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U.S. Department of Energy
Grand Junction Projects Office Remedial Action Project

Final Report of the Decontamination and Decommissioning of the Exterior Land Areas at the Grand Junction Projects Office Facility

September 1995

U.S. Department of Energy
Grand Junction Projects Office

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Final Report of the Decontamination and Decommissioning of the Exterior Land Areas at the Grand Junction Projects Office Facility

September 1995

Prepared for

U.S. Department of Energy Richland Operations Office
Defense Waste and Transportation Management
Division of Hazardous Waste and Remedial Action
Defense Facilities Decommissioning Program Office

Prepared by
U.S. Department of Energy
Albuquerque Operations Office
Grand Junction Projects Office
Rust Geotech
Grand Junction, Colorado

Rust Geotech has been granted authorization to conduct remedial action under the Decontamination and Decommissioning Program. Remedial action was conducted in accordance with all applicable or relevant and appropriate requirements.

Work Performed Under DOE Contract No. DE-AC04-86ID12584

Signature Page

Prepared by:

Richard K Johnson /FOR

M.R. Widdop, Senior Technical Writer
Technical Coordination and Reports
Rust Geotech

9/15/95
Date

Approved by:

Carl L Jacobson

C.L. Jacobson, Program Manager
Decommissioning Programs
Rust Geotech

9/15/95
Date

DN Leske

D.N. Leske, Project Manager
U.S. Department of Energy
Grand Junction Projects Office

9/21/95
Date

Abstract

The U.S. Department of Energy (DOE) Grand Junction Projects Office (GJPO) facility occupies approximately 56.4 acres (22.8 hectares) along the Gunnison River near Grand Junction, Colorado. The site was contaminated with uranium ore and mill tailings during uranium-refining activities conducted by the Manhattan Engineer District and during pilot-milling experiments conducted for the U.S. Atomic Energy Commission's (AEC's) domestic uranium procurement program. The GJPO facility was the collection and assay point for AEC uranium and vanadium oxide purchases until the early 1970s. The DOE Decontamination and Decommissioning Program sponsored the Grand Junction Projects Office Remedial Action Project (GJPORAP) to remediate the facility lands, site improvements, and the underlying aquifer. The site contractor, Rust Geotech, was the Remedial Action Contractor for GJPORAP. The exterior land areas of the facility assessed as contaminated have been remediated in accordance with identified standards and can be released for unrestricted use. Restoration of the aquifer will be accomplished through the natural flushing action of the aquifer during the next 50 to 80 years. The remediation of the DOE–GJPO facility buildings is ongoing and will be described in a separate report.

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Acronyms

AEC	U.S. Atomic Energy Commission
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*U.S. Code of Federal Regulations*
D&D	Decontamination and Decommissioning
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EA	environmental assessment
EP Tox	extraction procedure toxicity
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
FONSI	Finding of No Significant Impact
FS	feasibility study
FUSRAP	Formerly Utilized Sites Remedial Action Program
GJPO	Grand Junction Projects Office
GJPORAP	Grand Junction Projects Office Remedial Action Project
ICRP	International Commission on Radiological Protection
IVC	Independent Verification Contractor
LAV	Large Area Verification
LTSM	Long-Term Surveillance and Maintenance
NEPA	National Environmental Policy Act
NPL	National Priorities List
PCB	polychlorinated biphenyl
PPE	personal protective equipment
ppm	parts per million
QA	quality assurance
RAC	Remedial Action Contractor
RCRA	Resource Conservation and Recovery Act
RESRAD	Residual Radioactive Material [software program]
RI	remedial investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SFMP	Surplus Facilities Management Program
TCLP	toxicity-characteristic leaching procedure
TLD	thermoluminescent dosimeter
TSCA	Toxic Substances Control Act
UMTRA	Uranium Mill Tailings Remedial Action
UMTRCA	Uranium Mill Tailings Radiation Control Act
U.S.C.	United States Code
V-area	verification area

I. Introduction and Background

Description of Project

The purpose of the Grand Junction Projects Office Remedial Action Project (GJPORAP) was to eliminate health hazards resulting from uranium mill tailings and associated contaminated materials at the U.S. Department of Energy (DOE) Grand Junction Projects Office (GJPO) facility and to bring contaminated portions of the facility, including the underlying aquifer, into compliance with applicable environmental regulations.

In 1984, the DOE–GJPO facility was accepted into the DOE Surplus Facilities Management Program (SFMP). In 1988, the facility was transferred to the DOE Decontamination and Decommissioning (D&D) Program. The D&D Program is responsible for the surveillance and maintenance of surplus DOE facilities, including the performance of any necessary decommissioning and decontamination activities. DOE–GJPO has specific responsibility for GJPORAP under the D&D Program. Rust Geotech is the Remedial Action Contractor (RAC) for GJPORAP.

This report summarizes the remedial action conducted on the exterior land areas of the DOE–GJPO facility and demonstrates that those exterior land areas comply with applicable regulations. After the remedial action is completed, the facility is expected to be transferred to the Long-Term Surveillance and Maintenance (LTSM) Program to allow restoration of the aquifer. The remediation of the buildings and associated utilities on the DOE–GJPO facility is not yet complete; the results of that remediation will be summarized in a separate report.

Basis for Remedial Action

In 1980, the U.S. Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 *United States Code* [U.S.C.] 9601). In 1986, Congress amended CERCLA with the Superfund Amendments and Reauthorization Act (SARA). Section 120 of SARA and Executive Order 12580, *Superfund Implementation*, directed DOE to coordinate with the U.S. Environmental Protection Agency (EPA) to respond to actual or potentially imminent releases of hazardous substances into the environment at federally owned DOE facilities. D&D Program policy specifies that remedial action will be conducted in accordance with DOE Order 5480.1B, *Environment, Safety, and Health Program for Department of Energy Operations*, and all other applicable environmental regulations (DOE 1989l).

The DOE–GJPO facility was evaluated using the Hazard Ranking System. Although the resulting score of 14.6 (DOE 1989f) did not qualify the facility for placement on the National Priorities List (NPL), remedial action under GJPORAP conformed to the applicable provisions of CERCLA, as amended by SARA, and the Uranium Mill Tailings Radiation Control Act (UMTRCA) (42 U.S.C. 7901), the National Environmental Policy Act (NEPA) (42 U.S.C. 4321), and other applicable Federal and State regulations. Remedial action was conducted with an emphasis on maintaining all health and safety risks at levels as low as reasonably achievable (ALARA).

II. Facility Physical Description

Description of Site

The DOE–GJPO facility is located approximately 0.6 mile (1 kilometer) south and west of populated areas of the city of Grand Junction in Mesa County, Colorado (Figure 1). The facility encompasses approximately 56.4 acres (22.8 hectares) of floodplain within an accretionary bend along the east bank of the Gunnison River. Access to most of the facility is restricted by security personnel and a fence that surrounds the occupied portion of the facility. Beyond the fence are vehicle parking lots to the east and an earthen dike along the Gunnison River to the west and north. There are approximately 30 structures on the facility. The DOE–GJPO facility is the site of the borehole models that are used as the primary calibration standards for gamma borehole measurements throughout the United States.

The DOE–GJPO facility is situated within Sections 26 and 27, Township 1 South, Range 1 West, Ute Principal Meridian, at an elevation of approximately 4,560 feet (1,390 meters). The facility is located on the northeast edge of the Uncompahgre Plateau, which is in the northeast part of the Canyonlands section of the Colorado Plateau physiographic province. The facility sits on Quaternary alluvium, consisting mostly of silty sandy gravel deposited by the Gunnison River. This gravel is underlain by bedrock consisting of the variegated red and green mudstones of the Brushy Basin Member of the Upper Jurassic Morrison Formation. The walls of the Gunnison River canyon in the vicinity are formed by the Upper Cretaceous Dakota Sandstone and the Lower Cretaceous Burro Canyon Formation, which overlie the Brushy Basin Member. The freshwater alluvial aquifer underlying the facility is in direct hydraulic contact with the Gunnison River.

Two bodies of water with surrounding wetlands are located on the DOE–GJPO facility: the North Pond and the South Pond. The area west of the North Pond (referred to as Treasure Island) was formerly a landfill used for rubbish and debris generated on the facility. The area adjacent to the facility to the north is the former Black Bridge Park, which is owned by DOE. The facility is bordered on the east by the Southern Pacific Railroad (formerly the Denver and Rio Grande Western Railroad) right-of-way.

Site History

DOE–GJPO facility lands were acquired by the U.S. War Department in 1943 for the Manhattan Engineer District. A refinery was operated on the site from 1943 to 1946 to treat and concentrate uranium oxide, a by-product of vanadium production in the area. As much as 2,360,000 pounds (lb) (1,070 metric tons) of uranium oxide and a comparable amount of vanadium concentrate were produced and shipped off site for further refining. Wastes from this refinery included dust losses, a few hundred tons of alumina cake, and liquid discharges (DOE 1987a).

In late 1947, the U.S. Atomic Energy Commission (AEC) established the Colorado Raw Materials Office on site to manage the domestic uranium procurement program. An exploration branch office was also located in the city of Grand Junction, which led to the combination of procurement and exploration functions within the AEC Grand Junction Operations Office. This office was responsible for the receipt, sampling, and analysis of uranium and vanadium concentrates purchased from ore processing operations in the western United States. AEC operated a uranium-concentrate sampling plant and assay laboratory on site until 1974. Between 1948 and 1971, a total of approximately 345,000,000 lb (156,000 metric tons) of uranium oxide and 29,000,000 lb (13,200 metric tons) of vanadium oxide passed through the facility in steel drums. The remaining stockpiled vanadium and uranium were shipped off site in 1965 and 1975, respectively (DOE 1987a).

A research program to test experimental uranium-ore milling techniques was initiated at the DOE–GJPO facility in 1953. Operations were conducted in a small pilot mill from 1953 to 1954, near the present location of Building 46. In 1954, a larger pilot mill commenced operations on the southern end of the property.

Milling operations ceased in 1958, after approximately 30,000 tons (27,200 metric tons) of ore had been processed (DOE 1987a). Most of the small pilot-mill buildings were demolished by the time remedial action was completed. Building 31, part of the large pilot-mill complex; Building 6, part of the small pilot mill; and Building 37 and Building 39 were demolished during remedial action. The remaining large pilot-mill buildings are currently used as warehouse facilities.

The pilot-mill operations were the primary source of the contaminated materials buried at the DOE–GJPO facility. Other potential sources of contamination included former laboratory and vehicle-maintenance activities and activities related to the sampling and stockpiling of uranium concentrates.

Surplus uranium ore, uranium mill tailings, and contaminated equipment from site activities were disposed of on site. Historical data indicated that tailings and other waste from the pilot mills and sampling plant were disposed of to the west of the original pilot mill (near Building 46) and Building 31 and Building 33. Nonhazardous waste materials were buried in the landfill area northwest of Building 7. The drains from the analytical laboratory discharged into the South Pond, and stormwater

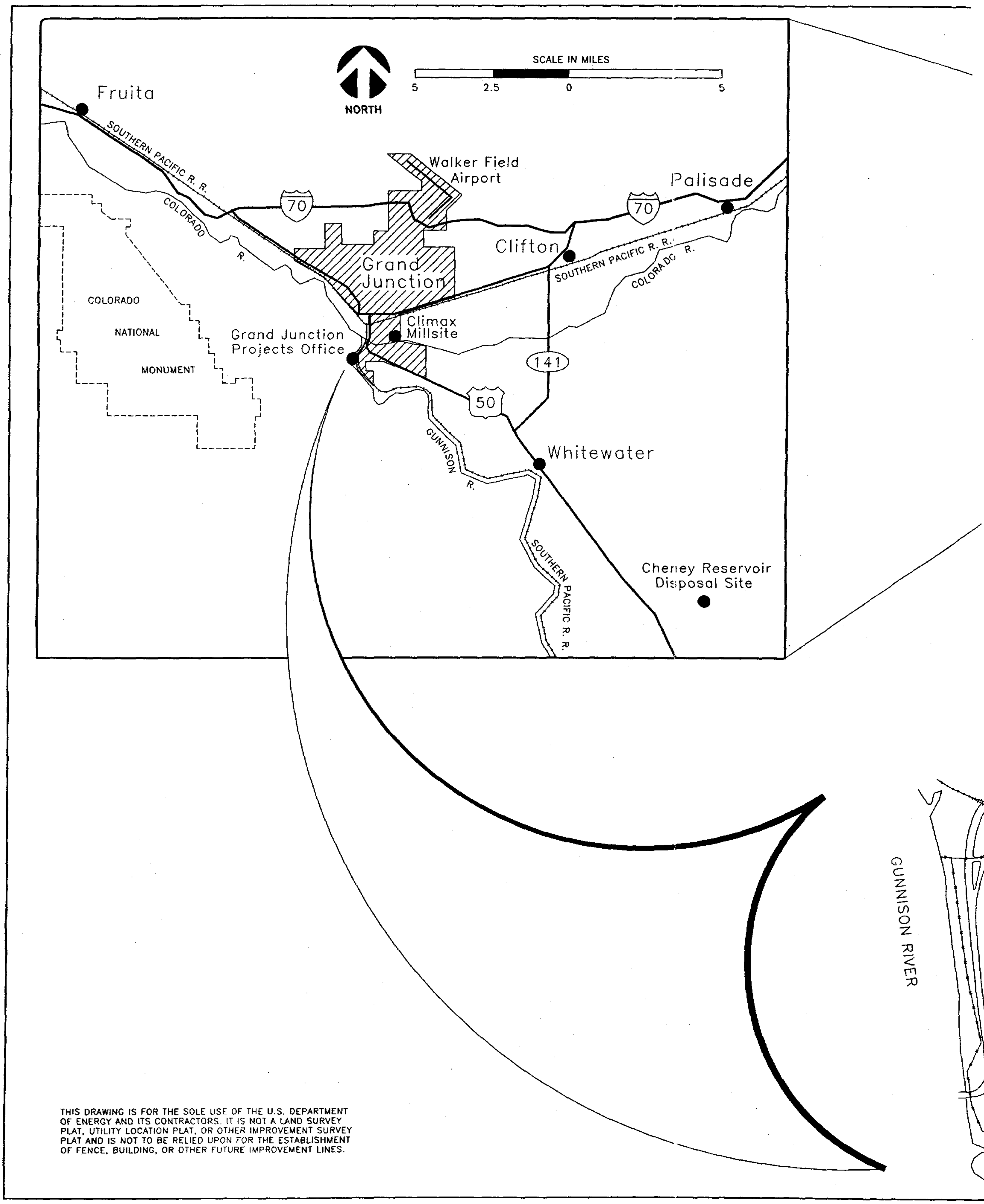
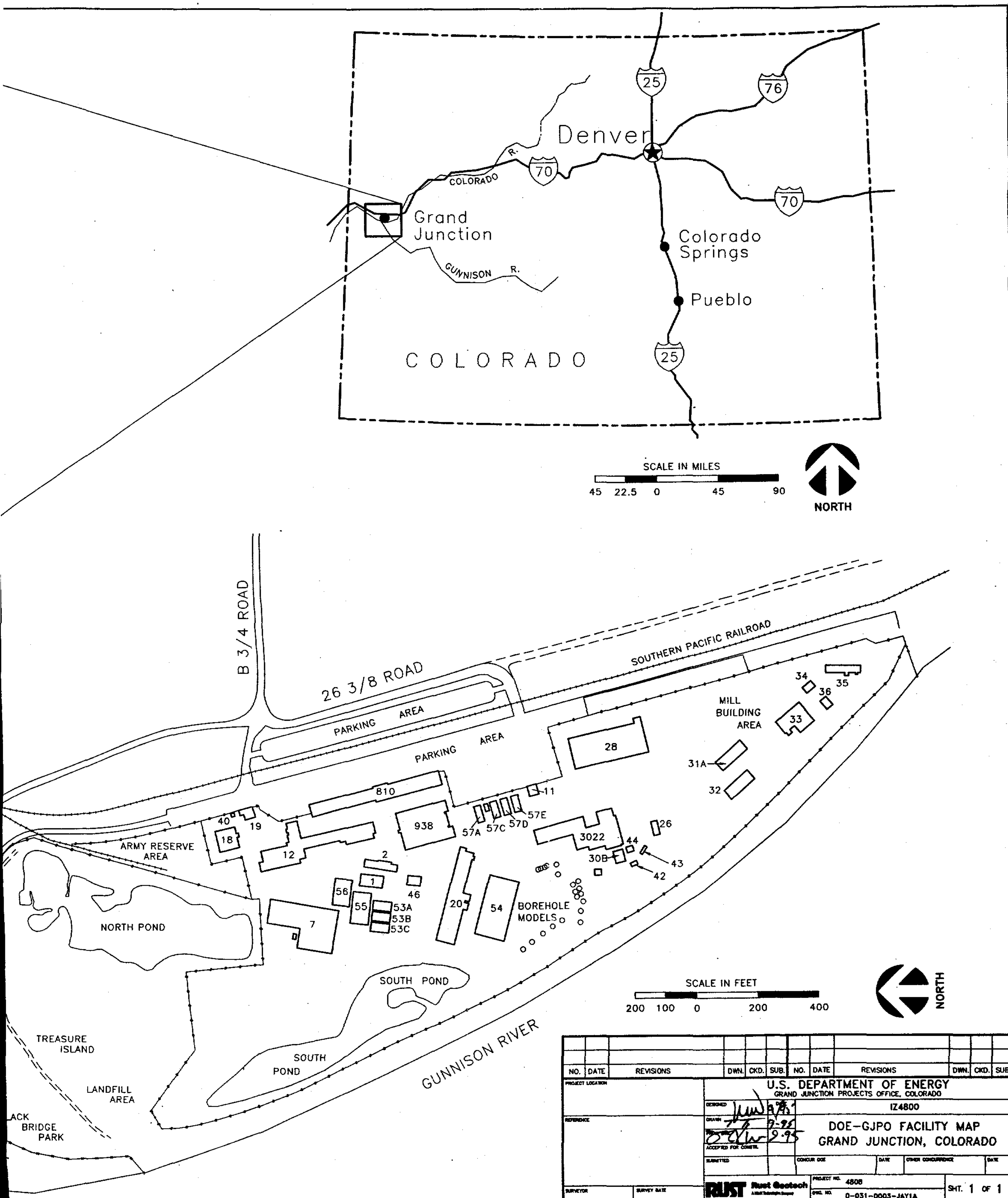


Figure 1. Site Map of the DOE-G



PO Facility, Grand Junction, Colorado

runoff drained into the North Pond. An estimated 100,000 cubic yards (yd^3) (76,500 cubic meters [m^3]) of tailings and contaminated soils were stabilized on site, and another 300 yd^3 (230 m^3) of contaminated process equipment was buried at the facility. Equipment that could be released and used elsewhere was taken off site. Nearly 18 acres (7 hectares), or about one-third, of the facility was assessed as contaminated.

Following the AEC uranium milling and assaying activities and prior to initiation of the UMTRA and D&D Programs, DOE–GJPO supported the National Uranium Resource Evaluation Program, which was a nationwide uranium modeling effort. DOE–GJPO currently supports D&D projects, environmental restoration projects, and associated technology development.

III. Decommissioning Objectives, Criteria, and Work Scope

Applicable Guidelines and Standards

The primary cleanup criteria for GJPORAP are specified in EPA's "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings" (40 *U.S. Code of Federal Regulations* [CFR] 192). Although these standards were promulgated in response to the mandates of UMTRCA, which guides remedial action activities at inactive privately owned uranium-processing sites and vicinity properties, they were found to be applicable to GJPORAP. Guidelines for other contaminants were established in accordance with DOE orders, the Formerly Utilized Sites Remedial Action Program (FUSRAP)/SFMP guidelines (DOE 1987b), and the more stringent of applicable Federal or State of Colorado regulations and guidelines (see Table 1–2 in DOE 1990b and Table 10 in DOE 1994e).

The focus of 40 CFR 192 is radium-226 (Ra-226) because of its associated radioactivity (alpha, beta, and gamma emissions of Ra-226 and its daughter isotopes) and its decay product, radon gas; this gas constitutes the primary health risk associated with residues from uranium-ore processing facilities. The exposure pathways of concern are direct contact, long-term exposure to gamma radiation, and long-term exposure to elevated radon concentrations.

The radiological standard for open land, as specified in 40 CFR 192.12(a), is

(a) The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than—

(1) 5 pCi/g [picocuries per gram], averaged over the first 15 cm [centimeters] [about 6 inches] of soil below the surface, and

(2) 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface.

The background concentration of Ra-226 at the DOE–GJPO facility is approximately 1.0 pCi/g. The method used to determine the background concentrations of all radiological contaminants is described in the *Radiologic Characterization of the Department of Energy Grand Junction Projects Office Facility* (DOE 1986a) and in the *Grand Junction Projects Office Remedial Action Program, Radiological Assessment for Construction Phase IB* (DOE 1990c).

With the acceptance of GJPORAP into SFMP, cleanup criteria for thorium-230 (Th-230) and thorium-232 (Th-232) became applicable. Concentrations of Th-230 and Th-232 must satisfy the same 5 pCi/g and 15 pCi/g above-background criteria that apply to Ra-226, as specified in the FUSRAP/SFMP guidelines and in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. The background concentrations of Th-230 and Th-232 at the DOE–GJPO facility are 2.0 pCi/g and 1.0 pCi/g, respectively. Because the mills on the DOE–GJPO facility processed only uranium ores, Th–232 is not a contaminant at this site.

The DOE Residual Radioactive Material (RESRAD) computer software program was used to derive the release guidelines for total uranium concentrations in soil. RESRAD, Version 4.0 (Argonne National Laboratory 1989), was re-run in 1993 and confirmed initial results (DOE 1993c). RESRAD evaluates exposure pathways to the public and calculates the dose-equivalent limit for specific sources so that guidelines can be developed to ensure that the exposure from each source does not exceed 25 millirems per year (mrem/yr). RESRAD-derived uranium guidelines for GJPORAP land areas were 191 pCi/g for uranium-234 (U-234), 241 pCi/g for uranium-238 (U-238), and 432 pCi/g for total uranium—averaged over 100 square meters (m^2). Through the application of the ALARA process, an administrative guideline of 103 pCi/g for total uranium was adopted for GJPORAP land areas. The background concentration of total uranium at the DOE–GJPO facility is 2.0 pCi/g.*

Environmental pathway analysis was used to evaluate the application of the site-specific uranium guideline to the sediments of the North Pond, in accordance with DOE Order 5400.5 (Thorne 1995). This model was based on three assumptions: (1) the source of uranium contamination of the groundwater and the sediments has been removed, (2) the radon pathway is not applicable, and (3) future occupants of the site would be expected to obtain domestic water from a municipal water source for the 50- to 80-year duration of the aquifer cleanup. The limit for total uranium in the North Pond sediments was determined to be greater than the 432 pCi/g guideline limit established for the soils.

The alpha and beta-gamma activity (surface contamination) release-limit guidelines for GJPORAP were specified in DOE Order 5400.5 and the FUSRAP/SFMP guidelines (DOE 1987b). Nonremovable (fixed) alpha or beta-gamma activity shall not exceed 5,000 disintegrations per minute per 100 square centimeters (dpm/cm^2), averaged over 1 m^2, and shall in no case exceed 15,000 dpm/100 cm^2. The guideline for removable activity is 1,000 dpm/100 cm^2, averaged over 1 m^2. These limits are applicable to interiors and exteriors of buildings, as well as to any other structural surface (e.g., concrete, asphalt, equipment).

*In the original project documentation, the RESRAD-derived uranium guideline defined release limits in micrograms per gram (µg/g), which were converted to units of pCi/g using a conversion factor of 0.33. Through the application of the ALARA process, an administrative release guideline of 150 µg/g (50 pCi/g) was established for total uranium. Subsequent investigation revealed that the correct conversion factor was 0.68687, which raised the administrative release guideline to 103 pCi/g (Rust 1994).

Ra-226 and Th-230 may not be in secular equilibrium on the DOE–GJPO facility. The provisions of DOE Order 5400.5 were applicable that specify when Ra-226 and Th-230 are not in equilibrium, the guideline for the most concentrated radionuclide shall be applicable. If radionuclides other than Ra-226 or Th-230 are present, the sum of the contributions of the individual radionuclides, expressed as a decimal percentage of the guideline, cannot exceed one (unity).

Residual radionuclide concentrations must also satisfy the "hot-spot" criteria specified in the FUSRAP/SFMP guidelines and DOE Order 5400.5. These criteria establish the maximum allowable concentration of a radionuclide within an area of 25 m^2 or less.

The Public Dose Limit from all sources is 100 mrem/yr, as specified in DOE Order 5400.5 and recommended by the International Commission on Radiological Protection (ICRP) in *Limits for Intakes of Radionuclides by Workers* (ICRP 1982) and *Recommendations of the ICRP* (ICRP 1987). When more than one release limit was applicable for a given situation, the most conservative release limit was used. DOE guidelines specify that any exposure of the public to above-background levels of radiation must be kept ALARA. The background gamma exposure rate at the DOE–GJPO facility is approximately 14 microroentgens per hour (µR/h) (DOE 1986a).

Community Relations

DOE has directed its field offices to encourage public participation in its remedial action projects (DOE 1991). GJPORAP community relations activities complied with DOE direction and the requirements of CERCLA (EPA 1992). DOE–GJPO ensured that public concerns and interests were considered during the GJPORAP planning and implementation process, and DOE–GJPO contractors were continuously informed of those concerns. DOE–GJPO and Rust provided information to public officials, interest groups, businesses, and concerned individuals regarding the work conducted for GJPORAP (DOE 1990d). Community concerns focused on the potential impacts resulting from transportation of the waste, including road safety, noise, dust, congestion, and road damage.

The following community relations activities were conducted for GJPORAP:

- Community interviews with local officials and facility employees were conducted in 1987.
- The draft Community Relations Plan for DOE–GJPO was written in 1988.
- Facility tours and briefings were conducted in 1989 for the Mesa County Commissioners, the Grand Junction City Council, and the Mesa County Planning Commission.
- The Administrative Record and Information Repositories were established in 1989 at the Mesa County Public Library and at the DOE–GJPO Technical Resource Center, enabling the public to review project documents.
- A public comment period for the draft remedial investigation/feasibility study—environmental assessment (RI/FS–EA) was offered in June and July 1989, as announced through two Notices of Public Opportunity to Comment in the local newspaper.
- A public meeting was held at the Two Rivers Convention Center in the city of Grand Junction in June 1989. Four meetings for DOE–GJPO employees were also held to discuss the decontamination work being performed at the site and to answer questions.
- The DOE–GJPO Public Relations Officer conducted media briefings on the history of facility cleanup activities and issued press releases that described current program activities. Rust established a facility newsletter for DOE–GJPO employees, keeping them informed on the status of GJPORAP. Rust has a full-time public relations representative who has assisted DOE–GJPO with community relations activities since 1986.
- The availability of the Record of Decision (ROD) and the Finding of No Significant Impact (FONSI) for public review was announced through Public Notices in the local newspaper in May 1990.
- The availability of the Site-Specific Plans for 1990, 1991, and 1994 for public review and comment was announced through Notices of Public Opportunity to Comment in the local newspaper in September 1990, September 1991, and February 1993.
- The availability of the Conceptual Site Treatment Plan for public review and comment was announced through a DOE press release in December 1993.

Quality Assurance Program

DOE Order 5820.2A, *Radioactive Waste Management*, requires that all waste management practices and decommissioning activities be conducted in accordance with all applicable requirements of the *Quality Assurance Program for Nuclear Facilities* (NQA–1) (ASME 1989). NQA–1 sets forth requirements for establishing and conducting quality assurance (QA) programs for siting, designing, constructing, operating, and decommissioning nuclear facilities. The *Grand Junction Projects Office Remedial Action Project Quality Assurance Program Plan* (DOE 1990e) complies with NQA–1. The GJPORAP QA Program Plan was revised in August 1994 to comply with DOE Order 5700.6C, *Quality Assurance*. Additionally, all work conducted by or for Rust, including all subcontractor work performed for GJPORAP, complied with the requirements of the Rust QA Program, as set forth in the Rust *Quality Assurance Manual* (Manual 101) and other applicable guidance (see Appendix A).

Demonstration and verification of QA and quality control during the cleanup activities were accomplished internally and externally. Rust management and Rust QA personnel conducted document reviews, audits, and surveillance to verify that remedial action activities complied with approved procedures. Surveillance and audit findings are filed in the project record and will be incorporated in the Certification Docket.

Independent checks and verifications were provided by the Colorado Department of Public Health and Environment (CDPHE) and by Oak Ridge National Laboratory, which is the GJPORAP Independent Verification Contractor (IVC). IVC activities began in May 1989 and included document reviews, meetings, and independent measurements to ensure that Rust's methods, measurements, procedures, and general approach were appropriate to achieve remedial action objectives. Because of increases in the scope of work and funding problems, no IVC activities were conducted between September 16, 1989, and February 26, 1990. The IVC will conduct a Type A review of the remediation activities completed during that time period.

IV. Work Performed

Remedial Investigation and Feasibility Study

The RI, released in July 1989 (DOE 1989c), summarized the results of surveys of the DOE–GJPO facility for radiological and nonradiological contaminants, as well as the results of groundwater monitoring and modeling, and provided a historical survey of facility activities.

Site surveys for radiological contamination were conducted in 1980 and 1981 (DOE 1982). Groundwater monitoring wells were installed in 1982 and 1984 (DOE 1984) and in 1985 and 1987.

Remedial action site investigations and characterization studies formally commenced at the DOE–GJPO facility in 1984 when the facility was accepted into SFMP. These characterization studies were designed to identify and describe radiological contamination that exceeded the guidelines set forth in 40 CFR 192. The characterization process included studies of the hydrological, geochemical, geological, and climatological features of the site. The results of these studies were presented in the *Radiologic Characterization of the Department of Energy Grand Junction Projects Office Facility* (DOE 1986a).

The 1986 characterization survey was based on a 100-foot by 100-foot grid system that was established over the DOE–GJPO facility; this survey sought to define the extent of Ra-226 contamination. Investigations were not conducted for other radioactive isotopes. These practices satisfied the applicable requirements of 40 CFR 192 and were consistent with the DOE contractor's method of UMTRA Program millsite characterization, which addressed Ra-226 concentrations in soil (see "Lessons Learned," page 20). Radiological assessment data collected subsequent to the 1986 characterization survey were based on smaller grid systems (usually 10-foot by 10-foot) and included all potential radiological contaminants: Ra-226, Th-230, Th-232, and uranium (see Figure B–1 in Appendix B for the estimated extent of exterior contamination).

The original objective of the radiological characterization was to prepare an EA in accordance with NEPA. With the passage of SARA in October 1986 and the subsequent implementation of DOE Order 5400.4, *Comprehensive Environmental Response, Compensation, and Liability Act Requirements*, GJPORAP was expanded to evaluate the DOE–GJPO facility in accordance with CERCLA, including the preparation of an RI. The results of the RI were used to evaluate remedial action alternatives for the facility, which were published in the FS. The requirements of both SARA and NEPA were satisfied with the release of an integrated RI/FS–EA. A FONSI was issued by DOE in February 1990 (DOE 1990a).

Environmental monitoring was initiated at the DOE–GJPO facility in 1979. This monitoring included sampling and analysis of water from the monitoring wells and the river, as well as conducting radon measurements and air monitoring. Monitoring results indicated that residual radioactive material from the ore-processing operations presented a hazard to human health and the environment (see Appendix C for a list of environmental monitoring reports that were used for this analysis). The main pathways of exposure (risk) were inhalation and ingestion of airborne radioparticulates, ingestion of contaminated surface water or groundwater, and risks related to Ra-226 and radon gas derived from the tailings.

Radiological Contamination—Radiological waste at the DOE–GJPO facility consisted primarily of uranium mill tailings, uranium ore, and contaminated process equipment.

The 1986 characterization study estimated a total of 81,500 yd^3 (62,300 m^3) of contaminated material covering 85,900 square yards (yd^2) or 71,800 m^2 (DOE 1986a). Contamination was assessed to depths greater than 108 inches (274 centimeters). The highest noted concentration of Ra-226 was measured at 12,338 pCi/g; the highest outdoor gamma-exposure rate was measured at 415 μR/h. Total metals analyses conducted on tailings samples indicated the presence of uranium ore in several locations. The coexistence of uranium ore with tailings is expected at uranium mill-tailings sites.

Contaminated material was concentrated in the earthen dike along the Gunnison River to the west and north of the DOE–GJPO facility, in the tailings disposal and South Pond areas west of Building 7 and Building 20, in the mill area on the southern end of the facility, and was found in lesser amounts throughout the facility. Contaminated material was associated with a section of sanitary sewer. Contamination was also identified at two off-site locations: (1) Black Bridge Park to the north of the facility and (2) east of the railroad tracks and opposite Building 11 (see Figure B–1 in Appendix B).

Elevated concentrations of uranium were detected in the water of the North and South Ponds, and Ra-226 contamination was detected in the sediments of the South Pond. Analysis of samples from monitoring wells revealed total uranium levels as high as 5,994 picocuries per liter (pCi/L) in the water of the alluvial aquifer underlying the facility, which is in direct hydraulic contact with the Gunnison River.

There were 814 fifty-five-gallon drums on the DOE–GJPO facility at the time of the RI. Of these drums, 135 were empty and free of contamination; the remainder contained radioactive ore samples and radiological waste.

Buildings associated with the large pilot mill were identified in the RI/FS as having surface contamination. Remediation of these buildings and other contaminated buildings now included in the scope of GJPORAP will be addressed in a separate report.

Nonradiological Contamination—Varying amounts of nonradiological, potentially hazardous substances were identified on the DOE–GJPO facility.

Elevated levels of molybdenum, arsenic, and selenium were identified in groundwater samples collected from the alluvial aquifer underlying the facility, with maximum concentrations of greater than 2.0 micrograms per liter (μg/L), 0.46 μg/L, and 0.16 μg/L, respectively. These metals also were detected in elevated concentrations in the waters of the North and South Ponds. Hydrological modeling results indicated that aquifer discharges into the Gunnison River will not cause the river water to exceed Colorado water quality standards.

The EPA-approved extraction procedure toxicity (EP Tox) test was used to analyze soil samples for metals contamination on the DOE–GJPO facility. The results of these analyses indicated that none of the samples tested exceeded Resource Conservation and Recovery Act (RCRA) toxicity-characteristic regulatory levels. Analyses of composite samples collected from the South Pond sediments did not indicate the presence of any Hazardous Substance List volatile or semivolatile organic compounds or polychlorinated biphenyls (PCBs).

Remedial Action Alternatives—The FS was released in July 1989 (DOE 1989c). The FS focused on technologies applicable to radioactive materials because contamination found at that time on the DOE–GJPO facility was determined to be associated with uranium mill tailings and was not hazardous or RCRA-regulated mixed waste.

