LTSM007953

DOE/OR/21548-892
CONTRACT NO. DE-AC05-86OR21548

POST-REMEDIAL ACTION REPORT FOR THE CONSTRUCTION MATERIALS STAGING AREA WORK ZONE (WP-437/RU019)

WELDON SPRING SITE REMEDIAL ACTION PROJECT
WELDON SPRING, MISSOURI

OCTOBER 2001 **REV. 0**

RECORD

U.S. Department of Energy
Oak Ridge Operations Office
Weldon Spring Site Remedial Action Project

Prepared by MK-Ferguson Company and Jacobs Engineering Group

510.20
LWEL02.03

MORRISON KNUDSEN CORPORATION MK-FERGUSON GROUP Weldon Spring Site Remedial Action Project Contract No. DE-AC05-86OR21548	Rev. No. 0
PLAN TITLE: Post-Remedial Action Report for the Construction Materials Staging Area Work Zone (WP-437/RU019)	

APPROVALS

Environmental Safety and Health Manager	Sept 5, 2001 Date
Data Administration Coordinator	9/6/01 Date
Engineering Manager	9-27-01 Date
Project Quality Manager	10/2/2001 Date
Deputy Project Director	10/3/01 Date

DOE/OR/21548-892

Weldon Spring Site Remedial Action Project

Post-Remedial Action Report for the Construction Materials Staging Area Work Zone (WP-437/RU019)

Revision 0

October 2001

Prepared by

MK-FERGUSON COMPANY
and
JACOBS ENGINEERING GROUP
7295 Highway 94 South
St. Charles, Missouri 63304

for the

U.S. DEPARTMENT OF ENERGY
Oak Ridge Operations Office
Under Contract DE-AC05-86OR21548

ABSTRACT

Work Package-437 (WP-437) has been divided into 12 work zones. This report details the confirmation field activities and analytical results for contaminated soil removal of the Construction Materials Staging Area work zone portion of WP-437. Most of this 22-acre work zone was confirmed as part of the removal of contaminated soil under WP-253 during 1995-1996. The remaining portions of this work zone that have been identified for remediation and confirmation have been designated as Remedial Unit 19.

Remedial Unit 19 originally consisted of only one confirmation unit encompassing a portion of road that was not remediated during WP-253 activities. During WP-437 field activities, a shop area for working on contaminated equipment was constructed within the work zone. Due to this construction, the shop area and its associated facilities have been added to confirmation activities under WP-437. In addition, the original confirmation unit boundary has been expanded to include the roadway leading to the shop area.

Remediation was designed to achieve surface ALARA goals, and confirmation of soil remediation was required to meet cleanup standards, as established in the *Record of Decision for Remedial Action at the Chemical Plant Area of the Weldon Spring Site*. Final confirmation data verify that the established goals and standards were achieved.

TABLE OF CONTENTS

SECTION **PAGE**

1. INTRODUCTION 1
1.1 Purpose 1
1.2 Scope 1
1.3 Remediation and Confirmation Process 4
2. PRE-REMEDIATION ACTIVITIES 5
2.1 Review of Characterization Data 5
2.1.1 Additional Characterization 5
2.2 Data Quality Objectives 5
2.3 Cleanup Standards 7
2.4 Cleanup Confirmation Process 7
3. REMEDIAL ACTIVITIES 9
3.1 Field Activities 9
3.1.1 Walkover Surveys 9
3.1.2 Soil Sampling 9
3.2 Laboratory Activities 10
3.3 Verification Activities 10
4. CONFIRMATION UNITS RESULTS SUMMARY 11
5. DATA EVALUATION 22
5.1 Data Verification 22
5.2 Data Review 22
5.3 Data Validation 22
6. SUMMARY OF CLOSURE REPORT FINDINGS 24
6.1 Data Evaluation 24
6.2 Summary of WP-437 Confirmation Results 24
6.3 Summary of Chemical Plant Confirmation Results 25
6.4 Comparison of Standard Deviations 25
7. REFERENCES 27

APPENDIXES

A WP437 RU19 Final Walkover Forms
B WP437 RU19 Final Data
C WP437 RU19 Sample Location Coordinates
D Interoffice Correspondence

LIST OF FIGURES

NUMBER **PAGE**

Figure 1-1 WP-437 Work Zone Designations 2
Figure 1-2 Confirmation Units in Remedial Unit RU019 3
Figure 2-1 Location of Characterization Location HR-1 6
Figure 2-2 Cleanup Confirmation Process 8
Figure 4-1 Sample Locations in Remedial Unit RU019 Confirmation Unit CU369 13
Figure 4-2 Sample Locations in Remedial Unit RU019 Confirmation Unit CU406 15
Figure 4-3 Sample Locations in Remedial Unit RU019 Confirmation Unit CU407 17
Figure 4-4 Sample Locations in Remedial Unit RU019 Confirmation Unit CU408 19
Figure 4-5 Sample Locations in Remedial Unit RU019 Confirmation Unit CU409 21

LIST OF TABLES

NUMBER **PAGE**

Table 2-1 ROD Cleanup Standards for COCs within the WP-437 CMSA Work Zone 7
Table 4-1 Summary of CU369 12
Table 4-2 Summary of CU406 14
Table 4-3 Summary of CU407 16
Table 4-4 Summary of CU408 18
Table 4-5 Summary of CU409 20
Table 6-1 Summary Totals for RU019 24
Table 6-2 Summary Totals for Confirmation 25
Table 6-3 Comparison of Standard Deviations 26

1. INTRODUCTION

1.1 Purpose

Work Package-437 (WP-437) is divided into 12 work zones, 11 of which are identified in Figure 1-1. In addition, there is the Vicinity Property DA-6 work zone off site just west of the Ash Pond work zone. This report details the confirmation field activities and analytical results for contaminated soil removal of the Construction Materials Staging Area (CMSA) work zone portion of WP-437.

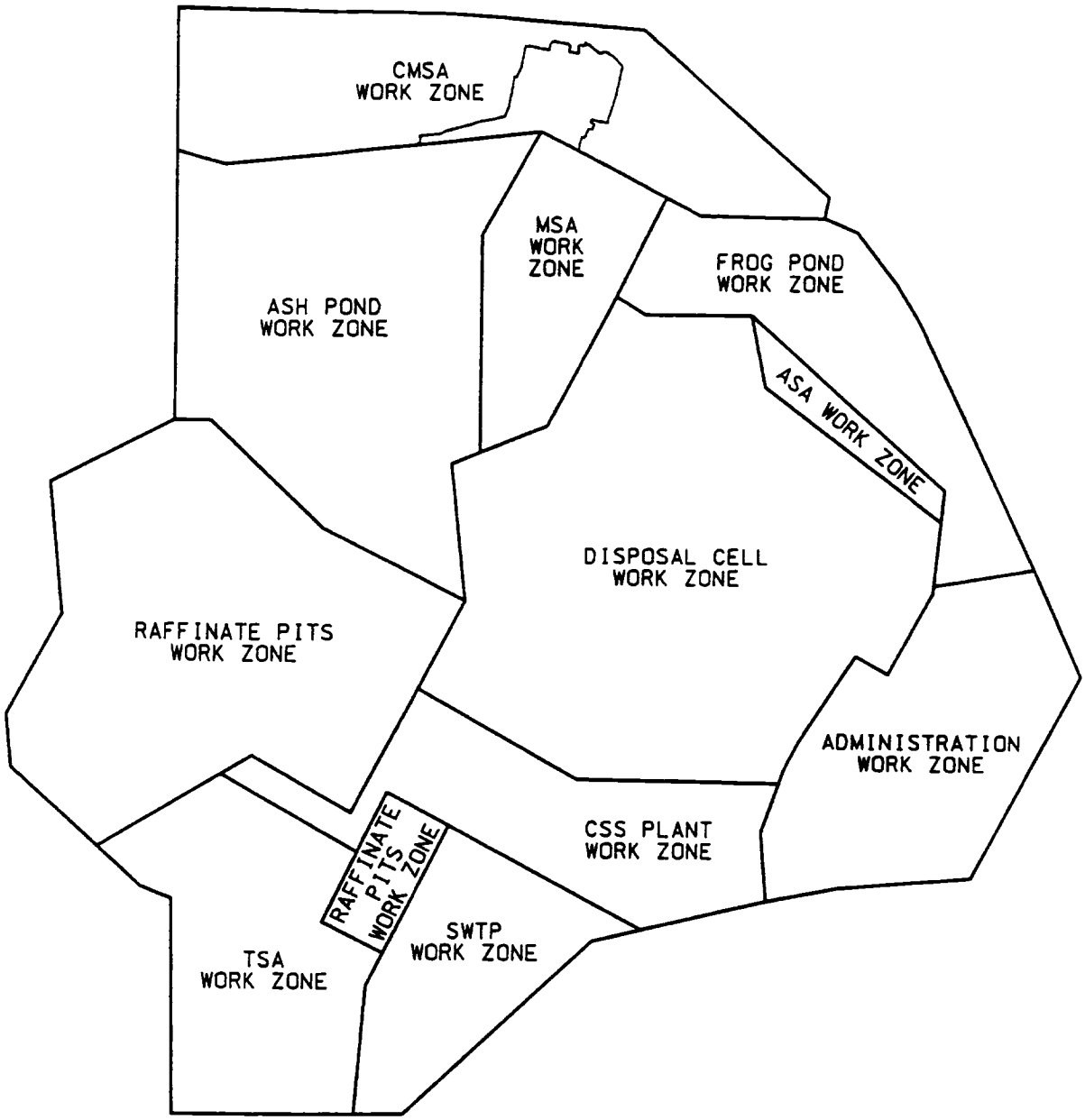
Soil characterization results and pre-excavation walkovers of the WP-437 work zones determined that the work zones contained contaminant concentrations that exceeded the As Low As Reasonably Achievable (ALARA) goals established in the *Record of Decision for Remedial Action at the Chemical Plant Area of the Weldon Spring Site* (ROD) (Ref. 1). Remediation was designed to achieve surface ALARA goals, and confirmation of soil remediation to the ROD cleanup standards was required.

Most of the area within this 22-acre work zone was previously confirmed during WP-253. Details can be found in the *Post-Remedial Action Report for the Chemical Plant Construction Materials Staging Area (WP-253)* (Ref. 8). Remedial unit (RU) 19, the remaining portion of the CMSA work zone requiring remediation and confirmation, originally consisted of only one confirmation unit (CU) encompassing a portion of road that was not remediated during WP-253 activities. The CU was identified as CU369 in the *Confirmation Sampling Plan Details for the Disposal Cell Facility (WP-437)* (Ref. 2).

During WP-437 field activities, a shop area was constructed within the CMSA work zone for working on contaminated equipment. The shop area included a decontamination pad, a sedimentation basin, and a parking lot. The shop and its associated facilities have been added to confirmation activities under WP-437 as CUs 406 through 409, and the original confirmation unit boundary for CU369 has been expanded to include the roadway leading to the shop area. Details can be found in the interoffice correspondence in Appendix D. In addition, a non-contiguous portion of CU369 initially identified in the sampling plan has been deleted from the CU as a result of further characterization as described in the *Supplemental Engineering Characterization for In Situ Soils at the Weldon Spring Site* (Ref. 9). Figure 1-2 shows the five redefined CUs that make up RU019, and individual CU figures are presented in Section 4 of this report.

1.2 Scope

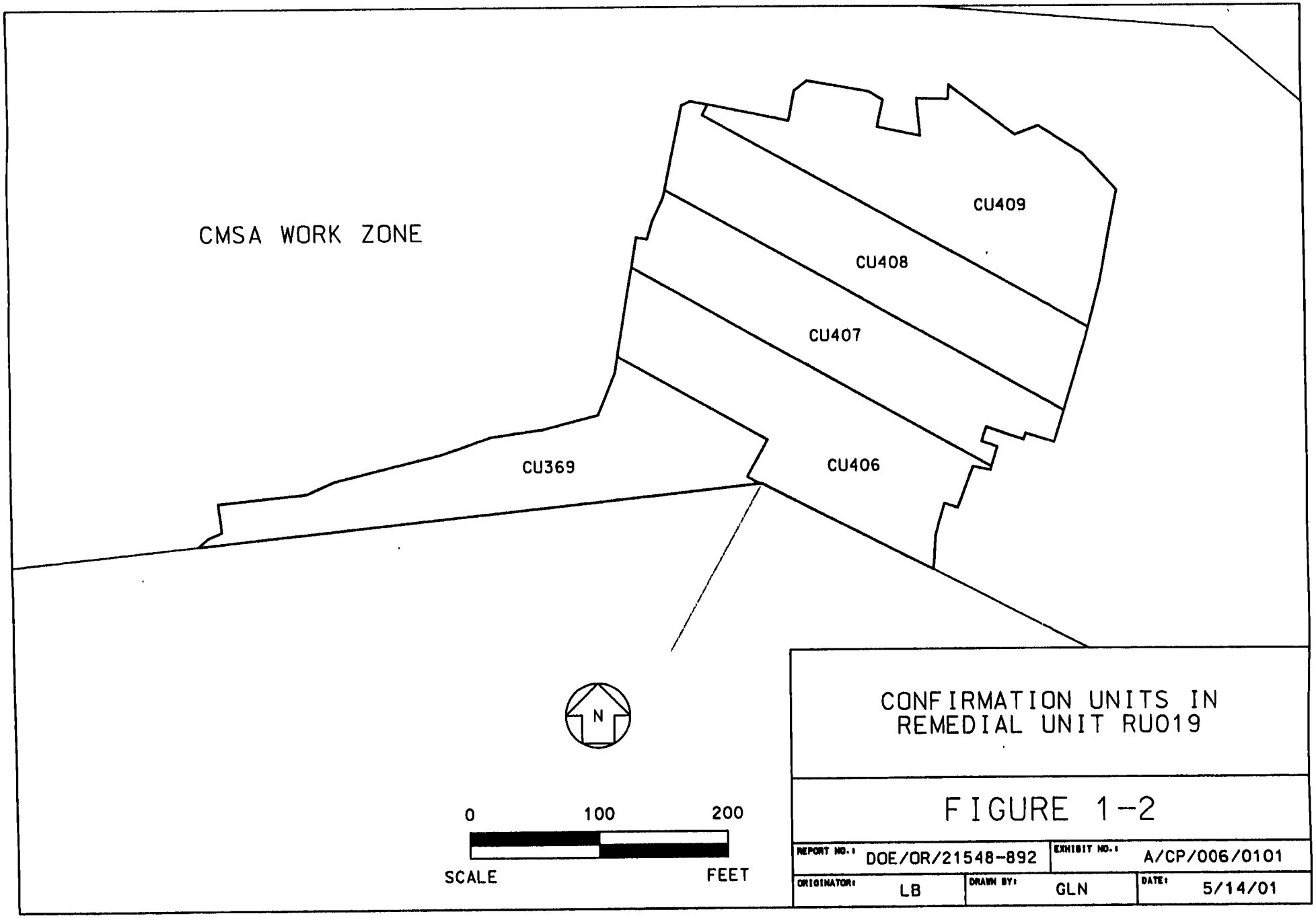
This report describes the remedial activities and confirmation surveying and sampling conducted on contaminated soils within RU019. Confirmation walkovers and soil sampling were conducted in accordance with the *Confirmation Sampling Plan Details for the Disposal*



WP-437 WORK ZONE DESIGNATIONS

FIGURE 1-1

REPORT NO.: DOE/OR/21548-892		EXHIBIT NO.: A/CP/001/0101	
ORIGINATOR: LB	DRAWN BY: GLN	DATE: 5/14/01	



CONFIRMATION UNITS IN REMEDIAL UNIT RU019

FIGURE 1-2

REPORT NO.:	DOE/OR/21548-892	EXHIBIT NO.:	A/CP/006/0101		
ORIGINATOR:	LB	DRAWN BY:	GLN	DATE:	5/14/01

Cell Facility (WP-437) (Ref. 2). This plan was developed to ensure that the objectives identified in the *Chemical Plant Area Cleanup Attainment Confirmation Plan* (Ref. 3) hereafter referred to as the *Attainment Plan* were accomplished, and to ensure that the remediation requirements of the ROD were met.

1.3 Remediation and Confirmation Process

This report details the activities conducted to remediate the CMSA portion of WP-437, which consists of CU369 and CUs 406 through 409. Remediation consisted of excavation of contaminated soils, roadway material, sediment, and debris. Following remediation, walkovers were conducted, and confirmation samples were collected to ensure that all contaminated materials had been remediated.

The entire remediation process included characterization sampling, historical data review, contaminants of concern (COC) identification, confirmation plan development, contaminated soil excavation, radiological walkover surveys, confirmation soil sampling, preliminary and final data review, completion of disposition forms, quality assurance/quality control (QA/QC) review, summary of findings and conclusions, and closure report preparation.

2. PRE-REMEDIATION ACTIVITIES

2.1 Review of Characterization Data

Contaminants of concern (COCs) were identified for each confirmation unit (CU) by reviewing results of characterization data. The full process for identifying COCs is detailed in the *Confirmation Sampling Plan Details for the Disposal Cell Facility (WP-437)* (Ref. 2). COCs identified for RU019 were Radium-226 (Ra-226), Radium-228 (Ra-228), Thorium-230 (Th-230), Thorium-232 (Th-232), and Uranium-238 (U-238), and, at one specific location, arsenic (As).

COC determination was dependent upon historical information, characterization results, and visual observation during field activities. In the case of confirmation unit (CU) 369, further characterization took place after the confirmation plan was developed and showed that arsenic did not exceed either surface ALARA or criteria limits at sample location SC-36902-S. Details of this characterization can be found in the *Supplemental Engineering Characterization for In Situ Soils at the Weldon Spring Site* (Ref. 9). Based on results of the additional characterization, arsenic was deleted as a COC at SC-36902-S and the non-contiguous portion of CU369 was deleted.

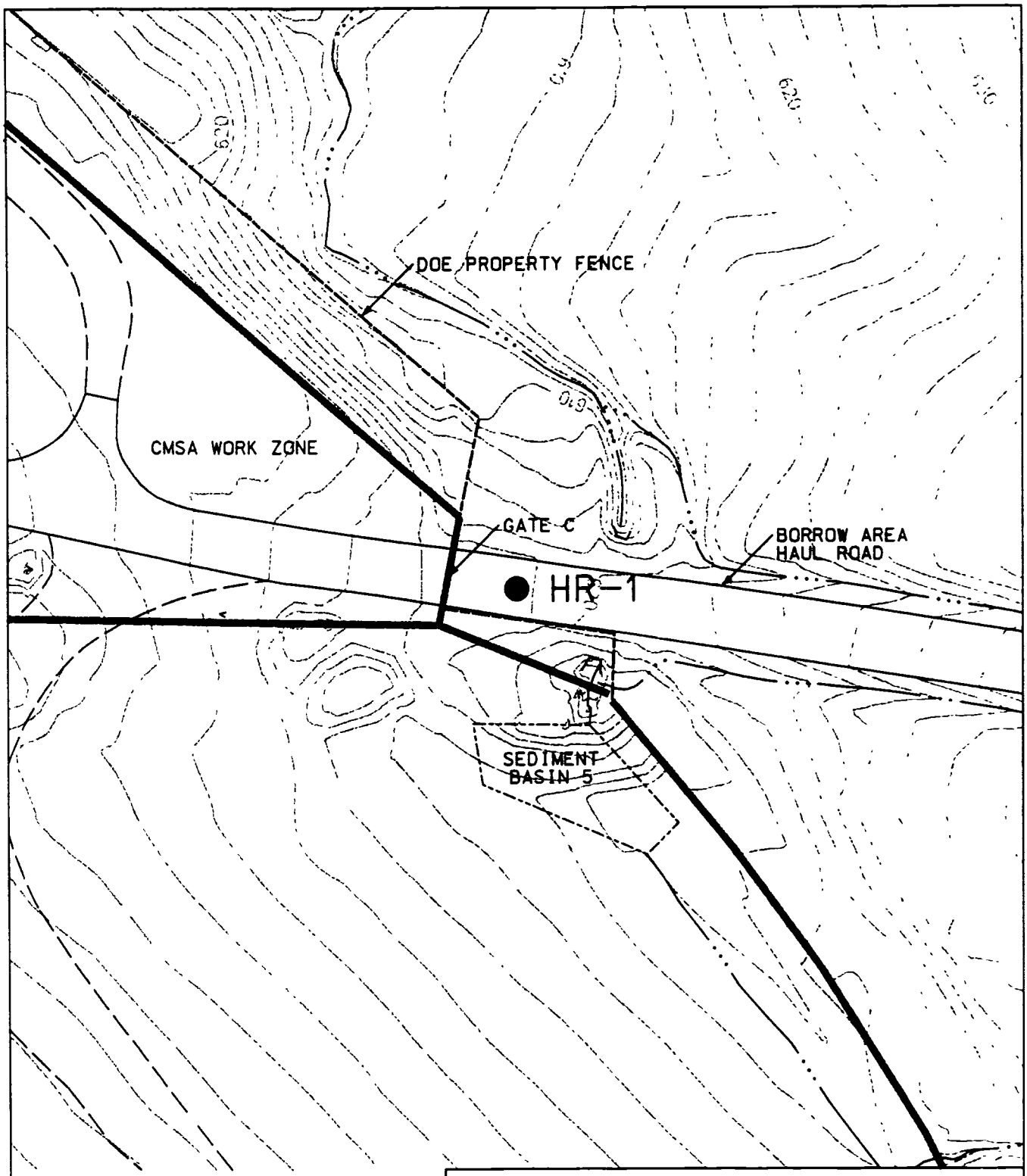
2.1.1 Additional Characterization

An additional characterization sample was taken as described in the *Supplementary Soil Sampling Plan Addendum: Preconstruction Detailed Characterization Sampling For Soils on Perimeter Property at the Site of the Proposed Borrow Haul Road Site Entry Location* (Ref. 10). Location HR-1 was sampled during July 1994 (Figure 2-1). This location is near Gate C under a haul road within the 100-ft buffer of the site perimeter.

At sample location HR-1, no contamination was detected in the sampling intervals between 0 ft and 7 ft, but the 7-ft to 10-ft interval showed a combined radium concentration of 6.02 pCi/g. This concentration exceeds surface ALARA, but not surface criteria. The ALARA committee convened on May 11, 1999, to discuss the results of sample HR-1 and agreed that no further excavation was required and that the results should be presented in this post-remedial action report. Additionally, since the area was not excavated during construction of the Frog Pond drainage culvert replacement, and the sample was not available for reanalysis, the committee considered the issue closed.

2.2 Data Quality Objectives

Data Quality Objectives (DQOs) were identified to specify quality data and ensure that the data would be sufficient to support the decision making process throughout remedial activities, including the confirmation process. Confirmation DQOs were developed for sampling and analyzing soils during remediation and for the subsequent data evaluation. The DQOs were



LOCATION OF CHARACTERIZATION SAMPLE HR-1

FIGURE 2-1

REPORT NO.: DOE/OR/21548-892		EXHIBIT NO.: A/CP/046/0601	
ORIGINATOR: LB	DRAWN BY: GLN	DATE: 6/6/01	

designed to make statistically defensible decisions regarding attainment of cleanup standards. Sampling and analytical programs for the WP-437 work zones were designed in accordance with DQOs stated in the *Attainment Plan* (Ref. 3).

2.3 Cleanup Standards

The objective of the Department of Energy (DOE) ALARA process is to reduce exposures and risks associated with residual contamination. The ROD (Ref. 1) established two different sets of cleanup standards: risk-based cleanup criteria and As Low As Reasonably Achievable (ALARA) goals. Remedial activities for WP-437 were designed to remove soil where the COC concentrations were found by characterization or during remediation activities to exceed ALARA goals. Table 2-1 summarizes the cleanup criteria and ALARA goals established in the ROD that are applicable for COCs in the Construction Materials Staging Area (CMSA) work zone. Throughout the remedial activities at RU019, COC concentrations were evaluated with the ALARA process.

2.4 Cleanup Confirmation Process

The cleanup confirmation process is used to determine, under the remedial guidelines, if remediation activities have achieved the cleanup standards. Figure 2-2 shows the cleanup confirmation process for remedial activities conducted at the WP-437 area.

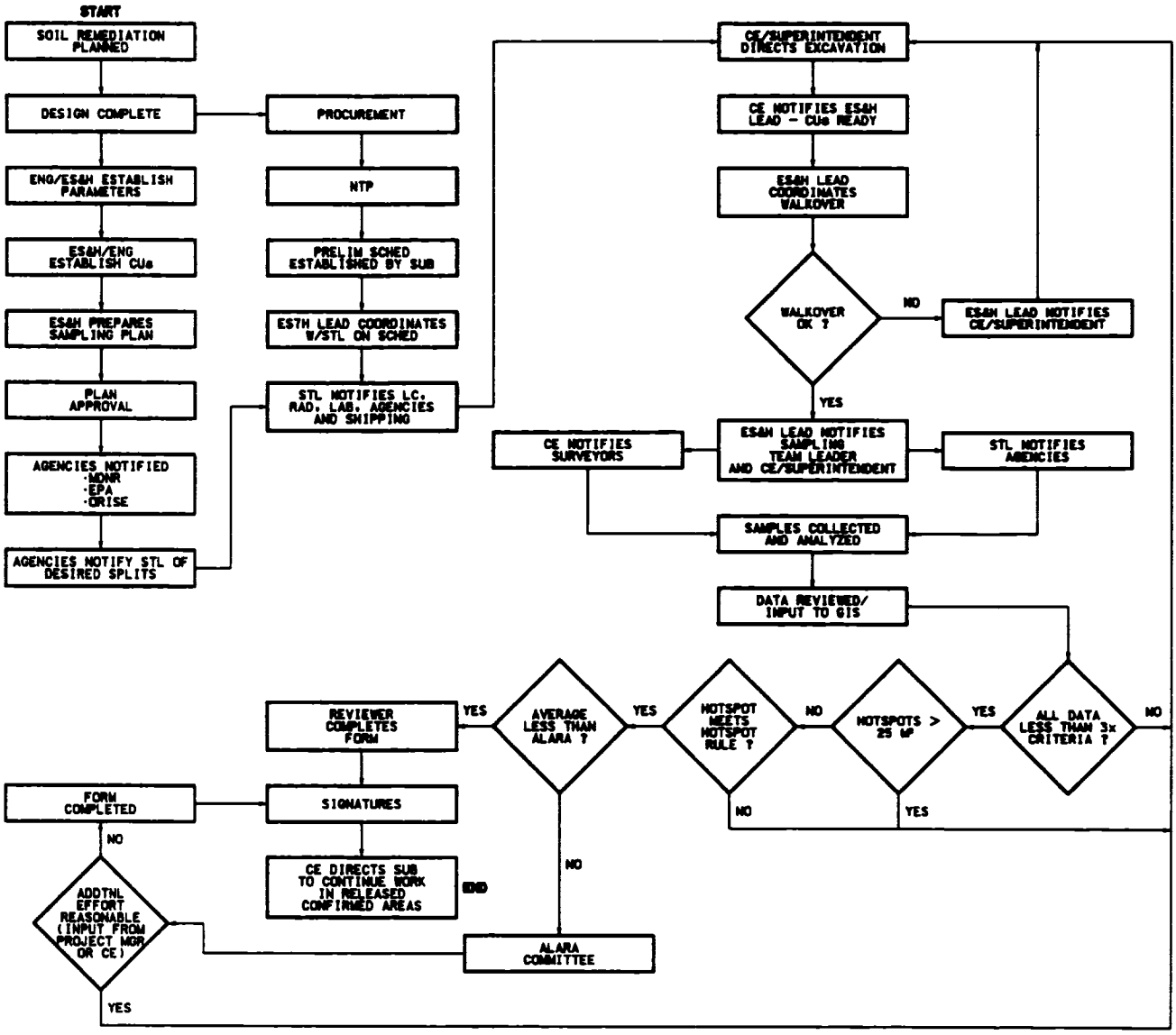
The decision-making process specifies how the data will be applied and evaluated within the cleanup confirmation process. The decision-making process includes provisions for any hot spots that may be encountered by applying a formula to determine the acceptable concentration for the COC.

Table 2-1 ROD Cleanup Standards for COCs within the WP-437 CMSA Work Zone

	SURFACE [a]		SUBSURFACE [b]	
RADIONUCLIDE (pCi/g)	ALARA	CRITERIA	ALARA	CRITERIA
Ra-226	5.0	6.2	5.0	16.2
Ra-228	5.0	6.2	5.0	16.2
Total Radium	5.0	6.2	5.0	16.2
Th-230	5.0	6.2	5.0	16.2
Th-232	5.0	6.2	5.0	16.2
U-238	30.0	120	30.0	120.0

(a) Values listed for surface soils apply to contamination within the upper 15 cm (6 in.) of the soil column.
(b) Values for subsurface apply to contamination in soils below 15 cm (6 in.).

Source: *Record of Decision for Remedial Action at the Chemical Plant Area of the Weldon Spring Site* (Ref. 1)



CLEANUP CONFIRMATION PROCESS

FIGURE 2-2

REPORT NO.: DOE/OR/21548-892		EXHIBIT NO.: A/PI/044/0801	
ORIGINATOR: ML	DRAWN BY: GLN	DATE: 8/13/01	

3. REMEDIAL ACTIVITIES

3.1 Field Activities

Contaminated soils, roadway material, sediment, and other debris from the Construction Materials Staging Area (CMSA) work zone were first excavated to design depth as detailed in the CMSA work zone specifications (Ref. 6). After the initial excavation was complete, radiological walkover surveys were conducted to evaluate the need for additional excavation. When the surveys indicated no additional excavation was needed, confirmation soil samples were collected.

Confirmation sample results were then reviewed, and additional excavation and confirmation sampling was conducted in hot spot areas, if necessary. After achieving cleanup standards, a disposition form was completed with preliminary analytical results. The form was reviewed and signed by authorized project personnel. The confirmation unit (CU) was then released back to the subcontractor for final grading.

Field activities completed during remediation, such as walkover surveys and soil sampling, were conducted in accordance with procedures specified in the *Confirmation Sampling Plan Details for the Disposal Cell Facility (WP-437)* (Ref. 2). Field activities were conducted to achieve and document sampling objectives specified in the *Attainment Plan* (Ref. 3). All sampling and remedial action surveys were conducted and documented in accordance with Weldon Spring Site Remedial Action Project (WSSRAP) Environmental Safety and Health (ES&H) procedures.

3.1.1 Walkover Surveys

Radiological walkover surveys were conducted after contaminated soil removal was completed to determine if confirmation sample collection could begin. The surveys were conducted using a 2 in. x 2 in. sodium iodide (NaI) scintillation detector. The survey readings were within an acceptable range (less than 1.5 times background) throughout the entire work zone. The ranges for each CU are listed in the CU Summary Forms in Section 4 of this report.

3.1.2 Soil Sampling

Once the walkovers were completed, soil sampling was conducted as part of the confirmation process. The sampling locations for CUs in RU019 are shown in the figures in Section 4. Analytical suites for the CUs were dependant upon the COC list developed from historical information, characterization data, and visual identification in the field as discussed in Section 2.

Nine Th-230 hot spots were encountered during confirmation of this RU. Eight of these locations were further remediated in accordance with the guidelines established in the *Attainment*

Plan (Ref. 3). The remaining hotspot location met the hotspot rule as defined in the *Attainment Plan* and no additional excavation was required. Details can be found in the appropriate CU Summary Forms in Section 4 of this report.

The subsequent survey and confirmation sample results indicated that contaminants were below cleanup standards and the averages were less than ALARA; therefore, no further remediation was conducted for RU019. Disposition forms were completed following the receipt of preliminary analytical data for all CUs within the CMSA work zone.

3.2 Laboratory Activities

Radiological analyses for RU019 were conducted at the on-site laboratory in accordance with the *Project Management Contractor Quality Assurance Program* (Ref. 4) and the *Environmental Quality Assurance Project Plan* (EQAPjP) (Ref. 5). CU releases were based on estimated Ra-226 results. In addition, the concentration of Th-232 was calculated based on the analytical results of Ra-228 and the calculated value was used for CU releases. Both of these calculations are explained in detail in interoffice correspondences (IOCs) in Appendix D.

3.3 Verification Activities

The Oak Ridge Institute for Science and Education (ORISE) was contracted by the U. S. Department of Energy (DOE) to verify confirmation soil sampling in the chemical plant area. Verification activities included independent walkover radiological surveys and collection and analysis of soil samples to verify proper disposition of CUs. Field verification activities were conducted in accordance with ORISE's final survey plan (Ref. 7).

A final verification report will be prepared by ORISE. The report will contain verification of walkover surveys and soil sampling results and will affirm that the remedial action objectives were achieved. ORISE visits to the Weldon Spring site to verify WP-437 remediation activities did not include a visit to the CMSA work zone.

4. CONFIRMATION UNITS RESULTS SUMMARY

This section summarizes the confirmation unit analytical results for the five CUs in RU019. In total, 163 locations were sampled between June and September 2000. Preliminary results were below cleanup criteria with the exception of eight hot spots as discussed in Section 3 of this report. Average COC concentrations as indicated by preliminary data for RU019 remained below ALARA goals. All 100 m^2 averages from final data were less than criteria.

After the preliminary data were reviewed, disposition forms were completed and signed by authorized reviewers. Based on the preliminary confirmation data, all CUs in RU019 were fully released as complying with surface cleanup standards.

Note that the preliminary data were the initial results available immediately from the laboratory and were used for releases. These preliminary results could vary from the final results based upon laboratory quality checks or Weldon Spring Site Remedial Action Project (WSSRAP) verification activities. Upon receipt of the data packages, the final data were reviewed and compared to the preliminary data. The final analytical results agreed with the preliminary results and indicated that the remedial activities were completed. The final results met the cleanup standards as detailed in the *Attainment Plan* (Ref. 3) for all CUs in RU019. Tables 4-1 through 4-5 and associated figures provide the confirmation details for each CU, and all data presented is final data. Copies of the final walkover forms are in Appendix A. The final data are presented in Appendix B. The list of coordinates is in Appendix C.

Table 4 - 1 Summary of CU369

CU 369 RU 19

COC				
	Ra-226	X	As	
	Ra-228	X	Cr	
	Th-230	X	Pb	
	Th-232	X	Tl	
	U-238	X	PAH	
			PCB	
			TNT	

Reference Figure: 4 - 1

DATE RELEASED FOR UNRESTRICTED USE: 7 / 12 / 00

CLEANUP STANDARD [X] SURFACE [ ] SUBSURFACE

EACH 100m² < CRITERIA? [X] YES [ ] NO

LOCATION DESCRIPTION: *This CU is located in the southwest portion of Remedial Unit 19 in the CMSA work zone.*

WALKOVER SURVEY INFORMATION

BACKGROUND: *10,000* cpm
(shielding may have been used on a case-by-case basis)

FINAL SURVEY(S) BELOW 1.5 X BACKGROUND ? [X] YES [ ] NO

DATE(S) SCANNED: *6/22/00*

CONFIRMATION SAMPLING INFORMATION

TOTAL # OF SAMPLE LOCATIONS : *31*

AVERAGES < ALARA? [X] YES [ ] NO

HOTSPOTS? [X] YES [ ] NO

TOTAL # OF UTILITY SAMPLES : *0*

ADDITIONAL EXCAVATION REQUIRED? [X] YES [ ] NO

GENERAL COMMENTS - *One Th-230 hotspot was identified at SC-36913-S. Area was excavated and resampled All final results are below criteria.*

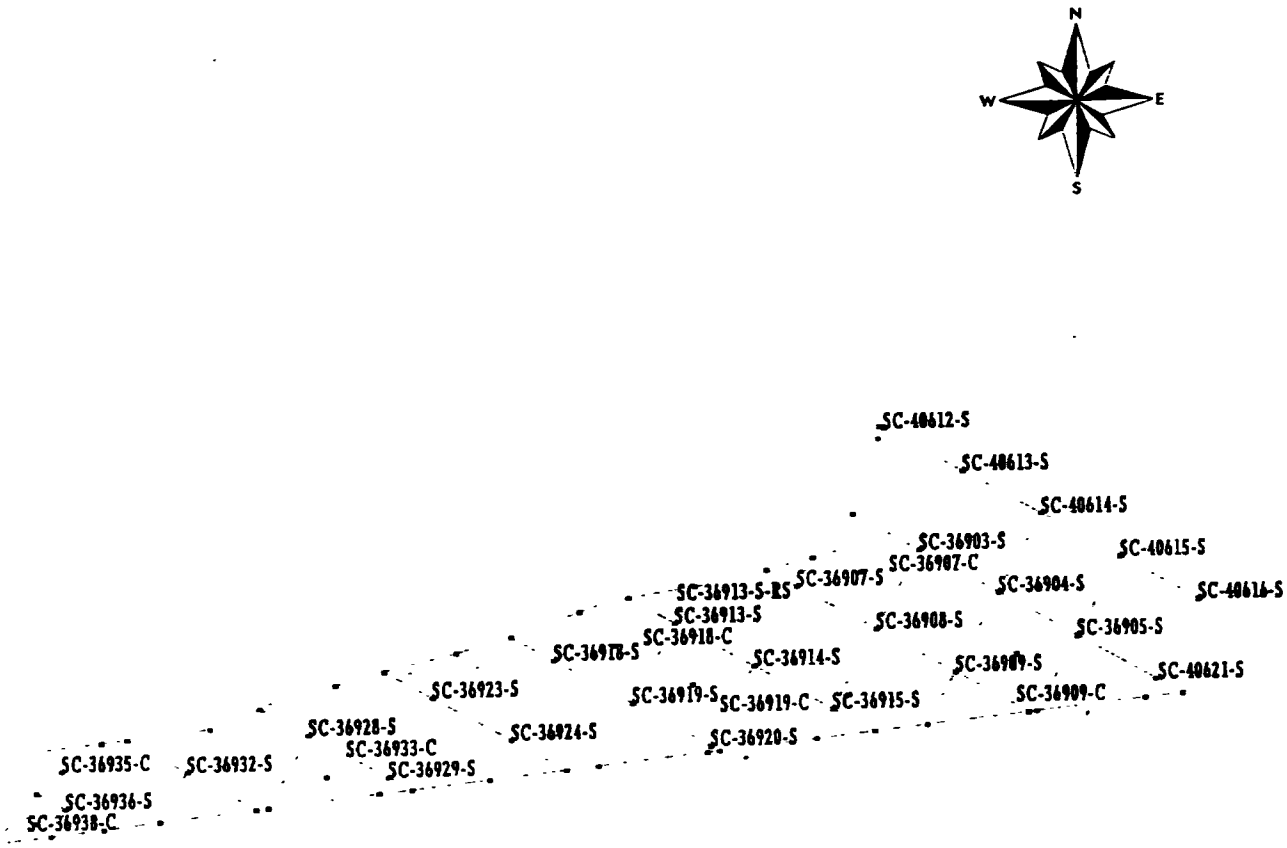
ORISE ACTION - *None*

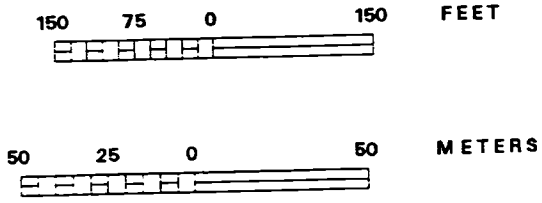
ALARA COMMITTEE ACTION - *None*

CU SUMMARY DATA

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ra-226	31	0.22 - 0.89	0.69	5	6.2	0	0
Ra-228	31	0.36 - 1.48	0.95	5	6.2	0	0
Total Radium	31	0.58 - 2.34	1.65	5	6.2	0	0
Th-230	31	0.72 - 5.24	1.51	5	6.2	1	0
Th-232	31	0.37 - 1.52	0.98	5	6.2	0	0
U-238	31	1.02 - 2.02	1.15	30	120	0	0

NOTE: Radiological contaminants are listed in pCi/g.





