properly labeled.

The IWCS is currently being addressed by the USACE Buffalo District under the Feasibility Study for the NFSS.

Correspondence 16, dated 8/13/2012:

Comment 26: When will the revised report "Assessment of Historical Knolls Atomic power Laboratory Locations, Niagara Falls Storage Site FUSRAP Site, Lewiston, New York" February 2012 be released?

Will the revised report address KAPL SPRU processing wastes sent to LOOW in carbon steel drums? These processing wastes are distinct from the 394 stainless steel drums of mixed fission product slurry. The processing wastes in carbon steel drums appear were not addressed in the February 2012 report.

Note the number of carbon steel drums sent to LOOW from KAPL far exceeded the 394 stainless steel drums (of slurry) sent.

According to the memo, Waste Storage, S. R. Sapirie, Oak Ridge to B. Sparks, Cleveland Area Office, September 3, 1954:

" The most radioactive material (plutonium and fission product waste) is contained in steel drums."

"The KAPL material can generally be divided into three different categories:

1. Combustibles stored in wooden crates

2. Non-combustibles boxed similarly

3. Slurry and processing wastes drummed in 55 gallon

   a. stainless steel drums
   b. carbon steel drums"

"Wastes type 3, a and b, are stored in a building the condition of which is even worse than the buildings storing the boxed wastes. We understand that the drums contain highly radioactive wastes and the escape of this material from the confines of the stored drum could constitute a serious problem. Wastes type 3a in stainless steel drums would probably be safe if stored without building protection. This is because should a fire occur in these wooden buildings the contents of the drum being liquid could build up an internal pressure causing rupture due to the heat. Material type 3b stored in common iron drums is best stored in a structure even if it is wooden. The danger of release of contamination due to corrosion of the container appears greater than the danger of rupture under fire conditions."

Response 26: *The revised report should be available in May 2013.*

The carbon steel drums were addressed in the February 2012 draft within the text in discussing the shipments and again in Attachments I and II of the report. The carbon steel drums did outnumber the stainless steel drums in the inventories of waste shipped to the LOOW from KAPL. Any plutonium contaminated waste was first containerized in 1 gallon paint cans and then placed inside carbon steel drums essentially overpacking the contaminated materials for safer shipping and to provide additional shielding.

The information provided by the stakeholder was reviewed in the writing of the February 2012 version of the report and provided insight into the waste handling processes used during the 1950s. The information was important from an historical aspect but is not indicative of the site conditions documented in the final reports from the remediation and verification of the vicinity properties.

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ORAU (Oak Ridge Associated Universities), 1989. *Verification of 1983 and 1984 Remedial Actions, Niagara Falls Storage Site Vicinity Properties, Lewiston, New York*, Final, December. http://www.lm.doe.gov/Considered_Sites/references/nfv55.pdf

ORNL (Oak Ridge National Laboratory), 1981. *Radiological Survey at Selected Locations in Niagara Falls, New York*, ORNL/CF-80/320, Health and Safety Research Division, prepared for the U.S. Department of Energy, October 22.

ORNL (Oak Ridge National Laboratory), 1985. *Results of the Mobile Gamma Scanning Activities in Niagara Falls, New York, Area*, ORNL/RASA-85/1, Radiological Survey Activities Program, Oak Ridge, Tennessee, prepared for the U.S. Department of Energy, August.

SAIC (Science Applications International Corporation), 2007. *Baseline Risk Assessment for the Niagara Falls Storage Site*, prepared for U.S. Army Corps of Engineers Buffalo District, December.

Scan 0010_KAPL Waste Disposal Letter. Letter from J.J. Hendrix, Director, Reactor Engineering and Technical Services Division, Schenectady Operations, to Herman M. Roth, Director, Research and Development Division, Oak Ridge Operations, "KAPL Wastes Stored at LOOS," December 26, 1957.

Scan 0106_Waste Ship Report. B. James, *Report on KAPL Waste Shipment and Storage at Lake Ontario Ordnance Works, Model City, New York* (no additional information given).

Scan 0107_Liq Waste Disp Memos. Memorandum, to J.W. [last name illegible], Director, Feed Materials Division, Oak Ridge Operations Office, from F.W. Malone, Chief, Niagara Falls Branch, "Disposal of Liquid Wastes at Niagara Falls Branch," October 24, 1957.

Scan 0108_Boron Plant Trip Report. Memorandum from Fred E. Marsh, Feed Materials Division, to Files/R.E. Wedemeyer, "Trip Report—Boron Metal Plant, Niagara Falls, New York, August 1–3, 1960," December 14, 1960.

Scan 0109_E′H′ Survey Update. Memorandum from Jim Berger, Oak Ridge Associated Universities, to Claude Yarbro, "Update on Surveys of LOOW Properties E′ and H′, July 26, 1982.

Scan 0013_Burn KAPL Waste Conference Notes. "Burning of KAPL Wastes," notes from a conference attended by representatives from AEC, Hooker, NYO AEC, Brookhaven National Lab, and KAPL-Schenectady on February 27, 1958.

