FEDERAL FACILITY AGREEMENT AND CONSENT ORDER (FFACO) RECORD OF TECHNICAL CHANGE (ROTC)

Corrective Action Unit (CAU) Number: 374
CAU Description: Area 20 Schooner Unit Crater
CAU Owner: Soils - Environmental Restoration (ER)

ROTC No. DOE/NV--1456-ROTC 3 **Page** 1 of 20

Document Type Corrective Action Decision Document/Closure Report (CADD/CR) **Date** 05/01/2025

The following technical changes (including justification) are requested by:

Jaclyn Petrello — Requestor Name

Long-Term Monitoring Activity Lead — Requestor Title

Description of Change:	Justification:
1. This ROTC replaces the Use Restriction (UR) information listed in the documentation for CAU 374. UR forms have been updated to list all UR requirements, including but not limited to: post-closure site controls (signs, fencing, etc.), inspection and maintenance requirements, and Geographic Information Systems (GIS) coordinate information. The UR requirements and form(s) included in this ROTC represent the current corrective action requirements for each Corrective Action Site (CAS) in this CAU and supersede information concerning corrective action and post-closure requirements in existing documentation.	1. Some changes in the UR requirements from those found in closure documents have been subsequently modified in letters, memos, and inspection reports. This has resulted in difficulty in determining current post-closure requirements. A review of the post-closure requirements for this CAU has been conducted to ensure that all requirements have been identified and documented on the new UR form. The new UR form was developed to e inclusive of all requirements for long-term monitoring and standardize information contained in the URs consistent with current protocols.
2. For CAS 20-45-03, the UR boundary coordinate values changed due to conversion from North American Datum (NAD) 1927 to NAD 1983.	2. UR boundary coordinates need to be in one standardized coordinate system.
3. The interior Administrative UR boundary for CAS 20-45-03 was removed from the Administrative UR.	3. The purpose of the interior Administrative UR boundary for this CAS was to exclude the area restricted by the FFACO UR. The

UNCONTROLLED

FEDERAL FACILITY AGREEMENT AND CONSENT ORDER (FFACO)
RECORD OF TECHNICAL CHANGE (ROTC)

Corrective Action Unit (CAU) Number: 374
CAU Description: Area 20 Schooner Unit Crater
CAU Owner: Soils - Environmental Restoration (ER)

ROTC No.	DOE/NV--1456-ROTC 3	**Page**	2 of 20
Document Type	Corrective Action Decision Document/Closure Report (CADD/CR)	**Date**	05/01/2025

Description of Change:	**Justification:**
	Administrative UR boundary change simplifies this boundary to also include the FFACO UR area.

Schedule Impacts:

No impacts to schedule.

ROTC applies to the following document(s):

- ROTC 2 for CAU 374 CADD/CR (DOE/NV--1456), dated 01/09/2017.
- ROTC-1 for CAU 374 CADD/CR (DOE/NV--1456), dated 10/26/2011.
- U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2011. Corrective Action Decision Document/Closure Report for Corrective Action Unit 374: Area 20 Schooner Unit Crater, Nevada National Security Site, Nevada, Rev. 0, DOE/NV--1456. Las Vegas, NV.

UNCONTROLLED

FEDERAL FACILITY AGREEMENT AND CONSENT ORDER (FFACO)
RECORD OF TECHNICAL CHANGE (ROTC)

Corrective Action Unit (CAU) Number: 374
CAU Description: Area 20 Schooner Unit Crater
CAU Owner: Soils - Environmental Restoration (ER)

ROTC No. DOE/NV--1456-ROTC 3 **Page** 3 of 20

Document Type Corrective Action Decision Document/Closure Report (CADD/CR) **Date** 05/01/2025

Approvals:

JACLYN PETRELLO Digitally signed by JACLYN PETRELLO Date: 2025.05.05 10:57:11 -07'00' Date ____________

Jaclyn Petrello
Activity Lead
Environmental Management (EM) Nevada Program

TIFFANY GAMERO Digitally signed by TIFFANY GAMERO Date: 2025.05.02 07:23:13 -07'00' Date ____________

Tiffany Gamero
FFACO Agreement Coordinator
Environmental Management (EM) Nevada Program

Christine Andres Digitally signed by Christine Andres Date: 2025.05.07 08:48:06 -07'00' Date ____________

Christine Andres
Chief, Bureau of Federal Facilities
Nevada Division of Environmental Protection (NDEP)

U.S. Department of Energy, Environmental Management Nevada Program
Use Restriction Information

General Information

Use Restriction (UR) Type(s): Both FFACO and Administrative

Corrective Action Unit (CAU) Number & Description: 374 - Area 20 Schooner Unit Crater

Corrective Action Site (CAS) Number & Description: 18-23-01 - Danny Boy Contamination Area

CAU/CAS Owner: Soils - ER

Note: N/A

Section I. *Federal Facility Agreement and Consent Order* (FFACO) UR

Basis for FFACO UR

Summary Statement: This FFACO UR is established to protect workers from inadvertent exposure to Radiological contaminants that were released at this site. Radiological contaminants are present that exceed final action levels.

FFACO UR Physical Description

Surveyed Area (UTM, Zone 11, NAD 83, meters):

UR Boundary	UR Point[1]	Easting[2]	Northing[2]
FFACO Boundary	Point 1	556,375	4,107,143
	Point 2	556,242	4,107,236
	Point 3	556,223	4,107,379
	Point 4	556,293	4,107,628
	Point 5	556,467	4,107,614
	Point 6	556,442	4,107,485
	Point 7	556,468	4,107,479
	Point 8	556,506	4,107,409
	Point 9	556,481	4,107,205
	Point 10	556,375	4,107,143

[1]UR Points are listed clockwise beginning at the southernmost point. If multiple points share the southernmost Northing coordinate, the easternmost point is listed as Point 1.

UR is effective upon acceptance by NDEP.

U.S. Department of Energy, Environmental Management Nevada Program Use Restriction Information

[2]UR coordinate values presented herein were transformed from the North American Datum of 1927, and rounded to the nearest meter; resultant coordinates may not reflect the original precision of values contained within the source GIS data set.

Boundary Applies to: Both Surface and Subsurface

Depth is unknown.

Survey Source: GIS

FFACO UR Requirements

Site Controls:

This FFACO UR is recorded as described in Section IV. Recordation Requirements to restrict activities within the area by the coordinates listed above and depicted in the attached figure without prior notification of NDEP unless the activities are conducted under the provisions of 10 CFR, Part 835, Occupational Radiation Protection and 10 CFR, Part 851, Worker Safety and Health Program.

Control	Criteria
Gate	Gate is locked.
Lock	Present and functioning.
Signage	Present and legible.

Inspection Frequency: Annual

Additional Considerations:

Consideration	Criteria
None	None

Requirements Comments: A warning sign will be placed at the location of Gate 18-4C on the access road that is the only road leading to the use-restricted area.

U.S. Department of Energy, Environmental Management Nevada Program
Use Restriction Information

Section II. Administrative UR

Basis for Administrative UR

Summary Statement: This Administrative UR is established to protect workers should future land use result in increased exposure to site contaminants. Radiological contaminants are present that exceed action levels under the Industrial Area (2,000 hours per year) exposure scenario.

Administrative UR Physical Description

Surveyed Area (UTM, Zone 11, NAD 83, meters):

UR Boundary	UR Point[1]	Easting[2]	Northing[2]
Admin Boundary 1	Point 1	556,234	4,107,300
	Point 2	556,143	4,107,388
	Point 3	556,166	4,107,438
	Point 4	556,246	4,107,458
	Point 5	556,223	4,107,379
	Point 6	556,234	4,107,300
Admin Boundary 2	Point 1	556,504	4,107,396
	Point 2	556,506	4,107,409
	Point 3	556,477	4,107,462
	Point 4	556,489	4,107,464
	Point 5	556,510	4,107,457
	Point 6	556,525	4,107,408
	Point 7	556,504	4,107,396

[1]UR Points are listed clockwise beginning at the southernmost point. If multiple points share the southernmost Northing coordinate, the easternmost point is listed as Point 1.

[2]UR coordinate values presented herein were transformed from the North American Datum of 1927, and rounded to the nearest meter; resultant coordinates may not reflect the original precision of values contained within the source GIS data set.

Boundary Applies to: Both Surface and Subsurface

Starting Depth: 0.00 **Ending Depth:** 5.00

Depth Unit: Centimeters

Survey Source: GIS

U.S. Department of Energy, Environmental Management Nevada Program Use Restriction Information

Administrative UR Requirements

Administrative URs do not require onsite postings or other physical barriers, and they do not require periodic inspections or maintenance.

Site Controls:

This Administrative UR is recorded as described in Section IV. Recordation Requirements to restrict activities within the area defined by the coordinates listed above and depicted in the attached figure without prior notification of NDEP unless the activities are conducted under the provisions of 10 CFR, Part 835, Occupational Radiation Protection and 10 CFR, Part 851, Worker Safety and Health Program.

Section III. Supporting Documentation

UR Source Document(s)

ROTC 3 for CAU 374 CADD/CR (DOE/NV--1456), dated **05/01/2025**.

ROTC 2 for CAU 374 CADD/CR (DOE/NV--1456), dated 01/09/2017.

ROTC-1 for CAU 374 CADD/CR (DOE/NV--1456), dated 10/26/2011.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2011. Corrective Action Decision Document/Closure Report for Corrective Action Unit 374: Area 20 Schooner Unit Crater, Nevada National Security Site, Nevada, Rev. 0, DOE/NV--1456. Las Vegas, NV.

Attachments

UR Boundary Maps (UTM, Zone 11, NAD 83 meters)

Supplemental Information Figure (UTM, Zone 11, NAD 83 meters)

Section IV. Recordation Requirements

Recordation

The above UR(s) are recorded in the:

EM Nevada Program CAU/CAS Files

FFACO Database

NNSA M&O Contractor GIS

U.S. Department of Energy, Environmental Management Nevada Program Use Restriction Information

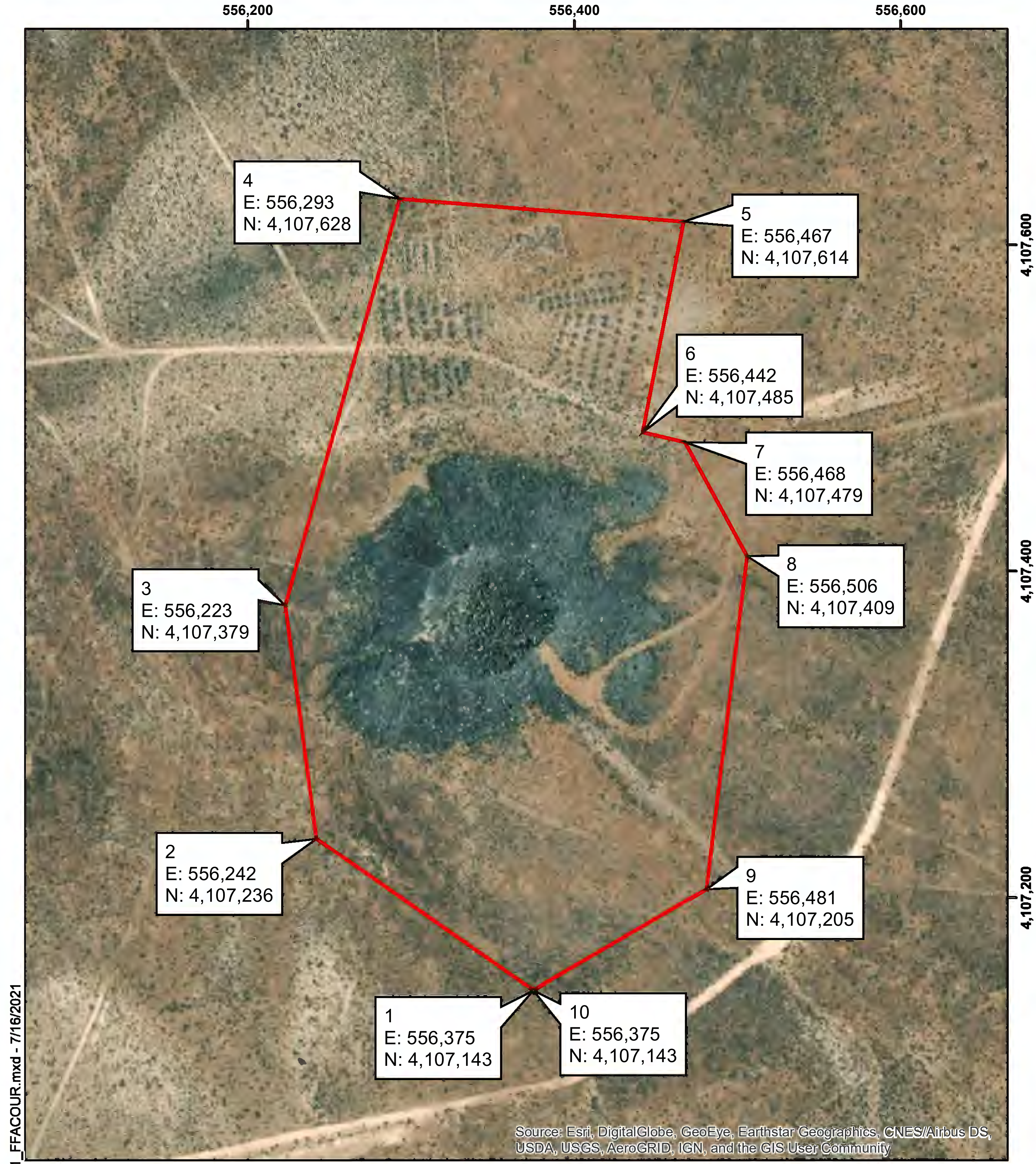
Section V. EM Nevada Program Approval

JACLYN PETRELLO Digitally signed by JACLYN PETRELLO Date: 2025.05.05 10:57:41 -07'00' Date: ____________