DOE managed the remediation of properties in the Grand Junction area for several years under the UMTRA Program and used the Climax Uranium Company millsite (located approximately 2 miles [3.2 kilometers] northeast of the DOE–GJPO facility) as a temporary repository for contaminated material. DOE's ROD for the Climax millsite specifically addressed the disposal of contaminated material from GJPORAP with UMTRA Program material (DOE 1988b).

A final disposal site was established for UMTRA Program waste at Cheney Reservoir. This site is located approximately 7 miles (11.3 kilometers) south of Whitewater, Colorado. The disposal cell at Cheney Reservoir conforms to the controls specified in 40 CFR 192.

The FS found the following remedial action alternatives to be suitable for GJPORAP:

- No action.
- Complete removal and co-disposal with UMTRA Program tailings at the Cheney

Disposal Site and passive groundwater restoration.

- Complete removal and co-location with UMTRA Program tailings at the Cheney Disposal Site in two adjacent disposal cells —one specifically for GJPORAP material— and passive groundwater restoration.

- Complete removal and co-disposal with UMTRA Program tailings at the Cheney Disposal Site and active groundwater restoration.

- Stabilization on site and passive groundwater restoration.

These alternatives were evaluated for effectiveness, implementability, conformance to applicable regulations, community acceptance, and cost. Only those alternatives involving complete removal met or exceeded all applicable or relevant and appropriate requirements (ARARs). The no-action alternative would allow continued contamination of air, soil, and groundwater. The stabilization-on-site alternative would risk inundation by the probable maximum (1,000-year) flood.

Record of Decision

DOE approved the ROD for GJPORAP in April 1990 (DOE 1990b). The ROD detailed the selected remedial action alternative for the DOE–GJPO facility, which included

- Removal of all radiological waste from the DOE–GJPO facility and transport by truck to the temporary repository at the Climax millsite for consolidation with UMTRA Program waste.

- Co-disposal of GJPORAP and UMTRA Program waste at the Cheney Disposal Site.

- Passive restoration of the shallow alluvial aquifer beneath the DOE–GJPO facility.

- Reconstruction and revegetation of the affected areas on the DOE–GJPO facility.

- Long-term monitoring of the Cheney Disposal Site and the groundwater at the DOE–GJPO facility.

Implementation of the selected remedial action would allow unrestricted use of the site.

Under the selected remedial action, the contaminated material at the Cheney Disposal Site would be covered with an earthen radon barrier and an erosion-protection layer of rock. All environmental controls were intended to last 1,000 years, to the extent reasonably achievable, with a minimum life of 200 years.

The remedy selected for GJPORAP included remediation of the alluvial aquifer through the natural flushing action identified during hydrologic modeling that was performed for the RI. Contamination is expected to flush from the aquifer by natural sorptive processes, precipitation, and discharge into the Gunnison River. Groundwater models indicated that the aquifer would be free of contamination (including uranium, molybdenum, arsenic, and selenium) in 50 to 80 years. This time frame was within the proposed UMTRCA groundwater compliance limit of 100 years (DOE 1990b).

GJPORAP was the first non-NPL DOE project to implement the CERCLA process and receive a DOE-approved ROD. The remedial action alternative was selected in accordance with CERCLA (as amended by SARA) and UMTRCA guidelines. The State of Colorado, through CDPHE, concurred with the selected remedy. The GJPORAP Project Plan (DOE 1986b) detailed procedures to stabilize and control the uranium mill tailings and related contaminated material, while maintaining compliance with EPA and other program requirements.

Post-ROD Changes—The actual remediation differed from the selected remedy because of project requirements and field conditions that were encountered after GJPORAP began. DOE–GJPO will release an Explanation of Significant Differences (ESD) upon completion of remediation of the facility buildings and closeout of GJPORAP. The ESD will address changes in the selected remedial action resulting from

- The recognition of FUSRAP/SFMP guidelines, which led to the inclusion of Th-230 and uranium guidelines to project release criteria.

- D&D Program inclusion.

- Additional radiological contamination identified in the facility buildings.

- Other nonradiological contaminants identified in facility soils, drums, and abandoned sumps.
- An increased area of contamination and associated volume of waste.

The selected alternative was modified during the last phases of GJPORAP when, because remediation of the Climax millsite was completed, radiological waste materials from the DOE–GJPO facility were hauled by truck directly to the Cheney Disposal Site.

Supplemental Data Collection

A radiological assessment of the facility areas inside the security fence (except the mill area on the southern end of the facility) was conducted to more accurately determine the areal extent and quantity of contamination and to survey for Ra-226, Th-230, and total uranium contamination (DOE 1990c). The maximum gamma exposure rate was measured at 1,350 µR/h. Maximum radionuclide concentrations were measured at 2,483 pCi/g for Ra-226; 2,301 pCi/g for total uranium; and 1,526 pCi/g for Th-230. Contamination was detected from 6 inches (15 centimeters) to more than 87 inches (221 centimeters) deep. Alpha and beta contamination was detected near Building 2 and Building 7. The volume of contaminated material was revised to 136,000 yd^3 (103,980 m^3) as a result of this assessment.

A radiological assessment was conducted at Black Bridge Park (DOE 1989j). This survey identified Ra-226 contamination ranging from 6 inches (15 centimeters) to 108 inches (274 centimeters) deep, with Ra-226 concentrations measured as high as 271 pCi/g. Black Bridge Park and Treasure Island were reassessed in 1993 to accurately determine the quantities of contaminated material and the presence and extent of Th-230 and total uranium contamination (DOE 1993a). This reassessment was necessitated, in part, by program changes that recognized cleanup criteria for Th-230 and total uranium for the GJPORAP remedial design. Existing data were supplemented with exploratory trenching in areas of known or suspected contamination. The disposal trenches in the landfill area of Treasure Island were monitored and sampled for radiological and nonradiological contamination; no hazardous nonradiological materials were identified in these trenches. This reassessment identified approximately 44,000 yd^3 (33,600 m^3) of radiologically contaminated material ranging from 6 inches (15 centimeters) to 180 inches (457 centimeters) deep, with maximum radionuclide concentrations measured at 377 pCi/g for Ra-226, 264 pCi/g for Th-230, and 190 pCi/g for total uranium.

Sediments from the South Pond were resampled in 1988 and analyzed according to RCRA guidelines; the results of this analysis confirmed the absence of RCRA-regulated waste (DOE 1989c).

In 1994, sediment samples were collected from the North Pond and analyzed for Ra-226, Th-230, Th-232, and total uranium (Rust 1995b). This survey was designed to augment the sediment sampling results from the 1986 site characterization. On the basis of sample analysis results, the North Pond sediments are not contaminated. Total uranium concentrations of the 45 samples ranged from 2.1 to 232.1 pCi/g, with an average of 41.3 pCi/g and a standard deviation of 43.4 pCi/g. The highest total uranium concentration is less than the guideline limit for total uranium. The analysis of a single sample aliquot from the southern end of the pond indicated a Th-230 concentration in excess of the release limit; however, a composite sample collected from the surrounding 100-m^2 area had a Th-230 concentration of 4.8 pCi/g. All other sample results were below the guideline limits. A sedimentation study conducted in the North Pond indicated that mill tailings were not disposed of in the pond (Abraham 1995). A biota study did not find evidence of significant uptake of radionuclides (DOE 1993d). Because the North Pond is in hydraulic contact with the alluvial aquifer and the Gunnison River, any elevated uranium concentrations in the water or sediments of the pond should flush clean along with the aquifer.

In 1988, a geophysical survey was conducted in the landfill area of Treasure Island to identify burial sites and buried metallic objects (DOE 1988c). Trenches were excavated in the Treasure Island landfill to determine whether hazardous waste had been disposed of in the landfill (DOE 1989b). At DOE's request, a trench was excavated in the landfill area in 1990, and samples were collected and analyzed for EP Tox metals, volatiles, and semivolatiles;

no such contamination was found (UNC Geotech 1990).

The Treasure Island landfill area was sampled in 1987 and 1989 to screen the area for nonradiological hazardous waste (DOE 1989b, 1989c). Of the 64 samples that were collected and analyzed using the EP Tox and toxicity-characteristic leaching procedure (TCLP) methods, 3 samples contained detectable levels of lead and 2 additional samples exhibited the RCRA toxicity characteristic for lead. All other samples were negative for metals, volatiles, and semivolatiles. On April 22, 1994, at the request of CDPHE, two samples were collected in an area containing ceramic chips to determine whether lead contamination was related to those chips. Results of the sample analysis, using the TCLP method, were negative for all metals (DOE 1994d).

In 1994, the IVC conducted a trenching and sampling program in the landfill area of Treasure Island to help ensure that no unauthorized hazardous or radiological waste would unknowningly be transported to the Cheney Disposal Site and to provide data for the Certification Docket. Samples were analyzed for TCLP volatile and semivolatile organic compounds, PCBs, pesticides, high boiling-point hydrocarbons, and target analyte metals; no contamination above regulatory guidelines was found (ORNL 1994).

Remedial Design

The objective of the engineering and design task was to completely remediate the facility in accordance with the ROD. The selected remedy involved removing all radiological and toxic or hazardous materials from the facility and transporting these materials to an approved off-site disposal facility, thereby eliminating real and potential hazards to the public and the environment. Radiologically contaminated materials would be impounded at the Cheney Disposal Site. Any nonradiological hazardous materials would be disposed of as appropriate.

Several operations and criteria were considered during the design of the remedial action. Procedures were adopted to prevent contaminant releases during construction operations and to minimize disturbances to the sensitive local ecology without affecting the ongoing operations of the DOE–GJPO facility. Exposure to personnel had to be restricted to acceptable levels and kept ALARA.

After the removal of uranium tailings and other associated contaminated material, the affected areas would be backfilled, recontoured, reconstructed, and revegetated, as appropriate. No radiological hazards would remain at the facility, and the facility would comply with all identified cleanup standards. At the conclusion of the remedial action, the use of the entire DOE–GJPO facility would be unrestricted. The GJPORAP organization and implementation strategy was defined in the *Grand Junction Projects Office Remedial Action Project Remedial Action Plan* (DOE 1990g).

Decommissioning Operations

Summary of Remedial Action—Decontamination activities for the exterior areas of the DOE–GJPO facility were initiated in July 1989 and were completed in January 1995. Remediation was carried out in phases to facilitate scheduling and planning. Some decontamination of the mill buildings was performed in 1989.

Some decontamination activities took place before the start of GJPORAP. These activities included the remediation in 1984 and 1985 of the area south and east of and adjacent to Building 7, the remediation in 1985 of a portion of the Army Lease Area north of Building 18, and the remediation in 1987 of several sections of sidewalk near Building 46. Material that was remediated before the ROD was issued was stockpiled on site.

In 1988, five underground storage tanks were removed from the DOE–GJPO facility; three tanks were located west of Building 28 and two tanks were located south of Building 33. Radiologically contaminated soil associated with these tanks was stockpiled north of the South Pond. Some of this soil was also contaminated with petroleum products and was aerated prior to disposal (DOE 1988a).

Four radiologically contaminated buildings (Buildings 6, 31, 37, and 39) were demolished during GJPORAP. Partial decontamination activities were conducted in 1989 on Buildings 33, 34, and 35. Remediation of these buildings and the remainder of the contaminated facility buildings will be completed and documented in a separate report (see "Cost and Schedule," page 17, first bullet).

Radiologically contaminated material was excavated using front-end loaders and track hoes. Excavated material was loaded into dump trucks and hauled off site (DOE 1990g). Contaminated material that was removed from the facility before January 1994 was transported by truck to the temporary repository at the Climax millsite and then transported by train and truck to the Cheney Disposal Site for permanent disposal. Material that was removed from the facility after January 1994 was transported directly to the Cheney Disposal Site by truck.

On June 21, 1991, DOE was granted an exemption by the U.S. Department of Transportation (DOT) that allowed mill tailings and associated contaminated material to be hauled in closed vehicles and bulk containers without detailed analysis of the contents (DOT 1992). This exemption also provided alternative requirements for hazard communication and packaging. Contaminated material was blended on site, if necessary, to ensure that the activity of the material was within the limits of the exemption.

Decontamination Procedures—Immediately prior to the initiation of decontamination operations, exterior areas that had been previously identified as contaminated were confirmed and marked to indicate the excavation boundaries for the construction subcontractor. Contamination was confirmed by conducting a systematic gamma scan with scintillometers (portable radiation detectors) to delineate areas of elevated gamma activity. Technicians monitored the excavation by using scintillometers and by sampling soils to ensure that all contaminated material was removed with minimal overexcavation. When contamination was found to be more extensive than originally assessed, excavation continued horizontally and vertically until all contaminated material was removed. Areas that were assessed as free of contamination were rescanned and sampled, if necessary, to confirm the absence of contamination.

Procedures for certifying that radiological contaminants were removed to guideline levels were established in written and approved plans (DOE 1989k, 1990g, and 1993b). Certification will be conducted in accordance with the certification protocol for FUSRAP and D&D Programs (DOE 1990f). Procedures for the calibration and use of instruments, sampling, and analysis were established in the Rust *Field Assessments Procedures Manual.*

Two methods of verification were employed:

- For most of the remediated area, a 10-foot by 10-foot grid was established over the excavation. Individual grid blocks or smaller individual excavations were grouped together to create a verification area (V-area) no larger than approximately 900 square feet (ft^2) (84 m^2) to 1,000 ft^2 (93 m^2). The gamma exposure-rate range was measured, and a soil sample aliquot was collected at the approximate center of each 100-ft^2 grid block. The aliquots were composited to form a representative soil sample for each V-area.
- Beginning in December 1991, where the areal extent of the excavation was at least 21,500 ft^2 (2,000 m^2), the Large Area Verification (LAV) protocol was used (Chem-Nuclear Geotech, Inc. 1991). A 30-foot by 30-foot grid was established over the excavated area, and as many as 12 blocks were grouped together to form a V-area. To provide a conservative result for each V-area, individual blocks were scanned to determine the gamma exposure-rate range, and a soil sample aliquot was collected where the highest gamma exposure-rate range was measured. The aliquots were composited to form a representative soil sample for each V-area. The use of the LAV protocol was discontinued in February 1993. Certification of the 47 LAV areas was justified in a RAC report (DOE 1994h).

Compliance with the FUSRAP/ SFMP hotspot criteria was demonstrated by gamma scans and/or soil sample results.

Compliance with the "unity" criterion in DOE Order 5400.5 has been demonstrated by soil sample results indicating that all radionuclide concentrations are below the project standards. Uranium oxide ("yellow cake") from historical milling and procurement activities is not a contaminant of concern below the top 18 inches of soil because it was not disposed of with the mill tailings. The soil guidelines for Ra-226 and Th-230 assume secular equilibrium and these two radionuclides are in equilibrium in the remediated areas of the DOE–GJPO facility. Only the radionuclide with the higher concentration is used in the unity calculation. No other radionuclides were present above background levels in significant amounts in the soils of the remediated areas.

Exterior structural surfaces of the DOE–GJPO facility comply with the surface contamination guidelines, as demonstrated by the results of a 1995 survey of exterior surfaces (Rust 1995c) and as supported by data from the 1989 characterization survey (DOE 1989g).

When an excavation was too deep to enter safely, soil samples were collected with a backhoe in accordance with Procedure 3.5.3.3.6 of the Rust *Field Assessments Procedures Manual.* Starting with Area V–498, when a soil sample consisted of river alluvium containing cobbles and fines, it was dried, crushed, and blended in accordance with Procedure 3.5.3.3.5 of the Rust *Field Assessments Procedures Manual.*

At the DOE–GJPO Analytical Laboratory, composite soil samples were analyzed for Ra-226 and, as necessary, potassium-40, Th-230, Th-232, and total uranium. As a cost-saving measure for Areas V–349 through V–674, each sample was scanned with a beta-gamma detector before submittal to the laboratory. When the scan indicated activity in excess of 2,500 dpm/100 cm^2, the sample was analyzed for total uranium. Activities below this value indicated a measurable uranium concentration that was still within the authorized limit. All other verification soil samples were analyzed for total uranium.

Excavation was monitored continuously by RAC personnel. When the RAC field representative suspected that nonradiological contamination had been encountered, construction activity in that area was halted until the occurrence was investigated. The RAC coordinated with the IVC and CDPHE so that they could perform independent verifications. IVC procedures were specified in the *Work Plan for Independent Verification of the Grand Junction Projects Office Remedial Action Project* (ORNL 1991).

Once excavation had been completed for each exterior area and satisfactory verification results had been obtained, the excavation was backfilled with uncontaminated material. Each area was restored in accordance with the ROD.

Radiological Contamination—Figure B–1 in Appendix B shows the exterior V-areas for GJPORAP. The results of the radionuclide analyses of the composite soil samples are presented in Table D–1 in Appendix D. Table D–1 also provides the gamma exposure-rate range, the average excavation depth, and the unique soil sample identification number for each V-area.

The results of the soil sample analyses for the 1,075 exterior V-areas indicated that Ra-226 concentrations ranged from less than 0.01 pCi/g to 29.3 pCi/g, Th-230 concentrations ranged from 0.4 pCi/g to 42.6 pCi/g, and total uranium concentrations ranged from 1.4 pCi/g to 91.4 pCi/g. Excavated depths ranged from 6 inches (15 centimeters) to 220 inches (559 centimeters) deep.

Gamma exposure rates in the remediated areas ranged from 10 µR/h to 767 µR/h. Elevated gamma exposure rates (those exceeding background by greater than 20 µR/h) were caused by "shine" from adjacent unremediated areas or from residual radioactive material that was left in place and area-averaged.

In four relatively small areas, Ra-226 and/or Th-230 concentrations of the composite soil samples exceeded GJPORAP standards. Concentrations of Ra-226 and Th-230, area-averaged over 100 m^2, were computed for these areas because field conditions precluded the safe or cost-effective removal of the remaining contamination. These areas are summarized below. The sample results, area-averaged Ra-226 and Th-230 concentrations, and the hot-spot limits are presented in Table D–2 in Appendix D.

Area V–406 is a 10-ft^2 (0.9-m^2) deposit of Ra-226- and Th-230-contaminated soil located adjacent to the Gunnison River near Building 33. This deposit was left in place because excavation had proceeded below groundwater and the excavation could not be dewatered. The average Ra-226 and Th-230 concentrations in Area V–406 were 4.2 pCi/g and 4.9 pCi/g, respectively, which were within applicable limits. The hot-spot limit for Area V–406 is 150.0 pCi/g for both Ra-226 and Th-230; this limit was not exceeded by the maximum concentrations of these radionuclides. The total uranium concentration did not exceed the administrative release limit for GJPORAP.

Area V–612 is a 40-ft^2 (3.7-m^2) deposit of Ra-226- and Th-230-contaminated soil located near the southwest corner of Building 20. This deposit was left in place because the contamination surrounded a sanitary sewer that could not be taken out of service. The average Ra-226 and Th-230 concentrations in Area V–612 were 2.6 pCi/g and 4.6 pCi/g, respectively, which were within applicable limits. The hot-spot limit for Area V–612 is 77.8 pCi/g for both Ra-226 and Th-230; this limit was not exceeded by the maximum concentrations of these radionuclides. The total uranium concentration did not exceed the administrative release limit for GJPORAP.

Area V–661 is a 40-ft^2 (3.7-m^2) deposit of Ra-226- and Th-230-contaminated soil located adjacent to the Gunnison River near the northwest corner of the site. This deposit was left in place to avoid damaging the root system of a mature tree. The average Ra-226 and Th-230 concentrations in Area V–661 were 2.1 pCi/g and 2.6 pCi/g, respectively, which were within applicable limits. The hot-spot limit for Area V–661 is 77.8 pCi/g for both Ra-226 and Th-230; this limit was not exceeded by the maximum concentrations of these radionuclides. The total uranium concentration did not exceed the administrative release limit for GJPORAP.

Area V–662 is a 28-ft^2 (2.6-m^2) deposit of Ra-226- and Th-230-contaminated soil located adjacent to the Gunnison River near the northwest corner of the site. This deposit also was left in place to avoid damaging the root system of a mature tree. The average Ra-226 and Th-230 concentrations in Area V–662 were 2.2 pCi/g and 2.8 pCi/g, respectively, which were within applicable limits. The hot-spot limit for Area V–662 is 93.0 pCi/g for both Ra-226 and Th-230; this limit was not exceeded by the maximum concentrations of these radionuclides. The total uranium concentration did not exceed the administrative release limit for GJPORAP.

Radiologically contaminated soil samples and concrete waste were stored on site in 55-gallon drums. This material, along with 902 contaminated drums, was disposed of at the Cheney Disposal Site.

Area V–586 defines the location of a fire hydrant that had surface contamination from tailings backfill. The soil underlying Area V–586 was included in Areas V–160 and V–247. Area V–587 defines the location of pipes that contained internal contamination. Because gamma exposure rates did not exceed background rates by more than 30 percent after the pipes were removed, the soil was determined to be uncontaminated and soil samples were not collected.

Areas V–601, V–602, and V–615 represent buried concrete that was found to have detectable levels of fixed surface contamination that did not exceed the release limits; this concrete was scanned prior to burial. Beta-gamma scans indicated activities of 0–2,400 dpm/100 cm^2 for Area V–601; 800–2,800 dpm/100 cm^2 for Area V–602; and 0–1,200 dpm/100 cm^2 for Area V–615. In situ measurements indicated that the concrete was not contaminated. Although remedial action was not required to bring these areas into compliance with project guidelines, these areas were included as exterior V-areas so that the detectable contamination could be recorded.

Radiological Contamination With Associated Nonradiological Contaminants—Remediation activities revealed the presence of small quantities of radiological waste with associated nonradiological contaminants. All of this waste that has not been disposed of is currently controlled and managed on the DOE–GJPO facility in accordance with the RCRA Treatment, Storage, and Disposal permit for DOE–GJPO.

Approximately 50 yd^3 (38 m^3) of radiologically contaminated soil with detectable levels of lead was found in the Treasure Island landfill area west of the North Pond. According to results of EP Tox analysis, concentrations of leachable lead were measured as high as 30 milligrams per liter (mg/L) and varied widely (DOE 1989d, 1989h, and 1994d). The lead contamination was not associated with any visually discernable waste. The source of the lead could not be definitely established. Because the average lead concentration was less than the RCRA action limit of 5.0 mg/L, the waste was determined not to be RCRA regulated. With the concurrence of CDPHE, DOE–GJPO, and the IVC, the material was disposed of at the Cheney Disposal Site (CDPHE 1994).

Approximately 1.0 yd^3 (0.8 m^3) of radiologically contaminated soil mixed with PCBs was excavated from the southern end of the facility and temporarily stockpiled west of Building 7. The PCB-contaminated material was inadvertently mixed with other radiologically contaminated soil to create a volume of 61 yd^3 (47 m^3). This Toxic Substances Control Act (TSCA)-regulated mixed waste has been placed in TSCA-compliant storage and will be stored on site until a disposal plan is approved. The initial maximum PCB concentration in the soil was 920 parts per million (ppm) (DOE 1989i). The waste material in the roll-off bins has an average PCB concentration of 0.16 ppm (Rust 1993).

An abandoned concrete sump was uncovered near Building 31. The contents of the sump were placed in four 55-gallon drums. In one drum, analysis of the sump contents for TCLP metals, semivolatiles, and volatiles revealed the presence of radiologically contaminated chloroform, benzene, and carbon tetrachloride in concentrations of 690 mg/L, 3.8 mg/L, and 5.7 mg/L, respectively. These concentrations exceed the toxicity characteristic limits for these materials of 6 mg/L, 0.5 mg/L, and 0.5 mg/L, respectively (DOE 1994b). This drum is currently managed on the DOE–GJPO facility pending approval of a treatment and/or disposal plan. The contents of the other three drums were found to be below RCRA toxicity-characteristic limits and were disposed of at the Cheney Disposal Site. The sump was determined to be free of nonradiological contamination and was disposed of at the Cheney Disposal Site.

Other abandoned sumps, discolored soil, and piping were uncovered near Building 1 and Building 3022 and near the site that was formerly Building 6. Hazardous materials were not detected in any of these locations, and all radiologically contaminated material associated with these structures was disposed of at the Cheney Disposal Site.

Approximately 5 pounds of red-stained material was uncovered in the landfill area of Treasure Island. This material exhibited a TCLP lead concentration of 812 mg/L, which exceeds the RCRA regulatory limit of 5.0 mg/L (DOE 1994g). The results of x-ray defraction testing identified this lead-contaminated material as the mineral minium (lead oxide), which is probably a remnant of red lead paint. This mixed radiological waste was placed in a 5-gallon bucket and will be stored on the DOE–GJPO facility pending disposal at an approved facility.

Parts of several rusted electrical ballasts were found in the Treasure Island landfill area, with detected PCB concentrations of 250,000 ppm (DOE 1994g). These ballasts were radiologically contaminated and are currently managed as a TSCA-regulated mixed waste. The ballasts and the surrounding radiologically contaminated soil were placed in a drum and stored on the DOE–GJPO facility pending disposal at an approved facility.

Approximately 150 lb (68 kilograms [kg]) of petroleum-stained, radiologically contaminated soil was placed in a drum after TCLP test results indicated a leachable lead concentration of 11.6 mg/L (DOE 1994f). This material, a RCRA toxicity-characteristic mixed waste, is stored on the DOE–GJPO facility. Upon approval of a treatment plan, the waste will be treated to remove the toxicity characteristic and will be disposed of at an approved facility.

Asbestos, in the form of discarded asbestos cement pipe and other building materials, was frequently identified in the excavation of the landfill area. The asbestos and surrounding radiologically contaminated soil were removed by an asbestos-abatement contractor and placed in drums. Other asbestos-containing material from GJPORAP abatement activities was stored on site in 372 fifty-five-gallon drums. All of the asbestos was disposed of at the Cheney Disposal Site.

Approximately 4.8 lb (2.2 kg) of radiologically contaminated soil and building debris mixed with mercury was removed from Building 6. Analysis of the material, using the TCLP method, indicated a leachable mercury concentration of 0.39 mg/L, which exceeds the RCRA toxicity characteristic limit of 0.2 mg/L for that metal (DOE 1995a). This material currently is stored in plastic bags on the

DOE–GJPO facility pending treatment and/or disposal at an approved facility.

A 10-gallon drum containing oily sludge, rags, and automotive parts was uncovered in the Treasure Island landfill area. Volatile organics analysis of the sludge, using the TCLP method, identified trichloroethylene at a concentration of 3.7 mg/L, which exceeds the RCRA toxicity-characteristic limit of 0.7 mg/L for that substance (DOE 1994c). This material was placed in a drum and currently is managed on the DOE–GJPO facility as a RCRA-regulated mixed waste, pending approval of a plan to treat the waste so it can be properly disposed of.

Personal protective equipment (PPE) that was used for the GJPORAP remedial action was disposed of at the Cheney Disposal Site.

V. Cost and Schedule

Project costs and the project schedule were managed in accordance with DOE Order 4700.5, *Project Control System Guidelines*, using a validated Project Control System.

The total cost for GJPORAP originally was estimated at $10,948,000 (DOE 1989l). As of July 1995, the actual cost of the project is $25,935,946, which includes $125,439 in capital expenditures. Total estimated costs at project completion are $36,864,000. Table 1 presents a summary of the financial history of GJPORAP.

GJPORAP originally was scheduled for completion by the end of fiscal year 1991 (DOE 1989l). As of July 1995, GJPORAP is scheduled to be completed in fiscal year 1998, at which time the DOE–GJPO facility is expected to be accepted into the LTSM Program (Figure 2).

Variances between the original and the current projected cost and schedule occurred because of the following:

- Remediation of additional facility buildings was added to the project scope. At the inception of GJPORAP, under SFMP, the

Table 1. Funding, Budget, and Cost Summary for GJPORAP

Year	Estimated Cost[a]	Funding[b]	Budget [b]	Actual Cost[b]	Carryover[b]
1986		495,000	464,180	464,180	30,820
1987		930,000	853,345	853,345	107,475
1988	2,229,000	1,000,000	750,004	750,004	357,471
1989	4,864,000	4,176,000	2,021,307	2,021,307	2,512,164
1990	3,684,000	2,193,000	2,175,709	3,047,454	1,657,710
1991	171,000	4,775,000	3,733,283	3,622,928	2,809,782
1992		5,901,000	5,846,757	5,891,920	2,818,862
1993		735,000	2,853,323	3,070,934	482,928
1994		5,349,000	5,429,995	4,664,344	1,167,584
1995		2,310,000	2,245,056[c]	1,549,530[c]	
1996		2,900,000			
1997		5,350,000			
1998		750,000			
Total	10,948,000	36,864,000	26,372,959	25,935,946	

NOTE: All amounts are in actual dollars.

[a]Estimates were taken from the *Defense Decontamination and Decommissioning Program: Program Management Plan* (DOE 1989l). These estimates do not include funds for site surveillance and maintenance or site program support.

[b]Funding and budget amounts taken from Rust 1995a and DOE 1995b.

[c]As of July 1995.

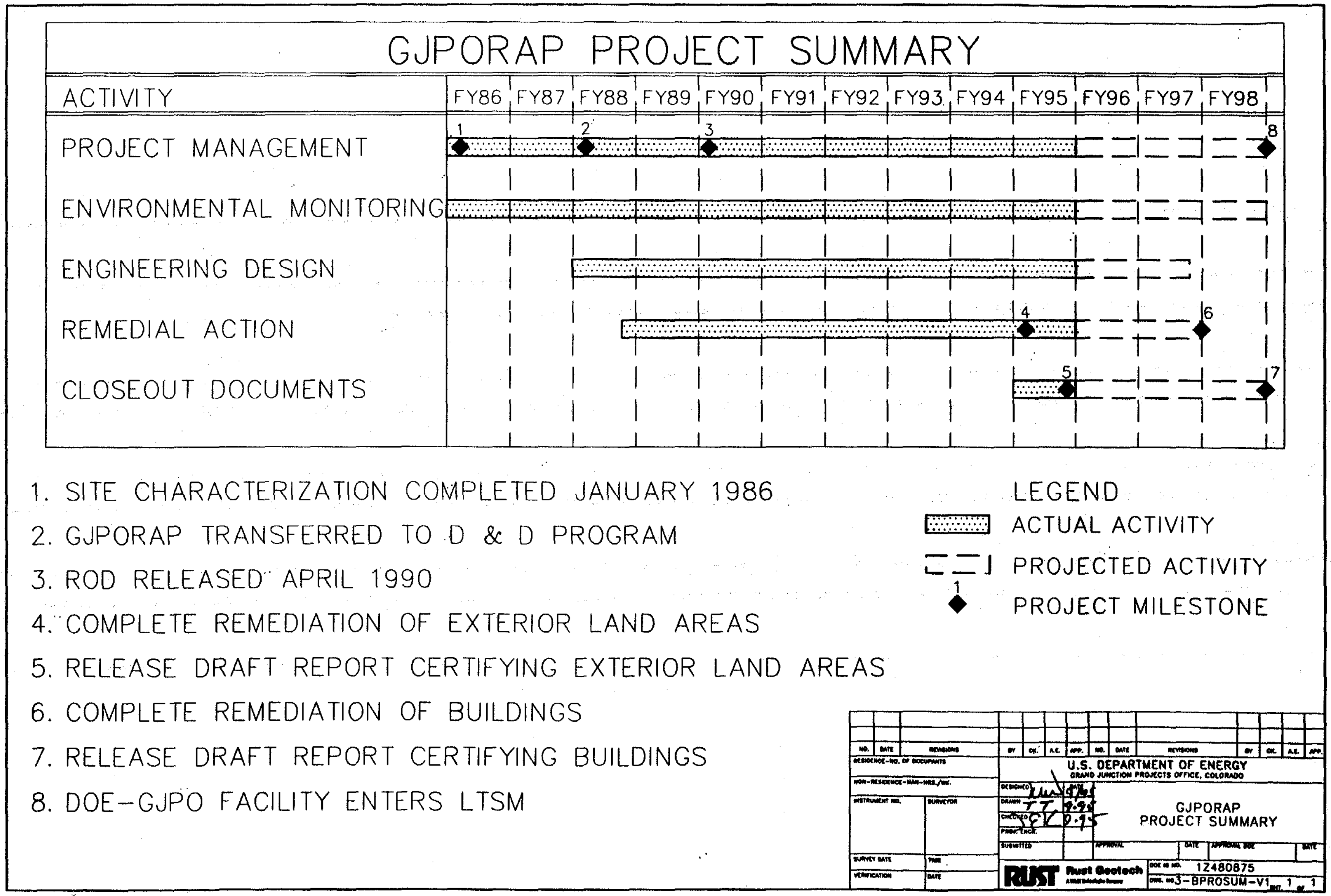


Figure 2. GJPORAP Schedule as of July 1995

project included only Buildings 31, 33, 34, and 35 because these buildings were considered surplus. The original assessment (DOE 1986a) surveyed these four buildings for gamma exposure rates in accordance with the ARARs identified in the ROD. This assessment also surveyed the buildings for alpha surface contamination and identified only minor contamination. Incorporation of the FUSRAP/SFMP guidelines imposed release limits for alpha and beta surface contamination that necessitated additional surveys. Beta surface contamination was found, which increased the scope of the remediation of the original four buildings. GJPORAP subsequently was accepted into the D&D Program and the project was expanded to include remediation of all of the contaminated buildings at the DOE–GJPO facility.

- The actual quantity of radiologically contaminated soil was greater than the quantity originally estimated. The quantity increase and the associated cost increase occurred because the method that was employed for the original assessment was designed to identify major deposits of contamination without going to excessive detail and expense, with the expectation that remediation would proceed until compliance was achieved. Therefore, some overruns were anticipated (DOE 1989e).
- Remediation of Black Bridge Park was added to the scope of the project.
- Additional guidelines and regulations were recognized (e.g., Th-230 cleanup criteria, additional health-and-safety compliance requirements), which increased the scope of the project. The inclusion of Th-230 guidelines increased the quantity of material to be remediated.

VI. Occupational Exposure

Successful application of the ALARA process was demonstrated by personnel and area monitoring that did not detect above-background radiation exposures to workers or the public during the GJPORAP remedial action.

A comprehensive Health and Safety Plan was in effect for the duration of the remedial activities. The Health and Safety Plan established procedures for access control and baseline monitoring, PPE and training requirements, and contingency plans for possible exposures to radiological and nonradiological contaminants (DOE 1994a).

In 1992, DOE Order 5480.11, *Radiation Protection for Occupational Workers*, was revised to require full implementation of the provisions for radiological safety contained in the DOE *Radiological Control Manual*, which formalized the method of evaluating and preventing exposure to radiological hazards and established uniform training requirements for radiation workers. These provisions were incorporated into Rust's *Health and Safety Manual*, Volume 2, and were adopted for GJPORAP.

Access to areas undergoing decontamination was restricted, which prevented the spread of contamination and minimized the exposure of nonessential personnel to contamination. Individuals, equipment, and vehicles leaving controlled areas were monitored for possible contamination and, when necessary, were decontaminated before leaving the controlled area. Dust-control measures were employed when necessary.

