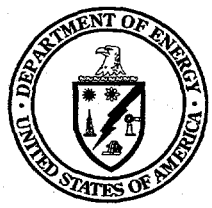
DOE/ID/12584–275
GJPO–GJ–35

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

Final Report of the Decontamination and Decommissioning of Building 36 at the Grand Junction Projects Office Facility

August 1996



U.S. Department of Energy
Grand Junction Projects Office

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Work Performed Under DOE Contract No. DE–AC04–86ID12584 for the U.S. Department of Energy

DOE/ID/12584–275
GJPO–GJ–35

Grand Junction Projects Office Remedial Action Project

Final Report of the Decontamination and Decommissioning of Building 36 at the Grand Junction Projects Office Facility

August 1996

Prepared for
U.S. Department of Energy
Albuquerque Operations Office
Grand Junction Projects Office

Prepared by
Rust Geotech
Grand Junction, Colorado

Technical Coordination and Reports Project Number TCR–031–0007–00–000
Technical Coordination and Reports Document Number T0001900

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.

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Signature Page

Prepared by:

Michael R. Widdop — August 28, 1996

M. R. Widdop, Project Technical Specialist
Technical Coordination and Reports
Rust Geotech

Date

Approved by:

Carl J. Jacobson — 8/28/96

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

Date

D. N. Leske — 8/28/96

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

Date

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Abstract

The U.S. Department of Energy (DOE) Grand Junction Projects Office (GJPO) occupies a 61.7-acre facility along the Gunnison River near Grand Junction, Colorado. This site was contaminated with uranium ore and mill tailings during uranium refining activities of the Manhattan Engineer District and during pilot milling experiments conducted for the U.S. Atomic Energy Commission's domestic uranium procurement program. The DOE Defense Decontamination and Decommissioning Program established the GJPO Remedial Action Project to clean up and restore the facility lands, improvements, and the underlying aquifer. The site contractor for the facility, Rust Geotech, also is the remedial action contractor.

Building 36 was found to be radiologically contaminated and was demolished in 1996. The soil beneath the building was remediated in accordance with identified standards and can be released for unlimited exposure and unrestricted use. This document was prepared in response to a DOE request for an individual final report for each contaminated GJPO building.

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Acronyms

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
FUSRAP	Formerly Utilized Sites Remedial Action Program
GJPO	Grand Junction Projects Office
GJPORAP	Grand Junction Projects Office Remedial Action Project
IVC	independent verification contractor
LTSM	long-term surveillance and maintenance
QA	quality assurance
RAC	remedial action contractor
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SFMP	Surplus Facilities Management Program
U.S.C.	United States Code
V-area	verification area

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I. Introduction and Background

This report summarizes the results of the remedial action conducted on Building 36 at the U.S. Department of Energy Grand Junction Projects Office (DOE–GJPO) facility. The walls and concrete foundation and floor of this building were radiologically contaminated, and the building was demolished in 1996. The soil within the building footprint complies with applicable regulations and can be released for unrestricted use and unlimited exposure. After all Grand Junction Projects Office Remedial Action Project (GJPORAP) 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 exterior land areas and the other buildings and associated utilities on the DOE–GJPO facility will be summarized in separate reports.

Description of Facility

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 Sections 26 and 27, Township 1 South, Range 1 West, Ute Principal Meridian, Mesa County, Colorado (Figure 1). The facility occupies 61.7 acres* (25 hectares) of floodplain within an accretionary bend along the east bank of the Gunnison River.

The elevation of the DOE–GJPO facility is approximately 4,560 feet (1,390 meters). The facility is situated on silty sandy gravel underlain by mudstone bedrock. Two bodies of water with associated wetlands are located on the DOE–GJPO facility: the North Pond and the South Pond. A freshwater alluvial aquifer underlying the facility is in direct hydraulic contact with the ponds and the Gunnison River. A semiarid climate prevails.

Access to the occupied portion of the facility is restricted by security personnel and a fence. There are approximately 40 structures on 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. The area adjacent to the facility to the north was formerly Black Bridge Park, now 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.