Jaclyn Petrello

Activity Lead

EM Nevada Program



CAU 374, CAS 18-23-01
Danny Boy Contamination Area
FFACO UR Boundary

Explanation

FFACO UR

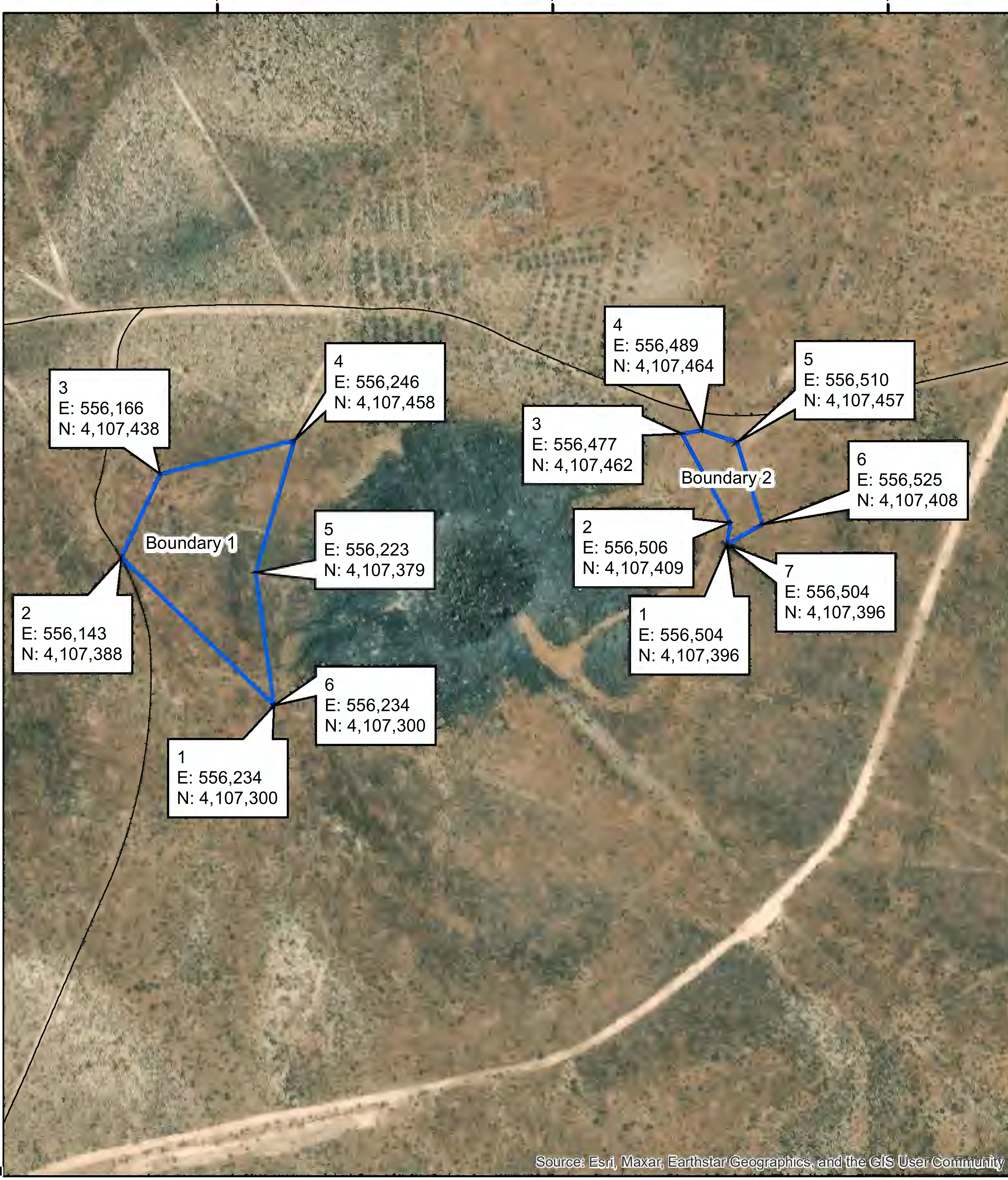
0 25 50 100 Meters

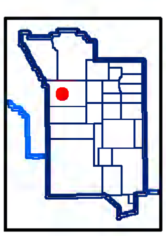
0 75 150 300 Feet

N

Source: Navarro GIS, 2021

Coordinate System: NAD 1983 UTM Zone 11N, Meter





CAU 374, CAS 18-23-01
Danny Boy Contamination Area
Administrative UR Boundaries

Explanation

Administrative UR

Unimproved Road

0 25 50 100 *Meters*

0 100 200 400 *Feet*

N

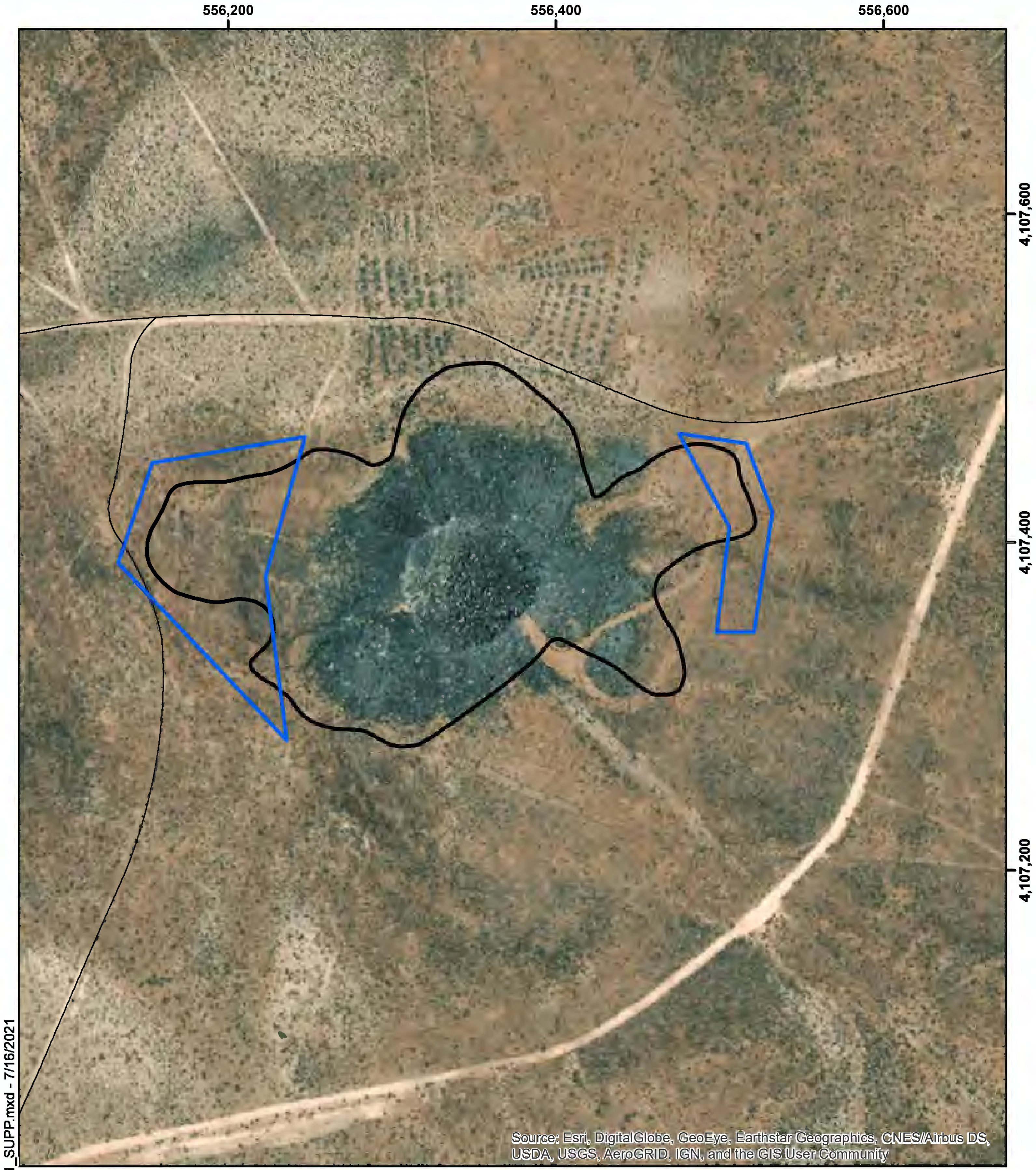
Source: Navarro GIS, 2025

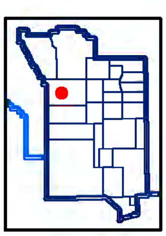
Coordinate System: NAD 1983 UTM Zone 11N, Meter

H:\374\GPS\CAS18-23-01_AdminUR.mxd - 4/3/2025

Supplemental Information Figure

The attached supplemental information figure(s) are included to capture site feature information that was available in previous iterations of this Use Restriction (UR) to prevent loss of that information.





CAU 374, CAS 18-23-01
Danny Boy Contamination Area
Supplemental Information
General Location of Site Features

Explanation

- Industrial Area Scenario Isopleth
- Administrative UR
- Unimproved Road

0 25 50 100 Meters

0 100 200 400 Feet

N

Source: Navarro GIS, 2021

Coordinate System: NAD 1927 UTM Zone 11N, Meter

U.S. Department of Energy, Environmental Management Nevada Program Use Restriction Information

General Information

Use Restriction (UR) Type(s):	Both FFACO and Administrative
Corrective Action Unit (CAU) Number & Description:	374 - Area 20 Schooner Unit Crater
Corrective Action Site (CAS) Number & Description:	20-45-03 - U-20u Crater (Schooner)
CAU/CAS Owner:	Soils - ER
Note:	N/A

Section I. *Federal Facility Agreement and Consent Order* (FFACO) UR

Basis for FFACO UR

Summary Statement: This FFACO UR is established to protect workers from inadvertent exposure to Radiological contaminants that were released at this site. Radiological contaminants are present that exceed final action levels.

FFACO UR Physical Description

Surveyed Area (UTM, Zone 11, NAD 83, meters):

UR Boundary	UR Point[1]	Easting[2]	Northing[2]
FFACO Boundary	Point 1	538,585	4,132,595
	Point 2	538,241	4,132,624
	Point 3	537,906	4,132,775
	Point 4	537,895	4,133,207
	Point 5	538,097	4,133,611
	Point 6	538,618	4,133,871
	Point 7	539,062	4,133,423
	Point 8	539,058	4,132,843
	Point 9	538,585	4,132,595

[1]UR Points are listed clockwise beginning at the southernmost point. If multiple points share the southernmost Northing coordinate, the easternmost point is listed as Point 1.

[2]UR coordinate values presented herein were transformed from the North American Datum of 1927, and rounded to the nearest meter; resultant coordinates may not reflect the original precision of values contained within the source GIS data set.

U.S. Department of Energy, Environmental Management Nevada Program
Use Restriction Information

Boundary Applies to: Both Surface and Subsurface

Depth is unknown.

Survey Source: GIS

FFACO UR Requirements

Site Controls:

This FFACO UR is recorded as described in Section IV. Recordation Requirements to restrict activities within the area by the coordinates listed above and depicted in the attached figure without prior notification of NDEP unless the activities are conducted under the provisions of 10 CFR, Part 835, Occupational Radiation Protection and 10 CFR, Part 851, Worker Safety and Health Program.

Control	Criteria
Signage	Present and legible.

Inspection Frequency: Annual

Additional Considerations:

Consideration	Criteria
None	None

Requirements Comments: Site controls include warning signs placed on the access road outward from the use-restricted area.

Section II. Administrative UR

Basis for Administrative UR

Summary Statement:

This Administrative UR is established to protect workers should future land use result in increased exposure to site contaminants. Radiological contaminants are present that exceed action levels under the Industrial Area (2,000 hours per year) exposure scenario.