Sample Locations in Remedial Unit RU019 Confirmation Unit CU369

Figure: 4-1

REPORT NO.: DOE/OR/21548-892		EXHIBIT NO :	
ORIGINATOR: MGL	DRAWN BY: LGB	DATE: 5/7/01	

Table 4 - 2 Summary of CU406

CU 406 RU 19

COC

Ra-226	X	As	
Ra-228	X	Cr	
Th-230	X	Pb	
Th-232	X	Tl	
U-238	X	PAH	
		PCB	
		TNT	

Reference Figure: 4 - 2

DATE RELEASED FOR UNRESTRICTED USE: 9 / 26 / 00

CLEANUP STANDARD [X] SURFACE [ ] SUBSURFACE

EACH 100m² < CRITERIA? [X] YES [ ] NO

LOCATION DESCRIPTION: *This CU is located in the southern portion of Remedial Unit 19 in the CMSA work zone.*

WALKOVER SURVEY INFORMATION

BACKGROUND: *9,000 - 10,000* cpm
(shielding may have been used on a case-by-case basis)

FINAL SURVEY(S) BELOW 1.5 X BACKGROUND ? [X] YES [ ] NO

DATE(S) SCANNED: *6/22/00 8/8/00 9/16/00*

CONFIRMATION SAMPLING INFORMATION

TOTAL # OF SAMPLE LOCATIONS : *31*

AVERAGES < ALARA? [X] YES [ ] NO

HOTSPOTS? [ ] YES [X] NO

TOTAL # OF UTILITY SAMPLES : *0*

ADDITIONAL EXCAVATION REQUIRED? [ ] YES [X] NO

GENERAL COMMENTS - *All final results are below criteria.*

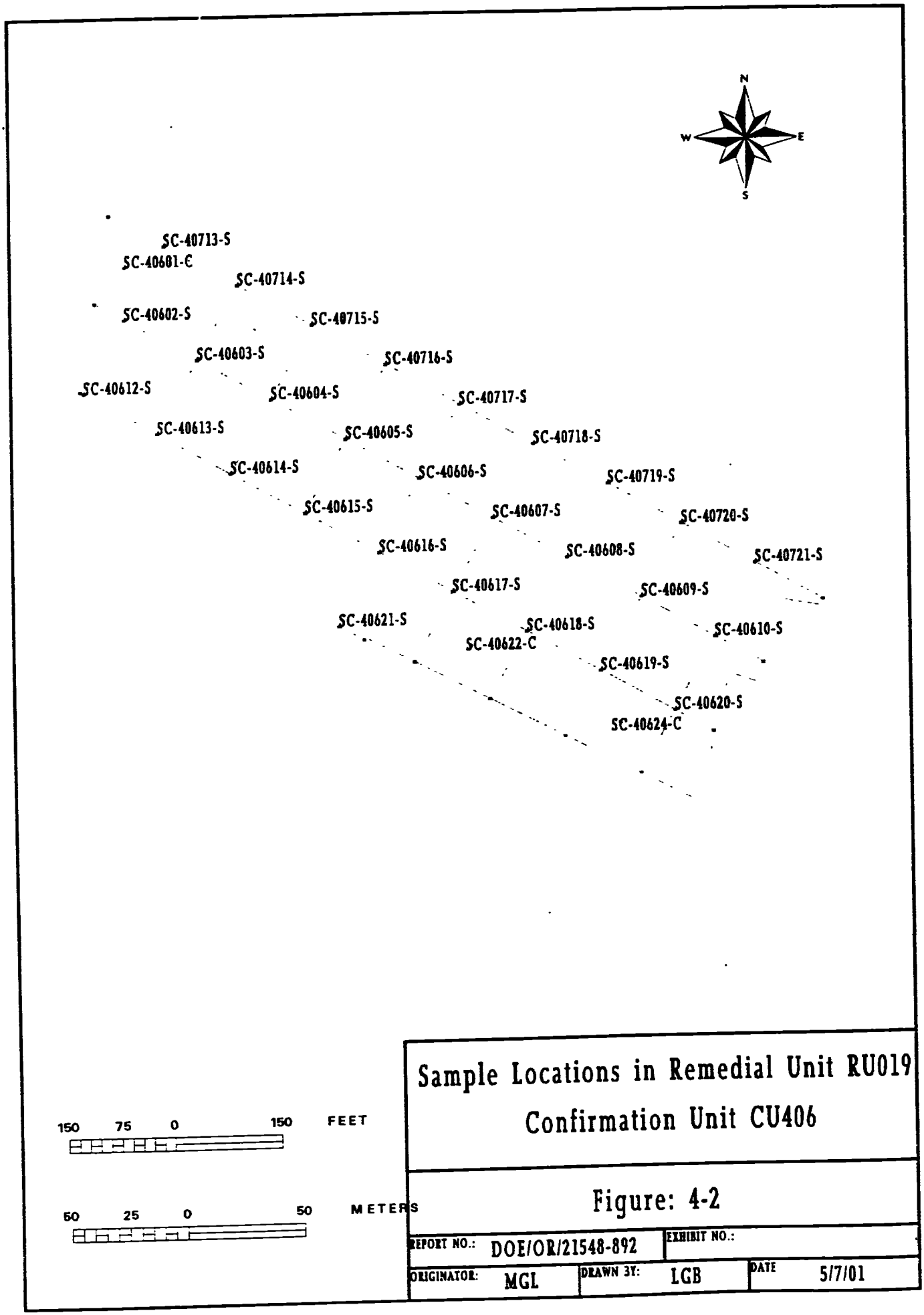
ORISE ACTION - *None*

ALARA COMMITTEE ACTION - *None*

CU SUMMARY DATA

CONTAMINANT	NO. OF SAMPLES	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ra-226	31	0.22 - 0.93	0.69	5	6.2	0	0
Ra-228	31	0.36 - 1.36	0.89	5	6.2	0	0
Total Radium	31	0.58 - 2.17	1.57	5	6.2	0	0
Th-230	31	0.74 - 1.94	1.05	5	6.2	0	0
Th-232	31	0.37 - 1.39	0.91	5	6.2	0	0
U-238	31	0.99 - 2.66	1.2	30	120	0	0

NOTE: Radiological contaminants are listed in pCi/g.



Sample Locations in Remedial Unit RU019
Confirmation Unit CU406

Figure: 4-2

REPORT NO.: DOE/OR/21548-892		EXHIBIT NO.:	
ORIGINATOR: MGL	DRAWN BY: LGB	DATE 5/7/01	

Table 4 - 3 Summary of CU407

CU 407 RU 19

COC

Ra-226	X	As	
Ra-228	X	Cr	
Th-230	X	Pb	
Th-232	X	Tl	
U-238	X	PAH	
		PCB	
		TNT	

Reference Figure: 4 - 3

DATE RELEASED FOR UNRESTRICTED USE: 9 / 26 / 00

CLEANUP STANDARD [X] SURFACE [ ] SUBSURFACE

EACH 100m² < CRITERIA? [X] YES [ ] NO

LOCATION DESCRIPTION: *This CU is located in the central portion of Remedial Unit 19 in the CMSA work zone.*

WALKOVER SURVEY INFORMATION

BACKGROUND: *5,000 - 10,000* cpm
(shielding may have been used on a case-by-case basis)

FINAL SURVEY(S) BELOW 1.5 X BACKGROUND ? [X] YES [ ] NO

DATE(S) SCANNED: *6/22/00 7/16/00 7/19/00 8/8/00 9/14/00 9/16/00*

CONFIRMATION SAMPLING INFORMATION

TOTAL # OF SAMPLE LOCATIONS: *31*

AVERAGES < ALARA? [X] YES [ ] NO

HOTSPOTS? [X] YES [ ] NO

TOTAL # OF UTILITY SAMPLES: *0*

ADDITIONAL EXCAVATION REQUIRED? [X] YES [ ] NO

GENERAL COMMENTS - *One Th-230 hotspot was identified at SC-40824-S. Area was excavated and resampled All final results are below criteria*

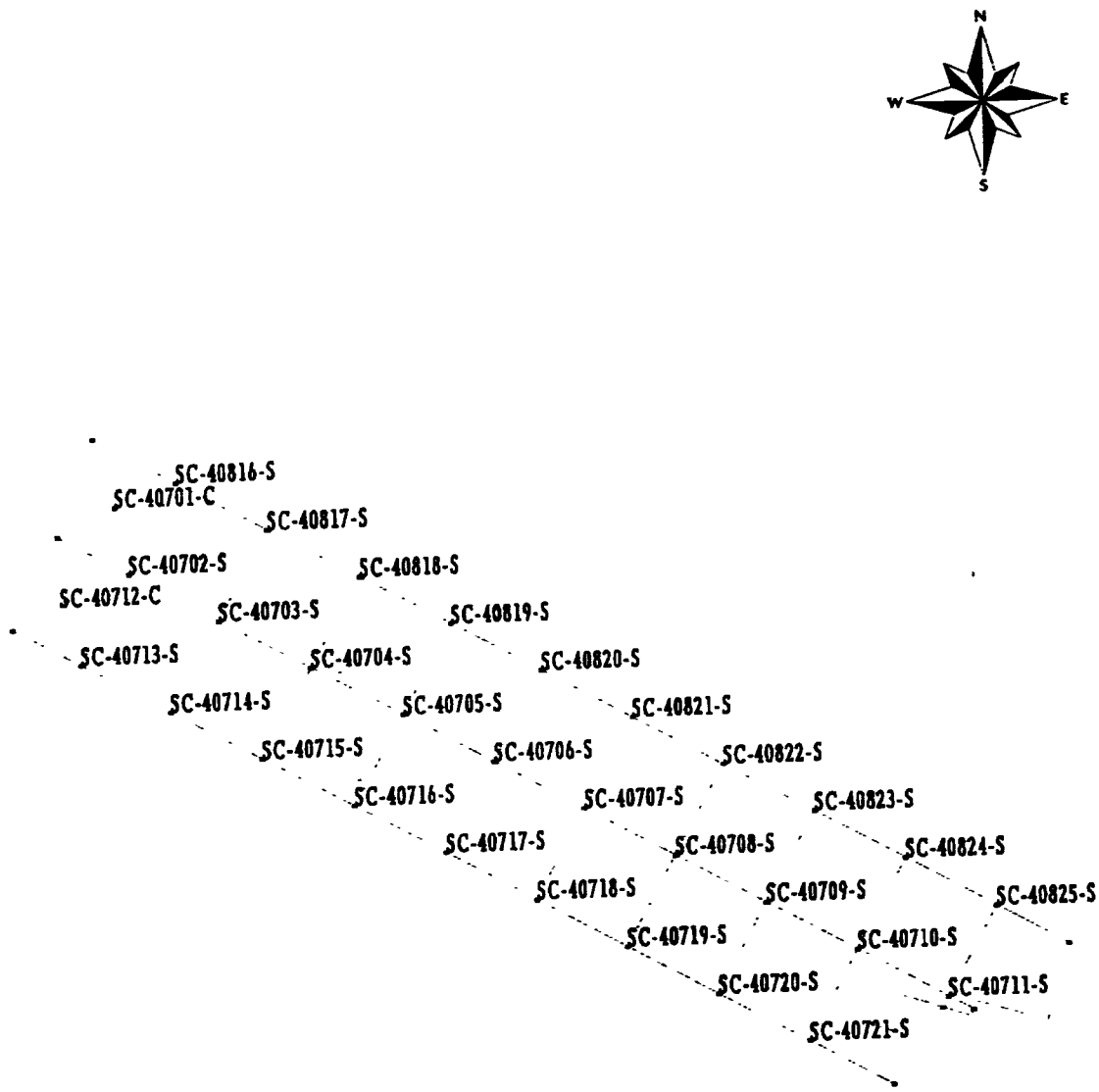
ORISE ACTION - *None*

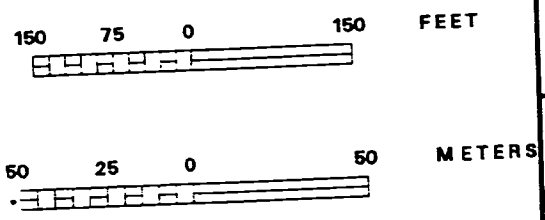
ALARA COMMITTEE ACTION - *None*

CU SUMMARY DATA

CONTAMINANT	NO. OF SAMPLES	CONCENTRATION RANGE	AVERAGE CONCENTRATION	[illegible]	[illegible]	NO. [illegible]	NO. [illegible]
Ra-226	31	0.25 - 1.13	0.7	5	6.2	0	0
Ra-228	31	0.34 - 1.60	0.94	5	6.2	0	0
Total Radium	31	0.60 - 2.73	1.64	5	6.2	0	0
Th-230	31	0.77 - 4.54	1.23	5	6.2	0	0
Th-232	31	0.35 - 1.64	0.96	5	6.2	0	0
U-238	31	0.94 - 1.46	1.11	30	120	0	0

NOTE. Radiological contaminants are listed in pCi/g.





Sample Locations in Remedial Unit RU019 Confirmation Unit CU407

Figure: 4-3

REPORT NO.: DOE/OR/21548-892		EXHIBIT NO.:	
ORIGINATOR: MGL	DRAWN BY: LGB	DATE 5/7/01	

Table 4 - 4 Summary of CU408

CU 408 RU 19

COC				
	Ra-226	X	As	
	Ra-228	X	Cr	
	Th-230	X	Pb	
	Th-232	X	Tl	
	U-238	X	PAH	
			PCB	
			TNT	

Reference Figure: 4 - 4

DATE RELEASED FOR UNRESTRICTED USE: 9 / 26 / 00

CLEANUP STANDARD [X] SURFACE [ ] SUBSURFACE

EACH 100m² < CRITERIA? [X] YES [ ] NO

LOCATION DESCRIPTION: *This CU is located in the northern portion of Remedial Unit 19 in the CMSA work zone.*

WALKOVER SURVEY INFORMATION

BACKGROUND: *5,000 - 10,000* cpm
(shielding may have been used on a case-by-case basis)

FINAL SURVEY(S) BELOW 1.5 X BACKGROUND ? [X] YES [ ] NO

DATE(S) SCANNED: *7/16/00 8/8/00 9/14/00 9/16/00 9/20/00 9/22/00*

CONFIRMATION SAMPLING INFORMATION

TOTAL # OF SAMPLE LOCATIONS: *33*

TOTAL # OF UTILITY SAMPLES: *0*

AVERAGES < ALARA? [X] YES [ ] NO

HOTSPOTS? [X] YES [ ] NO

ADDITIONAL EXCAVATION REQUIRED? [X] YES [ ] NO

GENERAL COMMENTS - *Two Th-230 hotspots were identified at SC-40824-S and SC-40934-S. Areas were excavated and resampled. SC-40812-S was also resampled due to potential recontamination as it was located between the two hotspots All final results are below criteria*

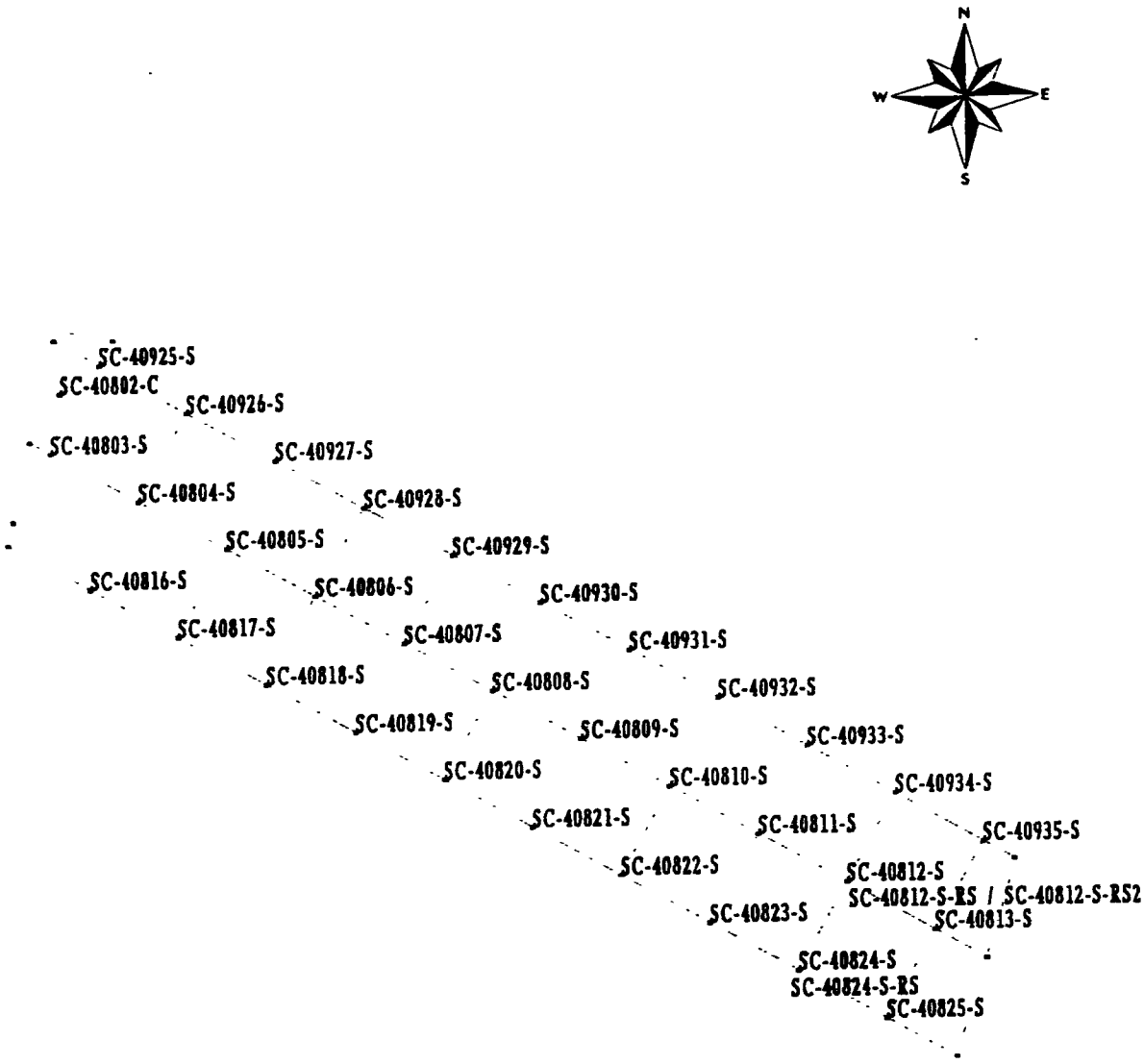
ORISE ACTION - *None*

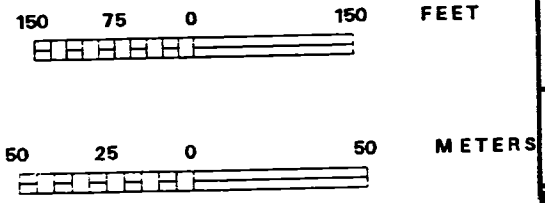
ALARA COMMITTEE ACTION - *None*

CU SUMMARY DATA

CONTAMINANT	NO. OF SAMPLES	CONCENTRATION RANGE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ra-226	33	0.26 - 1.32	0.71	5	6.2	0	0
Ra-228	33	0.34 - 1.60	0.9	5	6.2	0	0
Total Radium	33	0.60 - 2.73	1.61	5	6.2	0	0
Th-230	33	0.67 - 6.01	1.54	5	6.2	1	0
Th-232	33	0.35 - 1.64	0.92	5	6.2	0	0
U-238	33	0.98 - 1.59	1.11	30	120	0	0

NOTE: Radiological contaminants are listed in pCi/g.





Sample Locations in Remedial Unit RU019
Confirmation Unit CU408

Figure: 4-4

REPORT NO.: DOE/OR/21548-892		EXHIBIT NO.:	
ORIGINATOR: MGL	DRAWN BY: LGB	DATE: 5/7/01	

Table 4 - 5 Summary of CU409

CU 409 RU 19

COC				
	Ra-226	X	As	
	Ra-228	X	Cr	
	Th-230	X	Pb	
	Th-232	X	Tl	
	U-238	X	PAH	
			PCB	
			TNT	

Reference Figure: 4 - 5

DATE RELEASED FOR UNRESTRICTED USE: 9 / 26 / 00

CLEANUP STANDARD [X] SURFACE [ ] SUBSURFACE

EACH 100m² < CRITERIA? [X] YES [ ] NO

LOCATION DESCRIPTION: *This CU is located in the northern portion of Remedial Unit 19 in the CMSA work zone.*

WALKOVER SURVEY INFORMATION

BACKGROUND: *5,000 - 10,000* cpm
(shielding may have been used on a case-by-case basis)

FINAL SURVEY(S) BELOW 1.5 X BACKGROUND ? [X] YES [ ] NO

DATE(S) SCANNED: *6/27/00 7/16/00 8/22/00 9/14/00 9/16/00 9/20/00 9/21/00 9/22/00*

CONFIRMATION SAMPLING INFORMATION

TOTAL # OF SAMPLE LOCATIONS : 37

TOTAL # OF UTILITY SAMPLES : 0

AVERAGES < ALARA? [X] YES [ ] NO

HOTSPOTS? [X] YES [ ] NO

ADDITIONAL EXCAVATION REQUIRED? [X] YES [ ] NO

GENERAL COMMENTS - *Seven Th-230 hotspots were identified at SC-40905-S, SC-40913-C, SC-40913-S, SC-40914-S, SC-40922-S, SC-40923-S, and SC-40934-S. Areas were excavated and resampled. One location, SC-40905-S, meets the hotspot rule. Concentration = 17.36 pCi/g. Hotspot was sampled around to determine size Hotspot < 13 sq m No additional excavation required at this location. During remediation of the remaining Th-230 hotspots, the contaminated sediment was stockpiled in the CMSA shop area basin. Two sample locations were added within the footprint of the stockpile upon its removal. The locations are SC-40912-C and SC-40921-C. All final results, with the exception of the Th-230 hotspot discussed above, are below ALARA*

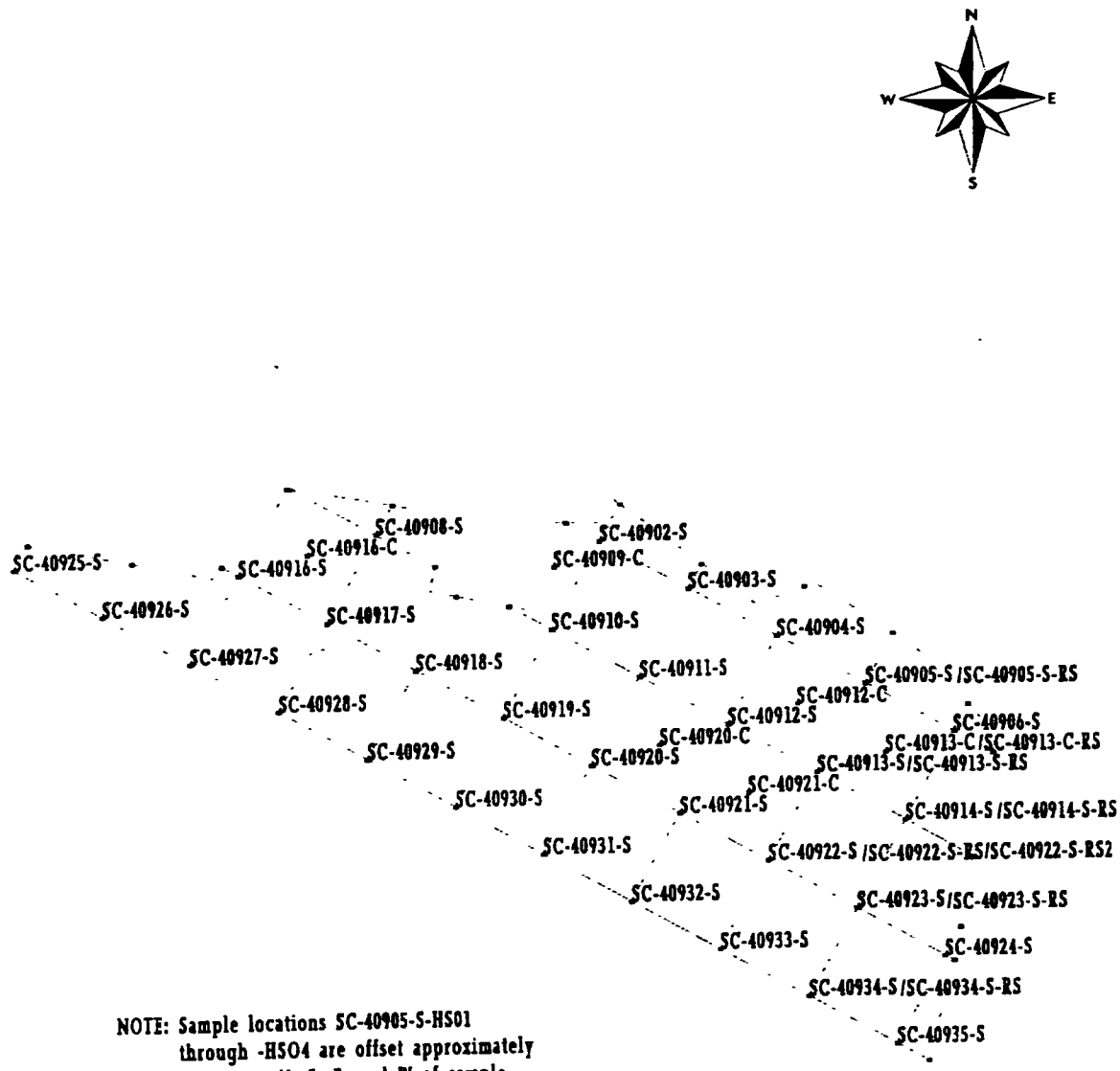
ORISE ACTION - *None*

ALARA COMMITTEE ACTION - *None*

CU SUMMARY DATA

CONTAMINANT	NO. OF SAMPLES	CONCENTRATION RANGE					
Ra-226	35	0.16 - 1.51	0.75	5	6.2	0	0
Ra-228	35	0.35 - 1.76	0.98	5	6.2	0	0
Total Radium	35	0.90 - 3.27	1.73	5	6.2	0	0
Th-230	37	0.69 - 17.4	1.63	5	6.2	1	1
Th-232	35	0.35 - 1.80	1.01	5	6.2	0	0
U-238	35	1.01 - 4.77	1.23	30	120	0	0

NOTE. Radiological contaminants are listed in pCi/g.



NOTE: Sample locations SC-40905-S-HS01 through -HS04 are offset approximately 2.5 meters N, S, E, and W of sample location SC-40905-S.

150 75 0 150 FEET

50 25 0 50 METERS

Sample Locations in Remedial Unit RU019 Confirmation Unit CU409

Figure: 4-5

REPORT NO.: DOE/OR/21548-892		EXHIBIT NO.:	
ORIGINATOR: MGL	DRAWN BY: LGB	DATE: 5/7/01	

5. DATA EVALUATION

Work Package-437 (WP-437) final analytical data were evaluated to determine whether data quality objectives developed for the Weldon Spring Site Remedial Action Project (WSSRAP) were met and to ensure that overall data quality results were generated from these remedial activities. The data were evaluated in accordance with the *Project Management Contractor Quality Assurance Program* (Ref. 4) and the *Environmental Quality Assurance Project Plan* (Ref. 5). The data evaluation process was completed by data verification, data review, data validation, and data management activities as stated in the *Attainment Plan* (Ref. 3).

5.1 Data Verification

Data verification was conducted in accordance with ES&H 4.9.1, *Environmental Monitoring Data Verification*, to ensure that documentation and data were reported in compliance with established reporting requirements and standard operating procedures (SOPs), and to ensure that all analyses were performed. All analytical results received from the laboratory were reviewed to verify that samples were properly handled according to WSSRAP protocol. The following factors were reviewed and evaluated: sample identification, chain of custody, holding times, sample preservation requirements, sample analysis request forms, data reviews, laboratory tracking, data reporting requirements, and the database transfer.

5.2 Data Review

Data packages were reviewed to ensure that final data were properly identified, analyzed, reported, and that they met data quality requirements (DQRs). The data were also reviewed to check for inconsistencies with the field quality control (QC) samples. Final analytical results were also compared to the preliminary results to identify any changes in data.

During confirmation of WP-437 areas, which included RU019, soil samples were obtained in accordance with the details provided in the *Confirmation Sampling Plan Details for the Disposal Cell Facility* (WP-437) (Ref. 2). This plan indicates that quality control samples were to be taken at a frequency of 1 per 20 samples or 5%. The quality control samples collected included duplicates, field replicates, secondary duplicates, matrix spikes/matrix spike duplicates, and equipment blanks. Since the 5% requirement was based on all WP-437 confirmation sampling, the quality control data will be discussed in a separate report entitled *WP-437 Confirmation Quality Control Results Report*.

5.3 Data Validation

Data validation was performed on 10% of all analytical data generated from the confirmation sampling activities. Data validation was conducted in accordance with ES&H 4.9.2, *Environmental Monitoring Data Validation*. Note that the validation of 10% of the data is based upon all confirmation data collected for WP-437, and not 10% of each work zone.

The percentage of confirmation validated will be discussed in the *WP-437 Confirmation Quality Control Results Report*.

6. SUMMARY OF CLOSURE REPORT FINDINGS

The portions of the Construction Materials Staging Area work zone requiring confirmation under WP-437 consisted of the five confirmation units within RU019. Summary information regarding the remedial activities is presented in Section 4 of this report.

6.1 Data Evaluation

Upon completion of remediation activities, preliminary results were used to complete disposition forms in accordance with ES&H 1.2.1, *Soil Remediation Disposition Process*. Based on the preliminary results, each CU was released when disposition forms were reviewed and signed by authorized project personnel.

6.2 Summary of WP-437 Confirmation Results

Table 6-1 provides a summary of the total number of samples collected and analyzed for each contaminant during remedial activities in RU019. The number of results and the minimum, maximum, and average concentrations are also provided for each contaminant. The table was generated using final data sets compiled from all samples that represented soils left in place.

Table 6-1 Summary Totals for RU019

CONTAMINANT	NO OF SAMPLES	CONCENTRATION RANGE	AVERAGE CONCENTRATION	SURFACE ALARA	SURFACE CRITERIA	RESULTS > ALARA
Ra-226 (pCi/g)	125	0 16 - 1 51	0 71	5 00	6 20	0
Ra-228 (pCi/g)	125	0 34 - 1 76	0 94	5 00	6 20	0
Total Radium* (pCi/g)	125	0 58 - 3 27	1 65	5 00	6 20	0
Th-230 (pCi/g)	127	0 67 - 17 4	1 42	5 00	6 20	3
Th-232 (pCi/g)	125	0 35 - 1 80	0 96	5 00	6 20	0
U-238 (pCi/g)	125	0 94 - 4.77	1 17	30 00	120 00	0

* Total Radium consists of Ra-226 values plus Ra-228 values

Final analytical results generated from the remedial activities indicated that the RU019 average concentrations for each COC were below the ALARA goal. For each of the five CUs, COC averages are also below ALARA. All 100 m^2 averages were less than criteria.

6.3 Summary of Chemical Plant Confirmation Results

To meet the requirements of the ROD, more than 50% of the results for each parameter had to be less than the ALARA goal. Table 6-2 summarizes the cumulative results to date.

Table 6-2 Summary Totals for Confirmation

CONTAMINANT	NO. OF SAMPLES	MINIMUM CONCENTRATION	MAXIMUM CONCENTRATION	AVERAGE CONCENTRATION	RESULTS > ALARA
Arsenic (mg/kg)	1044	0.48	123.00	7.74	1
Chromium (mg/kg)	1416	3.80	41.60	17.13	0
Pb (mg/kg)	1141	2.40	817.00	16.88	2
Thallium (mg/kg)	383	0.12	19.00	1.24	1
TNT (µg/g)	247	0.00	34.00	0.46	1
PAH (mg/kg)	851	0.00	6.65	0.16	80
PCB (mg/kg)	1651	0.00	6.00	0.04	21
Ra-226 (pCi/g)	3080	0.13	9.43	1.25	3
Ra-228 (pCi/g)	2889	0.30	6.60	1.21	2
Th-230 (pCi/g)	2140	0.09	23.10	1.54	39
Th-232 (pCi/g)	2366	0.30	6.77	1.25	2
Toluene (mg/kg)	4	0.00	3.40	0.85	0
U-238 (pCi/g)	4515	0.27	228.00	3.57	50

NOTE: This table contains summary results from cumulative confirmation including WP-253, WP-399, WP-420, WP-458, WP-461, WP-471, WP-437 (RU016, RU017, RU018, and RU019), and WP-551/Task D (RU026).

6.4 Comparison of Standard Deviations

This section compares the estimated standard deviations calculated following U. S. Environmental Protection Agency (EPA) guidance with deviations calculated using confirmation results. Since there were no existing remediation data available to calculate the standard deviation (sigma), the *Attainment Plan* (Ref. 3) estimated sigma using the range (assuming the average concentration remaining after remediation would not exceed cleanup criteria) divided by six. To determine whether the specified level of precision was obtained, a comparison was made between the estimated sigma and the calculated sigma using the RU019 results.

The comparison indicated that the specified level of precision (a false positive = 0.05 and a false negative = 0.20) had been obtained. With the exception of Th-230, all of the calculations

were less than estimated sigmas, indicating that the minimum specified precision was met. Table 6-3 presents the estimated sigma and calculated sigmas for each COC.

Table 6-3 Comparison of Standard Deviations

COC	Estimated Sigma(a)	RU019 Sigma (b)	Cumulative Sigma (c)
Arsenic	12.5	N/A	5.02
Chromium	18.3	N/A	4.86
Lead	75	N/A	28.73
Thallium	3.3	N/A	1.43
PAH	0.93	N/A	0.49
PCB	1.33	N/A	0.29
TNT	23.3	N/A	2.48
Ra-226	1.03	0.21	0.41
Ra-228	1.03	0.31	0.35
Th-230	1.03	1.64	1.31
Th-232	1 03	0.32	0 38
U-238	20	0.40	8.29

(a) Sigma estimated in the *Attainment Plan* (Ref. 3).
(b) Sigma calculated using only the WP437 (RU019) confirmation results.
(c) Sigma calculated using cumulative confirmation results (WP-253, WP-399, WP-458, WP-461, WP-471, WP-437 (RU016, RU017, RU018, and RU019), and WP-551/Task D (RU026).
N/A Not applicable for this remedial unit.