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. The U.S. Atomic Energy Commission operated a uranium-concentrate sampling plant and assay laboratory on the site until 1974. Pilot-scale uranium ore mills were operated from 1953 to 1958, processing 30,000 tons (27,200 metric tons) of ore (DOE 1987a). Mill operations were the primary source of contaminated materials at the DOE–GJPO facility, resulting in the on-site burial of approximately 247,000 cubic yards (yd^3), or 189,000 cubic meters (m^3), of uranium ore tailings. Other potential sources of contamination included laboratory and vehicle-maintenance wastes and byproducts, and activities related to sampling and stockpiling uranium concentrates. Approximately 22 acres (8.9 hectares) of open land and 19 buildings were contaminated.

Description of Project

In 1984, the DOE–GJPO facility was accepted into the DOE Surplus Facilities Management Program (SFMP) for the purpose of eliminating health hazards resulting from uranium mill tailings and associated contaminated materials at the facility; and to bring contaminated portions of the facility, including the underlying aquifer, into compliance with applicable environmental regulations. 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, and performing any necessary decontamination and decommissioning activities. DOE–GJPO has specific responsibility for GJPORAP under the D&D Program.

*Previous to the reacquisition of Black Bridge Park, the facility occupied approximately 56.4 acres.

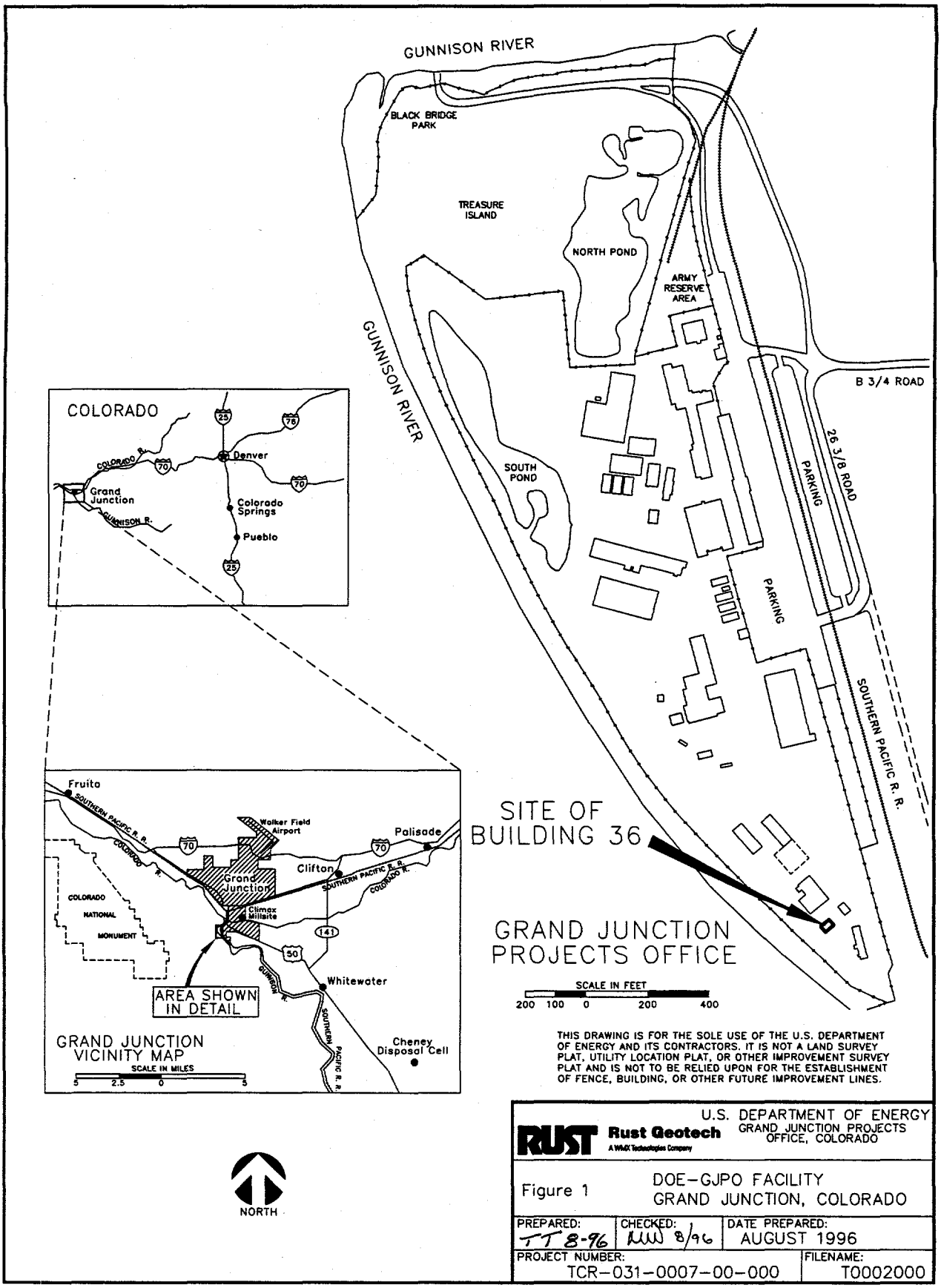

Figure 1. Site Map of the DOE–GJPO Facility, Grand Junction, Colorado

Rust Geotech is the Remedial action contractor (RAC) for GJPORAP. The GJPORAP organization and implementation strategy was defined in the *Grand Junction Projects Office Remedial Action Project Remedial Action Plan* (DOE 1990c).

Description of Building 36

Building 36 was a Quonset hut-style structure of approximately 770 square feet (ft^2), or 72 square meters (m^2), with a steel frame, corrugated steel sides, and a concrete floor. The building was used as early as 1945 as a paint shop for the original small pilot mill near the present location of Building 12. In 1954 the building was moved to the south end of the DOE–GJPO facility for use as a uranium concentrate drying facility. Subsequently, it was used for storage of uranium concentrate and later for general storage. The roof was covered with insulating foam in the 1980s.