Scan 0014_Pu in Waste Letter. Letter to F.W. Malone, Chief, U.S. Atomic Energy Commission Niagara Falls Branch, Model City, NY, from J.D. Sweeney, Department Head, Plant 31, Subject: Unable to proceed with burning low-level waste because dose rate markings on crates are weathered and illegible.

Scan 0015_Disp Unmarked Packages Conf Notes. Conference Notes, "Disposal of KAPL Wastes," conference attended by representatives from AEC, Hooker, April 3, 1958.

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E-mail Correspondence from Stakeholder

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Correspondence 1

From:	
To:	FUSRAPinfo
Cc:	Darr, Bob (CONTR); Clayton, Christopher (HQ); Gillespie, Joey (CONTR); ambax@roadrunner.com; billc313@yahoo.com; jbharrin@gw.dec.state.ny.us; Giardina.Paul@epamail.epa.gov; kdjohnso@gw.dec.state.ny.us; jimitche@gw.dec.state.ny.us; annlyon16@aol.com
Subject:	Comments on Assessment of Historical KAPL Waste Storage Locations NFSS,Feb 2012
Date:	Wednesday, April 04, 2012 9:17:06 AM
Attachments:	

Dear Mr Clayton,

Comment #1 Please find attached comments regarding," Assessment of Historical Knolls Atomic Power Laboratory Waste Storage Locations, Niagara Falls Storage Site, Lewiston, NY", February 2012. Following discussion with yourself and Mr. Bob Darr and Mr. Joey Gillespie at the USACE Public Workshop on March 28, 2012, it became clear that the assessment carried out to date was based on limited historical data. Significantly more data exists, which I shall forward to Mr. Gillespie for his review, along with further detailed comments.

Thank you,
Ann Roberts

Ann Roberts

March 28, 2012

Mr. Christopher Clayton
Department of Energy Office of Legacy Management
FUSRAPinfo@lm.doe.gov

RE: "Assessment of Historical Knolls Atomic Power Laboratory Waste Storage Locations, Niagara Falls Storage Site FUSRAP Site, Lewiston, New York, February 2012" (Assessment)

Dear Mr. Clayton,

The DOE Office of Legacy Management issued the above-referenced report in response to community concerns that Knolls Atomic Power Laboratory (KAPL) wastes from the Separations Process Research Laboratory (SPRU) had not been adequately addressed on the Niagara Falls Storage Site (NFSS) and surrounding Vicinity Properties (VPs) at the LOOW site, in Lewiston and Porter, New York.

The above-referenced Assessment understates the types and amounts of nuclear reprocessing waste sent to the NFSS and Vicinity Properties. Please accept the following comments.

KAPL wastes incorrectly characterized.

Comment #2 The report findings appear to be based on the assumption that the predominant radionuclide in the KAPL wastes sent to the NFSS is Cesium-137 (Cs-137) with minor amounts of Strontium-90 (Sr-90) and Americium-241 (Am-241). However, this assumption is incorrect:

Comment #3 The processing of irradiated uranium at the KAPL SPRU facility produced mixed fission product waste containing approximately equal amounts of Cesium-137 and Strontium-90. Review of historical SPRU process documentation confirms that there was no separation of Cesium-137 and Strontium-90, with respect to the mixed fission product waste.

Comment #4 Waste profile information from the remediation of the SPRU facility reflects the preferential adherence of Cesium-137 to surface soils at the KAPL site, not the absence of Strontium-90 in the mixed fission product waste stream.

DOE's KAPL waste analyses targeted only Cesium-137, not other contaminants of concern (The issue of plutonium may be addressed in future correspondence to you.)

Comment #5 Given that the disposal and storage of KAPL wastes on the NFSS and associated Vicinity Properties would be expected to result in both Cesium-137 and Strontium-90 contamination, why has Cesium-137 been identified as a contaminant of concern for the NFSS but not Strontium-90? The answer seems to be a lack of analyses. Please consider the following:

Comment #5 con't

An investigative survey of the NFSS, performed by ORAU in 1986 and 1987 identified areas of elevated Cesium-137 up to 838 pCi/g, but not Strontium-90. No Strontium analyses were performed on the samples.

Review of the radiological survey reports, prepared by ORAU in support of the DOE Formerly Utilized Sites Remedial Action Program reveals that only a very small fraction of survey samples, containing elevated Cesium-137, were analyzed for Strontium-90. Note Strontium-90 was detected up to 111pCi/g.

No Strontium-90 analyses were performed for verification survey samples.

Similarly, for the USACE's NFSS *Remedial Investigation* and *Remedial Investigation Addendum*, Strontium-90 analyses were extremely limited and added as an after-thought, only after Cesium-137 had been identified as a radionuclide of concern for the NFSS.

Impact of KAPL waste on groundwater not addressed.

Comment #6 In the early 1990s the NFSS environmental surveillance program identified and investigated elevated beta contamination in groundwater. Radium, thorium, uranium and potassium were all eliminated as the source of the beta contamination.

