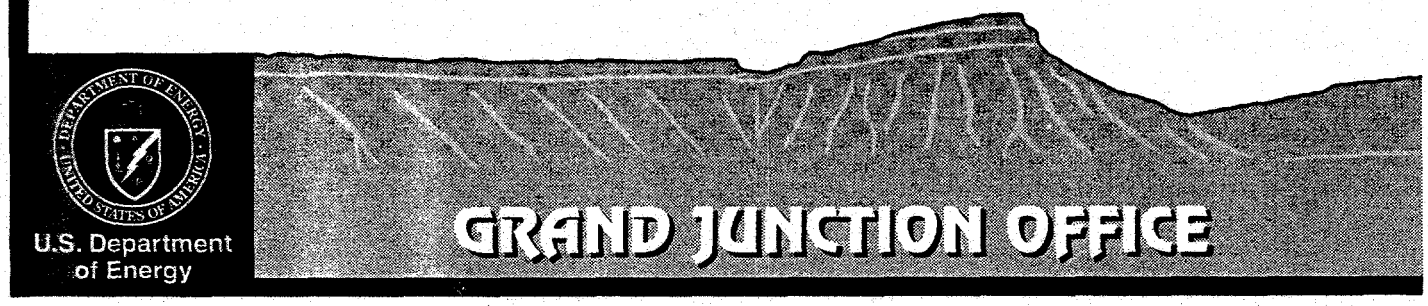
GJO–97–17–FOS
GJO–GJ–48

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

Final Report of the Radiological Release Survey of Building 29 at the Grand Junction Office Facility

September 1997



Work Performed Under DOE Contract No. DE–AC13–96GJ87460 for the U.S. Department of Energy
Approved for public release; distribution is unlimited.

GJO–97–17–FOS
GJO–GJ–48

Grand Junction Office Remedial Action Project

Final Report of the Radiological Release Survey of Building 29 at the Grand Junction Office Facility

September 1997

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

Prepared by
WASTREN-Grand Junction
Grand Junction, Colorado

WASTREN-Grand Junction has been granted authorization to conduct remedial action under the Decontamination and Decommissioning Program. Remedial action was conducted at the DOE–GJO facility in accordance with all applicable or relevant and appropriate requirements.

Work Performed Under DOE Contract No. DE–AC13–96GJ87460
Approved for public release; distribution is unlimited.

Signature Page

Prepared by:

R. K. Johnson, Senior Technical Specialist
L & R Technical Services — 9/15/97 Date

S. G. Corle, Technical Lead
Grand Junction Office Remedial Action Project
Holmes & Narver Services, Inc. — 9/16/97 Date

Approved by:

J. W. Gardner, Project Manager
Grand Junction Office Remedial Action Project
Holmes & Narver Services, Inc. — 9/16/97 Date

R. L. Morris, Radiation Protection Program Manager
WASTREN-Grand Junction — 9/16/97 Date

B. H. Young, Project Manager
U.S. Department of Energy
Grand Junction Office — 9/16/97 Date

This page intentionally blank

Abstract

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

Building 29 and the underlying soil were found not to be radiologically contaminated; therefore, the building can be released for unrestricted use. Placards have been placed at the building entrances indicating the completion of the radiological release survey and prohibiting the introduction of any radioactive materials within the building without written approvals from the GJO Facilities Operations Manager. This document was prepared in response to a DOE–GJO request for an individual final release report for each GJO building.

This page intentionally blank

Contents

Figures

Tables

Appendices

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
EPA	U.S. Environmental Protection Agency
FOS	Facilities Operations & Support contractor (*WASTREN-Grand Junction*)
FUSRAP	Formerly Utilized Sites Remedial Action Program
GJO	Grand Junction Office
GJORAP	Grand Junction Office Remedial Action Project
GJPORAP	Grand Junction Projects Office Remedial Action Project
IVC	independent verification contractor (Oak Ridge National Laboratory)
LTSM	long-term surveillance and maintenance
MDC	minimum detectable concentration
ORNL	Oak Ridge National Laboratory
RDC	radon decay-product concentration
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SFMP	Surplus Facilities Management Program
TAR	Technical Assistance & Remediation contractor (MACTEC-ERS)
U.S.C.	United States Code
WL	working level

I. Introduction and Background

This report summarizes the results of the radiological release survey for Building 29 at the U.S. Department of Energy Grand Junction Office (DOE–GJO) facility. After all Grand Junction Office Remedial Action Project (GJORAP) remedial action is completed, the DOE–GJO facility will be transferred to the Long-Term Surveillance and Maintenance (LTSM) Program to monitor the passive restoration of the underlying aquifer. Additional reports summarize the remediation and release surveys of the exterior land areas, the other buildings, and associated utilities on the DOE–GJO facility.

Description of Facility

The DOE–GJO facility (Figure 1) 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. 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–GJO facility is approximately 4,560 feet, or 1,390 meters (m). The facility is situated on silty sandy gravel underlain by mudstone bedrock. Two bodies of water with associated wetlands are located on the DOE–GJO 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 currently is restricted by security personnel and a fence. There are approximately 36 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 Union Pacific Railroad right-of-way.

DOE–GJO facility lands were acquired by the U.S. War Department in 1943 for the Manhattan Engineer District. A vanadium 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–GJO facility, resulting in the on-site burial of approximately 247,000 cubic yards (189,000 cubic meters) of uranium mill products. Other potential sources of contamination included laboratory and vehicle-maintenance wastes and byproducts, and activities related to sampling and stockpiling uranium concentrates (including yellowcake—U_3O_8). Approximately 22 acres (8.9 hectares) of open land and 19 buildings were contaminated.

Description of Project

In 1984, the DOE–GJO 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 (DOE 1989a).

The facility was transferred to the DOE Decontamination and Decommissioning (D&D) Program in 1988. The D&D Program is responsible for the surveillance and maintenance of surplus DOE facilities, and performing any necessary decontamination and decommissioning activities. DOE–GJO has specific responsibility for GJORAP under the D&D Program.

WASTREN-Grand Junction (WASTREN) is the Facilities Operations & Support (FOS) contractor for DOE–GJO, and is the remedial action contractor for GJORAP. The GJORAP

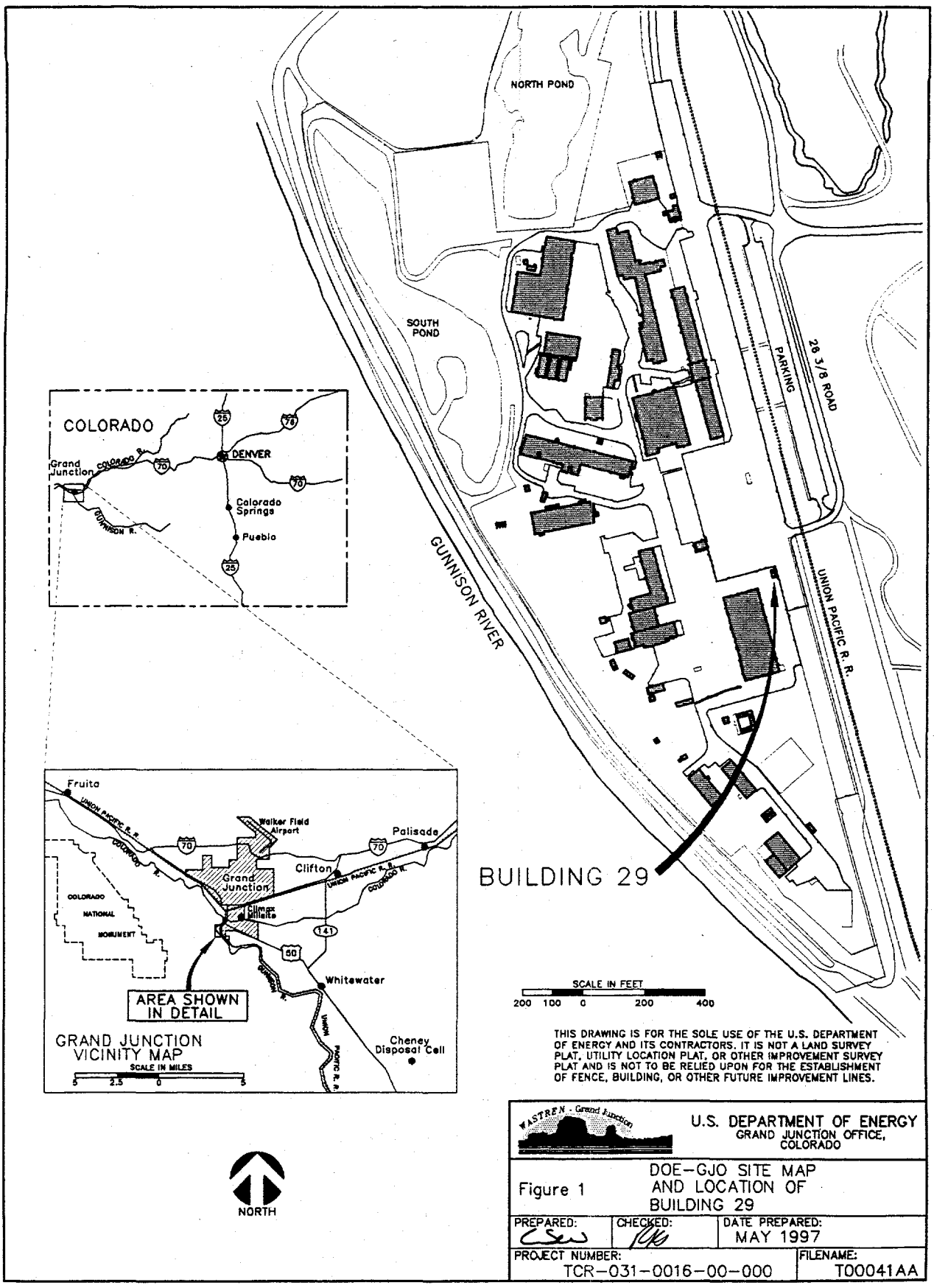


Figure 1. DOE– GJO Site Map and Location of Building 29

organization and implementation strategy was defined in the *Grand Junction Projects Office Remedial Action Project Remedial Action Plan* (DOE 1990c). The project originally was administered as the Grand Junction Projects Office Remedial Action Project (GJPORAP).

Description of Building 29

Building 29 was constructed on the DOE–GJO facility in 1954. It was built as a guard station and scale house for trucks entering the site with uranium ore, and later was used for paint storage. Presently, Building 29 serves as office space for facilities management personnel. The building has a footprint of approximately 226 square feet, or 21.0 square meters (m^2). It is constructed of a wood frame on a concrete slab, with wood siding and a flat roof. The interior walls and ceiling are finished with sheetrock.

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 O 440.1, *Worker Protection Management for DOE Federal and Contractor Employees*, and all other applicable environmental regulations.

The DOE–GJO 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 GJORAP conformed to the applicable provisions of CERCLA, as amended by SARA, 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 has been 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 guideline documents that specify the authorized limits for releasing GJORAP buildings and open land (the applicable authorized limits are provided in Table 3). Remedial action activities on the facility have been conducted in accordance with 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 29 was not included in this study because it was outside the original scope of GJPORAP. Consequently, the release survey 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 GJORAP remedial action activities to address departures from the ROD, including the release survey of Building 29.

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 (building surfaces)	FUSRAP/SFMP Guidelines[b] DOE Order 5400.5[c]
Gamma Exposure Rate (interior areas only)	40 CFR 192[a] FUSRAP/SFMP Guidelines[b] DOE Order 5400.5[c]
Radon Decay-Product Concentration (interior areas only)	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 and Remote Surplus Facilities Management Program Sites* (DOE 1987b).
[c]DOE Order 5400.5, *Radiation Protection of the Public and the Environment.*

Characterization

Building 29 was included in the 1993 comprehensive survey of the structures at the DOE–GJO facility. No radiological contamination was identified (Chem-Nuclear Geotech, Inc. 1993a,b).