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 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.

The DOE–GJPO facility was evaluated using the CERCLA Hazard Ranking System. Although the resulting score of 14.6 (DOE 1989b) did not qualify the facility for placement on the National Priorities List, remedial action under GJPORAP conformed to the applicable provisions of CERCLA, as amended by SARA, and the Uranium Mill Tailings Radiation Control Act (42 ~U.S.C. 7901), the National Environmental Policy Act (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 as low as reasonably achievable.

II. Decommissioning Criteria, Objectives, and Work Scope

Applicable Guidelines and Standards

Table 1 presents the guidelines that specify the authorized limits for GJPORAP.

Remedial action activities were conducted in accordance with the Rust *Quality Assurance* [QA] *Manual* (Manual 101) and approved plans and procedures (Appendix A), which incorporate the applicable provisions of Title 10, *U.S. Code of Federal Regulations*, Part 830, (10 CFR 830) Section 120, "Quality Assurance Requirements."

III. Work Performed

Remedial Investigation/Feasibility Study and Record of Decision

The Remedial Investigation/Feasibility Study –Environmental Assessment for GJPORAP was released in 1989 (DOE 1989a). Building 36 was not included in this study because it was outside the original scope of GJPORAP. Consequently, remediation of this building was not addressed in the Record of Decision (ROD) (DOE 1990a).

Post-ROD Changes—An Explanation of Significant Differences will be prepared at the conclusion of GJPORAP remedial action activities to address departures from the ROD, including the demolition of Building 36.

Characterization

The gamma exposure rate was measured in Building 36 in 1982. Radiological contamination was identified in Building 36 in 1989 during remediation of the adjacent soil, after which time the building was monitored routinely.

Building 36 was included in the 1993 comprehensive survey of the structures at the DOE–GJPO facility.