Until 1992, each individual entering a contaminated area wore a thermoluminescent dosimeter (TLD), which is a beta-gamma radiation-detection device. In addition, members of the construction and monitoring crews were periodically selected to wear particulate air samplers when working near contaminated areas. These samplers provided data on exposure to dust, airborne radioparticulates, and other airborne particulates. Analysis of the particulate air samplers indicated that no abnormal exposures had occurred. This conclusion was supported by the results of a bioassay monitoring program, which showed no exposures for workers in the contaminated zones. Off-site air sampling results indicated that air quality had not been degraded by remedial action activities. TLD use was reduced in 1992 because monitoring had been conducted in the construction area by Health, Safety, and Security personnel and TLD results, to this time, had not indicated any exposures above background for workers in the vicinity of typical GJPORAP radiological waste.

VII. Waste Volumes

Under GJPORAP, a total of 416,133 tons (377,433 metric tons) of contaminated materials, representing a volume of approximately 255,250 yd^3 (195,150 m^3) and covering an area of approximately 22.6 acres (9.2 hectares), was removed during remediation of the exterior portions of the DOE–GJPO facility. This material was disposed of at the Cheney Disposal Site.

VIII. Final Facility Condition

All decontamination requirements identified in the ROD for GJPORAP have been satisfied for the exterior land portions of the DOE–GJPO facility. The IVC will issue a Statement of Verification to signify its concurrence that this portion of the remedial action has achieved program objectives.

Radiologically contaminated soil has been removed, and all remediated exterior land areas comply with the applicable provisions of 40 CFR 192, FUSRAP/SFMP guidelines, and RESRAD. Suspected occurrences of nonradiological contamination have been investigated, and all identified occurrences of nonradiological contamination have been remediated. Excavated areas have been restored to comply with floodplain permits, the Endangered Species Act, and other applicable regulations. Groundwater sampling will provide further assurance that contaminated materials currently managed on site will not pose any threat to human health or the environment.

Sufficient data have been collected to document the final site conditions and to demonstrate that the cleanup levels specified in the ROD were attained. These data and associated information are available to the public and will be archived in the Certification Docket.

Because of the limitations of current technology and procedures for identifying and remediating radiologically contaminated soils, unknown deposits of contamination may be found in the future. Any future excavations, including the removal of fence posts, poles, and other utilities, will be monitored for radiological and nonradiological contamination. The DOE–GJPO facility is routinely surveyed for radiation and other hazards.

No assessed hazardous substances were left in the exterior land areas; these areas can be released for unrestricted use. At the time of this report, contamination is still present in some interior areas of the DOE–GJPO facility; access to these areas is controlled and will be addressed by future GJPORAP remedial actions. Once the interior remedial action is completed, the facility will be managed as an LTSM site by DOE until restoration of the alluvial aquifer is completed.

With the source of contamination removed, groundwater restoration at the DOE–GJPO facility will be accomplished by the natural flushing of the alluvial aquifer over a period of 50 to 80 years. Groundwater and surface water will be monitored every 9 months for analytes associated with uranium mill tailings that exceed Federal or State standards, including arsenic, molybdenum, selenium, U-234, U-238, Ra-226, Ra-228, nitrates, and total dissolved solids. Ground-water will also be surveyed for gross-alpha radiation activity.

IX. Lessons Learned

A number of lessons were learned during GJPORAP. The experience that was gained is being applied to other projects administered by DOE–GJPO and should be useful to projects conducted elsewhere in the DOE complex. A GJPORAP lessons-learned session was conducted in February 1995. The following lessons were identified in this session:

- Before initiating activities, all project criteria need to be established, including cleanup criteria, ARARs, and certification and closeout requirements. At the inception of GJPORAP, few projects in the DOE complex had been completed; therefore, little experience was available regarding the requirements for closeout of a project. Two issues that arose during GJPORAP involved the addition of project cleanup criteria and the use of a new verification protocol.
  - — Because the millsite at DOE–GJPO was functionally identical to other millsites remediated under the UMTRA Program, GJPORAP was initially conducted as if it was an UMTRA mill tailings remedial action project, with 40 CFR 192 identified as the principal ARAR in the ROD.

After the project started, FUSRAP/SFMP guidelines were recognized as appropriate cleanup criteria. These guidelines included a cleanup criterion for Th-230 that, because of suspected physical separation of this radionuclide from Ra-226 at the DOE–GJPO facility, necessitated additional identification surveys and increased the volume of contaminated material requiring remediation.

— The LAV protocol was adopted without securing the formal approval of DOE Headquarters, which necessitated a lengthy analysis to justify the certification of the areas where the LAV protocol was applied.

- Compliance personnel need to remain involved for the life of the project to interpret any changes in applicable regulations. Regulations changed significantly during the course of GJPORAP. DOE mandated that contractors achieve compliance with the Occupational Safety and Health Act, which added to the health and safety requirements for the project. The guidelines in the DOE *Radiological Control Manual* were adopted and incorporated in the Rust *Health and Safety Manual*, Volume 2, which added additional training requirements to the project.

- Project personnel need to research all available historical data to develop realistic expectations regarding the project's scope and the materials likely to be encountered. The discovery of mixed waste caused downtime during GJPORAP; this mixed waste was expected during remediation of the Treasure Island landfill area and was addressed in contingency plans. However, a study of historical building and facility plans might have revealed the presence of some of the sumps and helped to identify their contents. This study would have revealed that Building 6 formerly had been used as a laboratory for the refinery and that radiological contamination was likely. (Building 6 was not originally included in the scope of GJPORAP because it was not considered "surplus" under SFMP.)

- A project team that includes all support organizations and the IVC must be organized during the early planning stages so that the team can establish procedures and provide design input. This team approach encourages the application of experience gained from other projects. GJPORAP established a dedicated project team of field personnel and managers which saved the project time and money.

- Communications between the owner (DOE), the IVC, and the contractor must remain open. GJPORAP project managers held weekly meetings with subcontractors, the IVC, and the DOE–GJPO Project Manager.

- The project suffered adverse cost and schedule impacts because a field method of screening for Th-230 was not available. The application of FUSRAP/SFMP guidelines as ARARs necessitated compliance with Th-230 release limits in the field so construction could proceed. Rust attempted to develop a field alpha-spectroscopy method for GJPORAP and the Denver Radium Site (a concurrent Superfund remedial action project). A practical quantitative field-analysis system could not be developed; therefore, project management adopted the policy of cleaning Ra-226 in the subsurface soils to concentrations below 5 pCi/g above background. Because the Th-230 to Ra-226 ratio for GJPORAP was approximately 3 to 1, there was reasonable assurance that the Th-230 analysis results would be below the release limits. Before this policy was adopted, several areas had to be reexcavated when laboratory analysis determined that Th-230 levels were not in compliance with release limits. After this policy was adopted, all soil sample results indicated compliance with Th-230 release limits.

- GJPORAP experienced cost and quantity increases. Most of the subcontracts were small business set-asides. The initial contracts contained weak language that allowed for numerous change orders. Later contracts incorporated lessons learned on other projects to strengthen the contractual language, resulting in fewer change orders. Budgets and milestones were sometimes set before complete characterization data were available. The project was driven by construction-based milestones and the time and money required to perform supporting activities were sometimes underestimated. Remediation of the mill buildings required more effort than was originally anticipated because the degree of contamination was greater than expected. The implementation of the Th-230 cleanup criterion resulted in an increase in the volume of contaminated waste.

- Rust applied for and received a DOT exemption (DOT 1992) from some of the requirements for transporting hazardous waste. This exemption allowed low-level radiologically contaminated waste to be transported using conventional equipment and without detailed analysis of each shipment, which resulted in significant time and cost savings.
- The assessment underestimated the quantity of contamination because of a decision to accept a 30-percent confidence interval for the sampling frequency. This approach allowed for quick, positive identification of affected areas and reflected experience gained in remediation of UMTRA vicinity properties, where the excavation was monitored and remediation proceeded until the property was certifiably clean. In 1989, the Treasure Island area was reassessed for radiological and nonradiological waste before the remedial design for that area, resulting in accurate volume estimates for that phase of the project. While the 1989 facility reassessment did not identify significant additional contamination, this survey accomplished its goal of confirming areas to be free of contamination. Projects must balance the cost and benefit of assessment accuracy with the need to devote project funds to actual remediation.

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Appendix A
Applicable Quality Assurance Requirements and Implementing Procedures

Appendix B
Extent of Contamination and Verification Areas

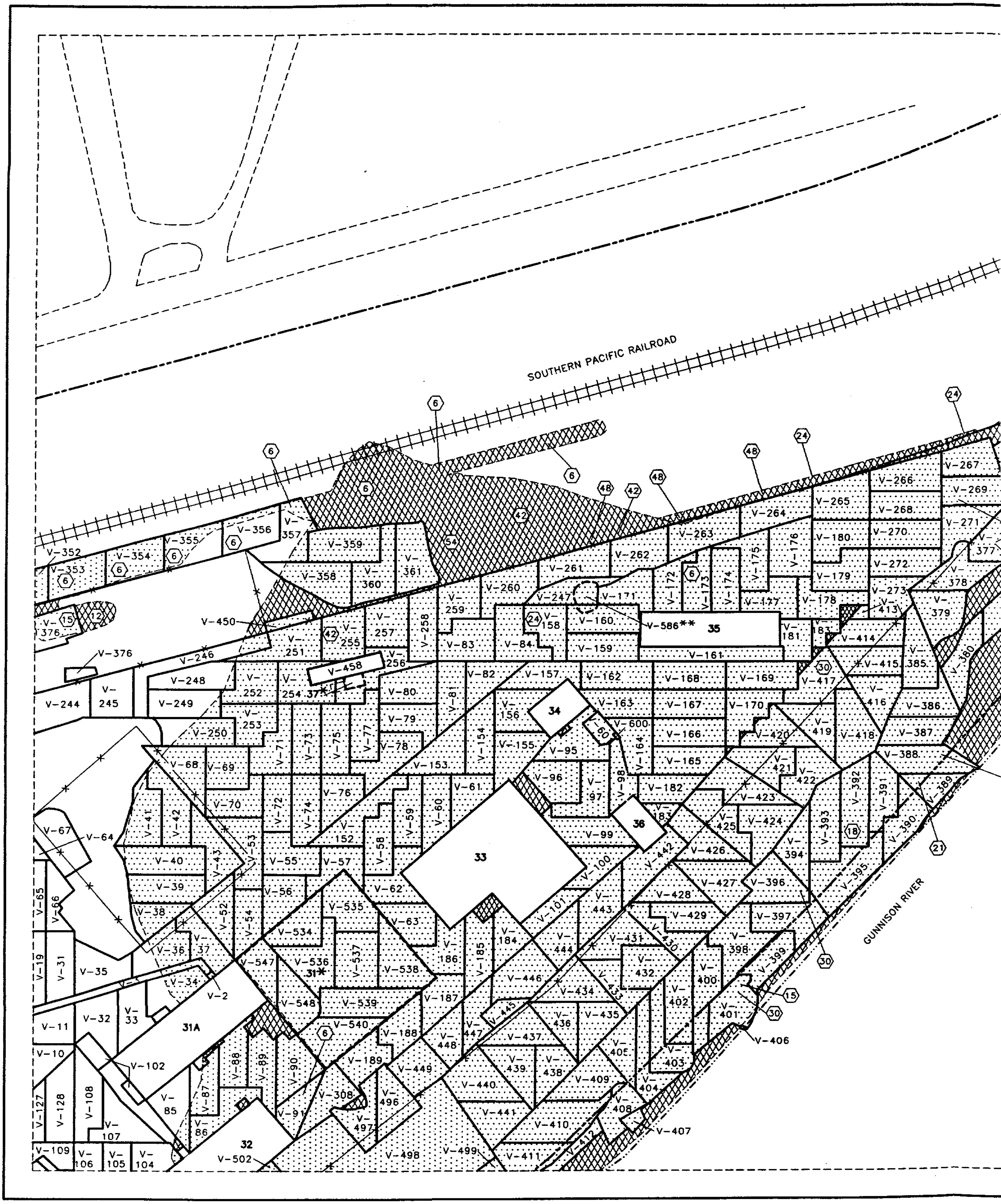
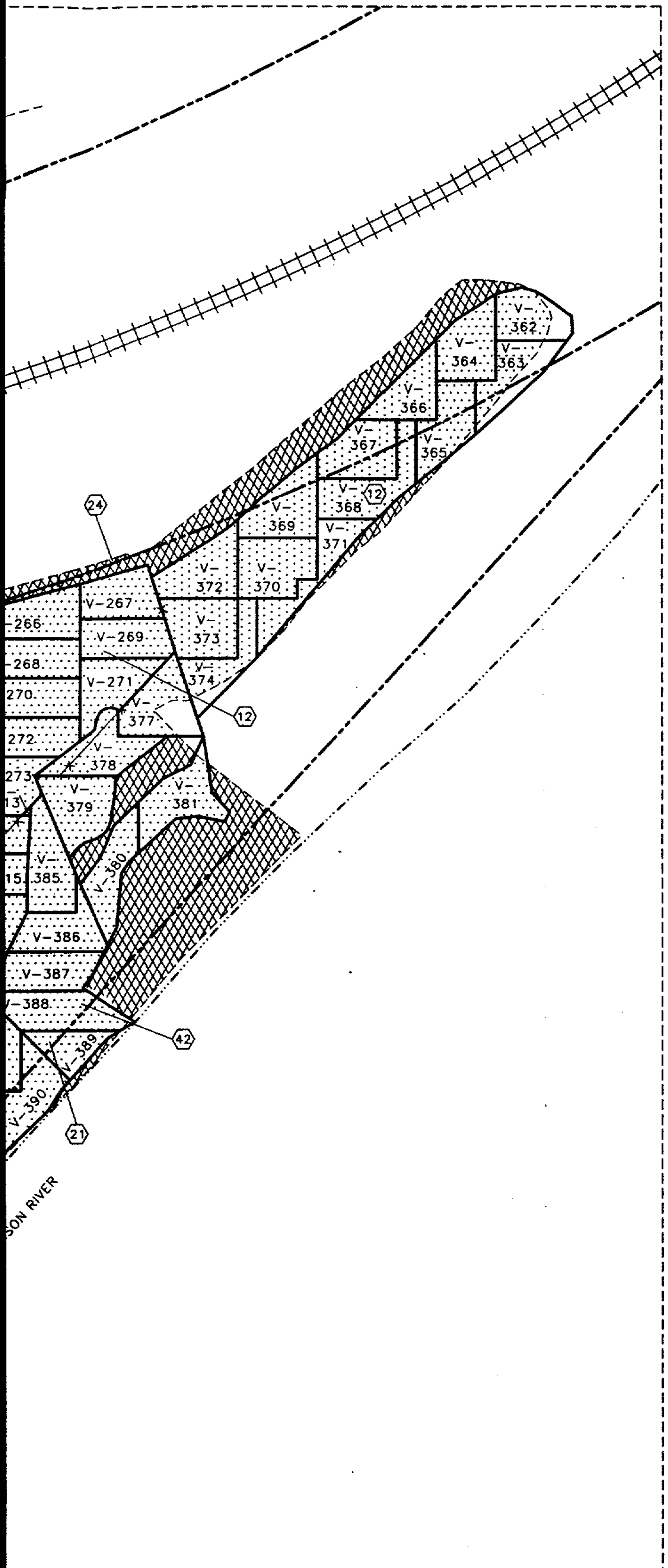
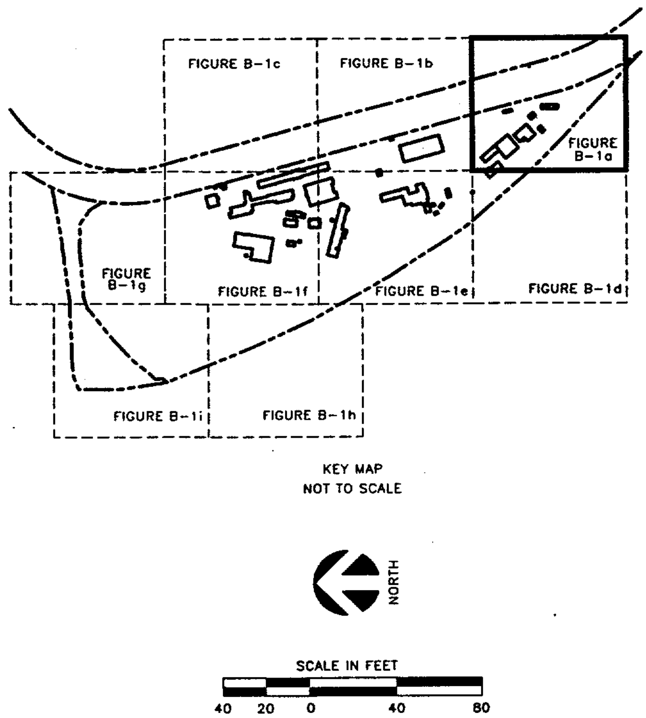


Figure B–1a. Extent of Exterior Contamination a





LEGEND

- (6) AVERAGE DEPTH OF ASSESSED CONTAMINATION IN INCHES
- AREA OF ASSESSED CONTAMINATION
- V-277 VERIFICATION SOIL SAMPLE AREA IDENTIFIER
- VERIFICATION AREA BOUNDARY
- ASSESSED CONTAMINATION NOT FOUND AT TIME OF REMEDIAL ACTION
- [34] BUILDING OUTLINE AND IDENTIFIER
- * BUILDINGS 31 AND 37 WERE DEMOLISHED DURING REMEDIAL ACTION
- ** CONTAMINATED PIPES. SOIL VERIFIED AS V-160 AND V-247

NO.	DATE	REVISIONS	BY	CK.	A.E.	APP.	NO.	DATE	REVISIONS	BY	CK.	A.E.	APP.
									10000500 01/24/95 TMT/712				

RESIDENCE-NO. OF OCCUPANTS
NON-RESIDENCE-MAN-HRS./WK.
INSTRUMENT NO. SURVEYOR
SURVEY DATE TIME
VERIFICATION DATE

U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION PROJECTS OFFICE, COLORADO

DESIGNED: DATE: 9/95
DRAWN: TT 9-95
CHECKED: 9-95
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REMEDIAL ACTION PROJECT
GRAND JUNCTION, COLORADO

RUST Rust Geotech

DOE ID NO. FAS-031-0003-00-000
DWG. NO. 3-DI0000500 SHT. 1 OF 9

ontamination and Exterior Verification Areas

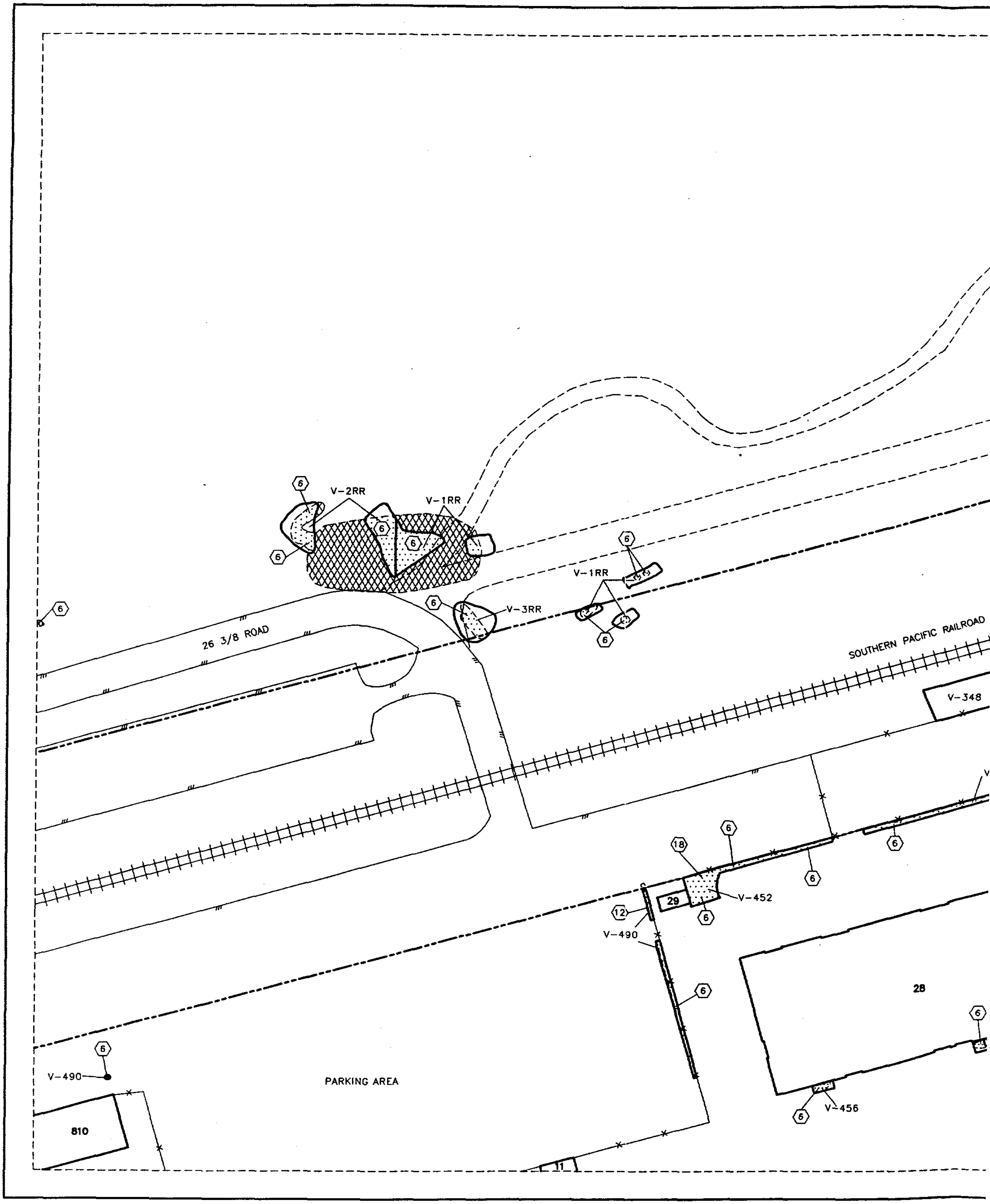
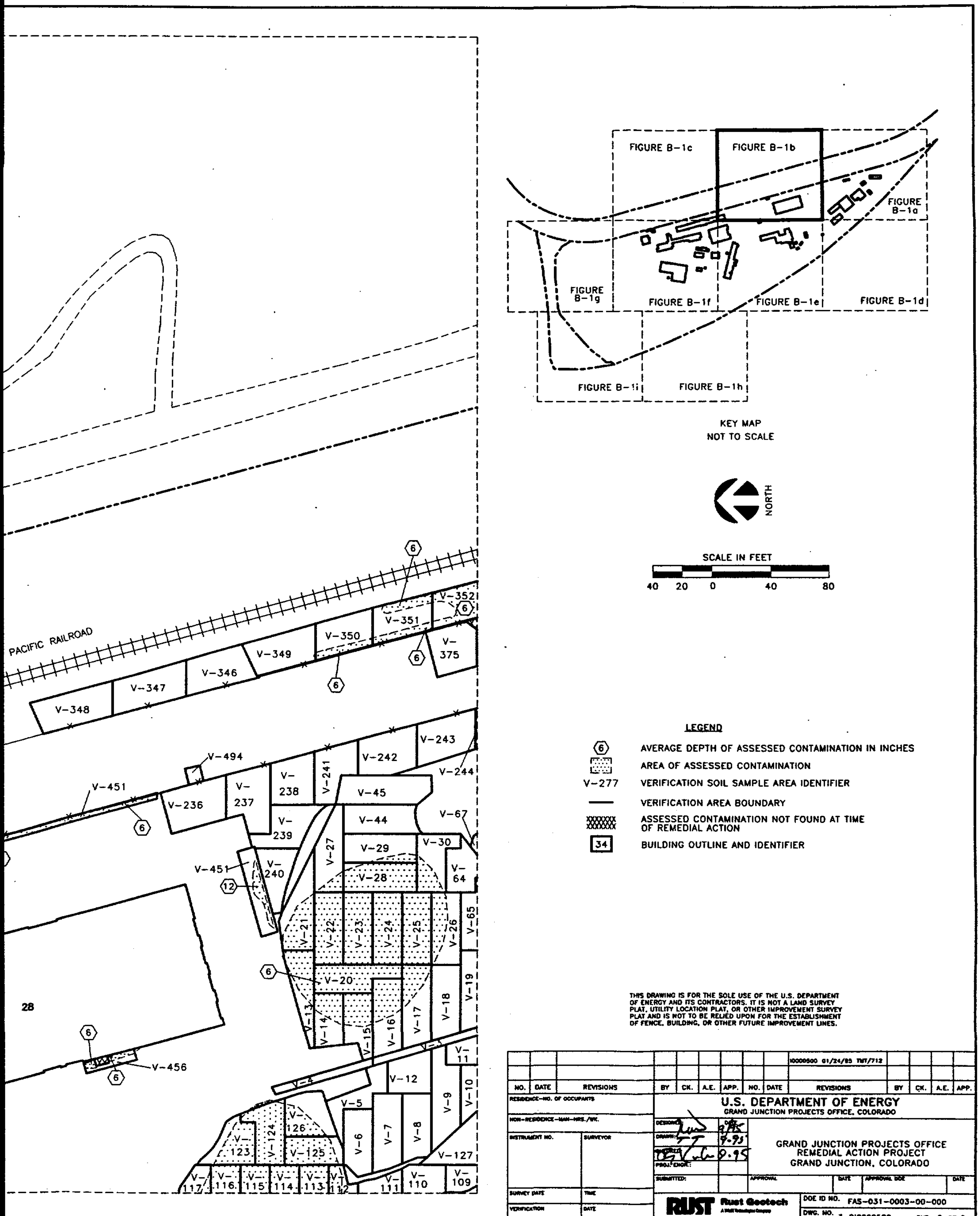
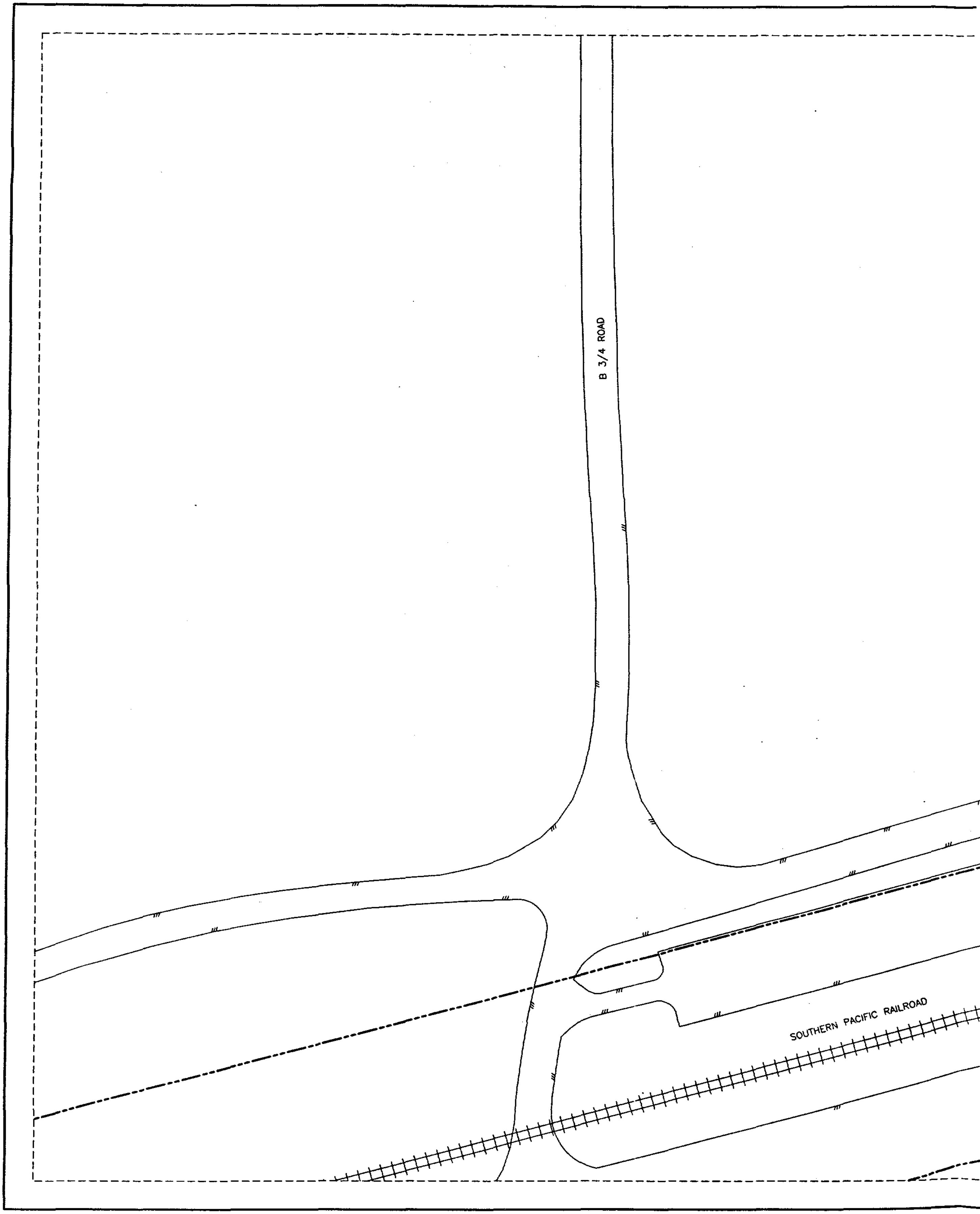


Figure B–1b. Extent of Exterior Contaminatior



ntamination and Exterior Verification Areas



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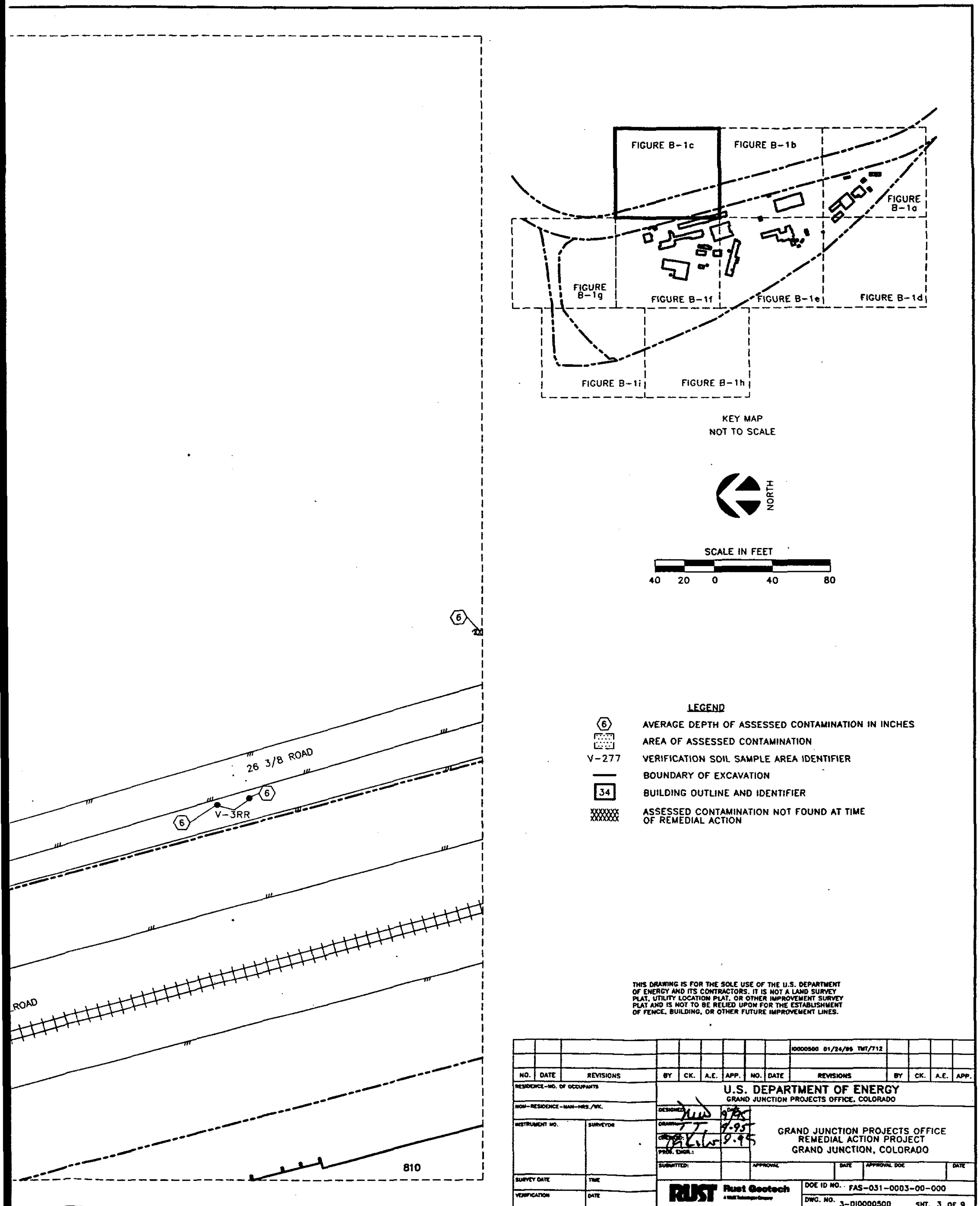


ontamination and Exterior Verification Areas

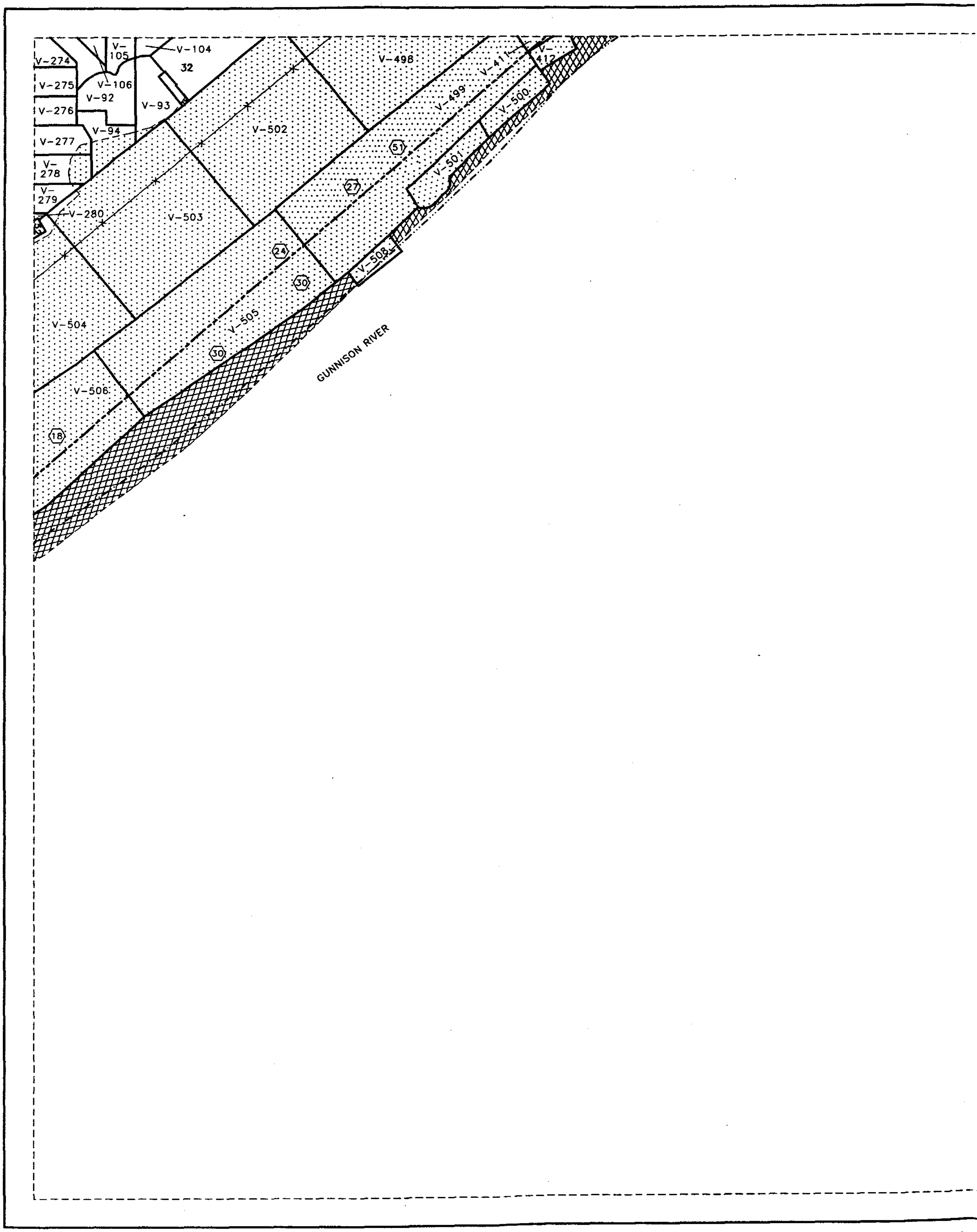
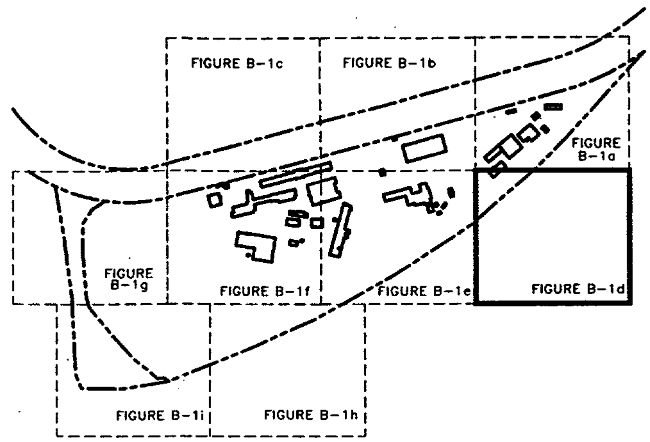