In the Remedial Investigation USACE detected beta contamination in groundwater on Modern at:

236 pCi/L in well MW-17 (gross beta)
497 pCi/L in well SP-2M (gross beta)
372 pCi/L in well PZ-8D (dissolved beta)
2,340 pCi/L in well W-11 (total beta)

The NFSS and Modern were both used to store and dispose of KAPL waste. And the groundwater on both the NFSS and Modern show elevated gross beta. Review of SPRU analytical data appended to the Assessment reveals Strontium-90 and Tritium (beta) contamination of groundwater.

Validity of Using Cesium-137 as an indicator of all KAPL waste contaminants.

Comment #7 The remediation work at the KAPL SPRU facility also raises the question of whether Cesium-137 should be used as an indicator of Strontium-90 and other KAPL waste contaminants. Cesium-137 has been found to adhere strongly to soil, whereas other contaminants, such as Strontium-90, migrate much more easily and have been found in groundwater. The apparent lack of Strontium-90 on the NFSS and Vicinity Properties is likely to be due to a failure to target locations where strontium exists, since Cesium-137 and Strontium-90 would only be co-located in the securely contained KAPL wastes, not in the areas of spills and ground disposal.

KAPL Waste Remaining on Site.

Comment #8 The NFSS *Remedial Investigation* located several abandoned chemical drums on the NFSS and Vicinity Property G. One drum contained elevated uranium and traces of Americium-241,

which pointed to it being part of the SPRU wastes sent to the site from KAPL. This type of waste was not reviewed in the current assessment. Discrepancies also exist between the number of drums of mixed fission product waste quoted in the review, compared with the actual number sent to the site.

The DOE review should encompass all of the types and quantities of KAPL wastes stored and disposed of at the NFSS and the NFSS Vicinity properties.

I look forward to your reply.

Thank you.

Sincerely,

Ann Roberts

cc: LOOW RAB
U.S. EPA
NYS DEC

Correspondence 2

From:	_____
To:	Gillespie, Joey (CONTR)
Cc:	FUSRAPinfo
Subject:	Mischaracterization of KAPL waste sent to LOOW as low level
Date:	Wednesday, April 04, 2012 10:51:00 AM
Attachments:	radioactive waste disposal at KAPL March 1958.pdf

---

Dear Mr. Gillespie,

Comment #9

I am attaching a 1958 monograph by D. A. Manieri and W. H. Truran, "Radioactive Waste Disposal at Knolls Atomic Power Laboratory", which contradicts the characterization of the KAPL wastes sent to LOOW as low level.
Page 2 of the document describes high level and intermediate solid wastes being canned and drummed and high level liquid waste being processed to produce drummed slurry. The term low level waste only applies to boxed solid waste and liquid waste which was released to the sewer at KAPL.

In summary,

high level solid waste is packaged in aluminium tubing containers and placed within lead casks
intermediate level solid waste is packaged in 55 gallon carbon steel drums (page 6)
Note, the monograph does not specify the type of drums to be used for radioactive slurry from the processing of high level liquid waste, but documentation (which I will send) consistently shows stainless steel drums were used, probably because the slurry was more aggressive than the solid waste.

The September/October/November 1951 Waste Disposal progress Report for KAPL records an overall average radiation level of 1,190 mr/hr per slurry drum.

Ann Roberts

Correspondence 3

From:	_____
To:	Gillespie, Joey (CONTR)
Cc:	FUSRAPinfo
Subject:	Drummed KAPL wastes sent to LOOW not completely quantified
Date:	Thursday, April 05, 2012 10:16:51 AM
Attachments:	scan0010.pdf scan0106.pdf scan0107.pdf

Dear Mr. Gillespie,

Comment #10 Please find attached a report re. the first shipment of KAPL wastes sent to LOOW. The report refers to stainless steel slurry drums. In addition to the 191 stainless steel slurry drums received at LOOW, the shipment included 217 carbon steel drums.

Comment #11 On page 12 of "Assessment of Historical Knolls Atomic power Laboratory Waste Storage Locations, NFSS FUSRAP Site, Lewiston New York", February 2012, only the drums of slurry sent to LOOW (394 drums in total) are addressed. The radioactive content of wastes sent in carbon steel drums (intermediate solid waste according to the 1958 Manieri and Truran monograph) is not addressed.

Other documents refer to 1000 drums of KAPL waste being received at LOOW.(see attached)

Comment #12 Particular concern was expressed about the carbon steel drums, because they deteriorated more than the stainless steel drums.(see attached) The contents of the carbon steel drums has not been addressed.

Ann Roberts

Correspondence 4

From: _____
To: Gillespie, Joey (CONTR)
Cc: FUSRAPinfo
Subject: color slides of AEC property August 1960
Date: Thursday, April 05, 2012 11:01:35 AM
Attachments: scan0108.pdf

Dear Mr. Gillespie,

Comment #13 As discussed at the March 28, 2012 USACE NFSS public workshop, please find attached an AEC trip report from 1960. The report references photographs of the 512 acres of AEC land at the NFSS. Slides 9, 10, 11 and 12 refer to Schenectady wastes. I would very much like to see all 36 color slides, if you manage to locate them.

