2-1-5

ORISE

OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

August 23, 1993

Mr. George M. France
Region III
U.S. Regulatory Commission
799 Roosevelt Rd.
Glen Ellyn, IL 60137

SUBJECT: CONFIRMATORY RADIOLOGICAL SURVEY OF THE WET CERAMICS AREA, CIMARRON CORPORATION FACILITY, CRESCENT,OKLAHOMA - FINAL REPORT

Dear Mr. France:

Enclosed, are five copies of the final report for the subject confirmatory survey. If you have any questions or need additional information, please contact me at (615) 576-2908.

Sincerely,

Michele Landis
Project Manager
Environmental Survey and
Site Assessment Program

ML:age

Enclosures

cc: T. Mo, NRC/4E4
D. Tiktinsky, NRC/6E6
J. Swift, NRC/6H3
J. Berger, ORISE
File/196

CONFIRMATORY RADIOLOGICAL SURVEY OF THE WET CERAMICS AREA CIMARRON CORPORATION FACILITY CRESCENT, OKLAHOMA

Prepared by

M. R. Landis

Environmental Survey and Site Assessment Program
Energy/Environment System Division
Oak Ridge Institute for Science and Education
Oak Ridge, Tennessee 37831-0117

Prepared for
Division of Industrial and Medical Nuclear Safety
U.S. Nuclear Regulatory Commission
Region III Office

FINAL REPORT

JULY 1993

This report is based on work performed under an Interagency Agreement (NRC Fin. No. A-9076) between the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy. Oak Ridge Institute for Science and Education performs complementary work under contract number DE-AC05-76OR00033 with the U.S. Department of Energy.

CONFIRMATORY RADIOLOGICAL SURVEY
OF THE
WET CERAMICS AREA
CIMARRON CORPORATION FACILITY
CRESCENT, OKLAHOMA

Prepared by: _____ Date: 8/2/93
M. R. Landis, Project Manager
Environmental Survey and Site Assessment Program

Reviewed by: _____ Date: 8/4/93
W. L. Beck, Acting Laboratory Manager
Environmental Survey and Site Assessment Program

Reviewed by: _____ Date: 8/4/93
A. T. Payne, Quality Assurance Officer
Environmental Survey and Site Assessment Program

Reviewed by: _____ Date: 8/2/93
J. D. Berger, Program Director
Energy/Environment Systems Division

ACKNOWLEDGEMENTS

The author would like to acknowledge the significant contributions of the following staff members:

FIELD STAFF

S. F. Barnett
E. N. Huber
B. M. Smith

LABORATORY STAFF

R. D. Condra
J. S. Cox
R. L. Epperson
M. J. Laudeman
S. T. Shipley
F. E. Weaver

ILLUSTRATOR

E. A. Powell

CLERICAL STAFF

T. T. Claiborne
D. A. Cox
R. D. Ellis
K. E. Waters

TABLE OF CONTENTS

PAGE

LIST OF FIGURES

LIST OF TABLES

PAGE

ABBREVIATIONS

cm	centimeter
cm^2	square centimeter
cpm	counts per minute
dpm/100 cm^2	disintegrations per minute/100 square centimeters
GM	Geiger-Mueller
kg	kilogram
m	meter
m^2	square meter
MeV	megavolts
NaI(Tl)	sodium iodide (thallium activated)
pCi/g	picocuries per gram

ACRONYMS

ESSAP	Environmental Survey and Site Assessment Program
NRC	Nuclear Regulatory Commission
ORISE	Oak Ridge Institute for Science and Education
SFC	Sequoyah Fuels Corporation

CONFIRMATORY RADIOLOGICAL SURVEY OF THE WET CERAMICS AREA CIMARRON CORPORATION FACILITY CRESCENT, OKLAHOMA

INTRODUCTION AND SITE HISTORY

The Kerr-McGee Corporation operated the Cimarron Facility in Crescent, Oklahoma to produce slightly enriched (approximately 3%) uranium fuel and mixed oxide (uranium plus plutonium) fuel between 1965 and 1975. These activities were conducted under license SNM-928 with the Atomic Energy Commission, predecessor to the Nuclear Regulatory Commission (NRC). In 1983, Sequoyah Fuels Corporation (SFC) became the owner of the Cimarron Facility, when Kerr-McGee Nuclear Corporation was divided into SFC and Quivira Mining Corporation. Later, Cimarron Corporation, a subsidiary of the Kerr-McGee Nuclear Corporation, became responsible for the Cimarron Facility.

Decontamination of the Cimarron Facility began in 1979 with the goal of removing all contaminated equipment and materials so the facility could be released for unrestricted use. Cimarron Corporation has discontinued license activities and is in the process of performing the decontamination to terminate the NRC licensing restrictions. The decontamination and decommissioning project was divided into several phases, which involved the Mixed Oxide Plant, the Uranium Plant, the on-site Burial Ground, and the Sanitary Lagoons. Decontamination and decommissioning activities involving the Mixed Oxide Plant have been completed, and activities involving the Uranium Plant, Burial Grounds, and Sanitary Lagoons are nearing completion.

At the request of the NRC's Region III Office, the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) conducted an independent confirmatory radiological survey of the Wet Ceramics Area of the Uranium Plant at the Cimarron Corporation Facility. This report summarizes the procedures and results of the survey.

FACILITY DESCRIPTION

The Cimarron Corporation Facility is located on a site of approximately 450 hectares in Logan County, Oklahoma, about 8 kilometers south of the town of Crescent (Figure 1). The Site includes the Mixed Oxide Plant, the Uranium Plant, an on-site Burial Ground, two Sanitary Lagoons, and an Evaporation Pond (Figure 2).

The Uranium Plant Wet Ceramics Area is approximately 670 m^2 and is part of the ground floor of the Uranium Plant (Figure 3). The floor area has been extensively excavated (as deep as 5 meters in portions) as part of the decontamination efforts (Figure 4). Decontamination efforts for the overhead area require that the floor be filled and levelled to facilitate movement of equipment.

DOCUMENT REVIEW

ESSAP reviewed the licensee's post-remedial action data for accuracy, completeness, and compliance with the guidelines.

OBJECTIVE

The objective of the confirmatory survey was to develop independent document reviews and radiological data for use by the NRC in evaluating the adequacy and accuracy of the licensee's radiological status report, relative to established guidelines.

PROCEDURES

During the period June 22-24, 1992, ESSAP performed a confirmatory survey of the Wet Ceramics Area at the Cimarron Corporation Facility. The survey was in accordance with a plan dated May 29, 1992, submitted to and approved by the NRC Region III Office.[1]

REFERENCE GRID

A reference grid system (2 m x 2 m) was established by ESSAP for referencing measurements and sampling.