Figure B–1d. Extent of Exterior Contamina



KEY MAP
NOT TO SCALE

NORTH

SCALE IN FEET

40 20 0 40 80

LEGEND

6	AVERAGE DEPTH OF ASSESSED CONTAMINATION IN INCHES
	AREA OF ASSESSED CONTAMINATION
V-277	VERIFICATION SOIL SAMPLE AREA IDENTIFIER
—	VERIFICATION AREA BOUNDARY
XXXXXX	ASSESSED CONTAMINATION NOT FOUND AT TIME OF REMEDIAL ACTION
34	BUILDING OUTLINE AND IDENTIFIER

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DOE ID NO. FAS-031-0003-00-000

DWG. NO. 3-DI0000500 SHT. 4 OF 9

ontamination and Exterior Verification Areas

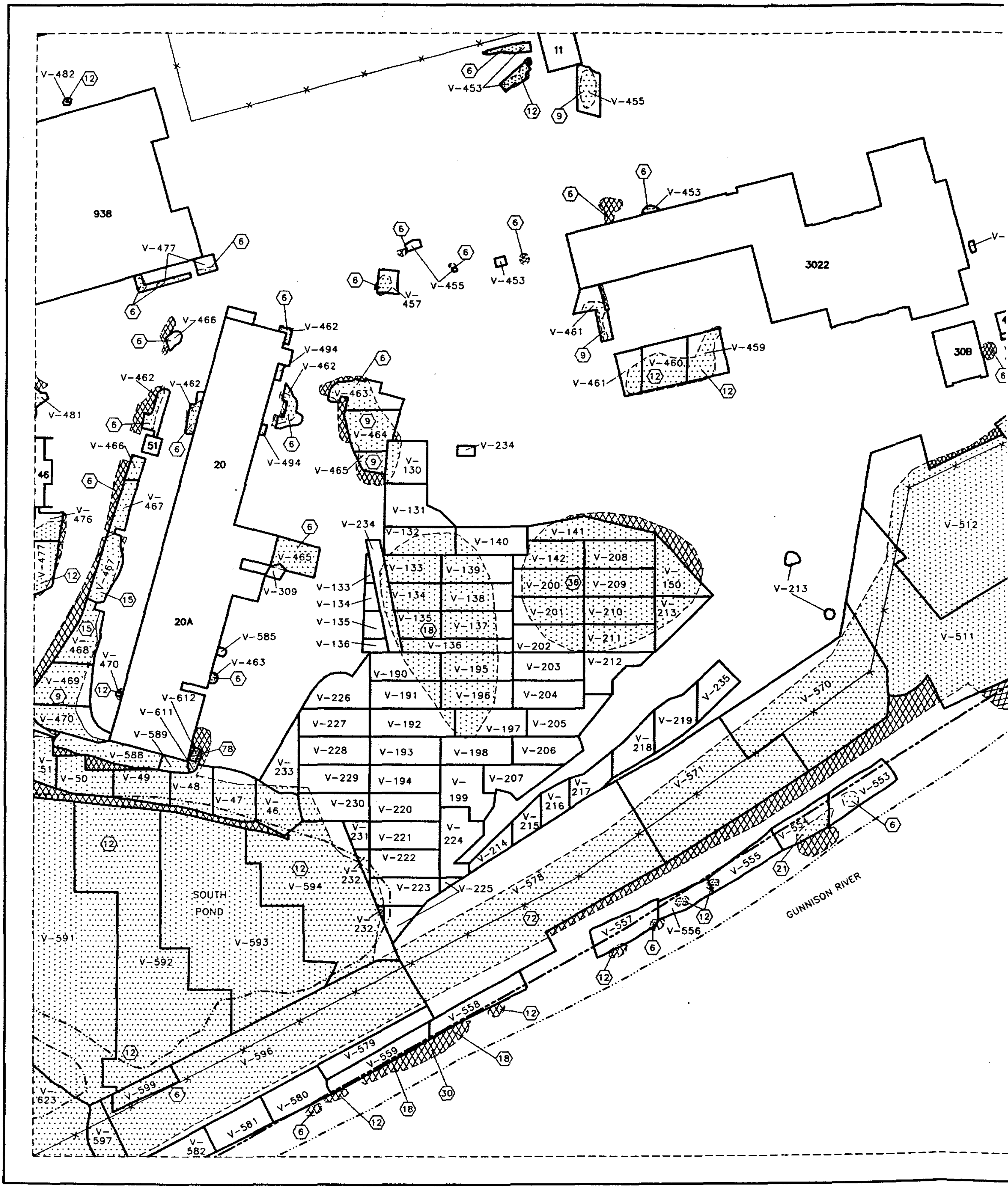
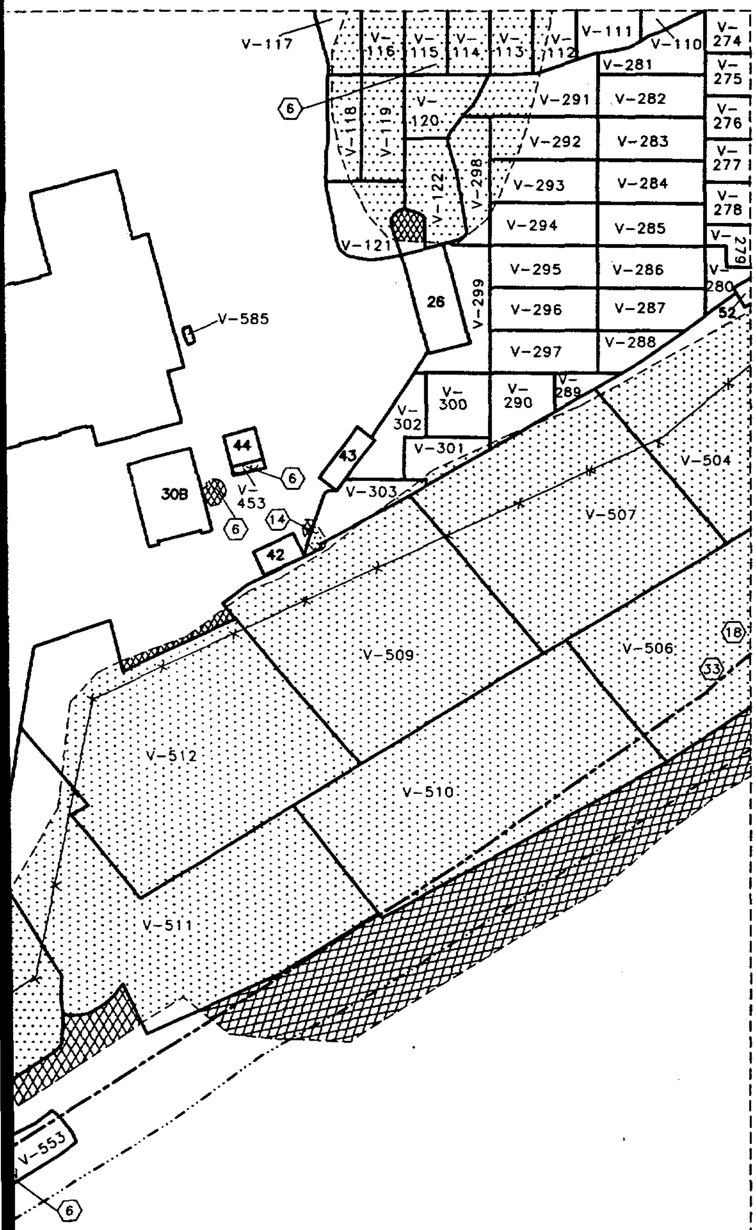
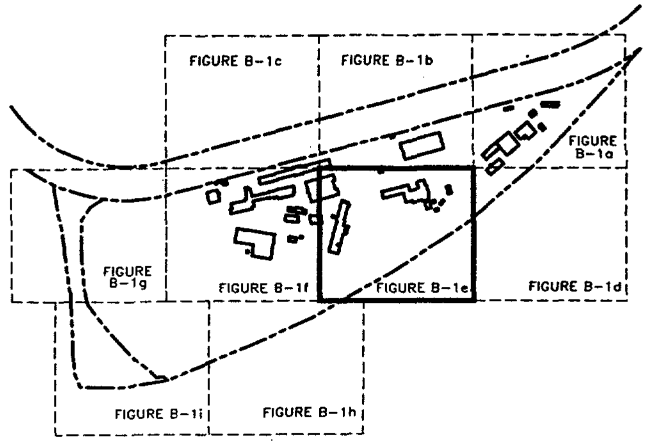


Figure B-1e. Extent of Exterior Contamination and





KEY MAP
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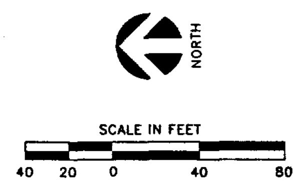

LEGEND

(6)	AVERAGE DEPTH OF ASSESSED CONTAMINATION IN INCHES
	AREA OF ASSESSED CONTAMINATION
V-277	VERIFICATION SOIL SAMPLE AREA IDENTIFIER
——	VERIFICATION AREA BOUNDARY
	ASSESSED CONTAMINATION NOT FOUND AT TIME OF REMEDIAL ACTION
34	BUILDING OUTLINE AND IDENTIFIER

10000500 01/24/95 TWT/712

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NON-RESIDENCE–MAN-HRS./WK.
INSTRUMENT NO. / SURVEYOR
SURVEY DATE / TIME
VERIFICATION / DATE

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RUST Rust Geotech

DOE ID NO. FAS-031-0003-00-000
DWG. NO. 3-010000500 SHT. 5 OF 9

Contamination and Exterior Verification Areas

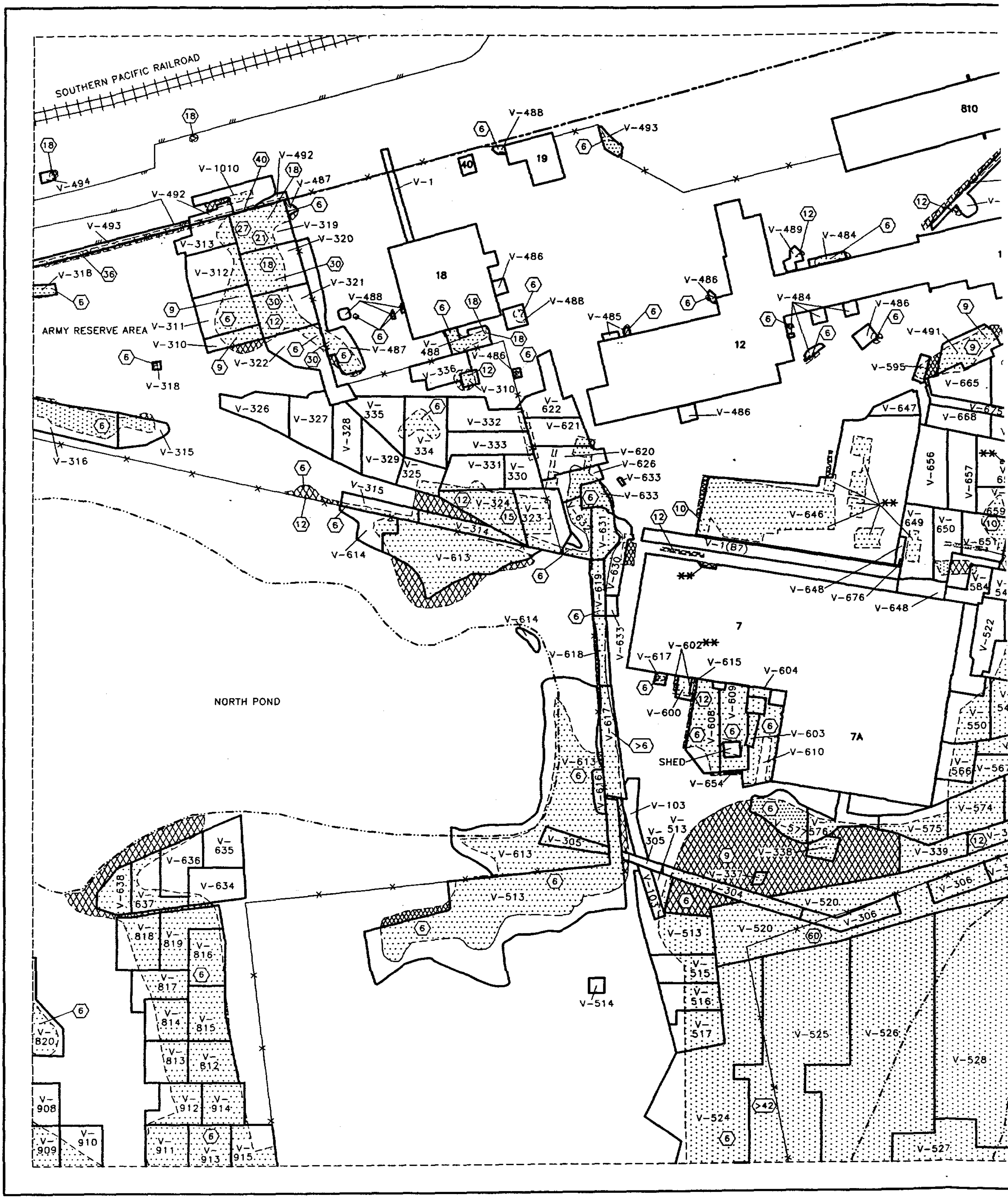
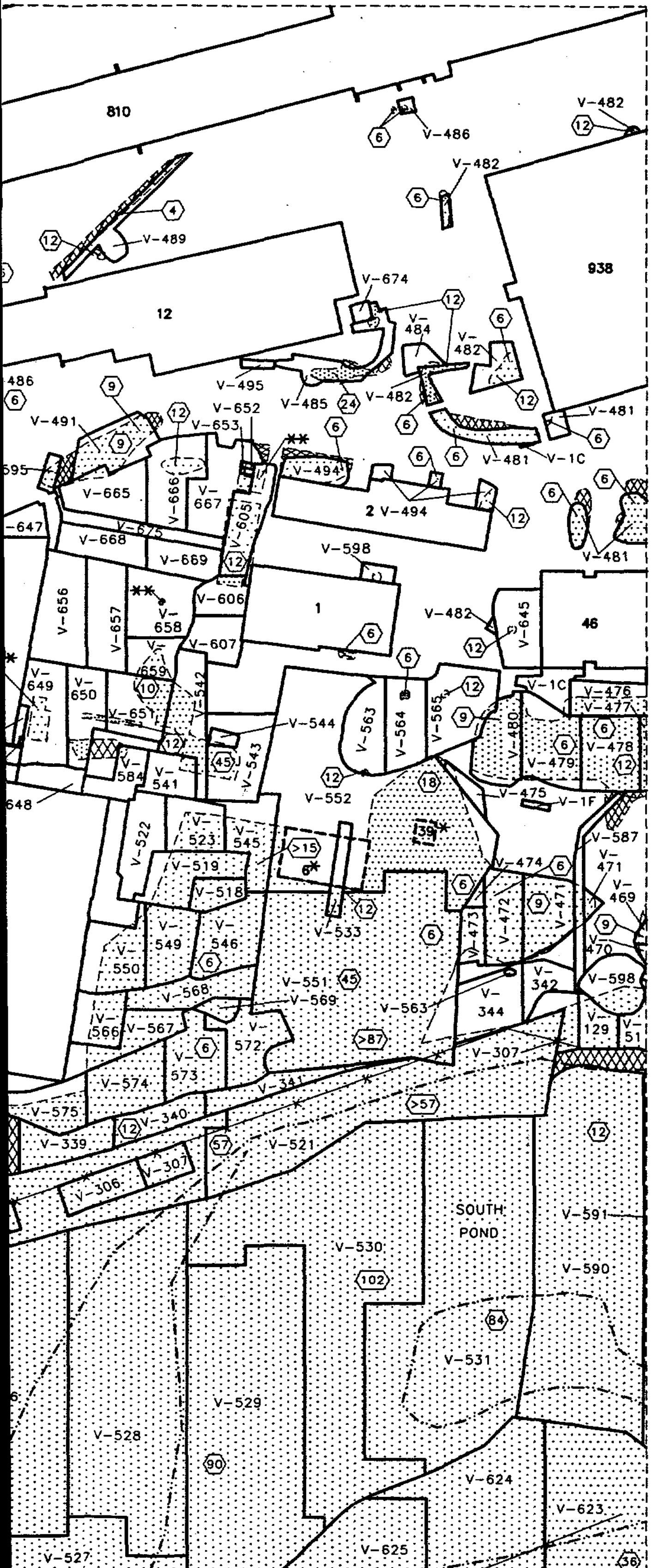
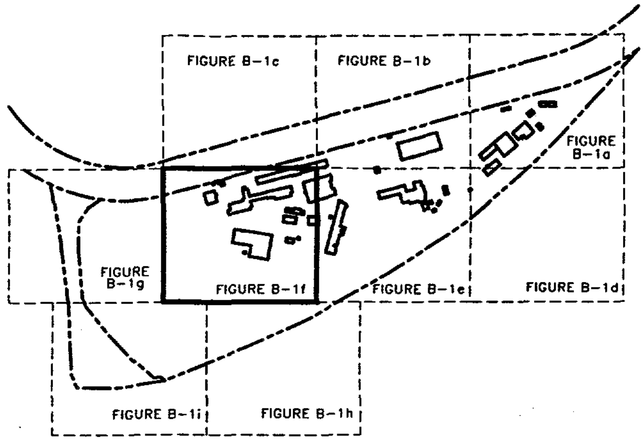


Figure B-1f. Extent of Exterior Contamination an





KEY MAP
NOT TO SCALE

NORTH

SCALE IN FEET

40 20 0 40 80

LEGEND

- (6) AVERAGE DEPTH OF ASSESSED CONTAMINATION IN INCHES
- AREA OF ASSESSED CONTAMINATION
- V-277 VERIFICATION SOIL SAMPLE AREA IDENTIFIER
- VERIFICATION AREA BOUNDARY
- ASSESSED CONTAMINATION NOT FOUND AT TIME OF REMEDIAL ACTION
- [34] BUILDING OUTLINE AND IDENTIFIER
- * BUILDINGS 6 AND 39 WERE DEMOLISHED DURING REMEDIAL ACTION
- ** BETA-GAMMA SURFACE CONTAMINATION

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									10000500 01/24/95 TMT/712				

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ntamination and Exterior Verification Areas

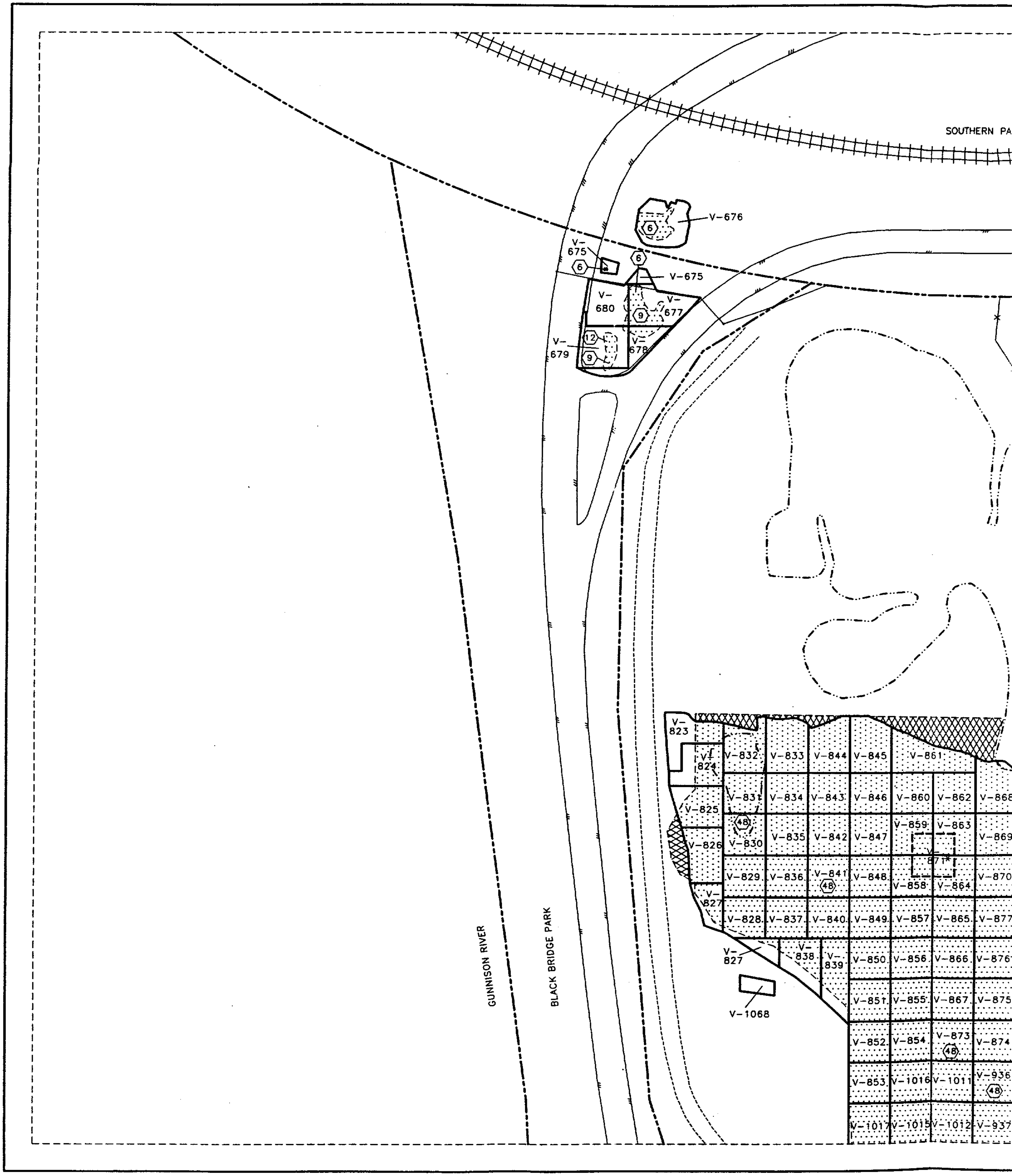

Figure B-1g. Extent of Exterior Contamination and E

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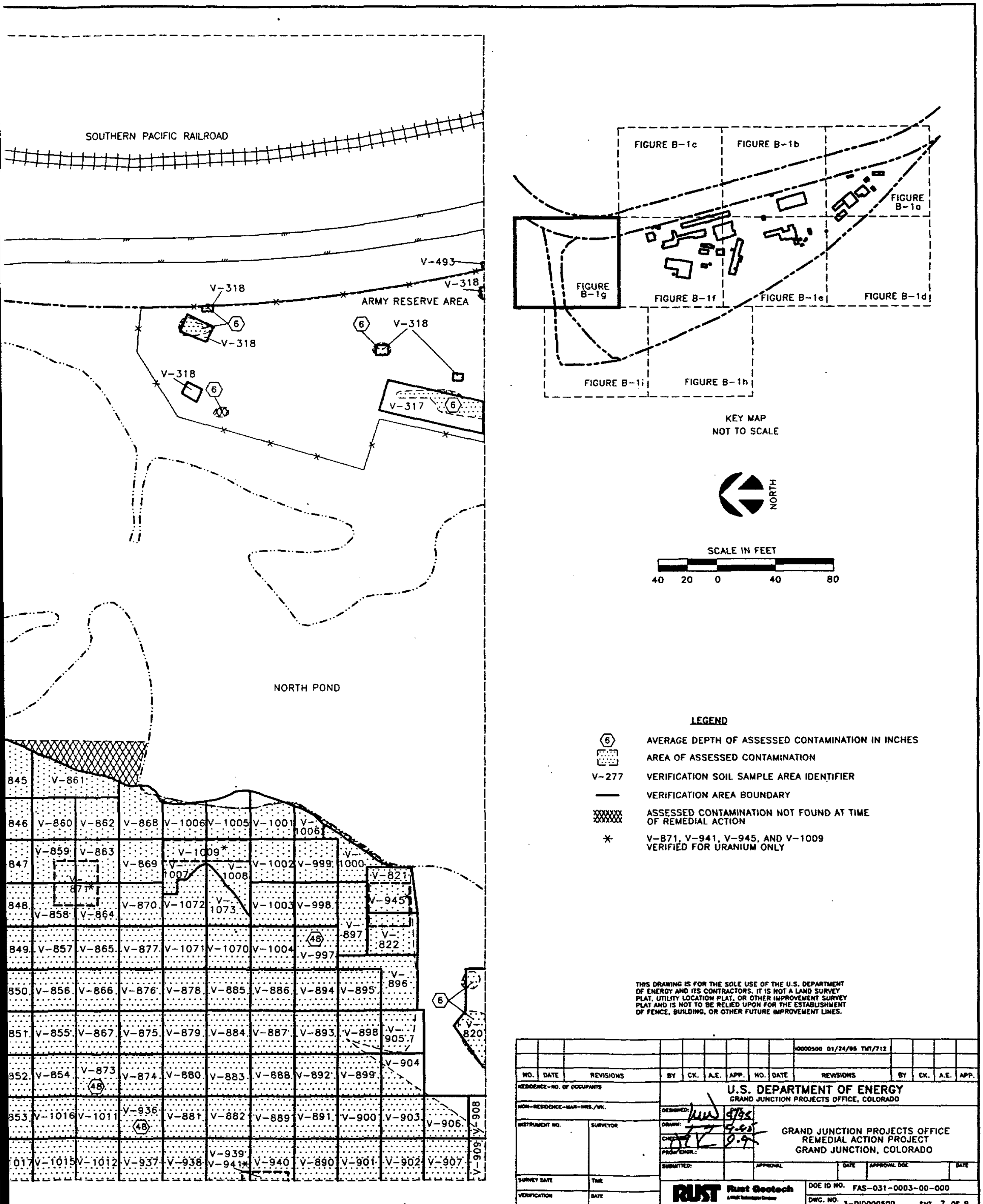
eptember 15, 1995



ontamination and Exterior Verification Areas

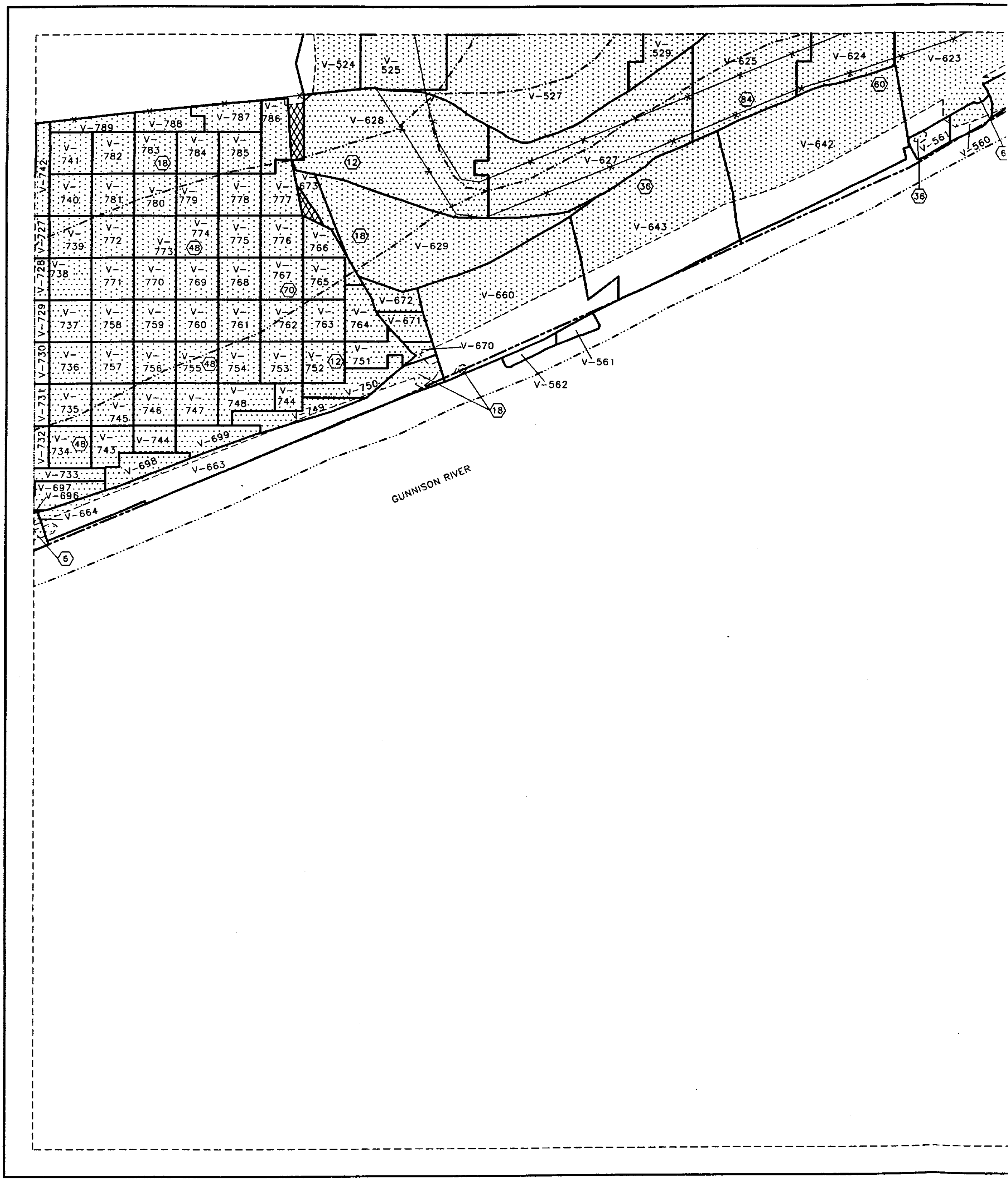
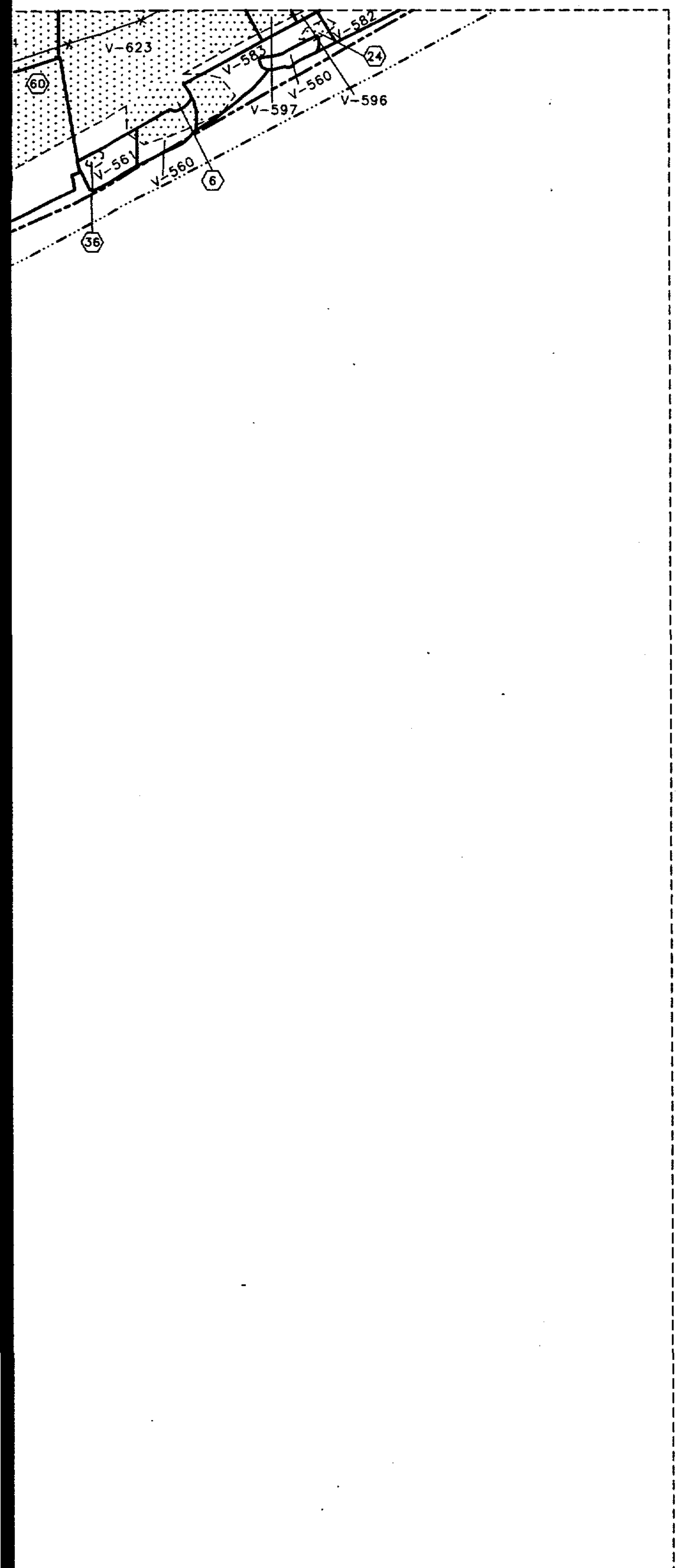
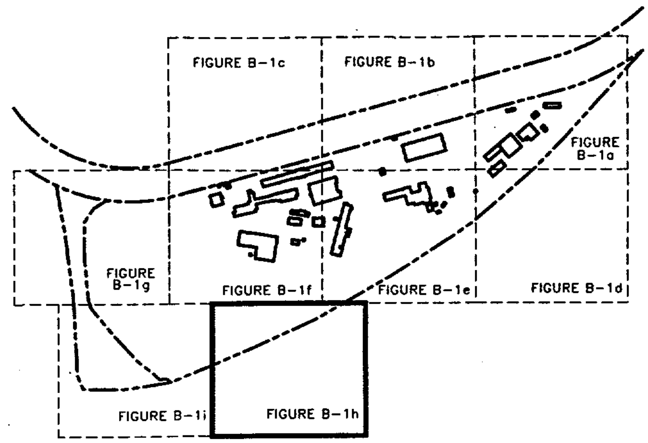