Both the RU019 calculated sigma and the cumulative sigma for Th-230 exceeded the estimated sigma. In the case of RU019 calculated sigma, this is due to one Th-230 hot spot that was left in place in accordance with the *Attainment Plan* (Ref. 3). In the case of cumulative sigma for Th-230, this is a factor of hot spots left in place based upon subsurface criteria in previous CUs. The estimated standard deviation, recalculated for Th-230 using subsurface criteria, was 2.7. The cumulative sigma was less than the estimated subsurface sigma.

7. REFERENCES

1. Department of Energy. *Record of Decision for Remedial Action at the Chemical Plant Area of the Weldon Spring Site*. DOE/OR/21548-376. Oak Ridge Field Office. St. Charles, MO. September 1993.

2. MK-Ferguson and Jacobs Engineering Group. *Confirmation Sampling Plan Details for the Disposal Cell Facility (WP-437)*, Rev 0. DOE/OR/21548-706. Prepared for the U.S. Department of Energy, Oak Ridge Field Office. St. Charles, MO. January 1998.

3. MK-Ferguson and Jacobs Engineering Group. *Chemical Plant Area Cleanup Attainment Confirmation Plan*, Rev. 3. DOE/OR/21548-491. Prepared for the U.S. Department of Energy, Oak Ridge Field Office. St. Charles, MO. December 1995.

4. MK-Ferguson Company and Jacobs Engineering Group. *Project Management Contractor Quality Assurance Program*, Rev. 3. DOE/OR/21548-506. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, MO. November 2000.

5. MK-Ferguson and Jacobs Engineering Group. *Environmental Quality Assurance Project Plan*, Rev. 5. DOE/OR/21548-352. Prepared for the U.S. Department of Energy, Oak Ridge Field Office. St. Charles, MO. November 2000.

6. MK-Ferguson Company. *Construction Materials Staging Area Work Zone Specifications*, Rev. 8. Specification Document No. 3840-7-437-02303. Prepared for the U.S. Department of Energy Weldon Spring Site Remedial Action Project. St. Charles, MO. August 1996.

7. Oak Ridge Institute for Science and Education. *Final Verification Survey Plan for the Chemical Plant Area Weldon Spring Site Remedial Action Project, Weldon Spring, Missouri*. Prepared by the Environmental Survey and Site Assessment Program, Energy/Environment Systems Division, for the U. S. Department of Energy. Weldon Spring, Missouri. December 7, 1995.

8. MK-Ferguson and Jacobs Engineering Group. *Post Remedial Action Report for the Chemical Plant Construction Materials Staging Area (WP-253)*, Rev. 0. DOE/OR/21548-714. Prepared for the U.S. Department of Energy, Oak Ridge Field Office. St. Charles, MO. January 1998.

9. MK-Ferguson Company and Jacobs Engineering Group. *Supplemental Engineering Characterization for In Situ Soils at the Weldon Spring Site*, Rev. 1. DOE/OR/21548-749. Prepared for the U.S. Department of Energy, Oak Ridge Field Office. St. Charles, MO. October 1998.

10. MK-Ferguson Company and Jacobs Engineering Group. *Supplementary Soil Sampling Plan, (Addendum 3): Preconstruction Detailed Characterization Sampling for Soils on Perimeter Property at the Site of the Proposed Borrow Haul Road Site Entry Location.* Rev. 0. DOE/OR/21548-408. Prepared for the U.S. Department of Energy, Oak Ridge Field Office. St. Charles, MO. June 1994.

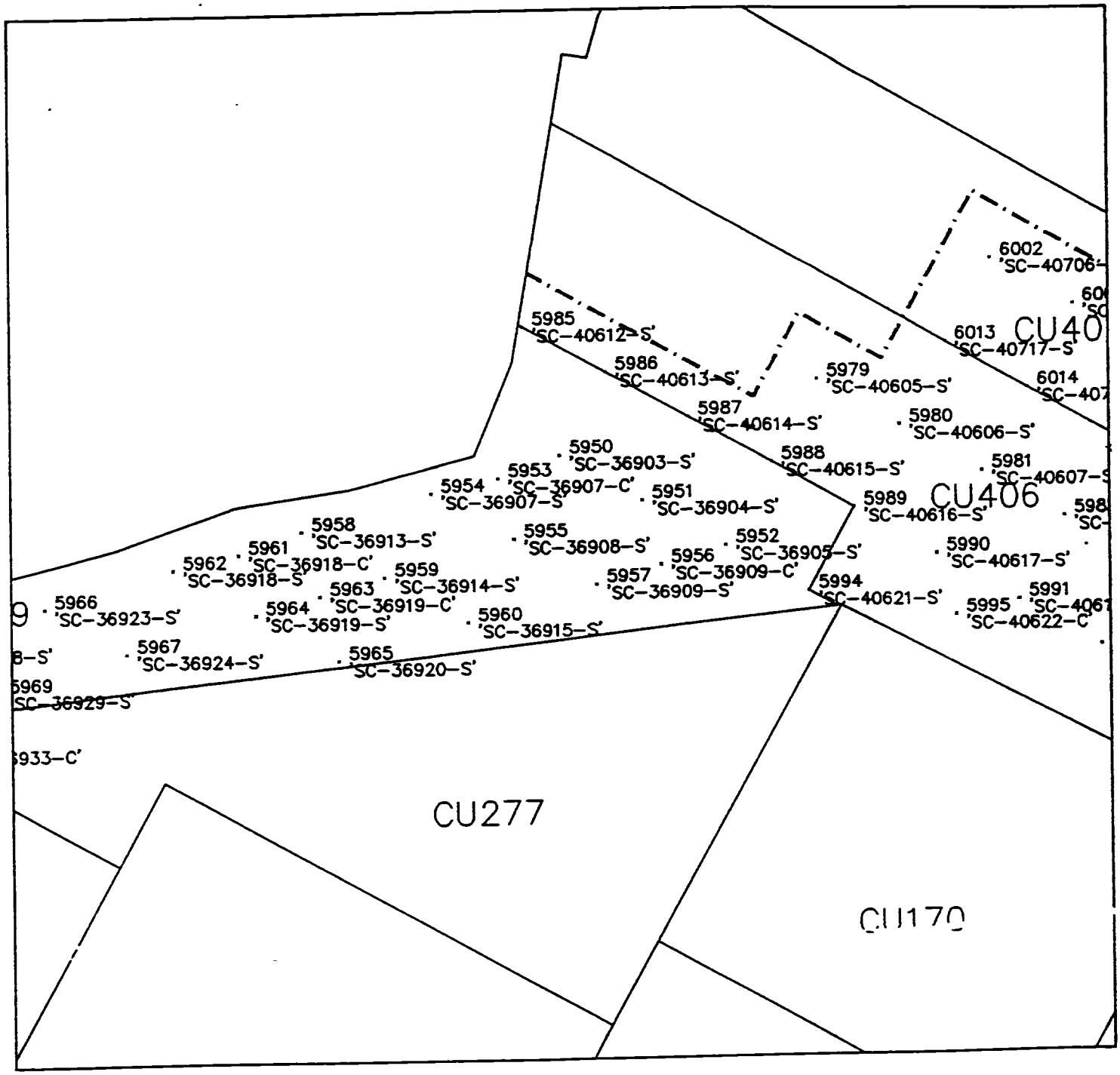
PROCEDURES

ES&H 1.2.1 *Soil Remediation Disposition Process*
ES&H 4.9.1 *Environmental Monitoring Data Verification*
ES&H 4.9.2 *Environmental Monitoring Data Validation*

ACRONYMS

ALARA	as low as reasonably achievable
CE	Construction Engineer
CLP	Contract Laboratory Program
CMSA	Construction Materials Staging Area
COC	contaminant of concern
CPM	counts per minute
CU	confirmation unit
DOE	Department of Energy
DQO	Data Quality Objectives
DQR	Data Quality Requirements
EPA	Environmental Protection Agency
EQAPjP	Environmental Quality Assurance Project Plan
ES&H	Environmental Safety and Health
LC	Laboratory Coordinator
NaI	sodium iodide
ORISE	Oak Ridge Institute for Science and Education
PMC	Project Management Contractor
QA	quality assurance
QC	quality control
ROD	Record of Decision for Remedial Action at the Chemical Plant Area of the Weldon Spring Site
RU	remedial unit
STL	Sampling Team Leader
SOP	standard operating procedure
WP	work package
WSSRAP	Weldon Spring Site Remedial Action Project

APPENDIX A
Final Walkover Forms



LEGEND

· 'SC-32606-S' SAMPLE POINTS PINNED

— · — · — PINNING LIMITS

N

GRAPHIC SCALE

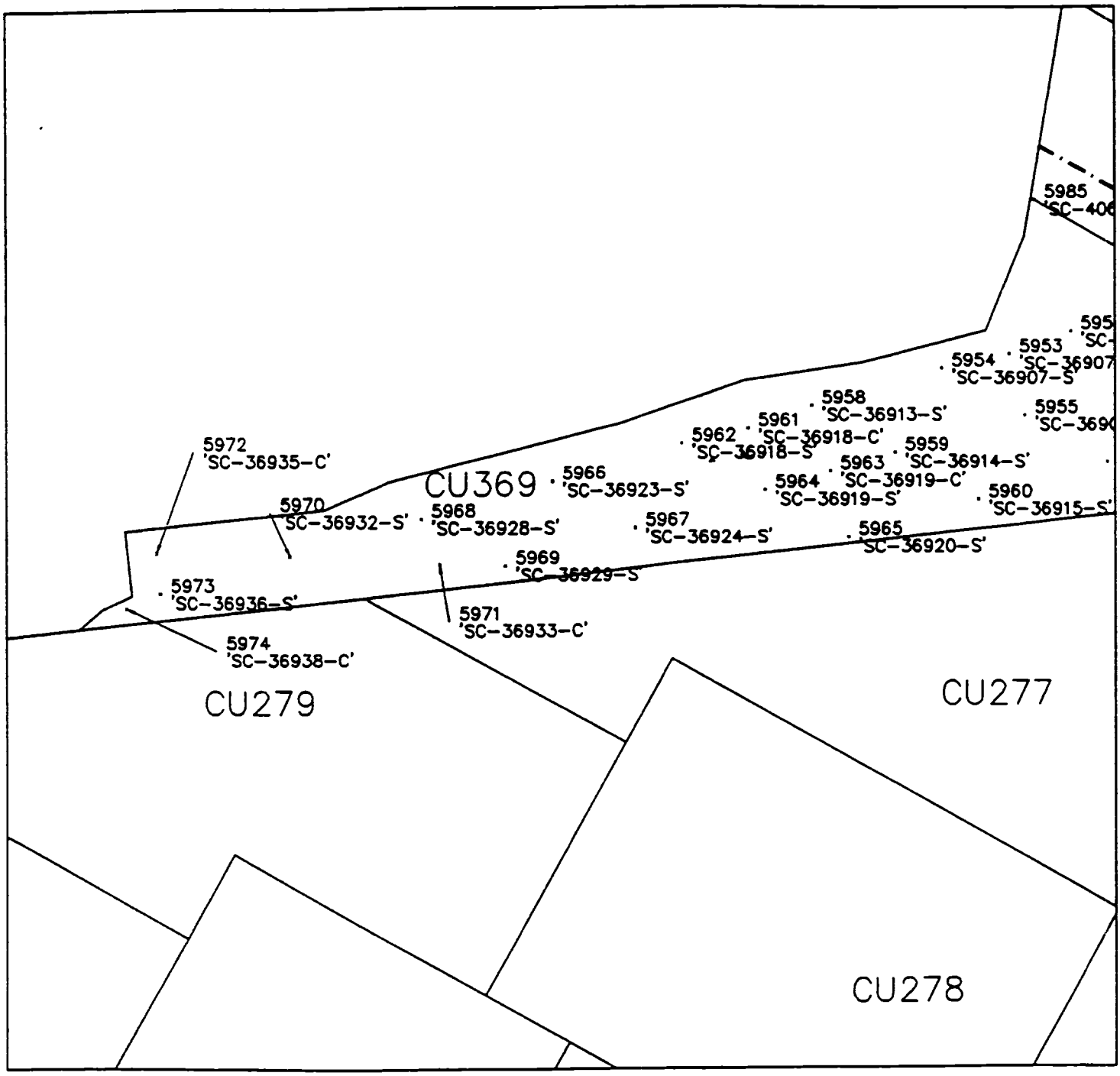
50 0 50 100

(IN FEET)
1 inch = 50 ft.

Radiation Survey Form WP 437, RU 19 CU 369 (1 of 2)

Date Plotted 6/23/00 DBO CAD

Meter Model #:	2221	Detector Model #:	2x2 P
Meter Serial #:	154199	Detector Serial #:	12606
Calibration Due:	2/9/01	Calibration Due:	1/21/01
Survey Date / Time:	6/22/00	Field Bkg.:	10,000 CPM
Surveyor(s):	J. Brower		
Comments:	All readings <1.5 Bkg		



LEGEND

· 'SC-32606-S' SAMPLE POINTS PINNED

— · — · — PINNING LIMITS

N

GRAPHIC SCALE

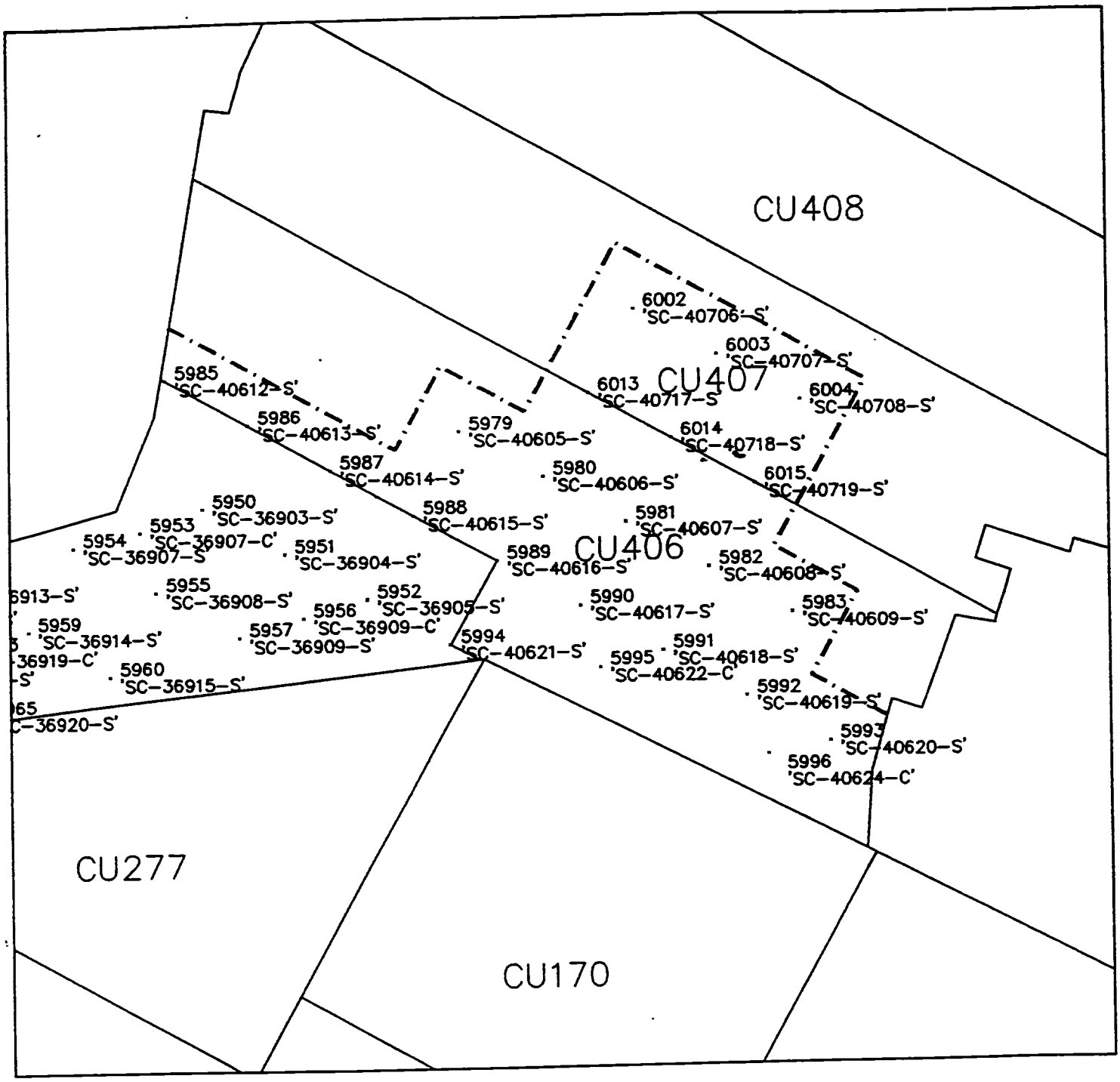
50 0 50 100

(IN FEET)
1 inch = 50 ft.

Radiation Survey Form WP 437, RU 19 CU 369(2 of 2)

Date Plotted 6/23/00 DBO CAD

Meter Model #:	2221	Detector Model #:	2x2 P
Meter Serial #:	154199	Detector Serial #:	17606
Calibration Due:	2/9/01	Calibration Due:	1/21/01
Survey Date / Time:	6/22/00	Field Bkg.:	10,000 CPM
Surveyor(s):	T. Brewer		
Comments:	All readings <1.5 Bkg		



LEGEND

· 'SC-32606-S' SAMPLE POINTS PINNED

— · — · — PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

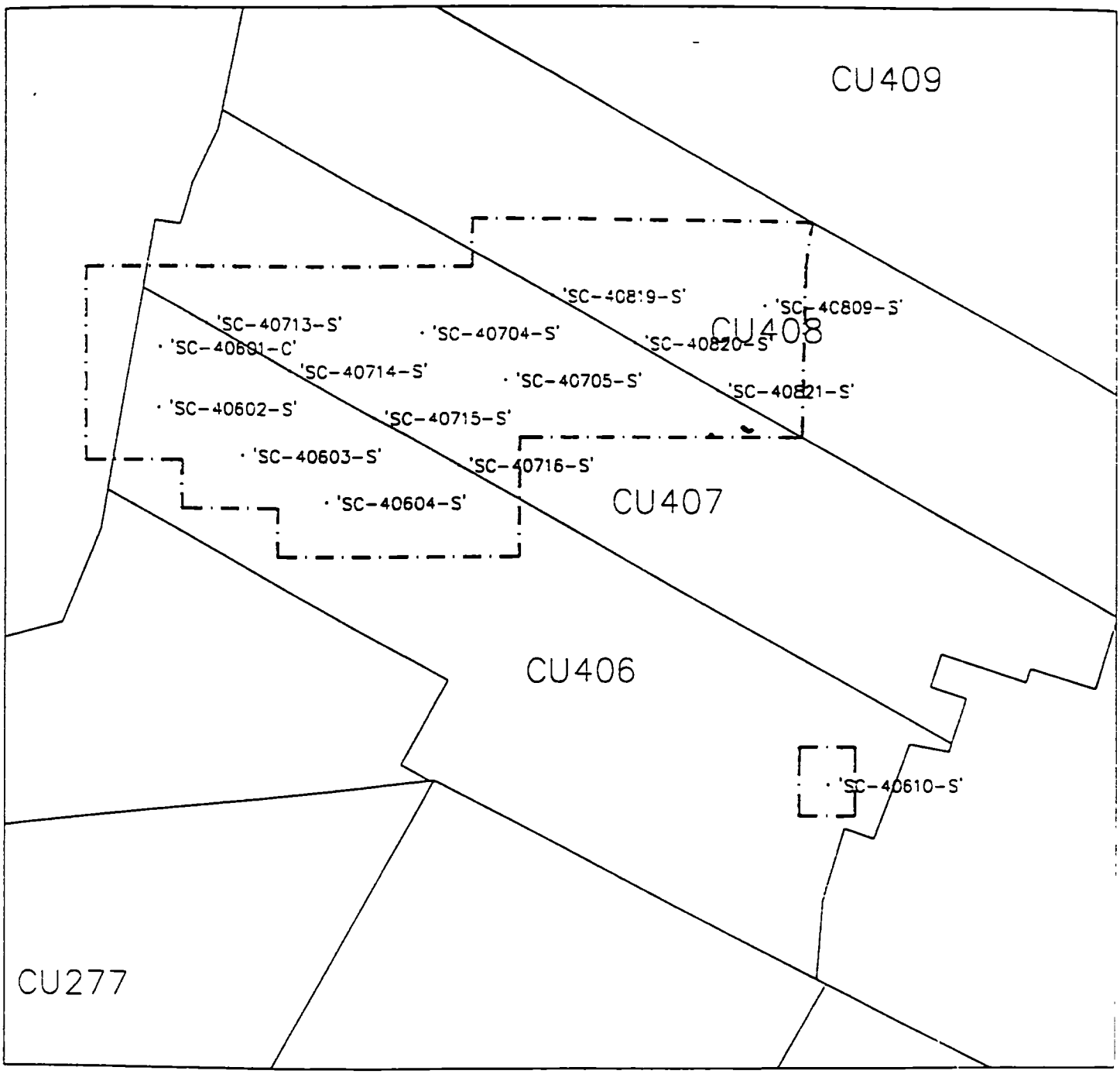
(IN FEET)
1 inch = 50 ft.

Radiation Survey Form WP 437, RU 19 CU 406

Date Plotted 6/23/00

DHO CAD

Meter Model #:	2221	Detector Model #:	2x2 P
Meter Serial #:	154199	Detector Serial #:	17606
Calibration Due:	2/9/01	Calibration Due:	1/21/01
Survey Date / Time:	6/22/00	Field Bkg.:	10,000 CPM
Surveyor(s):	T. Brower		
Comments:	All readings <1.5 Bkg		



LEGEND

'SC-32606-S' SAMPLE POINTS PINNED

PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

(IN FEET)
1 inch = 50 ft.

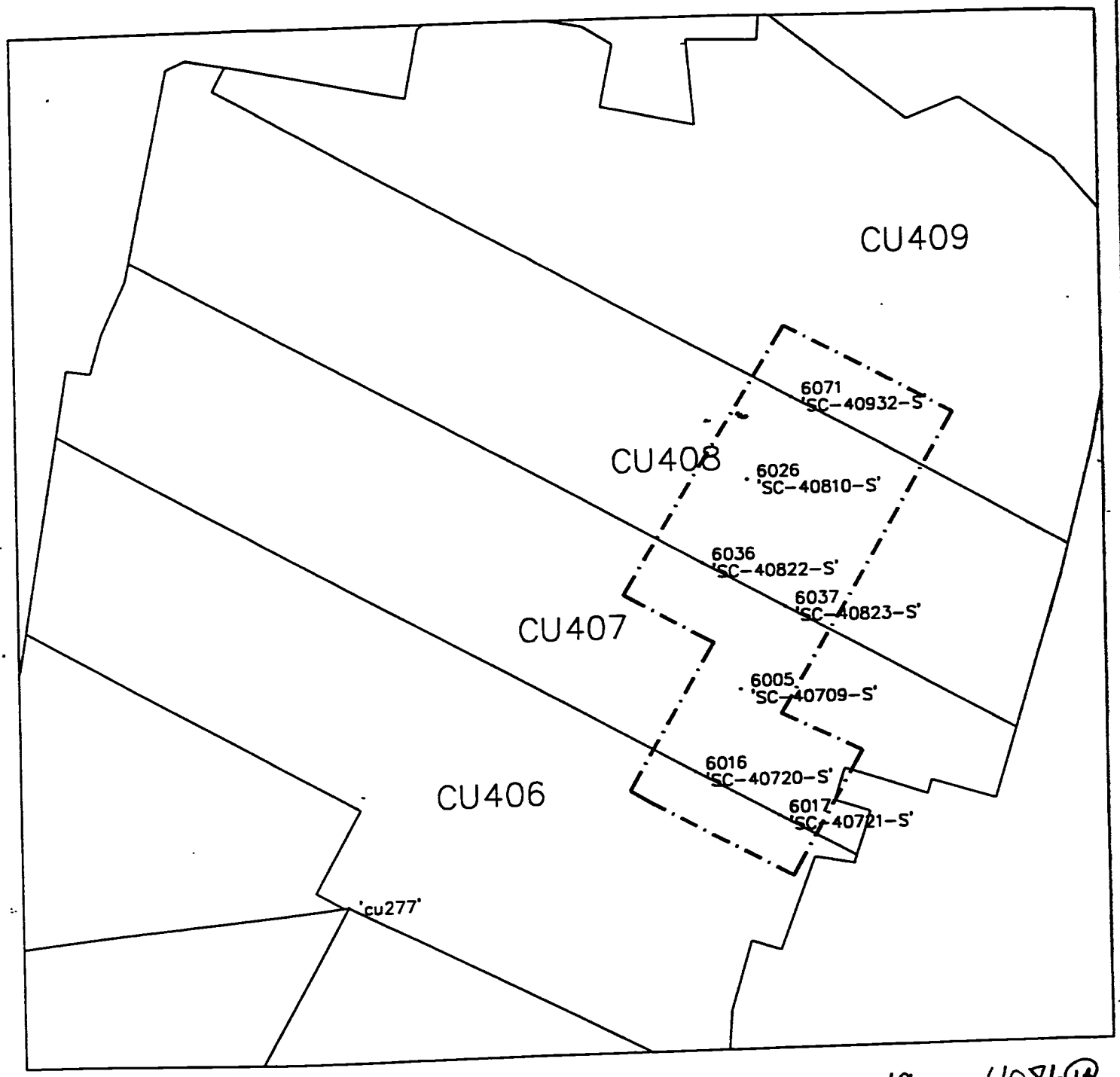
Radiation Survey Form WP 437, RU _____ CU _____

Date Plotted _____

DHO CAD

Meter Model #	2221	Detector Model #	2x2 NaI "x"
Meter Serial #	154216	Detector Serial #	22084
Calibration Due	4/26/01	Calibration Due	1/21/01
Survey Date / Time	9/8/00	Field Bkg.	9000 cpm
Surveyor(s)	T. Brower		

Comments: Area was surveyed and found to be less than 1.5 times background



LEGEND

· 'SC-32606-S' SAMPLE POINTS PINNED

—·—·—·— PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

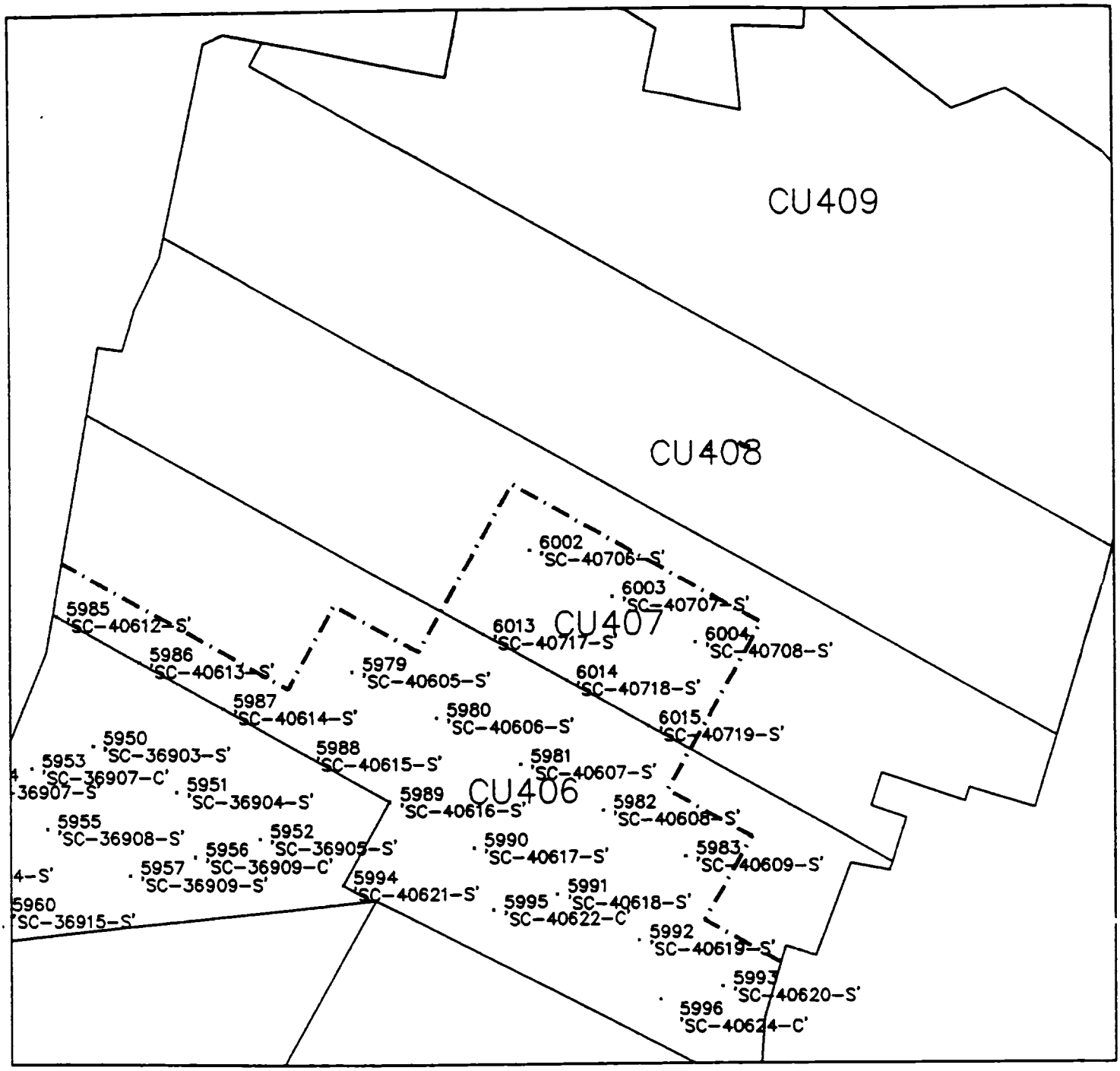
(IN FEET)
1 inch = 50 ft.

Radiation Survey Form WP 437, RU 19 CU 4086 (16)

Date Plotted 9/16/00

DHO CAD

Meter Model #:	2221	Detector Model #:	2x2 "x"
Meter Serial #:	154216	Detector Serial #:	22 084
Calibration Due:	4/28/01	Calibration Due:	1/21/01
Survey Date / Time:	9/16/00, 1400	Field Bkg.:	10,000 cpm
Surveyor(s):	T. Brown		
Comments:	All readings c1.5 BKg		



LEGEND

· 'SC-32606-S' SAMPLE POINTS PINNED

— · — · — PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

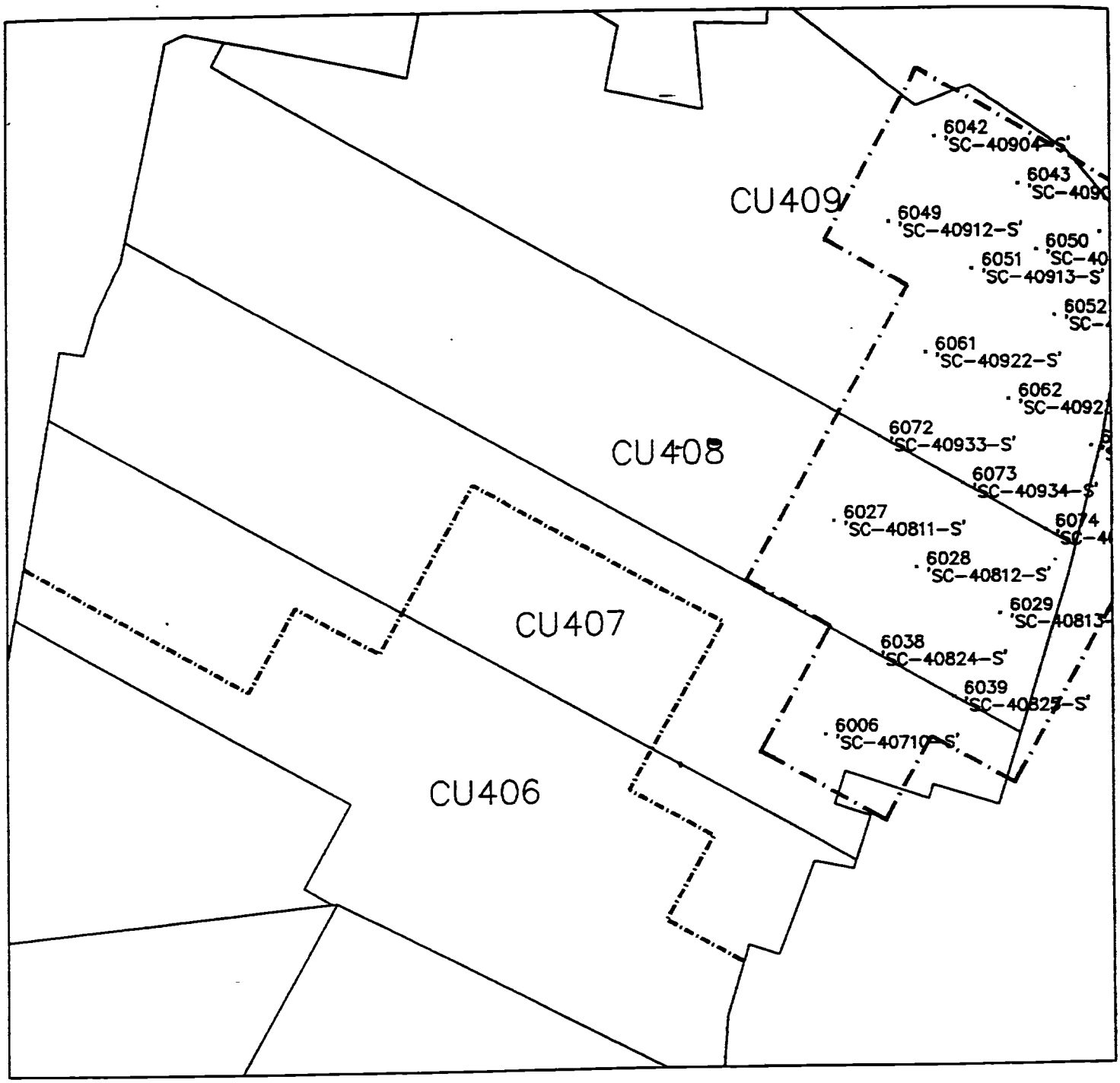
(IN FEET)
1 inch = 50 ft.

Radiation Survey Form WP 437, RU 12 CU 407

Date Plotted 6/23/00

DBO CAD

Meter Model #:	2221	Detector Model #:	2x2 P
Meter Serial #:	154199	Detector Serial #:	17606
Calibration Due:	2/9/01	Calibration Due:	1/21/01
Survey Date / Time:	6/22/00	Field Bkg.:	10,000 cPM
Surveyor(s):	T. Brower		
Comments:	All readings <1.5 BKg		



LEGEND

· 'SC-32606-S' SAMPLE POINTS PINNED

—·—·—·— PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

(IN FEET)

1 inch = 50 ft.