SURFACE SCANS

Gamma surface scans were performed using NaI(Tl) scintillation detectors. Girders were scanned using GM detectors. Detectors were coupled to ratemeter-scalers with audible indicators. Areas of elevated contact radiation were marked for further investigation.

SOIL SAMPLING

Surface soil samples (0-15 cm) were collected from grid line intersections, areas of elevated contact radiation identified by the surface scans, and areas of elevated activity identified by the licensee prior to remediation (Figure 5).

Subsurface soil samples were collected at 6 locations from depths ranging from 1 m to 2.8 m below the normal surface (0.3-2 m below the actual excavated surface). The samples were collected from previous locations of elevated activity, identified by the licensee prior to remediation. These sampling locations are shown on Figure 6.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and survey data were returned to the ESSAP laboratory in Oak Ridge, TN for analyses and interpretation. Soil samples were analyzed by gamma spectrometry. Spectra were reviewed for the radionuclides of interest (U-235 and U-238) and any other identifiable photopeaks. Approximately 10% of the soil samples were analyzed by alpha spectrometry for isotopic uranium. Soil concentrations were reported in units of pCi/g.

FINDINGS AND RESULTS

DOCUMENT REVIEW

The licensee provided preliminary and post remediation soil sample analysis results. This information was reviewed and indicated that post remediation soil concentrations were below the NRC guideline values. However, all of the locations which exceeded the NRC guidelines in the preliminary survey were not resampled in the post remediation phase. Therefore, it cannot be determined from the data provided by the licensee whether the current conditions of Wet Ceramics Area floor and subfloor meet the NRC guidelines.

SURFACE SCANS

Surface scans identified several areas of elevated direct radiation; these were marked for further investigation.

RADIONUCLIDE CONCENTRATIONS IN SOIL

Six samples were analyzed by alpha spectrometry for isotopic uranium. The uranium concentrations for these samples are summarized in Table 1. Isotopic uranium concentrations ranged from 8.1 to 156.7 pCi/g for U-234, 0.3 to 9.6 pCi/g for U-235, and 2.2 to 101.0 pCi/g for U-238. The total uranium concentrations ranged from 10.5 to 267.3 pCi/g. On the basis of alpha spectrometry analysis, the ratio of U-234 to U-235 activity is approximately 25:1.0. This ratio was used to calculate the total uranium concentrations in soil samples, analyzed only by gamma spectrometry.

Concentrations of radionuclides in surface soil samples are summarized in Table 2. Concentrations ranged from 0.1 to 6.1 pCi/g for U-235, 1.0 to 49 pCi/g for U-238, and 3.6 to 200 pCi/g for total uranium. The highest concentration was identified at grid coordinate 72N, 88.6E.

Radionuclide concentrations in subsurface soil samples are summarized in Table 3. Concentrations ranged from 0.1 to 4.3 pCi/g for U-235, 1.5 to 45 pci/g for U-238, and 4.3 to 160 pCi/g for total uranium. The highest concentration was at coordinate 82N, 84E, at a depth of 0-30 cm.

COMPARISON OF RESULTS WITH GUIDELINES

Surface activity guidelines established for the release of a licensed facility for unrestricted use and the guidelines for residual concentrations of uranium wastes in soil are presented in Appendix C.

The primary contaminant of concern is enriched uranium, with a soil concentration guideline of 30 pCi/g. This guideline is expressed in terms of concentration above normal background levels. Background radionuclide concentrations in soil were determined during the 1988 Oak Ridge Associated Universities (now ORISE) survey (Table 4). Total uranium concentrations ranged from <1.2 to 2.0 pCi/g (1.6 pCi/g, average). Therefore, the sample analysis result indicating that the NRC guideline has been exceeded is 31.6 pCi/g for total uranium.

Gamma spectrometry analysis identified 15 surface soil samples and 1 subsurface soil sample with total uranium concentrations exceeding the guideline value. The surface soil samples which exceed the guidelines were collected from 70N, 74E; 70N, 88E; 70N, 88.6E; 72N, 74E; 72N, 88.6E; 76N, 64.2E; 78N, 88.6E; 82N, 76E; 82N, 84E; 82N, 88.6E; 86N, 59E; 87N, 72E; 88N, 58E; 88N, 82E; and 88N, 88.6E. The subsurface soil sample which exceeds the guideline value was collected from 82N, 84E (0-30 cm). Alpha spectrometry analysis identified one surface soil sample which exceeded the guideline value for uranium (82N, 88E).

Five samples contained total uranium concentrations exceeding 3 times the guideline level, i.e., greater then 90 pCi/g; four of these five samples were obtained adjacent to the east wall of the building. Further evaluation of soil concentrations, performed at the request of Region III, indicated two ~ 100 m^2 areas with a weighted average uranium concentration above 39 pCi/g; these were 80-90N, 68-78E (37 pCi/g) and 80-90N, 78-88E (88 pCi/g).[2]

SUMMARY

In June 1992, ESSAP performed a confirmatory radiological survey of the Wet Ceramics Area at the Cimarron Corporation Facility in Crescent, Oklahoma. Survey activities included document reviews, surface scans, surface activity measurements, and soil sampling.

The documentation provided by the licensee was not complete and did not adequately address the current radiological status of this area. The results of the survey performed by ESSAP indicated that soil concentrations still exist in the Wet Ceramics Area which exceed the NRC guideline values. The findings, therefore, did not support the final survey performed by the Cimarron Corporation, and in ESSAP's opinion, indicated that the radiological conditions of the Wet Ceramics Area did not satisfy the NRC guidelines for release without radiological restrictions.