Two deposits of contaminated soil, parts of which were located within 3 m of the building, were assessed and remediated as verification areas V–452 and V–490 during the decontamination and decommissioning of the exterior land areas (DOE 1995a). The excavations were 6 to 11 inches (15 to 28 centimeters) deep. Radionuclide concentrations (including background) in the composite samples collected at the bottom of the excavations were 1.7 picocuries per gram (pCi/g) for radium-226 (Ra-226) for both samples, and were 1.7 and 2.2 pCi/g for thorium-230 (Th-230). The samples were not analyzed for total uranium. Gross gamma exposure rates at the bottom of the excavations ranged from 14 to 20 microroentgens per hour (μR/h).

Remedial Design

A remedial design was not required because no radioactive contamination was identified with Building 29.

IV. Final Release Survey

Building 29 was surveyed in January and February 1997 in accordance with the *Survey Plan for Releasing the Buildings at the Grand Junction Projects Office for Unrestricted Use* (DOE 1995b).

The soil areas adjacent to and beneath Building 29 were classified as unaffected because the associated exterior land area had been assessed and remediated and no contamination was found to extend beneath the building (DOE 1995a). One exterior soil survey unit was established: Survey Unit 3 (94 m^2) consisting of the exterior ground surfaces within 3 m of the building foundation.

The building surfaces were also classified as unaffected because existing survey data and the history of the building indicated low potential for contamination. Two survey units were established: Survey Unit 1 (87 m^2) consisting of the interior walls, floor, and ceiling; and Survey Unit 2 (102 m^2) consisting of the exterior walls, roof, and underside of the roof overhang.

Oak Ridge National Laboratory (ORNL) at Grand Junction was the independent verification contractor (IVC) for GJORAP. Oversight activities were conducted by representatives of the FOS Safety & Health Group and GJORAP Project Management.

Instrumentation

Radiation detection instruments were calibrated and used in accordance with the FOS *Calibration and Control Program Manual*. The instruments were checked daily for current calibration and proper operation. Calibrations used traceable standards and complied with 10 CFR 835, "Occupational Radiation Protection," DOE Order O 420.1, *Facility Safety*, and DOE Order O 440.1 *Worker Protection Management for DOE Federal and Contractor Employees*. Minimum detectable concentrations (MDCs) were calculated to ensure sufficient instrument sensitivity for measuring beta-gamma activity and gamma exposure rates at or below the authorized limits (*WASTREN* 1997c). MDCs are provided in Appendix B, Table B–1.

Background Determinations

Gamma-exposure-rate and radionuclide-concentration background values, determined for the DOE–GJO facility during previous investigation, are summarized in Table 2. Beta-gamma background activities used for this release survey were based on an average ambient air activity of 1500 disintegrations per minute per 100 square centimeters (dpm/100 cm^2) plus material-specific activities determined from measurements collected on construction materials similar to those used on the DOE–GJO facility (*WASTREN* 1997b, DOE 1997). The applicable beta-gamma background activities are listed in Appendix B, Tables B–2 through B–4.

Reference Grids

A 1-m by 1-m survey grid, tied to the southwest corner of the building and the DOE–GJO facility survey grid, was established for the building-surface survey units. Survey Unit 3 (exterior ground surfaces) was divided into four approximately equal verification cells of 25 m^2 or less.

Scanning Results

One hundred percent of the exposed ground surface and the floor were scanned for gamma activity. Gross gamma exposure rates for the exterior ground surfaces and the floor are shown in Appendix B, Figures B–1 and B–2.

Table 2. Gamma Exposure Rate and Soil Concentration Background Values for the DOE–GJO Facility

Criterion	Background Value	Source of Data
Gamma Exposure Rate	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

One-square-meter grid blocks were scanned for beta-gamma activity at randomly-selected locations on the building surfaces. Measured activities are listed in Appendix B, Tables B–2 and B–3.

Direct Measurements

Direct beta-gamma measurements were taken within the scanned grid blocks for statistical analysis. These measurement results are provided in Appendix B, Tables B–2 and B–3. Results of additional measurements taken at selected locations and behind building surfaces are included in Appendix B, Table B–4. Smear measurements for removable contamination were taken at two locations that indicated elevated activities and the results are provided in Table B–5. Measurement locations are shown in Appendix B, Figures B–1 through B–7.

The projected upper limits of the mean activities, calculated at the 95 percent confidence level, indicate that the surface activities on the building surfaces do not exceed the authorized limits (Appendix B, Table B–8). The additional measurements and smears indicated no significantly elevated activities, also.

In addition to measurements on building surfaces, direct measurements were taken on the exterior ground surfaces within 3 m of the building to screen for uranium. No significantly elevated activities were measured (Appendix B, Table B–4).

Other than the smear measurements, alpha activity was not measured. Alpha activity was not measured at other locations because any alpha-emitting contaminant at this site would also emit a detectable beta particle. For surfaces, uranium is the alpha-emitting contaminant of concern. Since uranium emits beta and alpha particles in a ratio nearly 1:1, compliance with authorized limits for beta-gamma activity demonstrates compliance with authorized limits for alpha activity.

Interior and exterior gamma exposure rates were measured 1 m above the floor or ground. Measurement locations are shown in Appendix B, Figures B–1 and B–2, and results are provided in Appendix B, Table B–6. The projected upper limits of the mean exposure rates, calculated at the 95 percent confidence level, indicate that the gamma exposure rates do not exceed the interior authorized limit or exterior guideline (Appendix B, Table B–8).

RDC Results

The average of three RDC measurements taken in Building 29 during a three-month-long period in 1997 was 0.0062 working level (WL), which indicates that the working level is below the authorized limit.

Sample Results

Soil samples were collected at the location of highest surface gamma exposure rate within each verification cell. The samples were analyzed for Ra-226, Th-230, and total uranium. The results demonstrate that the radionuclide concentrations do not exceed the authorized limits for radionuclide concentrations in hot spots or averaged over 100 m^2 (Appendix B, Table B–7). The projected upper limits of the mean concentrations, calculated at the 95 percent confidence level, indicate that the radionuclide concentrations for Th-230 and total uranium do not exceed the authorized limits. The confidence level that the mean concentration of Ra-226 does not exceed the authorized limit is approximately 85% (*WASTREN* 1997a). Ra-226 concentrations measured in a 1-m deep borehole at location 29–V–2 (Appendix B, Figure B–1) did not exceed the authorized limit for subsurface layers.

V. Cost and Schedule

Project costs and the schedule for the release survey of Building 29 will be presented in a summary final report addressing all GJORAP buildings.

VI. Occupational Exposure

Health and safety procedures were followed in accordance with *The GJO Health and Safety Standards* and *The GJO Site Radiological Control Manual* to ensure personnel associated with the release survey activities were protected from radiological and nonradiological hazards.

VII. Waste Volumes

Building 29 did not require remediation; therefore, no radiologically-contaminated materials were generated.

VIII. Final Condition

All release requirements identified for GJORAP have been met for Building 29 (Table 3). The IVC will issue a Statement of Verification to signify concurrence that the release survey has achieved program objectives.

Building 29 can be released for unrestricted use. Placards have been placed at the building entrances indicating the completion of the radiological release survey and prohibiting the introduction of any radioactive materials within the building without written approvals from the GJO Facilities Operations Manager.

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–GJO facility is routinely surveyed for radiation and other hazards.

At the time of this report, contamination is still present in other buildings located on the DOE–GJO facility; access to these areas is controlled and will be addressed by future GJORAP remedial actions. Once the interior remedial actions are completed, the facility will be managed as an LTSM site by DOE until the alluvial aquifer is restored by natural flushing.

IX. Lessons Learned

Several lessons were learned during release survey activities involving the DOE–GJO buildings in FY 1997. The experience gained has been applied to subsequent surveys, and should be considered for use on other DOE projects. The following lessons have been learned:

- Radiological protection managers should ensure that survey technicians and their trainers are fully trained and tested on every type of equipment that will be used for performing release surveys. A small quantity of unusable data were collected because survey crew members misinterpreted the display on a new type of survey instrument. Although the problem was caught early, it could have resulted in a large quantity of useless and expensive data. Special care is required when new types of equipment are introduced into the field. Furthermore, it may be desirable to involve manufacturers' technical representatives in the initial training and testing of personnel who will use the equipment.

- Project team members should be encouraged to think critically about all project activities so that wasteful or otherwise inappropriate practices are recognized and eliminated as soon as possible. An example of this process occurred when personnel not directly involved in the release surveys questioned the practice of measuring beta-gamma background activity on surfaces in the same buildings being surveyed for release. This practice could mask contamination by incorporating its activity in the background measurement, thus compromising the validity of release survey results. A subsequent study of beta-gamma activities

Table 3. Certification Summary for All Survey Units

Certification Criteria	Number of Observations	Authorized Limit	Results[a]
Surface Activity (building surfaces only)	60 direct beta-gamma measurements	Alpha or beta-gamma activity shall not exceed 5,000 dpm/100 cm^2 fixed averaged over 1 m^2.	Maximum beta-gamma = 478 dpm/100 cm^2 $\mu_{95\%}$ = 96 dpm/100 cm^2 for Survey Unit 1 $\mu_{95\%}$ = 60 dpm/100 cm^2 for Survey Unit 2
	2 smears	Alpha or beta-gamma activity shall not exceed 1,000 dpm/100 cm^2 removable.	Maximum alpha = 6 dpm/100 cm^2 Maximum beta-gamma = -8 dpm/100 cm^2
	60 scan beta-gamma measurements[b]	Alpha or beta-gamma activity shall not exceed 15,000 dpm/100 cm^2 maximum averaged over 100 cm^2.	Maximum direct beta-gamma = 478 dpm/100 cm^2
Gamma Exposure Rate (habitable areas only)	11 static measurements[c]	≤ 20 μR/h above background[d]	Maximum rate = -0.4 μR/h $\mu_{95\%}$ = -0.5 μR/h
	100% floor scan	≤ 20 μR/h above background[d]	Ranged from -1.2 to 1.1 μR/h
Radon Decay-Product Concentration (habitable areas only)	3 three-month measurements	Annual average shall not exceed 0.02 WL, to the extent practicable, and in no case shall exceed 0.03 WL.	$\bar{x}$ = 0.0062 WL
Radionuclide Concentrations in Soil		Ra-226 and Th-230:	
	4 individual samples	Shall not exceed 5 pCi/g above background[d] in the 15-cm surface layer, averaged over 100 m^2.	Ra-226: $\bar{x}$ = 3.3 pCi/g $\mu_{95\%}$ = 6.5 pCi/g[e] Th-230: $\bar{x}$ = 1.4 pCi/g $\mu_{95\%}$ = 4.1 pCi/g
	1 individual sample	Shall not exceed 15 pCi/g above background[d] in any 15-cm-thick soil layer more than 15 cm below the surface, averaged over 100 m^2.	Ra-226 = 0.5 pCi/g Th-230 = -0.8 pCi/g
		Total uranium:	
	5 individual samples	Shall not exceed 106 pCi/g above background[d] in any 15-cm–thick layer, averaged over 100 m^2.	$\bar{x}$ = 3.0 pCi/g $\mu_{95\%}$ = 5.4 pCi/g
Soil Hot-Spot Criteria	As required for samples exceeding authorized limits	Limit = (authorized limit) x $(100/\text{area})^{0.5}$	S_{hg} = 10.3 pCi/g Ra-226: 29–V–4 = 7.0 pCi/g

[a]Net results (background subtracted).