Thank you,
Ann Roberts

Correspondence 5

From: _____
To: Gillespie, Joey (CONTR)
Cc: fusrap@usace.army.mil
Subject: Drum of KAPL waste discovered on the NFSS
Date: Wednesday, April 11, 2012 7:21:48 AM
Attachments: NFSS waste profile drum 1.pdf

Dear Mr. Gillespie,

Comment #14 Please find attached the waste profile for the contents of an abandoned drum found on the NFSS during the 1999 - 2003 USACE NFSS Remedial Investigation field work. Analysis of the drum contents reveal high levels of uranium and a small amount of americium-241. Historical documentation records that KAPL waste sent to LOOW included drums of uranium residue. The recent DOE review of KAPL wastes does not reference this discovery.

Ann Roberts

Correspondence 6

From:	_____
To:	Gillespie, Joey (CONTR)
Cc:	FUSRAPinfo
Subject:	Burning of plutonium contaminated KAPL waste at LOOW
Date:	Wednesday, April 11, 2012 8:55:31 AM
Attachments:	scan0013.pdf scan0014.pdf scan0015.pdf

Dear Mr. Gillespie,

Comment #15 The USACE Remedial Investigation Report Addendum contains several KAPL historical documents, including waste manifests for KAPL wastes sent to Oak Ridge from LOOW. See Appendix 12A.

Review of the shipment manifests for KAPL waste sent from LOOW reveal no boxes of combustible waste left LOOW. The fact that no combustible waste left the site, leads to the conclusion that all combustible KAPL waste, including plutonium contaminated waste, must have been burnt on the LOOW site. I'm attaching the documents which detail the burning operation and the difficulties encountered by Hooker personnel in identifying plutonium contaminated packages.
There was clearly an intent to identify and ship plutonium contaminated waste to Oak Ridge, but the waste manifests contradict this. KAPL personnel confirm that all of the combustible waste was burnt at LOOW.

Ann Roberts

From: _____
To: FUSRAPinfo
Subject: Re: Drum of KAPL waste discovered on the NFSS
Date: Wednesday, April 11, 2012 11:41:35 AM

Bob,

Thank you. Yes, I had intended to copy fusrap.doe - apologies. With respect to the drum of uranium residue, please explain why americium-241 was detected in the drum contents.

Ann

In a message dated 4/11/2012 11:12:34 A.M. Central Daylight Time, FUSRAPinfo@lm.doe.gov writes:

> Ann, thank you again for providing additional information for our review. In regard to your comments below, we were aware of this finding, but the remediation of the NFSS has been under the jurisdiction of the USACE since the 1999 MOU. Our report therefore was focused on the cleanups of the historical storage of KAPL waste on the completed vicinity properties that took place prior to the MOU. In addition, our initial conclusion is that the drum described in the letter report contained natural uranium residue and was probably not associated with the KAPL waste. Any KAPL waste would have contained uranium that was not in secular equilibrium (altered) or refined and containing residues of other isotopes. The drum of waste found in 2006 was determined to be uranium ore (unaltered) without other isotopes that would have been part of the slurry from the evaporator bottoms of KAPL. In our report we focus on the results of the cleanups performed and the waste profile relative to what was looked for during the remediation.
>
> We are continuing to research this matter as well as the other comments and documents you provided and will provide a response to all at our earliest opportunity.
>
> I see that you cc'd fusrap@usace.army.mil on your email. I assume this was one of those very common Outlook address book mix-ups, so please continue to direct your future emails to, or cc, FUSRAPinfo@lm.doe.gov to help us maintain a central location for all of our communications. That will help us make sure that additional FUSRAP team members have access to your communications in the event that one of us is out of contact.
>
> Thanks again,
>
> Bob Darr
> Public Affairs
> SM Stoller Corporation
> DOE Legacy Management Support Contractor
> 720-377-9672
> bob.darr@lm.doe.gov

Correspondence 7

From:	
To:	Gillespie, Joey (CONTR)
Cc:	FUSRAPinfo
Subject:	KAPL contamination prior to remediation and movement of soil off the LOOW site
Date:	Friday, April 13, 2012 9:24:02 AM
Attachments:	scan0109.pdf

Dear Mr Gillespy,

Comment #16

Surface soil cesium-137 contamination, up to 59,000 pCi/g was identified on the NFSS prior to remediation. It is not known what levels of cesium-137 were present on VP H' prior to the first AEC clean up in 1972. However, cesium up to 33 pCi/g was still present in 1983.
It is concerning that surface soil from a Vicinity Property, VP H', known to be associated with KAPL waste disposal was removed from that Vicinity Property PRIOR to DOE remediation.The reported use of the soil was as top soil in domestic yards in Lewiston and at a school in Niagara Falls.

Please find the attached memo which documents the report of soil removal, prior to remediation. Is there a record of DOE follow up on the reported removal of soil from VP H'? The SCA employee's statement is supported by documentation of radium-226 and cesium-137 being detected in top soil at Love Canal, (99th Street School).