Radiation Survey Form WP 437, RU 19 CU 407

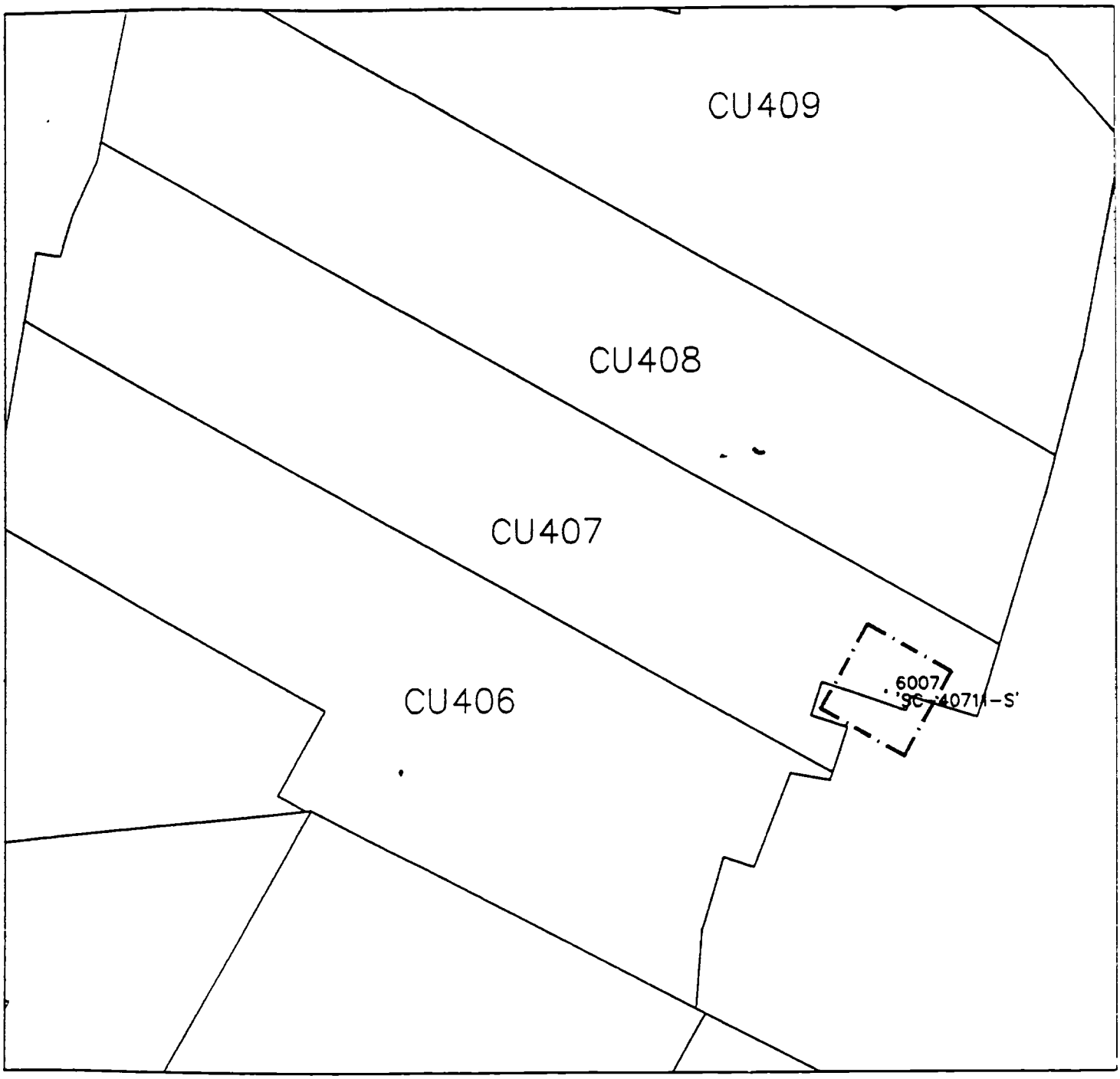
Date Plotted 7/17/00

DEO CAD

Meter Model #:	2221	Detector Model #:	44-10-2
Meter Serial #:	117617	Detector Serial #:	130765
Calibration Due:	10-13-00	Calibration Due:	9-24-00
Survey Date / Time:	7-16-00/1630	Field Bkg.:	5,000 cpm
Surveyor(s):	D FLEMING / T BROWER		
Comments:	ALL RESULTS <1.5 x BKG		

tumbarec <CPD: 07/14/00 [TIME: 1:41 PM] >

\Fieio_price\cdrive\cdsk\PROJ\CONUNIT\dwg\



LEGEND

'SC-32606-S' SAMPLE POINTS PINNED

PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

(IN FEET)
1 inch = 50 ft.

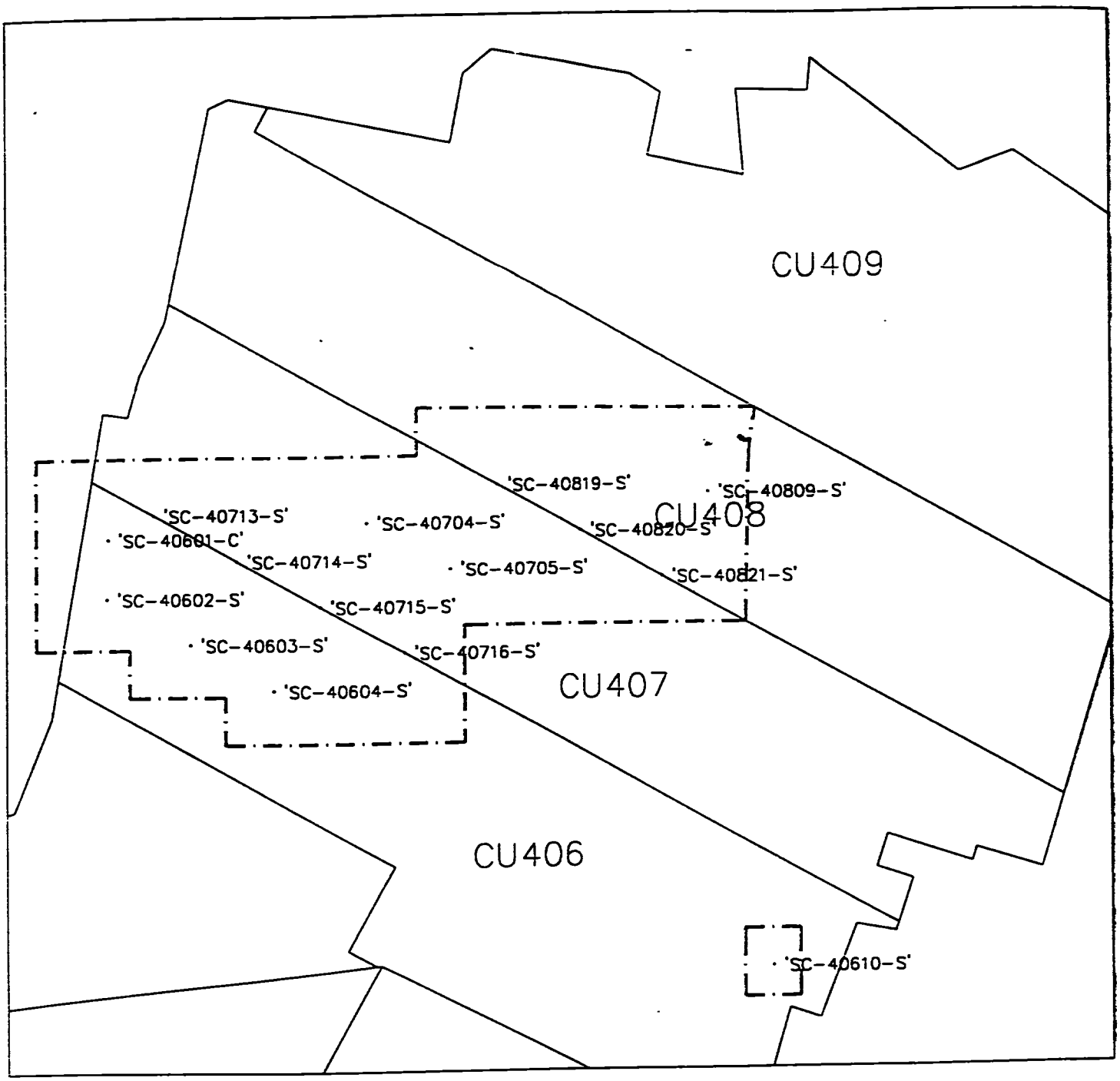
Radiation Survey Form WP 437, RU 19 CU 407

Date Plotted 7/19/00

DBO CAD

Meter Model #:	2221	Detector Model #:	2x2 "P"
Meter Serial #:	154199	Detector Serial #:	17606
Calibration Due:	2/9/01	Calibration Due:	1/21/01
Survey Date / Time:	7/19/00	Field Bkg.:	10,000 CPM
Surveyor(s):	J. Brown		
Comments:	All soil <1.5 Bkg		

\\Eleio price\cdrive\sdsk\PROJ\CONUNIT\dwg\ conunits.dwg



LEGEND

'SC-32606-S' SAMPLE POINTS PINNED

PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

(IN FEET)
1 inch = 50 ft.

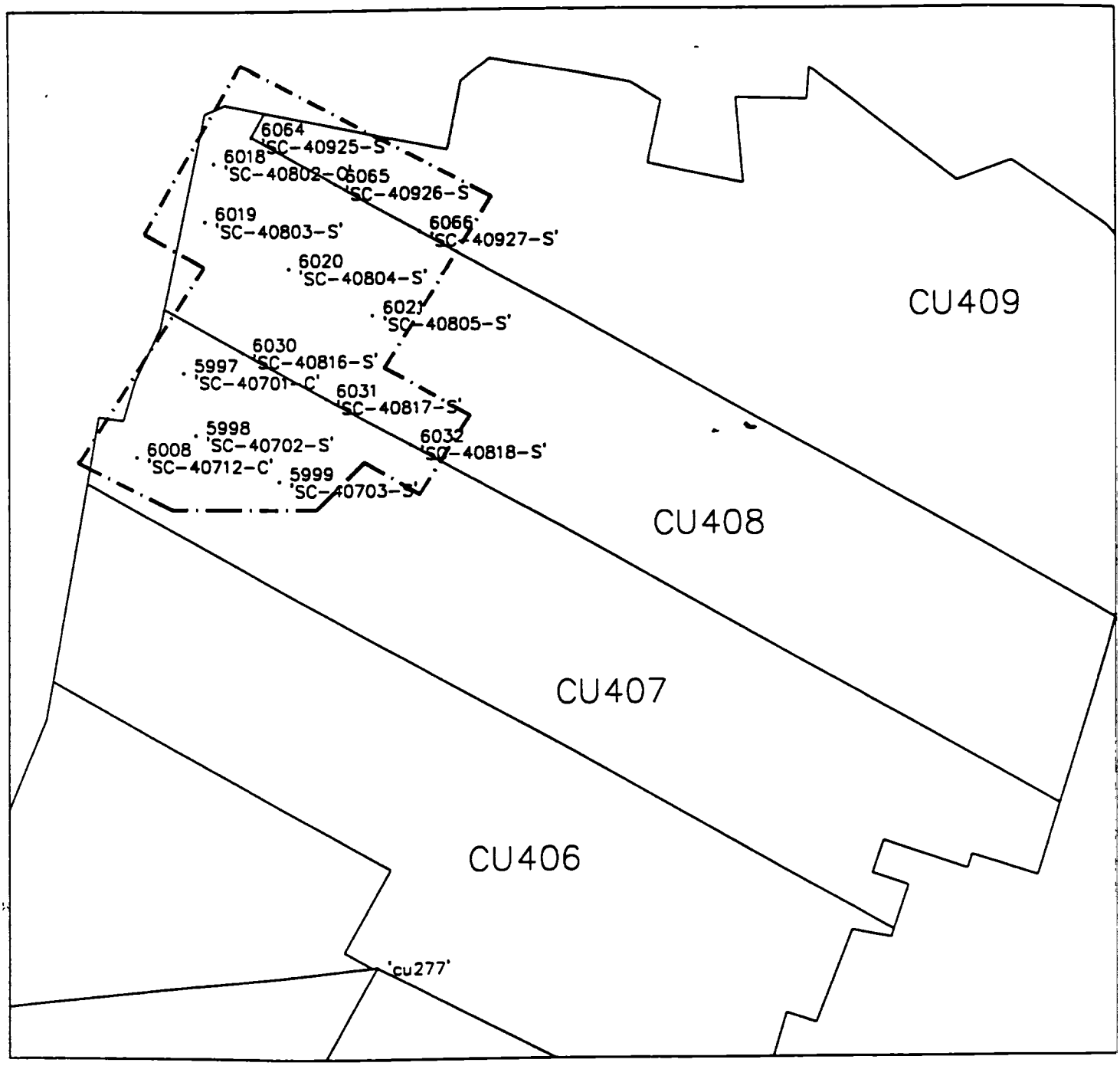
Radiation Survey Form WP 437, RU 19 CU [illegible]

Date Plotted [illegible]

DHO CAD

Meter Model #:	2221	Detector Model #:	2x2 NaI 6" x 6"
Meter Serial #:	154216	Detector Serial #:	22084
Calibration Due:	4/28/01	Calibration Due:	1/21/01
Survey Date / Time:	8/8/00	Field Bkg.:	9000 cpm
Surveyor(s):	J. Brower		

Comments: Area was surveyed and found to be less than 1.5 times background



LEGEND

· 'SC-32606-S' SAMPLE POINTS PINNED

—·—·—·— PINNING LIMITS

N

GRAPHIC SCALE

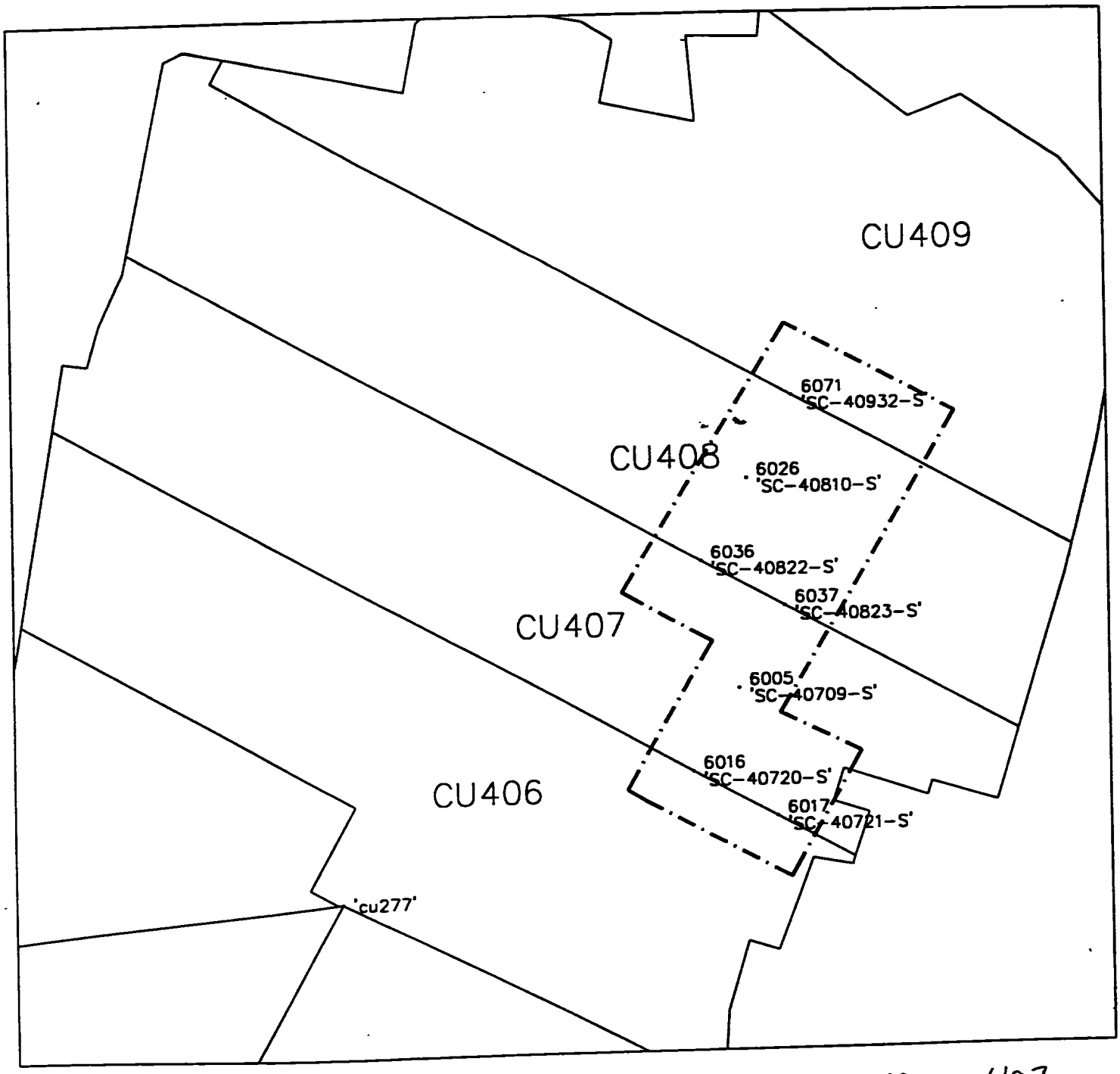
50 0 50 100

(IN FEET)
1 inch = 50 ft.

Radiation Survey Form WP 437, RU 19 CU 407

Date Plotted 9/16/00 DHO CAD

Meter Model # :	2221	Detector Model #.:	2x2"x"
Meter Serial # .	154216	Detector Serial #	22084
Calibration Due:	4/28/01	Calibration Due:	1/21/01
Survey Date / Time.	9/14/00	Field Bkg..	10,000CPM
Surveyor(s):	T. Brower		
Comments:	All readings <1.5 Bkg.		



LEGEND

· 'SC-32606-S' SAMPLE POINTS PINNED

—·—·—·— PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

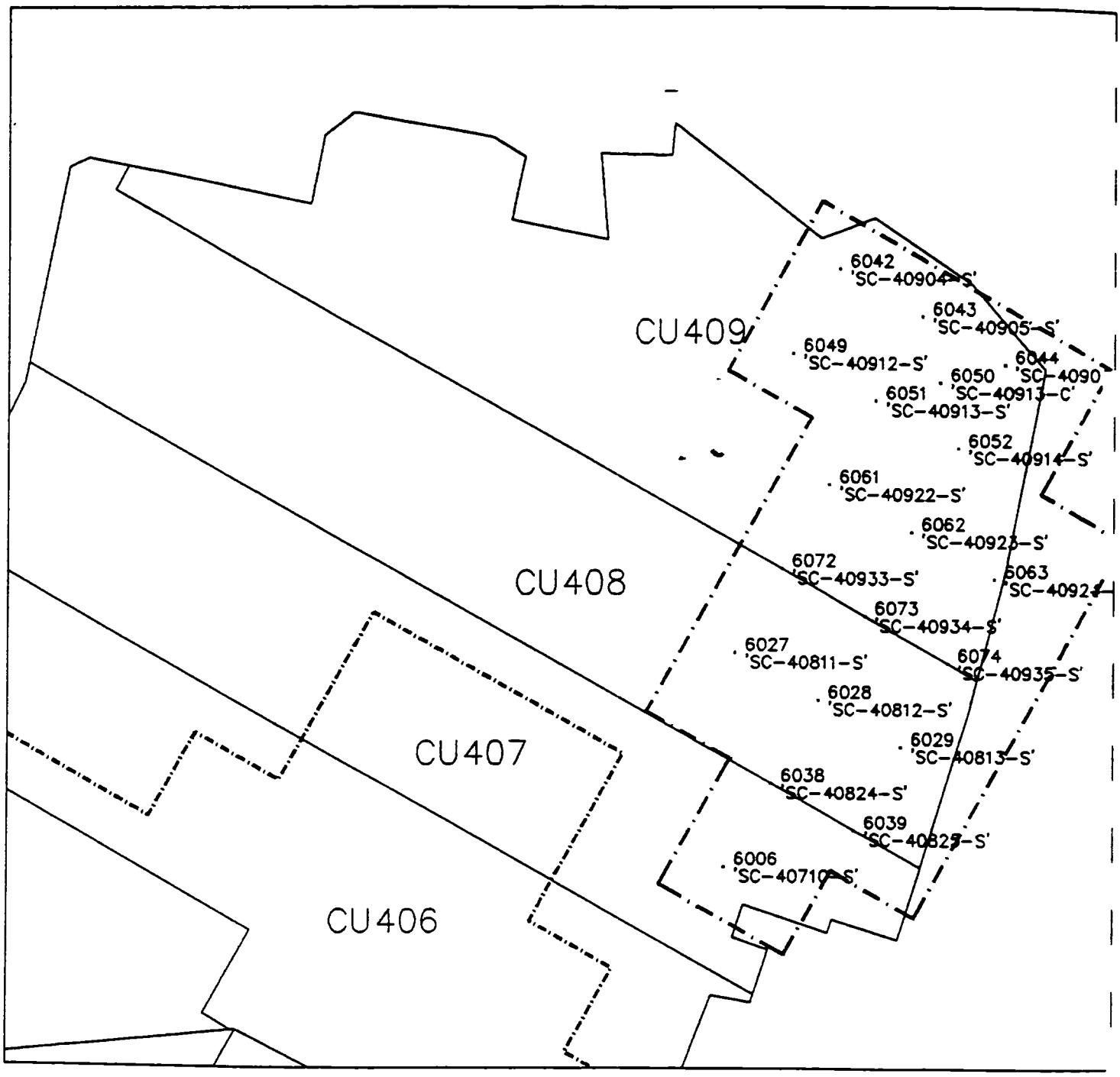
(IN FEET)
1 inch = 50 ft.

Radiation Survey Form WP 437, RU 19 CU 407

Date Plotted 9/16/00

DHO CAD

Meter Model #:	2221	Detector Model #:	2x2 "x"
Meter Serial #:	154216	Detector Serial #:	22 084
Calibration Due:	4/28/01	Calibration Due:	1/21/01
Survey Date / Time:	9/16/00, 1400	Field Bkg.:	10,000 cpm
Surveyor(s):	T. Brown		
Comments:	All readings c1.5 Bkg		



LEGEND

· 'SC-32606-S' SAMPLE POINTS PINNED

PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

(IN FEET)
1 inch = 50 ft.

Radiation Survey Form WP 437, RU 19 CU 408

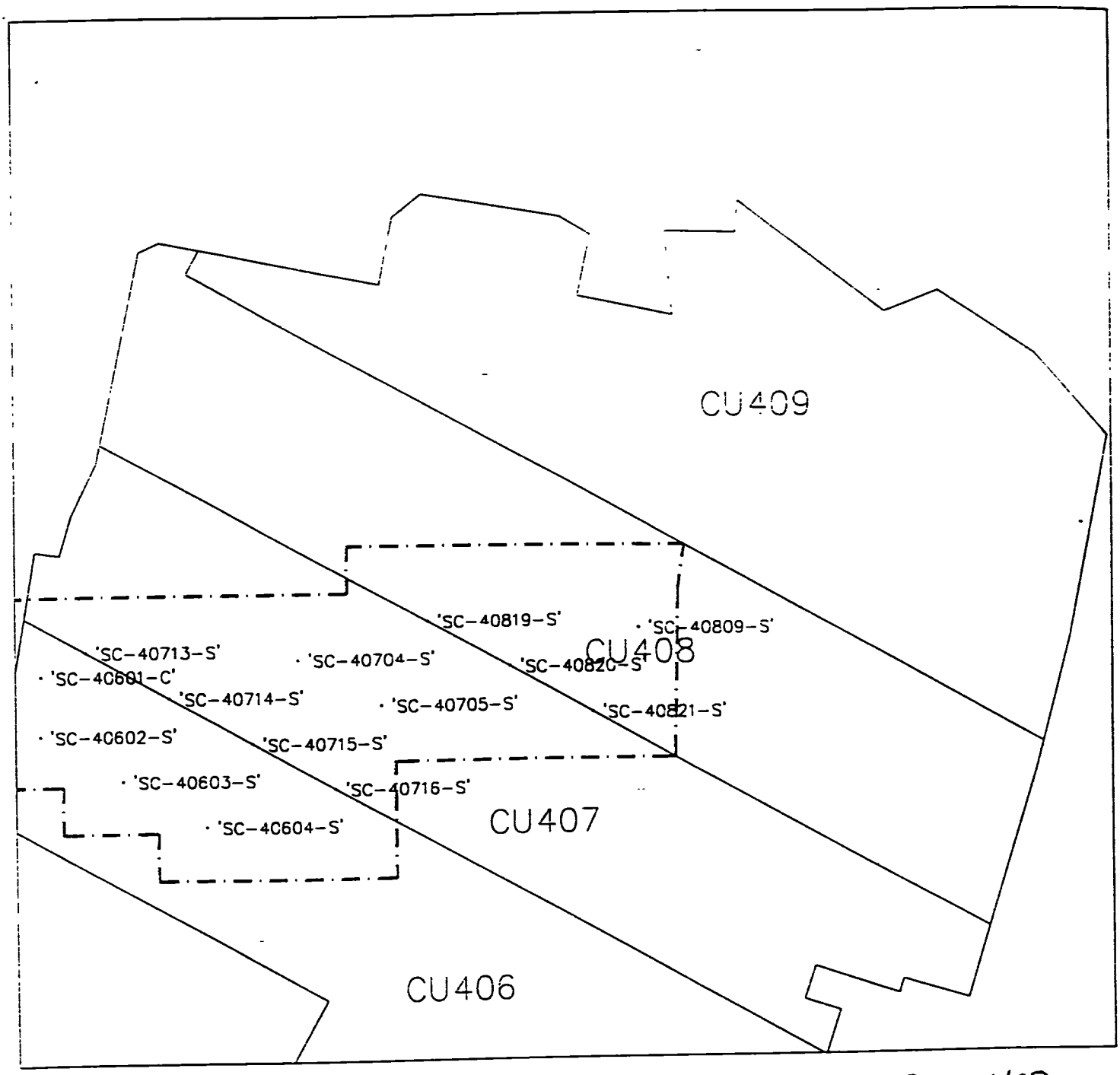
Date Plotted 7/17/00

DBO CAD

Meter Model #:	2221	Detector Model #:	44-10-2
Meter Serial #:	117617	Detector Serial #:	130765
Calibration Due:	10-15-00	Calibration Due:	9-24-00
Survey Date / Time:	7-16-00/1630	Field Bkg.	5,000 cpm
Surveyor(s):	D FLEMING / T BROWER		
Comments:	ALL RESULTS <1.5 x BKG		

tumbarec <CPD. 07/14/00 [TIME: 1:41 PM] >

\Eieio price\cdrive\sdsk\PROJ\CONUNIT\dwg\ conunits.dwg



LEGEND

'SC-32606-S' SAMPLE POINTS PINNED

PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

(IN FEET)

1 inch = 50 ft.

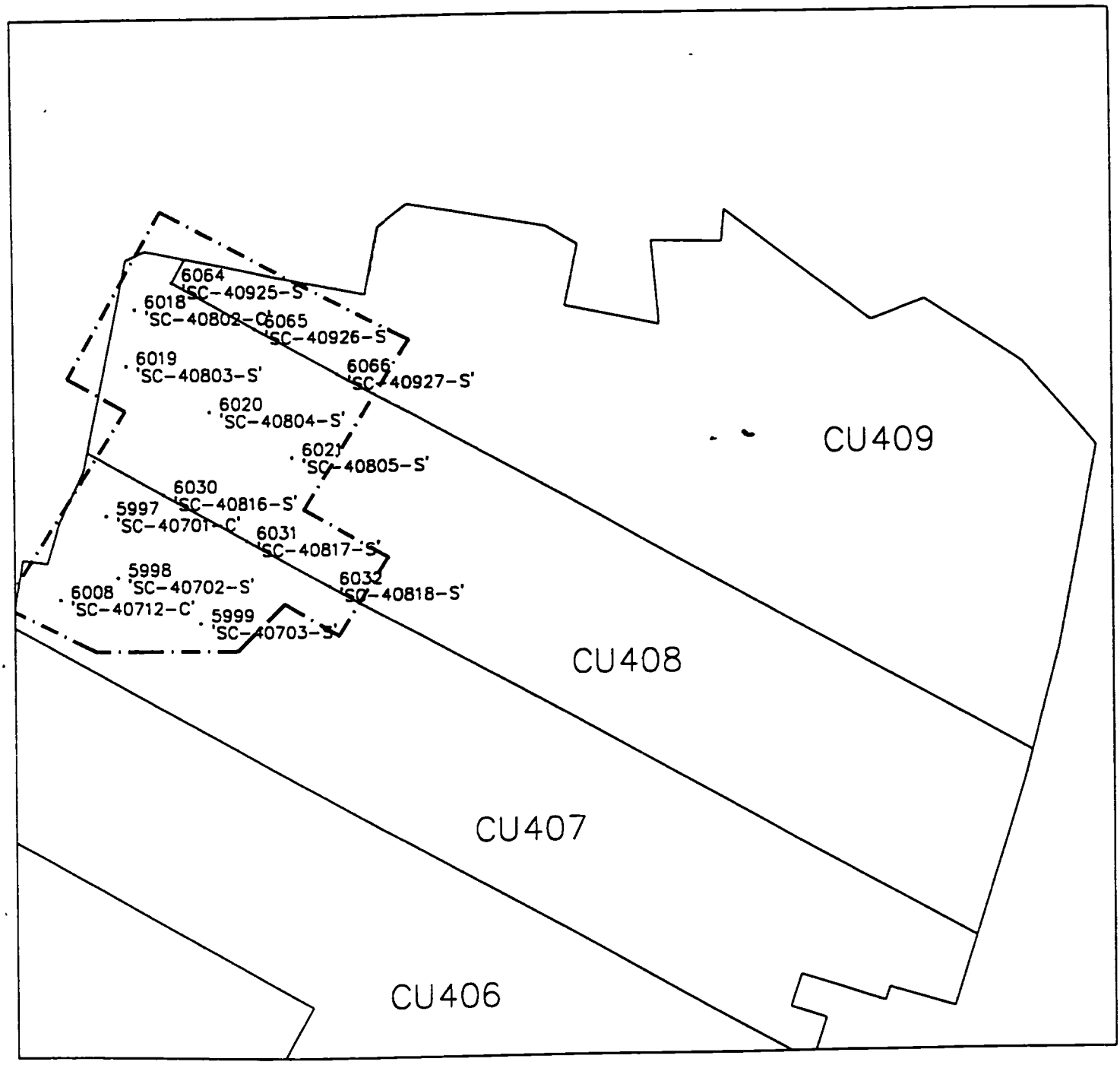
Radiation Survey Form WP 437, RU 19 CU 408

Date Plotted 8/8/00

DHC CAD

Meter Model #:	2221	Detector Model #:	2x2 NaI "X"
Meter Serial #:	154216	Detector Serial #:	22084
Calibration Due:	4/28/01	Calibration Due:	1/21/01
Survey Date / Time:	8/8/00	Field Bkg.:	9000 cpm
Surveyor(s):	T. Brown		

Comments: Area was surveyed and found to be less than 1.5 times background



LEGEND

· 'SC-32606-S' SAMPLE POINTS PINNED

— · — · — · — PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

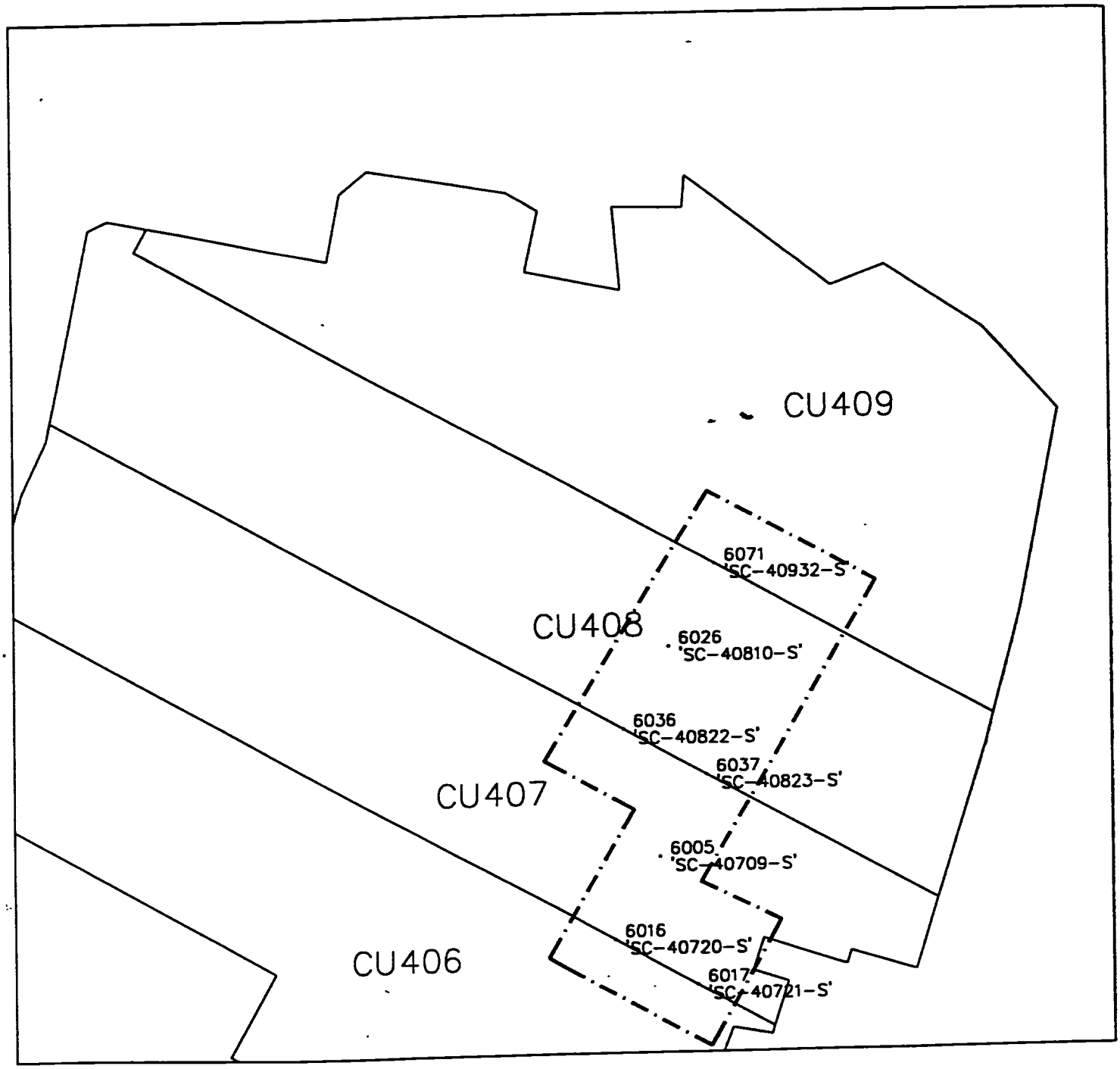
(IN FEET)
1 inch = 50 ft.

Radiation Survey Form WP 437, RU 19 CU 408

Date Plotted 9/15/00

DHO CAD

Meter Model # :	2221	Detector Model #:	2x2 "X"
Meter Serial # :	154216	Detector Serial #:	22084
Calibration Due:	4/28/01	Calibration Due:	1/21/01
Survey Date / Time:	9/14/00	Field Bkg.:	10,000 CPM
Surveyor(s):	T. Brower		
Comments:	All readings <1.5 Bkg		



LEGEND

· 'SC-32606-S' SAMPLE POINTS PINNED

PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

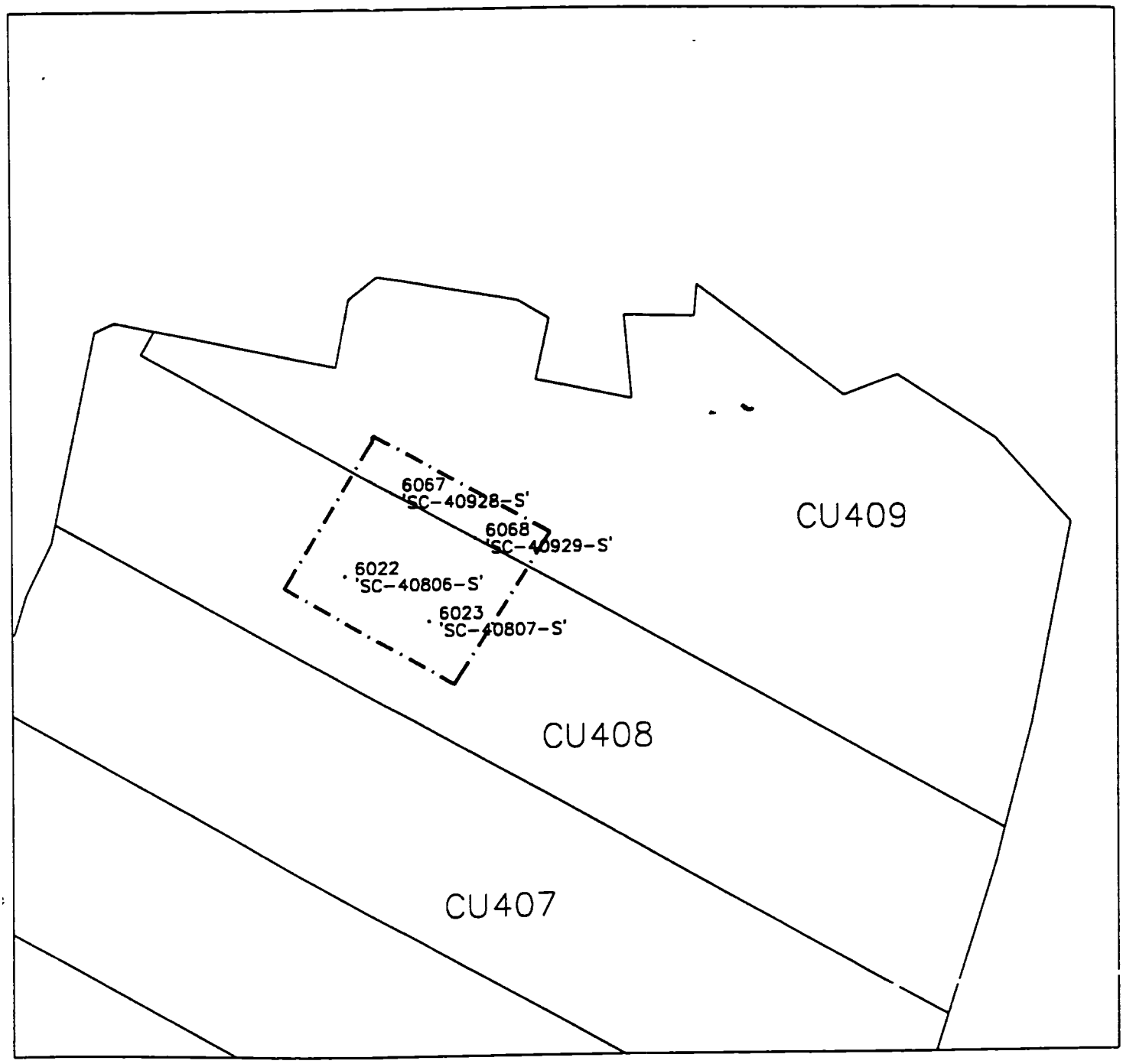
(IN FEET)
1 inch = 50 ft.