[b]Compliance was demonstrated by a combination of scans and direct measurements. Direct measurements were made at locations of highest elevated activity if elevated activity was present. Otherwise, direct measurements were made at the centers of the 1-m^2 grid blocks.

[c]Gamma exposure rates were measured 1 m above the floor.

[d]Background values are summarized in Table 2.

[e] $\mu_{95\%}$ is greater than the authorized limit for Ra-226; however, the authorized limit of 5 pCi/g averaged over 100 m^2 was not exceeded.

Table 3 (continued). Certification Summary for All Survey Units

Key for Table 3:

dpm/100 cm^2	=	disintegrations per minute per 100 square centimeters
cm	=	centimeter(s)
m^2	=	square meter(s)
$\mu_{95\%}$	=	upper limit of the true population mean at the 95 percent confidence level
μR/h	=	microroentgens per hour
WL	=	working level
Ra-226	=	radium-226
Th-230	=	thorium-230
pCi/g	=	picocuries per gram
$\bar{x}$	=	mean of sample concentrations
S_{hg}	=	hot spot limit (from DOE 1987b)

contributed by common building materials indicated that most background measurements for beta-gamma activity in the DOE-GJO buildings can be performed by measuring ambient background activity in air.

- Good communication and coordination of activities is essential for limiting unnecessary delays and costs. For example, organizations that prepare survey plans should also be involved in the release surveys. A staff member from the organization that prepared the GJORAP survey plan met with the survey crews each morning and occasionally during each day to answer survey crews' questions and observe the work. As a result, problems related to staffing, recording data, reading survey instruments, and interpreting the plan were identified and corrected before they resulted in delays to the project or significantly increased costs.

X. References

Chem-Nuclear Geotech, Inc., 1993a. *Comprehensive Building Survey Completion Report for Building 29*, memorandum from K.D. Briar to D.M. Frye, U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, July 1.

Chem-Nuclear Geotech, Inc., 1993b. *Comprehensive Compound Roof Surveys*, memorandum from K.D. Briar to D.M. Frye, U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, August 11.

U. S. Department of Energy (DOE), 1986. *Radiologic Characterization of the Department of Energy Grand Junction Projects Office Facility*, GJ–41, prepared by Bendix Field Engineering Corporation for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, January.

_____, 1987a. *Historical Survey of the Grand Junction Projects Office Facility—Hazardous (Non-radioactive) Wastes*, prepared by UNC Technical Services, Inc., for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, February.

_____, 1987b. *Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites*, Rev. 2, March.

_____, 1989a. *Final Remedial Investigation/Feasibility Study—Environmental Assessment for the U.S. Department of Energy Grand Junction (Colorado) Projects Office Facility*, DOE/EA–0402, prepared by UNC Geotech, Inc., for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, July.

_____, 1989b. "Review of Remedial Investigation/Feasibility Study (RI/FS) for a Site Which is Not Included on the National Priorities List (NPL)," letter from Dee Williamson, U.S. Department of Energy Grand Junction Projects Office, to David Schaller, U.S. Environmental Protection Agency Region VIII, Grand Junction, Colorado, August 4.

_____, 1990a. *Grand Junction Projects Office Remedial Action Project, Declaration for the Record of Decision and Record of Decision Summary* [includes the *Responsiveness Summary*], prepared by UNC Geotech, Inc., for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, April.

_____, 1990b. *Grand Junction Projects Office Remedial Action Program, Radiological Assessment for Construction Phase IB,* prepared by UNC Geotech, Inc., for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, April.

_____, 1990c. *Grand Junction Projects Office Remedial Action Project Remedial Action Plan*, P–GJPO–142, prepared by UNC Geotech, Inc., for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, December.

_____, 1995a. *Final Report of the Decontamination and Decommissioning of the Exterior Land Areas at the Grand Junction Projects Office Facility,* prepared by Rust Geotech for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, September.

_____, 1995b. *Survey Plan for Releasing the Buildings at the Grand Junction Projects Office for Unrestricted Use,* prepared by Rust Geotech for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, December.

_____, 1997. *Survey for Determining Background Activities of Common Building Materials,* prepared by *WASTREN-Grand Junction* for the U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado, August.

WASTREN-Grand Junction, 1997a. *Building 29 Closeout Report—Ra-226 Results*, memorandum from R.K. Johnson to Building 29 File, U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado, June 9.

_____, 1997b. *Ambient Air Activity for Release Surveys of Buildings 11, 19, 29, 30B, 54, and 56,* memorandum from S.G. Corle to GJORAP Building Files, U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado, August 8.

_____, 1997c. *MDC Calculations for GJORAP*, memorandum from R.L. Morris to S.G. Corle, U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado, August 22.

Appendix A

Applicable Program and Quality Assurance Requirements and Procedures

This page intentionally blank

The following manuals and guidance documents were used as applicable for conducting GJORAP administrative and performance activities. The specific manuals and documents pertinent to the activities associated with the release survey of this building are noted in the text of this report.

Joint Contractor Manuals

The GJO Quality Assurance Manual (GJO 1)

The GJO Health and Safety Standards (GJO 2)

The GJO Site Radiological Control Manual (GJO 3)

The GJO Training Manual (GJO 4)

The GJO Construction Procedures Manual (GJO 5)

The GJO Environmental Procedures Catalog (GJO 6)

The GJO Formality of Operations Manual (GJO 7)

The GJO Emergency Preparedness & Response Plan (GJO 8)

FOS Contractor Manuals

Safety and Health Manual

Environmental Compliance Manual

Operations Management Manual

Information Services Manual

Project Management Controls System Description

Budget Manual

Site Management Manual

Calibration and Control Program Manual

Information Management Support Manual

Grand Junction Projects Office Remedial Action Project Quality Assurance Program Plan (P–GJPO–141, Rev. 6)

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

Grand Junction Projects Office Remedial Action Project Health and Safety Plan (P–GJPO–144, Rev. 7)

Engineering Support Procedures Manual

AutoCAD Standards Manual

Analytical Chemistry Laboratory Administrative Plan and Quality Control Procedures

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

TAR Contractor Manual

Field Services Procedures Manual (Manual MAC-3000)

Other Guidance

10 CFR 830, "Nuclear Safety Management."

10 CFR 835, "Occupational Radiation Protection."

40 CFR 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings."

40 CFR 261, "Identification and Listing of Hazardous Waste."

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan."

A Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD Version 4.0, Argonne National Laboratory, June 1989.

"Approval of the Grand Junction Projects Office Remedial Action Project: National Environmental Policy Act and Comprehensive Environmental Response, Compensation, and Liability Act Documents," DOE, February 29, 1990.

"Calculation of Total Uranium Specific Activity From Total Uranium Chemical Concentration by Weight," Rust Geotech, November 11, 1994.

Community Relations in Superfund: A Handbook, EPA, January 1992.

Defense Decontamination and Decommissioning Program: Program Management Plan, DOE, December 1989.

DOE Order O 420.1, *Facility Safety*

DOE Order O 440.1, *Worker Protection Management for DOE Federal and Contractor Employees.*

DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, Change 2.

DOE Order 5700.6C, *Quality Assurance*, Change 1.

DOE Order 5820.2A, *Radioactive Waste Management.*

Environmental Implementation Guide for Radiological Survey Procedures, draft report, DOE, November 1992.

GJPORAP/IVC Project Management Summary, ORNL, May 1994.

Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material, U.S. Nuclear Regulatory Commission, 1982.

Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites, Rev. 2, DOE, March 1987.

Interim Final Guidance on Preparing Superfund Decision Documents: The Proposed Plan, The Record of Decision, Explanation of Significant Differences, The Record of Decision Amendment, EPA, July 1989.

Limits for Intakes of Radionuclides by Workers, International Commission on Radiological Protection (ICRP), August 1982.

Manual for Conducting Radiological Surveys in Support of License Termination, NUREG/CR 5849 [draft], prepared by Oak Ridge Associated Universities for the U.S. Nuclear Regulatory Commission, June 1992.

Procedures for Completion and Deletion of National Priority List Sites, EPA, October 1988.

Project Plan for the U.S. Department of Energy Grand Junction Projects Office Remedial Action Project, DOE, March 1986.

Proposed GJPORAP Release Criteria and Scope Impacts," DOE, July 20, 1989.

Public Participation in Environmental Restoration Activities, DOE, November 1991.

Quality Assurance Program for Nuclear Facilities, ANSI/ASME NQA–1, American Society of Mechanical Engineers, 1989.

Recommendations of the ICRP, ICRP, August 1987.

Record of Decision for Remedial Action at the Climax Uranium Company Uranium Mill Site, Grand Junction, Colorado, DOE, August 1988.

SFMP Resource Manual, DOE, 1989.

Verification and Certification Protocol for the Office of Environmental Restoration, Formerly Utilized Sites Remedial Action Program and Decontamination and Decommissioning Program, Rev. 3, DOE, November 1990.

Work Plan for Independent Verification of the Grand Junction Projects Office Remedial Action Project, ORNL, October 1991.

Appendix B

Final Radiological Conditions

This page intentionally blank

Appendix B Table Summary

Table B–1 provides MDC calculation results for the instruments used for beta-gamma activity and gamma exposure rate measurements. Beta-gamma scan and direct-measurement survey data for the building surfaces are listed in Tables B–2 and B–3. Table B–4 presents the results of additional measurements made during the release survey. Removable contamination survey data from smear measurements are provided in Table B–5. Interior and exterior static gamma exposure rate measurement data are provided in Table B–6. Listed in Table B–7 are the soil sample results for the exterior ground area located within 3 meters of Building 29. Table B–8 presents the statistical summary of the measurement results.

Appendix B Figure Summary

The verification cells and sample and measurement locations for the exterior ground area are shown on Figure B–1. Figures B–2 through B–7 show the locations where beta-gamma scans were performed and direct measurements were made on the surfaces of the building. Interior gamma scans of the floor surface and static gamma measurement locations (1 m above the floor) are shown on Figure B–2.

Table B–1. Survey Instrumentation Sensitivities

Type of Measurement	Instrumentation		MDC[a]	
	Detector	Meter	Static	Scan
Beta-Gamma	Eberline SHP–340 Gas Proportional	Eberline E–600	530 dpm/100 cm^2	1700 dpm/100 cm^2
Gamma	Same as meter	Mount Sopris SC–132 Portable Scintillometer[b]	Not calculated[c]	3.4 μR/h

[a]Calculations include background counts for a specified time period. Equations and calculations are provided in *MDC Calculations for GJORAP* (*WASTREN* 1997c).

[b]The instrument has a 1.5 x 1.5-inch sodium iodide detector.

[c]The calculation of MDC for static gamma measurements is not appropriate due to empirical characteristics of the measurement method and associated variables. However, instrument detection is expected to be at least as sensitive as the scan MDC.