Figure B–1h. Extent of Exterior Contamination and





KEY MAP
NOT TO SCALE

NORTH

SCALE IN FEET
40 20 0 40 80

LEGEND

6	AVERAGE DEPTH OF ASSESSED CONTAMINATION IN INCHES
	AREA OF ASSESSED CONTAMINATION
V-277	VERIFICATION SOIL SAMPLE AREA
—	VERIFICATION AREA BOUNDARY
XXXXXX	ASSESSED CONTAMINATION NOT FOUND AT TIME OF REMEDIAL ACTION

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RUST Rust Geotech
DOE ID NO. FAS-031-0003-00-000
DWG. NO. 3-DI0000500 SHT. 8 OF 9

Contamination and Exterior Verification Areas

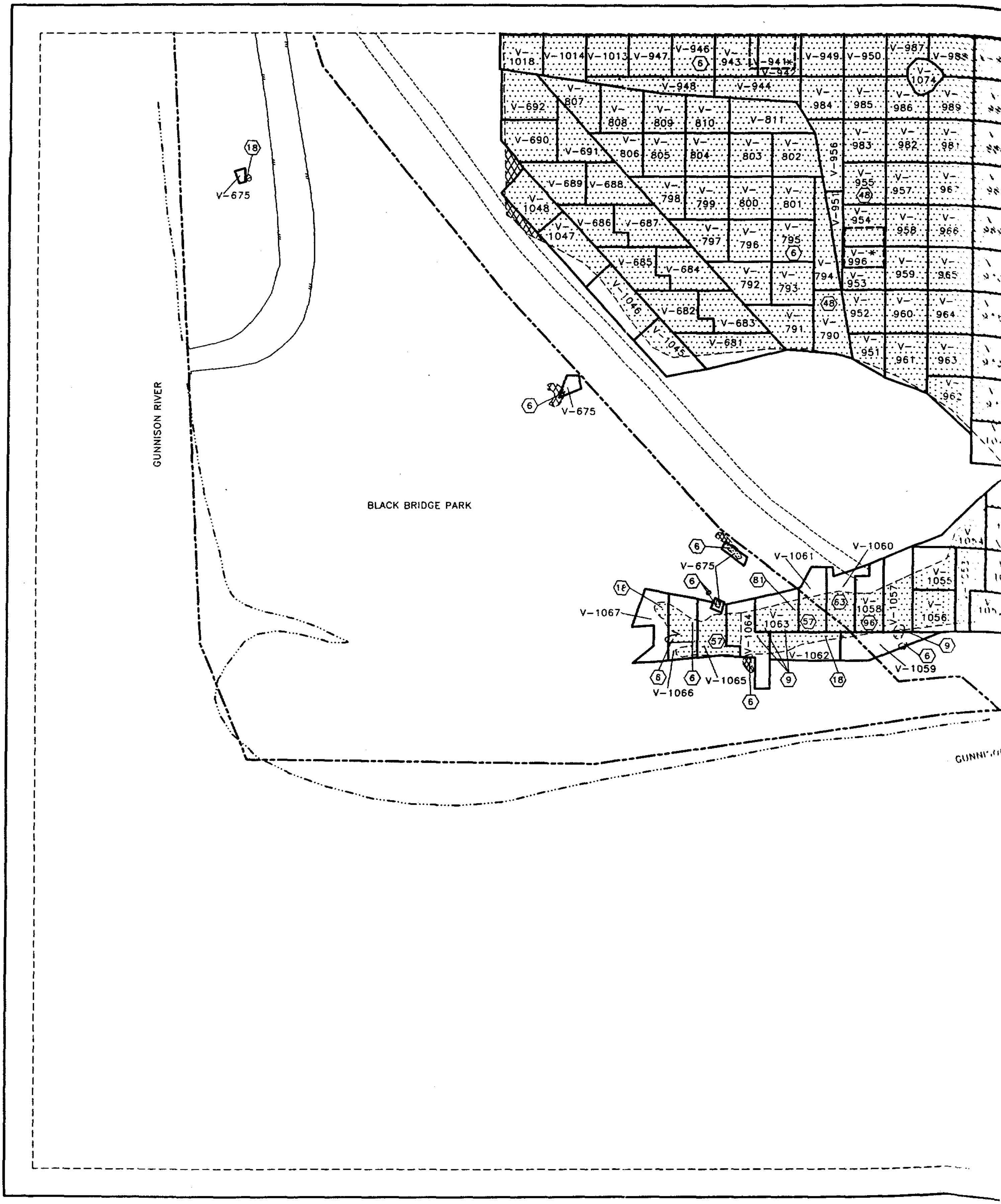
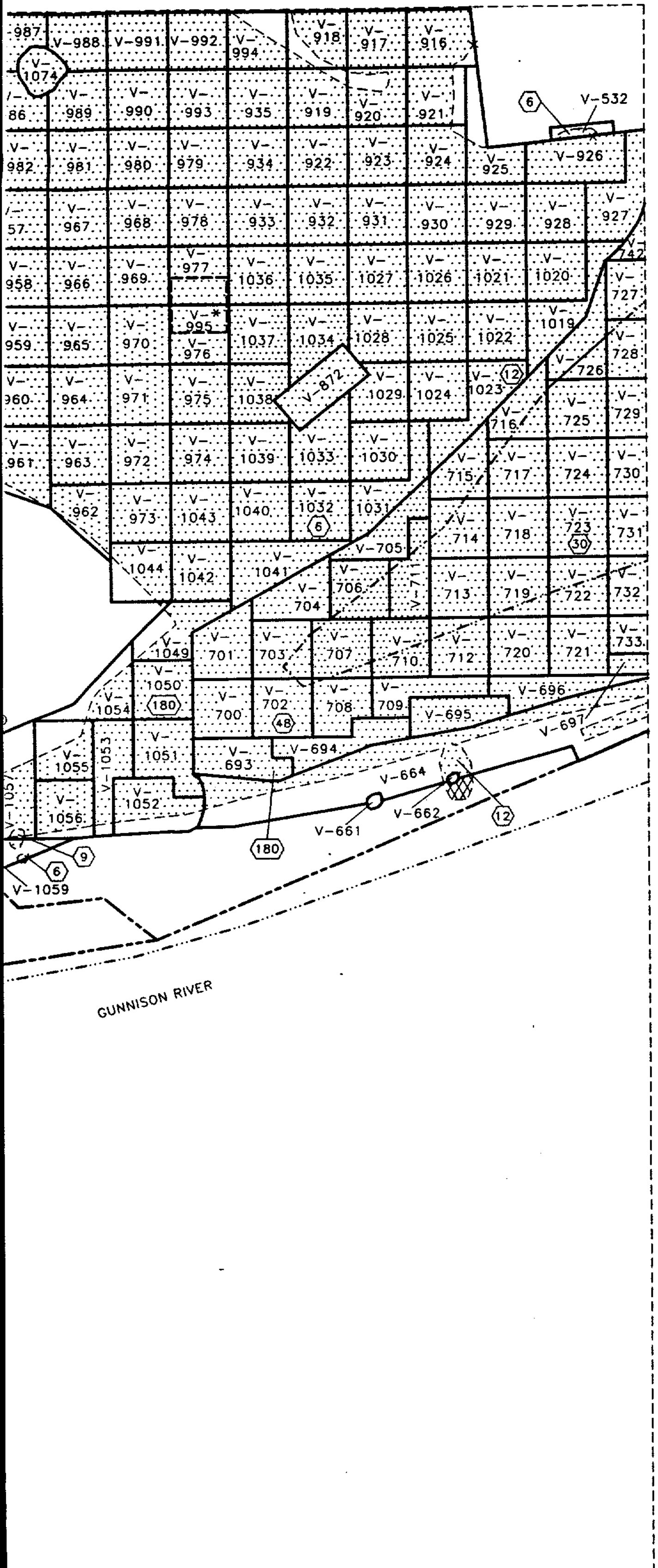
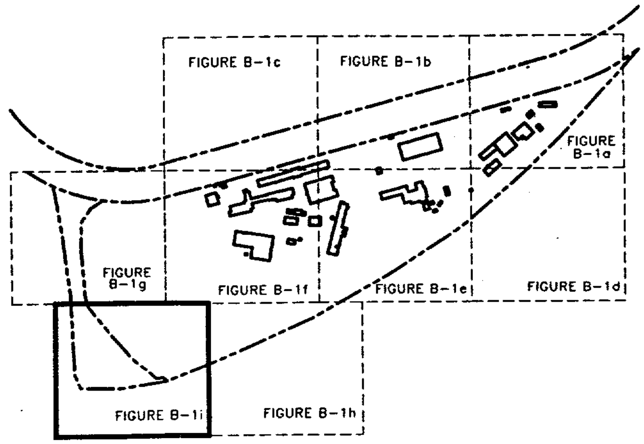


Figure B–1i. Extent of Exterior Contamination





KEY MAP
NOT TO SCALE

NORTH

SCALE IN FEET

40 20 0 40 80

LEGEND

(6)	AVERAGE DEPTH OF ASSESSED CONTAMINATION IN INCHES
	AREA OF ASSESSED CONTAMINATION
V-277	VERIFICATION SOIL SAMPLE AREA IDENTIFIER
	VERIFICATION AREA BOUNDARY
	ASSESSED CONTAMINATION NOT FOUND AT TIME OF REMEDIAL ACTION
*	V-941, V-995, AND V-996 VERIFIED FOR URANIUM ONLY

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									I0000500 01/24/95 TMT/712				

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DOE ID NO. FAS-031-0003-00-000
DWG. NO. 3-DI0000500 SHT. 9 OF 9

ontamination and Exterior Verification Areas

Appendix C
Environmental Monitoring Reports for the U.S. Department of Energy Grand Junction Projects Office Facility

U.S. Department of Energy, 1980. *1979 Environmental Monitoring Report, U.S. Department of Energy Facilities, Grand Junction, Colorado, and Monticello, Utah,* prepared by Bendix Field Engineering Corporation for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, 1980.

__________, 1981. *1980 Environmental Monitoring Report, U.S. Department of Energy Facilities, Grand Junction, Colorado, and Monticello, Utah,* prepared by Bendix Field Engineering Corporation for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, 1981.

__________, 1982. *1981 Environmental Monitoring Report, U.S. Department of Energy Facilities, Grand Junction, Colorado, and Monticello, Utah,* BFEC–1982–4, prepared by Bendix Field Engineering Corporation for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, April 1982.

__________, 1983. *1982 Environmental Monitoring Report, U.S. Department of Energy Facilities, Grand Junction, Colorado, and Monticello, Utah,* GJO–113(83), prepared by Bendix Field Engineering Corporation for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, April 1983.

__________, 1984. *1983 Environmental Monitoring Report, U.S. Department of Energy Facilities, Grand Junction, Colorado, and Monticello, Utah,* GJO–113(84), prepared by Bendix Field Engineering Corporation for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, March 1984.

__________, 1985. *1984 Environmental Monitoring Report, U.S. Department of Energy Facilities, Grand Junction, Colorado, and Monticello, Utah,* prepared by Bendix Field Engineering Corporation for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, April 1985.

__________, 1986. *Environmental Monitoring Report on Department of Energy Facilities at Grand Junction, Colorado, and Monticello, Utah, for Calendar Year 1985,* GJ–45, prepared by Bendix Field Engineering Corporation for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, March 1986.

__________, 1987. *Environmental Monitoring Report on Department of Energy Facilities at Grand Junction, Colorado, and Monticello, Utah, for Calendar Year 1986,* UNC/GJ–HMWP–2, prepared by UNC Technical Services, Inc., for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, March 1987.

__________, 1988. *Environmental Monitoring Report on the U.S. Department of Energy's Grand Junction Projects Office Facility, Grand Junction, Colorado, for Calendar Year 1987,* DOE/ID/12584–24, prepared by UNC Geotech, Inc., for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, May 1988.

__________, 1989. *Environmental Monitoring Report on the U.S. Department of Energy's Grand Junction Projects Office Facility, Grand Junction, Colorado, for Calendar Year 1988,* DOE/ID/12584–40, UNC/GJ–HMWP–9, prepared by UNC Geotech, Inc., for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, May 1989.

__________, 1990. *Environmental Monitoring Report on the U.S. Department of Energy's Grand Junction Projects Office Facility, Grand Junction, Colorado, for Calendar Year 1989,* DOE/ID/12584–66, UNC/GJ–E&RA–1, prepared by UNC Geotech, Inc., for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, May 1990.

__________, 1991. *Grand Junction Projects Office Site Environmental Report for Calendar Year 1990,* DOE/ID/12584–88, GJPO–EC&RA–4, prepared by Chem-Nuclear Geotech, Inc., for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, May 1991.

__________, 1992. *Grand Junction Projects Office Site Environmental Report for Calendar Year 1991,* DOE/ID/12584–104, GJPO–ES–6, prepared by Chem-Nuclear Geotech, Inc., for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, May 1992.

U.S. Department of Energy, 1993. *Grand Junction Projects Office Site Environmental Report for Calendar Year 1992*, DOE/ID/12584-137, GJPO-ES-8, prepared by Rust Geotech for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, May 1993.

_________, 1994. *Grand Junction Projects Office Site Environmental Report for Calendar Year 1993*, DOE/ID/12584-170, GJPO-ES-10, prepared by Rust Geotech for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, May 1994.

Appendix D
Final Radiological Conditions of the Exterior Land Areas

Table D–1. Postexcavation Sampling and Measurement Results for Exterior Land Areas

Summarized below are the postexcavation sampling and measurement results for each verification area (V–area). The samples were collected and measurements were performed prior to backfilling. Each sample is a composite, comprising as many as 13 individual aliquots representing the 6-inch-deep soil layer at the bottom of the excavation. Each sample was analyzed for radium-226 (Ra-226) using the Opposed Crystal System (OCS). Selected samples were analyzed by the DOE–GJPO Analytical Laboratory for Ra-226, potassium-40 (K-40), thorium-230 (Th-230), thorium-232 (Th-232), and total uranium. The concentrations of all isotopes are expressed in picocuries per gram (pCi/g). A "less-than" sign (<) indicates that the minimum detection limit, based on Compton background, was not exceeded. A tilde (~) indicates that the sample result was greater than background but below the value of the lowest calibration standard. The postexcavation gamma exposure-rate ranges are expressed in microroentgens per hour (μR/h). The V–areas are shown on Figure B–1 in Appendix B. Measurement uncertainties are presented in the original laboratory reports.

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g)						Average Depth of Excavation (inches)
			Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	
V–1	15–18	MJO–429	4.2	1.3	18.4	1.1	1.1	2.7	60
V–2	14–18	MJO–430	2.2	1.1	16.8	0.9	1.2	1.4	60
V–3	14–17	MJO–431	2.0	1.4	18.1	1.4	1.3	2.1	60
V–4	14–19	MJO–432	2.0	1.4	16.5	1.3	1.4	2.7	60
V–5	16–20	MCJ–851	2.2	1.2	19.4	1.4	1.0	4.1	14
V–6	16–20	MCJ–852	2.6	1.5	18.9	2.0	1.5	4.8	12
V–7	14–19	MCJ–853	2.4	1.8	18.1	1.8	1.1	6.2	20
V–8	16–19	MCJ–854	2.4	1.0	18.8	1.4	1.3	4.1	20
V–9	16–20	MCJ–855	2.0	1.3	19.7	1.8	0.8	6.2	18
V–10	16–19	MCJ–856	3.1	1.6	18.0	1.3	1.3	6.9	20
V–11	14–17	MCJ–857	2.4	1.1	18.2	1.7	1.2	4.8	20
V–12	14–18	MCJ–858	2.2	1.3	18.4	1.9	0.9	6.2	16
V–13	14–18	MCJ–859	1.9	1.7	17.3	1.3	1.2	4.8	16
V–14	14–17	MCJ–860	2.6	1.2	17.7	1.3	1.1	4.1	20
V–15	16–18	MCJ–861	2.8	1.5	18.4	1.2	1.2	4.1	20
V–16	16–19	MCJ–862	3.0	1.8	18.4	2.3	1.4	6.2	20
V–17	15–20	MCJ–863	2.2	1.4	18.5	1.5	1.1	6.9	20
V–18	16–20	MCJ–864	2.2	1.3	18.0	1.4	1.2	4.1	18
V–19	16–19	MCJ–865	1.5	1.2	22.0	1.2	1.4	3.4	18
V–20	14–20	MCJ–866	4.1	2.8	19.9	3.5	1.3	9.6	20
V–21	15–17	MCJ–867	2.8	1.6	17.8	1.6	1.0	4.1	20
V–22	14–17	MCJ–868	2.6	1.5	20.3	1.2	1.0	8.2	20
V–23	16–20	MCJ–869	2.0	2.0	17.3	1.8	1.1	5.5	20
V–24	16–20	MCJ–870	3.3	2.3	19.6	2.2	1.4	6.2	20
V–25	16–20	MCJ–871	4.2	2.7	18.7	3.3	1.4	8.2	18
V–26	14–19	MCJ–872	1.7	1.4	18.6	1.8	1.2	4.1	18
V–27	15–20	MCJ–873	2.4	1.4	17.9	1.0	1.2	4.1	18
V–28	16–18	MCJ–874	3.3	1.4	18.7	1.7	1.2	4.1	20
V–29	16–20	MCJ–875	3.7	1.9	17.5	1.5	1.5	4.8	20
V–30	15–19	MCZ–587	2.2	2.0	18.3	1.4	0.9	4.1	12
V–31	16–25	MKQ–978	2.6	1.8	17.5	2.3	1.3	7.6	20
V–32	15–20	MKQ–979	1.9	2.0	17.3	2.6	1.1	5.5	23
V–33	15–18	MKQ–980	3.0	1.8	17.2	2.3	1.2	6.2	18

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g)						Average Depth of Excavation (inches)
			Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	
V–34	15–18	MKQ–981	2.8	1.6	16.5	4.0	1.5	6.2	18
V–35	16–20	MKQ–982	2.6	1.9	17.7	2.4	1.1	8.2	23
V–36	15–27	MKQ–983	3.9	2.6	17.8	1.7	1.1	7.6	18
V–37	15–18	MKQ–984	2.4	1.5	18.2	2.2	0.9	5.5	18
V–38	15–18	MKQ–985	3.1	1.9	16.0	2.6	0.8	4.1	15
V–39	16–20	MKQ–986	2.0	2.0	17.5	4.7	1.0	4.1	15
V–40	15–27	MKQ–987	7.9	4.5	15.4	7.3	1.3	6.9	15
V–41	15–18	MKQ–988	2.2	1.6	17.8	1.8	1.0	2.7	15
V–42	15–19	MKQ–989	2.8	1.8	18.5	2.2	0.9	4.8	15
V–43	16–21	MKQ–990	4.1	3.4	18.4	3.0	1.3	7.6	15
V–44	15–20	MKQ–991	3.3	2.2	19.1	2.6	1.2	6.2	18
V–45	16–25	MKQ–992	3.5	2.4	18.5	2.1	1.1	7.6	18
V–46	16–24	MKQ–993	3.5	2.3	17.8	4.0	1.0	12.4	120
V–47	15–24	MKQ–994	1.5	2.0	15.8	3.5	0.9	9.6	144
V–48	16–28	MKQ–995	3.5	2.7	19.1	5.4	0.9	11.0	156
V–49	16–32	MKQ–996	3.3	2.6	20.0	3.3	1.1	26.8	156
V–50	16–28	MKQ–997	4.8	4.4	18.3	6.2	1.3	41.9	156
V–51	17–32	MKQ–998	6.3	5.3	19.4	5.8	1.2	15.1	120
V–52	14–18	MKQ–999	3.1	1.7	22.2	1.1	1.1	6.2	24
V–53	14–18	MHH–776	3.5	2.4	18.1	2.7	1.1	13.1	24
V–54	14–18	MHH–777	2.0	1.9	18.2	3.4	1.1	4.1	24
V–55	15–20	MHH–778	3.3	2.1	20.2	2.6	1.0	8.9	24
V–56	14–18	MHH–779	3.0	1.7	19.1	3.0	1.5	6.9	24
V–57	14–20	MHH–780	3.3	2.9	18.1	7.0	0.8	10.3	24
V–58	14–90	MHH–781	7.0	6.1	18.7	8.1	1.1	20.6	32
V–59	13–19	MHH–782	1.9	1.4	19.7	1.3	1.2	17.9	32
V–60	14–18	MHH–783	2.0	1.1	17.3	1.6	1.2	6.2	32
V–61	13–17	MHH–784	2.8	1.0	17.5	1.6	0.9	2.7	32
V–62	14–20	MHH–785	4.2	2.2	17.9	3.0	1.2	6.2	32
V–63	14–19	MHH–786	3.1	1.5	17.8	2.2	1.4	4.1	32
V–64	16–26	MHH–789	1.9	1.5	21.0	2.2	1.1	4.8	18
V–65	17–24	MHH–790	3.3	1.6	20.1	1.8	1.3	4.1	18
V–66	18–50	MHH–791	1.7	1.5	18.8	2.5	1.2	10.3	18
V–67	15–24	MHH–803	1.1	3.1	18.6	2.5	1.3	7.6	18
V–68	14–21	MHH–804	2.6	2.6	18.1	2.5	1.4	6.9	18
V–69	15–19	MHH–805	1.7	1.9	19.2	2.3	1.2	13.1	18
V–70	16–24	MHH–806	3.7	2.7	17.8	4.7	1.2	11.0	18
V–71	15–18	MHH–807	2.0	1.8	17.9	2.1	0.9	8.2	47
V–72	15–18	MHH–808	0.6	1.3	18.9	1.0	1.4	6.9	46
V–73	15–20	MHH–809	2.6	1.9	19.0	1.3	1.2	14.4	32
V–74	15–19	MHH–810	2.2	2.7	20.3	2.0	1.2	13.1	35
V–75	15–18	MHH–811	1.9	1.1	20.2	1.4	1.2	17.2	24
V–76	15–21	MHH–812	3.1	2.2	19.2	2.1	1.2	10.3	29
V–77	15–18	MHH–813	2.2	1.0	18.7	2.2	1.0	8.2	29
V–78	15–18	MHH–814	1.7	1.3	18.7	1.5	1.0	9.6	33

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g) Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	Average Depth of Excavation (inches)
V-79	15-18	MHH-815	1.5	1.4	18.1	2.0	1.0	10.3	33
V-80	15-19	MHH-816	2.2	1.2	19.6	2.1	1.2	6.2	30
V-81	15-21	MHH-817	2.4	1.2	18.7	1.9	1.5	7.6	24
V-82	15-18	MHH-818	2.4	1.2	18.4	2.0	1.4	6.2	24
V-83	15-24	MHH-819	1.3	1.8	20.3	2.1	1.2	6.2	24
V-84	15-19	MHH-820	3.0	1.8	19.3	3.6	1.4	13.1	24
V-85	15-17	MHH-821	1.5	1.1	18.5	1.7	1.2	4.1	8
V-86	15-18	MHH-822	1.7	1.3	20.1	1.8	1.3	6.2	11
V-87	15-18	MHH-823	2.6	1.7	18.7	2.4	1.3	5.5	9
V-88	15-17	MHH-824	1.5	1.3	18.6	4.7	1.1	6.2	12
V-89	15-21	MHH-825	2.2	1.6	15.4	3.0	1.2	5.5	14
V-90	15-18	MIP-926	2.2	1.5	18.7	1.7	1.1	5.5	15
V-91	15-18	MIP-927	1.9	1.2	17.7	1.9	1.1	6.9	13
V-92	17-24	MIP-931	3.0	1.5	16.5	0.9	1.3	4.8	20
V-93	16-22	MIP-932	3.5	1.7	17.7	1.5	1.0	3.4	20
V-94	17-25	MIP-933	1.9	1.6	16.1	1.6	1.2	4.1	20
V-95	15-19	MIP-934	2.0	1.0	16.4	2.1	1.2	5.5	26
V-96	15-19	MIP-935	3.3	1.4	17.0	1.5	1.1	4.8	26
V-97	15-18	MIP-936	3.0	2.1	16.4	2.1	1.3	5.5	26
V-98	17-20	MIP-937	2.6	1.4	16.0	1.9	1.1	6.2	28
V-99	15-21	MIP-938	2.2	1.7	18.4	2.2	1.3	7.6	24
V-100	15-22	MIP-939	2.2	1.5	16.8	1.4	1.0	5.5	22
V-101	16-22	MIP-940	2.8	1.8	17.5	1.9	1.1	6.2	20
V-102	15-18	MIP-941	2.2	1.3	18.7	0.9	1.2	4.8	15
V-103	19-22	MIP-942	1.7	1.6	16.9	1.6	1.1	4.1	48
V-104	18-39	MIP-943	3.7	2.6	19.6	5.6	1.3	4.8	10
V-105	18-24	MIP-944	4.1	3.0	17.4	3.9	1.2	6.2	10
V-106	18-24	MIP-945	3.7	2.5	19.3	3.7	1.0	4.8	10
V-107	16-21	MIP-946	2.0	1.8	17.9	1.8	1.2	4.8	10
V-108	16-19	MIP-947	2.6	1.9	16.5	1.6	1.6	4.1	16
V-109	18-20	MIP-948	2.0	1.3	18.4	1.6	1.1	4.1	18
V-110	18-21	MIP-949	1.9	1.5	18.9	2.2	1.1	4.8	18
V-111	18-32	MIP-950	3.1	3.0	19.8	4.2	1.1	5.5	18
V-112	18-24	MIP-951	3.7	1.9	21.5	2.8	0.8	4.8	12
V-113	18-22	MIP-952	2.2	1.3	17.8	1.5	1.2	4.1	12
V-114	17-21	MIP-953	2.8	2.2	18.0	2.6	1.1	4.1	12
V-115	16-19	MIP-954	1.7	1.3	19.1	0.9	0.9	2.1	12
V-116	15-19	MIP-955	1.9	1.3	20.1	2.0	0.9	2.7	12
V-117	15-18	MIP-956	1.1	1.1	19.8	1.8	1.3	2.1	12
V-118	15-18	MIP-957	2.0	1.5	19.4	1.9	1.4	2.7	12
V-119	16-20	MIP-958	1.9	1.1	17.7	1.5	1.4	4.1	11
V-120	17-24	MIP-959	2.4	1.7	20.5	1.7	1.1	5.5	12
V-121	16-19	MIP-960	3.0	1.0	18.6	1.5	1.1	2.7	11
V-122	18-21	MIP-961	3.0	1.6	17.5	1.9	1.1	4.8	10
V-123	15-19	MIP-962	2.0	0.9	21.5	2.5	1.3	2.1	12

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g)						Average Depth of Excavation (inches)
			Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	
V–124	15–18	MIP–963	1.3	1.3	20.0	1.5	1.2	3.4	12
V–125	15–21	MIP–964	2.0	1.4	20.1	2.7	1.3	4.8	12
V–126	16–19	MIP–965	2.8	1.6	19.4	1.4	1.1	4.8	12
V–127	16–20	MIP–966	3.3	1.2	20.3	1.1	1.4	4.8	12
V–128	16–19	MIP–967	2.2	1.3	19.9	1.6	1.3	4.1	9
V–129	20–32	MIP–968	3.7	2.5	20.5	4.5	1.2	4.1	192
V–130	15–20	MIP–971	2.2	1.5	18.2	2.0	1.0	12.4	12
V–131	15–20	MIP–972	3.3	2.6	19.6	3.1	1.5	18.5	36
V–132	15–18	MIP–973	1.5	1.3	21.3	1.7	1.5	5.5	32
V–133	15–21	MIP–974	3.3	1.3	20.1	1.7	1.5	5.5	36
V–134	15–18	MIP–975	1.1	1.2	20.8	1.3	1.4	3.4	36
V–135	15–18	MKQ–954	2.2	1.5	20.0	1.7	1.3	8.9	38
V–136	15–21	MKQ–955	2.8	1.8	19.3	1.7	1.1	11.7	38
V–137	14–22	MKQ–956	1.7	2.1	20.4	2.2	1.2	6.2	40
V–138	15–19	MKQ–957	2.6	1.2	21.1	1.3	1.2	4.1	36
V–139	15–20	MKQ–958	2.6	1.0	19.8	1.5	0.9	2.7	33
V–140	15–20	MKQ–959	2.2	1.9	19.5	2.3	1.0	6.9	18
V–141	15–20	MKQ–960	1.5	1.6	18.8	2.5	1.0	8.9	17
V–142	14–18	MKQ–961	2.6	1.2	17.7	1.8	1.3	8.2	18
V–143[a]	15–22	MKQ–962	1.3	1.4	17.4	2.3	0.9	12.4	
V–144[a]	16–22	MKQ–963	3.9	3.6	18.3	4.4	0.9	19.2	
V–145[a]	15–18	MKQ–964	2.8	1.1	18.9	1.7	0.9	8.9	
V–146[a]	16–21	MKQ–965	4.1	2.6	18.7	3.4	1.2	15.8	
V–147[a]	16–24	MKQ–966	2.8	2.0	19.2	2.5	1.2	12.4	
V–148[a]	17–22	MKQ–967	3.7	3.1	17.9	5.0	1.1	13.7	
V–149[a]	17–21	MKQ–968	4.2	3.1	18.8	4.3	1.1	14.4	
V–150	15–21	MKQ–969	3.7	3.2	17.9	4.3	1.2	11.0	10
V–151[a]	15–18	MKQ–970	2.4	1.9	20.0	3.7	0.9	8.9	
V–152	15–21	MKQ–933	3.5	2.4	18.5	2.6	1.3	10.3	32
V–153	15–18	MKQ–934	1.1	1.5	16.8	1.6	1.5	11.0	36
V–154	15–18	MKQ–935	2.4	1.0	19.5	2.3	1.4	6.2	37
V–155	15–18	MKQ–936	2.0	1.3	22.4	1.9	1.4	5.5	38
V–156	15–26	MKQ–937	3.3	1.6	19.8	2.0	0.8	5.5	47
V–157	15–21	MKQ–938	4.6	3.4	19.3	3.8	1.3	8.9	18
V–158	18–24	MKQ–939	3.7	1.8	19.6	2.0	1.3	9.6	24
V–159	17–28	MKQ–940	9.4	7.9	21.2	7.1	1.2	22.0	33
V–160	17–24	MKQ–941	4.8	2.8	21.3	3.0	1.4	14.4	33
V–161	15–20	MKQ–942	1.9	1.3	21.6	1.5	1.3	9.6	23
V–162	15–24	MKQ–943	4.6	3.7	18.6	3.1	0.9	7.6	26
V–163	15–21	MKQ–944	3.1	1.9	17.4	1.6	1.1	11.7	28
V–164	16–22	MKQ–945	2.0	1.3	18.6	1.4	1.1	5.5	38
V–165	18–24	MKQ–946	2.2	1.3	19.7	1.7	1.2	13.1	37

[a]Areas V–143 through V–149 and V–151 were later reverified. Contamination was encountered in adjacent areas that extended beneath these areas at greater depths. The new verification areas are V–200, V–201, V–202, V–208, V–210, V–211, and V–213.