Radiation Survey Form WP 437, RU 19 CU 408

Date Plotted 9/16/00

DHO CAD

Meter Model # :	2221	Detector Model #:	2x2 "X"
Meter Serial # :	154216	Detector Serial #:	22084
Calibration Due:	4/28/01	Calibration Due:	1/21/01
Survey Date / Time:	9/16/00, 1400	Field Bkg.:	10,000 cpm
Surveyor(s):	T. Brower		
Comments:	All readings <1.5 Bkg		



LEGEND

· 'SC-32606-S' SAMPLE POINTS PINNED

PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

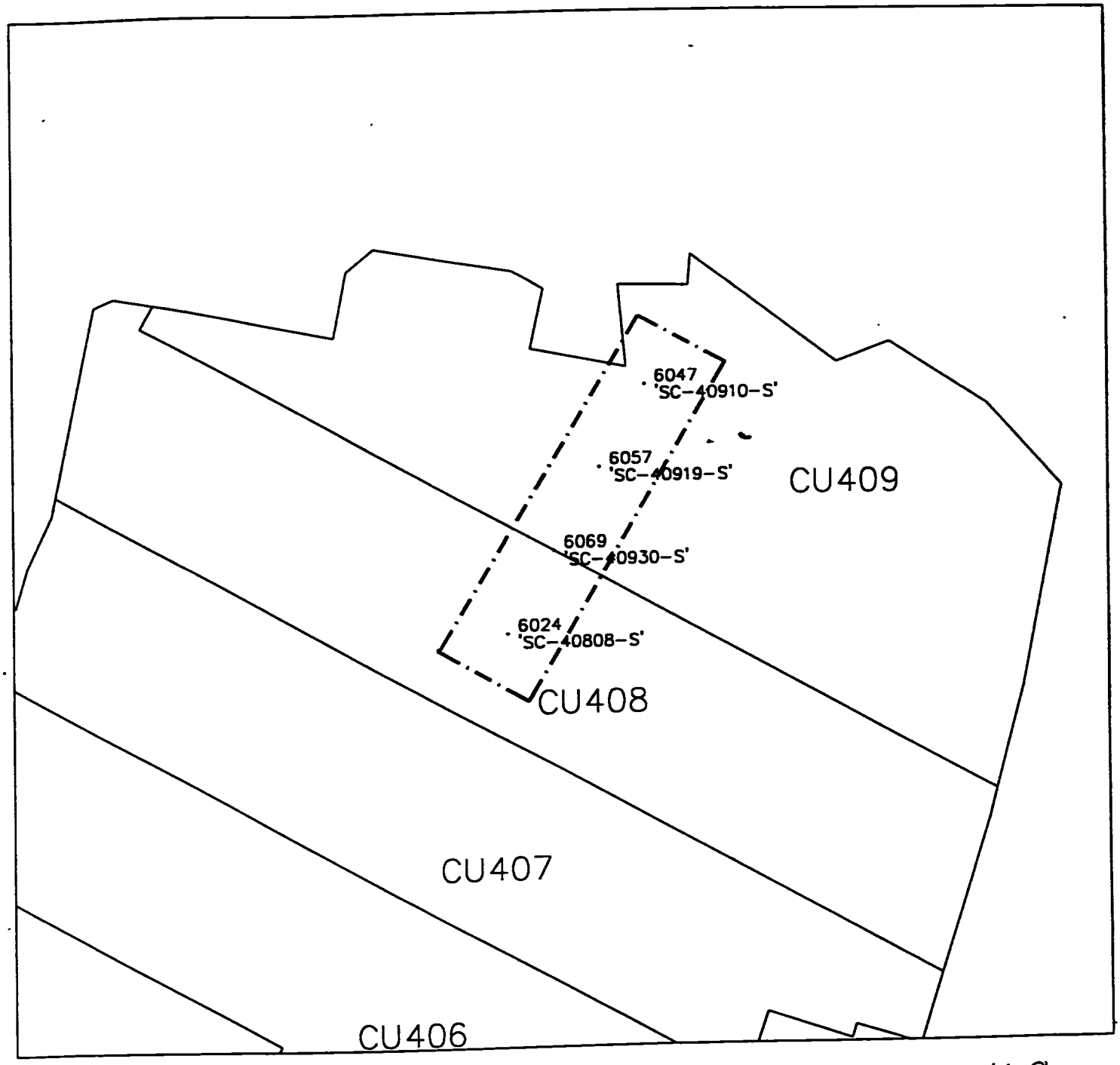
(IN FEET)
1 inch = 50 ft.

Radiation Survey Form WP 437, RU 19 CU 408

Date Plotted 9/21/00

DHO CAD

Meter Model # :	2221	Detector Model #:	2x2 "K"
Meter Serial # :	154216	Detector Serial #:	22044
Calibration Due:	4-28-01	Calibration Due:	1-21-01
Survey Date / Time:	9-20-00 ~~[illegible]~~ / 1400	Field Bkg.:	10,000 cpm
Surveyor(s):	T. BROWER		
Comments:	ALL READINGS <1.5xBKG		



LEGEND

· 'SC-32606-S' SAMPLE POINTS PINNED

—·—·—·— PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

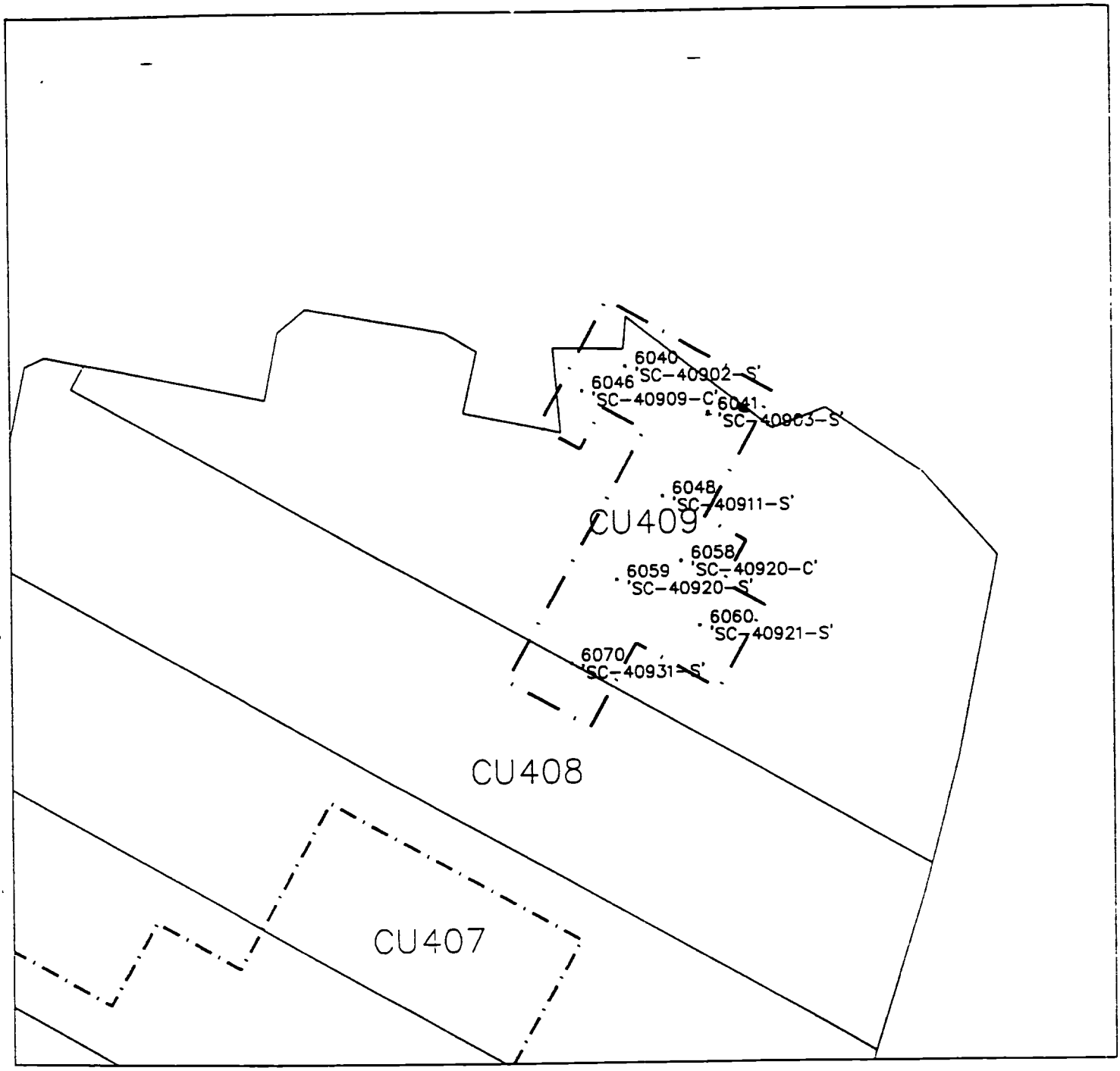
(IN FEET)
1 inch = 50 ft.

Radiation Survey Form WP 437, RU 19 CU 408

Date Plotted 9/22/00

DHO CAD

Meter Model #:	2221	Detector Model #:	2x2"x"
Meter Serial #:	154216	Detector Serial #:	22084
Calibration Due:	4-28-01	Calibration Due:	1-21-01
Survey Date / Time:	9-22-00/1500	Field Bkg.:	10,000 cpm
Surveyor(s):	T BROWER		
Comments:	ALL READINGS <1.5 x BKG		



LEGEND

· 'SC-32606-S' SAMPLE POINTS PINNED

— · — · — PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

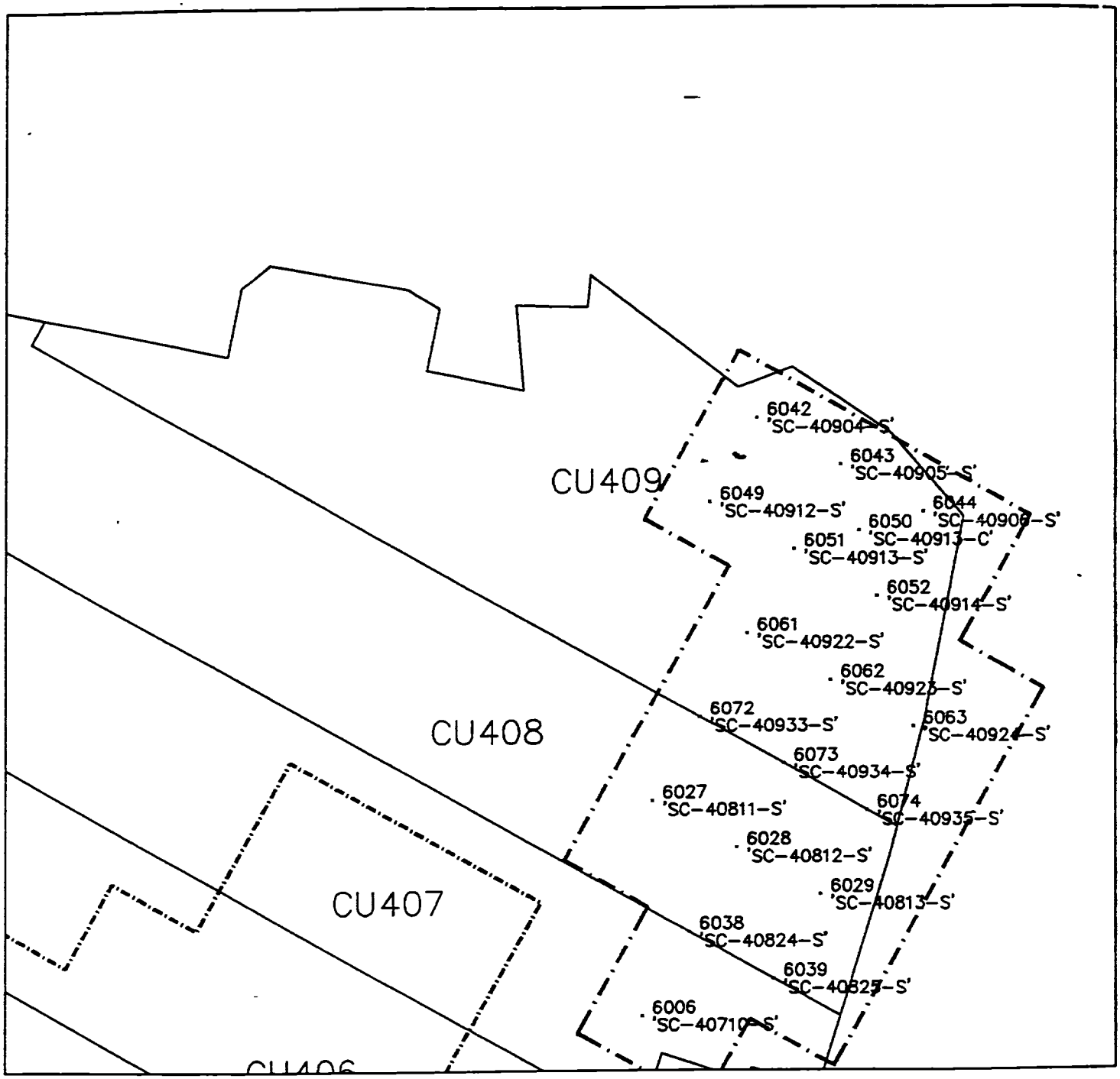
(IN FEET)

1 inch = 50 ft

Radiation Survey Form WP 437, RU 19 CU 409

Date Plotted 6/28/00 DHO CAD

Meter Model #	2221	Detector Model #	2x2 "P"
Meter Serial #	154199	Detector Serial #	12606
Calibration Due	2/9/01	Calibration Due	~~[illegible]~~ 1/21/01
Survey Date / Time	6/27/00	Field Bkg.	10,000 cpm
Surveyor(s)	T. Brown		BT
Comments	All readings <1.5 BKg		



LEGEND

• 'SC-32606-S' SAMPLE POINTS PINNED

PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

(IN FEET)
1 inch = 50 ft.

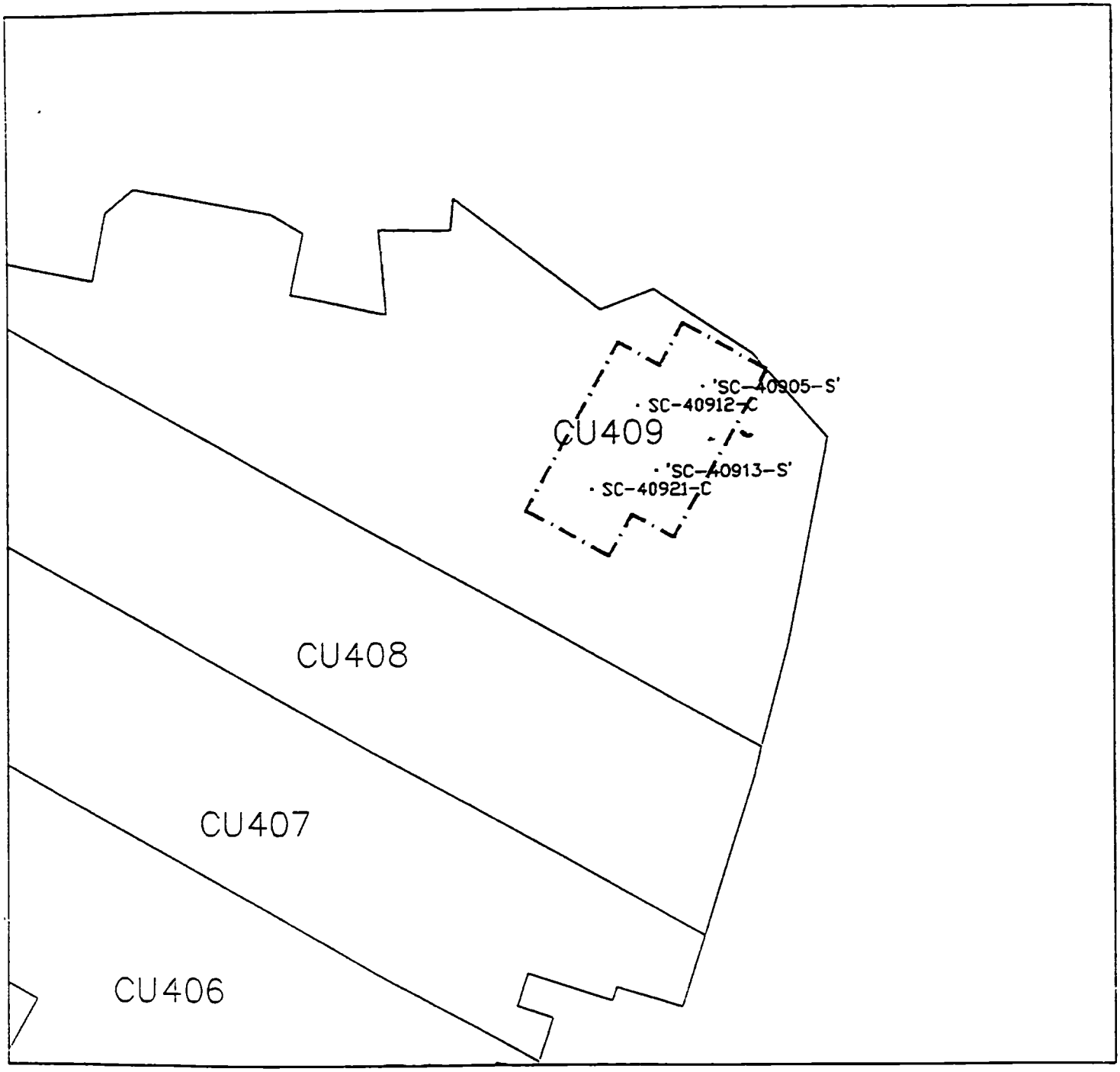
Radiation Survey Form WP 437, RU 19 CU 409

Date Plotted 7/17/00

DHO CAD

Meter Model #:	2221	Detector Model #:	44-10-2
Meter Serial #:	117617	Detector Serial #:	130763
Calibration Due:	10-13-00	Calibration Due:	9-24-00
Survey Date / Time:	7-16-00/1650	Field Bkg.:	5,000 cpm
Surveyor(s):	D. FLEMING / T BROWER		
Comments:	ALL RESULTS < 1.5x BKG		

\Eieio price\cdrive\sdsk\PROJ\CONUNIT\dwg\ conunits.dwg



LEGEND

'SC-32606-S' SAMPLE POINTS PINNED

PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

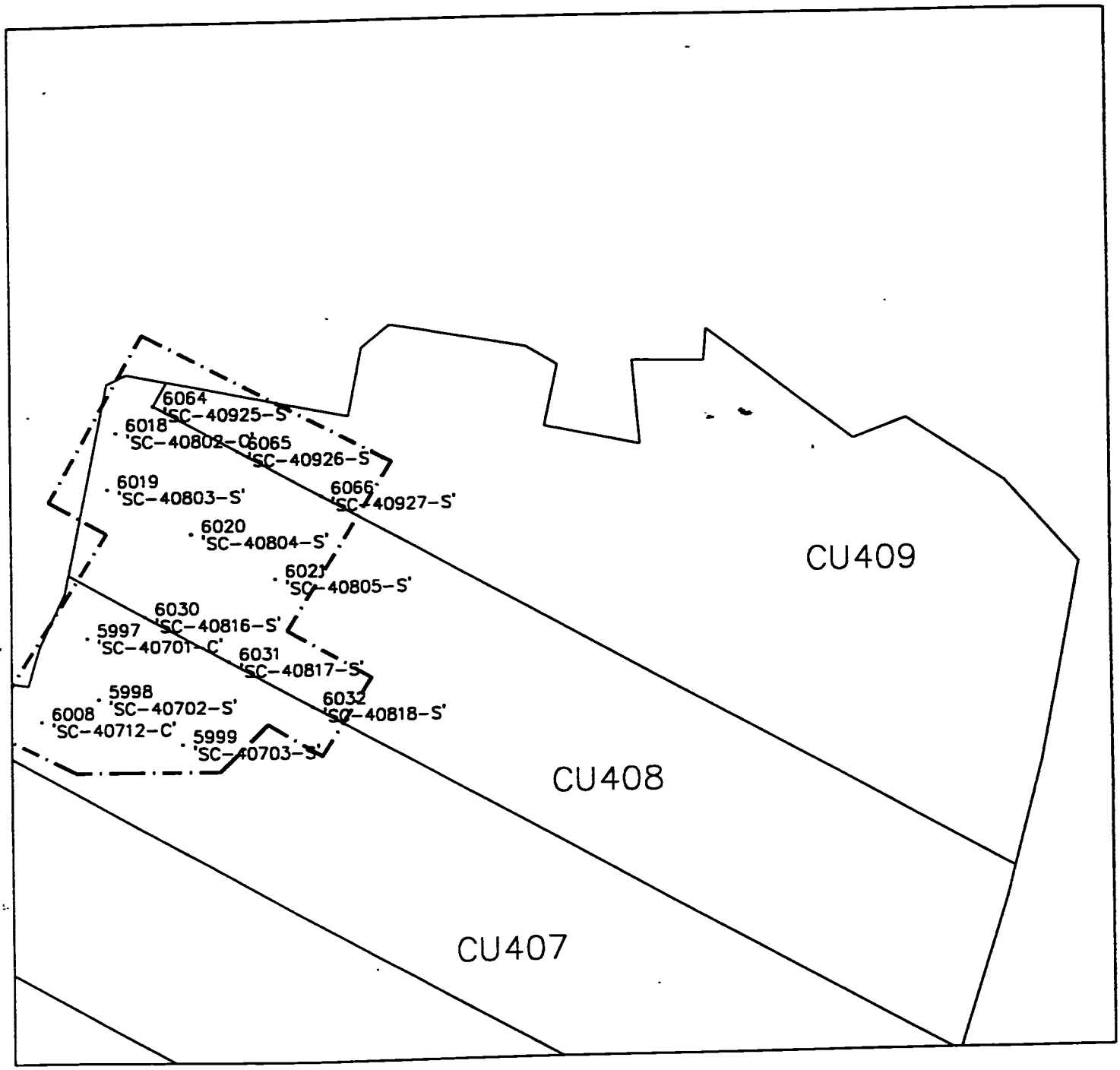
(IN FEET)
1 inch = 50 ft.

Radiation Survey Form WP 437, RU 19 CU 409

Date Plotted 8/23/00

DBO CAD

Meter Model #:	2221	Detector Model #:	2x2"x"
Meter Serial #:	154216	Detector Serial #:	22084
Calibration Due:	4/20/01	Calibration Due:	1/21/01
Survey Date / Time:	8/22/00	Field Bkg.	10,000 CPM
Surveyor(s):	T. Brower		
Comments:	All readings <1.5 Bkg		



LEGEND

· 'SC-32606-S' SAMPLE POINTS PINNED

—·—·—·— PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

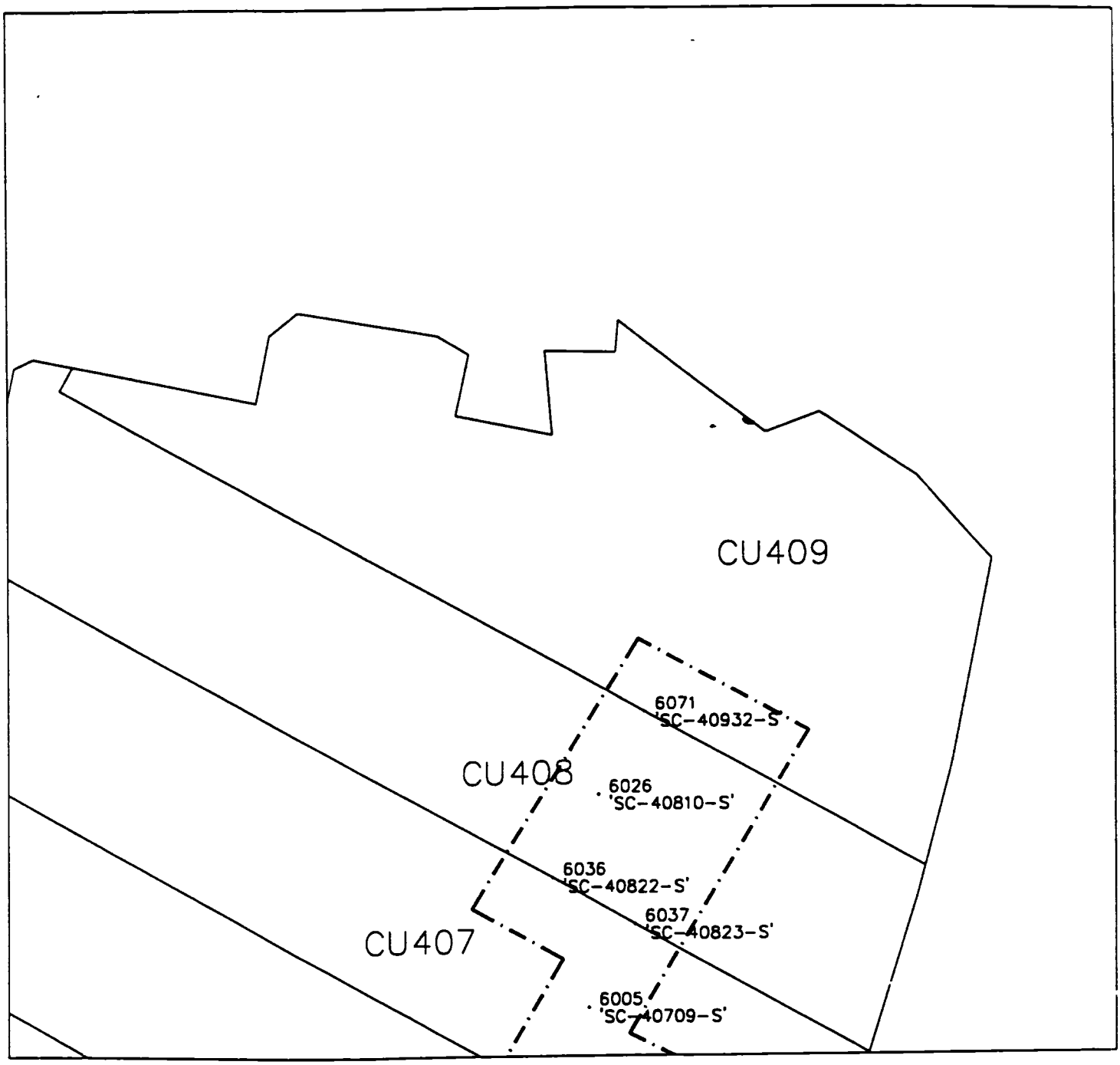
(IN FEET)
1 inch = 50 ft.

Radiation Survey Form WP 437, RU 19 CU 409

Date Plotted 9/15/00

DHO CAD

Meter Model #:	2221	Detector Model #:	2x2 ~~X~~ F
Meter Serial #:	154216	Detector Serial #:	22084
Calibration Due:	4/28/01	Calibration Due:	1/21/01
Survey Date / Time:	9/14/00	Field Bkg.:	10,000 cpm
Surveyor(s):	T. Brown		
Comments:	All readings <1.5 Bkg.		



LEGEND

· 'SC-32606-S' SAMPLE POINTS PINNED

— · — · — · — PINNING LIMITS

N

GRAPHIC SCALE

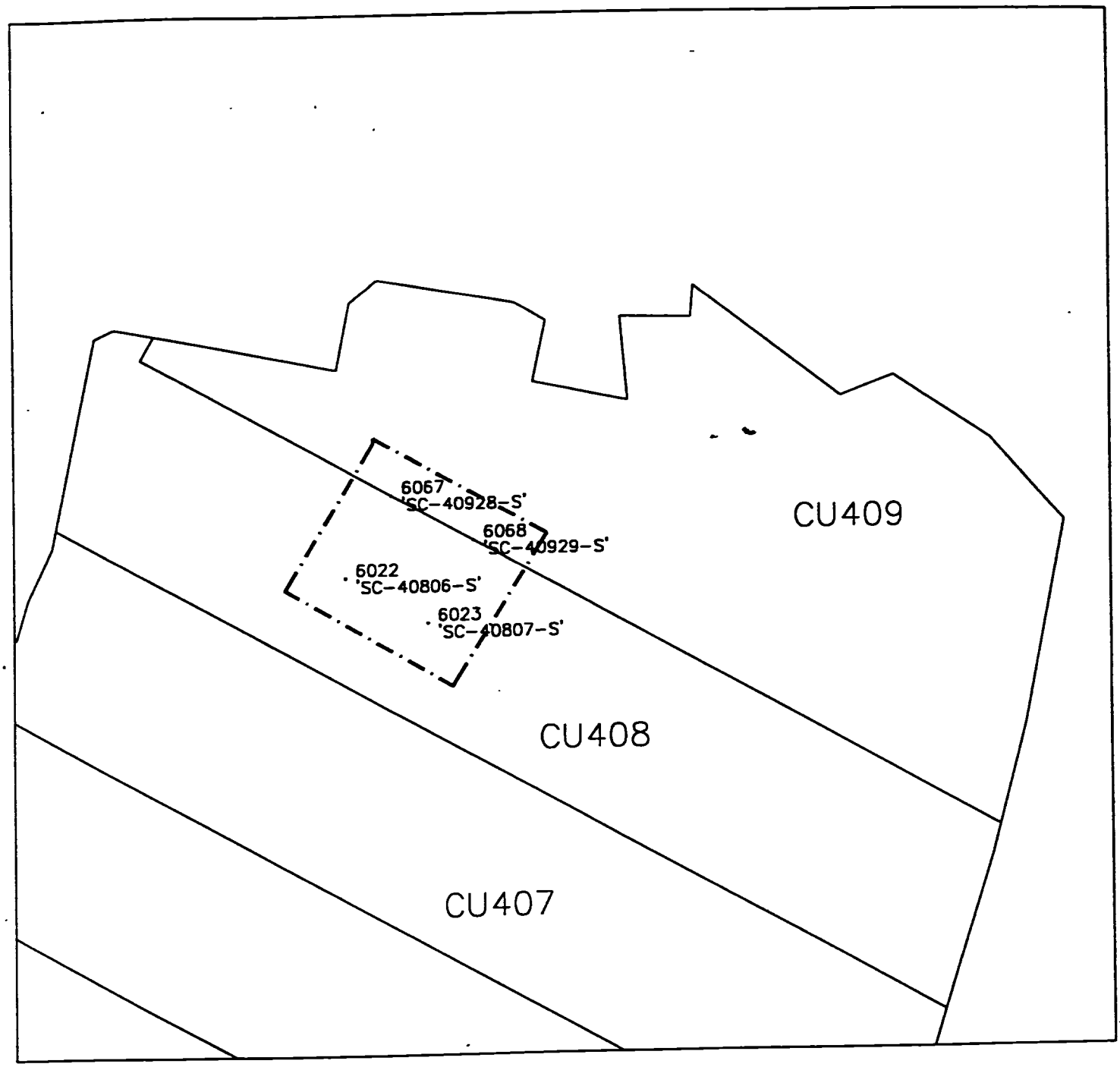
50 0 50 100

(IN FEET)
1 inch = 50 ft.

Radiation Survey Form WP 437, RU 19 CU 409

Date Plotted 9/16/00 DHO CAD

Meter Model # :	2221	Detector Model #:	2x2 "X"
Meter Serial # :	154216	Detector Serial #:	220F4
Calibration Due:	4/28/01	Calibration Due:	1/21/01
Survey Date / Time:	9/16/00, 1400	Field Bkg.	10,000 CPM
Surveyor(s):	T. Brown		
Comments:	All readings w/ Bkg		



LEGEND

· 'SC-32606-S' SAMPLE POINTS PINNED

—·—·—·— PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

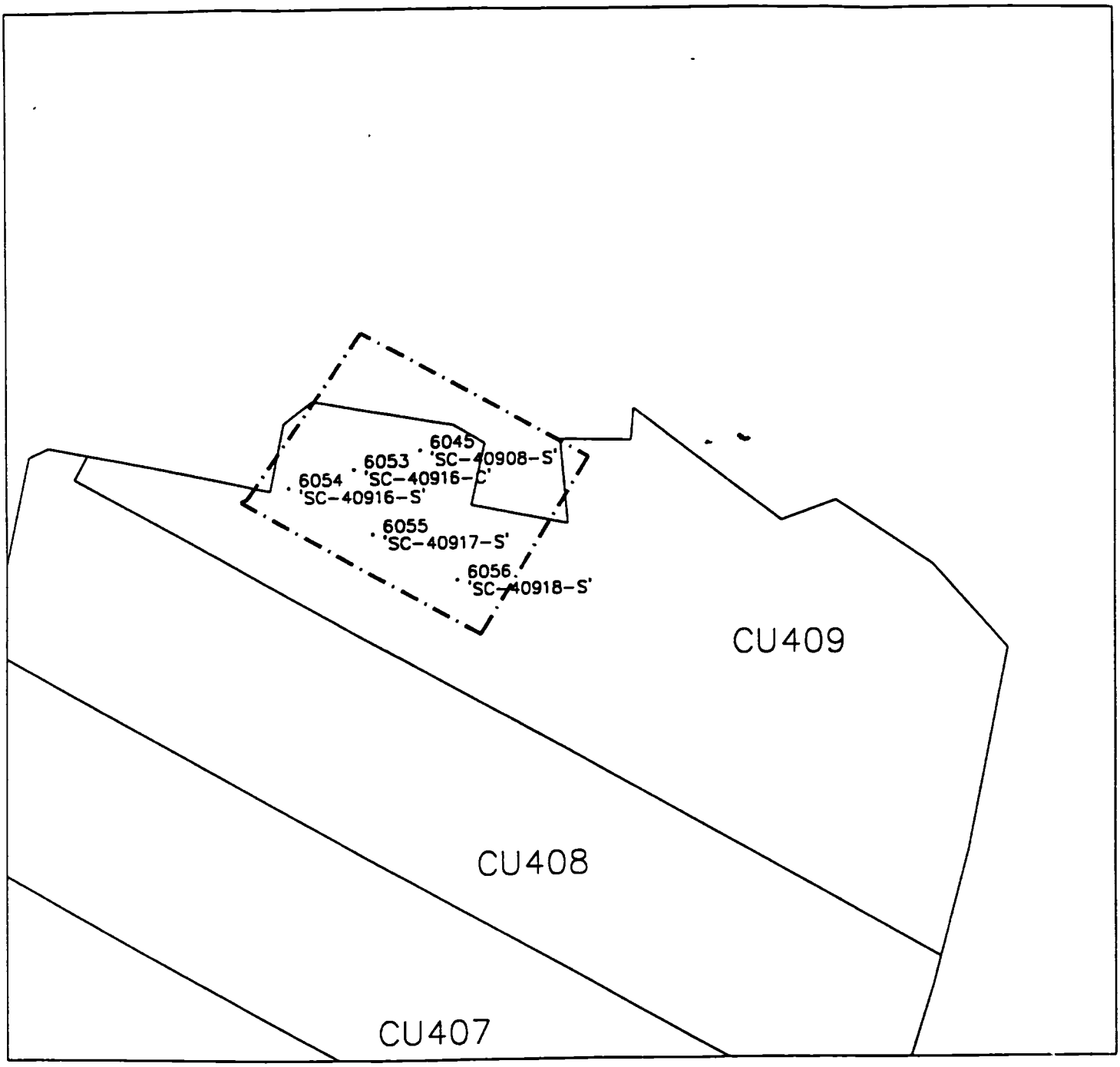
(IN FEET)
1 inch = 50 ft.