Key for Table B–1:

MDC	=	minimum detectable concentration
dpm/100 cm^2	=	disintegrations per minute per 100 square centimeters
μR/h	=	microroentgens per hour

The following equations and factors were used to calculate instrument sensitivities (from *WASTREN* 1997c):

$$Static\ MDC_{\beta-\gamma} = \frac{3 + 4.65 * \sqrt{C_b}}{T * \epsilon_T * A * K} = \frac{3 + 4.65 * \sqrt{230}}{1 * 0.19 * 73 * 0.01} = 530\ dpm/100\ cm^2$$

$$Scan\ MDC_{\beta-\gamma} = \frac{\frac{d' * \sqrt{B_r * T}}{T}}{\sqrt{E_{hf}} * \epsilon_T * A * K} = \frac{\frac{2 * \sqrt{230 * 1/60}}{1/60}}{\sqrt{1} * 0.19 * 73 * 0.01} = 1700\ dpm/100\ cm^2$$

$$Scan\ MDC_{\gamma} = \frac{\frac{d' * \sqrt{B_r * T}}{T}}{\sqrt{E_{hf}} * \epsilon_i * K} = \frac{\frac{2 * \sqrt{6300 * 1/60}}{1/60}}{\sqrt{0.65} * 450 * 1} = 3.4\ \mu R/h$$

Where:

$MDC_{\beta-\gamma}$	=	minimum detectable concentration for measuring beta-gamma activities
MDC_{γ}	=	mimimum detectable concentration for measuring gamma exposure rates
C_b	=	background counts for a count time T
T	=	count time or observational interval in minutes
ϵ_T	=	total detector efficiency in counts per disintegration (based on 1997 calibration)
A	=	probe area in square centimeters
K	=	unit or time conversion factors
d'	=	index of sensivity
B_r	=	applicable background count rate in counts per minute
E_{hf}	=	human factors efficiency
ϵ_i	=	instrument efficiency in counts per minute per μR/h (based on 1997 calibration where exposure rate (μR/h) = cps x 0.0748 + 6.03; therefore 105 cps = 13.9 μR/h, and 1 μR/h = 450 cpm)

Table B–2. Survey Unit 1 Surface Measurement Data

Loc. No.	Surface	Media	Background Activity[a]	Scan Beta-Gamma Activity				Direct Beta-Gamma Activity	
				Gross Max.	Gross Min.	Net Max.	Net Min.	Gross	Net
1	Floor	Carpet	1500	1999	979	499	-521	1649	149
2	Floor	Carpet	1500	2036	1309	536	-191	1731	231
3	Floor	Carpet	1500	1950	1200	450	-300	1465	-35
4	Floor	Carpet	1500	2580	1109	1080	-391	1978	478
5	Floor	Carpet	1500	2880	1206	1380	-294	1832	332
6	Floor	Carpet	1500	1900	1441	400	-59	1382	-118
7	Floor	Carpet	1500	2390	968	890	-532	1862	362
8	Ceiling	Sheetrock	1500	1590	1200	90	-300	1490	-10
9	Ceiling	Sheetrock	1500	1635	1230	135	-270	1369	-131
10	Ceiling	Sheetrock	1500	1666	1166	166	-334	1465	-35
11	Ceiling	Sheetrock	1500	1690	1160	190	-340	1439	-61
12	Ceiling	Sheetrock	1500	2460	949	960	-551	1661	161
13	Ceiling	Sheetrock	1500	2140	1115	640	-385	1707	207
14	Ceiling	Sheetrock	1500	1790	1125	290	-375	1357	-143
15	Interior Wall	Sheetrock	1500	1946	1046	446	-454	1455	-45
16	Interior Wall	Sheetrock	1500	1910	999	410	-501	1605	105
17	Interior Wall	Sheetrock	1500	2070	946	570	-554	1546	46
18	Interior Wall	Sheetrock	1500	1958	1292	458	-208	1776	276
19	Interior Wall	Sheetrock	1500	2110	955	610	-545	1409	-91
20	Interior Wall	Sheetrock	1500	1906	1003	406	-497	1396	-104
21	Interior Wall	Sheetrock	1500	1705	1006	205	-494	1415	-85
22	Interior Wall	Sheetrock	1500	2290	996	790	-504	1455	-45
23	Interior Wall	Sheetrock	1500	1835	1121	335	-379	1376	-124
24	Interior Wall	Sheetrock	1500	1956	1007	456	-493	1560	60
25	Interior Wall	Sheetrock	1500	1917	998	417	-502	1448	-52
26	Interior Wall	Sheetrock	1500	1998	1017	498	-483	1540	40
27	Interior Wall	Sheetrock	1500	2190	1100	690	-400	1619	119
28	Interior Wall	Sheetrock	1500	2290	1199	790	-301	1540	40
29	Interior Wall	Sheetrock	1500	1963	1054	463	-446	1487	-13
30	Interior Wall	Sheetrock	1500	2170	1133	670	-367	1297	-203

[a]Background activity includes average background ambient air and average material-specific activities (DOE 1997, *WASTREN* 1997b).

Note: All measurements were read in dpm/100 cm^2 and were collected with an Eberline E–600 meter with an Eberline SHP–340 probe to measure gross beta-gamma activity.

Table B–3. Survey Unit 2 Surface Measurement Data

Loc. No.	Surface	Media	Background Activity[a]	Scan Beta-Gamma Activity				Direct Beta-Gamma Activity	
				Gross Max.	Gross Min.	Net Max.	Net Min.	Gross	Net
33	Exterior Wall	Wood	1500	2260	969	760	-531	1605	105
34	Exterior Wall	Wood	1500	2220	862	720	-1358	1530	30
35	Exterior Wall	Wood	1500	1849	899	349	-950	1447	-53
36	Exterior Wall	Wood	1500	2150	825	650	-1325	1637	137
37	Exterior Wall	Wood	1500	2270	1300	770	-970	1586	86
38	Exterior Wall	Wood	1500	2010	1191	510	-819	1422	-78
39	Exterior Wall	Wood	1500	1790	860	290	-930	1268	-232
40	Exterior Wall	Wood	1500	1985	925	485	-1060	1262	-238
41	Exterior Wall	Wood	1500	1818	873	318	-945	1501	1
42	Exterior Wall	Wood	1500	2060	976	560	-1084	1498	-2
43	Exterior Wall	Wood	1500	2070	1211	570	-859	1422	-78
44	Exterior Wall	Wood	1500	2000	1112	500	-888	1324	-176
45	Exterior Wall	Wood	1500	1937	1131	437	-806	1619	119
46	Exterior Wall	Wood	1500	2040	934	540	-1106	1455	-45
47	Exterior Wall	Wood	1500	1680	868	180	-812	1388	-112
48	Exterior Wall	Wood	1500	1745	930	245	-815	1408	-92
49	Exterior Wall	Wood	1500	2084	796	584	-1288	1394	-106
50	Roof Overhang	Wood	1500	2390	1489	890	-901	1855	355
51	Roof Overhang	Wood	1500	2100	1027	600	-1073	1966	466
52	Roof Overhang	Wood	1500	1918	968	418	-950	1439	-61
53	Roof Overhang	Wood	1500	1560	960	60	-600	1395	-105
59	Roof	Vinyl	1500	2000	1039	500	-961	1579	79
60	Roof	Vinyl	1500	2150	1043	650	-1107	1645	145
61	Roof	Vinyl	1500	2030	1032	530	-998	1756	256
62	Roof	Vinyl	1500	2190	888	690	-1302	1468	-32
63	Roof	Vinyl	1500	1989	995	489	-994	1428	-72
64	Roof	Vinyl	1500	2030	851	530	-1179	1428	-72
65	Roof	Vinyl	1500	1799	721	299	-1078	1481	-19
66	Roof	Vinyl	1500	2050	637	550	-1413	1560	60
67	Roof	Vinyl	1500	1940	912	440	-1028	1566	66

[a]Background activity includes average background ambient air and average material-specific activities (DOE 1997, *WASTREN* 1997b).

Note: All measurements were read in dpm/100 cm^2 and were collected with an Eberline E–600 meter with an Eberline SHP–340 probe to measure gross beta-gamma activity.

Table B–4. Additional Measurement Data

Loc. No.[a]	Surface	Media	Background Activity[b]	Scan Beta-Gamma Activity				Direct Beta-Gamma Activity	
				Gross Max.	Gross Min.	Net Max.	Net Min.	Gross	Net
Survey Unit 1									
1 a	Floor	Concrete	1900	NM	NM	N/A	N/A	2100	200
31	Ceiling	Metal	1500	1540	970	-40	-530	1255	-245
32	Floor	Concrete/Wood	1700	1985	1500	-285	-200	NM	N/A
54 a	Interior Wall	Sheetrock	1500	NM	NM	N/A	N/A	1743	243
54 b	Interior Wall	Insulation	1500	NM	NM	N/A	N/A	2620	1120
55 a	Interior Wall	Sheetrock	1500	NM	NM	N/A	N/A	1632	132
55 b	Interior Wall	Insulation	1500	NM	NM	N/A	N/A	2540	1040
56 a	Interior Wall	Sheetrock	1500	NM	NM	N/A	N/A	1927	427
56 b	Interior Wall	Insulation	1500	NM	NM	N/A	N/A	2110	610
70 a	Floor	Concrete	1900	NM	NM	N/A	N/A	1632	-268
Survey Unit 2									
51 a	Roof Overhang	Wood	1500	NM	NM	N/A	N/A	2010	510
51 b	Roof Overhang	Wood	1500	NM	NM	N/A	N/A	1632	132
57 a	Roof Overhang	Wood	1500	NM	NM	N/A	N/A	1638	138
57 b	Roof Overhang	Wood	1500	NM	NM	N/A	N/A	1363	-137
58 a	Roof Overhang	Wood	1500	NM	NM	N/A	N/A	1769	269
58 b	Roof Overhang	Wood	1500	NM	NM	N/A	N/A	1540	40
64 a	Roof	Fiberboard	1500	NM	NM	N/A	N/A	1670	170
64 b	Roof	Pressed Board	1500	NM	NM	N/A	N/A	1642	142
64 c	Roof	Tar	1500	NM	NM	N/A	N/A	1924	424
66 a	Roof	Fiberboard	1500	NM	NM	N/A	N/A	1549	49
66 b	Roof	Pressed Board	1500	NM	NM	N/A	N/A	1604	104
66 c	Roof	Tar	1500	NM	NM	N/A	N/A	2310	810
66 d	Roof	Wood	1500	NM	NM	N/A	N/A	1658	158
66 e	Roof	Insulation	1500	NM	NM	N/A	N/A	2840	1340
68	Exterior Wall	Painted Wood	1500	NM	NM	N/A	N/A	1448	-52
68 a	Exterior Wall	Bare Wood	1500	NM	NM	N/A	N/A	1553	53
69	Exterior Wall	Painted Wood	1500	NM	NM	N/A	N/A	1448	-52
69 a	Exterior Wall	Bare Wood	1500	NM	NM	N/A	N/A	1494	-6
Survey Unit 3									
V1	Exterior Soil	Soil	1800	NM	NM	N/A	N/A	1972	172
V2	Exterior Soil	Soil	1800	NM	NM	N/A	N/A	3190	1390
V3	Exterior Soil	Soil	1800	NM	NM	N/A	N/A	2470	670
V4	Exterior Soil	Soil	1800	NM	NM	N/A	N/A	2410	610

[a]Alpha-numeric location numbers (e.g. 54 a) represent instrusive measurements taken on material under or behind the surface material.

[b]Background activity includes average background ambient air and average material-specific activities (DOE 1997, *WASTREN* 1997b).

Note: All measurements were read in dpm/100 cm^2 and were collected with an Eberline E–600 meter with an Eberline SHP–340 probe to measure gross beta-gamma activity.

Key for Table B–4:
NM = no measurement
N/A = not applicable

Table B–5. Removable Contamination Survey Data

Loc. No.	Surface	Media	Counts per 5 minutes		Alpha Background (cpm)	Beta Background (cpm)	Net Alpha Activity (dpm/100 cm^2)	Net Beta-Gamma Activity (dpm/100 cm^2)
			Alpha	Beta				
54 b	Interior Wall	Rockwool Insulation	1	339	0.1	71	0.3	-8.3
55 b	Interior Wall	Rockwool Insulation	11	325	0.1	71	6.3	-15.6

Notes:

1) Smears were counted for 5 minutes on a Ludlum 2929 scaler.
2) All smears were wiped over an area of 100 cm^2.
3) Counts per 5 minutes were converted to net activity using:

   [(counts/5) - Background] x CF = net activity

4) Location 66e also indicated elevated activity (1340 dpm/100 cm^2). However, it was not smeared because it consisted of the same material as locations 54b and 55b (rockwool insulation).