U.S. Department of Energy, Environmental Management Nevada Program Use Restriction Information

Administrative UR Physical Description

Surveyed Area (UTM, Zone 11, NAD 83, meters):

UR Boundary	UR Point[1]	Easting[2]	Northing[2]
Admin Boundary	Point 1	538,148	4,132,219
	Point 2	537,829	4,132,479
	Point 3	537,607	4,133,049
	Point 4	538,531	4,134,331
	Point 5	538,641	4,135,046
	Point 6	538,792	4,135,046
	Point 7	538,779	4,133,822
	Point 8	539,162	4,133,359
	Point 9	539,085	4,132,431
	Point 10	538,898	4,132,231
	Point 11	538,148	4,132,219

[1]UR Points are listed clockwise beginning at the southernmost point. If multiple points share the southernmost Northing coordinate, the easternmost point is listed as Point 1.

[2]UR coordinate values presented herein were transformed from the North American Datum of 1927, and rounded to the nearest meter; resultant coordinates may not reflect the original precision of values contained within the source GIS data set.

Boundary Applies to: Both Surface and Subsurface

Depth is unknown.

Survey Source: GIS

Administrative UR Requirements

Administrative URs do not require onsite postings or other physical barriers, and they do not require periodic inspections or maintenance.

Site Controls:

This Administrative UR is recorded as described in Section IV. Recordation Requirements to restrict activities within the area defined by the coordinates listed above and depicted in the attached figure without prior notification of NDEP unless the activities are conducted under the provisions of 10 CFR, Part 835, Occupational Radiation Protection and 10 CFR, Part 851, Worker Safety and Health Program.

U.S. Department of Energy, Environmental Management Nevada Program
Use Restriction Information

Section III. Supporting Documentation

UR Source Document(s)

ROTC 3 for CAU 374 CADD/CR (DOE/NV--1456), dated **05/01/2025.**

ROTC 2 for CAU 374 CADD/CR (DOE/NV--1456), dated 01/09/2017.

ROTC-1 for CAU 374 CADD/CR (DOE/NV--1456), dated 10/26/2011.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2011. Corrective Action Decision Document/Closure Report for Corrective Action Unit 374: Area 20 Schooner Unit Crater, Nevada National Security Site, Nevada, Rev. 0, DOE/NV--1456. Las Vegas, NV.

Attachments

UR Boundary Maps (UTM, Zone 11, NAD 83 meters)

Supplemental Information Figure (UTM, Zone 11, NAD 83 meters)

Section IV. Recordation Requirements

Recordation

The above UR(s) are recorded in the:

EM Nevada Program CAU/CAS Files

FFACO Database

NNSA M&O Contractor GIS

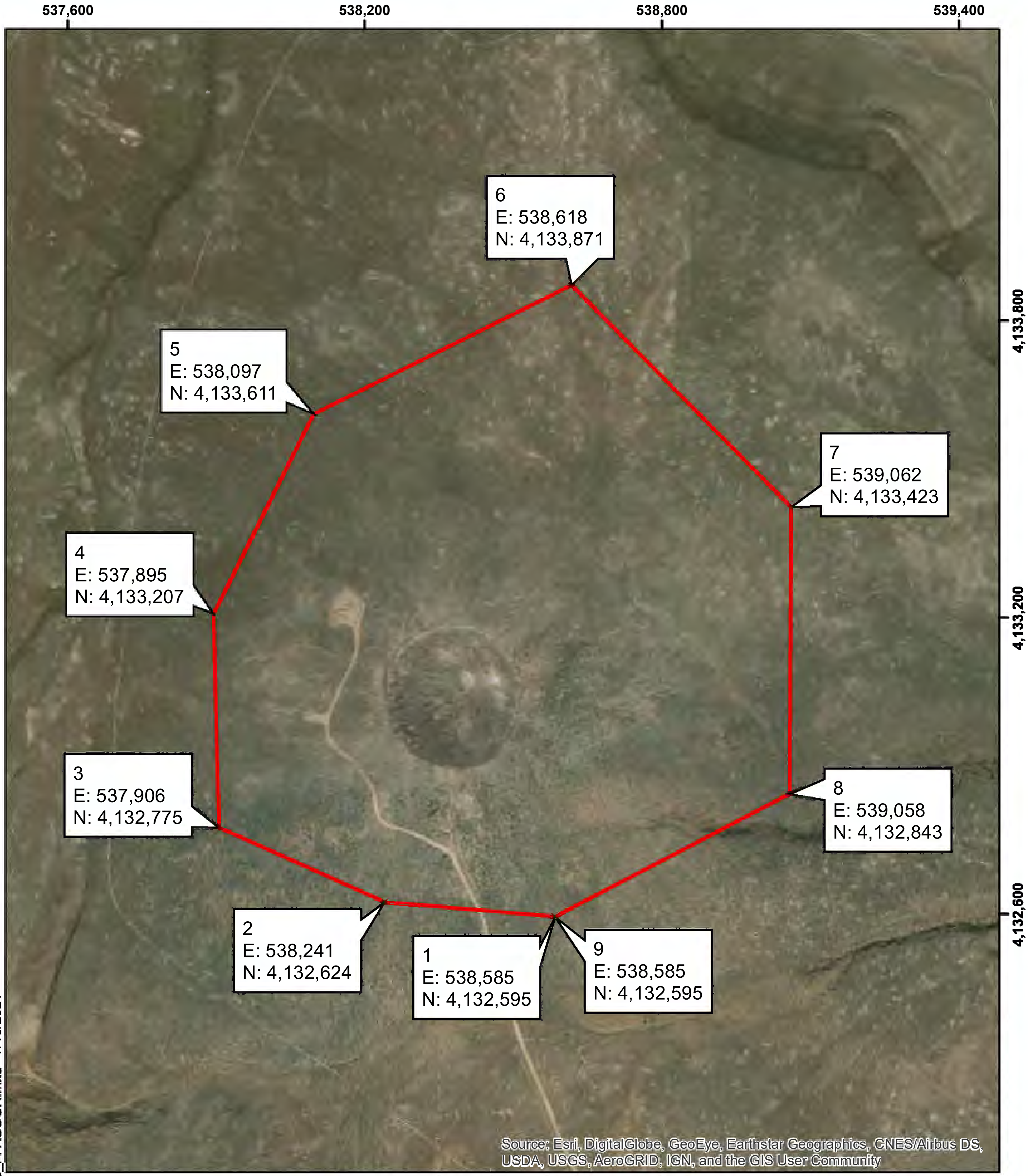
Section V. EM Nevada Program Approval

JACLYN PETRELLO Digitally signed by JACLYN PETRELLO Date: 2025.05.05 10:58:23 -07'00' **Date:** ____________

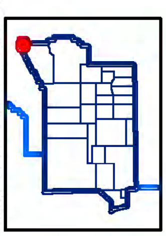
Jaclyn Petrello

Activity Lead

EM Nevada Program



H:\374\GPS\CAS20-45-03_FFACOUR.mxd - 7/16/2021



CAU 374, CAS 20-45-03
U-20u Crater (Schooner)
FFACO UR Boundary

Explanation

FFACO UR

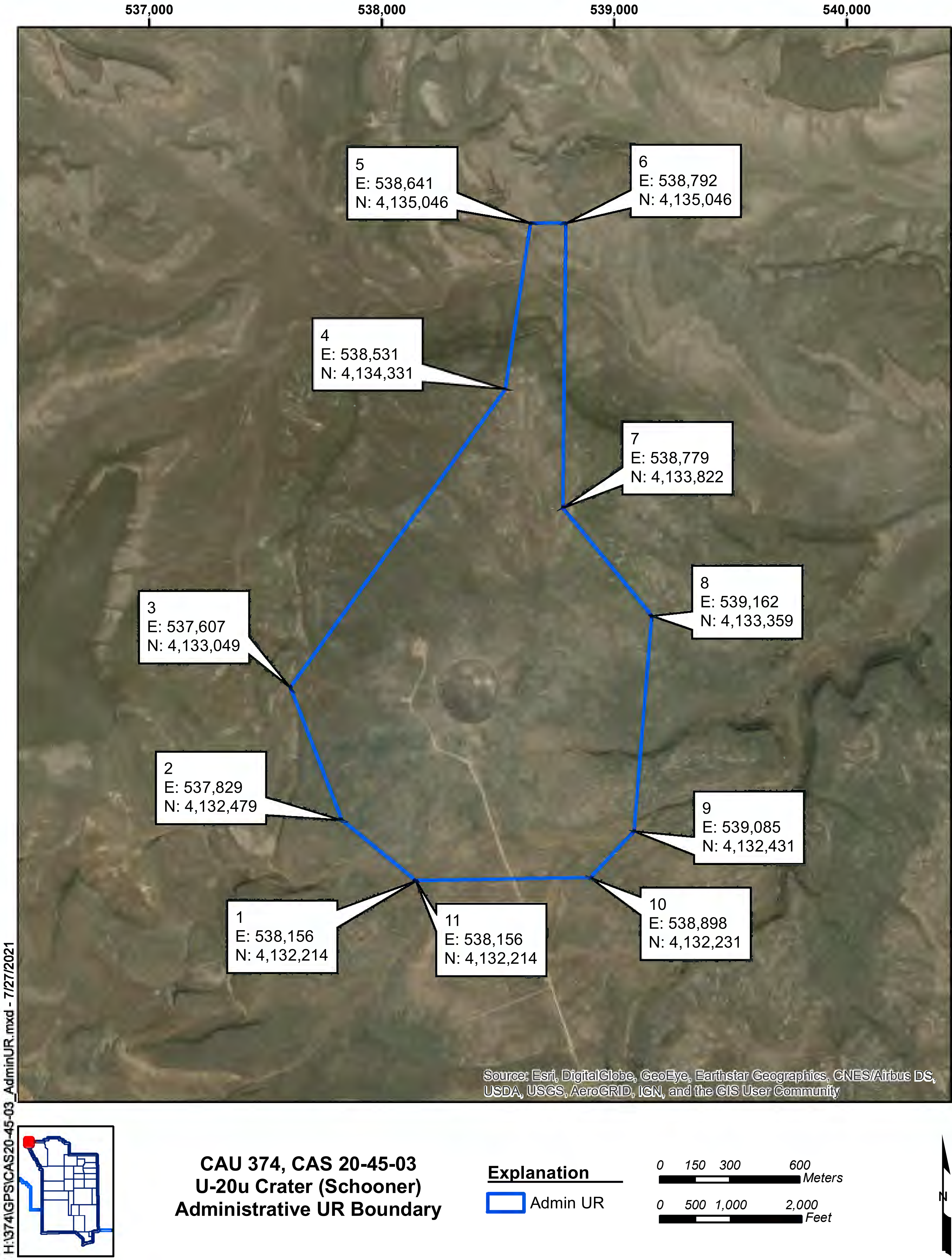
0 100 200 400 Meters

0 300 600 1,200 Feet

N

Source: Navarro GIS, 2021

Coordinate System: NAD 1983 UTM Zone 11N, Meter



H:\374\GPS\CAS20-45-03_AdminUR.mxd - 7/27/2021

CAU 374, CAS 20-45-03
U-20u Crater (Schooner)
Administrative UR Boundary

Source: Navarro GIS, 2021

Coordinate System: NAD 1983 UTM Zone 11N, Meter

Supplemental Information Figure

The attached supplemental information figure(s) are included to capture site feature information that was available in previous iterations of this Use Restriction (UR) to prevent loss of that information.

CAU 374, CAS 20-45-03
U-20u Crater (Schooner)
Supplemental Information
General Location of Site Features

Explanation

- Industrial Area Scenario Isopleth
- Admin UR
- Vehicular Trail

0 150 300 600 Meters

0 500 1,000 2,000 Feet

N

Source: Navarro GIS, 2021

Coordinate System: NAD 1983 UTM Zone 11N, Meter

`RECORD OF TECHNICAL CHANGE

Technical Change No. DOE/NV--1456 ROTC 2 Page 1 of 7

Activity Name Corrective Action Unit (CAU) CAU 374: Area 20 Schooner Unit Crater Date January 9, 2017

The following technical changes (including justification) are requested by:

Patrick Matthews	Project Manager
(Name)	(Title)

Description of Change:

Replace the CAS 18-23-01, Danny Boy Contamination Area Use Restriction (UR) Information Form in Appendix D of the CAU 374 CADD/CR with the attached UR Information Form. Site controls and technical changes include:

- The UR Form has been updated since the original submittal to include changes in terminology, format, and location of information. This change includes utilizing the updated UR Form.
- For the FFACO UR and Administrative UR, updated Coordinates to UTM, Zone 11, NAD 83, meters, and source information updated to GIS.
- Updated the Administrative UR to include revised coordinates and an additional coordinate to correct the boundary of the use restriction. The original boundary included some areas that were within the FFACO UR boundary.
- Updated language in the 'Comments' section to be consistent with language used in other Use Restrictions.
- FFACO UR 'Site Controls' section - Replaced existing text with the following text: "New activities that would cause a site worker to be exposed to site radiological contamination for a period of more than that of current land use (defined above) are restricted within the area defined by the coordinates listed above and in the attached figure without prior notification and approval of NDEP unless the activities are conducted under the provisions of 10 CFR Part 835. Site controls include a warning sign placed at the location of Gate 18-4C on the access road that is the only road leading to the use-restricted area."
- 'Description' section was updated to replace the "Facility Management System" with "M&O GIS".
- Inspection/Maintenance Frequency was updated to read: "Annual post-closure inspections will be conducted to ensure the FFACO UR postings are in place, intact, and legible and Gate 18-4C is secure."
- The FFACO and Administrative UR figures were revised to include the updated figure protocol.