Ann Roberts

Correspondence 8

From:	
To:	Gillespie, Joey (CONTR)
Cc:	FUSRAPinfo
Subject:	Omission of Post Remed. Survey /underestimation of contamination VP N/N" N
Date:	Friday, April 13, 2012 11:28:01 AM
Attachments:	NY.17-8[1].pdf

Dear Mr. Gillespie,

Comment #17 Reference the February 2012 Report, "Assessment of Historical Knolls Atomic power Laboratory Waste Storage Locations Niagara Falls Storage Site, FUSRAP Site Lewsiton, New York", please note that KAPL contamination on Modern property N/N' North is underestimated on page 19 of the report.

See attached report: DOE, Berger, "Post Remedial Action Survey, Property of Modern landfill Inc, Former LOOW Site, Lewiston,NY", January 1982.

Comment #18 Elevated cesium-137 up to 1,025 pCi/g was detected in biased surface soil samples, after the Eberline remediation, (69 pCi/g after subsequent soil removal) See pages 8 and 9 and table 4.
Limited analysis also revealed the presence of strontium-90 contamination, which would not be detected by gamma surveillance.
The underestimation of cesium-137 and the failure to recognize Sr-90 as a contaminant of concern with respect to KAPL waste on the NFSS and Vicinity Properties are both significant oversights in the report.

Ann Roberts

Correspondence 9

From: _____
To: FUSRAPinfo
Subject: Re: Omission of Post Remed. Survey /underestimation of contamination VP N/N...
Date: Friday, April 20, 2012 9:19:19 AM

Bob,

Comment #19

Many thanks. I do have a couple of questions for USACE on more recent KAPL waste detections, before I can complete my review: I'll follow up with USACE as soon as possible and copy you. It would be helpful for the public to better understand the process by which reports such as the KAPL report are written and reviewed. Please answer the following questions for me.

How was information used in the report gathered?
Was the draft KAPL report reviewed by other agencies, outside DOE, before being released to the public for comment in mid February, 2012?
If so, which agencies were given access to the KAPL report and when?
How long was the period of internal review for the KAPL report?

Reference the documentation I already submitted, has DOE managed to track down the slides showing KAPL waste stored on the NFSS in late 1960? According to the records, KAPL waste shipments to Oak Ridge began and ended in 1958, so KAPL waste left on the NFSS in 1960 would have remained on site and likely been incorporated into the IWCS.

I appreciate the offer of a comprehensive response to all my comments and questions, but it would be far more useful, if DOE answered those questions it has answers to and responded to those comments it is able to respond to, as we progress. Two way dialogue is far more effective and helps build public confidence in an open and transparent DOE.

Ann Roberts

In a message dated 4/18/2012 4:47:46 P.M. Central Daylight Time, FUSRAPinfo@lm.doe.gov writes:

> Ann, I just want to let you know that we received your latest comments and documents related to the KAPL report on Friday, April 13. We are continuing to review and research the questions you have raised and will provide a comprehensive response to all your comments and questions. On that note, I'm curious as to how far along you are in your review of the KAPL report and the time-frame you anticipate for providing additional comments so that we may plan our response accordingly.
>
> Thank you again for your interest in the NFSS VPs and for providing us with the documents in your possession.
>
> Bob

Correspondence 10

From:
To: FUSRAPinfo
Subject: Re: Omission of Post Remed. Survey /underestimation of contamination VP N/N...
Date: Thursday, April 26, 2012 10:00:24 AM
Attachments: CLP Final Report Sept 08.pdf

Bob,

Comment #20

Thank you. Have you been able to locate the groundwater investigation carried out for DOE in the early 1990's, as part of the NFSS environmental surveillance program? The detection of elevated gross beta in the lower groundwater led to an investigation to identify the cause. Radium, thorium, uranium and potassium 40 were all eliminated as the cause of the beta contamination. At the time, the potential presence of beta emitting radioisotopes from KAPL was not considered...at least not according to the information made public.

I'm attaching a copy of the Community LOOW Project report. Appendix H contains a list of reference document related to KAPL wastes at LOOW. Please check whether you have all the documents listed.

Ann

In a message dated 4/25/2012 4:25:41 P.M. Central Daylight Time, FUSRAPinfo@lm.doe.gov writes:

> Ann, thanks for including us in your communications with USACE.
>
> To answer your first question, we reviewed historical site documentation that is contained in the DOE Legacy Management Considered Sites Database (CSD) and Considered Sites Library (CSL). We also reviewed the USACE Remedial Investigation Report and Remedial Investigation Addendum for the NFSS.
>
> Secondly, the draft KAPL report was reviewed by the DOE Office of Environmental Management (EM) Schenectady office, EPA, USACE, NY Department of Health and the NY Department of Environmental Compliance. Once that was completed, we released the KAPL report to the public in February 2012.
>
> In reference to the 1960 trip report you provided, so far we have not been able to find the slides associated with the trip report or the trip report itself in our CSD or CSL Library. We are continuing our search for these slides in other potential document collections and repositories, but it might help us locate them if you could tell us the source from which you obtained the trip report. If we can narrow down the collections to search, we will have a better chance of locating the slides. We are also researching definitive information on KAPL waste shipments post 1958.
>
> We will try to answer your individual questions and respond to your comments as we are able, however, some of the questions and comments are interrelated and we will best be able to respond to them collectively. You may anticipate our initial responses in the near future.
>
> Thanks,
>
> Bob

From: [redacted]
To: FUSRAPinfo
Subject: Re: Omission of Post Remed. Survey /underestimation of contamination VP N/N...
Date: Friday, April 27, 2012 6:04:24 AM

Bob,

The trip report was contained in files related to the reactivation of the Boron-10 Plant by NUMEC in the early 1960s. Hope this helps.