Key for Table B–5:

CF	=	conversion factor: 3.0 dpm/cpm for alpha; 2.6 dpm/cpm for beta-gamma
cpm	=	counts per minute
dpm/100 cm^2	=	disintegrations per minute per 100 square centimeters

Table B–6. Gamma Exposure Rate Measurement Data

Interior Static Measurements

Location Number	Gross		Net[a]
	cps	μR/h	μR/h
G1	95	13.2	-0.8
G2	95	13.2	-0.8
G3	95	13.2	-0.8
G4	100	13.6	-0.4
G5	95	13.2	-0.8
G6	100	13.6	-0.4
G7	100	13.6	-0.4
G8	100	13.6	-0.4
G9	95	13.2	-0.8
G10	100	13.6	-0.4
G11	90	12.8	-1.2

Exterior Static Measurements

Location Number	Gross		Net[a]
	cps	μR/h	μR/h
29–V–1	100	13.6	-0.4
29–V–2	110	14.3	0.3
29–V–3	110	14.3	0.3
29–V–4	100	13.6	-0.4

[a]Background gamma exposure rate for the facility is 14 μR/h (Table 2).

Note: Gamma exposure rates were read in cps and were measured with a Mount Sopris SC–132 scintillometer at 1 m above the floor or ground.

Key for Table B–6:
cps = counts per second
μR/h = microroentgens per hour (μR/h = cps x 0.0748 + 6.1)

Table B–7. Soil Sample Results for Exterior Areas

Sample Number	Cell Area (m^2)	Soil Sample Ticket No.	Sample Depth (cm)	Concentration (pCi/g)					
				Ra-226		Th-230		Total Uranium	
				Gross	Net[a]	Gross	Net[a]	Gross	Net[a]
29–V–1	23.9	NCK 716	0 – 15	1.56 ± 0.49	0.6	0.99	-1.0	2.3	0.3
29–V–1a	23.9	NDL 004	23 – 38	1.50 ± 0.42	0.5	1.2	-0.8	3.0	1.0
29–V–2	23.6	NCK 717	0 – 15	3.11 ± 0.56	2.1	2.3	0.3	5.0	3.0
29–V–3	23.1	NCK 718	0 – 15	4.26 ± 0.73	3.3	4.1	2.1	6.1	4.1
29–V–4	23.7	NCK 719	0 – 15	7.98 ± 0.89	7.0[b]	6.3	4.3	8.5	6.5

[a]See Table 2 for background concentrations used to calculate net concentrations.

[b]The laboratory result for individual sample 29–V–4 exceeded the Ra-226 authorized limit for the surface layer; however, the 100 m^2 average (3.3 pCi/g) is less than the authorized limit, and the sample result does not exceed the hot spot limit [S_{hg} = (5.0) x $(100/23.7)^{0.5}$ = 10.3 pCi/g]. Therefore, the release criteria for the surface soil layer are met.

Notes:

1) Ra-226 was analyzed by gamma spectrometry.
2) Th-230 and total uranium were analyzed by induction-coupled plasma-mass spectrometry with a flow-injection analysis system.
3) Analytical laboratory measurement methods, results, uncertainties, and quality control for these samples are contained in the Grand Junction Office Analytical Laboratory *Analytical Report*, Volumes 1 and 2, for Project L20A41000, June 11, 1997. All Ra-226 results were above minimum detectable activities. Uncertainties were not calculated for Th-230 and total uranium.

Key for Table B–7:

m^2	=	square meter(s)
cm	=	centimeter(s)
pCi/g	=	picocuries per gram
Ra-226	=	radium-226
Th-230	=	thorium-230
S_{hg}	=	hot spot limit (from DOE 1987b)

Table B–8. Statistical Summary of Measurement Surveys

Net Building Surface Beta-Gamma Activity

Survey Unit	Surfaces	n	$t_{95\%,d.f.}$	Net Activity (dpm/100 cm^2)		
				$\bar{x}$	s	$\mu_{95\%}$
1	Interior walls, floor, and ceiling	30	1.699	43.70	167.61	96
2	Exterior walls, roof, and roof overhang	30	1.699	11.07	156.44	60

Net Interior Gamma Exposure Rates

n	$t_{95\%,d.f.}$	Net Gamma Exposure Rates (μR/h)		
		$\bar{x}$	s	$\mu_{95\%}$
11	1.812	-0.65	0.27	-0.5

Net Exterior Gamma Exposure Rates

n	$t_{95\%,d.f.}$	Net Gamma Exposure Rates (μR/h)		
		$\bar{x}$	s	$\mu_{95\%}$
4	2.353	-0.05	0.40	0.4

Net Soil Concentrations (Surface Layer)

Contaminant	n	$t_{95\%,d.f.}$	Net Concentrations (pCi/g)		
			$\bar{x}$	s	$\mu_{95\%}$
Ra-226	4	2.353	3.25	2.73	6.5[a]
Th-230	4	2.353	1.43	2.30	4.1
Total Uranium[b]	5	2.132	2.98	2.49	5.4

[a] $\mu_{95\%}$ is greater than the authorized limit for Ra-226; however, additional sampling and analysis were not conducted to satisfy the standard with 95% confidence because all of the release criteria were met. The confidence level that $\mu_{95\%} \leq 5.0$ pCi/g total Ra-226 in the tp 15 cm of soil, based on the samples collected, is approximately 85% (*WASTREN* 1997a).

[b] The authorized limit for total uranium applies to any soil layer; therefore, all 5 samples were included in the statistical analysis.

Note: See Tables B–2, B–3, B–6, and B–7 for the survey data.

Key for Table B–8:

dpm/100 cm^2	=	disintegrations per minute per 100 square centimeters
μR/h	=	microroentgens per hour
pCi/g	=	picocuries per gram
n	=	number of measurements

Table B–8 (continued). Statistical Summary of Measurement Surveys

Key for Table B–8 (continued):

- $t_{95\%,d.f.}$ = Student's t distribution statistic for n-1 degrees of freedom at 95% confidence ($n \leq 30$)
- $z_{95\%}$ = z distribution statistic at 95% confidence ($n > 30$)
- $\bar{x}_{max.}$ = maximum mean of soil sample concentrations representing contiguous areas totalling approximately 100 m^2 (not used to calculate s and $\mu_{95\%}$)
- $\bar{x}$ = sample mean
- s = sample standard deviation
- $\mu_{95\%}$ = upper limit of the true population mean at the 95% confidence level, derived from:

$n \leq 30$

$$\mu_{95\%} = \bar{x} + t_{95\%,d.f.} \frac{s}{\sqrt{n}}$$

$n > 30$

$$\mu_{95\%} = \bar{x} + z_{95\%} \frac{s}{\sqrt{n}}$$

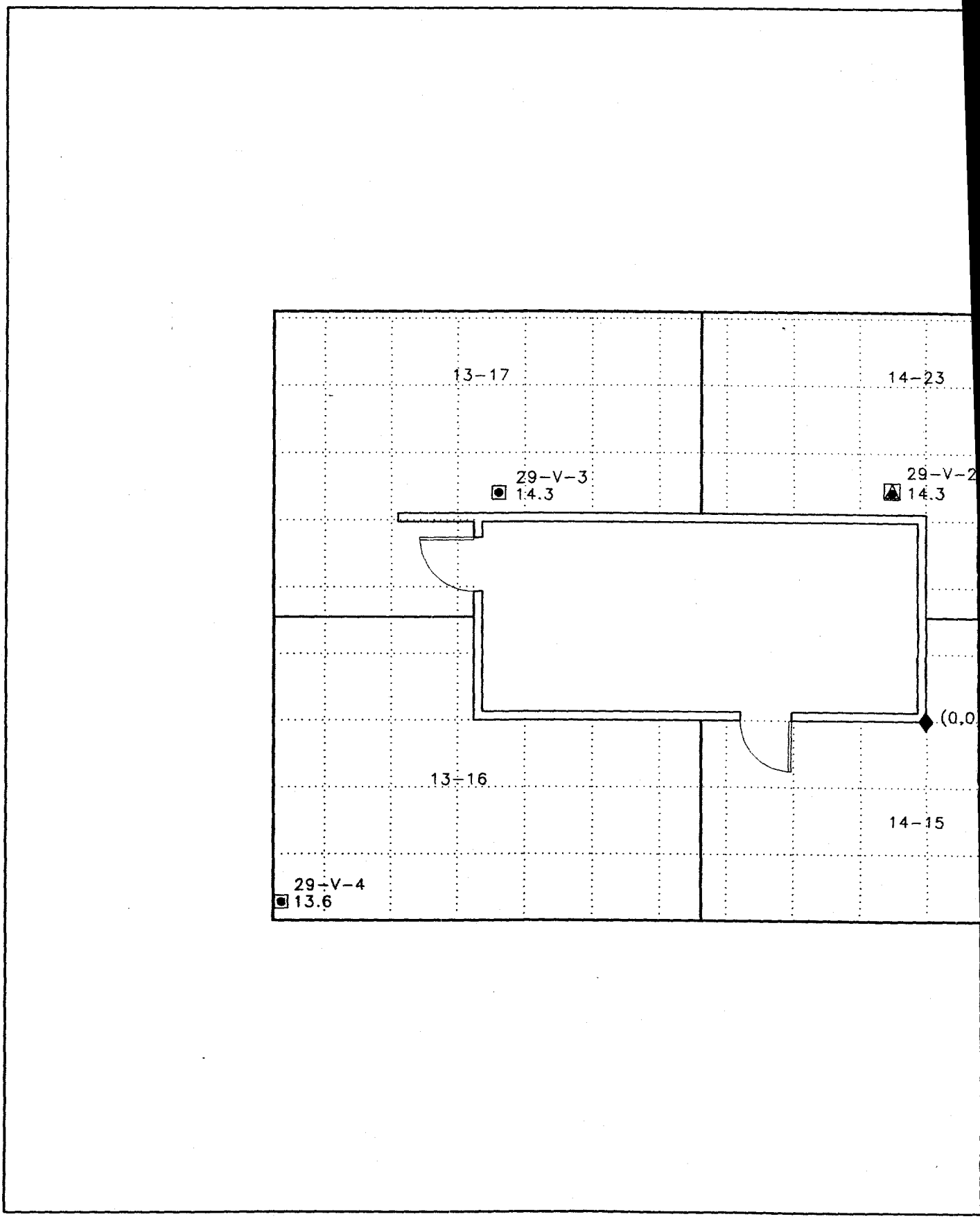
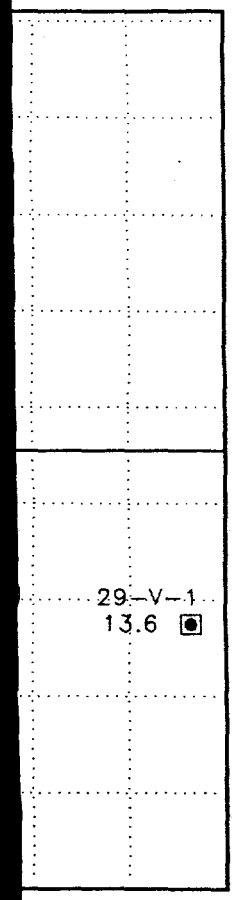