Radiation Survey Form WP 437, RU 19 CU 409

Date Plotted 9/21/00

DHO CAD

Meter Model #:	2221	Detector Model #:	2x2 "X"
Meter Serial #:	154216	Detector Serial #:	22084
Calibration Due:	4-28-01	Calibration Due:	1-21-01
Survey Date / Time:	9-20-00/1400	Field Bkg.:	10.000 cpm
Surveyor(s):	T. BROWER		
Comments:	ALL READINGS <1.5 x BKG		



LEGEND

· 'SC-32606-S' SAMPLE POINTS PINNED

— · — · — · — PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

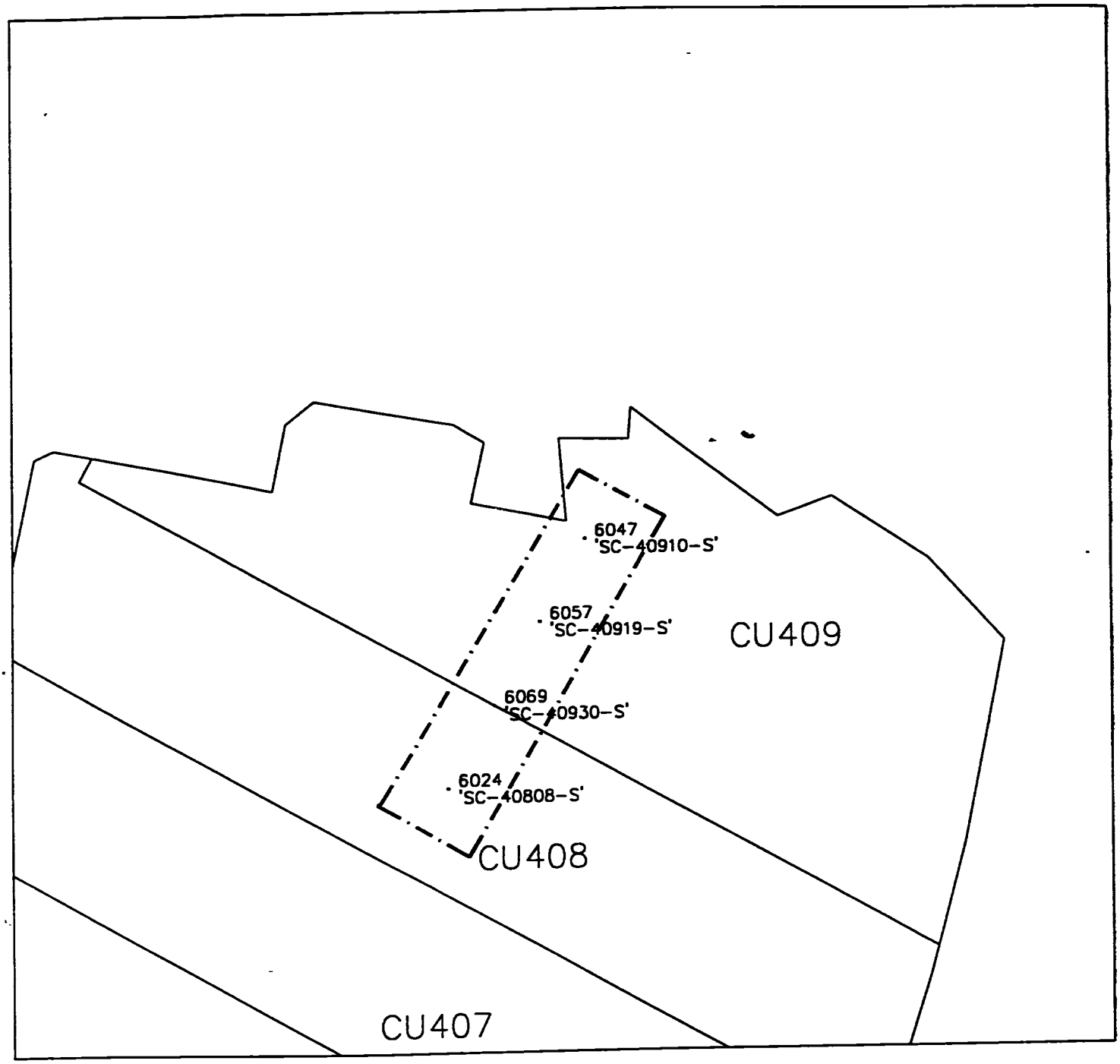
(IN FEET)
1 inch = 50 ft.

Radiation Survey Form WP 437, RU 19 CU 409

Date Plotted 9/22/00

DBO CAD

Meter Model #:	2221	Detector Model #:	2x2 "X"
Meter Serial #:	154216	Detector Serial #:	22084
Calibration Due:	4/28/01	Calibration Due:	1/21/01
Survey Date / Time:	9/21/00 1630	Field Bkg.	10,000 CPM
Surveyor(s):	T. Brower		
Comments:	All readings 41.5 Bkg		



LEGEND

· 'SC-32606-S' SAMPLE POINTS PINNED

PINNING LIMITS

N

GRAPHIC SCALE

50 0 50 100

(IN FEET)
1 inch = 50 ft.

Radiation Survey Form WP 437, RU 19 CU 409

Date Plotted 9/22/00

DBO CAD

Meter Model #:	2221	Detector Model #:	2x2 "X"
Meter Serial #:	154216	Detector Serial #:	2D084
Calibration Due:	4-28-01	Calibration Due:	1-21-01
Survey Date / Time:	9-22-00/1500	Field Bkg.:	10,000 cpm
Surveyor(s):	T. GROWER		
Comments:	ALL READINGS <1.5 x BKG		

APPENDIX B
Final Data

APPENDIX B WP-437 RU19 FINAL DATA

WSSRAP_ID	DATE_SAM	PARAMETER	CONC	DL	UNITS
SC-36903-S	6/27/2000	RADIUM-226	0.69	0.25	PCI/G
SC-36904-S	6/27/2000	RADIUM-226	0.71	0.25	PCI/G
SC-36905-S	6/27/2000	RADIUM-226	0.25	0.5	PCI/G
SC-36907-C	6/27/2000	RADIUM-226	0.7	0.25	PCI/G
SC-36907-S	6/27/2000	RADIUM-226	0.22	0.44	PCI/G
SC-36908-S	6/27/2000	RADIUM-226	0.7	0.26	PCI/G
SC-36909-C	6/27/2000	RADIUM-226	0.71	0.25	PCI/G
SC-36909-S	6/27/2000	RADIUM-226	0.86	0.22	PCI/G
SC-36913-S	6/27/2000	RADIUM-226	0.81	0.27	PCI/G
SC-36914-S	6/27/2000	RADIUM-226	0.79	0.25	PCI/G
SC-36915-S	6/27/2000	RADIUM-226	0.75	0.22	PCI/G
SC-36918-C	6/27/2000	RADIUM-226	0.67	0.24	PCI/G
SC-36918-S	6/27/2000	RADIUM-226	0.61	0.28	PCI/G
SC-36919-C	6/27/2000	RADIUM-226	0.77	0.25	PCI/G
SC-36919-S	6/27/2000	RADIUM-226	0.76	0.24	PCI/G
SC-36920-S	6/27/2000	RADIUM-226	0.76	0.2	PCI/G
SC-36923-S	6/27/2000	RADIUM-226	0.68	0.24	PCI/G
SC-36924-S	6/27/2000	RADIUM-226	0.78	0.23	PCI/G
SC-36928-S	6/27/2000	RADIUM-226	0.86	0.21	PCI/G
SC-36929-S	6/27/2000	RADIUM-226	0.73	0.24	PCI/G
SC-36932-S	6/27/2000	RADIUM-226	0.71	0.26	PCI/G
SC-36933-C	6/27/2000	RADIUM-226	0.83	0.26	PCI/G
SC-36935-C	6/29/2000	RADIUM-226	0.63	0.24	PCI/G
SC-36936-S	6/27/2000	RADIUM-226	0.77	0.28	PCI/G
SC-36938-C	6/27/2000	RADIUM-226	0.73	0.25	PCI/G
SC-40601-C	8/9/2000	RADIUM-226	0.82	0.23	PCI/G
SC-40602-S	8/9/2000	RADIUM-226	0.275	0.55	PCI/G
SC-40603-S	8/9/2000	RADIUM-226	0.86	0.29	PCI/G
SC-40604-S	8/9/2000	RADIUM-226	0.64	0.25	PCI/G
SC-40605-S	6/28/2000	RADIUM-226	0.68	0.25	PCI/G
SC-40606-S	6/28/2000	RADIUM-226	0.69	0.25	PCI/G
SC-40607-S	6/28/2000	RADIUM-226	0.7	0.24	PCI/G
SC-40608-S	6/28/2000	RADIUM-226	0.82	0.23	PCI/G
SC-40609-S	6/28/2000	RADIUM-226	0.79	0.26	PCI/G
SC-40610-S	8/9/2000	RADIUM-226	0.77	0.26	PCI/G
SC-40612-S	6/28/2000	RADIUM-226	0.22	0.44	PCI/G
SC-40613-S	6/28/2000	RADIUM-226	0.64	0.23	PCI/G
SC-40614-S	6/28/2000	RADIUM-226	0.89	0.23	PCI/G
SC-40615-S	6/28/2000	RADIUM-226	0.67	0.25	PCI/G
SC-40616-S	6/28/2000	RADIUM-226	0.75	0.26	PCI/G
SC-40617-S	6/28/2000	RADIUM-226	0.66	0.27	PCI/G
SC-40618-S	6/28/2000	RADIUM-226	0.93	0.25	PCI/G
SC-40619-S	6/28/2000	RADIUM-226	0.63	0.21	PCI/G
SC-40620-S	6/28/2000	RADIUM-226	0.84	0.29	PCI/G
SC-40621-S	6/28/2000	RADIUM-226	0.86	0.23	PCI/G
SC-40622-C	6/28/2000	RADIUM-226	0.62	0.22	PCI/G
SC-40624-C	6/28/2000	RADIUM-226	0.67	0.25	PCI/G
SC-40701-C	9/15/2000	RADIUM-226	0.83	0.27	PCI/G
SC-40702-S	9/15/2000	RADIUM-226	0.58	0.23	PCI/G
SC-40703-S	9/15/2000	RADIUM-226	0.62	0.2	PCI/G
SC-40704-S	8/9/2000	RADIUM-226	0.89	0.24	PCI/G
SC-40705-S	8/9/2000	RADIUM-226	0.8	0.21	PCI/G
SC-40706-S	6/28/2000	RADIUM-226	0.74	0.26	PCI/G
SC-40707-S	6/28/2000	RADIUM-226	0.74	0.24	PCI/G
SC-40708-S	6/28/2000	RADIUM-226	0.72	0.26	PCI/G
SC-40709-S	9/17/2000	RADIUM-226	0.83	0.23	PCI/G
SC-40710-S	7/20/2000	RADIUM-226	0.245	0.49	PCI/G
SC-40711-S	7/20/2000	RADIUM-226	0.84	0.25	PCI/G
SC-40712-C	9/15/2000	RADIUM-226	0.85	0.24	PCI/G
SC-40713-S	8/9/2000	RADIUM-226	0.92	0.24	PCI/G

APPENDIX B WP-437 RU19 FINAL DATA

WSSRAP_ID	DATE_SAM	PARAMETER	CONC	DL	UNITS
SC-40714-S	8/9/2000	RADIUM-226	0.85	0.28	PCI/G
SC-40715-S	8/9/2000	RADIUM-226	0.25	0.5	PCI/G
SC-40716-S	8/9/2000	RADIUM-226	0.71	0 2	PCI/G
SC-40717-S	6/28/2000	RADIUM-226	0.36	0 28	PCI/G
SC-40718-S	6/28/2000	RADIUM-226	0 7	0.25	PCI/G
SC-40719-S	6/28/2000	RADIUM-226	0.86	0.23	PCI/G
SC-40720-S	9/17/2000	RADIUM-226	0 57	0 29	PCI/G
SC-40721-S	9/17/2000	RADIUM-226	0.69	0.26	PCI/G
SC-40802-C	9/15/2000	RADIUM-226	0.86	0 22	PCI/G
SC-40803-S	9/15/2000	RADIUM-226	0.81	0.23	PCI/G
SC-40804-S	9/15/2000	RADIUM-226	0 56	0.24	PCI/G
SC-40805-S	9/15/2000	RADIUM-226	0.72	0.25	PCI/G
SC-40806-S	9/21/2000	RADIUM-226	0.7	0.22	PCI/G
SC-40807-S	9/21/2000	RADIUM-226	0 83	0 25	PCI/G
SC-40808-S	9/22/2000	RADIUM-226	0 72	0 27	PCI/G
SC-40809-S	8/9/2000	RADIUM-226	0.275	0.55	PCI/G
SC-40810-S	9/17/2000	RADIUM-226	0.65	0.24	PCI/G
SC-40811-S	7/20/2000	RADIUM-226	0.26	0.52	PCI/G
SC-40812-S	7/16/2000	RADIUM-226	0 74	0.25	PCI/G
SC-40813-S	7/16/2000	RADIUM-226	0.85	0.26	PCI/G
SC-40816-S	9/15/2000	RADIUM-226	0.7	0.27	PCI/G
SC-40817-S	9/15/2000	RADIUM-226	0.75	0.21	PCI/G
SC-40818-S	9/15/2000	RADIUM-226	0.84	0.25	PCI/G
SC-40819-S	8/9/2000	RADIUM-226	0.67	0.25	PCI/G
SC-40820-S	8/9/2000	RADIUM-226	0 255	0 51	PCI/G
SC-40821-S	8/9/2000	RADIUM-226	0.73	0.25	PCI/G
SC-40822-S	9/17/2000	RADIUM-226	0 69	0.25	PCI/G
SC-40823-S	9/17/2000	RADIUM-226	0 76	0.25	PCI/G
SC-40824-S	7/20/2000	RADIUM-226	1 13	0 27	PCI/G
SC-40825-S	7/20/2000	RADIUM-226	0.71	0 28	PCI/G
SC-40902-S	6/28/2000	RADIUM-226	0 54	0 24	PCI/G
SC-40903-S	6/28/2000	RADIUM-226	0 78	0 22	PCI/G
SC-40904-S	7/20/2000	RADIUM-226	0 74	0 23	PCI/G
SC-40905-S	7/16/2000	RADIUM-226	0 93	0.27	PCI/G
SC-40906-S	7/16/2000	RADIUM-226	0 59	0 23	PCI/G
SC-40908-S	9/22/2000	RADIUM-226	0 83	0 23	PCI/G
SC-40909-C	6/28/2000	RADIUM-226	0 71	0 24	PCI/G
SC-40910-S	9/22/2000	RADIUM-226	0.9	0.28	PCI/G
SC-40911-S	6/28/2000	RADIUM-226	0 66	0 22	PCI/G
SC-40912-S	7/20/2000	RADIUM-226	0 265	0 53	PCI/G
SC-40913-C	7/16/2000	RADIUM-226	0.99	0 25	PCI/G
SC-40913-S	7/16/2000	RADIUM-226	0 84	0.25	PCI/G
SC-40914-S	7/16/2000	RADIUM-226	1 08	0 27	PCI/G
SC-40916-C	9/22/2000	RADIUM-226	0 48	0 25	PCI/G
SC-40916-S	9/22/2000	RADIUM-226	0 78	0 3	PCI/G
SC-40917-S	9/22/2000	RADIUM-226	0.16	0.32	PCI/G
SC-40918-S	9/22/2000	RADIUM-226	0 82	0.26	PCI/G
SC-40919-S	9/22/2000	RADIUM-226	0 58	0 3	PCI/G
SC-40920-C	6/28/2000	RADIUM-226	0 57	0.24	PCI/G
SC-40920-S	6/28/2000	RADIUM-226	0.55	0.26	PCI/G
SC-40921-S	6/28/2000	RADIUM-226	0 78	0 28	PCI/G
SC-40922-S	7/16/2000	RADIUM-226	1 08	0.28	PCI/G
SC-40923-S	7/16/2000	RADIUM-226	1 51	0 33	PCI/G
SC-40924-S	7/20/2000	RADIUM-226	0 77	0 23	PCI/G
SC-40925-S	9/15/2000	RADIUM-226	0 67	0 24	PCI/G
SC-40926-S	9/15/2000	RADIUM-226	0 44	0.27	PCI/G
SC-40927-S	9/15/2000	RADIUM-226	0.84	0.28	PCI/G
SC-40928-S	9/21/2000	RADIUM-226	0 47	0.23	PCI/G
SC-40929-S	9/21/2000	RADIUM-226	0 77	0.26	PCI/G
SC-40930-S	9/22/2000	RADIUM-226	0 74	0.22	PCI/G

APPENDIX B WP-437 RU19 FINAL DATA

WSSRAP_ID	DATE_SAM	PARAMETER	CONC	DL	UNITS
SC-40931-S	6/28/2000	RADIUM-226	0.74	0.24	PCI/G
SC-40932-S	9/17/2000	RADIUM-226	0.72	0.24	PCI/G
SC-40933-S	7/16/2000	RADIUM-226	0.7	0.23	PCI/G
SC-40934-S	7/16/2000	RADIUM-226	1.32	0.35	PCI/G
SC-40935-S	7/16/2000	RADIUM-226	0.94	0.21	PCI/G
SC-36903-S	6/27/2000	RADIUM-228	1.07	0.44	PCI/G
SC-36904-S	6/27/2000	RADIUM-228	1.01	0.33	PCI/G
SC-36905-S	6/27/2000	RADIUM-228	0.375	0.75	PCI/G
SC-36907-C	6/27/2000	RADIUM-228	0.9	0.34	PCI/G
SC-36907-S	6/27/2000	RADIUM-228	1.15	0.36	PCI/G
SC-36908-S	6/27/2000	RADIUM-228	1.29	0.33	PCI/G
SC-36909-C	6/27/2000	RADIUM-228	0.39	0.78	PCI/G
SC-36909-S	6/27/2000	RADIUM-228	1.18	0.35	PCI/G
SC-36913-S	6/27/2000	RADIUM-228	0.395	0.79	PCI/G
SC-36914-S	6/27/2000	RADIUM-228	1.17	0.36	PCI/G
SC-36915-S	6/27/2000	RADIUM-228	0.41	0.82	PCI/G
SC-36918-C	6/27/2000	RADIUM-228	0.97	0.35	PCI/G
SC-36918-S	6/27/2000	RADIUM-228	0.92	0.44	PCI/G
SC-36919-C	6/27/2000	RADIUM-228	1.06	0.3	PCI/G
SC-36919-S	6/27/2000	RADIUM-228	0.91	0.33	PCI/G
SC-36920-S	6/27/2000	RADIUM-228	1.23	0.33	PCI/G
SC-36923-S	6/27/2000	RADIUM-228	0.81	0.4	PCI/G
SC-36924-S	6/27/2000	RADIUM-228	1.11	0.4	PCI/G
SC-36928-S	6/27/2000	RADIUM-228	1.48	0.36	PCI/G
SC-36929-S	6/27/2000	RADIUM-228	0.93	0.36	PCI/G
SC-36932-S	6/27/2000	RADIUM-228	1.01	0.44	PCI/G
SC-36933-C	6/27/2000	RADIUM-228	1.21	0.36	PCI/G
SC-36935-C	6/29/2000	RADIUM-228	0.94	0.33	PCI/G
SC-36936-S	6/27/2000	RADIUM-228	1.2	0.45	PCI/G
SC-36938-C	6/27/2000	RADIUM-228	0.92	0.37	PCI/G
SC-40601-C	8/9/2000	RADIUM-228	1.07	0.35	PCI/G
SC-40602-S	8/9/2000	RADIUM-228	0.86	0.45	PCI/G
SC-40603-S	8/9/2000	RADIUM-228	0.385	0.77	PCI/G
SC-40604-S	8/9/2000	RADIUM-228	1.08	0.32	PCI/G
SC-40605-S	6/28/2000	RADIUM-228	1.18	0.31	PCI/G
SC-40606-S	6/28/2000	RADIUM-228	0.81	0.43	PCI/G
SC-40607-S	6/28/2000	RADIUM-228	1.13	0.37	PCI/G
SC-40608-S	6/28/2000	RADIUM-228	0.365	0.73	PCI/G
SC-40609-S	6/28/2000	RADIUM-228	0.93	0.36	PCI/G
SC-40610-S	8/9/2000	RADIUM-228	0.4	0.8	PCI/G
SC-40612-S	6/28/2000	RADIUM-228	0.36	0.72	PCI/G
SC-40613-S	6/28/2000	RADIUM-228	0.87	0.33	PCI/G
SC-40614-S	6/28/2000	RADIUM-228	0.74	0.5	PCI/G
SC-40615-S	6/28/2000	RADIUM-228	1.1	0.31	PCI/G
SC-40616-S	6/28/2000	RADIUM-228	1.17	0.41	PCI/G
SC-40617-S	6/28/2000	RADIUM-228	1.09	0.45	PCI/G
SC-40618-S	6/28/2000	RADIUM-228	0.36	0.72	PCI/G
SC-40619-S	6/28/2000	RADIUM-228	0.95	0.32	PCI/G
SC-40620-S	6/28/2000	RADIUM-228	1.05	0.51	PCI/G
SC-40621-S	6/28/2000	RADIUM-228	1.31	0.35	PCI/G
SC-40622-C	6/28/2000	RADIUM-228	0.395	0.79	PCI/G
SC-40624-C	6/28/2000	RADIUM-228	1.02	0.3	PCI/G
SC-40701-C	9/15/2000	RADIUM-228	1.25	0.4	PCI/G
SC-40702-S	9/15/2000	RADIUM-228	1.07	0.33	PCI/G
SC-40703-S	9/15/2000	RADIUM-228	1.2	0.34	PCI/G
SC-40704-S	8/9/2000	RADIUM-228	0.43	0.86	PCI/G
SC-40705-S	8/9/2000	RADIUM-228	1.02	0.37	PCI/G
SC-40706-S	6/28/2000	RADIUM-228	1.13	0.41	PCI/G
SC-40707-S	6/28/2000	RADIUM-228	1.03	0.35	PCI/G
SC-40708-S	6/28/2000	RADIUM-228	0.405	0.81	PCI/G

APPENDIX B WP-437 RU19 FINAL DATA

WSSRAP_ID	DATE_SAM	PARAMETER	CONC	DL	UNITS
SC-40709-S	9/17/2000	RADIUM-228	1.16	0.25	PCI/G
SC-40710-S	7/20/2000	RADIUM-228	1.12	0.38	PCI/G
SC-40711-S	7/20/2000	RADIUM-228	0 69	0.39	PCI/G
SC-40712-C	9/15/2000	RADIUM-228	1.01	0.35	PCI/G
SC-40713-S	8/9/2000	RADIUM-228	0 425	0.85	PCI/G
SC-40714-S	8/9/2000	RADIUM-228	1.12	0.33	PCI/G
SC-40715-S	8/9/2000	RADIUM-228	0 4	0 8	PCI/G
SC-40716-S	8/9/2000	RADIUM-228	1 16	0.36	PCI/G
SC-40717-S	6/28/2000	RADIUM-228	1 12	0.32	PCI/G
SC-40718-S	6/28/2000	RADIUM-228	1.06	0.47	PCI/G
SC-40719-S	6/28/2000	RADIUM-228	1 13	0.34	PCI/G
SC-40720-S	9/17/2000	RADIUM-228	1.36	0.37	PCI/G
SC-40721-S	9/17/2000	RADIUM-228	1 05	0.29	PCI/G
SC-40802-C	9/15/2000	RADIUM-228	1.18	0.38	PCI/G
SC-40803-S	9/15/2000	RADIUM-228	1.03	0.32	PCI/G
SC-40804-S	9/15/2000	RADIUM-228	1 28	0.36	PCI/G
SC-40805-S	9/15/2000	RADIUM-228	1.04	0 3	PCI/G
SC-40806-S	9/21/2000	RADIUM-228	0 93	0 33	PCI/G
SC-40807-S	9/21/2000	RADIUM-228	0 94	0.36	PCI/G
SC-40808-S	9/22/2000	RADIUM-228	1.09	0 49	PCI/G
SC-40809-S	8/9/2000	RADIUM-228	0.345	0 69	PCI/G
SC-40810-S	9/17/2000	RADIUM-228	1.08	0.35	PCI/G
SC-40811-S	7/20/2000	RADIUM-228	0 94	0.31	PCI/G
SC-40812-S	7/16/2000	RADIUM-228	0.435	0 87	PCI/G
SC-40813-S	7/16/2000	RADIUM-228	0 9	0 36	PCI/G
SC-40816-S	9/15/2000	RADIUM-228	0 97	0 4	PCI/G
SC-40817-S	9/15/2000	RADIUM-228	1.06	0 37	PCI/G
SC-40818-S	9/15/2000	RADIUM-228	0 41	0 82	PCI/G
SC-40819-S	8/9/2000	RADIUM-228	0 9	0 31	PCI/G
SC-40820-S	8/9/2000	RADIUM-228	0 34	0 68	PCI/G
SC-40821-S	8/9/2000	RADIUM-228	0 99	0 35	PCI/G
SC-40822-S	9/17/2000	RADIUM-228	1 05	0 36	PCI/G
SC-40823-S	9/17/2000	RADIUM-228	1 01	0 34	PCI/G
SC-40824-S	7/20/2000	RADIUM-228	1 6	0 41	PCI/G
SC-40825-S	7/20/2000	RADIUM-228	0 375	0 75	PCI/G
SC-40902-S	6/28/2000	RADIUM-228	0.355	0 71	PCI/G
SC-40903-S	6/28/2000	RADIUM-228	0 9	0 37	PCI/G
SC-40904-S	7/20/2000	RADIUM-228	1 01	0 31	PCI/G
SC-40905-S	7/16/2000	RADIUM-228	0.425	0 85	PCI/G
SC-40906-S	7/16/2000	RADIUM-228	1 01	0 34	PCI/G
SC-40908-S	9/22/2000	RADIUM-228	1 22	0 31	PCI/G
SC-40909-C	6/28/2000	RADIUM-228	0 91	0 52	PCI/G
SC-40910-S	9/22/2000	RADIUM-228	1 02	0 49	PCI/G
SC-40911-S	6/28/2000	RADIUM-228	1 19	0.32	PCI/G
SC-40912-S	7/20/2000	RADIUM-228	1.07	0 43	PCI/G
SC-40913-C	7/16/2000	RADIUM-228	1 35	0 42	PCI/G
SC-40913-S	7/16/2000	RADIUM-228	0 99	0 37	PCI/G
SC-40914-S	7/16/2000	RADIUM-228	0 41	0 82	PCI/G
SC-40916-C	9/22/2000	RADIUM-228	1 06	0 3	PCI/G
SC-40916-S	9/22/2000	RADIUM-228	1 05	0 39	PCI/G
SC-40917-S	9/22/2000	RADIUM-228	0 98	0 33	PCI/G
SC-40918-S	9/22/2000	RADIUM-228	1 07	0 37	PCI/G
SC-40919-S	9/22/2000	RADIUM-228	0 99	0 37	PCI/G
SC-40920-C	6/28/2000	RADIUM-228	1 3	0 37	PCI/G
SC-40920-S	6/28/2000	RADIUM-228	1 06	0 31	PCI/G
SC-40921-S	6/28/2000	RADIUM-228	1 12	0 34	PCI/G
SC-40922-S	7/16/2000	RADIUM-228	1 45	0 35	PCI/G
SC-40923-S	7/16/2000	RADIUM-228	1 76	0 54	PCI/G
SC-40924-S	7/20/2000	RADIUM-228	0 9	0 28	PCI/G
SC-40925-S	9/15/2000	RADIUM-228	0 88	0 34	PCI/G

APPENDIX B WP-437 RU19 FINAL DATA

WSSRAP_ID	DATE_SAM	PARAMETER	CONC	DL	UNITS
SC-40926-S	9/15/2000	RADIUM-228	1.22	0.35	PCI/G
SC-40927-S	9/15/2000	RADIUM-228	0.37	0.74	PCI/G
SC-40928-S	9/21/2000	RADIUM-228	0.92	0.48	PCI/G
SC-40929-S	9/21/2000	RADIUM-228	0.345	0.69	PCI/G
SC-40930-S	9/22/2000	RADIUM-228	1.06	0.36	PCI/G
SC-40931-S	6/28/2000	RADIUM-228	1.19	0.33	PCI/G
SC-40932-S	9/17/2000	RADIUM-228	1.11	0.36	PCI/G
SC-40933-S	7/16/2000	RADIUM-228	1.06	0.24	PCI/G
SC-40934-S	7/16/2000	RADIUM-228	0.475	0.95	PCI/G
SC-40935-S	7/16/2000	RADIUM-228	1.12	0.33	PCI/G
SC-36903-S	6/27/2000	THORIUM-230	1.03	0.64	PCI/G
SC-36904-S	6/27/2000	THORIUM-230	1.13	0.62	PCI/G
SC-36905-S	6/27/2000	THORIUM-230	1.73	0.64	PCI/G
SC-36907-C	6/27/2000	THORIUM-230	0.84	0.62	PCI/G
SC-36907-S	6/27/2000	THORIUM-230	0.93	0.64	PCI/G
SC-36908-S	6/27/2000	THORIUM-230	1.19	0.62	PCI/G
SC-36909-C	6/27/2000	THORIUM-230	1.17	0.64	PCI/G
SC-36909-S	6/27/2000	THORIUM-230	1.16	0.62	PCI/G
SC-36913-S	6/27/2000	THORIUM-230	8.82	0.64	PCI/G
SC-36913-S-RS	7/11/2000	THORIUM-230	0.72	0.62	PCI/G
SC-36914-S	6/27/2000	THORIUM-230	5.24	0.62	PCI/G
SC-36915-S	6/27/2000	THORIUM-230	1.51	0.64	PCI/G
SC-36918-C	6/27/2000	THORIUM-230	2.17	0.62	PCI/G
SC-36918-S	6/27/2000	THORIUM-230	2.28	0.64	PCI/G
SC-36919-C	6/27/2000	THORIUM-230	1.22	0.62	PCI/G
SC-36919-S	6/27/2000	THORIUM-230	1.59	0.64	PCI/G
SC-36920-S	6/27/2000	THORIUM-230	1.43	0.62	PCI/G
SC-36923-S	6/27/2000	THORIUM-230	3.21	0.64	PCI/G
SC-36924-S	6/27/2000	THORIUM-230	1.42	0.62	PCI/G
SC-36928-S	6/27/2000	THORIUM-230	1.59	0.64	PCI/G
SC-36929-S	6/27/2000	THORIUM-230	0.93	0.62	PCI/G
SC-36932-S	6/27/2000	THORIUM-230	1.17	0.64	PCI/G
SC-36933-C	6/27/2000	THORIUM-230	1.24	0.62	PCI/G
SC-36935-C	6/29/2000	THORIUM-230	1.39	0.62	PCI/G
SC-36936-S	6/27/2000	THORIUM-230	2.62	0.64	PCI/G
SC-36938-C	6/27/2000	THORIUM-230	1.62	0.62	PCI/G
SC-40601-C	8/9/2000	THORIUM-230	1.33	0.64	PCI/G
SC-40602-S	8/9/2000	THORIUM-230	1.3	0.64	PCI/G
SC-40603-S	8/9/2000	THORIUM-230	1.26	0.64	PCI/G
SC-40604-S	8/9/2000	THORIUM-230	1.07	0.64	PCI/G
SC-40605-S	6/28/2000	THORIUM-230	1	0.64	PCI/G
SC-40606-S	6/28/2000	THORIUM-230	1.94	0.62	PCI/G
SC-40607-S	6/28/2000	THORIUM-230	0.83	0.64	PCI/G
SC-40608-S	6/28/2000	THORIUM-230	0.95	0.62	PCI/G
SC-40609-S	6/28/2000	THORIUM-230	1.18	0.64	PCI/G
SC-40610-S	8/9/2000	THORIUM-230	1.12	0.64	PCI/G
SC-40612-S	6/28/2000	THORIUM-230	0.87	0.62	PCI/G
SC-40613-S	6/28/2000	THORIUM-230	0.86	0.64	PCI/G
SC-40614-S	6/28/2000	THORIUM-230	0.97	0.62	PCI/G
SC-40615-S	6/28/2000	THORIUM-230	1.24	0.64	PCI/G
SC-40616-S	6/28/2000	THORIUM-230	1.14	0.62	PCI/G
SC-40617-S	6/28/2000	THORIUM-230	1.18	0.64	PCI/G
SC-40618-S	6/28/2000	THORIUM-230	1	0.62	PCI/G
SC-40619-S	6/28/2000	THORIUM-230	0.9	0.64	PCI/G
SC-40620-S	6/28/2000	THORIUM-230	0.92	0.64	PCI/G
SC-40621-S	6/28/2000	THORIUM-230	1.27	0.62	PCI/G
SC-40622-C	6/28/2000	THORIUM-230	0.83	0.64	PCI/G
SC-40624-C	6/28/2000	THORIUM-230	0.74	0.62	PCI/G
SC-40701-C	9/15/2000	THORIUM-230	1.1	0.64	PCI/G
SC-40702-S	9/15/2000	THORIUM-230	1.03	0.64	PCI/G

APPENDIX B WP-437 RU19 FINAL DATA

WSSRAP_ID	DATE_SAM	PARAMETER	CONC	DL	UNITS
SC-40703-S	9/15/2000	THORIUM-230	1 44	0.65	PCI/G
SC-40704-S	8/9/2000	THORIUM-230	1 53	0.64	PCI/G
SC-40705-S	8/9/2000	THORIUM-230	1 09	0.64	PCI/G
SC-40706-S	6/28/2000	THORIUM-230	0 88	0.64	PCI/G
SC-40707-S	6/28/2000	THORIUM-230	0 81	0 62	PCI/G
SC-40708-S	6/28/2000	THORIUM-230	1 71	0.64	PCI/G
SC-40709-S	9/17/2000	THORIUM-230	1 07	0.64	PCI/G
SC-40710-S	7/20/2000	THORIUM-230	0.78	0.65	PCI/G
SC-40711-S	7/20/2000	THORIUM-230	0.81	0 62	PCI/G
SC-40712-C	9/15/2000	THORIUM-230	1.22	0.64	PCI/G
SC-40713-S	8/9/2000	THORIUM-230	0.8	0.64	PCI/G
SC-40714-S	8/9/2000	THORIUM-230	0.97	0.64	PCI/G
SC-40715-S	8/9/2000	THORIUM-230	1.13	0 64	PCI/G
SC-40716-S	8/9/2000	THORIUM-230	1.1	0 64	PCI/G
SC-40717-S	6/28/2000	THORIUM-230	0.9	0 62	PCI/G
SC-40718-S	6/28/2000	THORIUM-230	0.88	0 64	PCI/G
SC-40719-S	6/28/2000	THORIUM-230	0.96	0 62	PCI/G
SC-40720-S	9/17/2000	THORIUM-230	1.08	0 65	PCI/G
SC-40721-S	9/17/2000	THORIUM-230	0.77	0 64	PCI/G
SC-40802-C	9/15/2000	THORIUM-230	1.17	0 64	PCI/G
SC-40803-S	9/15/2000	THORIUM-230	1.14	0 65	PCI/G
SC-40804-S	9/15/2000	THORIUM-230	1.22	0 64	PCI/G
SC-40805-S	9/15/2000	THORIUM-230	0.85	0 64	PCI/G
SC-40806-S	9/21/2000	THORIUM-230	0.67	0 65	PCI/G
SC-40807-S	9/21/2000	THORIUM-230	6 01	0 64	PCI/G
SC-40808-S	9/22/2000	THORIUM-230	0.87	0 64	PCI/G
SC-40809-S	8/9/2000	THORIUM-230	1.81	0 64	PCI/G
SC-40810-S	9/17/2000	THORIUM-230	0 92	0 64	PCI/G
SC-40811-S	7/20/2000	THORIUM-230	1.11	0 64	PCI/G
SC-40812-S	7/16/2000	THORIUM-230	1 31	0 65	PCI/G
SC-40812-S-RS	8/19/2000	THORIUM-230	6 41	0 65	PCI/G
SC-40812-S-RS2	8/26/2000	THORIUM-230	0.8	0 64	PCI/G
SC-40812-S-RS-HS01	8/24/2000	THORIUM-230	4.93	0 64	PCI/G
SC-40812-S-RS-HS02	8/24/2000	THORIUM-230	3 28	0 65	PCI/G
SC-40812-S-RS-HS03	8/24/2000	THORIUM-230	19 6	0 64	PCI/G
SC-40812-S-RS-HS04	8/24/2000	THORIUM-230	14	0 64	PCI/G
SC-40813-S	7/16/2000	THORIUM-230	0 91	0 62	PCI/G
SC-40816-S	9/15/2000	THORIUM-230	0 94	0 65	PCI/G
SC-40817-S	9/15/2000	THORIUM-230	0 99	0 64	PCI/G
SC-40818-S	9/15/2000	THORIUM-230	1 14	0 64	PCI/G
SC-40819-S	8/9/2000	THORIUM-230	1 49	0 64	PCI/G
SC-40820-S	8/9/2000	THORIUM-230	1 78	0.64	PCI/G
SC-40821-S	8/9/2000	THORIUM-230	1 41	0 64	PCI/G
SC-40822-S	9/17/2000	THORIUM-230	1 29	0 65	PCI/G
SC-40823-S	9/17/2000	THORIUM-230	1 12	0.64	PCI/G
SC-40824-S	7/20/2000	THORIUM-230	35 4	0.64	PCI/G
SC-40824-S-RS	8/19/2000	THORIUM-230	4.54	0 64	PCI/G
SC-40825-S	7/20/2000	THORIUM-230	1 46	0 65	PCI/G
SC-40902-S	6/28/2000	THORIUM-230	0 86	0 64	PCI/G
SC-40903-S	6/28/2000	THORIUM-230	0.77	0 62	PCI/G
SC-40904-S	7/20/2000	THORIUM-230	0 86	0 62	PCI/G
SC-40905-S	7/16/2000	THORIUM-230	1 1	0 64	PCI/G
SC-40905-S-RS	8/23/2000	THORIUM-230	17.4	0 64	PCI/G
SC-40905-S-RS-HS01	8/24/2000	THORIUM-230	1 38	0.65	PCI/G
SC-40905-S-RS-HS02	8/24/2000	THORIUM-230	2 38	0 64	PCI/G
SC-40905-S-RS-HS03	8/24/2000	THORIUM-230	1	0 64	PCI/G
SC-40905-S-RS-HS04	8/24/2000	THORIUM-230	0.94	0 65	PCI/G
SC-40906-S	7/16/2000	THORIUM-230	0 81	0 64	PCI/G
SC-40908-S	9/22/2000	THORIUM-230	1.12	0 65	PCI/G
SC-40909-C	6/28/2000	THORIUM-230	0 85	0.64	PCI/G