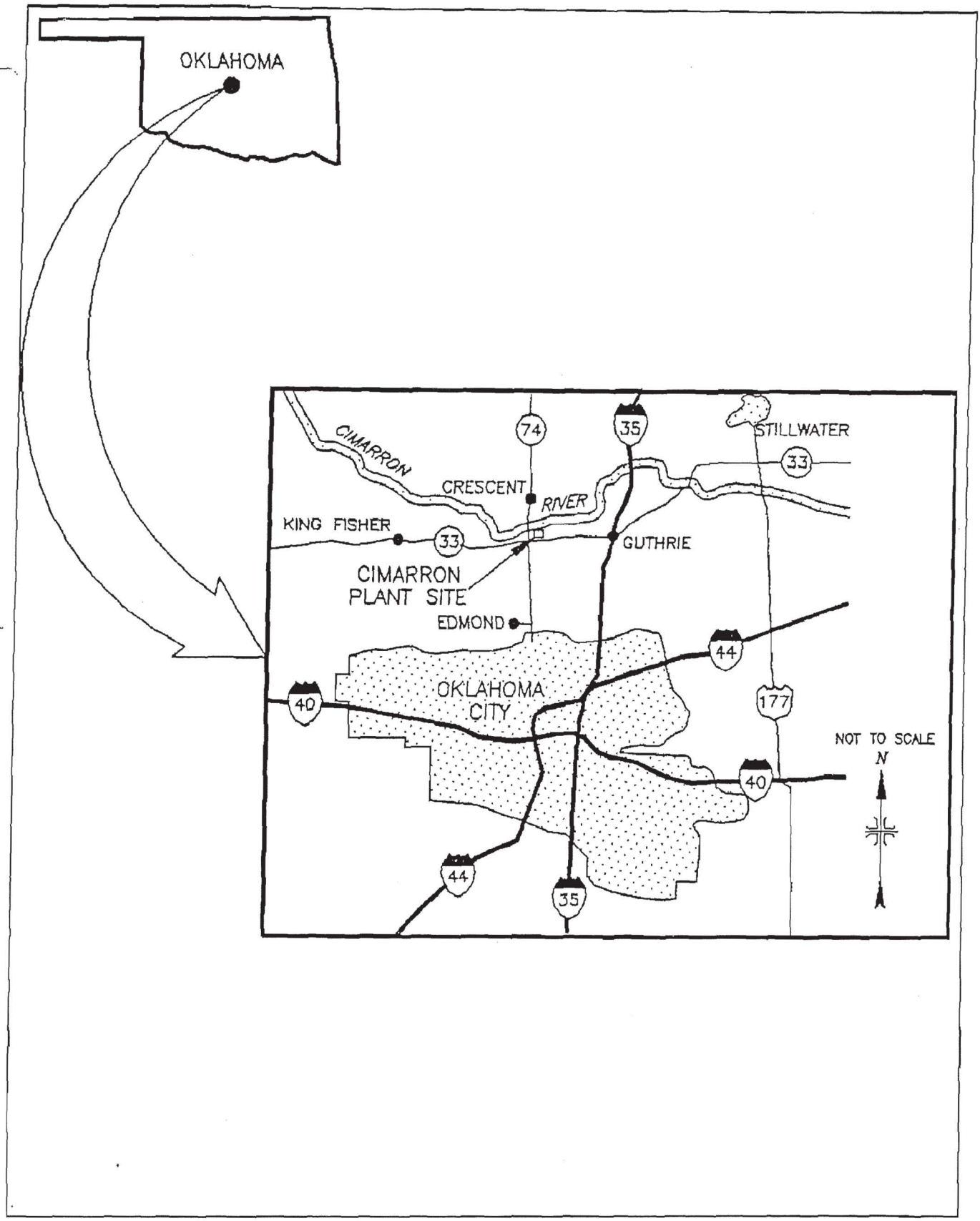

FIGURE 1: Location of the Cimarron Facility, Crescent, Oklahoma

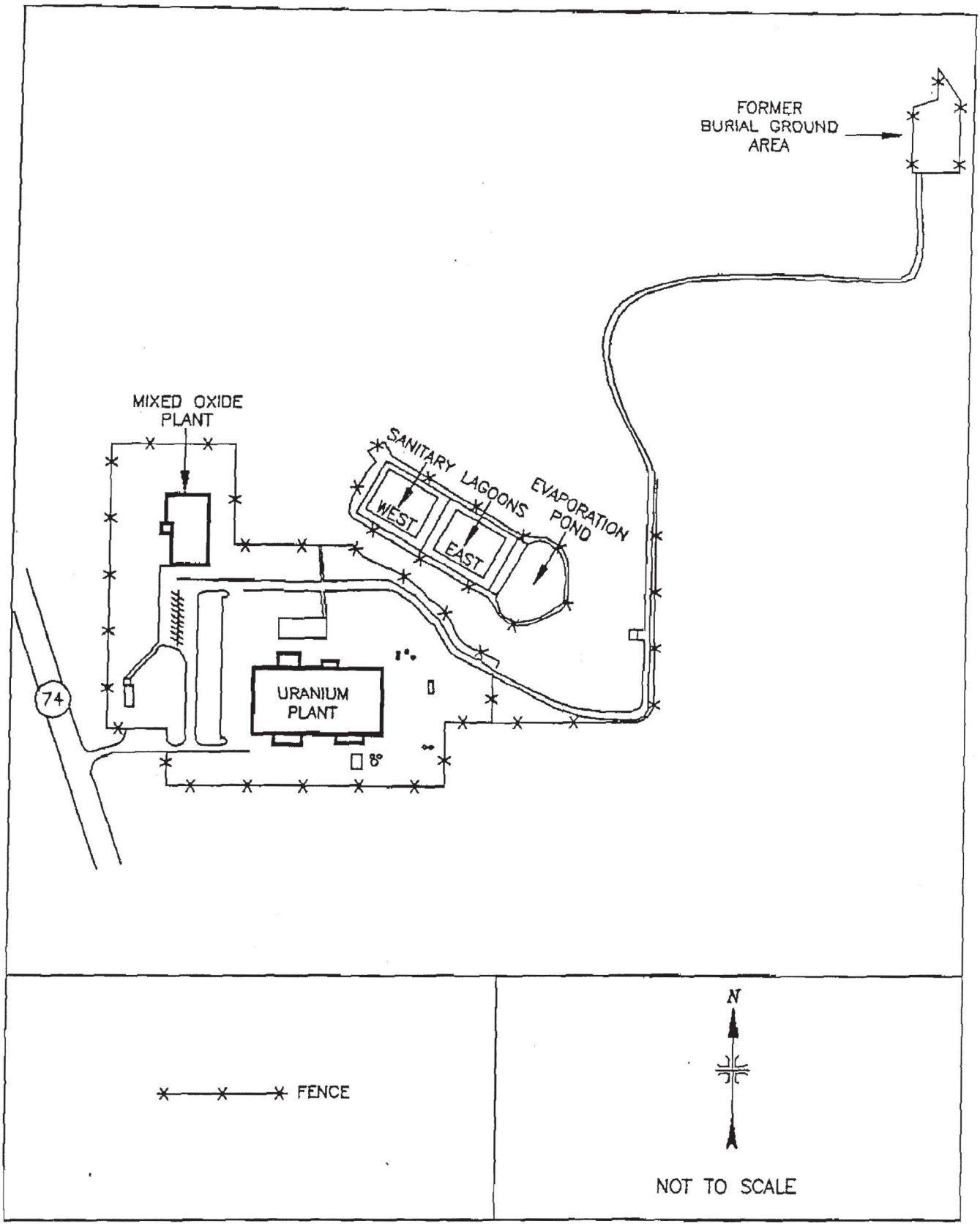

FIGURE 2: Plot Plan – Cimarron Facility