Radiological Contamination—The gamma exposure rate in Building 36 in the 1982 survey was 15 microroentgens per hour (μR/h) (DOE 1982). Subsequent measurements were affected by emanations from radioactive sources stored in the building. Beta-gamma surface activities measured in 1989 ranged as high as 100,462 disintegrations per minute per 100 square centimeters (dpm/100 cm²) on the concrete and wall surfaces of the building; analysis of the underlying soil indicated that the soil was not contaminated (UNC Geotech, Inc. 1990). The building was reportedly vacuumed in 1989 or 1990 (Rust 1995). Fixed beta-gamma contamination ranging as high as 8,790 dpm/100 cm² was identified on the roof (Chem–Nuclear Geotech, Inc. 1992) but the observed activity may have been emanations from the stored sources (Chem–Nuclear Geotech, Inc. 1993). Fixed beta-gamma activity of 5,000 dpm/100 cm² was detected on the concrete floor (Chem–Nuclear Geotech, Inc. 1993). Fixed beta-gamma activity of 80,400 dpm/100 cm² was detected on wall materials (Rust 1995).

Nonradiological Contamination—Asbestos was identified in window putty and construction felt in Building 36.

Remedial Design

A preliminary design investigation was conducted to assess the physical condition and extent of contamination of Building 36 (Rust 1995). The remedial design for the demolition of Building 36 called for dismantling the structure and, as a separate contract activity, removing the concrete foundation and floor slab. All materials were surveyed and uncontaminated materials were unconditionally released for salvage or disposal at the Mesa County Landfill. Radiologically contaminated materials were disposed at the Cheney Disposal Cell. After the removal of uranium tailings and other associated contaminated material, the remediated area was reconstructed.

Building 36 was determined to not have historical significance and was exempt from National Historic Preservation Act requirements for documentation.

Decontamination Operations

Summary of Remedial Action—The exterior areas adjacent to Building 36 were remediated in 1989 during Construction Phase IB.

The above-ground structure of Building 36 was disassembled in January 1996 and the concrete slab and foundation and some of the

Table 1. Applicable or Relevant and Appropriate Standards

Type of Occurrence	Standard
Contamination in Soil	40 CFR 192[a] FUSRAP/SFMP Guidelines[b] DOE Order 5400.5[c]
Surface Activity (structural surfaces)	FUSRAP/SFMP Guidelines[b] DOE Order 5400.5[c]
Gamma Exposure Rate (interior areas)	40 CFR 192[a] FUSRAP/SFMP Guidelines[b] DOE Order 5400.5[c]
Radon Decay-Product Concentration (interior areas)	40 CFR 192[a] FUSRAP/SFMP Guidelines[b] DOE Order 5400.5[c]

[a]40 CFR 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings."
[b]*Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program* [FUSRAP] *and Remote Surplus Facilities Management Program Sites* (DOE 1987b).
[c]DOE Order 5400.5, *Radiation Protection of the Public and the Environment.*

underlying soil were removed in April 1996. The remediation process involved disassembling the steel building and breaking up the foundation and floor slab. Contaminated materials were hauled by truck to the Cheney Disposal Cell. Uncontaminated materials were surveyed and unconditionally released in accordance with the Rust *Health and Safety Desktop Procedures* (Manual 303), procedure HS–304, and either salvaged or disposed at the Mesa County Landfill. The windows with the asbestos-containing putty were found to be free of radiological contamination and were disposed at the Mesa County Landfill.

Radiological Contamination—The remediated area associated with Building 36 is shown in Figure 2. Radiologically contaminated building debris, including sheet metal siding and concrete, was removed from within the footprint of Building 36, as indicated by the results of soil sample analyses and gamma exposure rate scans (Appendix B, Table ~B–1).The steel structural members were found to have fixed beta-gamma surface contamination in previously inaccessible areas ranging as high as 100,000 dpm/100 cm^2 (Rust 1996a).

Radiological Contamination with Associated Nonradiological Contaminants—Asbestos-containing mastic and construction felt were disposed at the Cheney Disposal Cell.

IV. Final Release Survey

The final release survey of the soil underlying the location of Building 36 was conducted in accordance with the *Survey Plan for Releasing the Buildings at the Grand Junction Projects Office for Unrestricted Use* (DOE 1995), as modified in March 1996 (Rust 1996b).

The area of Building 36 was classified as affected because of the potential for contamination in the soils underlying the building. One survey unit of 71 m^2 was established, consisting of the soil surface remaining after removal of the concrete foundation.

Oak Ridge National Laboratory at Grand Junction was the independent verification contractor (IVC) for GJPORAP. Oversight activities were conducted by representatives of the RAC QA group and the Colorado Department of Public Health and Environment.