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g) Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	Average Depth of Excavation (inches)
V–166	18–22	MKQ–947	3.5	1.4	18.1	1.6	1.1	7.6	36
V–167	15–20	MKQ–948	1.9	1.4	18.0	1.2	1.2	8.2	32
V–168	15–24	MKQ–949	3.9	1.7	18.5	1.7	1.3	9.6	30
V–169	18–24	MKQ–950	3.5	1.6	18.8	1.5	1.2	10.3	31
V–170	17–23	MKQ–971	3.1	1.4	16.9	1.6	1.6	6.9	36
V–171	14–19	MKQ–972	1.7	1.6	23.1	1.7	1.9	6.9	24
V–172	15–17	MKQ–973	2.8	1.5	22.5	2.0	1.8	13.1	24
V–173	15–17	MKQ–974	4.2	1.5	20.2	1.7	1.1	9.6	24
V–174	15–19	MKQ–975	4.2	1.3	19.9	1.6	1.3	8.9	24
V–175	14–17	MDH–609	2.0	1.6	17.1	1.2	1.5	3.4	24
V–176	14–17	MDH–610	3.0	1.9	18.3	2.5	1.3	5.5	24
V–177	14–18	MDH–611	2.8	1.5	17.0	1.0	1.0	4.8	24
V–178	14–17	MDH–612	1.9	1.5	15.3	1.5	1.2	3.4	24
V–179	15–18	MDH–613	2.4	1.6	18.8	1.3	1.4	7.6	24
V–180	15–17	MDH–614	3.0	1.7	21.0	1.7	1.3	6.2	24
V–181	15–18	MDH–615	2.6	1.5	18.1	1.4	1.0	3.4	24
V–182	16–25	MDH–618	2.0	1.6	17.8	2.6	1.1	6.2	38
V–183	16–22	MDH–619	1.7	1.6	16.5	1.2	1.0	6.2	36
V–184	16–20	MDH–620	2.2	1.6	17.1	1.9	1.1	4.1	60
V–185	15–23	MDH–621	3.5	3.7	16.6	3.6	1.1	7.6	18
V–186	16–20	MDH–622	5.2	2.8	16.6	2.6	1.0	4.8	24
V–187	15–20	MDH–623	3.3	2.6	16.7	2.2	0.9	5.5	18
V–188	17–20	MDH–624	2.8	2.1	19.4	2.1	0.8	8.2	39
V–189	16–20	MGD–001	3.0	2.2	17.3	2.3	1.4	11.7	22
V–190	15–18	MGD–003	2.6	2.3	17.8	2.0	1.4	8.2	72
V–191	16–18	MGD–004	1.3	1.6	18.4	1.4	0.8	4.8	67
V–192	14–20	MGD–005	4.6	2.7	17.4	3.1	1.2	6.2	70
V–193	15–16	MGD–006	1.9	1.4	18.7	1.4	0.9	4.8	82
V–194	15–17	MGD–007	1.3	1.4	16.7	1.3	1.0	4.1	60
V–195	15–19	MGD–008	3.1	1.7	20.1	3.3	1.2	6.9	78
V–196	15–18	MGD–009	2.2	1.4	19.2	1.7	1.3	10.3	63
V–197	16–17	MGD–010	2.6	1.8	18.2	1.7	0.7	9.6	85
V–198	15–17	MGD–011	2.8	2.1	18.4	2.5	1.1	6.9	90
V–199	14–17	MGD–012	2.6	1.5	18.5	1.0	1.2	7.6	38
V–200	16–18	MGD–013	2.8	1.8	17.6	2.9	0.9	8.9	40
V–201	16–19	MGD–014	5.5	3.7	17.3	3.3	1.1	12.4	54
V–202	16–17	MGD–015	1.5	1.4	19.5	1.3	0.9	8.2	65
V–203	15–17	MGD–016	3.0	1.3	19.0	1.3	1.5	7.6	80
V–204	15–17	MGD–017	3.5	1.6	17.9	1.0	0.9	6.2	100
V–205	15–17	MGD–018	3.0	1.5	18.7	1.3	1.1	4.8	70
V–206	16–17	MGD–019	3.5	1.7	17.3	2.0	1.0	6.2	50
V–207	15–18	MGD–020	3.5	2.2	18.9	1.7	0.7	4.8	35
V–208	14–17	MGD–021	2.2	1.9	18.9	1.9	1.2	6.2	59
V–209	15–17	MGD–022	1.9	2.1	17.7	1.8	0.9	8.9	65
V–210	16–17	MGD–023	2.6	1.6	16.6	1.1	1.4	6.9	70

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g) Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	Average Depth of Excavation (inches)
V–211	15–17	MGD–024	3.3	1.6	18.7	1.0	1.1	4.8	70
V–212	16–18	MGD–025	1.9	1.8	17.9	2.0	1.0	8.2	70
V–213	16–17	MGD–026	4.1	1.9	17.2	2.0	1.0	6.2	34
V–214	15–17	MGD–027	3.0	2.4	18.4	2.5	1.3	22.0	21
V–215	15–18	MGD–028	3.9	2.1	18.5	2.0	1.2	17.9	16
V–216	15–20	MGD–029	5.9	4.8	18.6	4.3	1.0	18.5	21
V–217	14–20	MGD–030	6.1	3.0	19.0	2.6	1.1	8.9	19
V–218	15–17	MGD–031	2.4	1.8	19.6	2.3	0.7	13.1	12
V–219	15–18	MGD–032	3.1	2.1	19.7	2.0	0.8	10.3	12
V–220	15–17	MGD–033	2.2	1.4	19.2	3.0	1.1	4.1	60
V–221	16–17	MGD–034	2.4	1.8	18.2	1.7	1.1	8.2	56
V–222	16–17	MGD–035	2.0	1.5	18.1	1.5	1.1	6.2	52
V–223	15–17	MGD–036	1.5	2.0	21.4	1.9	1.3	10.3	48
V–224	16–17	MGD–037	3.3	2.1	22.2	1.2	1.2	6.9	31
V–225	15–17	MGD–038	2.8	1.4	20.2	1.2	1.1	13.7	29
V–226	15–17	MGD–039	3.9	1.9	19.8	1.8	1.4	6.9	21
V–227	15–17	MGD–040	1.7	1.5	22.5	0.6	1.0	4.1	21
V–228	15–17	MGD–041	2.4	1.5	21.3	0.8	1.1	6.2	37
V–229	16–17	MGD–042	3.1	1.8	19.2	1.4	1.5	6.2	59
V–230	14–17	MGD–043	3.3	2.3	18.9	1.5	1.1	8.2	47
V–231	15–17	MGD–044	2.2	2.6	20.6	2.1	<0.2	16.5	37
V–232	15–17	MGD–045	2.6	1.9	18.7	1.1	1.2	6.2	36
V–233	16–19	MGD–046	2.4	2.1	21.8	1.5	0.8	10.3	13
V–234	16–22	MGD–047	3.5	3.3	21.0	1.6	1.1	17.9	79
V–235	16–17	MGD–048	2.8	2.4	20.9	1.9	1.3	9.6	12
V–236	15–17	MGD–049	2.2	1.9	18.5	2.4	1.5	4.1	17
V–237	15–17	MGD–050	2.2	2.0	21.5	1.8	1.2	6.2	14
V–238	16–17	MIP–583	3.7	2.1	19.9	2.0	1.6	6.2	14
V–239	15–17	MIP–584	2.6	1.8	16.4	2.7	1.5	5.5	12
V–240	15–17	MIP–585	2.6	1.6	16.3	1.9	1.2	3.4	12
V–241	15–18	MIP–586	2.8	2.9	19.6	2.8	1.3	7.6	14
V–242	15–18	MIP–587	4.2	2.3	20.3	2.6	1.6	7.6	18
V–243	16–18	MIP–588	2.8	2.3	19.8	2.0	1.4	6.9	19
V–244	16–19	MIP–589	2.6	2.5	19.8	2.2	1.1	6.9	18
V–245	16–21	MIP–590	3.9	3.6	19.8	3.0	1.4	7.6	16
V–246	17–20	MIP–591	3.0	2.1	21.0	2.3	0.9	8.2	19
V–247	17–24	MIP–592	2.6	2.6	21.3	3.8	1.1	9.6	49
V–248	16–20	MIP–593	2.6	3.0	21.2	1.7	1.5	6.9	42
V–249	16–20	MIP–594	2.2	2.5	22.0	2.3	1.7	8.9	42
V–250	16–18	MIP–595	1.3	1.7	22.0	1.7	1.3	8.2	42
V–251	17–23	MIP–596	3.3	3.0	22.4	2.6	1.5	6.9	42
V–252	16–20	MIP–597	2.4	1.8	21.7	1.6	1.6	5.5	42
V–253	16–20	MIP–598	4.2	3.0	22.5	2.3	1.0	9.6	42
V–254	16–19	MIP–599	3.0	1.9	23.7	2.1	1.4	3.4	42
V–255	17–20	MIP–600	2.4	1.8	21.6	1.4	1.7	4.8	42

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g)						Average Depth of Excavation (inches)
			Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	
V–256	16–20	MIP–801	2.4	2.1	21.7	1.7	1.2	11.7	45
V–257	17–22	MIP–802	3.1	2.8	23.4	1.4	1.7	6.2	42
V–258	17–22	MIP–803	7.2	5.0	22.6	2.0	1.6	6.9	42
V–259	17–22	MIP–804	6.5	5.9	23.7	2.7	1.7	11.7	54
V–260	17–22	MIP–805	3.0	2.7	22.1	3.0	1.7	7.6	54
V–261	19–24	MIP–807	2.0	1.3	18.4	2.2	1.2	4.8	45
V–262	22–24	MIP–808	1.9	1.6	18.2	2.2	1.2	5.5	42
V–263	28–44	MIP–809	1.9	1.6	18.1	2.4	1.2	4.1	48
V–264	28–39	MIP–810	2.6	1.1	17.9	1.4	1.4	2.7	48
V–265	22–28	MIP–811	3.9	1.9	18.9	1.7	1.1	5.5	24
V–266	20–26	MIP–812	3.1	3.1	19.6	2.7	0.9	8.2	24
V–267	19–22	MIP–813	3.1	2.8	20.4	2.4	1.2	7.6	24
V–268	20–24	MIP–814	3.7	4.2	19.3	2.6	1.4	6.9	42
V–269	20–23	MIP–815	1.1	2.0	16.8	1.3	1.3	9.6	34
V–270	20–22	MIP–816	2.6	1.9	16.8	2.0	1.0	3.4	39
V–271	20–25	MIP–817	9.2	9.3	21.2	2.7	1.4	11.0	45
V–272	22–32	MIP–818	2.4	0.9	18.5	1.4	1.3	2.1	40
V–273	26–39	MIP–819	3.5	1.9	19.4	1.1	1.2	4.1	59
V–274	16–17	MIP–820	1.7	1.2	18.1	1.3	1.1	2.1	18
V–275	16–17	MIP–821	1.5	1.1	18.4	0.8	1.1	2.1	18
V–276	16–18	MIP–822	2.0	1.4	20.8	1.4	1.3	3.4	18
V–277	17–22	MIP–823	1.1	1.5	19.9	1.4	1.0	4.1	19
V–278	20–26	MIP–824	1.9	1.2	18.4	1.2	1.4	4.1	19
V–279	27–95	MIP–825	2.2	1.4	19.1	0.7	1.1	7.6	24
V–280	24–286	MLT–001	2.8	2.9	19.9	2.5	1.1	8.9	24
V–281	16–18	MLT–002	1.5	2.7	19.1	1.8	1.2	12.4	18
V–282	17–19	MLT–003	1.9	1.5	19.6	1.2	1.2	8.9	18
V–283	17–20	MLT–004	1.5	1.6	22.0	1.1	1.2	11.7	18
V–284	16–22	MLT–007	2.8	1.9	20.0	1.6	1.1	6.9	18
V–285	17–28	MLT–008	1.5	1.3	20.1	1.3	1.3	6.9	18
V–286	17–35	MLT–009	4.1	3.4	20.5	2.3	0.7	10.3	18
V–287	17–30	MLT–010	3.1	1.6	18.7	1.6	1.3	6.9	18
V–288	17–24	MLT–011	7.9	7.6	18.6	5.5	1.6	13.7	18
V–289	16–20	MLT–012	3.3	3.9	19.9	2.2	1.3	8.9	18
V–290	16–20	MLT–013	3.5	2.1	19.6	1.2	1.3	5.5	18
V–291	16–19	MLT–005	1.3	1.6	18.8	1.0	1.2	52.9	18
V–292	17–20	MLT–006	3.0	2.3	19.1	1.9	1.4	7.6	18
V–293	15–18	MLT–014	2.0	1.4	18.5	1.7	1.0	8.9	18
V–294	16–17	MLT–015	2.6	2.3	20.1	0.4	1.1	8.9	18
V–295	16–17	MLT–016	2.0	1.2	19.0	2.1	0.9	11.0	18
V–296	15–20	MLT–017	2.8	1.8	19.2	2.0	1.1	7.6	18
V–297	16–20	MLT–018	2.2	2.3	19.1	2.2	0.9	5.5	18
V–298	16–17	MLT–019	2.0	1.5	18.9	1.4	1.7	11.0	18
V–299	14–16	MLT–020	2.8	1.3	17.7	1.2	1.4	5.5	18
V–300	16–17	MLT–021	2.4	1.8	19.2	1.7	1.6	3.4	16

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g)						Average Depth of Excavation (inches)
			Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	
V–301	16–17	MLT–022	5.2	3.9	19.8	2.5	1.8	5.5	17
V–302	15–17	MLT–023	3.3	1.6	20.0	1.6	0.8	4.8	12
V–303	16–17	MLT–024	2.8	1.2	21.6	1.3	1.3	4.1	14
V–304	14–24	MLT–025	2.0	1.2	17.2	1.5	1.2	37.1	60
V–305	15–24	MLT–026	2.4	1.5	17.7	1.8	0.9	8.2	54
V–306	18–24	MLT–027	3.0	2.0	18.0	5.3	1.0	7.6	66
V–307	18–24	MLT–028	4.6	3.0	17.9	4.3	1.0	7.6	119
V–308	16–24	MLT–178	3.3	1.7	17.8	2.2	1.2	12.4	24
V–309	16–28	MDH–587	2.4	1.5	19.9	3.3	1.4	89.3	48
V–310	14–21	MDH–588	2.2	4.1	18.5	5.5	1.0	39.8	16
V–311	14–20	MDG–589	2.8	2.0	18.5	1.3	1.0	7.6	30
V–312	14–24	MDH–590	3.7	2.5	18.0	1.2	1.2	8.9	36
V–313	14–35	MDH–591	1.5	1.6	18.8	<1.3	1.3	6.2	36
V–314	14–21	MDH–592	4.2	2.8	17.9	3.5	1.0	17.2	12
V–315	14–22	MDH–593	1.9	1.4	17.3	1.3	0.6	8.2	11
V–316	14–20	MDH–594	0.7	1.0	18.1	<1.5	1.2	7.6	10
V–317	14–19	MDH–595	2.2	1.8	15.9	1.4	0.9	15.8	10
V–318	14–20	MDH–596	2.8	1.5	17.5	<1.2	0.9	23.4	8
V–319	14–35	MDH–597	2.0	1.4	14.8	2.1	1.1	4.1	40
V–320	14–32	MDH–598	2.8	2.0	16.8	2.3	1.5	4.8	40
V–321	14–24	MDH–599	2.6	1.5	15.4	1.4	0.9	4.1	40
V–322	14–28	MDH–600	2.4	2.1	17.2	2.0	1.2	4.8	36
V–323	15–50	MLT–037	3.3	1.4	15.6	1.6	1.1	3.4	77
V–324	14–18	MLT–038	2.4	1.3	17.5	1.4	0.9	3.4	84
V–325	16–80	MLT–039	2.0	1.7	17.8	1.8	0.8	4.1	123
V–326	14–18	MLT–180	2.2	1.3	18.1	1.5	1.0	5.5	24
V–327	14–18	MLT–181	1.9	1.2	16.8	1.6	1.1	5.5	51
V–328	13–35	MLT–182	3.5	1.5	17.3	2.0	1.0	6.2	66
V–329	14–39	MLT–183	3.7	1.9	16.8	3.1	1.2	6.9	106
V–330	14–28	MLT–184	3.1	1.1	18.1	0.9	1.0	4.1	120
V–331	15–58	MLT–185	1.5	1.3	16.9	1.5	1.3	3.4	120
V–332	14–58	MLT–186	1.5	1.2	17.0	<0.8	0.7	4.1	125
V–333	14–58	MLT–187	2.0	1.3	15.5	1.0	1.3	4.1	126
V–334	14–18	MLT–188	1.7	1.0	16.1	1.3	0.6	4.1	120
V–335	14–18	MLT–189	2.8	1.7	16.0	2.5	1.0	4.8	120
V–336	14–18	MLT–190	3.1	1.9	15.0	1.2	0.8	9.6	12
V–337	17–21	NAF–952	1.7	1.5	18.6	3.2	0.9	17.9	24
V–338	17–20	NAF–954	3.0	1.1	17.7	2.3	1.0	13.7	20
V–339	20–767	NAE–327	2.6	2.4	17.8	4.9	0.9	9.6	86
V–340	18–52	NAE–329	7.0	6.1	17.9	9.6	1.0	14.4	120
V–341	18–21	NAE–330	7.9	7.3	16.6	12.3	0.9	11.7	120
V–342	21–37	NAE–331	<1.0	1.4	18.5	1.6	1.0	3.4	88
V–343	21–37	NAE–333	6.3	6.7	16.6	5.1	1.4	7.6	76

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (µR/h)	Soil Sample Ticket No.	Concentration (pCi/g)						Average Depth of Excavation (inches)
			Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	
V–344[b]									
V–345[c]		NAB–672	3.1	3.6	16.7	7.0	1.2	4.8	
V–346	15–17	NAE–981	4.6	1.8	18.9	4.4	1.4	3.4	12
V–347	15–17	NAE–982	4.6	1.8	18.4	2.1	1.2	3.4	12
V–348	15–17	NAE–983	3.7	1.6	20.2	2.0	1.2	2.7	12
V–349	15–25	NAE–176	4.2	3.8	21.3		1.2		12
V–350	15–21	NAE–177	3.0	3.9	22.6		0.8		12
V–351	15–25	NAE–178	3.1	2.2	23.5		1.5		12
V–352	15–21	NAE–179	3.7	4.8	22.0		1.0		12
V–353	15–21	NAE–180	3.0	4.5	20.9		0.9		12
V–354	15–25	NAE–181	2.4	1.5	19.6		1.3		12
V–355	15–25	NAE–182	3.3	2.3	19.9		1.0		12
V–356	15–25	NAE–183	3.9	3.8	19.7		1.4		12
V–357	15–21	NAE–184	2.4	1.7	17.7		1.3		12
V–358	16–25	NAE–185	2.6	1.5	20.3		1.4		12
V–359	15–21	NAE–186	2.2	1.3	21.0		1.5		12
V–360	15–21	NAE–187	2.6	1.8	19.4		1.2		12
V–361	15–21	NAE–188	3.0	1.6	20.1		1.4		12
V–362	13–16	NAE–993	5.0	3.5	19.4	6.0	1.3		24
V–363	13–19	NAE–994	3.7	1.4	14.8	1.5	1.1		24
V–364	14–17	NAE–995	5.0	3.7	18.4	1.1	0.9		6
V–365	13–20	NAE–996	3.3	3.3	17.3	1.3	1.2		220
V–366	13–24	NAE–997	3.3	3.0	17.2	1.0	1.4		60
V–367	13–19	NAE–998	4.1	2.3	20.4	1.9	1.1		70
V–368	13–31	NAE–999	8.1	6.2	17.1	2.8	1.4		132
V–369	14–17	NAF–001	3.1	1.6	18.8	3.4	1.4		76
V–370	16–17	NAL–080	4.8	1.8	16.0	1.2	1.3		145
V–371	15–20	NAL–081	5.9	4.4	16.0	2.0	1.3		140
V–372	14–16	NAL–082	4.1	2.8	18.0	3.3	0.9		60
V–373	13–20	NAL–083	2.8	1.9	17.3	2.0	0.9		130
V–374	16–24	NAL–084	2.4	1.5	16.5	1.2	1.1		130
V–375	13–19	NAF–084	<1.0	1.3	20.1	1.1	1.2	3.4	18
V–376	13–24	NAF–085	3.1	1.1	18.7	1.9	1.4	4.1	18
V–377	16–19	NAL–086	5.4	2.4	19.7	1.4	1.0		100
V–378	16–24	NAL–087	3.9	1.5	19.6	1.5	0.9		144
V–379	19–26	NAL–088	5.4	2.3	20.2	3.3	1.0		144
V–380	26–31	NAL–089	5.4	1.9	18.8	1.4	1.0		80
V–381	14–20	NAL–090	4.4	1.1	16.5	1.3	1.1		12
V–382	15–18	NAL–091	3.5	1.0	18.7	1.0	0.8		6
V–383	16–19	NAL–092	2.8	1.1	17.8	0.8	0.5		6
V–384	14–19	NAL–093	3.1	1.0	18.4	0.9	0.8		6
V–385	35–76	NAL–094	3.5	1.9	23.5	3.8	0.7		144
V–386	35–76	NAL–095	3.7	1.1	22.1	1.2	<0.1		160

[b]Additional excavation was required, reverified as V–551.

[c]This area was reexcavated to remove contamination lying below the assessed contamination.

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g) Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	Average Depth of Excavation (inches)
V–387	24–114	NAL–096	4.4	1.4	24.2	1.7	1.0		130
V–388	17–110	NAL–097	3.1	1.9	21.9	2.1	0.9		124
V–389	16–31	NAL–098	4.4	3.7	20.5	3.2	1.1		160
V–390	20–31	NAL–099	4.4	2.5	21.0	2.7	0.9		92
V–391	22–80	NAF–086	2.2	1.6	20.5	2.3	0.7		80
V–392	20–118	NAF–087	1.1	1.2	21.8	1.5	1.1		120
V–393	24–140	NAL–102	2.4	1.4	22.1	1.6	<0.2		120
V–394	43–155	NAL–103	2.8	1.7	22.6	2.7	1.1		156
V–395	19–65	NAL–104	3.0	2.4	21.3	2.5	0.8		150
V–396	28–125	NAF–088	3.5	1.6	21.3	0.7	1.1		120
V–397	20–110	NAF–089	4.2	1.5	22.8	1.5	0.9		120
V–398	28–193	NAF–090	4.4	1.9	22.3	1.6	1.2		136
V–399	20–24	NAF–091	4.2	2.2	23.4	2.2	1.0		98
V–400	20–230	NAF–092	6.1	3.2	21.2	1.4	0.9		120
V–401	20–28	NAF–093		4.9	22.1	5.8	0.7		58
V–402	24–193	NAF–094	10.5	6.0	23.3	4.5	1.0		116
V–403	24–193	NAF–095	7.0	4.5	21.2	2.4	1.1		135
V–404	24–230	NAF–096	6.6	4.5	20.3	2.5	1.1	74.2	135
V–405	30–193	NAF–097	11.8	9.2	21.0	6.5	0.9		108
V–406[d]	43 μR/h	NAF–098	29.6	26.3	21.8	24.5	<0.3	91.4	24
V–407	24–31	NAF–099	3.0	1.0	17.1	1.4	1.4		133
V–408	24–35	NAF–100	9.2	9.6	16.4	11.4	1.2		133
V–409	28–230	NAF–101	7.2	5.4	16.9	5.7	1.0		105
V–410	43–155	NAF–502	7.5	2.0	17.3	2.2	1.0		106
V–411	46–110	NAF–503	6.7	1.3	17.3	1.3	0.8		82
V–412	22–35	NAF–504	7.3	5.4	17.7	9.5	1.2		135
V–413	18–24	NAE–191	1.7	1.7	20.9	2.6	0.7		6
V–414	18–24	NAE–192	3.8	3.2	20.8	6.5	<0.1		68
V–415	19–28	NAE–193	3.5	3.0	20.4	4.6	1.1		68
V–416	13–16	NAH–402	3.5	1.9	21.4	2.1	1.0		120
V–417	14–20	NAE–195	3.8	1.9	22.8	2.7	0.8		48
V–418	16–26	NAE–196	6.7	4.5	21.3	12.3	0.7		144
V–419	14–26	NAE–197	7.1	4.4	20.7	9.0	0.5		86
V–420	14–242	NAE–198	6.2	4.4	18.4	7.3	0.9		24
V–421	14–20	NAE–199	3.7	2.4	18.8	4.1	1.1		56
V–422	16–26	NAE–200	3.9	2.0	19.1	3.6	1.0		86
V–423	16–24	NAA–569	4.5	3.0	18.1	5.1	0.7		56
V–424	16–31	NAA–570	7.5	5.2	18.8	14.4	1.0		82
V–425	16–24	NAA–571	3.9	2.3	18.8	4.6	1.4		53
V–426	19–24	NAA–572	3.3	3.1	17.9	5.0	0.9		53
V–427	19–28	NAA–573	4.4	3.3	21.0	8.1	0.6		82
V–428	17–20	NAA–575	4.6	3.1	19.2	9.2	0.7		82
V–429	16–22	NAA–576	4.2	2.6	20.5	7.1	<0.2		82

[d]Contamination was left in place and area-averaged. Average Ra-226 and Th-230 concentrations are 4.2 pCi/g and 4.9 pCi/g, respectively.

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g) Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	Average Depth of Excavation (inches)
V–430	16–224	NAA–577	6.5	3.8	17.4	10.1	0.5		82
V–431	16–20	NAA–578	2.1	1.6	18.3	2.9	1.1		82
V–432	16–21	NAA–579	4.8	3.0	19.6	6.6	1.2		82
V–433	16–20	NAA–580	2.0	2.0	20.9	4.2	1.1		82
V–434	16–24	NAA–581	4.3	2.1	19.8	5.1	1.0		82
V–435	16–22	NAA–582	4.5	3.2	20.2	8.0	<0.2		82
V–436	17–24	NAA–583	4.5	3.2	19.3	8.3	1.1		82
V–437	19–28	NAA–584	2.6	2.1	20.6	4.1	0.9		82
V–438	20–28	NAA–585	5.2	3.8	20.2	9.2	0.9		82
V–439	20–28	NAA–586	4.4	2.7	19.3	6.6	0.7		82
V–440	20–33	NAA–587	4.6	3.0	19.7	5.9	1.3		82
V–441	20–39	NAA–588	2.8	2.1	19.4	3.3	0.8		82
V–442	16–24	NAA–605	5.4	2.6	21.5	2.9	0.8		24
V–443	16–24	NAA–602	4.7	1.9	18.5	2.5	0.8		24
V–444	17–24	NAA–603	5.3	3.3	18.6	5.4	0.7		24
V–445	17–26	NAH–401	3.3	3.1	21.2	11.9	0.9		24
V–446	15–26	NAF–512	3.1	2.0	18.3	1.5	0.9		24
V–447	19–26	NAF–513	5.5	2.6	18.3	2.7	1.0		24
V–448	16–28	NAF–514	3.6	1.4	19.8	2.1	1.1		24
V–449	19–28	NAB–993	4.7	3.0	17.4	5.0	0.9		24
V–450	17–24	NAB–996	7.4	5.7	20.5	8.0	1.0		6
V–451	14–24	NAB–997	3.1	1.8	20.8	1.9	0.9		14
V–452	14–20	NAB–998	3.1	1.7	20.4	1.7	1.6		6
V–453	13–20	NAP–308	2.7	1.4	18.9	1.8	1.1		8
V–454[e]									
V–455	13–19	NAF–119	2.4	1.4	18.2	2.2	0.7		6
V–456	13–17	NAF–120	1.5	1.0	20.1	1.2	1.3		10
V–457	16–17	NAF–121	1.5	1.1	17.4	2.1	1.1		6
V–458	16–24	NAF–122	4.8	4.2	21.1	7.5	<0.2		55
V–459	17–43	NAF–123	5.0	4.4	23.2	4.6	1.2		20
V–460	17–22	NAF–124	2.3	1.5	20.9	1.7	0.9		12
V–461	14–221	NAF–125	1.6	1.6	21.0	1.8	0.7		10
V–462	14–19	NAF–126	1.2	1.8	22.1	2.0	1.1		6
V–463	16–19	NAF–279	2.9	1.5	22.0	1.1	1.1		6
V–464	16–17	NAF–280	1.9	1.6	11.1	1.6	0.9		8
V–465	14–20	NAF–281	3.4	1.4	22.2	2.0	<0.2		13
V–466	17–24	NAF–282	3.9	2.0	22.0	2.5	1.1		9
V–467	19–24	NAF–283	4.8	3.9	23.7	4.8	<0.2		10
V–468	17–20	NAF–284	2.3	2.5	22.9	3.8	<0.2		12
V–469	17–24	NAF–285	1.6	1.8	23.1	2.3	1.0		12
V–470	17–20	NAF–286	1.7	2.0	23.3	2.7	0.8		12
V–471	17–24	NAF–287	1.5	1.7	24.2	2.9	1.0		6
V–472	19–24	NAF–288	<1.0	1.6	22.4	3.5	0.8		6
V–473	17–24	NAF–289	1.2	1.4	24.5	1.7	0.7		12

[e]Interior area—no soil sample was collected.

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g)						Average Depth of Excavation (inches)
			Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	
V–474	19–24	NAF–290	2.2	2.5	23.8	4.0	<0.2		6
V–475	19–24	NAF–291	2.0	2.2	23.9	3.0	1.4		6
V–476	17–24	NAF–292	3.2	1.2	21.4	1.3	1.0		16
V–477	14–24	NAF–293	2.5	1.4	19.2	3.5	1.0		10
V–478	17–24	NAF–294	3.9	2.7	18.5	5.2	1.2		14
V–479	17–24	NAF–295	1.7	1.2	19.9	2.4	1.1		12
V–480	17–24	NAF–296	3.5	2.8	18.3	4.4	1.2		12
V–481	16–20	NAF–297	3.5	2.8	19.0	5.0	1.2		6
V–482	17–24	NAF–298	1.2	2.4	18.5	8.1	0.9		19
V–483[f]									
V–484	19–24	NAF–300	1.9	2.1	18.6	6.1	1.0		15
V–485	16–24	NAH–418	3.6	3.5	17.7	3.0	1.3		6
V–486	14–20	NAF–301	2.2	1.3	19.7	1.0	1.4		8
V–487	17–24	NAP–136	1.4	1.5	18.6	1.7	1.0		23
V–488	14–24	NAP–137	2.3	1.9	17.5	3.3	0.8		9
V–489	14–20	NAP–138	2.9	2.4	18.5	4.1	1.0		10
V–490	14–19	NAP–139	1.6	1.7	20.5	2.2	1.0		11
V–491	14–19	NAP–140	1.9	1.2	18.1	1.3	1.5		6
V–492	17–24	NAP–141	1.8	1.4	18.0	1.7	1.3		46
V–493	14–20	NAP–142	1.8	1.4	18.9	2.5	0.9		28
V–494	14–20	NAP–143	3.7	1.3	20.8	1.6	1.2		6
V–495	14–19	NAP–309	1.3	1.4	24.1	2.8	1.1		8
V–496	19–24	NAE–309	5.9	4.9	22.9	9.1	0.7		36
V–497	20–24	NAE–310	5.5	3.5	23.6	4.6	<0.2		24
V–498	14–26	NAO–779	2.2	2.5	26.5	4.5	1.2		47
V–499	13–26	NAO–793	3.8	4.7	19.4	11.4	1.1		82
V–500	17–24	NAO–785	1.6	1.7	21.2	2.0	1.1		48
V–501	16–24	NAO–787	1.5	1.8	22.4	2.4	1.3		48
V–502	13–24	NAO–788	2.0	1.8	22.5	3.3	1.0		47
V–503	13–20	NAO–796	2.2	3.1	17.6	8.9	0.8		47
V–504	13–28	NAO–792	2.8	3.8	22.0	5.3	1.5		45
V–505	13–24	NAO–797	2.5	2.2	19.6	4.5	1.1		82
V–506	13–19	NAQ–358	1.7	1.4	19.3	2.4	1.2		82
V–507	13–19	NAO–799	3.4	4.0	19.6	8.9	1.1		45
V–508	14–24	NAP–311	3.8	3.5	15.8	4.9	0.8		82
V–509	13–16	NAO–802	6.3	2.8	20.1	6.8	1.0		54
V–510	13–18	NAO–801	2.5	3.0	20.2	9.6	1.1		82
V–511	13–19	NAO–803	6.6	2.5	19.2	7.5	1.0		60
V–512	13–19	NAQ–359	6.1	1.9	17.9	3.2	1.0		54
V–513	13–32	NAO–345	3.7	5.5	19.6	7.3	<0.1		10
V–514	13–16	NAO–346	1.7	3.7	19.9	1.9	1.3		6
V–515	14–18	NAO–347	2.1	3.7	19.1	2.0	<0.1		8
V–516	14–19	NAO–348	1.6	3.6	20.7	1.7	1.4		8
V–517	15–19	NAO–349	1.0	3.4	20.7	2.2	<0.1		8

[f]Additional excavation was required, reverified as V–674.