Justification:

CAS 18-23-01 can only be accessed by vehicle by passing through Gate 18-4C. A lock on the gate will provide site control. Coordination with the Facility Manager will be required to access the site. Therefore, posting at Gate 18-4C is the preferred method of site control.

This approach is consistent with the management of similar sites on the Nevada National Security Site; for example, this type of control is in place at use restricted areas near T-Tunnel in Area 12, where there is one large use restriction sign at Gate 12-18C. This gate controls access to CAUs 476, 478, and 559, which are all located beyond the gate. Annual inspections are performed at these sites to verify the condition of the gate and the single sign, and access beyond the gate for inspections at these sites is not required.

Additional language being changed in the site controls section of the UR form has become standard text for similar sites currently being closed in the Soils Activity. Changing this language for CAS 18-23-01 will help maintain consistency among closed sites.

The task time will be Unchanged by approximately 0 days.

Applicable Activity-Specific Document(s):

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office 2011. *Corrective Action Decision Document/Closure Report for Corrective Action Unit 374: Area 20 Schooner Unit Crater, Nevada National Security Site, Nevada,* DOE/NV--1456. Las Vegas, NV

Approved By: /s/ Tiffany A. Lantow Date 1/10/2017
Activity Lead

/s/ Robert F. Boehlecke Date 1/11/2017
FAA Operations Manager

/s/ Chris Andres Date 1/17/17
NDEP

Use Restriction Information

CAU Number/Description: CAU 374, Area 20 Schooner Unit Crater

Applicable CAS Number/Description: CAS 18-23-01, Danny Boy Contamination Area

Contact (DOE AL/Activity): NNSA/NFO Soils Activity Lead

FFACO Use Restriction Physical Description:

Surveyed Area (UTM, Zone 11, NAD 83, meters):

UR Points	Northing	Easting
Southeast	4,107,205	556,481
	4,107,143	556,375
	4,107,236	556,242
	4,107,379	556,223
	4,107,628	556,293
	4,107,614	556,467
	4,107,485	556,442
	4,107,479	556,468
	4,107,409	556,506

Depth: No depth limitations

Survey Source (GPS, GIS, etc): GIS

Basis for FFACO UR(s):

Summary Statement: This FFACO use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicates that a worker could potentially receive a 25 mrem dose in 176 hours of exposure to the surface location with the maximum detected radioactivity. Also, radioactivity is assumed to be present at similar or higher levels within the crater and ejecta piles. The analytical results and locations of all samples collected are presented in the CADD/CR for CAU 374.

Personnel are restricted from performing work in this area that would require personnel to be present for other than short term activities. The permissible short term activities include site visits, maintenance of the fence, radiological surveys, short duration radiological training, and retrieval of objects within the use-restricted area. Any activities to be conducted within this area that are not consistent with these defined short term activities requires the prior notification and approval of the NDEP.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 374 CAS 18-23-01, Danny Boy Contamination Area			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED	47.8	25	mrem/336 hours

Site Controls: New activities that would cause a site worker to be exposed to site radiological contamination for a period of more than that of current land use (defined above) are restricted within the area defined by the coordinates listed above and in the attached figure without prior notification and approval of NDEP unless the activities are conducted under the provisions of 10 CFR Part 835. Site controls include a warning sign placed at the location of Gate 18-4C on the access road that is the only road leading to the use-restricted area.

Administrative Use Restriction Physical Description*:

Surveyed Area (UTM, Zone 11, NAD 83, meters):

UR Points	Northing	Easting
Southeast	4,107,408	556,525
	4,107,396	556,504
	4,107,409	556,506
	4,107,462	556,477
	4,107,464	556,489
	4,107,457	556,510
Southeast	4,107,300	556,234
	4,107,388	556,143
	4,107,438	556,166
	4,107,458	556,246
	4,107,379	556,223

Depth: To 5 cm below native soil surface

Survey Source (GPS, GIS, etc): GIS

*Coordinates for the Administrative Use Restriction exclude the area defined by the FFACO Use Restriction coordinates.

Basis for Administrative UR(s):

Summary Statement: This administrative use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicates that a worker could potentially receive a 25 mrem dose in 1,150 hours of exposure to the surface location with the maximum detected radioactivity. Current land use at this site does not require site workers to be present for this amount of exposure time. However, as a best management practice, this administrative use restriction will prevent a future (more intensive) use of the area. The analytical results and locations of all samples collected are presented in the CADD/CR for CAU 374.

Personnel are restricted from performing work in this location that would require any use of the area within the UR for activities that would result in a more intensive use of the site than the current land use. Activities included in the current land use would include short duration activities such as site visits, maintenance of the fence, radiological surveys, short duration radiological training, and retrieval of objects within the use-restricted area. Any activities to be conducted within this area that are not consistent with this defined current land use requires the prior notification and approval of the NDEP.

Use Restriction Information

Contaminants Table:

Maximum Concentration of Contaminants for CAU 374 CAS 18-23-01, Danny Boy Contamination Area			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED	48.9	25	mrem/2250 hrs

Site Controls: This administrative use restriction area is established at the boundary identified by the coordinates listed above and depicted in the attached figure but does not include the FFACO use restriction at this site.

UR Maintenance Requirements (applies to both FFACO and Administrative UR(s) if Administrative UR exists):

Description: The UR is recorded in the FFACO Database, M&O GIS, and the NNSA/NFO CAU/CAS files

Inspection/Maintenance Frequency: Annual post-closure inspections will be conducted to ensure the FFACO UR postings are in place, intact, and legible and Gate 18-4C is secure.

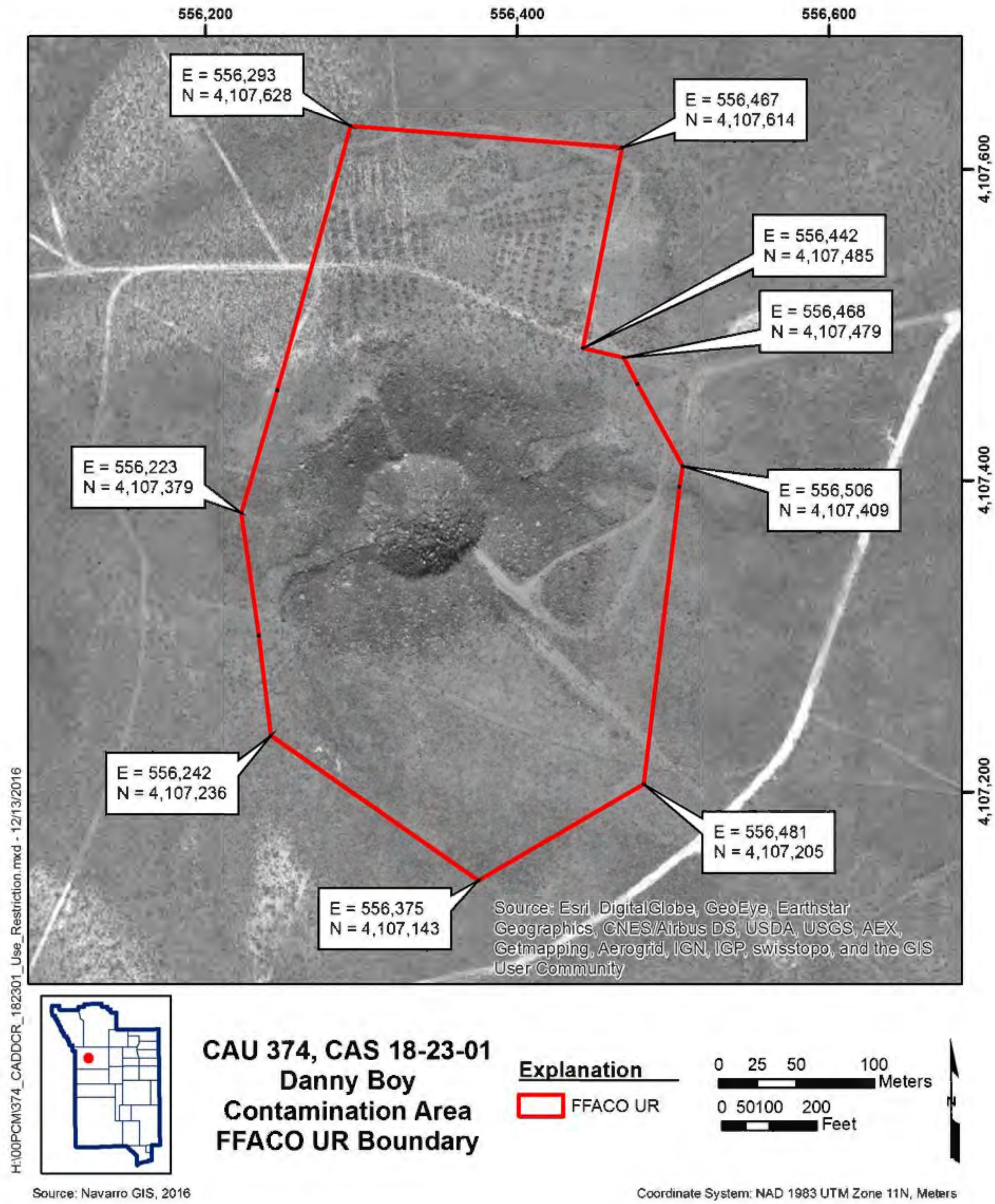
> The future use of any land related to this Corrective Action Unit (CAU), as described by the above surveyed location, is restricted from any DOE or Air Force activity that may alter or modify the containment control as approved by the state and identified in the CAU CR or other CAU documentation unless appropriate concurrence is obtained in advance.

Comments:

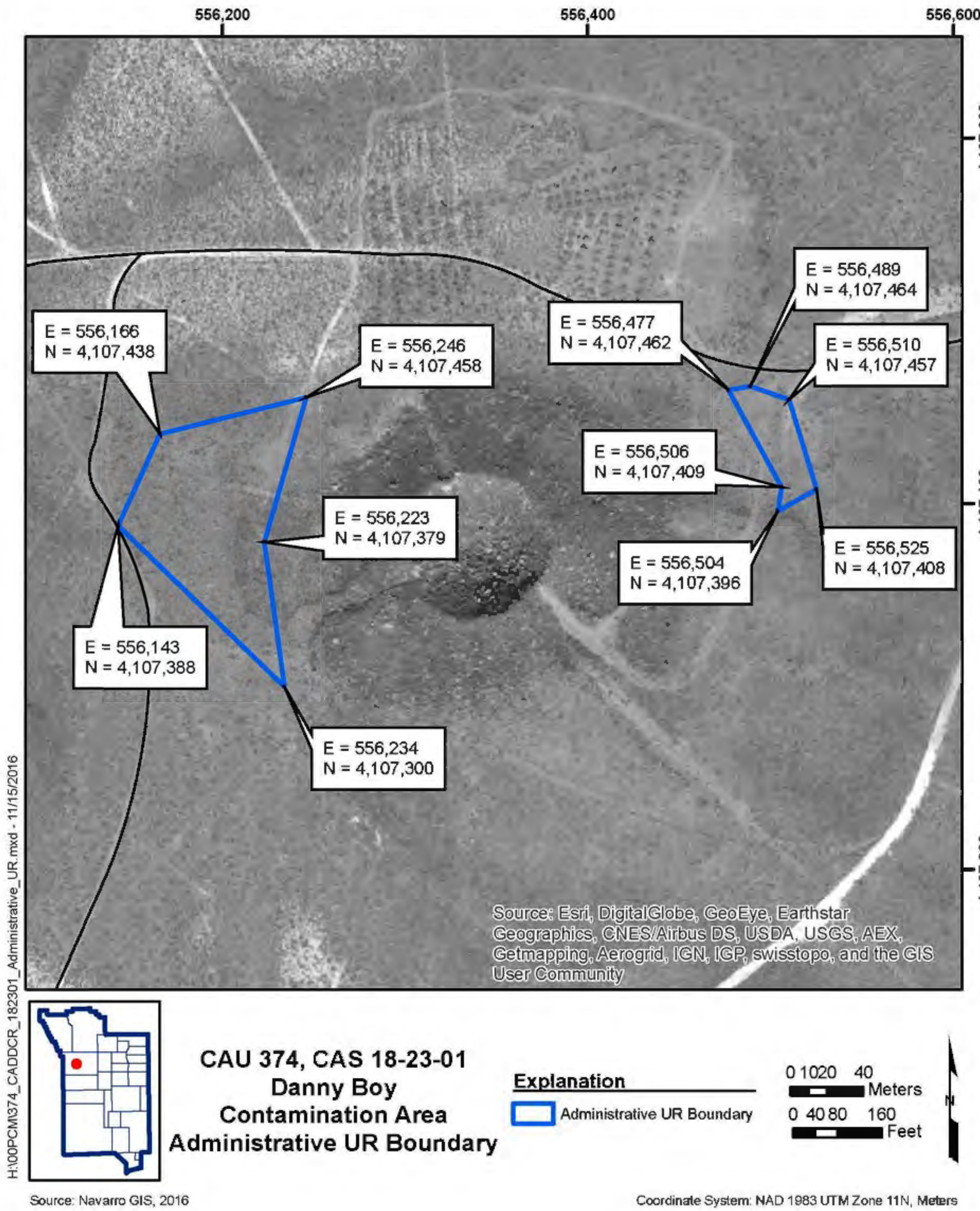
Personnel are restricted from performing work in this location that would require any use of the area within the UR for activities that would result in a more intensive use of the site than the current land use. Activities included in the current land use would include short duration activities such as site visits, maintenance of the fence, radiological surveys, short duration radiological training, and retrieval of objects within the use-restricted area. Any activities to be conducted within this area that are not consistent with this defined current land use requires the prior notification and approval of the NDEP.