In a message dated 4/25/2012 4:25:41 P.M. Central Daylight Time, FUSRAPinfo@lm.doe.gov writes:

> Ann, thanks for including us in your communications with USACE.
>
> To answer your first question, we reviewed historical site documentation that is contained in the DOE Legacy Management Considered Sites Database (CSD) and Considered Sites Library (CSL). We also reviewed the USACE Remedial Investigation Report and Remedial Investigation Addendum for the NFSS.
>
> Secondly, the draft KAPL report was reviewed by the DOE Office of Environmental Management (EM) Schenectady office, EPA, USACE, NY Department of Health and the NY Department of Environmental Compliance. Once that was completed, we released the KAPL report to the public in February 2012.
>
> In reference to the 1960 trip report you provided, so far we have not been able to find the slides associated with the trip report or the trip report itself in our CSD or CSL Library. We are continuing our search for these slides in other potential document collections and repositories, but it might help us locate them if you could tell us the source from which you obtained the trip report. If we can narrow down the collections to search, we will have a better chance of locating the slides. We are also researching definitive information on KAPL waste shipments post 1958.
>
> We will try to answer your individual questions and respond to your comments as we are able, however, some of the questions and comments are interrelated and we will best be able to respond to them collectively. You may anticipate our initial responses in the near future.
>
> Thanks,
>
> Bob

Correspondence 11

From: _____
To: FUSRAPinfo
Subject: Re: Omission of Post Remed. Survey /underestimation of contamination VP N/N...
Date: Thursday, May 03, 2012 1:55:30 AM

Comment #21

Bob,
NUMEC division of Atlantic Richfield operated the Boron-10 isotopic separation plant at Model City out of Niagara Falls for the US Atomic Energy Commission through the Oak Ridge Operations Office.

Regarding the reported transportation of soil off VP H', have you found any record of DOE follow up?
Thanks,
Ann

In a message dated 5/1/2012 6:19:52 P.M. Central Daylight Time, FUSRAPinfo@lm.doe.gov writes:

> Ann, thanks for your reply. Do you have any more information that would help us determine what records collection or depository from which the trip report was obtained? If you know the agency or office that originally maintained this record, that would be a big help. I'm not sure where to go to find the Boron-10 Plant reactivation records.
>
> Thanks,
>
> Bob

From:	
To:	FUSRAPinfo
Cc:	fusrap@usace.army.mil
Subject:	Re: Omission of Post Remed. Survey /underestimation of contamination VP N/N...
Date:	Wednesday, June 06, 2012 1:19:39 PM

Bob,
I am still awaiting a response from USACE Buffalo, regarding information relavent to KAPL SPRU wastes on the NFSS, which I requested back in April and May 2012.
As soon as I receive the requested data, I shall complete my review. meanwhile, please update me on any progress in tracking down the 1960 slides of KAPL waste on the NFSS or records of KAPL wastes shipped to Oak Ridge in 1958.
Thank you,
Ann Roberts

In a message dated 4/18/2012 4:47:46 P.M. Central Daylight Time, FUSRAPinfo@lm.doe.gov writes:

> Ann, I just want to let you know that we received your latest comments and documents related to the KAPL report on Friday, April 13. We are continuing to review and research the questions you have raised and will provide a comprehensive response to all your comments and questions. On that note, I'm curious as to how far along you are in your review of the KAPL report and the time-frame you anticipate for providing additional comments so that we may plan our response accordingly.
>
> Thank you again for your interest in the NFSS VPs and for providing us with the documents in your possession.
>
> Bob

Correspondence 12

From: _____
To: FUSRAPinfo
Subject: Re: Omission of Post Remed. Survey /underestimation of contamination VP N/N...
Date: Thursday, June 14, 2012 10:22:00 PM

Bob,

Comment #22

The 1960 trip report came from a private collector, who had connections to the Boron-10 plant. I'm surprised DOE has not yet managed to locate the report with associated photographs and slides: these were important documents, relevant to the future use of the AEC portion of the LOOW site. The documents must be available in one of the DOE archives.
The trip report documents the presence of KAPL wastes in 1960, more than a year after all of the KAPL wastes were reportedly sent to Oak Ridge. The presence of plutonium and fission products in the KAPL wastes is a source of ongoing concern to the surrounding community, so a record of plutonium and fission product wastes being left behind on the LOOW site, after the 1958 remediation requires detailed follow up.
Which available locations has DOE searched to date? Has DOE reviewed the Oak Ridge records with respect to KAPL wastes sent there from LOOW? What do these records show with respect to the quantities and timing of KAPL wastes sent to Oak Ridge from LOOW?
Ann Roberts