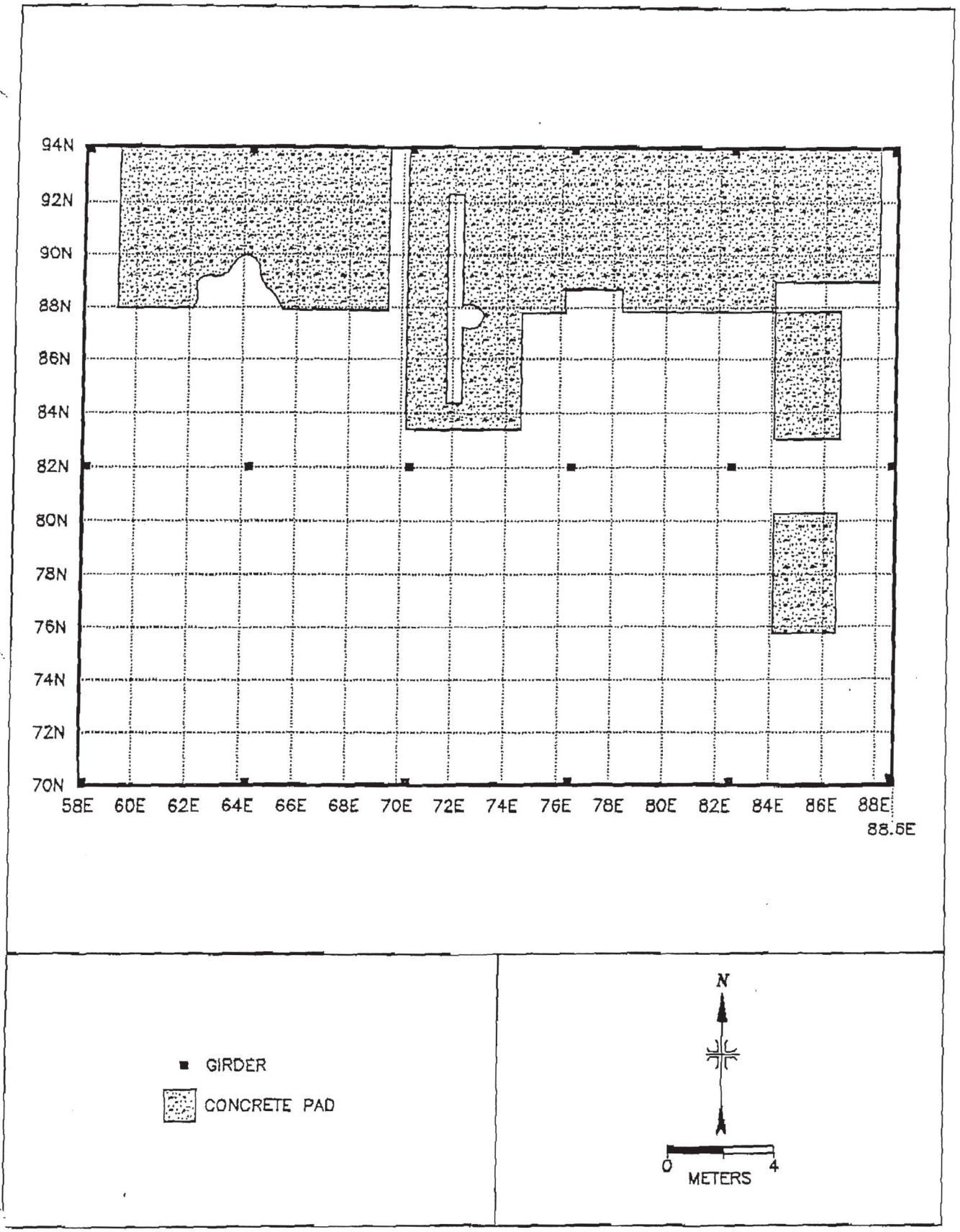

FIGURE 3: Wet Ceramics Area, Concrete Pads and Girders

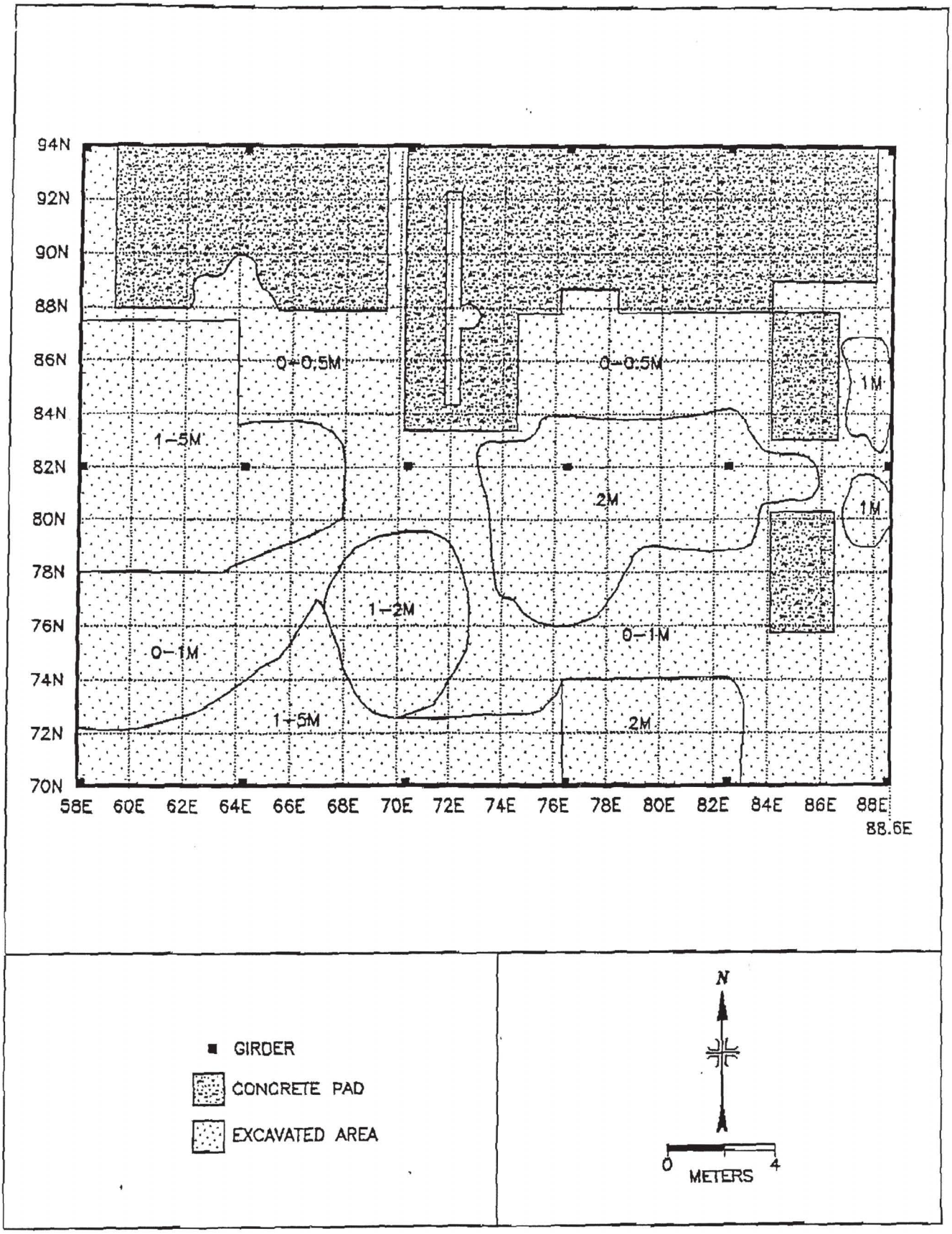

FIGURE 4: Wet Ceramics Area, Concrete