Instrumentation

Radiation detection instruments were calibrated and used in accordance with the Rust *Field Assessments Procedures Manual.* The instruments were checked for current calibration and proper operation before and after each survey. Calibrations used traceable standards and complied with 10 CFR 835, "Occupational Radiological Protection," and DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards.*

Background Determinations

Background values determined for the DOE–GJPO facility are summarized in Table 2.

Table 2. Background Values for the DOE–GJPO Facility

Criterion	Background Value	Source of Data
Gamma Exposure Rate—Exterior	14 µR/h	DOE 1986
Radium-226 Concentration in Soil	1.0 pCi/g	DOE 1990b
Thorium-230 Concentration in Soil	2.0 pCi/g	DOE 1990b
Total Uranium Concentration in Soil	2.0 pCi/g	DOE 1990b

Key: µR/h = microroentgens per hour; pCi/g = picocuries per gram

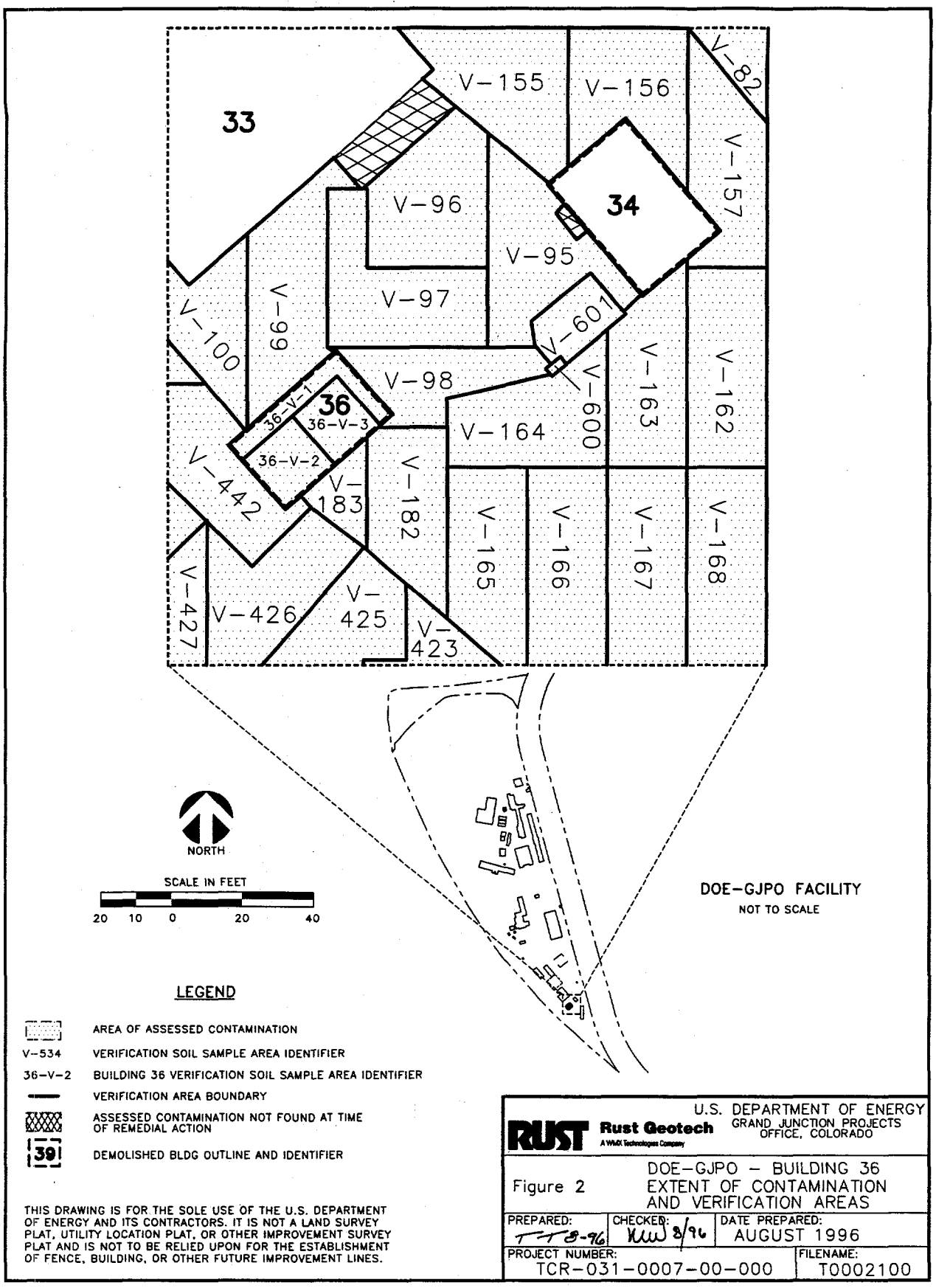

Figure 2. Extent of Contamination and Verification Areas

Reference Grids

Three verification areas (V-areas) less than or equal to 25 m^2 each were established over the area of Building 36 and referenced to the documented location of the building.

Scanning Results

No structural surfaces remain in this area; therefore, scanning for alpha or beta-gamma surface activity was not conducted. One hundred percent of the exposed soil surface was scanned for gamma activity. Gross gamma exposure rates ranged from 14 to 23 μR/h, as indicated in Appendix B, Tables B–1 and B–2.

Direct Measurements

No structural surfaces remain in this area; therefore, direct measurements for alpha or beta-gamma surface activity were not taken.

Sample Results

A composite soil sample comprising 4 aliquots representing the first 6 inches (15 centimeters) of soil was collected systematically from each V-area. The results of analysis for radium-226 (Ra-226), thorium-230 (Th-230), and total uranium are presented in Appendix B, Table B–1. Additionally, an individual soil sample was collected from Area 36-V-2 where gamma exposure rates exceeded background by more than 30 percent (Appendix B, Table B–2). The individual sample analysis results were averaged mathematically with the corresponding composite sample.