In a message dated 6/6/2012 4:34:39 P.M. Central Daylight Time, FUSRAPinfo@lm.doe.gov writes:

> Anne, we are still working on finding those slides. Could you please let me know the location where you encountered the document without the color slides. Was it through a FOIA, or was it from a Repository document?. As it stands now, we have looked in all readily available locations and can not find the slides or the cover letter. Additional assistance in locating the document would be much appreciated. We are also looking into the answers to your other questions and will provide responses as soon as we are able.
>
> Thanks,
>
> Bob

Correspondence 13

From: _____
To: Gillespie, Joey (CONTR)
Cc: FUSRAPinfo
Subject: clarification on specific point
Date: Thursday, June 14, 2012 10:27:45 PM

Comment #23

Joey,
Reference your report, "Assessment of historical Knolls Atomic Power Laboratory Waste Storage Locations Niagara falls Storage Site, FUSRAP Site, Lewiston, New York, February 2012, paragraph 3.2 on page 11 states that KAPL waste was shipped from LOSA (LOOW) from 1958 to 1960. However, the referenced summary in Attachment I, shows all 8 shipments (14 boxcars) occurred between January 1958 and June 1958. Please explain why the report refers to waste shipment between 1958 and 1960.
Thank you,
Ann Roberts

Correspondence 14

From:	
To:	FUSRAPinfo
Cc:	Gillespie, Joey (CONTR)
Subject:	Re: clarification on specific point
Date:	Wednesday, June 20, 2012 8:49:48 AM

Bob,

Comment #24 Thank you. Since no additional record of KAPL waste shipment from LOOW to Oak Ridge has been identified, should we assume the KAPL wastes identified in the 1960 trip report remained on the NFSS?

Ann

In a message dated 6/19/2012 1:36:33 P.M. Central Daylight Time, FUSRAPinfo@lm.doe.gov writes:

> Ann,
>
> We have received your recent comment dated June 14, 2012, and will revise the text in the report to be consistent with the existing record in Attachment I of the report that states the KAPL waste shipments from LOOW to ORNL were performed during the fiscal year of 1958. At this time no additional record of shipping after 1958 has been identified.
>
> To date, we have reviewed the readily available records in the DOE Considered Sites Database and other DOE Legacy Management records collections. We are following up with inquiries to a number of other agency repositories, including the Atlanta National Archives collection, which contains the majority of the AEC records, as well as other NARA collections and the Oak Ridge collections and hope to provide additional responses to your questions in the near future.
>
> Thanks,
>
> Bob

Correspondence 15

From: _____
To: FUSRAPinfo
Subject: Re: clarification on specific point
Date: Tuesday, July 17, 2012 8:52:41 AM

Bob, Mr. Clayton,

Comment #25

The 1960 trip report indicates that that not all KAPL waste packages were sent to Oak Ridge. Further indication that KAPL wastes remained at the NFSS after 1958 is given in the 1995 annual environmental surveillance report for the NFSS (158-96-009. Rev 0. ESTM 1995-NFSS).

"Residues stored in the WCS originated from sites other than NFSS. The WCS also contains contaminated rubble, uranium metal billets, combustibles stored in wooden crates, processing wastes stored in drums and contaminated soils and wastes excavated from onsite and offsite areas."
page 2, paragraph 2.

Combustibles stored in wooden crates is unique to KAPL wastes. Note, plutonium contaminated crates of combustibles were supposed to be shipped to Oak Ridge, but there is no record of crates of combustibles being shipped there from the NFSS/LOOW site. Review of the LOOW KAPL waste shipment manifests will confirm this.

Ann

In a message dated 7/10/2012 2:52:39 P.M. Central Daylight Time, FUSRAPinfo@lm.doe.gov writes:

> On behalf of Christopher Clayton
> DOE Legacy Management
> FUSRAP Program manager
> FUSRAPinfo@lm.doe.gov
>
> Ann,
>
> Based on the existing information reviewed to date, DOE does not believe that anyone should assume that KAPL waste storage continued on the NFSS after 1958 as described in the 1960 trip report. The description of the areas photographed on page two, item #4, references the "Baker-Smith" area and describes it as contaminated warehouses and, although we know that KAPL waste was stored there prior to the 1958 shipments and demolition of the buildings, makes no reference to any waste being present. The captions for photos 10, 11, and 12 also describe the "Baker-Smith" areas and provide the associated building numbers for those warehouses. Based on the parenthetical statements in the other photo captions, the Army Schenectady waste description in parentheses appears to identify what waste stream had been stored in those buildings; although we haven't determined why it is described as "Army" Schenectady waste (we could find no connection between the Army and the Schenectady KAPL operation). There was a Schenectady Army Depot at that time, but we have not found any evidence that it was involved in any atomic energy activities. Caption 9, "Railroad Tract (Schenectady waste in grassless area)," also appears to be a reference to what had been stored at that location. Even so, these areas were decontaminated during the 1970s decontamination and again during the 1980s remedial action and post remedial actions that removed any radiological contamination that exceeded cleanup levels.
>
> The building in which the boron plant was constructed was also