Submitted By: /s/ Tiffany A. Lantow **Date:** 1/10/2017

Note: Effective upon acceptance of closure documents by NDEP



Note: Effective upon acceptance of closure documents by NDEP



556,200
556,400
556,600
4,107,600
4,107,400
4,107,200
E = 556,166
N = 4,107,438
E = 556,246
N = 4,107,458
E = 556,477
N = 4,107,462
E = 556,489
N = 4,107,464
E = 556,510
N = 4,107,457
E = 556,506
N = 4,107,409
E = 556,223
N = 4,107,379
E = 556,504
N = 4,107,396
E = 556,525
N = 4,107,408
E = 556,143
N = 4,107,388
E = 556,234
N = 4,107,300
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
H:\00PCM374_CADDCR_182301_Administrative_UR.mxd - 11/15/2016
CAU 374, CAS 18-23-01
Danny Boy
Contamination Area
Administrative UR Boundary
Explanation
Administrative UR Boundary
0 10 20 40
Meters
0 40 80 160
Feet
N
Source: Navarro GIS, 2016
Coordinate System: NAD 1983 UTM Zone 11N, Meters

RECORD OF TECHNICAL CHANGE

Technical Change No. CAU 374 CADD/CR ROTC-1 Page 1 of 1

Project/Job No. RS10 - 450 Date 10/26/2011

Project/Job Name CAU 374, Area 20 Schooner Unit Crater Nevada National Security Site, Nevada

The following technical changes (including justification) are requested by:

Grant Evenson	Task Manager
(Name)	(Title)

Description of Change

1) Appendix D, CAS 18-23-01 Use Restriction Information form page 3 of 3, Inspection/Maintenance Frequency section: Change the "N/A" to "Annual post-closure inspections will be conducted to ensure the FFACO UR postings are in place, intact, and legible."

2) Appendix D, CAS 20-45-03 Use Restriction Information form page 3 of 3, Inspection/Maintenance Frequency section: Change the "N/A" to "Annual post-closure inspections will be conducted to ensure the FFACO UR postings are in place, intact, and legible."

Justification:

The annual inspection requirements were omitted from the UR forms and annual inspections are required.

The project time will be (Increased)(Decreased)(Unchanged) by approximately 0 days.

Applicable Project-Specific Document(s): Corrective Action Decision Document/Closure Report for Corrective Action Unit 374: Area 20 Schooner Unit Crater Nevada National Security Site, Nevada

CC:

Approved By: /s/ Kevin Cabble Date 10-31-11
NNSA/NSO Federal Subproject Director

for /s/ Wilhelm R. Wilborn Date 10/31/2011
NNSA/NSO Federal Project Director

NDEP Concurrence Yes X No ___ Date 11/1/11

NDEP Signature /s/ Jeff MacDougall

Contract Change Order Required Yes___ No ___

Contract Change Order No. ___

Nevada
Environmental
Restoration
Project

DOE/NV--1456

National Nuclear Security Administration

Corrective Action Decision Document/ Closure Report for Corrective Action Unit 374: Area 20 Schooner Unit Crater Nevada National Security Site, Nevada

Controlled Copy No.: UNCONTROLLED

Revision No.: 0

July 2011

Environmental Restoration
Project

U.S. Department of Energy
National Nuclear Security Administration
Nevada Site Office

Available for sale to the public from:

U.S. Department of Commerce
National Technical Information Service
5301 Shawnee Road
Alexandria, VA 22312
Telephone: 800.553.6847
Fax: 703.605.6900
E-mail: *orders@ntis.gov*
Online Ordering: *http://www.ntis.gov/help/ordermethods.aspx*

Available electronically at *http://www.osti.gov/bridge*

Available for a processing fee to U.S. Department of Energy and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
Phone: 865.576.8401
Fax: 865.576.5728
Email: *reports@adonis.osti.gov*

DOE/NV--1456

CORRECTIVE ACTION DECISION DOCUMENT/ CLOSURE REPORT FOR CORRECTIVE ACTION UNIT 374: AREA 20 SCHOONER UNIT CRATER NEVADA NATIONAL SECURITY SITE, NEVADA

U.S. Department of Energy
National Nuclear Security Administration
Nevada Site Office
Las Vegas, Nevada

Controlled Copy No.: UNCONTROLLED

Revision No.: 0

July 2011

Approved for public release; further dissemination unlimited.

Reviewed and determined to be UNCLASSIFIED.
Derivative Classifier: Joseph P. Johnston/N-I CO
(Name/personal identifier and position title)
Signature: /s/ Joseph P. Johnston
Date: 7/11/11

CORRECTIVE ACTION DECISION DOCUMENT/CLOSURE REPORT FOR CORRECTIVE ACTION UNIT 374: AREA 20 SCHOONER UNIT CRATER NEVADA NATIONAL SECURITY SITE, NEVADA

Approved by: /s/ Tiffany Lantow for Date: 7/7/2011

Kevin J. Cabble
Federal Sub-Project Director
Soils Sub-Project

Approved by: /s/ Kevin Cabble Date: 7/7/11

for Robert F. Boehlecke
Federal Project Director
Environmental Restoration Project

Table of Contents

Table of Contents *(Continued)*

Table of Contents (Continued)

Table of Contents *(Continued)*

Table of Contents *(Continued)*

Table of Contents *(Continued)*

List of Figures

List of Tables

List of Tables (Continued)

List of Tables (Continued)

List of Acronyms and Abbreviations

Ac	Actinium
Ag	Silver
Am	Americium
ANPR	Advance Notice of Proposed Rulemaking
ASTM	ASTM International
bgs	Below ground surface
BMP	Best management practice
CA	Contamination area
CAA	Corrective action alternative
CADD	Corrective action decision document
CAI	Corrective action investigation
CAIP	Corrective action investigation plan
CAS	Corrective action site
CAU	Corrective action unit
CD	Certificate of Disposal
CED	Committed effective dose
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
cm	Centimeter
Cm	Curium
Co	Cobalt
COC	Contaminant of concern
COPC	Contaminant of potential concern
CR	Closure report
Cs	Cesium
CSM	Conceptual site model

List of Acronyms and Abbreviations *(Continued)*

CZ	Contamination zone
day/yr	Days per year
DOE	U.S. Department of Energy
DQA	Data quality assessment
DQI	Data quality indicator
DQO	Data quality objective
DRO	Diesel-range organics
EML	Environmental Measurements Laboratory
EPA	U.S. Environmental Protection Agency
Eu	Europium
FAL	Final action level
FD	Field duplicate
FFACO	*Federal Facility Agreement and Consent Order*
FSR	Field-screening result
ft	Foot
gal	Gallon
g/yr	Grams per year
GPS	Global Positioning System
GWS	Gamma walkover survey
GZ	Ground zero
HASL	Health and Safety Laboratory
hr/day	Hours per day
hr/yr	Hours per year
ICRP	International Commission on Radiological Protection
ID	Identification
IDW	Investigation-derived waste

List of Acronyms and Abbreviations *(Continued)*

in.	Inch
K	Potassium
lb	Pound
LCS	Laboratory control sample
LLW	Low-level waste
LVF	Load Verification Form
m	Meter
m^2	Square meter
m/yr	Meters per year
MDC	Minimum detectable concentration
mg/day	Milligrams per day
mg/kg	Milligrams per kilogram
M&O	Management and operating
mrem	Millirem
mrem/IA-yr	Millirem per Industrial Area year
mrem/OU-yr	Millirem per Occasional Use Area year
mrem/RW-yr	Millirem per Remote Work Area year
mrem/yr	Millirem per year
N/A	Not applicable
NAC	*Nevada Administrative Code*
NAD	North American Datum
Nb	Niobium
NDEP	Nevada Division of Environmental Protection
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office

List of Acronyms and Abbreviations *(Continued)*

NNSS	Nevada National Security Site
NRDS	Nuclear Rocket Development Station
NTS	Nevada Test Site
PAL	Preliminary action level
PCB	Polychlorinated biphenyl
pCi/g	Picocuries per gram
PPE	Personal protective equipment
PRG	Preliminary Remediation Goal
PSM	Potential source material
Pu	Plutonium
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RBCA	Risk-based corrective action
RBSL	Risk-based screening level
RCRA	*Resource Conservation and Recovery Act*
RESRAD	Residual Radioactive
RIDP	Radionuclide Inventory and Distribution Program
RMA	Radioactive material area
RPD	Relative percent difference
RRMG	Residual radioactive material guideline
RWMS	Radioactive Waste Management Site
SCL	Sample collection log
SDG	Sample delivery group
Sr	Strontium
SSTL	Site-specific target level

List of Acronyms and Abbreviations (Continued)

SVOC	Semivolatile organic compound
TCLP	Toxicity Characteristic Leaching Procedure
TED	Total effective dose
Th	Thorium
TLD	Thermoluminescent dosimeter
TPH	Total petroleum hydrocarbons
U	Uranium
UCL	Upper confidence limit
UR	Use restriction
UTM	Universal Transverse Mercator
VOC	Volatile organic compound
VSP	Visual Sample Plan
μR/hr	Microroentgens per hour

Executive Summary

This Corrective Action Decision Document/Closure Report has been prepared for Corrective Action Unit (CAU) 374, Area 20 Schooner Unit Crater, located within Areas 18 and 20 at the Nevada National Security Site, Nevada, in accordance with the *Federal Facility Agreement and Consent Order* (FFACO). Corrective Action Unit 374 comprises five corrective action sites (CASs):

- 18-22-05, Drum
- 18-22-06, Drums (20)
- 18-22-08, Drum
- 18-23-01, Danny Boy Contamination Area
- 20-45-03, U-20u Crater (Schooner)

The purpose of this Corrective Action Decision Document/Closure Report is to provide justification and documentation supporting the recommendation that no further corrective action is needed for CAU 374 based on the implementation of corrective actions. The corrective action of closure in place with administrative controls was implemented at CASs 18-23-01 and 20-45-03, and a corrective action of removing potential source material (PSM) was conducted at CAS 20-45-03. The other CASs require no further action; however, best management practices of removing PSM and drums at CAS 18-22-06, and removing drums at CAS 18-22-08 were performed. Corrective action investigation (CAI) activities were performed from May 4 through October 6, 2010, as set forth in the *Corrective Action Investigation Plan for Corrective Action Unit 374: Area 20 Schooner Unit Crater, Nevada Test Site, Nevada*.

The approach for the CAI was divided into two facets: investigating the primary release of radionuclides and investigating other releases (migration in washes and chemical releases). The purpose of the CAI was to fulfill data needs as defined during the data quality objective (DQO) process. The CAU 374 dataset of investigation results was evaluated based on the data quality indicator parameters. This evaluation demonstrated the dataset is acceptable for use in fulfilling the DQO data needs.

Analytes detected during the CAI were evaluated against final action levels (FALs) established in this document. Radiological doses exceeding the FAL of 25 millirem per year were found to be present in the surface soil that was sampled. It is assumed that radionuclide levels present in subsurface media

within the craters and ejecta fields (default contamination boundaries) at the Danny Boy and Schooner sites exceed the FAL. It is also assumed that PSM in the form of lead-acid batteries at Schooner exceeds the FAL. Therefore, corrective actions were undertaken that consist of removing PSM, where present, and implementing a use restriction and posting warning signs at the Danny Boy and Schooner sites. These use restrictions were recorded in the FFACO database; the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) Facility Information Management System; and the NNSA/NSO CAU/CAS files.