APPENDIX B WP-437 RU19 FINAL DATA

WSSRAP_ID	DATE_SAM	PARAMETER	CONC	DL	UNITS
SC-40910-S	9/22/2000	THORIUM-230	1.28	0.64	PCI/G
SC-40911-S	6/28/2000	THORIUM-230	0.92	0.62	PCI/G
SC-40912-C	8/23/2000	THORIUM-230	0.88	0.65	PCI/G
SC-40912-S	7/20/2000	THORIUM-230	0.79	0.64	PCI/G
SC-40913-C	7/16/2000	THORIUM-230	14.8	0.65	PCI/G
SC-40913-C-RS	8/19/2000	THORIUM-230	2.8	0.64	PCI/G
SC-40913-S	7/16/2000	THORIUM-230	0.94	0.62	PCI/G
SC-40913-S-RS	8/23/2000	THORIUM-230	1.01	0.64	PCI/G
SC-40914-S	7/16/2000	THORIUM-230	17.2	0.64	PCI/G
SC-40914-S-RS	8/19/2000	THORIUM-230	1.23	0.65	PCI/G
SC-40916-C	9/22/2000	THORIUM-230	0.83	0.64	PCI/G
SC-40916-S	9/22/2000	THORIUM-230	1.07	0.65	PCI/G
SC-40917-S	9/22/2000	THORIUM-230	0.88	0.64	PCI/G
SC-40918-S	9/22/2000	THORIUM-230	1.13	0.65	PCI/G
SC-40919-S	9/22/2000	THORIUM-230	1.22	0.64	PCI/G
SC-40920-C	6/28/2000	THORIUM-230	0.69	0.64	PCI/G
SC-40920-S	6/28/2000	THORIUM-230	0.9	0.62	PCI/G
SC-40921-C	8/23/2000	THORIUM-230	1.13	0.64	PCI/G
SC-40921-S	6/28/2000	THORIUM-230	0.8	0.64	PCI/G
SC-40922-S	7/16/2000	THORIUM-230	26.9	0.64	PCI/G
SC-40922-S-RS	8/19/2000	THORIUM-230	6.53	0.64	PCI/G
SC-40922-S-RS2	8/26/2000	THORIUM-230	1	0.65	PCI/G
SC-40922-S-RS-HS01	8/24/2000	THORIUM-230	20.8	0.64	PCI/G
SC-40922-S-RS-HS02	8/24/2000	THORIUM-230	14.8	0.64	PCI/G
SC-40922-S-RS-HS03	8/24/2000	THORIUM-230	18.7	0.65	PCI/G
SC-40922-S-RS-HS04	8/24/2000	THORIUM-230	4.97	0.64	PCI/G
SC-40923-S	7/16/2000	THORIUM-230	63.8	0.65	PCI/G
SC-40923-S-RS	8/19/2000	THORIUM-230	1	0.64	PCI/G
SC-40924-S	7/20/2000	THORIUM-230	1.06	0.64	PCI/G
SC-40925-S	9/15/2000	THORIUM-230	0.78	0.65	PCI/G
SC-40926-S	9/15/2000	THORIUM-230	0.75	0.65	PCI/G
SC-40927-S	9/15/2000	THORIUM-230	1.24	0.64	PCI/G
SC-40928-S	9/21/2000	THORIUM-230	1.19	0.65	PCI/G
SC-40929-S	9/21/2000	THORIUM-230	0.96	0.64	PCI/G
SC-40930-S	9/22/2000	THORIUM-230	0.85	0.64	PCI/G
SC-40931-S	6/28/2000	THORIUM-230	0.86	0.62	PCI/G
SC-40932-S	9/17/2000	THORIUM-230	1.01	0.64	PCI/G
SC-40933-S	7/16/2000	THORIUM-230	3.58	0.62	PCI/G
SC-40934-S	7/16/2000	THORIUM-230	32.8	0.64	PCI/G
SC-40934-S-RS	8/19/2000	THORIUM-230	1.39	0.65	PCI/G
SC-40935-S	7/16/2000	THORIUM-230	4.42	0.62	PCI/G
SC-36903-S	6/27/2000	URANIUM-238	1.1	2.2	PCI/G
SC-36904-S	6/27/2000	URANIUM-238	1.105	2.21	PCI/G
SC-36905-S	6/27/2000	URANIUM-238	2.02	2.32	PCI/G
SC-36907-C	6/27/2000	URANIUM-238	1.085	2.17	PCI/G
SC-36907-S	6/27/2000	URANIUM-238	1.115	2.23	PCI/G
SC-36908-S	6/27/2000	URANIUM-238	1.21	2.42	PCI/G
SC-36909-C	6/27/2000	URANIUM-238	1.18	2.36	PCI/G
SC-36909-S	6/27/2000	URANIUM-238	1.13	2.26	PCI/G
SC-36913-S	6/27/2000	URANIUM-238	1.17	2.34	PCI/G
SC-36914-S	6/27/2000	URANIUM-238	1.185	2.37	PCI/G
SC-36915-S	6/27/2000	URANIUM-238	1.14	2.28	PCI/G
SC-36918-C	6/27/2000	URANIUM-238	1.09	2.18	PCI/G
SC-36918-S	6/27/2000	URANIUM-238	1.195	2.39	PCI/G
SC-36919-C	6/27/2000	URANIUM-238	1.085	2.17	PCI/G
SC-36919-S	6/27/2000	URANIUM-238	1.19	2.38	PCI/G
SC-36920-S	6/27/2000	URANIUM-238	1.115	2.23	PCI/G
SC-36923-S	6/27/2000	URANIUM-238	1.05	2.1	PCI/G
SC-36924-S	6/27/2000	URANIUM-238	1.11	2.22	PCI/G
SC-36928-S	6/27/2000	URANIUM-238	1.175	2.35	PCI/G

APPENDIX B WP-437 RU19 FINAL DATA

WSSRAP_ID	DATE_SAM	PARAMETER	CONC	DL	UNITS
SC-36929-S	6/27/2000	URANIUM-238	1.145	2.29	PCI/G
SC-36932-S	6/27/2000	URANIUM-238	1 165	2.33	PCI/G
SC-36933-C	6/27/2000	URANIUM-238	1 135	2.27	PCI/G
SC-36935-C	6/29/2000	URANIUM-238	1 1	2 2	PCI/G
SC-36936-S	6/27/2000	URANIUM-238	1 035	2 07	PCI/G
SC-36938-C	6/27/2000	URANIUM-238	1 135	2.27	PCI/G
SC-40601-C	8/9/2000	URANIUM-238	1 085	2.17	PCI/G
SC-40602-S	8/9/2000	URANIUM-238	1 165	2.33	PCI/G
SC-40603-S	8/9/2000	URANIUM-238	1.04	2.08	PCI/G
SC-40604-S	8/9/2000	URANIUM-238	1.22	2.44	PCI/G
SC-40605-S	6/28/2000	URANIUM-238	1.06	2 12	PCI/G
SC-40606-S	6/28/2000	URANIUM-238	1 075	2 15	PCI/G
SC-40607-S	6/28/2000	URANIUM-238	1 04	2.08	PCI/G
SC-40608-S	6/28/2000	URANIUM-238	2 66	2.34	PCI/G
SC-40609-S	6/28/2000	URANIUM-238	1 12	2.24	PCI/G
SC-40610-S	8/9/2000	URANIUM-238	2.6	2.36	PCI/G
SC-40612-S	6/28/2000	URANIUM-238	1.075	2 15	PCI/G
SC-40613-S	6/28/2000	URANIUM-238	1.015	2.03	PCI/G
SC-40614-S	6/28/2000	URANIUM-238	1 075	2.15	PCI/G
SC-40615-S	6/28/2000	URANIUM-238	1.15	2.3	PCI/G
SC-40616-S	6/28/2000	URANIUM-238	1 145	2 29	PCI/G
SC-40617-S	6/28/2000	URANIUM-238	1 06	2 12	PCI/G
SC-40618-S	6/28/2000	URANIUM-238	0.985	1 97	PCI/G
SC-40619-S	6/28/2000	URANIUM-238	1.055	2 11	PCI/G
SC-40620-S	6/28/2000	URANIUM-238	1 115	2.23	PCI/G
SC-40621-S	6/28/2000	URANIUM-238	1 085	2.17	PCI/G
SC-40622-C	6/28/2000	URANIUM-238	1.14	2 28	PCI/G
SC-40624-C	6/28/2000	URANIUM-238	1 11	2 22	PCI/G
SC-40701-C	9/15/2000	URANIUM-238	1 02	2.04	PCI/G
SC-40702-S	9/15/2000	URANIUM-238	1 1	2.2	PCI/G
SC-40703-S	9/15/2000	URANIUM-238	1.07	2.14	PCI/G
SC-40704-S	8/9/2000	URANIUM-238	1.23	2 46	PCI/G
SC-40705-S	8/9/2000	URANIUM-238	1 31	2 62	PCI/G
SC-40706-S	6/28/2000	URANIUM-238	0 985	1.97	PCI/G
SC-40707-S	6/28/2000	URANIUM-238	1 095	2 19	PCI/G
SC-40708-S	6/28/2000	URANIUM-238	1.08	2.16	PCI/G
SC-40709-S	9/17/2000	URANIUM-238	1 105	2.21	PCI/G
SC-40710-S	7/20/2000	URANIUM-238	0.935	1 87	PCI/G
SC-40711-S	7/20/2000	URANIUM-238	1 14	2 28	PCI/G
SC-40712-C	9/15/2000	URANIUM-238	1 125	2.25	PCI/G
SC-40713-S	8/9/2000	URANIUM-238	1 2	2.4	PCI/G
SC-40714-S	8/9/2000	URANIUM-238	1 11	2 22	PCI/G
SC-40715-S	8/9/2000	URANIUM-238	1.455	2 91	PCI/G
SC-40716-S	8/9/2000	URANIUM-238	1.08	2 16	PCI/G
SC-40717-S	6/28/2000	URANIUM-238	1.085	2 17	PCI/G
SC-40718-S	6/28/2000	URANIUM-238	1 06	2.12	PCI/G
SC-40719-S	6/28/2000	URANIUM-238	1 1	2.2	PCI/G
SC-40720-S	9/17/2000	URANIUM-238	1 045	2 09	PCI/G
SC-40721-S	9/17/2000	URANIUM-238	1 075	2 15	PCI/G
SC-40802-C	9/15/2000	URANIUM-238	1	2	PCI/G
SC-40803-S	9/15/2000	URANIUM-238	1 14	2 28	PCI/G
SC-40804-S	9/15/2000	URANIUM-238	1.045	2 09	PCI/G
SC-40805-S	9/15/2000	URANIUM-238	1 085	2 17	PCI/G
SC-40806-S	9/21/2000	URANIUM-238	1 04	2.08	PCI/G
SC-40807-S	9/21/2000	URANIUM-238	1 13	2.26	PCI/G
SC-40808-S	9/22/2000	URANIUM-238	1.12	2.24	PCI/G
SC-40809-S	8/9/2000	URANIUM-238	1 05	2 1	PCI/G
SC-40810-S	9/17/2000	URANIUM-238	1 06	2 12	PCI/G
SC-40811-S	7/20/2000	URANIUM-238	1.07	2 14	PCI/G
SC-40812-S	7/16/2000	URANIUM-238	1 15	2 3	PCI/G

APPENDIX B WP-437 RU19 FINAL DATA

WSSRAP_ID	DATE_SAM	PARAMETER	CONC	DL	UNITS
SC-40813-S	7/16/2000	URANIUM-238	1.18	2.36	PCI/G
SC-40816-S	9/15/2000	URANIUM-238	1.18	2.36	PCI/G
SC-40817-S	9/15/2000	URANIUM-238	1.09	2.18	PCI/G
SC-40818-S	9/15/2000	URANIUM-238	0.98	1.96	PCI/G
SC-40819-S	8/9/2000	URANIUM-238	1.02	2.04	PCI/G
SC-40820-S	8/9/2000	URANIUM-238	1.045	2.09	PCI/G
SC-40821-S	8/9/2000	URANIUM-238	1.11	2.22	PCI/G
SC-40822-S	9/17/2000	URANIUM-238	1.1	2.2	PCI/G
SC-40823-S	9/17/2000	URANIUM-238	0.98	1.96	PCI/G
SC-40824-S	7/20/2000	URANIUM-238	1.44	2.88	PCI/G
SC-40825-S	7/20/2000	URANIUM-238	1.1	2.2	PCI/G
SC-40902-S	6/28/2000	URANIUM-238	1.08	2.16	PCI/G
SC-40903-S	6/28/2000	URANIUM-238	1.055	2.11	PCI/G
SC-40904-S	7/20/2000	URANIUM-238	1.055	2.11	PCI/G
SC-40905-S	7/16/2000	URANIUM-238	1.22	2.44	PCI/G
SC-40906-S	7/16/2000	URANIUM-238	1.045	2.09	PCI/G
SC-40908-S	9/22/2000	URANIUM-238	1.08	2.16	PCI/G
SC-40909-C	6/28/2000	URANIUM-238	1.06	2.12	PCI/G
SC-40910-S	9/22/2000	URANIUM-238	1.16	2.32	PCI/G
SC-40911-S	6/28/2000	URANIUM-238	1.06	2.12	PCI/G
SC-40912-S	7/20/2000	URANIUM-238	1.115	2.23	PCI/G
SC-40913-C	7/16/2000	URANIUM-238	1.28	2.56	PCI/G
SC-40913-S	7/16/2000	URANIUM-238	1.125	2.25	PCI/G
SC-40914-S	7/16/2000	URANIUM-238	1.275	2.55	PCI/G
SC-40916-C	9/22/2000	URANIUM-238	1.03	2.06	PCI/G
SC-40916-S	9/22/2000	URANIUM-238	1.045	2.09	PCI/G
SC-40917-S	9/22/2000	URANIUM-238	1.02	2.04	PCI/G
SC-40918-S	9/22/2000	URANIUM-238	1.115	2.23	PCI/G
SC-40919-S	9/22/2000	URANIUM-238	1.17	2.34	PCI/G
SC-40920-C	6/28/2000	URANIUM-238	1.005	2.01	PCI/G
SC-40920-S	6/28/2000	URANIUM-238	1.035	2.07	PCI/G
SC-40921-S	6/28/2000	URANIUM-238	1.08	2.16	PCI/G
SC-40922-S	7/16/2000	URANIUM-238	1.395	2.79	PCI/G
SC-40923-S	7/16/2000	URANIUM-238	4.77	3.04	PCI/G
SC-40924-S	7/20/2000	URANIUM-238	1.09	2.18	PCI/G
SC-40925-S	9/15/2000	URANIUM-238	1.12	2.24	PCI/G
SC-40926-S	9/15/2000	URANIUM-238	1.1	2.2	PCI/G
SC-40927-S	9/15/2000	URANIUM-238	1.045	2.09	PCI/G
SC-40928-S	9/21/2000	URANIUM-238	1.145	2.29	PCI/G
SC-40929-S	9/21/2000	URANIUM-238	1.02	2.04	PCI/G
SC-40930-S	9/22/2000	URANIUM-238	1.085	2.17	PCI/G
SC-40931-S	6/28/2000	URANIUM-238	1.085	2.17	PCI/G
SC-40932-S	9/17/2000	URANIUM-238	1.09	2.18	PCI/G
SC-40933-S	7/16/2000	URANIUM-238	1.16	2.32	PCI/G
SC-40934-S	7/16/2000	URANIUM-238	1.59	3.18	PCI/G
SC-40935-S	7/16/2000	URANIUM-238	1.135	2.27	PCI/G

APPENDIX C
RU019 Sample Location Coordinates

APPENDIX C WP-437 RU019 SAMPLE LOCATION COORDINATES

WSSRAP_ID	NORTHING	EASTING	ELEVATION
SC-36903-S	1044683.79	754602.77	641.85
SC-36904-S	1044667.63	754631.69	641.57
SC-36905-S	1044651.57	754660.24	641.26
SC-36907-C	1044675.82	754581.54	643.06
SC-36907-S	1044671.06	754558.32	644.29
SC-36908-S	1044654.84	754587.05	642.43
SC-36909-C	1044645.33	754638.00	641.91
SC-36909-S	1044638.97	754615.35	642.15
SC-36913-S	1044658.28	754513.33	643.16
SC-36913-S-RS	1044658.43	754513.51	642.06
SC-36914-S	1044642.53	754541.94	642.63
SC-36915-S	1044626.26	754570.82	642.51
SC-36918-C	1044650.95	754491.59	642.66
SC-36918-S	1044645.69	754469.08	642.65
SC-36919-C	1044636.24	754519.69	643.06
SC-36919-S	1044629.73	754497.44	642.42
SC-36920-S	1044613.71	754526.00	642.31
SC-36923-S	1044633.19	754424.30	641.80
SC-36924-S	1044617.28	754452.65	641.79
SC-36928-S	1044620.53	754379.53	641.11
SC-36929-S	1044604.62	754407.92	640.98
SC-36932-S	1044608.11	754335.13	639.99
SC-36933-C	1044605.07	754385.66	640.95
SC-36935-C	1044609.42	754289.05	641.31
SC-36936-S	1044594.25	754290.61	639.40
SC-36938-C	1044590.44	754278.71	638.96
SC-40601-C	1044777.40	754606.61	633.99
SC-40602-S	1044756.77	754606.25	635.08
SC-40603-S	1044740.95	754634.75	633.58
SC-40604-S	1044725.18	754663.35	637.65
SC-40605-S	1044709.21	754692.25	638.42
SC-40606-S	1044692.76	754721.07	638.27
SC-40607-S	1044676.94	754749.40	637.93
SC-40608-S	1044660.80	754777.99	637.82
SC-40609-S	1044644.41	754806.74	636.67
SC-40610-S	1044628.56	754835.00	634.71
SC-40612-S	1044728.30	754589.50	640.11
SC-40613-S	1044712.34	754618.99	637.46
SC-40614-S	1044695.92	754647.87	641.55
SC-40615-S	1044680.10	754675.95	641.17
SC-40616-S	1044664.01	754704.81	640.42
SC-40617-S	1044648.20	754733.33	639.48
SC-40618-S	1044632.20	754762.06	638.95
SC-40619-S	1044615.99	754790.51	637.92
SC-40620-S	1044599.77	754819.22	636.91
SC-40621-S	1044635.51	754688.75	641.79
SC-40622-C	1044626.76	754739.92	640.97
SC-40624-C	1044595.70	754797.81	640.26
SC-40701-C	1044835.94	754634.32	630.28
SC-40702-S	1044814.05	754638.27	630.43
SC-40703-S	1044797.94	754666.93	631.24
SC-40704-S	1044782.41	754695.76	631.00

APPENDIX C WP-437 RU019 SAMPLE LOCATION COORDINATES

SC-40705-S	1044766.40	754724.15	630.35
SC-40706-S	1044749.83	754752.78	632.91
SC-40707-S	1044733.71	754781.61	631.57
SC-40708-S	1044718.23	754810.13	631.16
SC-40709-S	1044701.89	754838.94	631.19
SC-40710-S	1044685.91	754867.15	631.51
SC-40711-S	1044670.02	754895.95	633.80
SC-40712-C	1044806.81	754618.17	632.48
SC-40713-S	1044785.73	754622.38	631.61
SC-40714-S	1044769.39	754650.79	631.61
SC-40715-S	1044753.34	754679.59	633.17
SC-40716-S	1044737.71	754708.28	632.76
SC-40717-S	1044721.18	754736.86	632.21
SC-40718-S	1044705.27	754765.42	632.64
SC-40719-S	1044689.53	754794.20	632.41
SC-40720-S	1044673.33	754822.95	632.71
SC-40721-S	1044657.30	754851.34	632.69
SC-40802-C	1044906.88	754644.61	630.96
SC-40803-S	1044887.70	754641.71	630.52
SC-40804-S	1044871.38	754670.37	627.84
SC-40805-S	1044855.65	754699.04	631.00
SC-40806-S	1044839.01	754727.69	631.72
SC-40807-S	1044823.41	754756.42	632.60
SC-40808-S	1044807.24	754784.94	631.20
SC-40809-S	1044791.11	754814.00	631.10
SC-40810-S	10447775.47	754842.05	628.85
SC-40811-S	1044759.72	754870.93	630.46
SC-40812-S	1044743.05	754899.22	627.20
SC-40812-S-RS	1044743.29	754899.31	627.00
SC-40812-S-RS2	1044743.98	754897.79	625.71
SC-40813-S	1044727.07	754927.63	627.08
SC-40816-S	1044843.03	754654.30	630.01
SC-40817-S	1044826.48	754682.93	631.01
SC-40818-S	1044810.48	754711.73	630.61
SC-40819-S	1044794.49	754740.10	629.90
SC-40820-S	1044778.36	754768.78	630.43
SC-40821-S	1044762.67	754797.65	631.42
SC-40822-S	1044746.52	754825.96	631.01
SC-40823-S	1044730.33	754854.73	630.63
SC-40824-S	1044714.64	754883.65	627.82
SC-40824-S-RS	1044714.87	754883.24	626.64
SC-40825-S	1044698.59	754912.18	627.88
SC-40902-S	1044921.55	754848.90	630.65
SC-40903-S	1044905.65	754877.52	630.50
SC-40904-S	1044889.68	754906.48	629.01
SC-40905-S	1044873.92	754935.23	625.89
SC-40905-S-RS	1044873.67	754935.02	625.82
SC-40905-S-RS-HS01	1044876.17	754935.02	626.06 *
SC-40905-S-RS-HS02	1044873.67	754937.52	625.94 *
SC-40905-S-RS-HS03	1044871.17	754935.02	625.62 *
SC-40905-S-RS-HS04	1044873.67	754932.52	625.82 *
SC-40906-S	1044857.27	754963.38	627.59
SC-40908-S	1044925.33	754775.64	631.02

APPENDIX C WP-437 RU019 SAMPLE LOCATION COORDINATES

SC-40909-C	1044913.41	754834.01	631.15
SC-40910-S	1044893.11	754832.94	633.79
SC-40911-S	1044876.95	754861.68	630.64
SC-40912-C	1044867.20	754912.79	624.59
SC-40912-S	1044861.28	754890.45	630.66
SC-40913-C	1044851.03	754941.14	625.29
SC-40913-C-RS	1044851.34	754941.33	624.20
SC-40913-S	1044844.96	754919.00	625.71
SC-40913-S-RS	1044844.62	754918.54	625.39
SC-40914-S	1044828.84	754947.29	625.68
SC-40914-S-RS	1044828.92	754947.63	624.64
SC-40916-C	1044919.00	754753.41	627.22
SC-40916-S	1044912.56	754730.92	631.02
SC-40917-S	1044896.50	754759.62	627.21
SC-40918-S	1044880.48	754788.31	631.76
SC-40919-S	1044864.56	754817.17	630.48
SC-40920-C	1044854.98	754867.72	630.21
SC-40920-S	1044848.60	754845.69	630.52
SC-40921-C	1044838.87	754896.26	626.60
SC-40921-S	1044832.56	754874.38	630.38
SC-40922-S	1044816.37	754902.65	625.81
SC-40922-S-RS	1044816.58	754902.75	625.55
SC-40922-S-RS2	1044812.50	754899.89	624.71
SC-40923-S	1044800.39	754931.26	626.17
SC-40923-S-RS	1044800.46	754931.45	625.14
SC-40924-S	1044784.29	754960.03	630.04
SC-40925-S	1044916.16	754658.12	629.68
SC-40926-S	1044900.45	754686.25	628.92
SC-40927-S	1044883.95	754714.95	632.53
SC-40928-S	1044867.87	754743.74	627.38
SC-40929-S	1044852.02	754772.48	630.57
SC-40930-S	1044835.87	754800.94	631.49
SC-40931-S	1044819.75	754829.57	630.93
SC-40932-S	1044787.77	754886.75	627.42
SC-40933-S	1044787.77	754886.75	627.42
SC-40934-S	1044771.78	754915.31	626.45
SC-40934-S-RS	1044771.99	754915.55	625.46
SC-40935-S	1044755.78	754943.90	627.73

* approximate elevation as determined by as-built topo

APPENDIX D
Interoffice Correspondence

MORRISON KNUDSEN CORPORATION

MK-FERGUSON GROUP

INTER-OFFICE CORRESPONDENCE

DATE: November 17, 1995

TO: ALARA Committee

FROM: Michelle French/Richard Machado

SUBJECT: **RA-226 DETERMINATION FOR SITE CONFIRMATION SAMPLES**

Background

The issue surrounding Ra-226 analysis via gamma spectroscopy arises due to the fact that the Ra-226 soil concentration is determined by using the following energy peaks: 295 keV and 352 keV for Pb-214; and 609 keV, 1120 keV, and 1764 keV for Bi-214. These radionuclides are both short-lived daughters of Rn-222. The drying and grinding processes are known to drive off Rn-222 that is trapped in the soil pores and moisture held in the soil. In order to quantitatively identify Ra-226 using gamma spectroscopy, Rn-222 and its short-lived progeny must be allowed to grow into secular equilibrium following such sample preparation techniques. The following alternatives were evaluated for estimating the Ra-226 concentration in soil given gamma spectroscopy analysis within five working days of sample collection.

Alternative 1

Send all samples requiring Ra-226 analysis to an offsite laboratory. At offsite facilities, Ra-226 is typically analyzed through alpha spectroscopy which does not rely on the Ra-222 daughter products to provide a quantitative result. The minimum turnaround time that can be provided for alpha spectroscopy analysis for Ra-226 is four days. At one and two day turnaround times, the method for analysis is modified to use Gas Flow Proportional Counting for total alpha counting yielding a total radium number with no separation of isotopic contributions. Given the four day turnaround time and an estimate of 750 samples (WP-253 and WP-420), the total analytical costs will be $95,250.

The major disadvantage in this approach is the tight schedule involved with sample collection, packaging, shipping, data receipt, data review, and ALARA committee action. It may be impossible to accomplish this within five working days given the four day turnaround requirement.

Alternative 2

As stated above, the drying and grinding processes are known to drive off radon that is trapped in the soil matrix. However, the amount of radon removed from these processes is not quantified. If you were to assume that all the radon is removed during these processes and the time of final preparation was recorded, a correction factor can be applied based upon the secular equilibrium condition equation. For example, the following table summarizes the ratio of activity of Rn-222 to the activity of Ra-226.

A(Rn-222)/A(Ra-226)	Time Post Canning (Days)
0.167	1
0.306	2
0.422	3
0.665	6
0.807	9
0.888	12
0.935	15
0.963	18
0.978	21
0.987	24
0.993	27
0.996	30

Thus, if the samples were counted three days post canning, a correction factor of 0.422 would be used to determine the estimated final Ra-226 concentration. Given this approach, any concentration determined three days post preparation would be divided by 0.422 to arrive at the final concentration. For a 5 pCi/g ALARA goal, any result above 2.1 pCi/g would be rejected.

The major limitation with this approach is the assumption that the drying and grinding processes remove 100% of the radon. Samples that have been analyzed within one day of preparation have never yielded results much below expected background concentrations (0.8-1.0 pCi/g).

Thus, the use of a correction factor on the order of 0.167 could result in a very conservative approach for estimating the final Ra-226 soil concentration in background soils (in fact all samples analyzed one day after canning would equal or exceed 5 pCi/g).

Alternative 3

All samples that are collected to support confirmation can be analyzed as wet samples to virtually eliminate the radon removal that occurs during sample preparation. However, there are numerous considerations, such as sample homogeneity, particle size, moisture content variability, etc., that can produce error in such analyses. If the samples are analyzed wet, they would also be prepared and analyzed to provide final concentrations for each radionuclide of interest for the sample. This dry evaluation would require an analysis within the confirmation cleanup turnaround period and a second analysis within 20-30 days later to finalize Ra-226 concentrations to an acceptable quality level. This approach would involve three analyses of every sample. The initial wet analysis can be used to estimate the final Ra-226 concentration. However, this estimate must be made on a case by case basis through moisture corrections, etc.

The major limitation for this approach is the reduction in lab productivity as an extra canning effort would be needed to generate a wet and a dry sample for each sample and count time for each sample would increase by a factor of three.

Alternative 4

Over the last several months, the onsite radiological laboratory has been recounting samples that were analyzed during the months of April - September 1995. These reanalyses were done in order to support final analyses of SE Drainage and Quarry characterization samples. The graph on the attached page illustrates a portion of the recount results versus the initial results. The graph includes those samples that had initial Ra-226 results < 5 pCi/g. As illustrated, the background - 2.2 pCi/g sample range had 100% of all sample recounts fall less than 5 pCi/g. For those in the range of 2.2 - 3.2 pCi/g, the likelihood of exceeding 5 pCi/g was approximately 50%. All of the samples with initial results greater than 3.2 pCi/g had final Ra-226 results > 5 pCi/g.

This information can be used to establish a criteria about which samples can be said to meet the ALARA goal of 5 pCi/g within the five working day turnaround window.

Given the current study findings, it is recommended that any sample with an initial Ra-226 result > 2.2 pCi/g be expected to exceed the ALARA goal of 5 pCi/g. In addition, the estimated final Ra-226 soil concentration should be found by multiplying the initial result by 2.27 (2.2 pCi/g x 2.27 = 5 pCi/g). This correction factor is very close to the maximum increase from initial results to recount results (e.g., 2.56) in the background to 2.2 pCi/g concentration range. The average increase from initial results to recount results for this range was 1.51. However, use of a value closer to the maximum value affords less risk in exceeding expected confirmation goals. The laboratory will work to refine these numbers to further minimize the risk as they continue to recount samples collected over the last few months. The major limitation with this alternative is the potential to over excavate, increasing disposal costs.

Alternative 5

This alternative involves a combination of alternatives 3 and 4. Samples that do not have elevated direct survey results via a 2x2 NaI or a 44-9 survey should be prepared and evaluated in accordance with alternative 4. Samples that do have above background survey results will be analyzed wet and evaluated accordingly to determine the estimated final Ra-226 concentration. The sample will then be prepared and analyzed a second time to provide quality level data for the other radionuclides of interest. In addition, each prepared sample would be analyzed within 30 days after preparation to finalize the Ra-226 concentration to an acceptable quality level.

The major limitation with this approach is the loss in productivity as a result of the double canning needs and increased count times for a portion of the samples.

Recommendation

The Onsite Radiological Laboratory recommends the use of alternative 4. This alternative minimizes risk of failing to meet expected cleanup ALARA goals and provides for maximum efficiency/productivity within the laboratory. The second favorable alternative is number 5. This alternative would increase the workload in the laboratory, but would further reduce the risk of over excavation and failure to meet desired cleanup objectives.

In all of the above alternatives, the estimated final Ra-226 concentration will be used in conjunction with the measured Ra-228 concentration as follows to determine if the mixture rule for the ALARA goals as described in the Record of Decision is achieved.

$$\frac{\text{Est. Final Ra-226 (pCi/g)}}{5\ \text{pCi/g}} + \frac{\text{Ra-228 (pCi/g)}}{5\ \text{pCi/g}} = \text{Mixture Ratio}$$

If mixture ratio <= 1, then the sample meets cleanup confirmation design. If mixture ratio > 1, then the sample must be considered by the ALARA committee.

MLF/RM/pr

Attachment

Distribution:

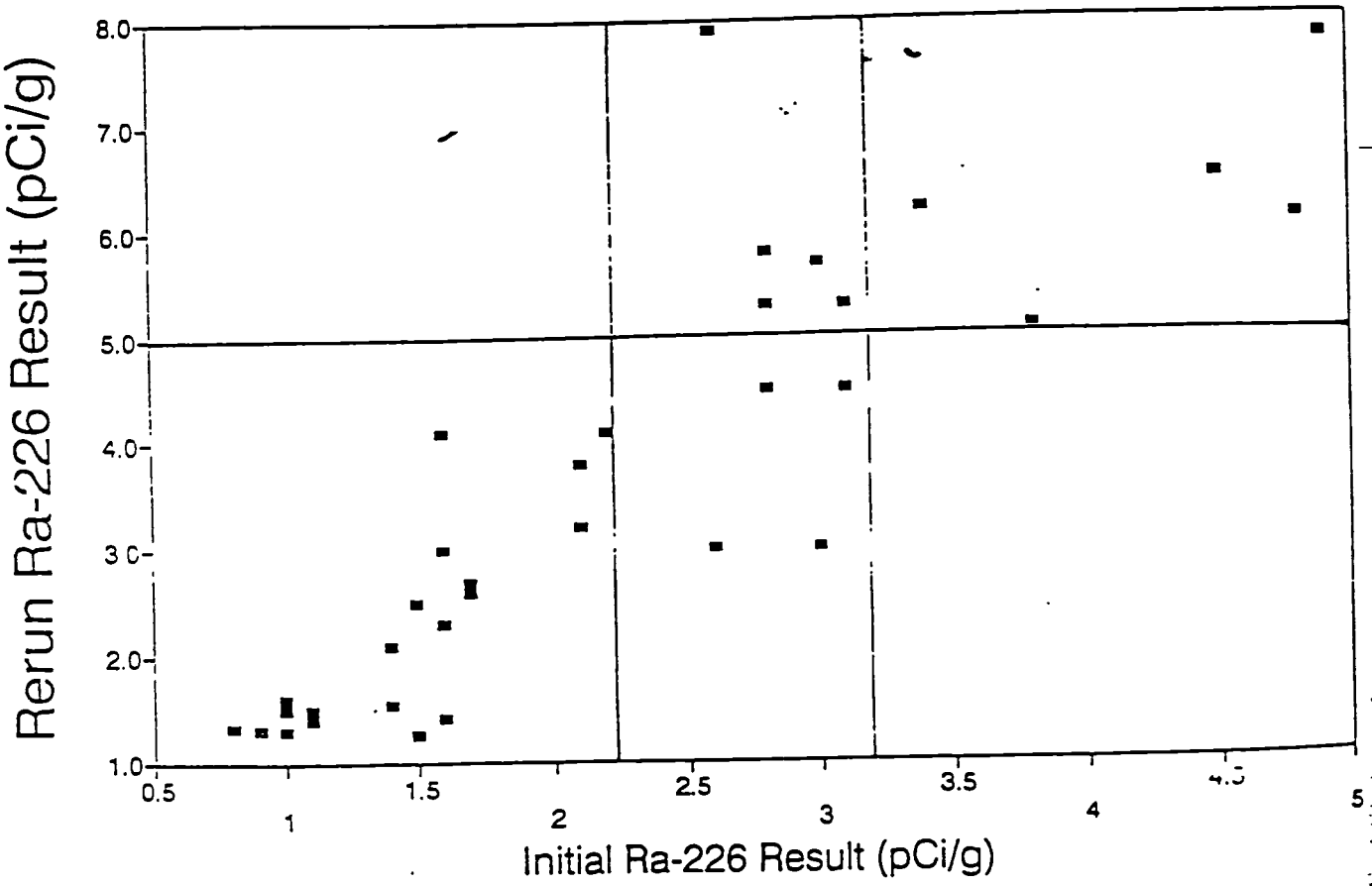
Ken Meyer
Steve Warren
Ken Greenwell
Jim Meier

Alternates:
Marj Wesley
Jack Cooney
Dan Hoffman

cc: Melissa Lutz

Ra226 Concentration Range

Background - 5.0 pCi/g



MORRISON KNUDSEN CORPORATION

MK-FERGUSON GROUP

INTER-OFFICE CORRESPONDENCE

DATE: November 20, 1995

TO: ALARA Committee

FROM: Richard Machado/Michelle French MF

SUBJECT: TH232 DETERMINATION FOR SITE CONFIRMATION SAMPLES

Th232 can occur in two forms at the site: (1) naturally and (2) processed to purify Th232. Both of these forms are subject to the same transformation equation. Given a Th232 half life of 1.39 x 10^{10} years and a Ra228 half life of 5.75 years, a condition known as secular equilibrium occurs. Secular equilibrium occurs when the half-life of the parent is very much greater than that of the daughter. If an initially pure parent (Th232) is formed, its radioactive transformation will result in accumulation of the daughter (Ra228). Since the daughter (Ra228) decays very much faster than the parent (Th232), a point is soon reached at which the amount of parent (Th232) present is equal to that of the daughter (Ra228).

The equation that represents this condition of secular equilibrium is:

$$Q_B = Q_A (1 - e^{-\lambda_B t})$$

where Q_A=parent (Th232) activity, Q_B=daughter (Ra228) activity, t=time since placement of material, and λ_B=decay constant for daughter (Ra228). Therefore, the fraction of daughter activity to parent activity

$$\left(\frac{A(RA\text{-}228)}{A(Th\text{-}232)}\right)$$

present at the WSSRAP in 1995 can be calculated.