Pads and Girders – Areas of Excavations

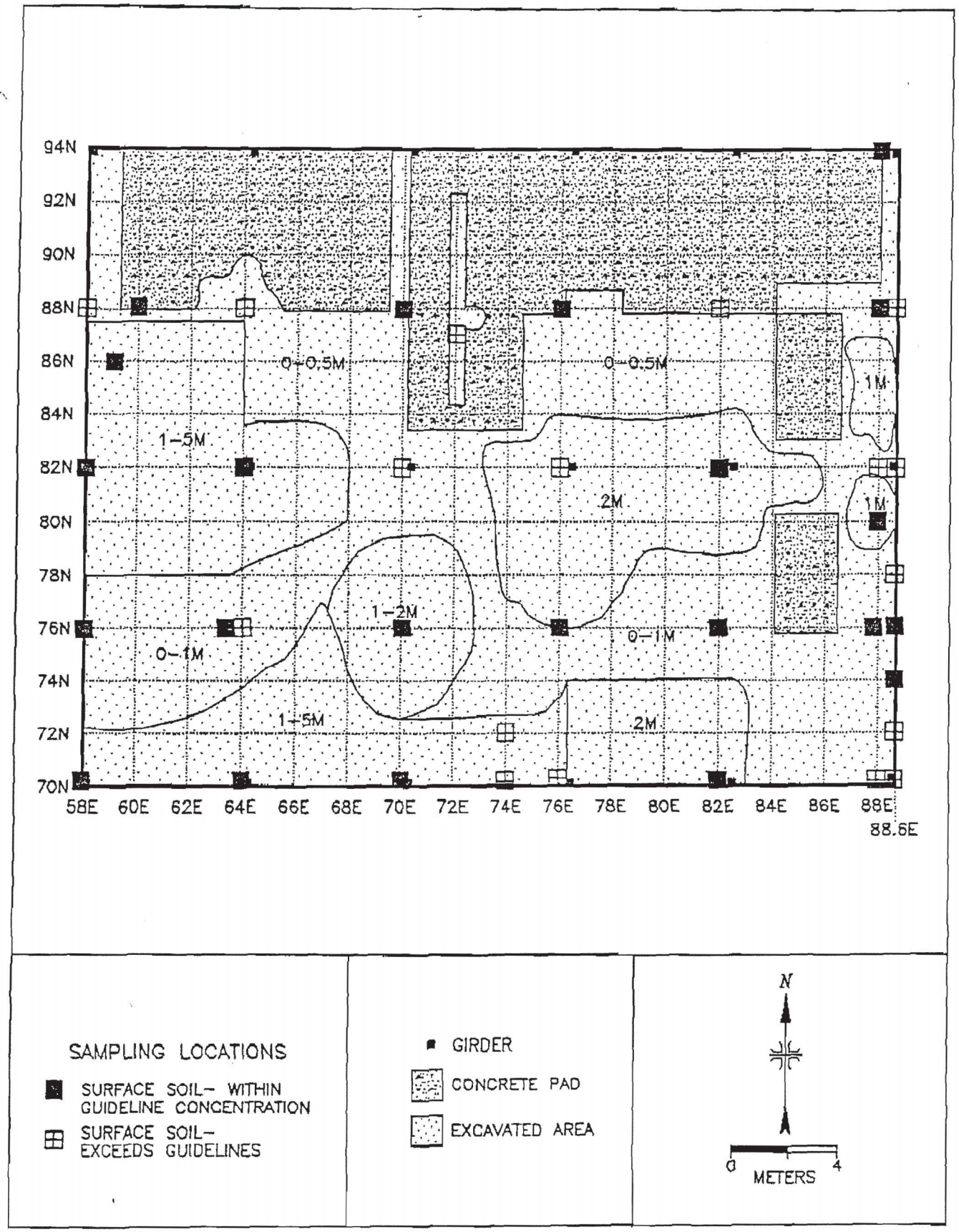

FIGURE 5: Wet Ceramics Area, Concrete Pads and Girders – Surface Soil Sampling Locations