Therefore, NNSA/NSO provides the following recommendations:

- No further corrective actions are necessary for CAU 374.
- A Notice of Completion to NNSA/NSO is requested from the Nevada Division of Environmental Protection for closure of CAU 374.
- Corrective Action Unit 374 should be moved from Appendix III to Appendix IV of the FFACO.

1.0 Introduction

This Corrective Action Decision Document (CADD)/Closure Report (CR) presents information supporting closure of Corrective Action Unit (CAU) 374, Area 20 Schooner Unit Crater, located at the Nevada National Security Site (NNSS), Nevada. The corrective actions described in this document were implemented in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) (1996, as amended) that was agreed to by the State of Nevada; U.S. Department of Energy (DOE), Environmental Management; U.S. Department of Defense; and DOE, Legacy Management. The NNSS (formerly the Nevada Test Site [NTS]) is located approximately 65 miles northwest of Las Vegas, Nevada.

Corrective Action Unit 374 comprises the five corrective action sites (CASs) shown on Figure 1-1 and listed below:

- 18-22-05, Drum
- 18-22-06, Drums (20)
- 18-22-08, Drum
- 18-23-01, Danny Boy Contamination Area (referred to herein as Danny Boy)
- 20-45-03, U-20u Crater (Schooner) (referred to herein as Schooner)

A detailed discussion of the history of this CAU is presented in the *Corrective Action Investigation Plan* (CAIP) *for Corrective Action Unit 374: Area 20 Schooner Unit Crater, Nevada Test Site, Nevada* (NNSA/NSO, 2010).

1.1 Purpose

This document provides documentation and justification for the closure of CAU 374, including a description of investigation activities, an evaluation of the data, and a description of corrective actions that were performed. The investigative activities were conducted in accordance with the CAIP (NNSA/NSO, 2010) except as noted herein. The corrective actions include removing contamination and implementing use restrictions (URs) for the remaining contamination that exceeds the final action levels (FALs). Based on the implementation of these corrective actions, no further corrective actions are necessary at CAU 374. The CAIP provides information relating to site history

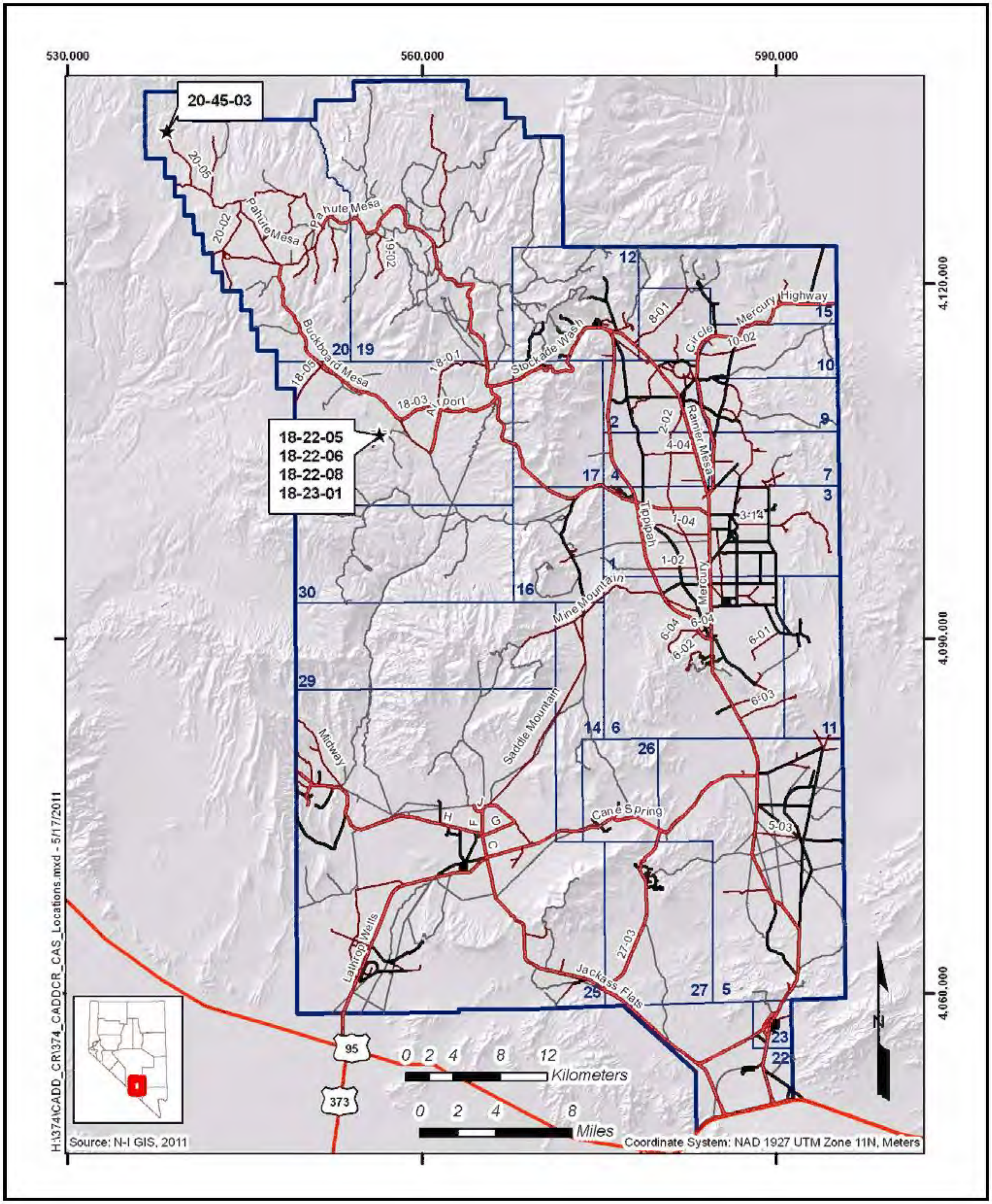


Figure 1-1
CAU 374, CAS Location Map

as well as the scope and planning of the investigation. Therefore, this information will not be repeated in this document.

Corrective Action Unit 374 consists of five inactive sites on the NNSS:

- Corrective Action Site 18-22-05, located in Area 18 at the Danny Boy Contamination Area crater, consists of four crushed drums inside the crater that are assumed to be empty and did not require investigation or evaluation of corrective action alternatives (CAAs). This CAS was pre-determined during the data quality objectives (DQOs) to be closed with no further action required due to the drum locations inside the crater (NNSA/NSO, 2010).

- Corrective Action Site 18-22-06, located in Area 18 at the Danny Boy Contamination Area crater, consists of three drums inside the fenced contamination area crater that contained test-related soil. Historical information about the CAS (REECo, 1991) stated that 20 drums were originally identified, all reported to be empty. A similar document (REECo, 1992) reported that 20 drums were removed, with three drums containing "rad contaminated sand and rocks" remaining at the site. The scope of the investigation is these three remaining drums and soil.

- Corrective Action Site 18-22-08, located in Area 18 at the Danny Boy Contamination Area crater, consists of five empty drums inside the fenced contamination area near the crater.

- Corrective Action Site 18-23-01 (referred to as Danny Boy in this document), located in Area 18, consists of a release of radioactive material from the Danny Boy weapons-effects test. This release resulted in the contamination of the soil surface from atmospheric deposition of radioactive material. The test created a crater and fallout plume. Because the test was conducted underground, radioactive contamination at this site also includes the prompt injection from the test detonation that remains within the crater and ejecta mounds surrounding the crater.

- Corrective Action Site 20-45-03 (referred to as Schooner in this document), located in Area 20, consists of a release of radioactive material from the Schooner Plowshare test. This release resulted in the contamination of the soil surface from atmospheric deposition of radioactive material. The test created a crater and fallout plume. Because the test was conducted underground, radioactive contamination at this site also includes the prompt injection from the test detonation that remains within the crater and ejecta mounds surrounding the crater.

1.2 Scope

The corrective action investigation (CAI) for CAU 374 was completed through environmental soil and thermoluminescent dosimeter (TLD) sample analytical results to define the nature and extent of contaminants of concern (COCs) that exist at the Danny Boy and Schooner CASs. For radiological releases, a COC is defined as the presence of radionuclides that jointly present a dose to a receptor exceeding 25 millirem per year (mrem/yr) (based on the appropriate exposure scenario). To investigate the drum CASs, analytical soil sample results and/or visual inspections were conducted.

The collection of samples was not feasible at some locations. Therefore, it was assumed that radionuclides are present within the craters and ejecta piles that would cause a dose exceeding the FAL.

The scope of the investigation activities at CAU 374 included performing visual surveys, collecting environmental and quality control (QC) samples, and placing TLDs. The scope of the corrective action activities included evaluating CAAs, removing lead-acid batteries, establishing and posting URs, and documenting and justifying closure activities.

1.3 CADD/CR Contents

This document is divided into the following sections and appendices:

Section 1.0, "Introduction," summarizes the document purpose, scope, and contents.

Section 2.0, "Corrective Action Investigation Summary," summarizes the investigation field activities and the results of the investigation, and justifies that no further corrective action is needed.

Section 3.0, "Recommendation," provides the basis for requesting that the CAU be moved from Appendix III to Appendix IV of the FFACO.

Section 4.0, "References," provides a list of all referenced documents used in the preparation of this CADD/CR.

Appendix A, *Corrective Action Investigation Results*, provides a description of the project objectives, field investigation and sampling activities, investigation results, waste management, and quality assurance (QA). Sections A.3.0 through A.7.0 provide specific information regarding field activities, sampling methods, and laboratory analytical results from the investigation.

Appendix B, *Data Assessment*, provides a data quality assessment (DQA) that reconciles DQO assumptions and requirements to the investigation results.

Appendix C, *Risk Assessment*, presents an evaluation of risk associated with the establishment of FALs.

Appendix D, *Closure Activity Summary*, provides details on the completed closure activities and includes supporting documentation.

Appendix E, *Evaluation of Corrective Action Alternatives*, provides a discussion of the results of the CAI, the alternatives considered, and the rationale for the recommended alternative.

Appendix F, *Data Tables*, provides tabular compilations of validated analytical results that provide a basis for the internal radiological dose estimates. This appendix also provides tabular compilations of TLD sample data that provide a basis for the external radiological dose estimates.

Appendix G, *Sample Location Coordinates*, presents the northing and easting coordinates for each sample plot, the biased sample locations, and other points of interest.

Appendix H, *Nevada Division of Environmental Protection* (NDEP) *Comments*, contains NDEP comments on the draft version of this document.

1.3.1 Applicable Programmatic Plans and Documents

All investigation activities were performed in accordance with the following documents:

- CAIP for CAU 374, Area 20 Schooner Unit Crater (NNSA/NSO, 2010)
- *Industrial Sites Quality Assurance Project Plan* (QAPP) (NNSA/NV, 2002)
- FFACO (1996, as amended)

1.3.2 Data Quality Assessment Summary

The CAIP for CAU 374, Area 20 Schooner Unit Crater (NNSA/NSO, 2010), contains the DQOs as agreed to by stakeholders before the field investigation. The DQO process ensures that the right type, quality, and quantity of data will be available to support the resolution of those decisions with an appropriate level of confidence.

A DQA was conducted that evaluated the degree of acceptability and usability of the reported data in the decision-making process. This DQA summary is presented in Appendix B and summarized in Section 2.2.2. Using both the DQO and DQA processes helps to ensure that DQO decisions are sound and defensible. Based on this evaluation, the nature and extent of COCs at CAU 374 have been adequately identified to implement the corrective actions. Information generated during the investigation supports the conceptual site model (CSM) assumptions, and the data collected met the DQOs and supports their intended use in the decision-making process.

2.0 Corrective Action Investigation Summary

The following sections summarize the investigation activities and investigation results, and justify why no further corrective action is required at CAU 374. Detailed investigation activities and results for individual CAU 374 CASs are presented in Appendix A of this document.

2.1 Investigation Activities

Corrective action investigation activities were performed as set forth in the CAU 374 CAIP (NNSA/NSO, 2010) from May 4 through October 6, 2010. The purpose of the CAU 374 CAI was to provide the additional information needed to resolve the following project-specific DQOs:

- Determining whether COCs are present in the soils associated with CAU 374.
- Determining the extent of identified COCs.
- Ensuring adequate data have been collected to evaluate closure alternatives under the FFACO (1996, as amended).

The scope of the CAI included the following activities:

- Performing visual surveys.
- Performing radiological surveys.
- Collecting environmental samples for laboratory analyses.
- Collecting QC samples.
- Placing, collecting, and analyzing TLDs.