Figure B-1. Building 29 E



NORTH

SCALE IN METERS

0 2

X
Y

(X,Y)=(0,0) BUILDING COORDINATE SYSTEM
=(544.02, 622.36) FACILITY COORDINATE SYSTEM [METERS]

LEGEND

◆	BASE COORDINATE FOR 1-METER GRID SYSTEM
●	DIRECT MEASUREMENT LOCATION
△	BOREHOLE LOCATION
□	SOIL SAMPLE LOCATION
29-V-2	SOIL SAMPLE IDENTIFIER
13.6	GAMMA EXPOSURE RATE MEASUREMENT AT 1M ABOVE GROUND (μR/h)
12-14	GAMMA EXPOSURE RATE RANGE AT GROUND LEVEL (μR/h)
▭	EXTERIOR VERIFICATION AREA BOUNDARY

EASTERN - Grand Junction

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

Figure B-1 BUILDING 29 EXTERIOR GROUND SURVEY

PREPARED:	CHECKED:	DATE PREPARED:
CSW	RKS	JUNE 1997

PROJECT NUMBER:	FILENAME:
TCR-031-0016-00-000	T00059AA

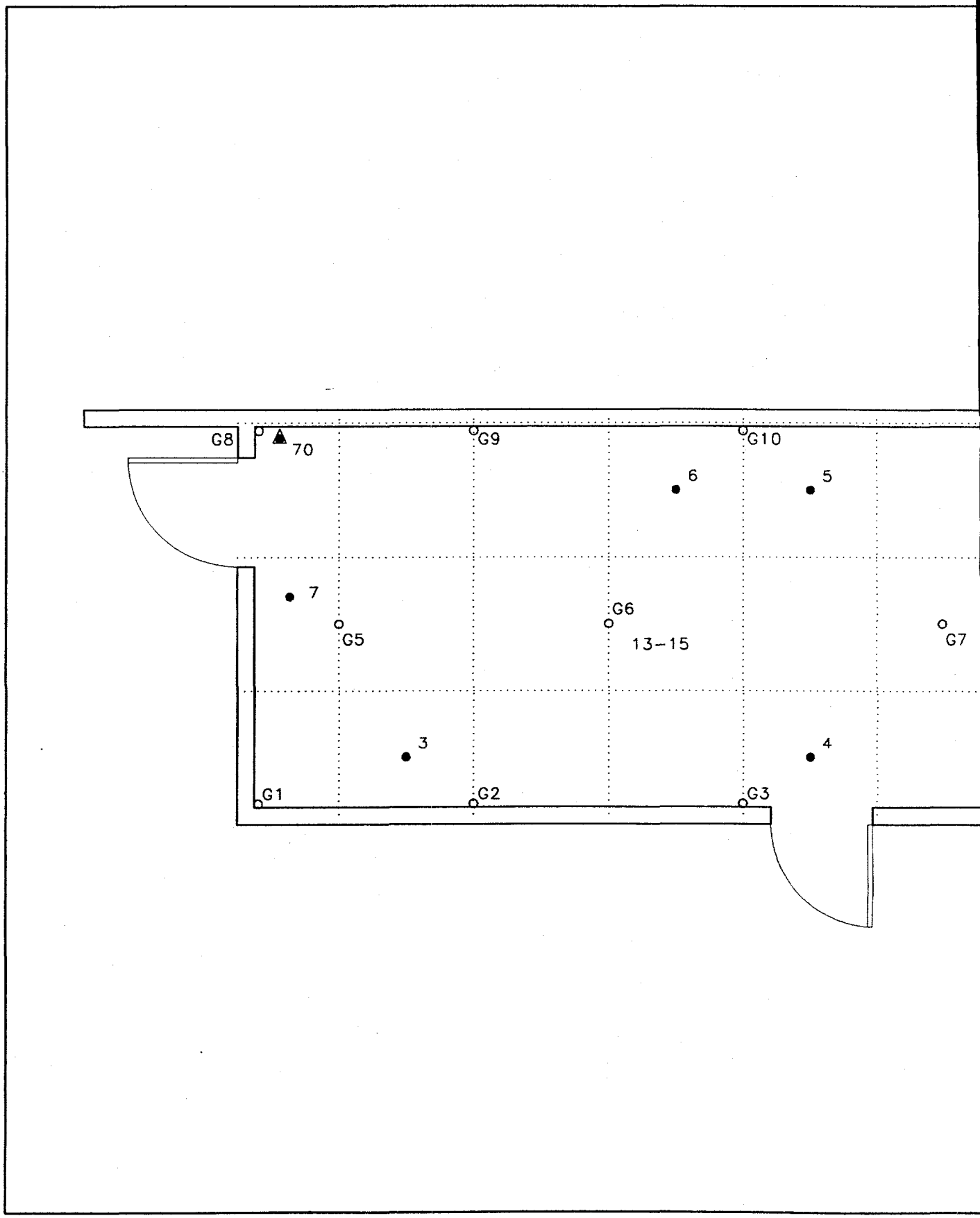
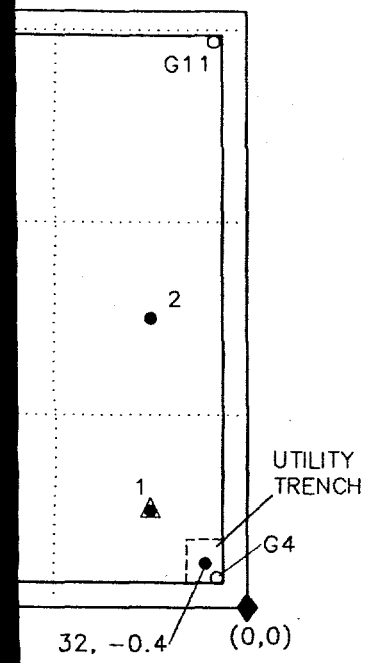
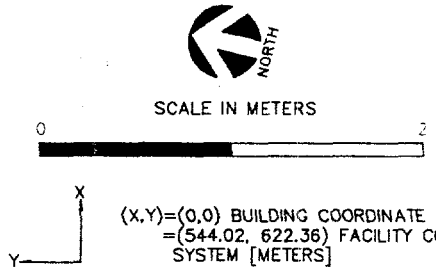


Figure B–2. Building 29 Floor





LEGEND

◆	BASE COORDINATE FOR 1 METER GRID SYSTEM
●	DIRECT MEASUREMENT LOCATION
o	GAMMA EXPOSURE RATE MEASUREMENT LOCATION AT 1M ABOVE FLOOR
35	MEASUREMENT LOCATION NUMBER
12-14	GAMMA EXPOSURE RATE RANGE AT FLOOR LEVEL (μR/h)

WESTREN - Grand Junction	U.S. DEPARTMENT OF ENERGY GRAND JUNCTION OFFICE, COLORADO	
Figure B-2	BUILDING 29 FLOOR AND INTERIOR GAMMA SURVEY	
PREPARED: CSC	CHECKED: [illegible]	DATE PREPARED: JUNE 1997
PROJECT NUMBER: TCR-031-0016-00-000		FILENAME: T00060AA

nd Interior Gamma Survey

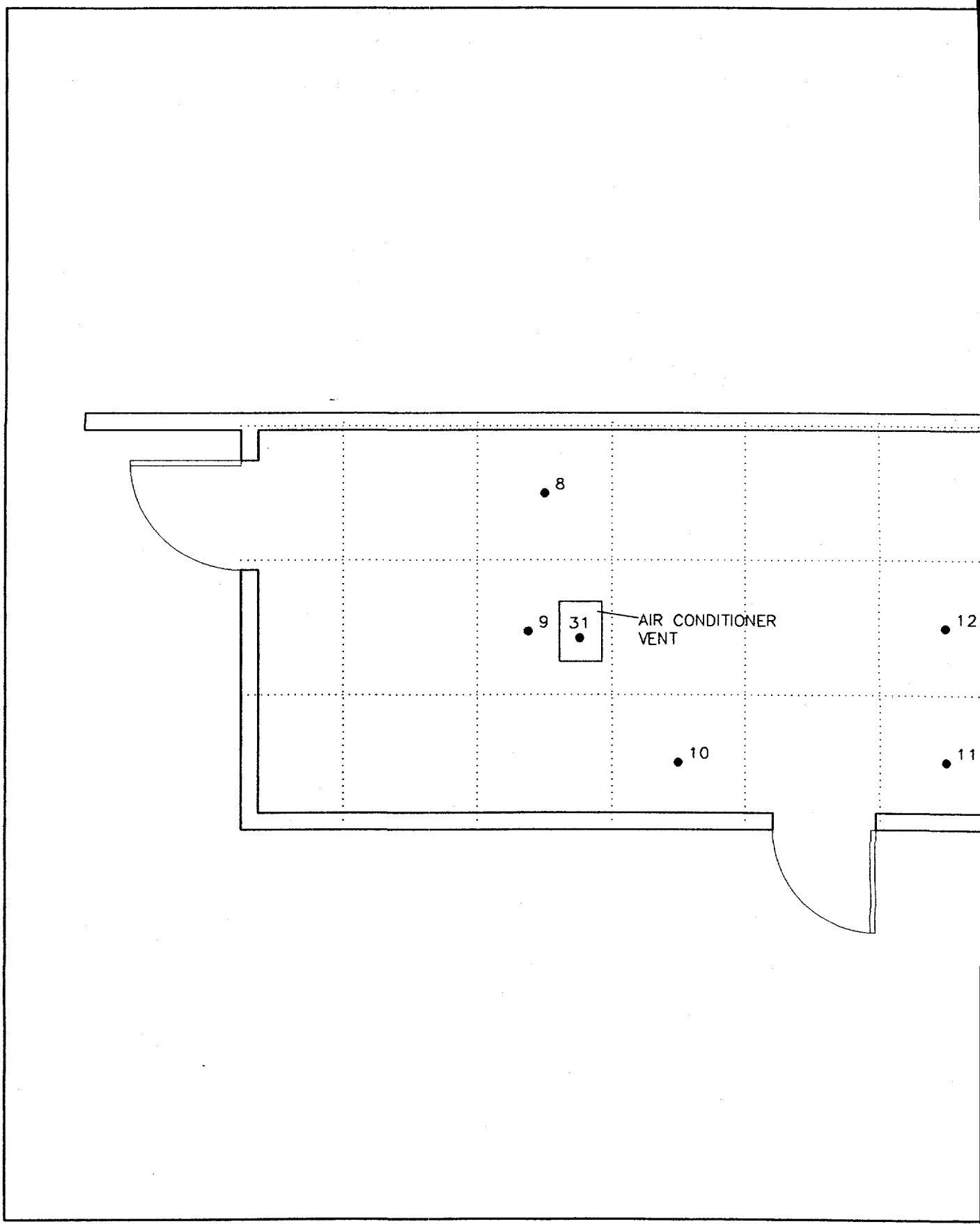
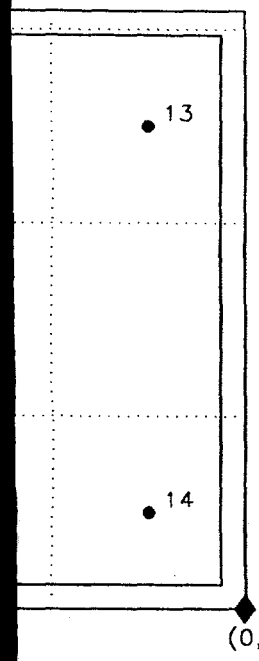


Figure B–3. Building



SCALE IN METERS

0 2

X
Y

(X,Y)=(0,0) BUILDING COORDINATE SYSTEM
=(544.02, 622.36) FACILITY COORDINATE SYSTEM [METERS]