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g) Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	Average Depth of Excavation (inches)
V–518	19–23	NAQ–525	3.0	2.6	16.7	3.0	1.5		48
V–519	16–23	NAO–350	2.0	2.9	17.5	3.4	<0.1		41
V–520	15–25	NAO–351	2.4	2.6	26.3	6.4	<0.1		48
V–521	15–23	NAO–352	1.6	2.8	23.3	7.7	<0.1		48
V–522	16–21	NAO–353	4.1	2.7	15.8	4.0	1.0		24
V–523	16–21	NAO–354	4.3	2.8	18.2	5.3	1.0		24
V–524	15–24	NAP–608	2.6	2.6	23.2	4.7	<0.1		12
V–525	16–31	NAP–609	2.1	2.6	25.9	7.4	<0.1		68
V–526	17–40	NAP–610	2.6	3.3	23.3	10.0	<0.1		68
V–527	21–120	NAP–611	1.8	1.8	25.0	3.6	<0.1		68
V–528	17–44	NAP–612	1.4	1.6	19.8	3.8	1.2		68
V–529	21–78	NAP–613	1.3	1.1	22.0	1.6	1.0		68
V–530	19–66	NAP–614	2.2	2.1	18.5	4.0	0.8		68
V–531	20–104	NAP–615	1.3	1.7	21.2	2.9	1.2		68
V–532	18–20	NAP–616	2.2	1.7	20.2	2.5	1.2		6
V–533	18–21	NAP–155	2.2	3.1	18.5	3.2	1.0		48
V–534	12–16	NAP–617	1.7	3.8	18.5	2.4	1.3		24
V–535	12–16	NAP–618	1.7	3.6	17.9	1.9	1.0		26
V–536	12–16	NAP–619	2.5	3.7	16.4	1.5	0.9		24
V–537	12–16	NAP–620	2.8	4.3	16.6	1.8	1.4		25
V–538	12–16	NAP–621	2.3	4.0	18.2	1.6	1.2		28
V–539	12–16	NAP–622	1.1	4.2	18.6	1.6	0.7	16.5	24
V–540	12–16	NAP–623	1.0	3.8	18.8	1.9	1.3		24
V–541	14–16	NAR–572	<1.0	1.1	23.1	1.5	0.7		36
V–542	15–18	NAR–594	1.8	1.5	24.7	2.7	0.8		30
V–543	15–20	NAR–595	2.8	1.6	25.4	2.4	1.1		32
V–544	15–18	NAR–601	2.1	1.7	25.0	5.7	1.4		30
V–545	13–17	NAP–624	2.5	1.7	17.9	3.0	0.8		42
V–546	13–17	NAP–625	2.6	1.0	17.9	1.3	1.4		36
V–547	14–17	NAR–604	1.1	1.1	18.8	1.1	0.8		35
V–548	13–16	NAR–605	1.6	1.0	19.0	1.4	0.7		36
V–549	18–23	NAP–156	2.6	1.3	21.7	0.7	0.6		38
V–550	18–25	NAP–157	2.0	1.3	21.1	4.3	1.3		38
V–551	16–23	NAP–159	1.2	1.3	17.8	2.0	0.9		72
V–552	16–25	NAP–160	1.7	1.1	18.1	1.1	0.9		72
V–553	13–25	NAR–620	3.4	3.4	16.2	2.8	<0.1		24
V–554	13–23	NAR–621	2.8	2.3	15.1	4.4	<0.2		24
V–555	13–23	NAR–622	1.5	1.5	13.8	<1.3	0.8		24
V–556	13–21	NAR–623	3.7	2.2	15.0	4.2	0.8		24
V–557	13–23	NAR–624	1.8	1.3	14.0	1.8	0.8		24
V–558	13–23	NAR–625	3.6	2.0	14.9	2.9	1.0		24
V–559	13–23	NAR–626	2.1	2.3	13.2	2.8	0.9		24
V–560	13–21	NAR–627	1.9	2.5	15.3	4.1	1.2		24
V–561	13–21	NAR–628	<1.0	0.6	9.0	0.9	0.7		18
V–562	15–19	NAR–629	6.5	4.2	12.0	1.7	0.6		12

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g)						Average Depth of Excavation (inches)
			Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	
V–563	13–18	NAR–766	2.3	1.0	16.4	1.2	1.1		72
V–564	15–18	NAR–767	2.7	1.0	17.3	1.4	1.0		72
V–565	15–18	NAR–768	1.9	2.0	17.9	2.5	1.1		72
V–566	18–21	NAP–626	4.0	2.3	19.1	5.3	0.7		36
V–567	16–19	NAR–630	2.2	0.9	16.4	2.1	0.9		36
V–568	16–19	NAR–631	1.3	1.0	17.5	<2.4	0.9		36
V–569	15–18	NAR–606	1.9	1.9	24.0	4.6	<0.2		36
V–570	14–22	NAR–607	1.2	1.2	22.4	1.7	<0.2	27.5	40
V–571	13–21	NAR–608	1.1	1.1	24.9	0.7	1.1		40
V–572	14–20	NAR–159	1.2	1.2	23.9	2.3	1.3		48
V–573	14–19	NAR–160	<1.0	1.1	17.5	1.3	1.0		48
V–574	15–19	NAR–161	1.7	0.8	19.5	1.1	1.0		78
V–575	15–20	NAR–162	3.5	2.2	19.8	5.5	<0.2		48
V–576	15–20	NAR–163	2.3	1.5	18.6	3.2	1.3		24
V–577	15–18	NAR–164	3.2	1.5	19.0	6.8	1.4		24
V–578	12–21	NAR–165	1.5	2.3	20.1	4.6	1.0		36
V–579	16–19	NAU–062	1.1	1.6	19.3	1.9	1.4		48
V–580	15–18	NAU–063	1.5	1.9	18.0	2.8	1.4		36
V–581	15–18	NAU–064	1.1	1.4	16.8	2.1	1.4		42
V–582	15–18	NAU–065	1.6	1.3	18.3	1.4	1.4		42
V–583	15–19	NAR–633	1.4	1.4	17.8	1.6	1.5		42
V–584	15–20	NAU–137	1.1	1.5	16.5	0.8	1.1		24
V–585[g]	14–19	NAU–138	1.1			<0.8			24
V–586[h]	15–16	N/A–contaminated pipes							48
V–587[h]	14–19	N/A–contaminated pipes							60
V–588	15–19	NAU–139	3.7	2.1	17.5	<1.1	1.3		42
V–589	15–17	NAU–140	1.4	1.7	17.2	1.2	1.1		24
V–590	15–42	NAV–822	2.6	2.2	29.0	3.7	1.7		42
V–591	15–32	NAV–823	4.1	3.1	<6.7	5.2	1.0		43
V–592	15–25	NAV–824	3.6	3.1	<8.0	6.2	<4.4		44
V–593	15–25	NAV–825	6.7	5.7	<114.0	14.2	1.1		42
V–594	13–21	NAV–826	2.8	3.4	26.6	7.4	1.4		36
V–595	14–18	NAV–833	1.9	1.7	28.6	1.8	1.2		24
V–596	13–21	NAV–827	2.6	2.6	<5.6	6.0	<6.6		36
V–597	15–19	NAV–828	1.5	1.7	<6.7	2.4	<4.1		48
V–598	13–25	NAU–236	2.6	2.0	<7.2	2.4	1.2		72
V–599	14–18	NAV–829	2.8	1.9	18.1	1.7	1.0		24
V–600	15–18	NAV–831	1.9	2.2	18.0	1.7	1.4		12
V–601[i]		N/A–contaminated concrete							0
V–602[j]		N/A–contaminated concrete							0
V–603	16–19	NAU–239	2.9	1.9	18.1	4.2	1.6		20

[g]Th-230 occurrences—no Ra-226 contamination.

[h]Piping with contamination on exterior—soils were included in V–160 and V–247.

[i]Contaminated concrete transformer pad—contaminant levels did not exceed release standards (see page 15).

[j]Contaminated concrete retaining wall—contaminant levels did not exceed release standards (see page 15).

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g) Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	Average Depth of Excavation (inches)
V–604	15–20	NAU–240	2.7	1.2	17.1	1.5	1.3		48
V–605	15–19	NAU–241	1.3	1.8	18.3	2.4	1.4		10
V–606	15–19	NAU–242	1.5	1.6	21.5	1.6	1.3		40
V–607	15–19	NAU–243	1.4	1.7	19.2	4.6	<6.5		50
V–608	16–19	NAU–141	3.8	1.5	26.0	2.9	1.2		6
V–609	15–20	NAU–142	4.1	2.2	24.7	5.9	1.1		6
V–610	16–20	NAU–143	2.7	1.7	25.9	3.9	1.0		6
V–611	15–19	NAU–148	1.9	1.4	24.7	3.3	1.2		48
V–612[k]	36–51	NAU–149	35.5	29.3	25.1	42.6	1.2		52
V–613	13–23	NAU–151	3.5	2.3	27.0	5.3	1.0		24
V–614	15–23	NAU–150	3.3	2.7	24.9	4.2	1.1		23
V–615[l]		N/A–contaminated concrete							0
V–616	15–21	NAW–389	4.6	3.6	24.6	6.3	0.9		15
V–617	15–21	NAT–857	1.8	3.4	26.1	5.3	1.1		12
V–618	15–21	NAT–858	3.8	4.3	24.4	6.6	1.0		12
V–619	18–20	NAW–391	2.6	2.3	17.1	5.6	1.5		18
V–620	15–19	NAW–392	2.1	1.6	17.7	2.8	1.2		100
V–621	15–21	NAW–393	1.2	1.7	17.9	1.8	1.3		100
V–622	15–23	NAW–394	1.4	1.6	18.3	2.1	1.4		90
V–623	13–22	NAW–396	2.0	2.8	19.3	5.4	1.5		85
V–624	13–21	NAW–397	1.2	1.7	20.7	2.9	1.4		96
V–625	14–21	NAW–398	1.7	1.8	21.4	5.1	1.5		84
V–626	15–19	NAW–399	1.9	2.0	17.2	2.0	1.4		100
V–627	15–25	NAW–400	2.4	4.4	20.1	9.9	1.1		84
V–628	14–25	NAW–401	2.1	2.8	22.2	12.9	1.4		84
V–629	15–30	NAW–517	2.9	3.8	23.5	16.4	1.3		55
V–630	18–20	NAW–514	1.7	1.7	20.9	2.3	1.0		84
V–631	18–20	NAW–515	4.0	2.2	22.1	3.4	1.2		96
V–632	18–20	NAW–516	2.5	1.6	21.0	2.6	1.1		108
V–633	17–19	NAV–837	1.7	1.6	20.7	1.7	1.1		24
V–634	15–18	NAW–405	<1.0	1.3	21.4	1.2	1.3		24
V–635	15–18	NAW–406	1.6	1.5	21.4	2.5	1.4		24
V–636	13–16	NAW–407	1.4	1.4	22.2	2.5	1.1		24
V–637	14–18	NAW–408	1.7	1.6	20.6	3.0	1.5		24
V–638	14–18	NAW–409	1.5	1.5	19.7	2.1	1.1		27
V–639[m]		N/A–backfill sample							
V–640[m]		N/A–backfill sample							
V–641[m]		N/A–backfill sample							
V–642	10–25	NAW–413	6.1	2.5	<8.4	13.4	1.3		55
V–643	12–17	NAY–341	1.6	3.8	23.6	4.6	2.9		55
V–644[n]		NAY–342	2.3	3.0	17.7	54.0	1.2		

[k]Contamination was left in place and area-averaged. Average Ra-226 and Th-230 concentrations are 2.6 pCi/g and 4.6 pCi/g, respectively.

[l]Contaminated concrete retaining wall—contaminant levels did not exceed release standards (see page 15).

[m]Samples of uncontaminated material were collected to demonstrate that the material was suitable for use as backfill.

[n]Th-230 exceeded standards. Additional material was excavated, reverified as V–660.

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (µR/h)	Soil Sample Ticket No.	Concentration (pCi/g)						Average Depth of Excavation (inches)
			Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	
V–645	14–21	NAY–347	3.3	4.1	25.2	3.3	2.9		30
V–646	13–18	NAY–349	2.2	3.1	24.6	2.8	2.9		12
V–647	13–16	NAY–350	<1.0	3.1	25.7	2.8	3.1		12
V–648	15–21	NAY–351	2.1	1.5	19.8	3.2	1.4		30
V–649	15–18	NAY–352	1.2	1.1	20.2	2.7	1.2		18
V–651	16–22	NAY–354	<1.0	1.2	20.8	2.3	1.3		30
V–650	15–18	NAY–353	1.5	1.5	18.4	4.0	1.0		12
V–652[o]		N/A–contaminated concrete							
V–653[o]		N/A–contaminated concrete							
V–654	18–22	NBA–468	1.9	1.6	20.5	8.3	0.9		18
V–655[p]	14–21	NAY–365	2.3	0.6	10.4	3.6	<0.03		
V–656	15–21	NCB–277	1.6	<0.01	12.8	1.7	<0.03		72
V–657	15–22	NCB–278	1.1	<0.01	13.8	2.2	<0.02		84
V–658	15–19	NCB–279	1.2	<0.01	13.7	1.4	<0.03		84
V–659	15–19	NCB–280	<1.0	<0.03	16.0	2.1	<0.03		84
V–660	13–18	NCA–701	1.2	1.3	25.1	6.2	1.1		79
V–661[q]	20–28	NCB–281	19.1	16.7	23.1	21.0	1.4	27.3	12
V–662[r]	19–27	NCB–282	21.0	29.2	30.5	36.0	1.2	29.7	12
V–663	14–25	NCB–284	2.7	3.1	22.8	7.1	1.6		96
V–664	12–20	NCB–285	1.5	1.9	21.8	1.7	<7.48		72
V–665	14–21	NCA–702	2.0	1.7	27.1	2.0	1.8		16
V–666	14–20	NCA–703	1.1	1.6	30.3	0.6	1.7		16
V–667	14–19	NCA–704	1.4	1.6	27.8	1.6	1.6		16
V–668	13–19	NCB–287	1.3	1.6	<64.9	3.3	1.5		24
V–669	13–19	NCB–288	1.7	0.3	<22.3	1.8	0.4		24
V–670	15–18	NCA–706	1.1	<0.01	16.6	1.7	<0.02		64
V–671	15–19	NCA–707	1.6	<0.12	16.7	4.8	<0.02		64
V–672	15–21	NCA–708	1.9	0.7	15.7	6.9	<0.02		64
V–673	15–18	NCA–709	1.4	<0.01	15.3	1.4	<0.02		64
V–674	16–19	NCB–291	1.7	1.7	25.8	1.5	1.5		22
V–675	13–19	NCE–287	3.3			1.1		3.4	18
V–676	13–18	NCE–288	1.9			1.1		4.5	18
V–677	13–25	NCE–289	2.2			1.6		4.7	20
V–678	13–16	NCE–290	2.8			1.3		3.2	36
V–679	13–15	NCE–291	2.9			1.9		6.4	10
V–680	12–15	NCE–292	3.0			1.0		2.7	10
V–681	13–16	NCF–296	1.6			1.5		3.8	12
V–682	13–16	NCF–290	2.6			1.2		4.8	21
V–683	13–16	NCF–291	2.6			1.4		4.2	12
V–684	13–17	NCF–292	2.5			1.2		4.3	12

[o]Contaminated concrete transformer pad—contaminant levels did not exceed release standards.

[p]This area was subsequently reverified during remediation of the dike at the northwest corner of the DOE–GJPO facility.

[q]Contamination was left in place and area-averaged. Average Ra-226 and Th-230 concentrations are 2.1 pCi/g and 2.6 pCi/g, respectively.

[r]Contamination was left in place and area-averaged. Average Ra-226 and Th-230 concentrations are 2.2 pCi/g and 2.8 pCi/g, respectively.

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (µR/h)	Soil Sample Ticket No.	Concentration (pCi/g)						Average Depth of Excavation (inches)
			Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	
V–685	13–17	NCF–293	3.4	2.5	16.9	1.7	1.4	4.3	21
V–686	14–18	NCF–294	3.0			1.7		4.9	21
V–687	13–17	NCF–295	3.5			3.3		9.3	12
V–688	13–18	NCF–297	2.2			1.3		4.4	30
V–690	13–16	NCF–299	1.5			1.2		5.6	48
V–691	13–16	NCF–300	1.4			1.8		4.8	48
V–692	13–16	NCF–301	1.9			1.4		2.7	48
V–693	13–16	NCE–294	2.2			4.1		4.5	24
V–689	14–18	NCF–298	2.2			2.4		6.0	30
V–694	13–16	NCE–295	2.9			7.4		3.9	96
V–695	13–16	NCE–296	2.7	1.7	16.8	3.9	1.4	11.7	96
V–696	13–17	NCE–297	2.9			5.2		3.6	84
V–697	13–18	NCE–298	2.2			7.8		3.6	96
V–698	13–17	NCE–299	2.6			3.2		3.0	60
V–699	13–16	NCE–300	2.3			1.2		2.5	84
V–700	14–19	NCE–301	3.0			2.7		3.9	18
V–701[s]									
V–702	14–18	NCE–303	1.8			6.3		5.2	36
V–703	14–16	NCE–304	1.7			1.5		3.0	24
V–704	14–16	NCE–305	1.9			2.4		3.8	30
V–705	14–19	NCE–306	2.2	1.4	18.5	3.4	1.2	6.5	36
V–706	14–16	NCE–307	1.9			1.5		3.1	24
V–707	13–16	NCE–308	2.2			1.4		2.6	24
V–708	13–16	NCE–348	2.1			6.8		4.5	60
V–709	14–17	NCE–349	3.1			7.7		7.8	54
V–710	13–16	NCE–309	2.6			2.2		3.0	36
V–711	14–17	NCE–310	2.0			1.6		2.5	27
V–712	14–19	NCE–314	3.0			5.6		8.7	42
V–713	13–16	NCE–311	2.7			1.5		2.5	24
V–714	14–16	NCE–312	2.3			1.5		3.4	36
V–715	14–16	NCE–313	3.0			1.9		4.4	48
V–716	13–16	NCE–315	2.3			2.3		3.3	60
V–717	14–16	NCE–316	3.4	1.6	17.0	5.2	1.0	5.0	48
V–718	14–16	NCE–317	2.8			3.2		10.7	36
V–719	14–16	NCE–318	2.8			2.8		3.9	24
V–720	14–16	NCE–319	3.0			7.3		12.1	48
V–721	14–16	NCE–320	3.1			6.3		6.3	66
V–722	14–16	NCE–321	3.3			4.0		4.9	60
V–723	14–19	NCE–322	3.9			3.4		6.9	54
V–724	13–16	NCE–323	2.4			4.5		5.2	54
V–725	14–16	NCE–324	3.3			4.2		4.5	60
V–726	14–16	NCE–325	1.5			1.1		2.8	68
V–727	14–16	NCE–326	3.1	1.6	18.8	1.6	1.4	2.8	30
V–728	13–16	NCE–327	2.4			2.2		4.0	68

[s]Additional excavation was required, reverified as V–1069.

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g) Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	Average Depth of Excavation (inches)
V–729	13–16	NCE–328	2.6			2.3		4.7	60
V–730	13–16	NCE–329	2.1			5.0		4.7	60
V–731	13–16	NCE–330	3.3			3.8		12.3	30
V–732	15–18	NCE–331	3.3			8.8		5.7	48
V–733	15–18	NCE–332	3.3			10.8		5.0	72
V–734	14–17	NCE–333	3.0			6.2		6.6	60
V–735	14–16	NCE–334	1.7			2.4		5.2	42
V–736	13–19	NCE–335	4.9			2.2		7.3	60
V–737	13–16	NCE–336	1.8	1.6	18.3	0.9	1.6	3.7	74
V–738	14–18	NCE–337	4.3			3.3		4.1	60
V–739	14–16	NCE–338	2.8			1.6		2.8	30
V–740	13–16	NCE–339	2.2			0.8		2.9	24
V–741	14–16	NCE–340	2.6			1.0		3.0	27
V–742	14–18	NCE–341	2.8			1.5		3.5	30
V–743	14–19	NCE–342	2.2			7.2		4.7	38
V–744	14–17	NCE–343	3.4			5.4		3.6	60
V–745	13–17	NCE–344	2.4			2.0		6.3	42
V–746	13–16	NCE–345	3.3			2.7		3.0	48
V–747	13–18	NCE–346	3.6	2.0	18.3	1.9	1.4	2.4	48
V–748	13–17	NCE–347	2.8			2.3		2.5	48
V–749	13–16	NCE–350	3.4			1.4		2.4	120
V–750	13–16	NCE–351	1.8			0.9		2.1	36
V–751	13–16	NCE–352	3.0			0.7		2.0	12
V–752	13–16	NCE–353	2.5			1.0		2.5	48
V–753	13–17	NCE–354	2.4			1.6		2.7	15
V–754	13–17	NCE–355	2.0			1.9		3.5	19
V–755	15–19	NCE–356	4.2	3.4	16.0	2.9	1.3	5.0	48
V–756	15–19	NCE–360	3.8			2.8		8.8	48
V–757	13–17	NCE–361	1.2			1.3		5.8	54
V–758	14–17	NCE–362	4.2			2.8		4.5	48
V–759	15–19	NCE–363	2.7			1.8		5.8	78
V–760	15–19	NCE–364	4.5			3.8		6.4	48
V–761	14–16	NCE–365	2.0			3.2		3.7	27
V–762	13–16	NCE–366	1.8	1.6	17.9	2.5	1.0	3.1	24
V–763	13–16	NCE–357	1.8			0.9		3.5	36
V–764	13–15	NCE–358	2.1			1.0		3.0	8
V–765	13–16	NCE–359	2.2			2.0		4.1	24
V–766	14–17	NCE–367	3.5			1.2		2.7	12
V–767	13–17	NCE–371	2.9			2.3		3.3	24
V–768	14–19	NCE–372	4.2			4.4		4.6	36
V–769	14–18	NCE–373	3.4			2.5		6.5	50
V–770	14–17	NCE–374	3.4			2.7		5.0	54
V–771	14–19	NCE–375	2.2			1.9		4.1	42
V–772	13–16	NCA–601	4.0	1.9	17.7	2.5	1.2	4.0	28
V–773	13–16	NCA–602	3.7			2.8		3.8	44

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g)						Average Depth of Excavation (inches)
			Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	
V–774	14–18	NCE–368	3.2			1.9		3.4	64
V–775	15–19	NCE–369	3.3			2.2		3.8	30
V–776	14–17	NCE–370	3.2			2.3		3.2	24
V–777	14–16	NCA–603	2.2			1.5		3.8	48
V–778	13–16	NCA–604	2.8			1.4		4.1	36
V–779	13–16	NCA–605	2.9			2.8		4.3	64
V–780	13–16	NCA–609	4.2			2.6		11.6	30
V–781	13–16	NCA–606	3.3			2.1		4.2	28
V–782	13–15	NCA–607	2.3			1.0		2.8	30
V–783	13–16	NCA–611	2.1	1.8	18.2	1.6	1.3	3.9	36
V–784	13–16	NCA–610	2.2			2.3		5.0	66
V–785	13–16	NCA–608	2.2			1.8		3.6	43
V–786	14–16	NCA–612	2.2			1.4		4.2	30
V–787	14–19	NCA–613	1.6			1.2		2.7	30
V–788	13–15	NCA–614	2.6			1.0		3.0	30
V–789	13–17	NCA–615	2.4			1.3		2.8	28
V–790	13–16	NCA–619	2.1			0.9		4.1	36
V–791	13–15	NCA–620	1.4			0.9		4.1	24
V–792	13–15	NCA–621	1.0			0.8		5.5	30
V–793	12–14	NCA–622	1.9	1.4	14.4	0.9	1.0	4.9	24
V–794	13–15	NCA–623	2.3			0.7		4.1	20
V–795	13–14	NCA–624	1.7			0.8		3.8	24
V–796	14–19	NCA–625	2.8			0.9		3.8	24
V–797	13–17	NCA–626	1.8			0.8		4.5	24
V–798	13–15	NCA–627	2.1			0.6		4.0	20
V–799	13–16	NCA–628	1.8			0.7		4.1	18
V–800	13–15	NCA–629	2.2			0.8		3.7	18
V–801	13–15	NCA–630	1.9			0.8		3.8	20
V–802	13–16	NCA–631	3.9			1.3		4.7	16
V–803	13–19	NCA–632	4.1	2.2	16.0	1.4	0.9	4.1	18
V–804	13–15	NCA–633	2.8			0.8		4.1	18
V–805	13–15	NCA–634	2.6			0.8		3.8	20
V–806	13–15	NCA–635	3.4			0.8		3.8	24
V–807	13–15	NCA–636	2.9			1.0		4.2	28
V–808	13–16	NCA–637	3.0			0.7		4.4	18
V–809	13–15	NCA–638	2.4			0.8		4.3	12
V–810	13–16	NCA–639	2.7			1.0		4.3	18
V–811	13 μR/h	NCA–640	3.9			1.5		5.5	28
V–812	12–15	NCA–642	2.2			1.1		4.2	12
V–813	12–14	NCA–643	2.5	1.4	30.1	1.1	1.2	3.4	6
V–814	12–14	NCA–644	2.8			–0.98		2.9	9
V–815	12–14	NCA–645	1.7			1.0		3.5	12
V–816	12–15	NCA–646	1.3			1.1		3.6	12
V–817	12–14	NCA–647	1.6			–0.85		3.1	12
V–818	12–15	NCA–648	1.5			1.1		3.8	12

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g) Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	Average Depth of Excavation (inches)
V–819	12–15	NCA–649	<1.0			~0.82		4.2	9
V–820	12–15	NCA–650	1.8			1.3		3.7	36
V–821	12–15	NAY–116	2.7			1.1		3.4	36
V–822	12–15	NAY–117	2.8			~0.86		3.8	36
V–823	12–14	NAY–118	1.5	1.6	29.2	1.2	1.6	3.3	12
V–824	12–15	NAY–119	2.9			1.4		5.2	12
V–825	12–14	NAY–120	2.5			~0.88		2.5	24
V–826	12–15	NAY–121	2.0			1.0		2.3	26
V–827	12–14	NAY–122	2.6			~0.88		2.9	24
V–828	12–13	NAY–123	2.6			1.1		6.0	40
V–829	12–15	NAY–124	3.1			1.1		4.5	36
V–830	12–15	NAY–125	2.1			1.3		3.7	48
V–831	12–17	NAY–805	1.0			2.1		4.3	18
V–832	13–16	NAY–806	1.8			1.8		7.5	12
V–833	12–15	NAY–807	1.8			1.4		4.3	18
V–834	13–15	NAY–808	1.6			2.0		4.4	48
V–835	12–15	NAY–130	1.6			1.3		5.4	48
V–836	12–15	NAY–131	1.1			1.2		3.4	54
V–837	12–15	NAY–132	2.1	1.7	32.0	~0.85	2.1	3.2	60
V–838	12–15	NAY–133	1.1			~0.95		2.9	36
V–839	12–15	NAY–134	2.5			~0.96		3.4	30
V–840	12–16	NAY–135	2.4			1.2		4.0	42
V–841	12–16	NAY–136	2.5			1.1		3.7	50
V–842	13–19	NAY–809	3.2			2.8		5.6	42
V–843	13–15	NAY–810	2.1			2.5		6.9	42
V–844	12–15	NAY–137	0.9			1.6		4.4	30
V–845	13–15	NAY–811	1.8			1.7		18.8	24
V–846	12–15	NAY–812	1.9			1.6		10.1	60
V–847	13–15	NAY–813	2.2	2.1	33.3	1.6	2.0	3.5	48
V–848	12–15	NAY–138	1.5			1.3		5.1	48
V–849	12–15	NAY–139	4.1			~0.99		3.6	34
V–850	12–17	NAY–140	3.9			1.0		3.3	36
V–851	12–15	NAY–791	2.6			~0.75		3.2	28
V–852	12–15	NAY–792	3.0	2.0	35.4	1.0	<0.52	4.2	19
V–853	12–15	NAY–793	3.7			1.0		2.9	15
V–854	12–14	NAY–794	3.4			1.1		3.8	15
V–855	13–20	NAY–795	3.7			~0.97		3.0	30
V–856	12–15	NAY–796	3.3			~0.84		3.4	36
V–857	12–15	NAY–797	3.9			1.7		6.0	36
V–858	13–15	NAY–814	1.7			2.0		4.1	48
V–859	12–13	NAY–815	2.6			1.9		3.2	48
V–860	12–15	NAY–817	1.6			1.6		3.2	42
V–861	12–15	NAY–818	2.6			1.5		8.7	24
V–862	13–15	NAY–798	3.1			1.1		3.6	54
V–863	12–16	NAY–819	<1.0			1.5		4.1	54

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g) Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	Average Depth of Excavation (inches)
V–864	12–15	NAY–820	1.5			1.6		3.2	76
V–865	12–15	NAY–799	3.1			1.1		4.1	36
V–866	13–17	NAY–800	3.2			1.1		4.3	32
V–867	13–17	NAY–801	4.1			1.5		4.5	32
V–868	12–15	NAY–802	2.9			1.6		4.5	30
V–869	12–15	NAY–803	1.9	1.9	31.4	1.0	1.8	3.0	54
V–870	12–15	NAY–804	3.1			1.0		2.7	66
V–871[t]		NAY–821						4.1	54
V–872	13–17	NAY–825	2.2			1.5		2.6	68
V–873	12–16	NAY–826	2.2			1.5		6.0	32
V–874	13–18	NAY–827	2.0			1.2		4.7	30
V–875	12–15	NAY–828	2.0	1.0	16.9	1.4	1.0	3.7	32
V–876	13–17	NAY–829	2.1			1.1		3.6	36
V–877	14–18	NAY–830	2.1			~0.78		3.0	54
V–878	13–16	NAY–831	1.5			1.4		4.5	36
V–879	13–17	NAY–832	2.3			1.6		6.0	31
V–880	14–19	NAY–833	2.5			1.0		4.3	33
V–881	12–15	NAY–834	3.0			~0.85		4.5	48
V–882	13–16	NAY–835	1.6			~0.82		3.1	42
V–883	13–15	NAY–836	1.6			1.2		4.0	30
V–884	13–15	NAY–837	3.3			~0.79		3.8	36
V–885	14–18	NAY–838	2.3	1.0	16.8	~0.76	0.9	2.7	42
V–886	12–15	NAY–839	2.0			1.3		4.1	42
V–887	12–15	NAY–840	2.5			1.1		3.4	42
V–888	12–15	NCB–403	1.6			~0.81		3.0	48
V–889	13–15	NCB–404	2.4			~0.72		2.6	30
V–890	12–15	NCB–405	3.1			1.1		3.7	36
V–891	12–15	NCB–406	3.6			1.2		3.4	30
V–892	12–15	NCB–407	3.1			~0.73		4.3	48
V–893	13–16	NCB–408	2.7			2.8		6.8	42
V–894	13–16	NCB–409	2.5			1.1		3.4	36
V–895	12–14	NCB–410	3.4	1.2	17.5	~0.94	1.3	3.2	36
V–896	13–18	NCB–411	1.9			1.1		3.2	40
V–897	13–18	NCB–412	2.7			~0.89		4.0	54
V–898	13–15	NCB–413	2.4			1.1		3.4	39
V–899	12–15	NCB–414	3.2			2.0		6.9	36
V–900	13–15	NCB–415	3.3			1.2		4.0	39
V–901	13–15	NCB–416	3.2			1.0		3.2	48
V–902	12–15	NCB–417	1.6			~0.78		2.7	48
V–903	12–13	NCB–418	2.9			~1.0		4.9	40
V–904	12–14	NCB–419	2.7			1.4		4.4	37
V–905	12–14	NCB–420	2.4	1.3	16.3	1.0	1.0	3.6	36
V–906	12–15	NCB–421	2.4			1.4		5.2	40

[t]This area was verified for conformance of the uranium concentration to the hot-spot criteria and is superimposed on areas verified for compliance with standards and limits for other radionuclides.

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g) Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	Average Depth of Excavation (inches)
V–907	13–15	NCB–422	2.3			~0.77		4.3	68
V–908	12–14	NCB–423	2.0			1.7		4.1	36
V–909	12–14	NCB–424	2.5			1.0		2.2	60
V–910	13–16	NCB–425	2.5			1.2		3.7	48
V–911	12–14	NCB–426	2.7			1.3		2.7	12
V–912	12–14	NCB–502	2.0			~0.83		2.5	12
V–913	12–15	NCB–503	2.2			1.4		3.4	12
V–914	12–14	NCB–504	2.0			1.1		4.1	12
V–915	12–14	NCB–505	2.6	1.1	16.8	~0.99	1.4	3.3	12
V–916	12–14	NCB–506	3.2			1.6		8.9	18
V–917	12–16	NCB–507	<1.0			1.3		4.1	36
V–918	12–15	NCB–508	2.1			1.2		3.0	36
V–919	12–15	NCB–509	1.7			1.3		2.3	66
V–920	12–15	NCB–510	2.1			1.1		2.9	48
V–921	12–14	NCB–511	2.8			1.5		2.7	18
V–922	12–15	NCB–512	1.9			~0.94		2.5	48
V–923	12–15	NCB–513	2.7			1.6		3.0	24
V–924	12–14	NCB–514	2.7			1.6		3.0	24
V–925	12–15	NCB–515	3.8	1.5	17.0	1.1	1.5	2.9	18
V–926	12–14	NCB–516	3.2			1.1		3.0	18
V–927	12–15	NCB–517	1.5			~0.99		2.6	30
V–928	12–14	NCB–518	2.5			1.4		4.4	18
V–929	12–14	NCB–519	3.6			~0.70		3.4	18
V–930	12–15	NCB–520	2.1			~0.96		3.2	18
V–931	12–18	NCB–521	3.7			2.2		5.7	24
V–932	12–15	NCB–522	2.1			1.1		3.0	36
V–933	13–18	NCB–523	1.6			1.5		5.3	48
V–934	12–15	NCB–524	3.3			1.8		10.5	54
V–935	13–17	NCB–525	3.9	3.6	19.8	2.8	1.2	11.3	60
V–936	12–15	NCB–526	2.8			1.3		4.3	48
V–937	13–17	NAZ–467	3.1			1.1		2.5	54
V–938	13–15	NAZ–468	2.3			1.1		4.3	72
V–939	13–16	NAZ–469	3.7			2.0		8.2	74
V–940	12–19	NAZ–470	2.8			1.2		4.6	48
V–941[t]		NAZ–471						2.8	66
V–942	12–15	NAZ–475	2.8			1.3		5.4	72
V–943	12–15	NAZ–476	2.8			1.5		6.9	68
V–944	12–15	NAZ–477	2.6			~0.90		5.7	72
V–945[t]		NAZ–478						2.6	36
V–946	12–14	NAZ–482	1.4			1.2		4.5	68
V–947	12–15	NAZ–483	2.1	1.1	17.5	~0.89	1.2	3.7	72
V–948	12–14	NAZ–484	1.6			~0.64		3.4	68
V–949	13–15	NAZ–485	3.1	2.5	<14.5	1.5	<0.80	8.3	74

[t]This area was verified for conformance of the uranium concentration to the hot-spot criteria and is superimposed on areas verified for compliance with standards and limits for other radionuclides.