The projected upper limit of the mean radionuclide concentration for the 71 m^2 remediated area was calculated at the 95 percent confidence level; the area complies with the cleanup standards (Table 3). The soil sample and gamma scan results for the V-areas, each 25 m^2 or less, demonstrate that the radionuclide concentrations in the remediated area do not exceed the hot spot criterion (Appendix B, Table B–1).

Exposure Rates

No habitable areas remain in this area; therefore, no discrete gamma exposure rate measurements were taken.

V. Cost and Schedule

Project costs and the schedule for remediation of Building 36 will be presented in a summary final report of the GJPORAP remediation of the interior areas.

VI. Occupational Exposure

Results of personnel and area monitoring indicate that GJPORAP activities created no above-background emissions of nonradiological hazards, radioparticulates (including radon daughters), or ionizing radiation.

VII. Waste Volumes

The remediation of Building 36 generated a total of 100 tons (91 metric tons) of contaminated materials, representing a volume of approximately 126 yd^3 (96 m^3) of contaminated material (Rust 1996c). This material was disposed at the Cheney Disposal Cell.

VIII. Final Condition

All cleanup requirements identified for GJPORAP have been met for the soil at the former location of Building 36 (Table 3). The IVC will issue a Statement of Verification to signify concurrence that this portion of remedial action has achieved program objectives.

Radiologically contaminated material has been removed, and all remediated areas comply with the applicable provisions of 40 CFR 192, FUSRAP/SFMP guidelines, and DOE Order 5400.5. Suspected occurrences of nonradiological contamination were investigated,