LEGEND

◆ BASE COORDINATE FOR 1-METER GRID SYSTEM

● DIRECT MEASUREMENT LOCATION

35 MEASUREMENT LOCATION NUMBER

WESTERN - Grand Junction	U.S. DEPARTMENT OF ENERGY GRAND JUNCTION OFFICE, COLORADO	
Figure B-3	BUILDING 29 CEILING SURVEY	
PREPARED: CSW	CHECKED:	DATE PREPARED: JUNE 1997
PROJECT NUMBER: TCR-031-0016-00-000		FILENAME: T00061AA

29 Ceiling Survey

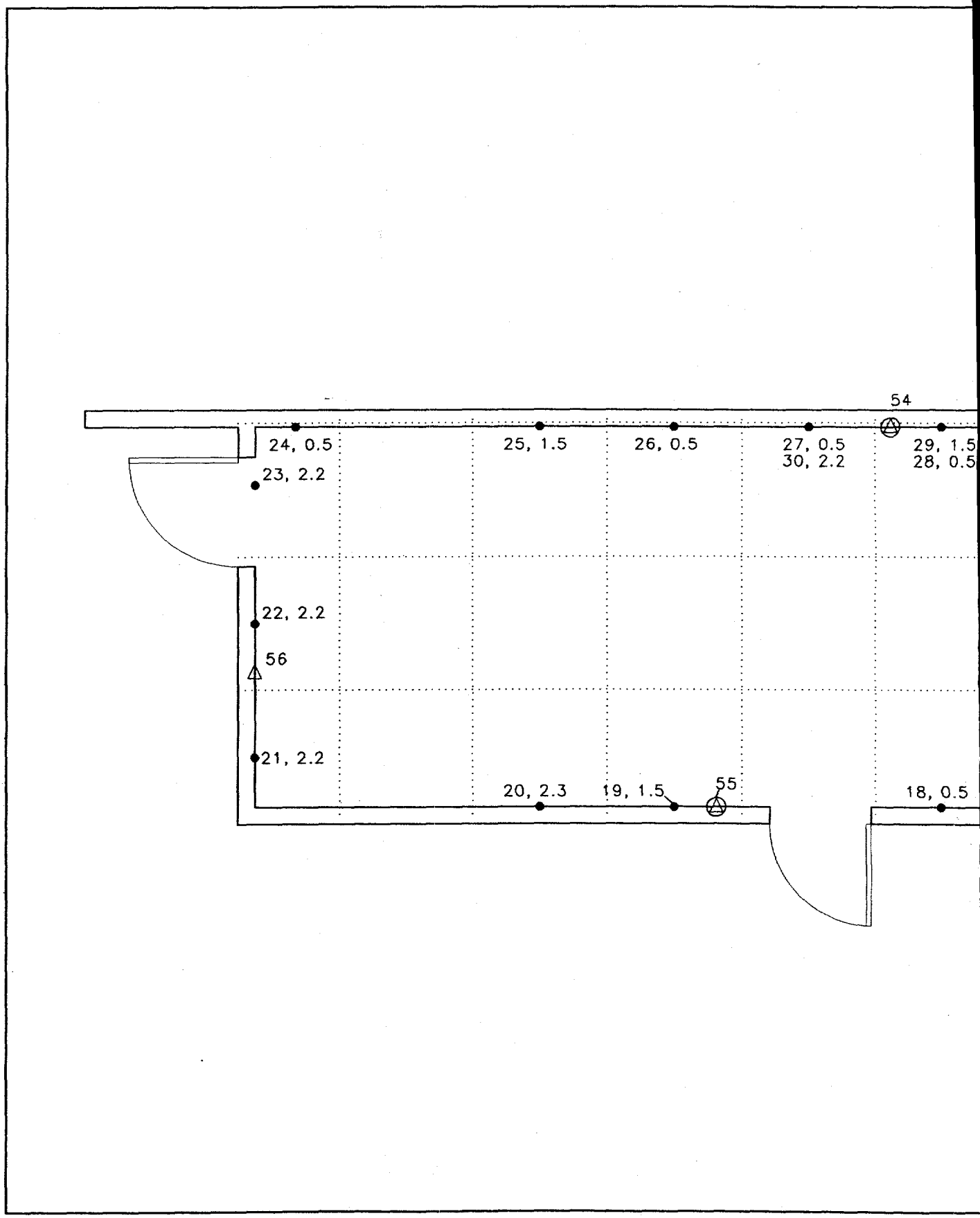
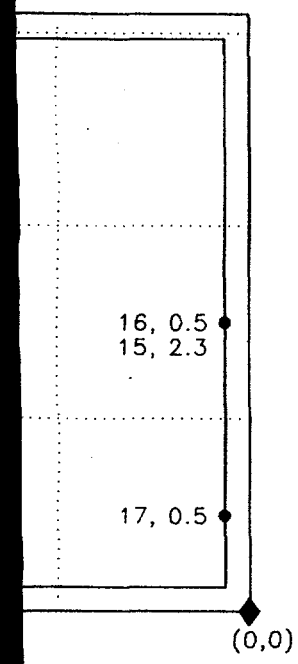


Figure B–4. Building 29



SCALE IN METERS

0 2

(X,Y)=(0,0) BUILDING COORDINATE SYSTEM
=(544.02, 622.36) FACILITY COORDINATE SYSTEM [METERS]

LEGEND

◆ BASE COORDINATE FOR 1–METER GRID SYSTEM

● DIRECT MEASUREMENT LOCATION

◯ SMEAR LOCATION

△ INTRUSIVE MEASUREMENT LOCATION

35 MEASUREMENT LOCATION NUMBER

35,1.5 MEASUREMENT LOCATION NUMBER, FOLLOWED BY HEIGHT ABOVE FLOOR (METERS)

WESTREN - Grand Junction	U.S. DEPARTMENT OF ENERGY GRAND JUNCTION OFFICE, COLORADO	
Figure B–4	BUILDING 29 INTERIOR WALL SURVEY	
PREPARED: CSW	CHECKED: RWO	DATE PREPARED: JUNE 1997
PROJECT NUMBER: TCR–031–0016–00–000		FILENAME: T00062AA

Interior Wall Survey

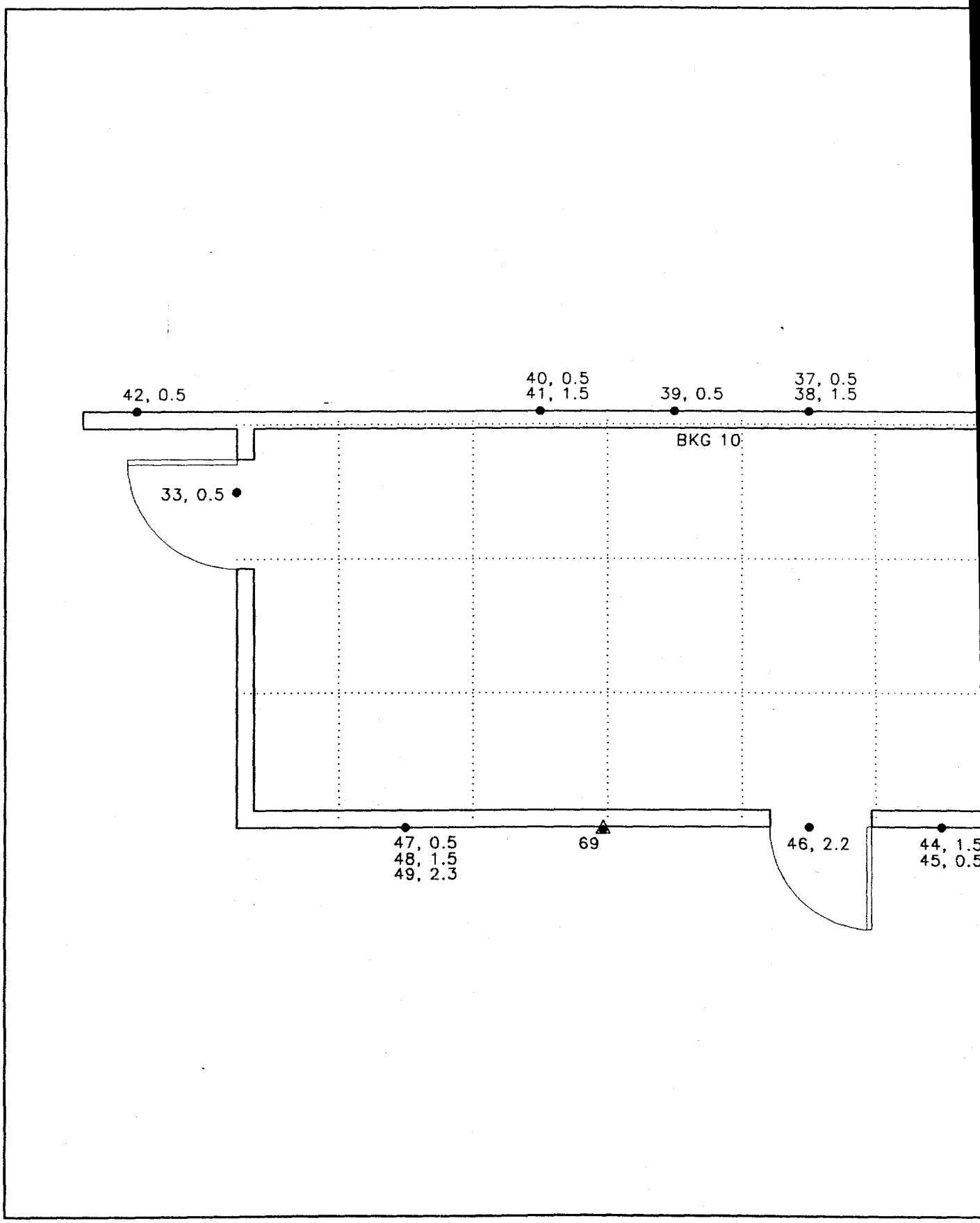
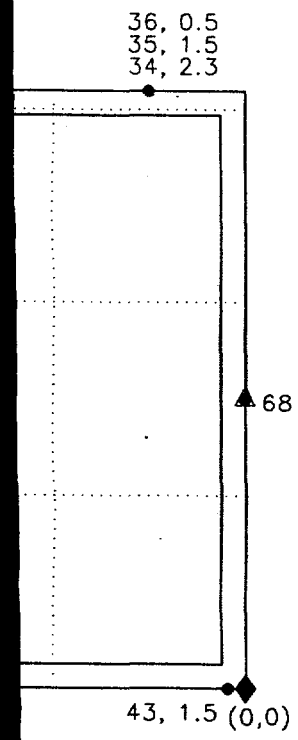
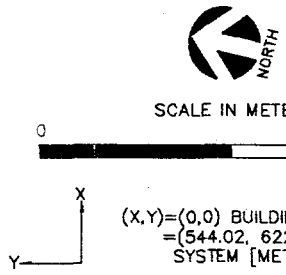


Figure B–5. Building 29





LEGEND

◆	BASE COORDINATE FOR 1-METER GRID SYSTEM
●	DIRECT MEASUREMENT LOCATION
△	INTRUSIVE MEASUREMENT LOCATION
35	MEASUREMENT LOCATION NUMBER
35, 1.5	MEASUREMENT LOCATION NUMBER, FOLLOWED BY HEIGHT ABOVE GROUND (METERS)

WASTREN - Grand Junction	U.S. DEPARTMENT OF ENERGY GRAND JUNCTION OFFICE, COLORADO	
Figure B-5	BUILDING 29 EXTERIOR WALL SURVEY	
PREPARED: CSW	CHECKED: [illegible]	DATE PREPARED: JUNE 1997
PROJECT NUMBER: TCR-031-0016-00-000		FILENAME: T00063AA