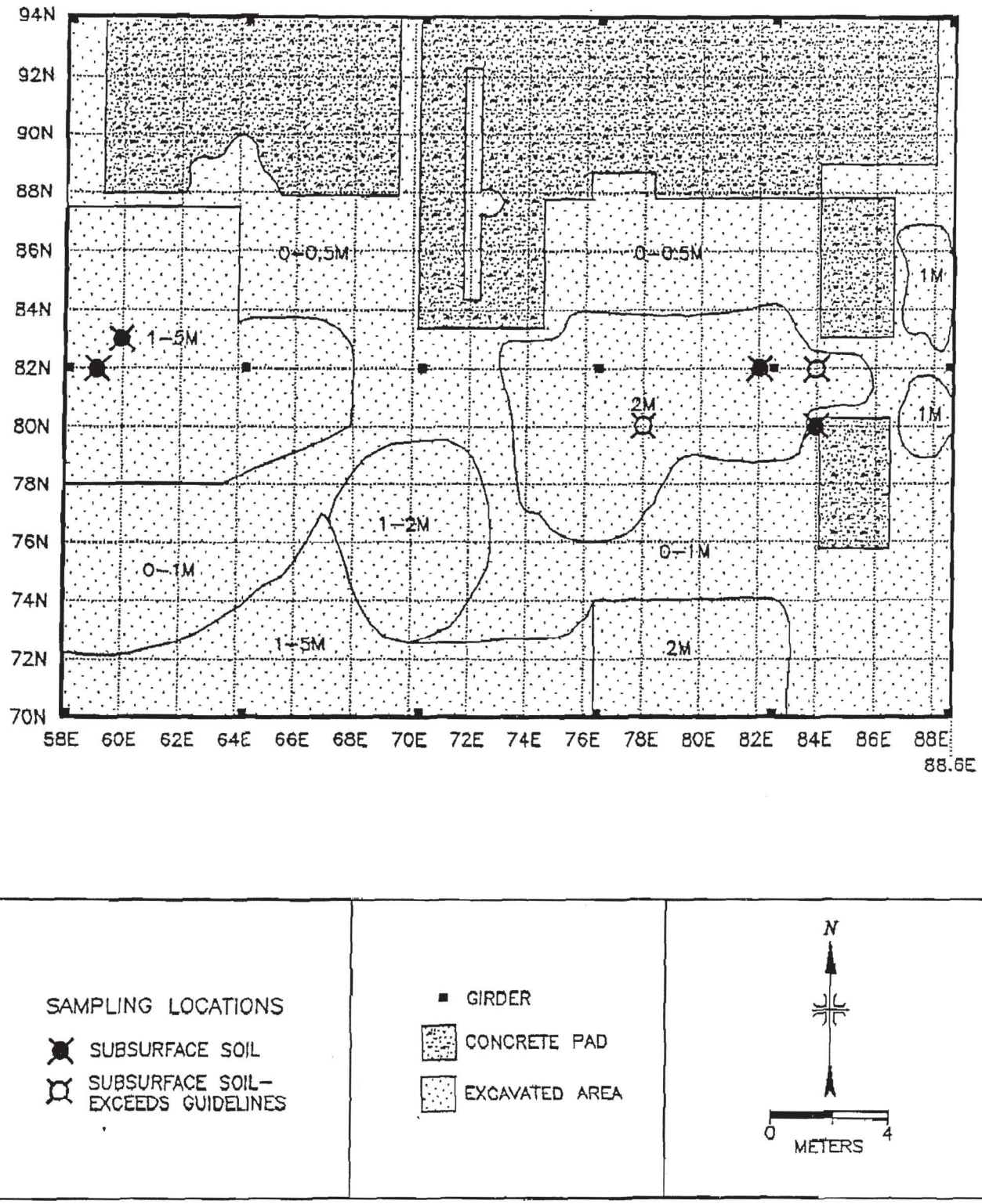

FIGURE 6: Wet Ceramics Area, Concrete Pads and Girders – Subsurface Soil Sampling Locations

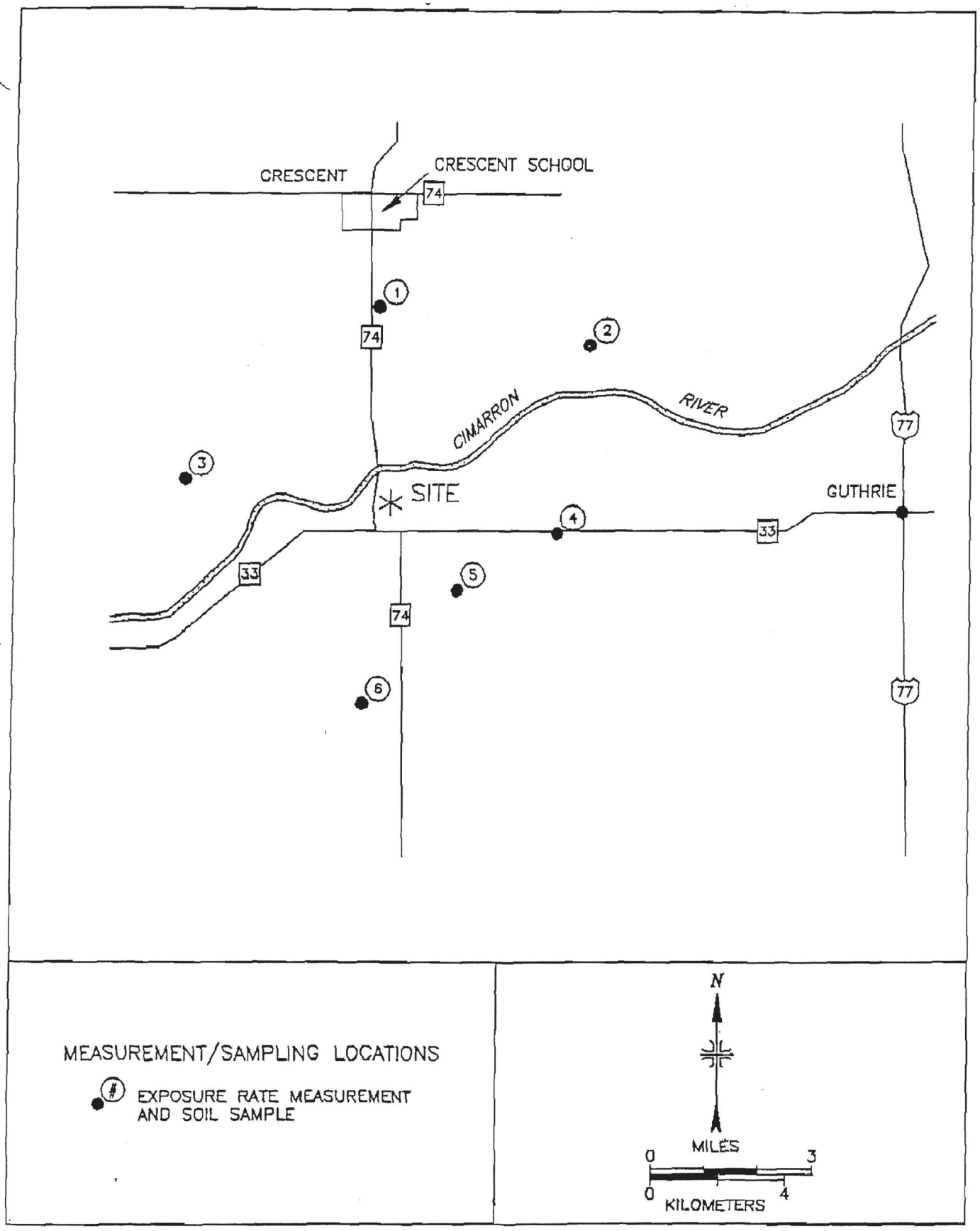

FIGURE 7: Background Measurement and Sampling Locations

TABLE 1

ISOTOPIC URANIUM CONCENTRATIONS IN SOIL SAMPLES WET CERAMICS AREA CIMARRON CORPORATION FACILITY CRESCENT, OKLAHOMA

Location[a]	Radionuclide Concentration (pCi/g)[b]			
	U-234	U-235	U-238	Total U
76N, 64E	10.1 ± 0.6[c]	0.4 ± 0.2	3.4 ± 0.4	13.9 ± 0.7
80N, 84E	8.1 ± 0.6	0.3 ± 0.2	2.2 ± 0.3	10.5 ± 0.7
82N, 64E	12.3 ± 0.7	0.4 ± 0.2	4.4 ± 0.4	17.1 ± 0.9
82N, 82N	19.2 ± 0.8	0.9 ± 0.2	3.7 ± 0.4	23.8 ± 0.9
82N, 88E	156.7 ± 3.4	9.6 ± 1.0	101.0 ± 2.7	267.3 ± 4.5
88N, 88E	14.0 ± 0.6	0.5 ± 0.2	3.7 ± 0.3	18.2 ± 0.7

[a]Refer to Figure 5.
[b]Based on alpha spectrometry analysis.
[c]Uncertainties represent the 95% confidence level, based only on counting statistics.