To facilitate site investigation and the evaluation of DQO decisions for different CSM components, the releases at each CAS were classified into one of the following two categories:

- **Primary releases** (referred to as “test releases” in the CAU 374 CAIP [NNSA/NSO, 2010]) – This release category is specific to the atmospheric deposition of radionuclide contamination onto the soil surface outside the default contamination boundary that has not been displaced through excavation or migration. Contamination associated with the primary release is limited to the top 5 centimeters (cm) of undisturbed soil. Sampling surface soils to a depth of 5 cm is appropriate for areas that have not been disturbed, as numerous studies of soils contaminated by atmospheric deposition after nuclear testing at the NNSS have shown that more than 90 percent of the radioactivity in undisturbed soil is contained within the top 5 cm of soil (McArthur and Kordas, 1983 and 1985; Gilbert et al., 1977; Tamura, 1977). Therefore, for the purposes of this CADD/CR, surface is defined as the upper 5 cm of soil.

- **Other releases** (referred to as “non-test releases” in the CAU 374 CAIP [NNSA/NSO, 2010]) – This release category includes any radionuclide contamination from test activities that is not limited to the surface 5 cm of soil. This includes radionuclide contaminants that were initially deposited onto the soil surface (as in the primary release category) but have subsequently been displaced through excavation or migration (such as in the drainages at the sites). This category also includes radionuclides that were deposited under mechanisms other than atmospheric deposition. This includes the prompt injection of radionuclides into native material from the nuclear detonation (such as in the Schooner and Danny Boy craters) and the deposition of ejecta piles around the Schooner and Danny Boy craters. Also included are other chemical or radiological contamination that may be discovered during the investigation through the identification of biasing factors that are not a part of a previously identified release (such as releases to the surface soil from drums or spills). The depth of radiological contamination from other releases is dependent upon the nature of the release or subsequent movement through excavation or migration. Investigation of other releases was accomplished through measurements of soil radioactivity using a judgmental sampling scheme at depths dependent upon the nature of the release, or by conservative assumptions that radioactivity is present at depth based on process knowledge.

For the primary release at CAU 374 CASs, sample plots were established judgmentally based on aerial radiation surveys and the results of the gamma walkover surveys (GWSs). Within each sample plot, probabilistic sample locations were established based on a randomized grid. For other releases at CAU 374 CASs, judgmental sample locations were determined based on biasing criteria such as elevated radiological readings, sediment accumulation areas, soil waste in drums, and stained soil.

Confidence in judgmental sampling scheme decisions was established qualitatively by validating the CSM and verifying that the selected plot locations meet the DQO criteria. Confidence in probabilistic sampling scheme decisions was established by validating the CSM, justifying that sampling locations are representative of the plot area, and demonstrating that a sufficient number of samples were collected to justify statistical inferences (e.g., averages and 95 percent upper confidence limits [UCLs]).

The potential internal dose at each sample location was determined based on the laboratory analytical results of soil samples taken at each location and residual radioactivity material guidelines (RRMGs) that were calculated using the Residual Radioactive (RESRAD) computer code (Yu et al., 2001) (see Appendix C, Attachment C-1). The RRMGs are the activity concentrations of individual radionuclides in surface soil that would cause a receptor to receive an internal dose equal to the radiological FAL. The internal doses from each of the radionuclides are then summed to produce the total potential internal dose.

The potential internal dose at each TLD location where soil samples were not collected was conservatively estimated using the potential external dose from the TLD and the ratio of internal dose to external dose from the plot with the maximum internal dose. This was done under the assumption that the internal dose at any CAU 374 location would constitute the same percentage of the total dose as at the plot where the maximum internal dose was observed. Therefore, at each CAS, the ratio of the internal to external dose was determined at the plot with the highest internal dose by dividing the internal dose by the external dose. This CAS-specific ratio was then multiplied by the external dose measured at each TLD location (where soil samples were not collected) to estimate the internal dose.

The potential external dose at each TLD location was determined from the results of a TLD placed at a height of 1 meter (m) above the soil surface. The net external dose (the gross TLD dose reading minus the background dose) was divided by the number of hours the TLD was exposed to site contamination resulting in an hourly dose rate. That hourly dose rate was then multiplied by the number of hours per year (hr/yr) that a site worker would be present at the site (i.e., the annual exposure duration) to establish the maximum potential annual external dose a site worker could receive. The appropriate annual exposure duration in hours is based on the exposure scenario used (as defined in this section).

The calculated total effective dose (TED) (the sum of internal and external dose) for each sample location is an estimation of the true radiological dose (true TED). The TED is defined in 10 *Code of Federal Regulations* (CFR) Part 835 (CFR, 2010) as the sum of the effective dose (for external exposures) and the committed effective dose (for internal exposures).

Because a measured TED is an estimate of the true (unknown) TED, it is uncertain how well the calculated TED represents the true TED. If the measured TED were significantly different than the true TED, a decision based on the measured TED could result in a decision error. To reduce the probability of making a false negative decision error at probabilistic sample locations, a conservative estimate of the true TED is used to compare to the FAL instead of the measured TED. This conservative estimate (overestimation) of the true TED was calculated as the 95 percent UCL of the average TED measurements. By definition, there will be a 95 percent probability that the true TED is less than the 95 percent UCL of the measured TED.

As described in Appendix C, the TED to a receptor from site contamination is a function of the time the receptor is present at the site and exposed to the radioactively contaminated soil. Therefore, TED is reported in this document based on the following three exposure scenarios:

- **Industrial Area –** Assumes continuous industrial use of a site. This scenario addresses exposure to industrial workers exposed daily to contaminants in soil during an average workday. This scenario assumes that this is the regular assigned work area for the worker who will be on the site for an entire career (225 days per year [day/yr], 10 hours per day [hr/day] for 25 years). The TED values calculated using this exposure scenario are the TED an industrial worker receives during 2,250 hours of annual exposure to site radioactivity and are expressed in terms of millirem per Industrial Area year (mrem/IA-yr).

- **Remote Work Area –** Assumes non-continuous work activities at a site. This scenario addresses exposure to industrial workers exposed to contaminants in soil during a portion of an average workday. This scenario assumes that this is an area where the worker regularly visits but is not an assigned work area where the worker spends an entire workday. A site worker under this scenario is assumed to be on the site for an equivalent of 336 hr/yr (or 42 day/yr) for an entire career (25 years). The TED values calculated using this exposure scenario are the TED a remote area worker receives during 336 hours of annual exposure to site radioactivity and are expressed in terms of millirem per Remote Work Area year (mrem/RW-yr).

- **Occasional Use Area –** Assumes occasional work activities at a site. This scenario addresses exposure to industrial workers who are not assigned to the area as a regular worksite but may occasionally use the site. This scenario assumes that this is an area where the worker does not regularly visit but may occasionally use for short-term activities. A site worker under this scenario is assumed to be on the site for an equivalent of 80 hours (or 10 days) per year, for 5 years. The TED values calculated using this exposure scenario are the TED an occasional use worker receives during 80 hours of annual exposure to site radioactivity and are expressed in terms of millirem per Occasional Use Area year (mrem/OU-yr).

The following sections describe specific investigation activities conducted at each CAS. Additional information regarding the investigation is presented in Appendix A.

2.1.1 CAS 18-22-05

These four crushed drums inside the Danny Boy crater are assumed to be empty, and did not require investigation or evaluation of CAAs. This CAS was predetermined during the DQOs to be closed with no further action required due to the drums being located inside the crater (NNSA/NSO, 2010).

2.1.2 CAS 18-22-06

The three drums inside the fenced contamination area crater were inspected and radiologically surveyed, and the soil within each drum was sampled. The drums and soil were removed as a best management practice (BMP), and no verification sampling was conducted. Results are discussed in Sections 2.2.1.1 and A.6.0.

The CSM and associated discussion for this CAS are provided in the CAU 374 CAIP (NNSA/NSO, 2010). The contamination within the drums at CAS 18-22-06 is consistent with the CSM. Information gathered during the CAI supports and validates the CSM as presented in the CAU 374 CAIP. No modification to the CSM was needed.

2.1.3 CAS 18-22-08

The five empty drums inside the fenced contamination area were inspected and then removed and disposed of as a BMP.

The CSM and associated discussion for this CAS are provided in the CAU 374 CAIP (NNSA/NSO, 2010). The drums at CAS 18-22-08 are consistent with the CSM. Information gathered during the CAI supports and validates the CSM as presented in the CAU 374 CAIP. No modification to the CSM was needed.

2.1.4 CAS 18-23-01 (Schooner)

Sampling activities included collecting 44 composite soil samples, and 1 judgmental sample, from 12 sample plots established along 3 vectors radiating outward from the crater area. In addition, TLDs were placed at other locations along and between the vectors based on locations of interest identified during the GWS, at the center of each sample plot, at the sediment accumulation areas, and at 4 field background locations outside the fallout plume to measure external doses. See Section A.3.1 for additional information on investigation activities conducted at Schooner. Results of the sampling effort are reported in Section 2.2.1.2.

Sampling activities at Schooner also included collecting biased samples from four sediment accumulation areas within the downgradient portions of each of the two major drainage areas at the site. Samples were collected at 5-cm lifts from the ground surface to 30 cm below ground surface (bgs) within three of the four sediment accumulation areas, and to a refusal depth at 15 cm in a fourth sediment accumulation area. Samples were field screened, and the sample with the highest field-screening result (FSR) from each location was sent to the laboratory for analysis. Although four batteries were identified and removed from the site, sampling was not conducted at the battery locations because they were intact and no biasing factors were identified.

The basis for the CSM and associated discussion for this CAS are provided in the CAU 374 CAIP (NNSA/NSO, 2010). The contamination pattern of the radionuclides at Schooner is consistent with the CSM in that the radiological contamination distributed at the time of the test generally decreases with distance from ground zero (GZ) and is biased in the northerly (downwind) direction. Information gathered during the CAI validates the CSM as presented in the CAIP. No modification to the CSM was needed.

2.1.5 CAS 20-45-03 (Danny Boy)

Sampling activities included collecting composite soil samples from two sample plots to measure internal dose at locations of interest identified during the GWS (i.e., individual highest radiation areas outside the default contamination boundary). In addition, TLDs were placed at the center of each sample plot, along the default contamination boundary, at the sediment accumulation area, at six areas of interest identified during the GWS, and at three field background locations outside the fallout plume. See Section A.4.1 for additional information on investigation activities conducted. Results of the sampling effort are reported in Section 2.2.1.3.

Sampling activities at Danny Boy also included collecting a biased sample (and a field duplicate [FD]) from the sediment accumulation area within the downgradient portion of the small wash at the site. Samples were collected at 5-cm lifts from the surface to 10 cm bgs within the sediment accumulation area. Samples were field screened, and the sample with the highest FSR was sent to the laboratory for analysis.

The CSM and associated discussion for this CAS are provided in the CAU 374 CAIP (NNSA/NSO, 2010). The contamination pattern of the radionuclides at Danny Boy is consistent with the CSM in that the radiological contamination generally decreases with distance from GZ. Information gathered during the CAI supports and validates the CSM as presented in the CAU 374 CAIP. No modification to the CSM was needed.

2.2 Results

The data summary provided in Section 2.2.1 defines the COCs identified at CAU 374. Section 2.2.2 summarizes the assessment made in Appendix B, which demonstrates that the investigation results satisfy the DQO data requirements.

The preliminary action levels (PALs) and FALs are based on an annual dose limit of 25 mrem/yr. This dose limit is specific to the annual dose a receptor could potentially receive from a CAU 374 release. As such, it is dependent upon the cumulative annual hours of exposure to site contamination. The PALs were established in the CAIP (NNSA/NSO, 2010) based on a dose limit of 25 mrem/yr over an annual exposure time of 2,250 hours (i.e., the Industrial Area exposure scenario that a site worker would be exposed to site contamination for 225 day/yr and 10 hr/day). The FALs were established in Appendix C based on a dose limit of 25 mrem/yr over an annual exposure time of 336 hours (i.e., the Remote Work Area exposure scenario that a site worker would be exposed to site contamination for 42 day/yr and 8 hr/day). To be comparable to these action levels, the CAU 374 investigation results are presented in terms of the dose a receptor would receive from site contamination under the Industrial Area (mrem/IA-yr), Remote Work Area (mrem/RW-yr), and Occasional Use Area (mrem/OU-yr) exposure scenarios.

2.2.1 Summary of Analytical Data

Results for both the primary releases and other releases are presented in the following sections. No investigation was required or conducted for CAS 18-22-05. For radioactivity, results are reported as TED based on the remote work area exposure scenario comparable to the radiological FAL as established in Appendix C. The FALs as established in Appendix C are based on the annual exposure duration of the Remote Work Area scenario (336 hr/yr). Calculation of the TED for each sample was accomplished by summing internal and external dose as described in Sections A.3.2.3 and A.4.2.3.