Assume that production ceased at the site on January 1, 1965, and that all Th232 was produced on that very last day (t=30.9 years). Given a half life for Ra228 of 5.75 years, the decay constant would equal

$$(\lambda_B = 0.121\ Y^{-1})$$

11-30-95

Given this information, the ratio of Ra228 activity to Th232 activity can be calculated as follows:

$$\frac{Q_B}{Q_\lambda} = \frac{A\,(Ra\text{-}228)}{A\,(Th\text{-}232)} = 1 - e^{-\lambda_B t}$$

$$\frac{A\,(Ra228)}{A\,(Th232)} = 1 - e^{-(0.121Y^{-1})\,(30.9Y)} = 1 - 0.024 = 0.976$$

$$\therefore \frac{A\,(Ra\text{-}228)}{A\,(Th\text{-}232)} = 0.976 \quad or \quad A\,(Th\text{-}232) = 1.025\,A\,(Ra\text{-}228)$$

This representation will be true for both naturally occurring Th232 and processed Th232. The other situation to be addressed includes the circumstance when Ra228 and associated decay products were placed as a waste material after purification of Th232. In this situation, the amount of Ra228 present will be much greater than the Th232 present. This information is illustrated in a previous assessment of the ratio of Ra228 concentrations to that of Th232 in raffinate pit wastes. The average ratio was reported as 7.02 in the *Concentration Ratios of Radionuclides* in the U238, U235, and Th232 *Decay Series* (DOE/OR/21548-250), indicating that the average activity concentration for Th232 is 0.14 of the activity concentration for Ra228.

The Record of Decision states that if Th232 and Ra228 are present and not in secular equilibrium, the cleanup criteria apply for the radionuclide with the higher concentration. Thus, for determination of successful cleanup, the use of a Ra-228 ALARA goal of 4.88 pCi/g and a criteria of 6.05 pCi/g will result in removing Th232 to within 5 pCi/g (ALARA) and 6.2 pCi/g (criteria), respectively.

Given this practice, it is recommended that the on-site radiological analyses for Ra-228 concentrations in soil be used to determine attainment of Th-232 cleanup. It is also recommended that 2% of the samples (1 of every 50) that are independently analyzed via an off-site facility be used as a quality check for all radionuclides of interest (U238, Th230, Th232, Ra228, and Ra226). In addition, these numbers should be summarized in post remediation reports for each work package to support the decision to use Ra228 to determine successful cleanup of Th232.

RM/MF/jn

<u>Distribution</u>: ALARA Committee

Steve Warren	Alternates:	Marj Wesley
Ken Meyer		Jack Cooney
Ken Greenwell		Dan Hoffman
Jim Meier		Melissa Lutz

MORRISON KNUDSEN CORPORATION
MK-FERGUSON GROUP

INTER-OFFICE CORRESPONDENCE

DATE: April 27, 1999

TO: Dan Hoffman

FROM: Dave Cowell DC

SUBJECT: RA-226 RECOUNTS

In an effort to eliminate repetitive work, the on-site lab performed a study to determine if recounts 30 days after sealing sample cans was necessary for samples that have background or near background Ra-226 concentrations. As a result of the study, the lab will now only perform Ra-226 recounts for samples that fail the Radium ALARA preliminary calculation.

This calculation will involve multiplying the Ra-226 result by a correction factor of 2.27 (established in an IOC dated 11/17/95) and adding it to the Ra-228 result. If this result is greater than 5 pCi/g then that sample will be held and recounted 30 days later with the intention of reducing the final reported value.

This approach is conservative because the correction factor of 2.27 was established using samples with concentrations of up to 8 pCi/g. Samples having near background concentrations of Ra-226 do not ingrow to that level. Additionally, the correction factor was intended identify samples with Ra-226 levels that could exceed 5 pCi/g and did not account for the contribution from Ra-228, which we will include in this new calculation.

The attached page is included to illustrate the results of the study.

DC/jn

Attachment

Cc: Jim Meier
Steve Warren
Dave Hixson
John Coniglio
Melissa Lutz
Randy Thompson

Date: **August 22, 2000**

To: **Distribution**

From: **Linda Broody**

Subject: **NEW AND MODIFIED CONFIRMATION UNITS IN THE CMSA SHOP AREA**

The CMSA Shop Area lies within a portion of the site that was initially classified as not requiring confirmation. Due to the construction of a contaminated shop and associated facilities, the confirmation units (CUs) in the CMSA Work Zone have been modified accordingly.

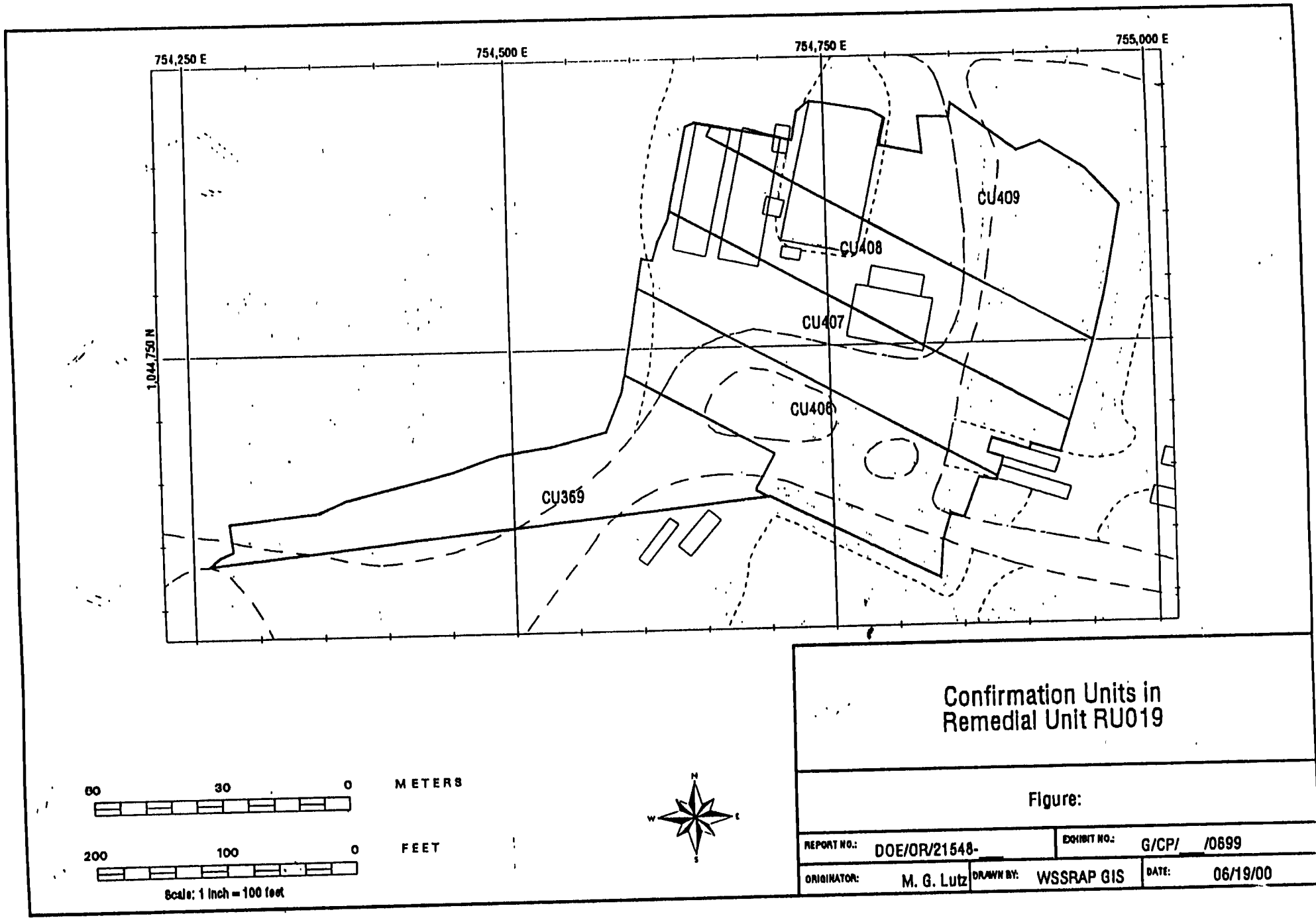
Four new CUs were created to include the shop, decon pad, sedimentation basin, and parking lot. An adjacent CU has been extended to include the road leading to the shop area.

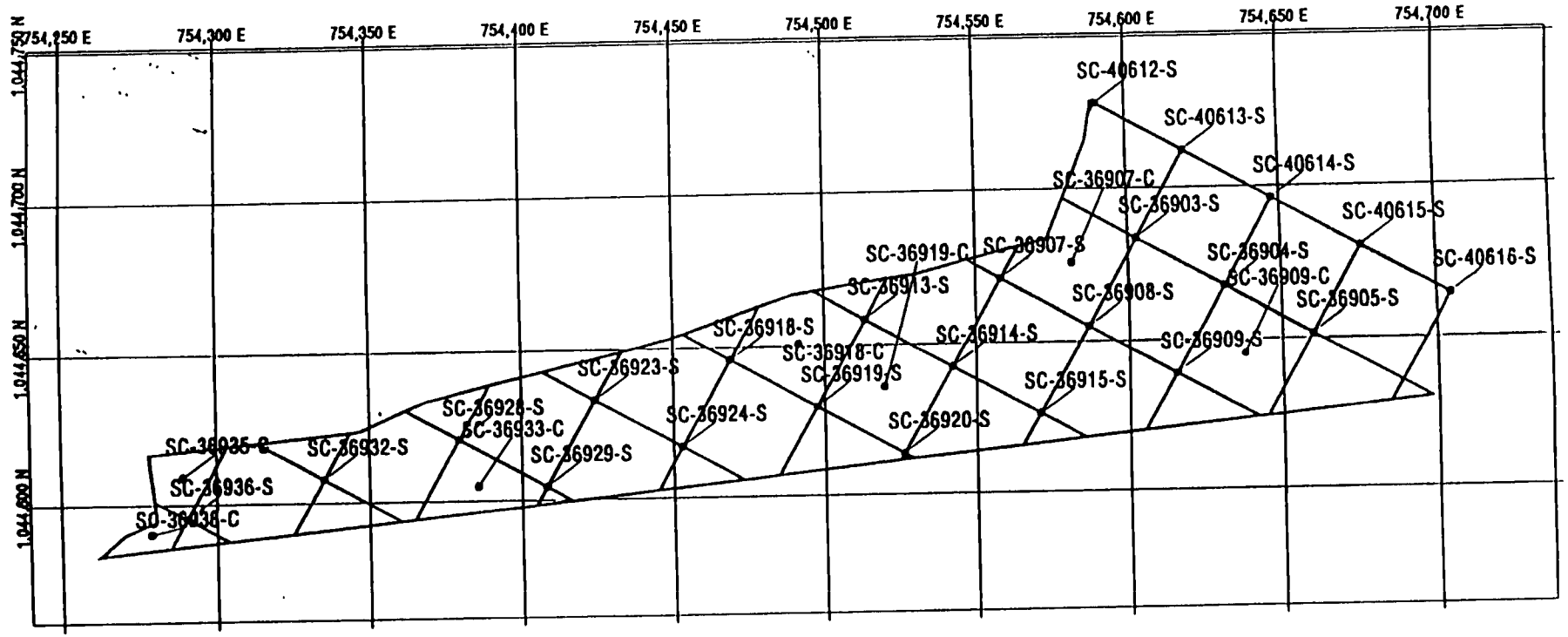
All samples will be analyzed for Radium-226, Radium-228, Thorium-230, Thorium-232, and Uranium 238 based upon field activities in the area.

Sample point ID's and locations for CU369, CU406, CU407, CU408, and CU409 are shown on the attached figures and tables. The figures and tables should be added to those in the *Confirmation Sampling Plan Details for the Disposal Cell Facility (WP-437)*, Rev. 0. The figure for CU369 supercedes the figure in the plan.

Attachments

Cc: Dan Boss
Terry Caldwell
Jason Fugate
Karl Hamilton
Melissa Lutz
Clark Oberlag
Steve Warren (w/out attachments)
Chris Weston
Confirmation File


754,250 E
754,500 E
754,750 E
755,000 E
1,044,750 N
CU409
CU408
CU407
CU406
CU369
60
30
0
METERS
200
100
0
FEET
Scale: 1 inch = 100 feet
N
W
E
S
Confirmation Units in
Remedial Unit RU019
Figure:
REPORT NO.: DOE/OR/21548-
EXHIBIT NO.: G/CP/ /0699
ORIGINATOR: M. G. Lutz
DRAWN BY: WSSRAP GIS
DATE: 06/19/00



20 10 0 METERS

50 25 0 FEET

Scale: 1 inch = 55 feet

N
W E
S

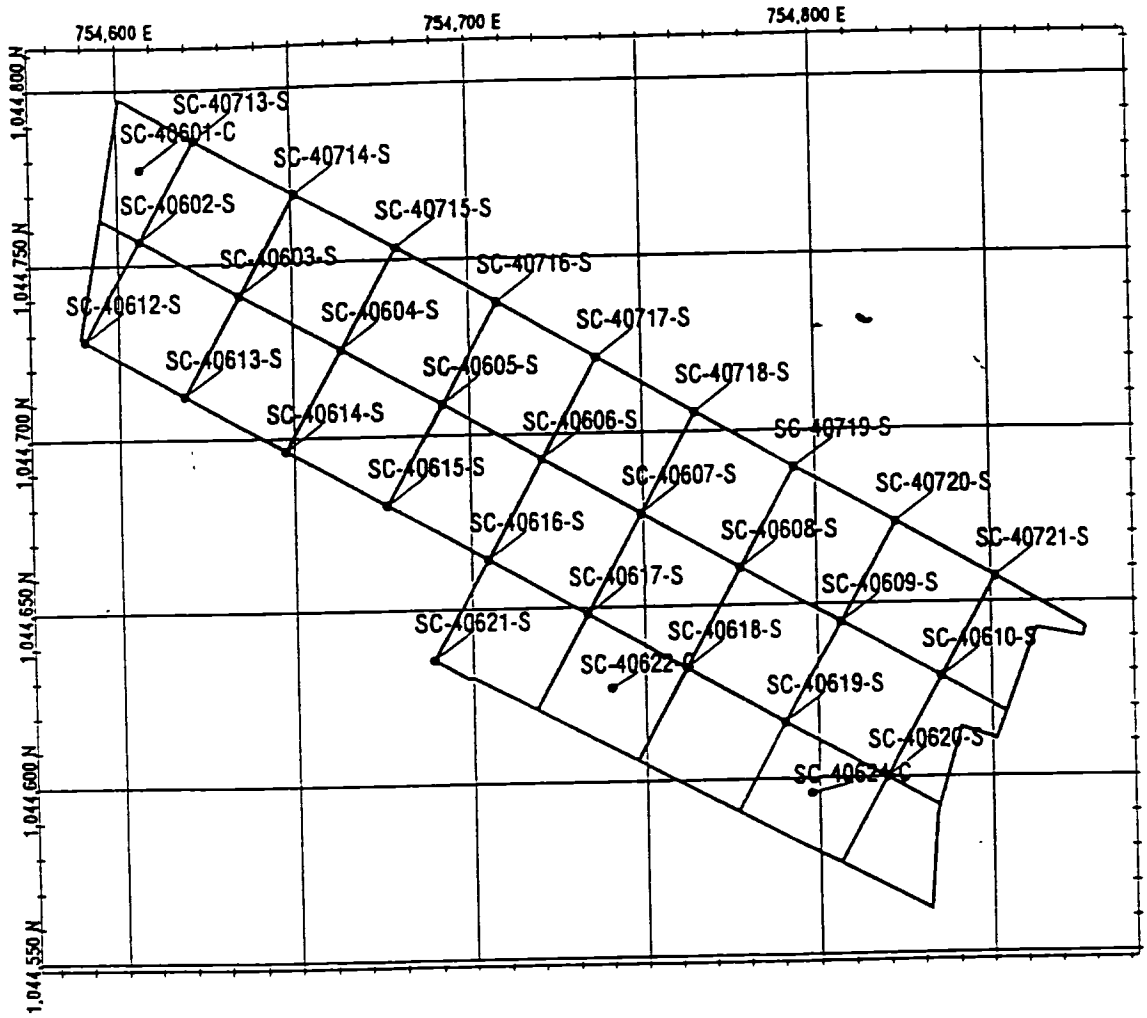
Sample Locations in Remedial Unit RU019 Confirmation Unit CU369

Figure:

REPORT NO: DOE/OR/21548-___		EXHIBIT NO. G/CP/___/0699	
ORIGINATOR. M. G. Lutz	DR/BVN BY: WSSRAP GIS	DATE. 06/16/00	

CU369

SC-36903-S	1044683.61779	754602.81700
SC-36904-S	1044667.59092	754631.44399
SC-36905-S	1044651.56406	754660.07097
SC-36907-C	1044675.86793	754581.43155
SC-36907-S	1044671.01767	754558.16314
SC-36908-S	1044654.99080	754586.79013
SC-36909-C	1044645.29987	754637.73419
SC-36909-S	1044638.96393	754615.41712
SC-36913-S	1044658.41754	754513.50929
SC-36914-S	1044642.39068	754542.13628
SC-36915-S	1044626.36381	754570.76327
SC-36918-C	1044650.80854	754491.55440
SC-36918-S	1044645.81742	754468.85544
SC-36919-C	1044636.09062	754519.80936
SC-36919-S	1044629.79056	754497.48242
SC-36920-S	1044613.76369	754526.10941
SC-36923-S	1044633.21730	754424.20158
SC-36924-S	1044617.19044	754452.82857
SC-36928-S	1044620.61718	754379.54773
SC-36929-S	1044604.59031	754408.17472
SC-36932-S	1044608.01706	754334.89387
SC-36933-C	1044605.09584	754385.73541
SC-36935-C	1044609.20787	754288.99752
SC-36936-S	1044595.41694	754290.24002
SC-36938-C	1044590.35541	754278.72892
SC-40612-S	1044728.27164	754590.21688
SC-40613-S	1044712.24478	754618.84386
SC-40614-S	1044696.21791	754647.47085
SC-40615-S	1044680.19104	754676.09784
SC-40616-S	1044664.16418	754704.72483



20 10 0 METERS

70 35 0 FEET

Scale: 1 inch = 55 feet

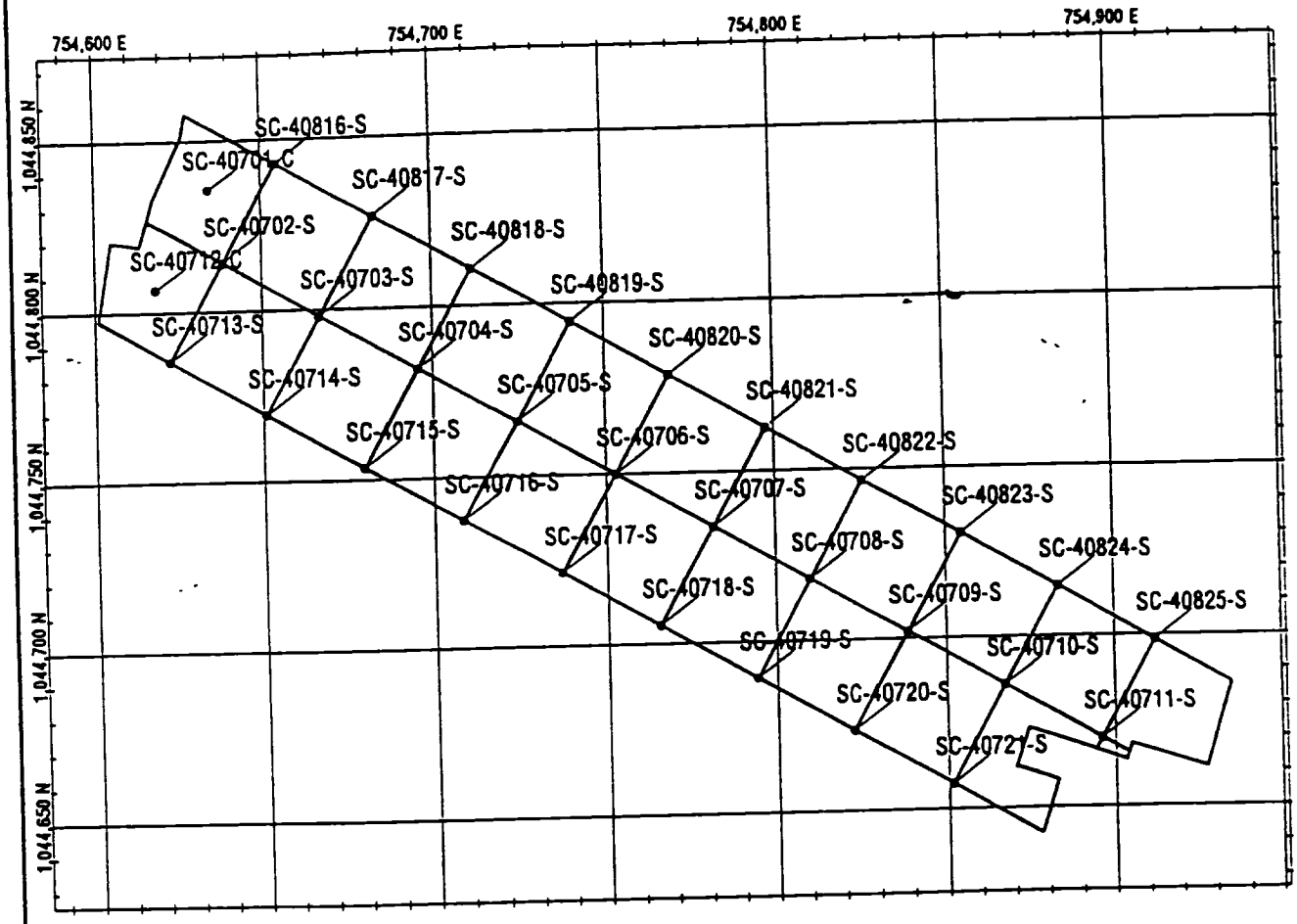
Sample Locations in Remedial Unit RU019
Confirmation Unit CU406

Figure:

REPORT NO.: DOE/OR/21548-___		EXHIBIT NO.: G/CP/___/0600	
ORIGINATOR: M.G. Lutz	DRAWN BY: WSSRAP GIS	DATE: 06/16/00	

CU406

SC-40601-C	1044777.40949	754606.61448
SC-40602-S	1044756.89863	754606.24374
SC-40603-S	1044740.87176	754634.87073
SC-40604-S	1044724.84490	754663.49772
SC-40605-S	1044708.81803	754692.12471
SC-40606-S	1044692.79116	754720.75169
SC-40607-S	1044676.76430	754749.37868
SC-40608-S	1044660.73743	754778.00567
SC-40609-S	1044644.71057	754806.63266
SC-40610-S	1044628.68370	754835.25964
SC-40612-S	1044728.27164	754590.21688
SC-40613-S	1044712.24478	754618.84386
SC-40614-S	1044696.21791	754647.47085
SC-40615-S	1044680.19104	754676.09784
SC-40616-S	1044664.16418	754704.72483
SC-40617-S	1044648.13731	754733.35181
SC-40618-S	1044632.11044	754761.97880
SC-40619-S	1044616.08358	754790.60579
SC-40620-S	1044600.05671	754819.23278
SC-40621-S	1044635.53719	754688.69796
SC-40622-C	1044626.83082	754740.10501
SC-40624-C	1044595.78730	754797.91492
SC-40713-S	1044785.52562	754622.27061
SC-40714-S	1044769.49875	754650.89760
SC-40715-S	1044753.47188	754679.52458
SC-40716-S	1044737.44502	754708.15157
SC-40717-S	1044721.41815	754736.77856
SC-40718-S	1044705.39129	754765.40555
SC-40719-S	1044689.36442	754794.03253
SC-40720-S	1044673.33755	754822.65952
SC-40721-S	1044657.31069	754851.28651



20 10 0 METERS

70 35 0 FEET

Scale: 1 inch = 55 feet

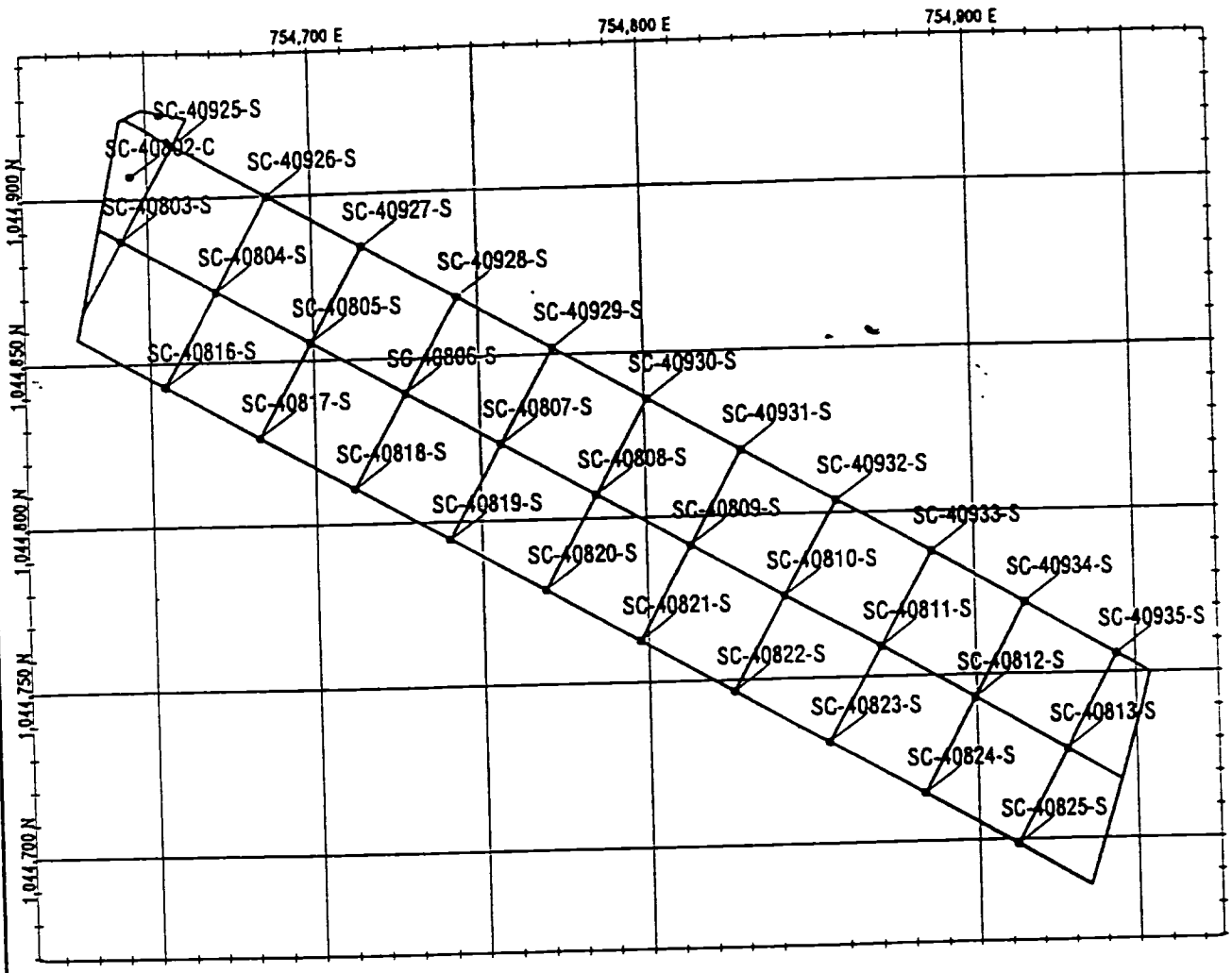
Sample Locations in Remedial Unit RU019
Confirmation Unit CU407

Figure:

REPORT NO.: DOE/OR/21548-___		EXHIBIT NO.: G/CP/___/0600	
ORIGINATOR: M.G. Lutz	DRAWN BY: WSSRAP GIS	DATE: 06/16/00	

CU407

SC-40701-C	1044835.58536	754634.25815
SC-40702-S	1044814.15260	754638.29747
SC-40703-S	1044798.12574	754666.92446
SC-40704-S	1044782.09887	754695.55145
SC-40705-S	1044766.07201	754724.17844
SC-40706-S	1044750.04514	754752.80543
SC-40707-S	1044734.01827	754781.43241
SC-40708-S	1044717.99141	754810.05940
SC-40709-S	1044701.96454	754838.68639
SC-40710-S	1044685.93768	754867.31338
SC-40711-S	1044669.91081	754895.94036
SC-40712-C	1044806.62585	754618.12867
SC-40713-S	1044785.52562	754622.27061
SC-40714-S	1044769.49875	754650.89760
SC-40715-S	1044753.47188	754679.52458
SC-40716-S	1044737.44502	754708.15157
SC-40717-S	1044721.41815	754736.77856
SC-40718-S	1044705.39129	754765.40555
SC-40719-S	1044689.36442	754794.03253
SC-40720-S	1044673.33755	754822.65952
SC-40721-S	1044657.31069	754851.28651
SC-40816-S	1044842.77959	754654.32434
SC-40817-S	1044826.75273	754682.95133
SC-40818-S	1044810.72586	754711.57832
SC-40819-S	1044794.69899	754740.20530
SC-40820-S	1044778.67213	754768.83229
SC-40821-S	1044762.64526	754797.45928
SC-40822-S	1044746.61840	754826.08627
SC-40823-S	1044730.59153	754854.71325
SC-40824-S	1044714.56466	754883.34024
SC-40825-S	1044698.53780	754911.96723



20 10 0 METERS

70 35 0 FEET

Scale: 1 inch = 55 feet

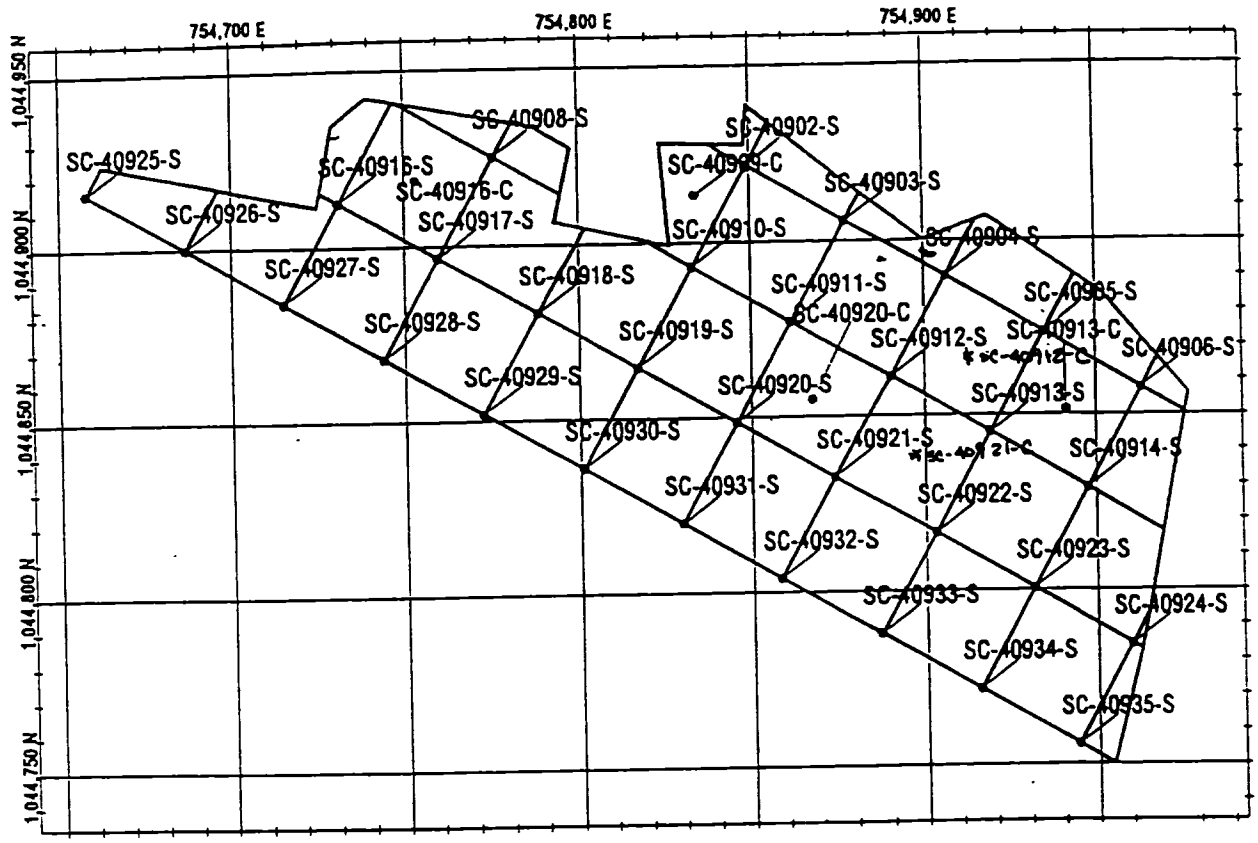
Sample Locations in Remedial Unit RU019
Confirmation Unit CU408

Figure:

REPORT NO.: DOE/OR/21548-___		EXHIBIT NO.: G/CP/___/0600	
ORIGINATOR: M.G. Lutz	DRAWN BY: WSSRAP GIS	DATE: 06/16/00	

CU408

SC-40802-C	1044906.92038	754644.85467
SC-40803-S	1044887.43345	754641.72422
SC-40804-S	1044871.40658	754670.35121
SC-40805-S	1044855.37971	754698.97819
SC-40806-S	1044839.35285	754727.60518
SC-40807-S	1044823.32598	754756.23217
SC-40808-S	1044807.29912	754784.85916
SC-40809-S	1044791.27225	754813.48615
SC-40810-S	1044775.24538	754842.11313
SC-40811-S	1044759.21852	754870.74012
SC-40812-S	1044743.19165	754899.36711
SC-40813-S	1044727.16478	754927.99410
SC-40816-S	1044842.77959	754654.32434
SC-40817-S	1044826.75273	754682.95133
SC-40818-S	1044810.72586	754711.57832
SC-40819-S	1044794.69899	754740.20530
SC-40820-S	1044778.67213	754768.83229
SC-40821-S	1044762.64526	754797.45928
SC-40822-S	1044746.61840	754826.08627
SC-40823-S	1044730.59153	754854.71325
SC-40824-S	1044714.56466	754883.34024
SC-40825-S	1044698.53780	754911.96723
SC-40925-S	1044916.06043	754657.75109
SC-40926-S	1044900.03357	754686.37807
SC-40927-S	1044884.00670	754715.00506
SC-40928-S	1044867.97984	754743.63205
SC-40929-S	1044851.95297	754772.25904
SC-40930-S	1044835.92610	754800.88602
SC-40931-S	1044819.89924	754829.51301
SC-40932-S	1044803.87237	754858.14000
SC-40933-S	1044787.84550	754886.76699
SC-40934-S	1044771.81864	754915.39397
SC-40935-S	1044755.79177	754944.02096



20 10 0 METERS

70 35 0 FEET

Scale: 1 inch = 55 feet

Sample Locations in Remedial Unit RU019
Confirmation Unit CU409

Figure:

REPORT NO.: DOE/OR/21548-___		EXHIBIT NO.: G/CP/___/0600	
ORIGINATOR: M.G. Lutz	DRAWN BY: WSSRAP GIS	DATE: 06/16/00	

CU409

SC-40902-S	1044921.80707	754848.96662
SC-40903-S	1044905.78020	754877.59361
SC-40904-S	1044889.75333	754906.22060
SC-40905-S	1044873.72647	754934.84759
SC-40906-S	1044857.69960	754963.47457
SC-40908-S	1044925.23381	754775.68578
SC-40909-C	1044913.61199	754833.90977
SC-40910-S	1044893.18008	754832.93976
SC-40911-S	1044877.15321	754861.56674
SC-40912-C	1044867.43000	754912.52000
SC-40912-S	1044861.12635	754890.19373
SC-40913-C	1044851.39954	754941.14764
SC-40913-S	1044845.09948	754918.82072
SC-40914-S	1044829.07261	754947.44771
SC-40916-C	1044918.93127	754753.35954
SC-40916-S	1044912.63369	754731.03193
SC-40917-S	1044896.60682	754759.65891
SC-40918-S	1044880.57996	754788.28590
SC-40919-S	1044864.55309	754816.91289
SC-40920-C	1044854.82629	754867.86681
SC-40920-S	1044848.52622	754845.53988
SC-40921-C	1044838.80000	754896.49000
SC-40921-S	1044832.49936	754874.16687
SC-40922-S	1044816.47249	754902.79385
SC-40923-S	1044800.44563	754931.42084
SC-40924-S	1044784.41876	754960.04783
SC-40925-S	1044916.06043	754657.75109
SC-40926-S	1044900.03357	754686.37807
SC-40927-S	1044884.00670	754715.00506
SC-40928-S	1044867.97984	754743.63205
SC-40929-S	1044851.95297	754772.25904
SC-40930-S	1044835.92610	754800.88602
SC-40931-S	1044819.89924	754829.51301
SC-40932-S	1044803.87237	754858.14000
SC-40933-S	1044787.84550	754886.76699
SC-40934-S	1044771.81864	754915.39397
SC-40935-S	1044755.79177	754944.02096