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g) Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	Average Depth of Excavation (inches)
V–950	13–16	NAZ–486	1.7			1.5		7.1	70
V–951	12–16	NAZ–487	2.4			~0.97		4.6	20
V–952	12–15	NAZ–488	1.6			1.3		5.5	28
V–953	12–15	NAZ–489	2.4			1.2		5.3	28
V–954	12–15	NAZ–490	2.3			1.2		5.2	36
V–955	12–15	NAZ–491	3.0			1.4		6.4	54
V–956	12–18	NCF–001	2.9			1.7		3.4	30
V–957	12–15	NCF–002	2.5			1.3		4.1	54
V–958	12–15	NCF–003	2.0			1.0		5.6	66
V–959	12–16	NCF–004	3.7	<0.65	<14.4	1.8	<1.17	4.7	60
V–960	12–15	NCF–005	2.7			1.6		3.3	40
V–961	12–15	NCF–006	2.5			1.7		3.8	36
V–962	12–15	NCF–007	2.9			2.3		3.8	42
V–963	12–15	NCF–008	1.7			1.2		4.7	48
V–964	12–15	NCF–009	1.9			1.5		5.5	48
V–965	12–15	NCF–010	2.7			1.5		4.7	54
V–966	12–16	NCF–011	2.3			1.3		5.6	60
V–967	12–16	NCF–012	3.3			1.7		8.1	60
V–968	12–15	NCF–013	3.1			2.1		7.4	60
V–969	13–16	NCF–014	1.9	3.4	<13.9	1.7	<0.70	5.4	68
V–970	13–19	NCF–015	4.5			1.7		4.4	56
V–971	13–16	NCF–016	2.5			1.7		5.2	48
V–972	12–15	NCF–017	1.9			1.9		12.2	48
V–973	12–16	NCF–018	3.2			2.2		5.6	48
V–974	12–15	NCF–019	3.6			2.4		8.4	24
V–975	12–15	NCF–020	3.2			1.5		5.8	46
V–976	12–18	NCF–021	3.3			2.5		4.3	66
V–977	13–15	NCF–022	2.8			2.0		5.7	72
V–978	14–18	NCF–023	3.0			1.6		4.7	60
V–979	14–17	NCF–024	4.1	3.8	<14.3	1.9	<0.75	7.8	54
V–980	12–15	NCF–025	2.4			1.4		8.9	60
V–981	12–15	NCF–026	2.5			1.4		7.0	60
V–982	12–15	NCF–027	2.0			1.5		5.8	60
V–983	12–16	NCF–028	3.5			1.5		3.9	60
V–984	12–16	NCF–029	1.7			1.7		4.0	60
V–985	12–16	NCF–030	3.1			2.0		3.0	66
V–986	12–16	NCF–031	2.9			1.8		4.6	60
V–987	12–15	NCF–032	1.9			1.3		4.6	72
V–988	12–16	NCF–033	2.0			1.2		4.0	60
V–989	12–16	NCF–034	1.9	<0.76	<13.8	1.3	4.1	5.3	66
V–990	12–15	NCF–035	2.6			2.1		5.4	72
V–991	13–18	NCF–036	2.7			1.8		4.7	72
V–992	12–15	NCF–037	2.6			1.5		3.2	78
V–993	12–16	NCF–038	3.2			3.3		4.1	68
V–994	13–17	NCF–039	2.7			2.2		5.0	42

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g) Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	Average Depth of Excavation (inches)
V–995[t]		NCF–040						3.8	78
V–996[t]		NCF–044						4.5	20
V–997	13–18	NCF–050	2.0			1.4		4.1	42
V–998	12–15	NCF–051	<1.0			1.1		4.5	42
V–999	12–14	NCF–052	2.2			1.6		5.5	36
V–1000	12–14	NCF–053	2.1			~0.92		3.7	36
V–1001	12–15	NCF–054	2.5	<0.65	<16.2	1.3	2.8	5.1	30
V–1002	14–16	NCF–055	3.5			1.3		7.2	66
V–1003	13–18	NCF–056	3.3			1.4		4.5	42
V–1004	12–15	NCF–057	3.3			1.2		5.2	42
V–1005	12–15	NCF–058	3.1			1.3		4.5	30
V–1006	12–16	NCF–059	1.8			1.2		3.3	27
V–1007	15–18	NCF–060	1.3			1.4		5.2	68
V–1008	15–121	NCF–061	1.7			1.2		3.0	60
V–1009[t]	12–14	NCF–062						7.2	63
V–1010	13–17	NCF–066	3.5			2.8		4.3	45
V–1011	12–15	NCF–067	2.2			1.0		2.8	26
V–1012	12–15	NCF–068	1.8			1.3		3.5	48
V–1013	12–16	NCF–069	1.3	<0.83	<16.5	1.2	2.7	3.4	54
V–1014	12–15	NCF–070	1.8			1.1		2.7	12
V–1015	12–15	NCF–071	1.0			1.1		3.8	28
V–1016	12–16	NCF–072	2.8			2.6		2.8	28
V–1017	12–15	NCF–073	1.4			1.2		2.8	12
V–1018	12–14	NCF–124	1.4			1.8		3.0	12
V–1019	12–15	NCF–126	2.2			1.2		7.4	36
V–1020	12–16	NCF–127	2.8			1.0		25.1	27
V–1021	13–17	NCF–128	3.9			1.9		4.5	18
V–1022	12–16	NCF–129	2.7			1.1		3.1	34
V–1023	12–15	NCF–130	3.0	2.3	<17.7	~0.98	0.6	3.8	38
V–1024	12–15	NCF–131	2.3			1.2		3.6	28
V–1025	13–18	NCF–132	3.1			1.2		4.4	28
V–1026	12–15	NCF–133	1.6			1.1		2.7	18
V–1027	12–15	NCF–134	3.4			1.9		8.0	24
V–1028	12–15	NCF–135	2.4			1.5		4.7	48
V–1029	12–16	NCF–136	2.1			1.3		12.0	54
V–1030	12–15	NCF–137	1.4			1.1		3.6	42
V–1031	12–15	NCF–138	2.2			~0.88		11.6	42
V–1032	13–15	NCF–139	2.5			1.2		4.1	54
V–1033	12–15	NCF–140	3.6	3.2	<13.9	1.2	2.9	3.5	66
V–1034	12–15	NCF–141	1.8			1.2		3.7	48
V–1035	12–15	NCF–142	2.5			1.2		4.0	32
V–1036	12–15	NCF–143	3.5			1.7		4.4	38
V–1037	12–15	NCF–144	1.9			1.5		4.7	48

[t]This area was verified for conformance of the uranium concentration to the hot-spot criteria and is superimposed on areas verified for compliance with standards and limits for other radionuclides.

Table D–1 (continued). Postexcavation Sampling and Measurement Results for Exterior Land Areas

Verification Area	Gamma Exposure Rate (μR/h)	Soil Sample Ticket No.	Concentration (pCi/g)						Average Depth of Excavation (inches)
			Ra-226 (OCS)	Ra-226 (lab)	K-40 (lab)	Th-230 (lab)	Th-232 (lab)	Total Uranium (lab)	
V–1038	12–15	NCF–145	2.5			1.3		3.9	48
V–1039	12–15	NCF–146	2.4			1.2		5.7	45
V–1040	13–18	NCF–147	3.8			2.4		4.7	42
V–1041	12–15	NCF–148	2.0			1.1		4.6	64
V–1042	12–15	NCF–304	3.1			1.6		5.2	36
V–1043	13–15	NCF–305	2.1	3.2	<14.8	1.4	4.0	3.0	36
V–1044	12–15	NCE–927	2.7			1.1		4.6	60
V–1045	12–14	NCF–099	2.4			1.1		3.0	18
V–1046	12–15	NCF–100	2.8			~0.99		2.1	18
V–1047	13–16	NCF–101	2.2			~0.69		2.2	18
V–1048	12–15	NCF–102	1.9			~0.88		2.6	18
V–1049	12–15	NCF–103	1.4			1.5		3.0	48
V–1050	13–18	NCF–104	2.0			4.9		5.0	36
V–1051	14–16	NCF–105	3.8			4.2		3.4	84
V–1052	14–17	NCF–106	2.6			~0.88		2.6	72
V–1053	13–15	NCF–107	2.0	3.4	<16.4	1.2	2.9	3.0	84
V–1054	12–16	NCF–109	2.4			1.2		3.2	48
V–1055	14–16	NCF–108	2.8			1.0		2.5	120
V–1056	12–17	NCF–110	2.1			1.2		2.7	48
V–1057	12–15	NCF–111	1.6			1.4		2.7	72
V–1058	12–15	NCF–112	2.6			1.4		2.8	96
V–1059	12–16	NCF–113	2.5			1.1		2.2	18
V–1060	12–17	NCF–114	1.5			1.3		4.5	84
V–1061	12–16	NCF–115	3.2			1.2		2.7	96
V–1062	12–15	NCF–116	2.1			1.2		2.4	18
V–1063	12–16	NCF–117	1.4	5.3	<16.1	1.5	3.9	2.9	78
V–1064	12–15	NCF–118	2.9			2.0		2.9	48
V–1065	12–16	NCF–119	2.6			1.6		2.9	60
V–1066	12–18	NCF–120	4.8			2.0		4.0	36
V–1067	12–15	NCF–121	3.0			1.4		2.2	24
V–1068	12–15	NCF–123	3.8			~0.93		2.9	21
V–1069	12–15	NCF–125	4.7			4.4		5.8	36
V–1070	12–15	NCE–809	2.6			1.0		2.7	36
V–1071	13–18	NCE–810	3.7			1.4		4.1	36
V–1072	13–16	NCE–811	4.0			1.7		4.5	36
V–1073	13–16	NCE–812	5.3	2.2		1.4		4.3	30
V–1074	12–15	NCE–813	3.1			1.2		4.1	54
V–1B7[u]	10–14			1.5	15.8		0.8		18
V–1C	15–22	MBT–364	2.3	2.1	18.5		1.1		12
V–1F	14–17	MJO–445	1.7	1.0	20.6	1.1	1.1	2.7	6
V–1RR	14–16	NAA–559	0.9	0.8	14.6	<0.9	0.7	4.8	6
V–2RR	12–18	NAA–560	2.0	1.3	11.3	1.4	0.5	6.9	6
V–3RR	15–23	NAB–675	2.2	2.2	18.8	3.9	1.1	13.1	6

[u]These concentrations are the arithmetic average of the results of soil sample ticket numbers MMK–035, MMK–036, MMK–037, MMK–042, MK–043, MMK–102, and MMK–103.

Table D–2. Average Radium-226 and Thorium-230 Concentrations and Hot-Spot Limits

The Ra-226 and Th-230 concentrations of a deposit of contamination left in place, averaged over a 100-m^2 (1,076-ft^2) area, are calculated using the following equation:

$$C_{avg} = \frac{(C_p \times A_p) + [C_r \times (1{,}076 - A_p)]}{1{,}076}$$

Where

C_{avg}	=	Ra-226 or Th-230 concentration (measured in picocuries per gram) averaged over a 100-m^2 area.
C_p	=	Ra-226 or Th-230 concentration (measured in picocuries per gram) of the residual radioactive material left in place, based on analysis of a composite sample, if available, or the average of the highest concentration at each deposit measurement location.
A_p	=	Area (measured in square feet) of the deposit of residual radioactive material left in place.
C_r	=	Ra-226 or Th-230 concentration (measured in picocuries per gram) of the remainder of the 100-m^2 area, including excavated and unexcavated areas.
1,076	=	Total area (measured in square feet) over which the standard is applied.

NOTE: This equation was derived from the U.S. Department of Energy's (DOE) *Environmental Implementation Guide for Radiological Survey Procedures* (DOE 1992) and was incorporated in Rust Geotech's *Field Assessments Procedures Manual.*

The hot-spot limit, which is defined in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, is the maximum allowable concentration of residual radioactive material allowed for a deposit of a given size. This value is calculated using the following equation:

$$S_{hg} = S_g \times (100 / A)^{1/2}$$

Where

S_{hg}	=	Hot-spot limit, or maximum concentration (not including background), of Ra-226 or Th-230 (measured in picocuries per gram).
S_g	=	Authorized limit of Ra-226 or Th-230 concentration (measured in picocuries per gram—5.0 pCi/g for surface soil and 15.0 pCi/g for subsurface soil).
100	=	Total area (measured in square meters) over which the hot-spot limit is applied.
A	=	Area of the hot spot (measured in square meters—if A is less than 1 m^2, S_{hg} is calculated for an area of 1 m^2).

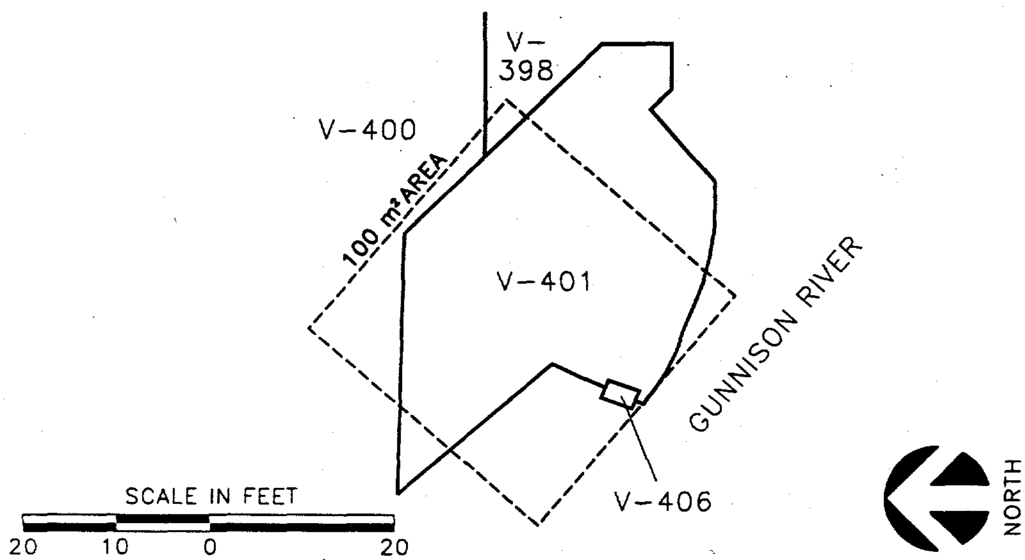
NOTE: A certification limit of S_{hg} plus background should be used to evaluate soil sample results. The background concentrations for the Grand Junction Projects Office Remedial Action Project are 1.0 pCi/g for Ra-226 and 2.0 pCi/g for Th-230.

Table D–2 (continued). *Average Radium-226 and Thorium-230 Concentrations and Hot-Spot Limits*

Average Radium-226 Concentration and Hot-Spot Limit of Area V–406							
Area	**Depth (inches)**	**A_p (ft^2)**	**C_p (pCi/g)**	**C_r (pCi/g)**	**C_{avg} (pCi/g)**	**Standard (pCi/g)**	**Hot-Spot Limit (pCi/g)**
V–406	>6	10	26.3	4.0	4.2	16.0	150.0

C_p of 26.3 pCi/g is the Ra-226 concentration of the composite soil sample for Area V–406. C_r is the area-weighted average of the Ra-226 concentration indicated for Area V–398 (11 ft^2 at 1.9 pCi/g), Area V–400 (106 ft^2 at 3.2 pCi/g), Area V–401 (764 ft^2 at 4.9 pCi/g), and the surrounding unremediated area (185 ft^2 at 1.0 pCi/g, which is the background Ra-226 concentration).

$$C_r = \frac{(11 \times 1.9) + (106 \times 3.2) + (764 \times 4.9) + (185 \times 1.0)}{(1076 - 10)} = 4.0\ pCi/g$$



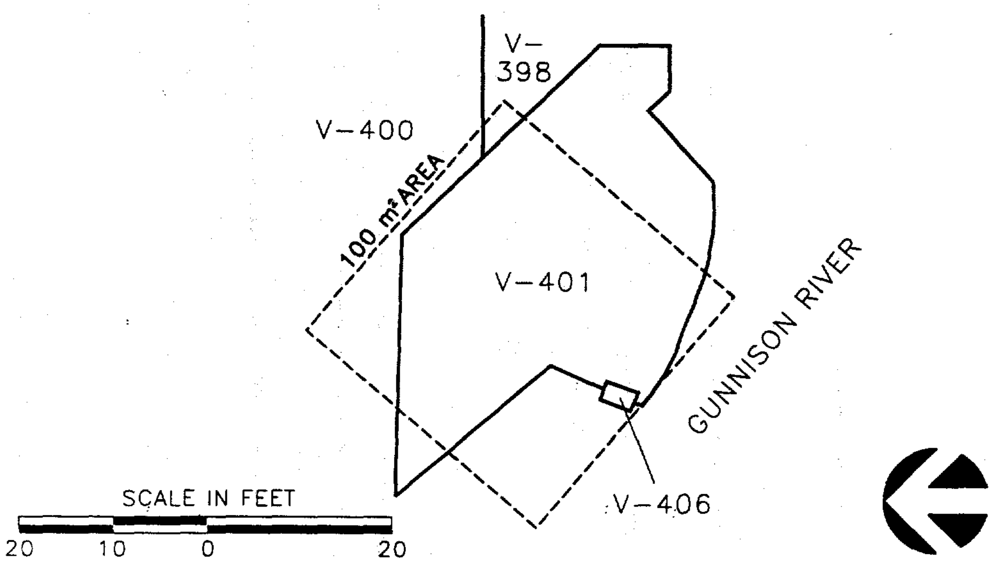
Average Radium-226 Concentrations and Depths of Excavation		
Area/ Location	**Depth (inches)**	**Ra-226 Concentration (pCi/g)**
V–398	136–142	1.9
V–400	120–126	3.2
V–401	58–64	4.9
V–406	24–30	26.3
Unremediated Area	N/A	1.0

Table D–2 (continued). Average Radium-226 and Thorium-230 Concentrations and Hot-Spot Limits

Average Thorium-230 Concentration and Hot-Spot Limit of Area V–406							
Area	**Depth (inches)**	**A_p (ft^2)**	**C_p (pCi/g)**	**C_r (pCi/g)**	**C_{avg} (pCi/g)**	**Standard (pCi/g)**	**Hot-Spot Limit (pCi/g)**
V–406	>6	10	24.5	4.7	4.9	17.0	150.0

C_p of 24.5 pCi/g is the Th-230 concentration of the composite soil sample for Area V–406. C_r is the area-weighted average of the Th-230 concentration indicated for Area V–398 (11 ft^2 at 1.6 pCi/g), Area V–400 (106 ft^2 at 1.4 pCi/g), Area V–401 (764 ft^2 at 5.8 pCi/g), and the surrounding unremediated area (185 ft^2 at 2.0 pCi/g, which is the background Th-230 concentration).

$$C_r = \frac{(11 \times 1.6) + (106 \times 1.4) + (764 \times 5.8) + (185 \times 2.0)}{(1076 - 10)} = 4.7\ pCi/g$$



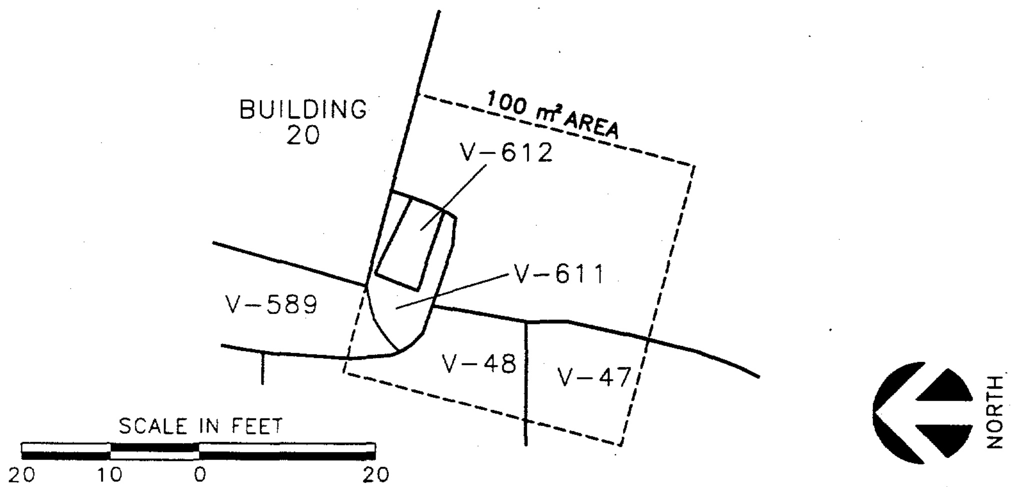
Average Thorium-230 Concentrations and Depths of Excavation		
Area/ Location	**Depth (inches)**	**Th-230 Concentration (pCi/g)**
V–398	136–142	1.6
V–400	120–126	1.4
V–401	58–64	5.8
V–406	24–30	24.5
Unremediated Area	N/A	2.0

Table D–2 (continued). Average Radium-226 and Thorium-230 Concentrations and Hot-Spot Limits

Average Radium-226 Concentration and Hot-Spot Limit of Area V–612							
Area	**Depth (inches)**	A_p **(ft^2)**	C_p **(pCi/g)**	C_r **(pCi/g)**	C_{avg} **(pCi/g)**	**Standard (pCi/g)**	**Hot-Spot Limit (pCi/g)**
V–612	>6	40	29.3	1.6	2.6	16.0	77.8

C_p of 29.3 pCi/g is the Ra-226 concentration of the composite soil sample for Area V–612. C_r is the area-weighted average of the Ra-226 concentration indicated for Area V–47 (314 ft^2 at 2.0 pCi/g), Area V–48 (179 ft^2 at 2.7 pCi/g), Area V–589 (21 ft^2 at 1.7 pCi/g), Area V–611 (76 ft^2 at 1.4 pCi/g), and the surrounding unremediated area (446 ft^2 at 1.0 pCi/g, which is the background Ra-226 concentration).

$$C_r = \frac{(314 \times 2.0) + (179 \times 2.7) + (21 \times 1.7) + (76 \times 1.4) + (446 \times 1.0)}{(1076 - 40)} = 1.6 \; pCi/g$$



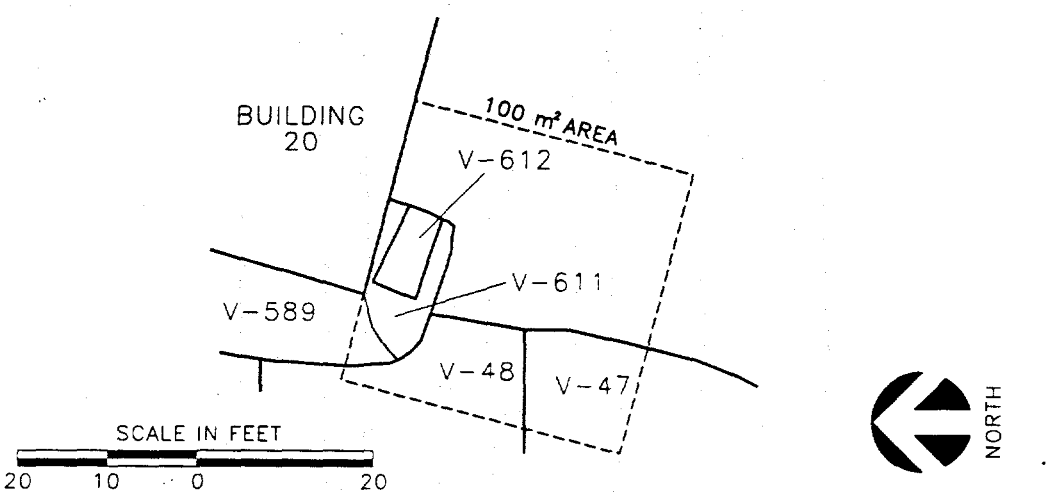
Average Radium-226 Concentrations and Depths of Excavation		
Area/ Location	**Depth (inches)**	**Ra-226 Concentration (pCi/g)**
V–47	144–150	2.0
V–48	156–162	2.7
V–589	24–30	1.7
V–611	48–54	1.4
V–612	52–58	29.3
Unremediated Area	N/A	1.0

Table D–2 (continued). Average Radium-226 and Thorium-230 Concentrations and Hot-Spot Limits

Average Thorium-230 Concentration and Hot-Spot Limit of Area V–612							
Area	**Depth (inches)**	**A_p (ft^2)**	**C_p (pCi/g)**	**C_r (pCi/g)**	**C_{avg} (pCi/g)**	**Standard (pCi/g)**	**Hot-Spot Limit (pCi/g)**
V–612	>6	40	42.6	3.1	4.6	17.0	77.8

C_p of 42.6 pCi/g is the Th-230 concentration of the composite soil sample for Area V–612. C_r is the area-weighted average of the Th-230 concentration indicated for Area V–47 (314 ft^2 at 3.5 pCi/g), Area V–48 (179 ft^2 at 5.4 pCi/g), Area V–589 (21 ft^2 at 1.2 pCi/g), Area V–611 (76 ft^2 at 3.3 pCi/g), and the surrounding unremediated area (446 ft^2 at 2.0 pCi/g, which is the background Th-230 concentration).

$$C_r = \frac{(314 \times 3.5) + (179 \times 5.4) + (21 \times 1.2) + (76 \times 3.3) + (446 \times 2.0)}{(1076 - 40)} = 3.1\ pCi/g$$



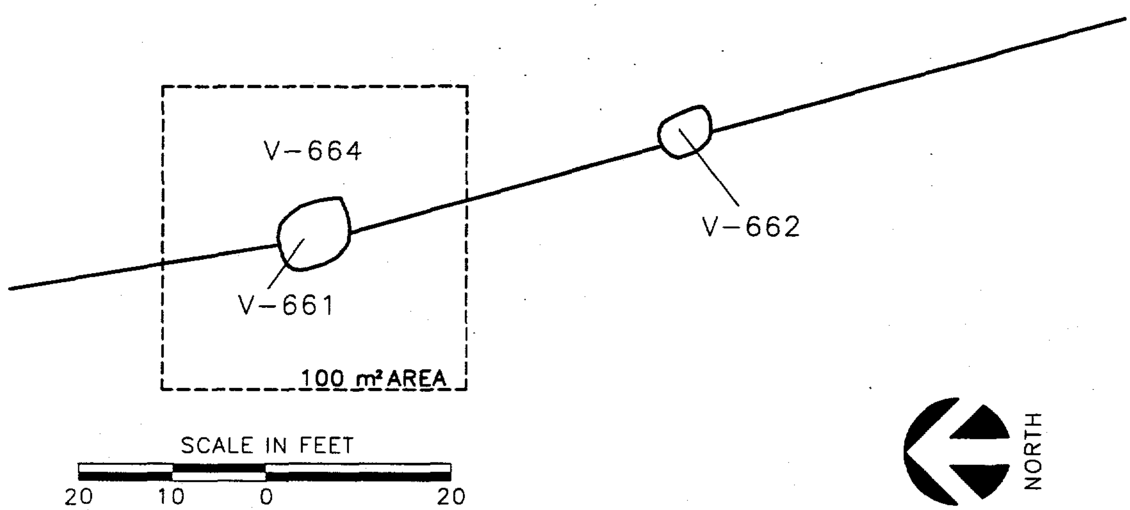
Average Thorium-230 Concentrations and Depths of Excavation		
Area/ Location	**Depth (inches)**	**Th-230 (pCi/g)**
V–47	144–150	3.5
V–48	156–162	5.4
V–589	24–30	1.2
V–611	48–54	3.3
V–612	52–58	42.6
Unremediated Area	N/A	2.0

Table D–2 (continued). Average Radium-226 and Thorium-230 Concentrations and Hot-Spot Limits

Average Radium-226 Concentration and Hot-Spot Limit of Area V–661							
Area	**Depth (inches)**	**A_p (ft^2)**	**C_p (pCi/g)**	**C_r (pCi/g)**	**C_{avg} (pCi/g)**	**Standard (pCi/g)**	**Hot-Spot Limit (pCi/g)**
V–661	>6	40	16.7	1.5	2.1	16.0	77.8

C_p of 16.7 pCi/g is the Ra-226 concentration of the composite soil sample for Area V–661. C_r is the area-weighted average of the Ra-226 concentration indicated for Area V–664 (518 ft^2 at 1.9 pCi/g) and the surrounding unremediated area (518 ft^2 at 1.0 pCi/g, which is the background Ra-226 concentration).

$$C_r = \frac{(518 \times 1.9) + (518 \times 1.0)}{(1076 - 40)} = 1.5\ pCi/g$$



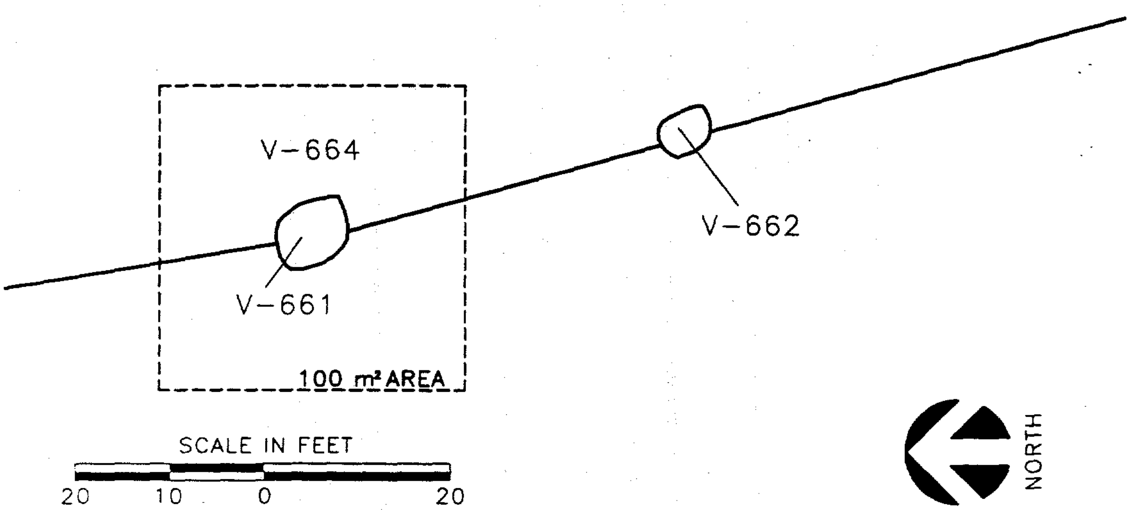
Average Radium-226 Concentrations and Depths of Excavation		
Area/ Location	**Depth (inches)**	**Ra-226 Concentration (pCi/g)**
V–661	12–18	16.7
V–664	72–78	1.9
Unremediated Area	N/A	1.0

Table D–2 (continued). Average Radium-226 and Thorium-230 Concentrations and Hot-Spot Limits

Average Thorium-230 Concentration and Hot-Spot Limit of Area V–661							
Area	**Depth (inches)**	**A_p (ft^2)**	**C_p (pCi/g)**	**C_r (pCi/g)**	**C_{avg} (pCi/g)**	**Standard (pCi/g)**	**Hot-Spot Limit (pCi/g)**
V–661	>6	40	21.0	1.9	2.6	17.0	77.8

C_p of 21.0 pCi/g is the Th-230 concentration of the composite soil sample for Area V–661. C_r is the area-weighted average of the Th-230 concentration indicated for Area V–664 (518 ft^2 at 1.7 pCi/g) and the surrounding unremediated area (518 ft^2 at 2.0 pCi/g, which is the background Th-230 concentration).

$$C_r = \frac{(518 \times 1.7) + (518 \times 2.0)}{(1076 - 40)} = 1.9\ pCi/g$$



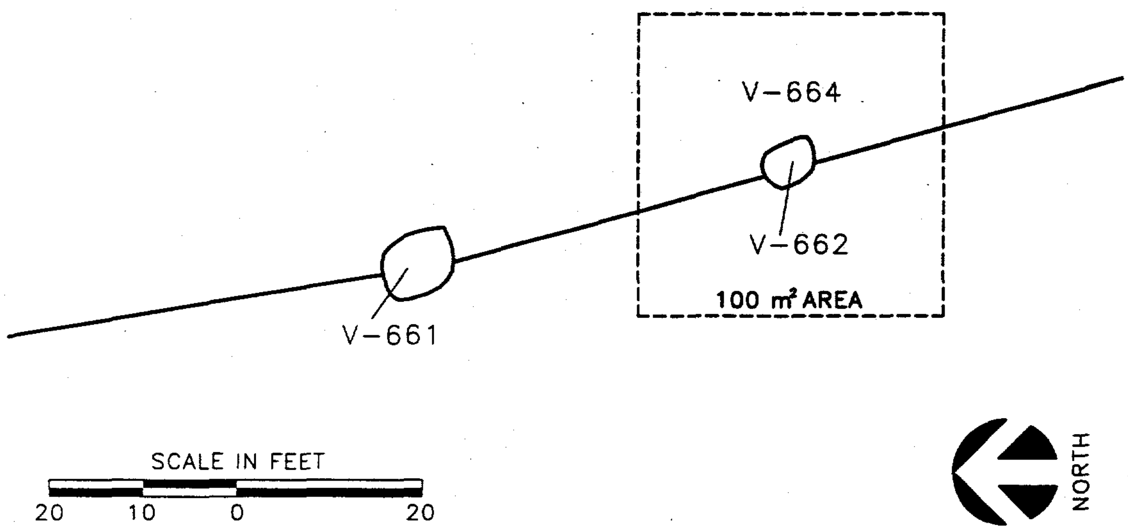
Average Thorium-230 Concentrations and Depths of Excavation		
Area/ Location	**Depth (inches)**	**Th-230 Concentration (pCi/g)**
V–661	12–18	21.0
V–664	72–78	1.7
Unremediated Area	N/A	2.0

Table D–2 (continued). *Average Radium-226 and Thorium-230 Concentrations and Hot-Spot Limits*

Average Radium-226 Concentration and Hot-Spot Limit of Area V–662							
Area	**Depth (inches)**	A_p **(ft²)**	C_p **(pCi/g)**	C_r **(pCi/g)**	C_{avg} **(pCi/g)**	**Standard (pCi/g)**	**Hot-Spot Limit (pCi/g)**
V–662	>6	28	29.2	1.5	2.2	16.0	93.0

C_p of 29.2 pCi/g is the Ra-226 concentration of the composite soil sample for Area V–662. C_r is the area-weighted average of the Ra-226 concentration indicated for Area V–664 (524 ft^2 at 1.9 pCi/g) and the surrounding unremediated area (524 ft^2 at 1.0 pCi/g, which is the background Ra-226 concentration).

$$C_r = \frac{(524 \times 1.9) + (524 \times 1.0)}{(1076 - 28)} = 1.5\ pCi/g$$



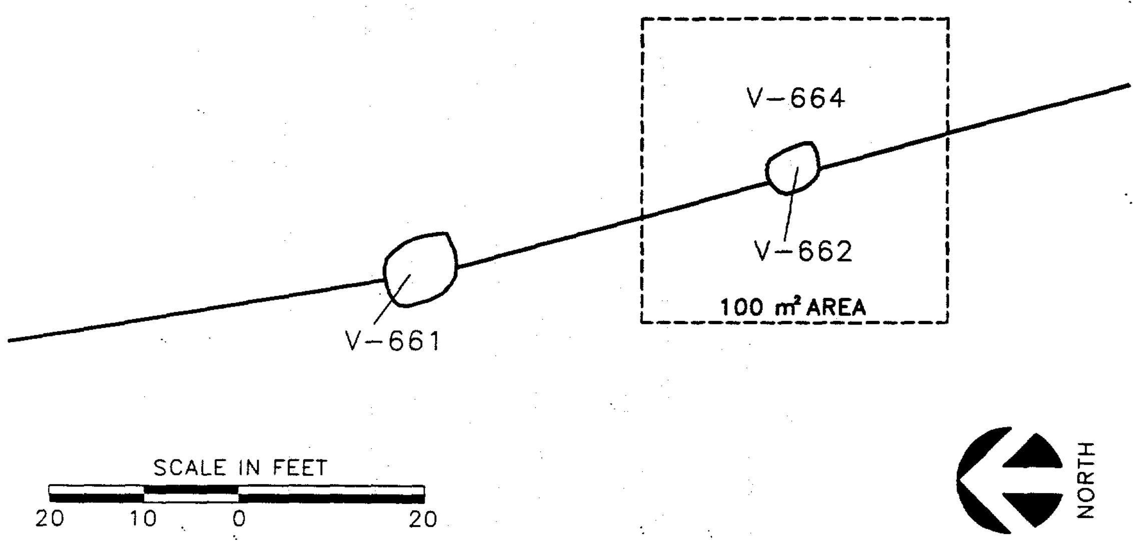
Average Radium-226 Concentrations and Depths of Excavation		
Area/ Location	**Depth (inches)**	**Ra-226 Concentration (pCi/g)**
V–662	12–18	29.2
V–664	72–78	1.9
Unremediated Area	N/A	1.0

Table D–2 (continued). Average Radium-226 and Thorium-230 Concentrations and Hot-Spot Limits

Average Thorium-230 Concentration and Hot-Spot Limit of Area V–662							
Area	Depth (inches)	A_p (ft^2)	C_p (pCi/g)	C_r (pCi/g)	C_{avg} (pCi/g)	Standard (pCi/g)	Hot-Spot Limit (pCi/g)
V–662	>6	28	36.0	1.9	2.8	17.0	93.0

C_p of 36.0 pCi/g is the Th-230 concentration of the composite soil sample for Area V–662. C_r is the area-weighted average of the Th-230 concentration indicated for Area V–664 (524 ft^2 at 1.7 pCi/g) and the surrounding unremediated area (524 ft^2 at 2.0 pCi/g, which is the background Th-230 concentration).

$$C_r = \frac{(524 \times 1.7) + (524 \times 2.0)}{(1076 - 28)} = 1.9 \ pCi/g$$



Average Thorium-230 Concentrations and Depths of Excavation		
Area/ Location	Depth (inches)	Th-230 Concentration (pCi/g)
V–662	12–18	36.0
V–664	72–78	1.7
Unremediated Area	N/A	2.0