decontaminated prior to construction of the boron facility (1953) and again prior to a contract change in 1967. As described in the pages attached to this response, "Prior to construction of the boron plant and removal of KAPL waste from Building 401 in 1953 it was determined that some decontamination from the planned boron plant was necessary" (Aerospace Nov 1982). The excerpt indicates that some KAPL material may have been stored at the boron plant prior to construction of that facility. The recent decontamination and decommissioning of Building 401 by the USACE did not reveal any evidence of KAPL waste above levels which would pose a threat to human health and the environment.

Without further indication that KAPL storage continued on the NFSS after 1958, the weight of evidence indicates that all packaged KAPL waste was shipped off site during that year. Furthermore, current investigations by USACE and DOE's review of final decontamination data indicate that no KAPL contaminants remain on the NFSS proper or the completed VPs that exceed levels protective of human health and the environment.

We continue to look for any additional information, including the color slides attached to the 1960 trip report that you brought to our attention. However, we have determined that the 1960 trip report would not have been considered a record that would be retained by the AEC and it doesn't appear to have been included in the official record. Only final decision documents and the supporting data are considered official records. Correspondence, contracts, photos and other historical documentation are typically sent on to the National Archives for evaluation for inclusion into the historical record, which is separate from the records that DOE maintains. We are continuing to follow up with the National Archives to determine if the trip report and slides are in their collection.

We are also preparing additional responses to your other questions. These responses will be used to update the KAPL report to complete the story on the KAPL storage at the NFSS.

Attached to this email is an excerpt from the 1982 background and resurvey recommendations report on what is now the NFSS conducted for DOE by the Aerospace Corporation of Washington, DC that contains pertinent information concerning the disposition of the KAPL wastes. The full document is not yet available for public release, but we will post it to the FUSRAP Considered Sites Database when we receive approval for the posting. In addition, below is a copy of the appropriate section of the USACE Remedial Investigation Report for your reference.

2007 USACE Remedial Investigation Report, page 1-9:

Other Wastes
In the period from 1952 to 1954, wastes generated at the Knolls Atomic Power Laboratory (KAPL) were shipped to the NFSS. Records indicate that the shipments consisted of approximately 700,000 pounds of contaminated wastes, including 676 wooden boxes and 394 slurry drums. The contaminated materials included combustible and noncombustible solids stored in wooden crates and processing wastes stored in 55-gallon drums. The processing wastes contained some residual plutonium and fission product radioactivity (Ce-137, Sr-90) from a low-level processing plant at Schenectady. It is estimated that 408 Ci of mixed fission products and 0.63 Ci of plutonium were shipped to the site during this time period. The KAPL residues were originally stored near a railroad spur north of NFSS. Later, the wastes were moved to Buildings 443, 444, 445, 446, 447 and 448 in the Baker-Smith area. Some of the waste was also

stored in Building 401. These materials were transferred to the Oak Ridge Burial Grounds during the late 1950's and most of the storage buildings were later destroyed (EA 1998).

Thanks,

Bob

Correspondence 16

From: _____
To: FUSRAPinfo
Subject: Re: clarification on specific point
Date: Monday, August 13, 2012 3:57:35 AM

Comment #26

Bob,
When will the revised report "Assessment of Historical Knolls Atomic power Laboratory Locations, Niagara Falls Storage Site FUSRAP Site, Lewiston, New York" February 2012 be released?

Will the revised report address KAPL SPRU processing wastes sent to LOOW in carbon steel drums? These processing wastes are distinct from the 394 stainless steel drums of mixed fission product slurry. The processing wastes in carbon steel drums appear were not addressed in the February 2012 report. Note the number of carbon steel drums sent to LOOW from KAPL far exceeded the 394 stainless steel drums (of slurry) sent.

According to the memo, Waste Storage, S. R. Sapirie, Oak Ridge to B. Sparks, Cleveland Area Office, September 3, 1954:

" The most radioactive material (plutonium and fission product waste) is contained in steel drums."

"The KAPL material can generally be divided into three different categories:

1. Combustibles stored in wooden crates

2. Non-combustibles boxed similarly

3. Slurry and processing wastes drummed in 55 gallon

   a. stainless steel drums
   b. carbon steel drums"

"Wastes type 3, a and b, are stored in a building the condition of which is even worse than the buildings storing the boxed wastes. We understand that the drums contain highly radioactive wastes and the escape of this material from the confines of the stored drum could constitute a serious problem. Wastes type 3a in stainless steel drums would probably be safe if stored without building protection. This is because should a fire occur in these wooden buildings the contents of the drum being liquid could build up an internal pressure causing rupture due to the heat.
Material type 3b stored in common iron drums is best stored in a structure even if it is wooden. The danger of release of contamination due to corrosion of the container appears greater than the danger of rupture under fire conditions."

Thanks,
Ann Roberts