TABLE 2

RADIONUCLIDE CONCENTRATIONS
IN SURFACE SOIL SAMPLES
WET CERAMICS AREA
CIMARRON, CORPORATION FACILITY
CRESCENT, OKLAHOMA

Location[a]	Radionuclide Concentration (pCi/g)		
	U-235	U-238	Total U[b]
70N, 58E	0.2 ± 0.1	1.4 ± 1.0	6.6
70N, 64E	0.5 ± 0.1	4.3 ± 1.6	17
70N, 70E	0.6 ± 0.1	6.2 ± 2.4	22
70N, 74E	1.0 ± 0.2	8.2 ± 2.4	34
70N, 76E	0.9 ± 0.2	8.0 ± 2.3	31
70N, 82E	0.6 ± 0.1	4.3 ± 1.7	20
70N, 88E	1.8 ± 0.3	9.8 ± 2.8	57
70N, 88.6E	5.8 ± 0.8	44.3 ± 9.8	200
72N, 74E	1.5 ± 0.2	7.7 ± 2.4	47
72N, 88.6E	6.1 ± 0.8	45 ± 10	200
74N, 88.6E	0.6 ± 0.1	3.2 ± 1.6	19
76N, 58E	0.5 ± 0.1	4.3 ± 16	17
76N, 64E	---[d]	---	---
76N, 64.2E	1.0 ± 0.2	8.4 ± 2.5	34
76N, 70E	0.5 ± 0.1	5.7 ± 2.1	19
76N, 76E	0.6 ± 0.1	6.0 ± 1.9	22
76N, 82E	0.3 ± 0.1	3.5 ± 1.7	11
76N, 88E	0.3 ± 0.1	4.3 ± 2.1	12
76N, 88.6E	0.7 ± 0.1	5.3 ± 1.9	24
78N, 88.6E	2.3 ± 0.3	14.9 ± 3.8	75
80N, 84E	---	---	---
80N, 88E	0.5 ± 0.1	3.8 ± 1.9	17
82N, 58E	0.4 ± 0.1	1.5 ± 1.1	12
82N, 64E	0.7 ± 0.1	6.5 ± 2.2	25
82N, 70E	1.3 ± 0.2	13.1 ± 3.3	47

TABLE 2 (Continued)

RADIONUCLIDE CONCENTRATIONS
IN SURFACE SOIL SAMPLES
WET CERAMICS AREA
CIMARRON, CORPORATION FACILITY
CRESCENT, OKLAHOMA

Location[a]	Radionuclide Concentration (pCi/g)		
	U-235	U-238	Total U[b]
82N, 76E	1.7 ± 0.3	14.8 ± 3.8	59
82N, 76.3E	0.3 ± 0.1	1.8 ± 1.5	9.6
82N, 82E	0.9 ± 0.1	4.6 ± 1.8	28
82N, 88E	---	---	---
82N, 88.6E	4.3 ± 0.6	49 ± 11	160
86N, 59E	0.7 ± 0.1	14.4 ± 4.2	33
87N, 72E	1.2 ± 0.2	9.8 ± 5.3	41
88N, 58E	1.2 ± 0.2	5.9 ± 1.9	37
88N, 60E	0.1 ± 0.1	4.7 ± 3.2	7.3
88N, 64E	1.0 ± 0.2	3.0 ± 8.3	29
88N, 70E	0.8 ± 0.1	6.6 ± 2.4	27
88N, 76E	0.1 ± 0.1	1.0 ± 0.8	3.6
88N, 82E	1.0 ± 0.2	8.5 ± 2.8	35
88N, 88E	---	---	---
88N, 88.6E	1.1 ± 0.2	7.9 ± 2.2	37
94N, 88E	0.3 ± 0.1	1.2 ± 1.3	9.0

[a]Refer to Figure 5.
[b]Calculated using a U-234:U-235 activity ratio of 25:1.0.
[c]Uncertainties represent the 95% confidence level, based only on counting statistics.
[d]---Indicates analysis was performed by alpha spectrometry, see Table 2.

TABLE 3

RADIONUCLIDE CONCENTRATIONS IN SUBSURFACE SOIL SAMPLES WET CERAMICS AREA CIMARRON CORPORATION FACILITY CRESCENT, OKLAHOMA

Location[a]	Depth (cm)	Radionuclide Concentration (pCi/g)		
		U-235	U-238	Total U[b]
80N, 78E	0-100	1.0 ± 0.2	5.1 ± 2.1	31
80N, 84E	30-60	---[d]	---	---
82N, 59E	0-30	0.2 ± 0.1	2.1 ± 2.4	7.3
	30-60	0.3 ± 0.1	1.5 ± 1.1	9.3
	60-90	0.4 ± 0.2	4.5 ± 5.9	15
	90-120	0.5 ± 0.1	3.2 ± 2.0	16
	120-150	0.3 ± 0.1	2.6 ± 1.7	10
	150-180	0.5 ± 0.1	2.7 ± 1.6	16
82N, 82E	0-30	---	---	---
	30-60	0.7 ± 0.1	3.3 ± 1.5	22
	60-90	0.7 ± 0.1	3.2 ± 1.7	21
	90-120	0.6 ± 0.1	3.6 ± 1.7	19
	120-150	0.4 ± 0.1	5.4 ± 2.8	16
	150-180	0.4 ± 0.1	3.0 ± 1.4	13
82N, 84E	0-30	4.3 ± 0.6	45 ± 10	160
	30-60	0.7 ± 0.1	3.9 ± 1.7	22
	60-90	0.8 ± 0.2	2.6 ± 1.5	23

TABLE 3 (Continued)

RADIONUCLIDE CONCENTRATIONS
IN SUBSURFACE SOIL SAMPLES
WET CERAMICS AREA
CIMARRON CORPORATION FACILITY
CRESCENT, OKLAHOMA

Location[a]	Depth (cm)	Radionuclide Concentration (pCi/g)		
		U-235	U-238	Total U[b]
83N, 60E	0-30	0.1 ± 0.1	1.7 ± 2.0	4.3
	30-60	0.4 ± 0.1	2.7 ± 1.5	13
	60-90	0.5 ± 0.1	2.0 ± 1.3	15
	90-120	0.8 ± 0.2	2.3 ± 1.7	23
	120-150	0.3 ± 0.1	5.5 ± 3.4	13
	150-180	0.4 ± 0.1	2.4 ± 1.8	13

[a]Refer to Figure 6.
[b]alculated using a U-234:U-235 activity ratio of 25:1.0.
[c]Uncertainties represent the 95% confidence level, based only on counting statistics.
[d]---Indicates analysis was performed by alpha spectrometry, see Table 2.