Table 3. Building 36 Certification Summary

Survey Unit: Building 36 Excavation (affected area, exterior soil surface)			
Certification Criteria	**Authorized Limit**	**Number of Observations**	**Results**
Gamma Exposure Rate (habitable areas only)	< 20 µR/h above background.[a]	None	Not applicable (no habitable areas).
Radon Decay-Product Concentration (habitable areas only)	Annual average shall not exceed 0.02 WL, to the extent practicable, and in no case shall exceed 0.03 ~WL.	None	Not applicable (no habitable areas).
Scans	Elevated activity will be investigated	Gamma: scanned 100% of surface Alpha and beta-gamma: none	Gamma: exposure rate range was 14 to 23 µR/h.[b] Alpha and beta-gamma: not applicable (no structural surfaces).
Surface Activity (structural surfaces only)	Alpha or beta-gamma activity shall not exceed 5,000 dpm/100 cm² fixed, 1,000 dpm/100 cm² removable, averaged over 1 m².	None	Not applicable (no structural surfaces).
Radionuclide Concentrations (soil surfaces only)	Ra-226 and Th-230: Shall not exceed 5 pCi/g above background[a] in the 15-cm surface layer, averaged over 100 m².	None	Not applicable (excavation > 15 cm deep).
	Shall not exceed 15 pCi/g above background[a] in any 15-cm-thick soil layer more than 15 cm below the surface, averaged over 100 m².	3 composite samples, each comprising at least 4 aliquots.	Ra-226: average was 1.8 pCi/g.[b,c] μ_α = 2.7 pCi/g[b,c] Th-230: average was 2.2 pCi/g.[b,c] μ_α = 4.8 pCi/g[b,c]
	Total uranium: Shall not exceed 106 pCi/g above background[a] in any 15-cm–thick layer, averaged over 100 m².	3 composite samples, each comprising at least 4 aliquots.	average was 9.0 pCi/g.[b,c] μ_α = 23.4 pCi/g[b,c]
Hot-Spot Criteria	Limit = (guideline value)(100/area)$^{0.5}$	As required	Maximum concentrations below hot-spot limit.

[a]Background activities are summarized in Table 2.
[b]Gamma exposure rates and radionuclide concentrations include background.
[c]Radionuclide concentrations were determined by laboratory analysis.
Note: Th-232 is not a contaminant of concern at the DOE–GJPO facility (DOE 1994).

Key:

cm	=	centimeter(s)
dpm/100 cm²	=	disintegration per minute per 100 square centimeters
m²	=	square meter(s)
pCi/g	=	picocuries per gram
Ra-226	=	radium-226
Th-230	=	thorium-230
Th-232	=	thorium-232
μ_α	=	upper limit of the true mean concentration at the 95 percent confidence level, based on soil sample results
WL	=	working level

and identified nonradiological contamination was remediated.

Remediated areas were restored to comply with floodplain permits, the Endangered Species Act, and other applicable regulations. Groundwater sampling under the LTSM Program 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 materials, unknown deposits of contamination may be found in the future. The potential for encountering contamination during future construction activities will be determined and at-risk activities 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 remediated area; therefore, the area can be released for unrestricted use and unlimited exposure. At the time of this report, contamination is still present in other interior areas of the DOE–GJPO facility; access to these areas is controlled and will be addressed by future GJPORAP remedial actions. After the interior remedial action is completed, the facility will be managed as an LTSM site by DOE until restoration of the alluvial aquifer by natural flushing action occurs.

IX. Lessons Learned

Lessons learned during remediation of Building 36 have been incorporated into subsequent operations. These lessons will be presented in a summary final report of the GJPORAP remediation of the interior areas.

X. References

10 CFR 830. U.S. Department of Energy, "Nuclear Safety Management," Section 120, "Quality Assurance Requirements," *U.S. Code of Federal Regulations.*

10 CFR 835. U.S. Department of Energy, "Occupational Radiation Protection," *U.S. Code of Federal Regulations.*

40 CFR 192. U.S. Environmental Protection Agency, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," *U.S. Code of Federal Regulations.*

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DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, Change 1.

DOE Order 5480.1B, *Environment, Safety, and Health Program for Department of Energy Operations*, Change 5.

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DOE Order 5480.11, *Radiation Protection for Occupational Workers*, Change 2.