Exterior Wall Survey

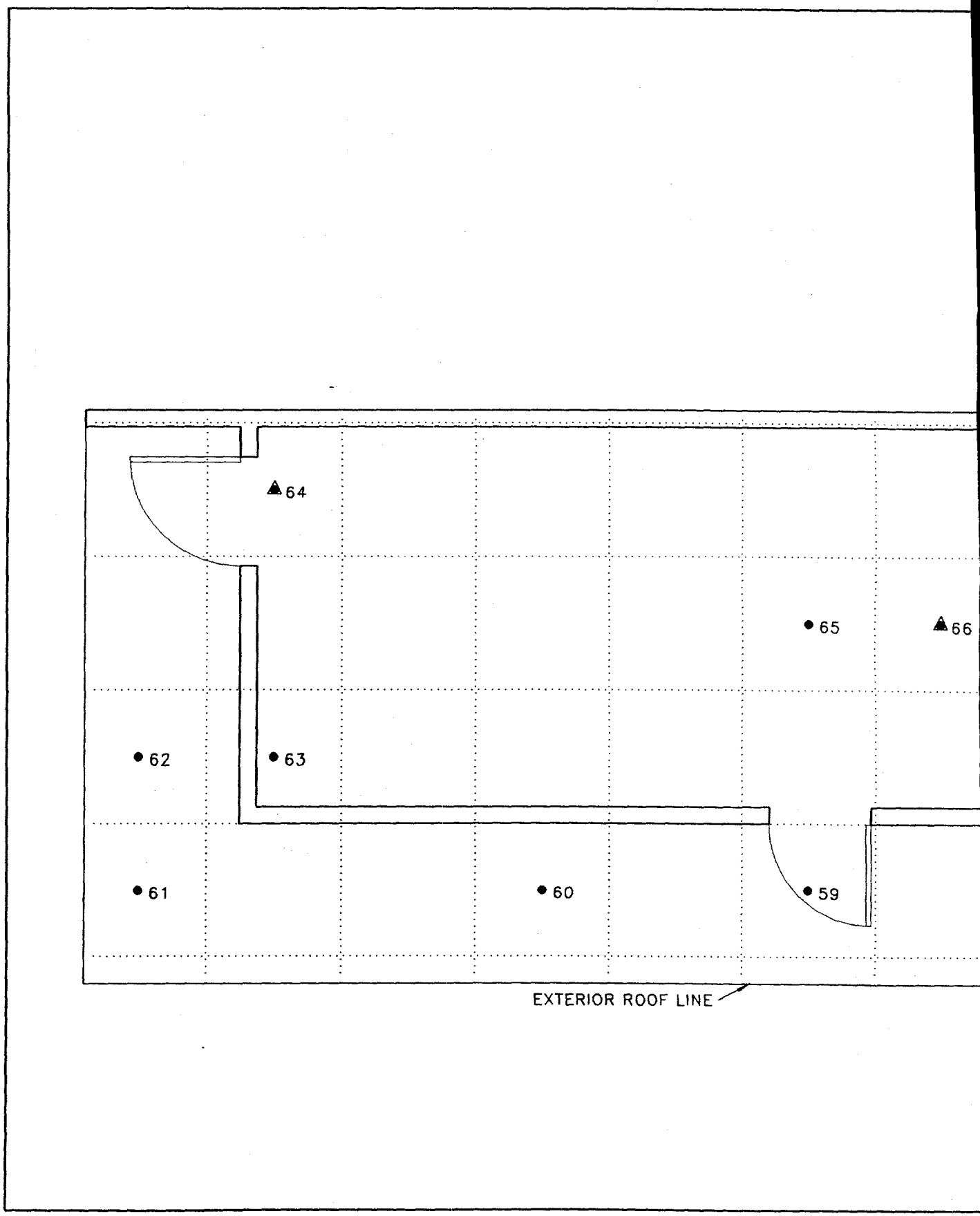
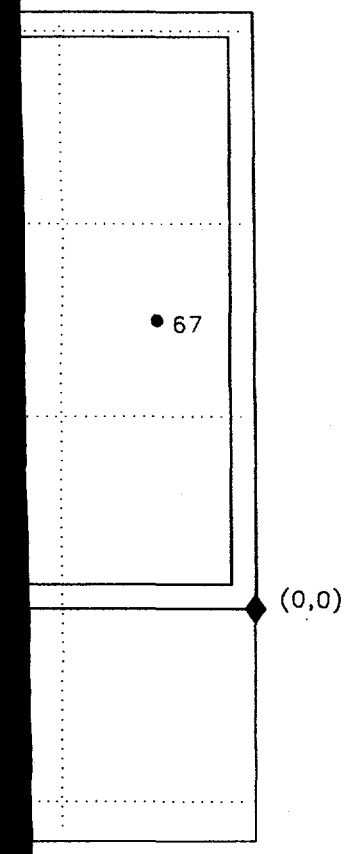
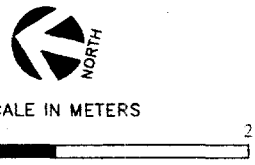


Figure B–6. Building





(X,Y)=(0,0) BUILDING COORDINATE SYSTEM
=(544.02, 622.36) FACILITY COORDINATE SYSTEM [METERS]

LEGEND

◆ BASE COORDINATE FOR 1-METER GRID SYSTEM

● DIRECT MEASUREMENT LOCATION

△ INTRUSIVE MEASUREMENT LOCATION

35 MEASUREMENT LOCATION NUMBER

WESTERN - Grand Junction	U.S. DEPARTMENT OF ENERGY GRAND JUNCTION OFFICE, COLORADO	
Figure B-6	BUILDING 29 ROOF SURVEY	
PREPARED: CSW	CHECKED: RKS	DATE PREPARED: JUNE 1997
PROJECT NUMBER: TCR-031-0016-00-000		FILENAME: T00064AA

29 Roof Survey

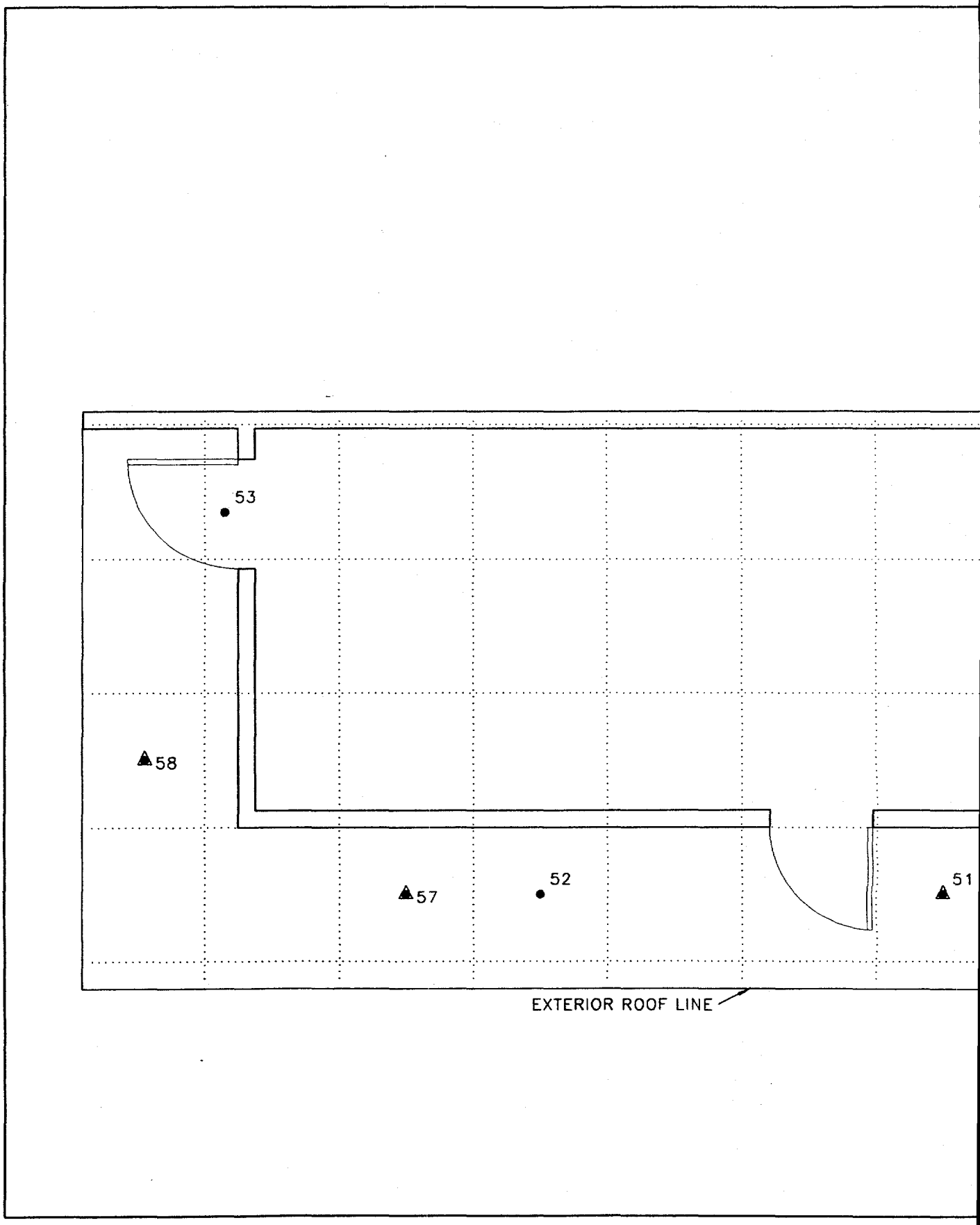
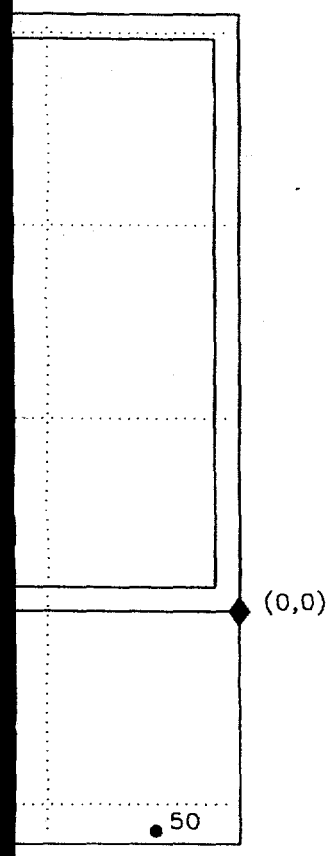


Figure B–7. Building 29 Unders



NORTH

SCALE IN METERS

0 2

X
Y

(X,Y)=(0,0) BUILDING COORDINATE SYSTEM
=(544.02, 622.36) FACILITY COORDINATE SYSTEM [METERS]

LEGEND

◆ BASE COORDINATE FOR 1-METER GRID SYSTEM

● DIRECT MEASUREMENT LOCATION

△ INTRUSIVE MEASUREMENT LOCATION

35 MEASUREMENT LOCATION NUMBER

WESTREN - Grand Junction	U.S. DEPARTMENT OF ENERGY GRAND JUNCTION OFFICE, COLORADO
Figure B-7	BUILDING 29 UNDERSIDE OF ROOF OVERHANG SURVEY
PREPARED:	CHECKED: / DATE PREPARED: JUNE 1997
PROJECT NUMBER: TCR-031-0016-00-000	FILENAME: T00065AA

...e of Roof Overhang Survey