TABLE 4

BACKGROUND EXPOSURE RATES
AND RADIONUCLIDE CONCENTRATIONS
IN SOIL
WET CERAMICS AREA
CIMARRON CORPORATION FACILITY
CRESCENT, OKLAHOMA

Location[a]	Exposure Rate (μR/h) at 1 m above the surface	Total Uranium Concentration (pCi/g)[b,c]
1	10	1.5
2	9	1.3
3	9	<1.7
4	10	2.0
5	10	1.9
6	10	<1.2
Average	10	1.6

[a]Refer to Figure 7.
[b]Based on gamma spectrometry analysis.
[c]Calculated based on natural activity ratios.

REFERENCES

1. "Confirmatory Radiological Survey Plan for the Uranium Plant, Wet Ceramics Area, Cimarron Corporation Facility, Cresent, Oklahoma" Betty M. Smith, May 29, 1992, revised June 5, 1992.

2. Letter, J. D. Berger, ORISE, to G. M. France, NRC Region III, "Average Soil Activities - Cimarron Wet Ceramics Facility," November 4, 1992.

APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the authors or their employers.

DIRECT RADIATION MEASUREMENT

Instruments

Eberline Pulse Ratemeter
Model PRM-6
(Eberline, Santa Fe, NM)

Eberline "Rascal" Ratemeter-Scaler
Model PRS-1
(Eberline, Santa Fe, NM)

Detectors

Eberline GM Detector
Model HP-260
Effective Area, 15.5 cm^2
(Eberline, Santa Fe, NM)

Victoreen NaI Scintillation Detector
Model 489-55
3.2 cm x 3.8 cm Crystal
(Victoreen, Cleveland, OH)

LABORATORY ANALYTICAL INSTRUMENTATION

Alpha Spectrometry System
Tennelec Electronics Model
(Tennelec, Oak Ridge, TN)
Used in conjunction with:
Surface Barrier Detectors
(EG&G ORTEC, Oak Ridge, TN) and
Multichannel Analyzer
ND 66
(Nuclear Data, Schaunburg, IL)

High-Purity Germanium Detector
Model GMX-23195-S, 23% Eff.
(EG&G ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Gamma Products, Palos Hills, IL) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

High-Purity Germanium Coaxial Well Detector
Model GWL-110210-PWS-S, 23% Eff.
(EG&G ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Applied Physical Technology, Atlanta, GA) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the probes slowly over the surface; the distance between the probe and the surface was maintained at a minimum - nominally about 1 cm. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument. Combinations of detectors and instruments used for the scans were:

Beta	-	pancake GM detector with ratemeter-scaler
Gamma	-	NaI scintillation detector with ratemeter

Soil Sampling

Approximately 1 kg of soil was collected at each sample location. Collected samples were placed in a plastic bag, sealed, and labeled in accordance with ESSAP survey procedures.

ANALYTICAL PROCEDURES

Gamma Spectrometry

Samples of solid material (soil) were dried, mixed, crushed, and/or homogenized as necessary, and a portion sealed in 0.5-liter Marinelli beaker or other appropriate container. The quantity placed in the beaker was chosen to reproduce the calibrated counting geometry. Net material weights were determined and the samples counted using intrinsic germanium

detectors coupled to a pulse height analyzer system. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. Energy peaks used for determination of radionuclides of concern were:

U-235	0.143 MeV or 0.186 MeV
U-238	0.063 MeV or 0.093 MeV from Th-234 *or 1.001 MeV from Pa-234 m*

*Secular equilibrium assumed.

Spectra were also reviewed for other identifiable photopeaks.

Alpha Spectrometry

Soil samples were crushed, homogenized and analyzed for isotopic uranium. Samples were dissolved by potassium fluoride and pyrosulfate fusion, and the elements of interest were precipitated with barium sulfate. Barium sulfate precipitate was redissolved, and the specific elements of interest were individually separated by liquid-liquid extraction and re-precipitated with a cerium fluoride carrier. The precipitate was then counted using surface barrier and ion implanted detectors (ORTEC), alpha spectrometers (Tennelec and Canberra), and a multichannel analyzer (Nuclear Data).

UNCERTAINTIES AND DETECTION LIMITS

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels. When the net sample count was less than 2.71 + 4.66 times the statistical deviation of the background count, the sample concentration was reported as less than the detection limit of the measurement procedures.

Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument. Additional uncertainties, associated with sampling and measurement procedures, have not been propagated into the data presented in this report.

CALIBRATION AND QUALITY ASSURANCE

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the Environmental Survey and Site Assessment Program:

-Survey Procedures Manual Revision 7 (May 1992)
-Laboratory Procedures Manual Revision 7 (April 1992)
-Quality Assurance Manual Revision 5 (May 1992)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 5700.6C and ASME NQA-1 for Quality Assurance and contain measures to assess processes during their performance.

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standards/sources were available. In cases where they were not available, standards of an industry recognized organization was used.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations,
- Participation in EPA and EML laboratory Quality Assurance Programs,
- Training and certification of all individuals performing procedures, and
- Periodic internal and external audits.

APPENDIX C

GUIDELINES FOR RESIDUAL CONCENTRATIONS OF THORIUM AND URANIUM WASTES IN SOIL

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
Division of Fuel Cycle & Material Safety
Washington, D.C. 20555

August 1987

Guidelines for Residual Concentrations of Thorium and Uranium Wastes in Soil

On October 23, 1981, the Nuclear Regulatory Commission published in the Federal Register a notice of Branch Technical Position on "Disposal or Onsite Storage of Thorium and Uranium Wastes from Past Operations." This document establishes guidelines for concentrations of uranium and thorium in soil, that will limit maximum radiation received by the public under various conditions of future land usage. These concentrations are as follows:

Material	Maximum Concentrations (pCi/g) for various options			
	1[a]	2[b]	3[c]	4[d]
Natural Thorium (Th-232 + Th-228) with daughters present and in equilibrium	10	50	---	500
Natural Uranium (U-238 + U-234) with daughters present and in equilibrium	10	--	40	200
Depleted Uranium:				
Soluble	35	100	---	1,000
Insoluble	35	300	---	3,000
Enriched Uranium:				
Soluble	30	100	---	1,000
Insoluble	30	250	---	2,500

[a]Based on EPA cleanup standards which limit radiation to 1 mrad/yr to lung and 3 mrad/yr to bone from ingestion and inhalation and 10 μR/h above background from direct external exposure.
[b]Based on limiting individual dose to 170 mrem/yr.
[c]Based on limiting equivalent exposure to 0.02 working level or less.
[d]Based on limiting individual dose to 500 mrem/yr and in case of natural uranium, limiting exposure to 0.02 working level or less.