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Appendix A

Applicable Program and Quality Assurance Requirements and Procedures

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GJPORAP Program Management

Operations Management Policy Manual (Manual 104)

Project Control System Manual (Manual 107)

Management Policies Manual (Manual 100), Section 1, "General Administration," and Section 12, "Organization Functions and Responsibilities"

Remedial Action Statements of Work

Grand Junction Projects Office Desk Procedures Manual

Grand Junction Projects Office Remedial Action Project (GJPORAP), Grand Junction, Colorado, Community Relations Plan Update

Grand Junction Projects Office Remedial Action Project Quality Assurance Program Plan, P–GJPO–141

Grand Junction Projects Office Remedial Action Project Records Management Plan, P–GJPO–143

GJPORAP Construction Management

Operations Management Policy Manual (Manual 104)

Operations Department Construction Procedures Manual

Engineering

Engineering Process Planning Guidelines

AutoCAD Standards Manual

Assessment/Verification

Land Survey Support Procedures

AutoCAD Standards Manual

Environmental Procedures Catalog (Manual 116)

Laboratory Services

Analytical Laboratory

Analytical Chemistry Laboratory Administrative Plan and Quality Control Procedures

Analytical Chemistry Laboratory Handbook of Analytical and Sample Preparation Procedures, Volumes I, II, and III

Gamma-Ray Spectroscopy System Operations Methods Manual

Environmental Instrumentation Laboratory

Calibration Control Program for Measurement and Test Equipment and Measurement Standards

Electronics Laboratory Procedures

Quality Assurance

Quality Assurance Desk Instructions and Administrative Procedures Manual (Manual 301)

Health, Safety, and Security

Health and Safety Manual (Manual 103), Volumes 1 and 2

Health and Safety Desktop Procedures (Manual~303)

Grand Junction Projects Office Remedial Action Project Health and Safety Plan, P–GJPO–144

Contracts and Procurement

Management Policies Manual (Manual 100), Section 5, "Procurement"

Procurement Manual

Stores, Property, and Transportation (SPAT) Manual (Manual 114)

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Appendix B

Final Radiological Conditions

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Table B–1 summarizes the post-remediation sampling and measurement results for the site of Building 36. The samples were collected prior to backfilling. The samples for Areas 36-V-1 and 36-V-3 are composites comprising four aliquots representing the 6-inch-thick soil layer at the bottom of the excavation. The results for Area 36-V-2 are the weighted average of a composite and an individual sample, as explained below. The results of the separate samples for Area 36-V-2 are presented in Table B–2. The samples were analyzed for radium-226 (Ra-226) using the Opposed Crystal System (OCS). The samples also were analyzed by the U. S. Department of Energy Grand Junction Projects Office analytical laboratory for Ra-226 using gamma spectroscopy and for total uranium and Thorium-230 (Th-230) using inductively-coupled plasma mass spectroscopy, in accordance with procedures specified in the analytical reports. The radionuclide concentrations are expressed in picocuries per gram (pCi/g) and include background. The gamma exposure rate range is expressed in microroentgens per hour (μR/h). The remediated area is shown on Figure 2.

Table B–1. Post-Remediation Sample/Measurement Results for Exterior 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)	Th-230 (lab)	Total Uranium (lab)	
36-V-1	14 - 18	NCK 771	1.1	1.6	1.4	5.3	12
36-V-2[a]	14 - 23		3.2	2.4	4.0	18.8	12
36-V-3	14 - 16	NCK 773	1.6	1.3	1.1	2.9	12
Mean			2.0	1.8	2.2	9.0	
Standard Deviation			1.1	0.6	1.6	8.6	
μ_α[b]			2.9	2.7	4.8	23.4	

[a]These results are for the weighted average of the composite soil sample for Area 36-V-2 (4 aliquots) and a sample collected where the gamma exposure rate exceeded background by 30 percent (1 aliquot).
[b] μ_α = the projected upper limit of the average concentration for this area at the 95 percent confidence level, (from Equation 8-13 of *Manual for Conducting Radiological Surveys in Support of License Termination*, NUREG/CR 5849 [U.S. Nuclear Regulatory Commission, 1992]).

Table B–2. Sample/Measurement Results for Area 36-V-2

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)	Th-230 (lab)	Total Uranium (lab)	
36-V-2[a]	14 - 16	NCK 772	2.5	1.7	1.3	3.5	12
36-V-2[b]	20 - 23	NCK 775	5.9	5.4	14.7	79.8	18

[a]Composite soil sample comprising 4 aliquots collected systematically.
[b]Individual soil sample collected at the point of highest gamma activity.

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