2.2.1.1 CAS 18-22-06

Summary of Investigation Results at CAS 18-22-06

The inspection and radiological survey of the drum contents revealed a total of 160 pounds (lb) of gravelly soil similar to the rock piles and ejecta fields throughout the Danny Boy site. Analytical results of the drummed soil did not exceed the FAL for the radiological dose (25 mrem/RW-yr). Therefore, no corrective action was required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) for the soil and drums is no further action. The drums and soil were removed and disposed of as a BMP.

2.2.1.2 CAS 18-22-08

Summary of Investigation Results at CAS 18-22-08

No sampling was conducted, as the five drums inside the fenced contamination area crater were inspected and determined to be empty. No biasing factors were present, and therefore no soil sampling was conducted nor were COCs identified. Therefore, no corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) for the empty drums is no further action. The drums were removed and disposed of as a BMP.

2.2.1.3 CAS 18-23-01 (Schooner)

Discussions of the results for samples collected at Schooner are grouped by the nature of the release.

Primary Release

The average TED values and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table 2-1.

The TEDs for surface soils exceeded the FAL of 25 mrem/RW-yr at TLD locations BT01, BT02, BT03, BT04, BT35, and BT43 inside the default contamination area. No locations outside the default decontamination boundary exceeded the FAL of 25 mrem/RW-yr.

Table 2-1
Schooner TED at Sample Locations (mrem/yr)
(Page 1 of 3)

Plot or Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
BT01	**202.8**	**225.9**	**30.8**	**34.3**	7.73	8.61
BT02	**256.4**	**297.8**	**38.9**	**45.2**	9.77	11.4
BT03	**351.0**	**415.8**	**53.3**	**63.1**	13.4	15.9
BT04	**247.1**	**268.4**	**37.5**	**40.7**	9.42	10.2
BT05	**146.2**	**156.4**	22.2	23.7	5.57	5.96
BT06	2.05	6.56	0.312	0.995	0.078	0.250
BT07	2.11	5.80	0.320	0.880	0.080	0.221
BT08	0.10	1.79	0.015	0.272	0.004	0.068
BT09	4.47	8.04	0.679	1.22	0.171	0.307
BT10	0.63	5.52	0.095	0.837	0.024	0.210
BT11	1.50	4.59	0.227	0.697	0.057	0.175
BT12/Plot BG	16.7	21.7	2.53	3.27	0.628	0.809
BT13/Plot BF	**47.0**	**49.7**	7.06	7.47	1.71	1.82
BT14/Plot BE	**80.2**	**90.5**	12.1	13.6	2.94	3.34
BT15	**94.0**	**102.0**	14.3	15.5	3.58	3.89
BT16	14.1	15.7	2.14	2.39	0.537	0.599
BT17	**32.6**	**36.6**	4.95	5.56	1.24	1.40
BT18	**48.9**	**54.1**	7.43	8.21	1.87	2.06
BT19	**72.2**	**81.9**	11.0	12.4	2.75	3.12
BT20/Plot BM	11.4	15.9	1.71	2.38	0.416	0.580
BT21/Plot BL	16.4	22.6	2.47	3.41	0.612	0.843
BT22/Plot BK	20.4	**26.7**	3.09	4.03	0.762	0.993
BT23/Plot BX	**62.8**	**69.5**	9.67	10.7	2.54	2.78
BT24	13.0	16.4	1.97	2.49	0.494	0.625
BT25	24.2	**28.1**	3.67	4.26	0.921	1.07
BT26	**32.6**	**40.6**	4.95	6.16	1.24	1.55
BT27	**97.1**	**108.1**	14.7	16.4	3.70	4.12

Table 2-1
Schooner TED at Sample Locations (mrem/yr)
(Page 2 of 3)

Plot or Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
BT28	22.5	**26.5**	3.41	4.02	0.858	1.01
BT29	**25.8**	**27.7**	3.91	4.21	0.982	1.06
BT30	**44.4**	**56.1**	6.75	8.51	1.69	2.14
BT31	**114.4**	**131.0**	17.4	19.9	4.36	4.99
BT32/Plot BC	19.1	23.2	2.89	3.54	0.720	0.903
BT33/Plot BB	**35.5**	**41.3**	5.34	6.22	1.30	1.52
BT34	**45.0**	**55.1**	6.84	8.42	1.72	2.16
BT35	**250.1**	**281.8**	**38.0**	**42.8**	9.54	10.7
BT36	11.0	12.5	1.67	1.90	0.420	0.477
BT37	18.0	22.5	2.73	3.42	0.684	0.859
BT38/Plot BA	22.4	**29.9**	3.39	4.54	0.852	1.14
BT39	**108.9**	**115.7**	16.5	17.6	4.15	4.41
BT40	**26.1**	**31.5**	3.96	4.78	0.996	1.20
BT41	**57.4**	**66.4**	8.72	10.1	2.19	2.53
BT42	**85.0**	**91.8**	12.9	13.9	3.24	3.50
BT43	**154.2**	**170.0**	23.4	**25.8**	5.88	6.48
BT48/Plot BH	3.59	5.38	0.547	0.82	0.139	0.207
BT49	4.37	8.54	0.664	1.30	0.167	0.326
BT50	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT51	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT52	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT53	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT54	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT55	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT56	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT57	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT58/Plot BD	0[a]	2.57	0[a]	0.394	0[a]	0.102

Table 2-1
Schooner TED at Sample Locations (mrem/yr)
(Page 3 of 3)

Plot or Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
BT59	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT60	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT61	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT62	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT63	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT64	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT65	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT66	1.75	5.25	0.279	0.802	0.081	0.206
BT67	1.14	3.52	0.178	0.534	0.049	0.134
BT68	8.54	16.4	1.29	2.47	0.321	0.601

[a]Where the net reading was less than zero, a value of zero was used.

Bold indicates the values exceeding 25 mrem/yr.

Other Release

Samples collected from the four sediment accumulation areas (locations BT65, BT66, BT67, and BT68) did not exceed the FAL of 25 mrem/RW-yr. Values for the average TED and the 95 percent UCL for the TED for each scenario are presented in Table 2-1.

Summary of Investigation Results at Schooner

Based on analytical results of samples collected at Schooner, the surface radiological contamination at the site exceeds the FAL for the radiological dose (25 mrem/RW-yr) at sample locations BT01, BT02, BT03, BT04, BT35, and BT43 (Table 2-1). No locations outside the default decontamination boundary exceeded the FAL of 25 mrem/RW-yr. It is assumed that contamination present in the default decontamination boundary exceeds the FAL due to prompt injection of radionuclides into the subsurface soil and ejecta mounds surrounding the crater from the nuclear test and that the four lead-acid batteries exceed the FAL. Therefore, a corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is closure in place with a UR and a corrective action removal of the lead-acid batteries. A UR was established around the default decontamination boundary, as shown in Figure A.3-3 and in Attachment D-1 of Appendix D.

2.2.1.4 CAS 20-45-03 (Danny Boy)

Discussions of the results for samples collected at Danny Boy are grouped by the nature of the release.

Primary Release

The average TED values and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table 2-2.

The TEDs for surface soils exceeded the FAL of 25 mrem/RW-yr at TLD location AT23 inside the default contamination boundary. No locations outside the default decontamination boundary exceeded the FAL of 25 mrem/RW-yr.

Other Release

Samples from the sediment accumulation area at TLD location AT28 did not exceed the FAL of 25 mrem/RW-yr. Values for the average TED and the 95 percent UCL for the TED for each scenario are presented in Table 2-2.

Summary of Investigation Results at Danny Boy

Based on the analytical results of samples collected within Danny Boy, no surface soil COCs were identified at this CAS outside the default contamination boundary. However, it is assumed that COCs are present in the default contamination area (see Section D.1.1) due to prompt injection of radionuclides into the subsurface soil and ejecta mounds surrounding the crater from the nuclear test. Therefore, a corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) for the subsurface contamination is closure in place with a UR. A UR was established around the default contamination boundary, as shown in Figure A.4-4 and in Attachment D-2 of Appendix D.

Table 2-2
Danny Boy TED at Sample Locations (mrem/yr)

Plot or Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
AT01	**27.8**	**29.8**	3.92	4.58	0.999	1.20
AT02	**29.4**	**34.8**	4.50	5.33	1.16	1.37
AT03	19.4	**25.3**	2.96	3.87	0.763	0.997
AT04	**31.5**	**36.5**	4.82	5.58	1.24	1.44
AT05	**34.8**	**42.7**	5.32	6.52	1.37	1.67
AT06	**36.1**	**45.5**	5.52	6.96	1.42	1.79
AT07	**40.7**	**48.9**	6.22	7.48	1.60	1.92
AT08	**28.8**	**32.7**	4.41	5.01	1.14	1.29
AT09	15.0	19.6	2.30	3.01	0.593	0.774
AT10	**62.9**	**79.1**	9.63	12.1	2.48	3.11
AT11	5.07	7.82	0.775	1.20	0.200	0.308
AT12	2.59	5.45	0.396	0.834	0.102	0.215
AT13	0[a]	0.765	0[a]	0.117	0[a]	0.030
AT14	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
AT15	5.81	8.25	0.888	1.26	0.229	0.325
AT16	15.8	18.5	2.42	2.83	0.622	0.728
AT17	10.1	10.9	1.55	1.67	0.399	0.429
AT18	0.850	2.02	0.130	0.309	0.033	0.080
AT19	6.10	11.2	0.934	1.71	0.240	0.439
AT20	8.87	10.0	1.36	1.53	0.350	0.394
AT21	15.8	**43.2**	2.42	6.62	0.623	1.70
AT22	**65.0**	**73.4**	9.94	11.2	2.56	2.89
AT23	**252.1**	**312.6**	**38.6**	**47.8**	9.93	12.3
AT27	**38.7**	**53.8**	5.92	8.24	1.52	2.12
AT28	0[a]	1.46	0[a]	0.243	0[a]	0.078

[a]Where the reading was less than zero, a value of zero was used.

Bold indicates the values exceeding 25 mrem/yr.

2.2.2 Data Assessment Summary

The DQA is presented in Appendix B and includes an evaluation of the data quality indicators (DQIs) to determine the degree of acceptability and usability of the reported data in the decision-making process. The DQO process assures that the right type, quality, and quantity of data are available to support the resolution of those decisions at an appropriate level of confidence. Using both the DQO and DQA processes help to ensure that DQO decisions are sound and defensible.

The DQA process as presented in Appendix B is composed of the following steps:

- Step 1: Review DQOs and Sampling Design.
- Step 2: Conduct a Preliminary Data Review.
- Step 3: Select the Test.
- Step 4: Verify the Assumptions.
- Step 5: Draw Conclusions from the Data.

The results of the DQI evaluation show that accuracy was the only indicator that did not meet the associated criterion. The only analytes that failed to meet the criterion were barium, selenium, and lead. As presented in Appendix B, there is a negligible potential for this accuracy deficiency to cause a false negative decision error. Therefore, the barium, selenium, and lead results that were qualified for accuracy can be confidently used for comparison to respective FALs. All other DQI criteria were met. The DQA determined that information generated during the investigation supports the CSM assumptions, and the data collected support their intended use in the decision-making process. Based on the results of the DQA presented in Appendix B, the DQO requirements have been met.

2.3 Justification for No Further Action

No further corrective action is needed for the five CASs within CAU 374 based on implementation of the corrective action at Schooner (removal of the lead-acid batteries), and closure in place with URs at the Danny Boy and Schooner CASs. This corrective action was selected to ensure protection of the public and the environment in accordance with *Nevada Administrative Code* (NAC) 445A (NAC, 2008) based on an evaluation of risk, feasibility, and cost effectiveness (the evaluation of CAAs is presented in Appendix E).

2.3.1 Final Action Levels

The establishment of the FALs (presented in Appendix C) was based on risk to receptors. The radiological risk to receptors from contaminants at CAU 374 is due to chronic exposure to radionuclides (i.e., receiving a dose over time). Therefore, the risk to a receptor is directly related to the amount of time a receptor is exposed to the contaminants. A review of the current and projected use of both sites determined that workers may only be present at these sites for a few hours per year, and it is not reasonable to assume that any worker would be present at this site on a full-time basis (DOE/NV, 1996). In the CAU 374 DQOs, it was conservatively determined that the Occasional Use Area exposure scenario (as listed in Section 3.1.1 of the CAU 374 CAIP [NNSA/NSO, 2010]) would be used in calculating receptor exposure time. This exposure scenario assumes workers may use the site occasionally for intermittent or short-term activities and be exposed to site contaminants for 80 hr/yr (i.e., equivalent to 8 hr/day, 10 day/yr, for 5 years).

In order to quantify the maximum number of hours a site worker may be present at CAU 374, current and anticipated future site activities were evaluated as part of the CAI (see Appendix C, Section C.1.10). This evaluation concluded that the most exposed worker under current land usage is a tour escort that has the potential to be present at the site for up to 96 hr/yr. As a result, it was determined that the most exposed worker could be exposed to site contamination for more time than is assumed under the Occasional Use exposure scenario (80 hr/yr).

Using the 95 percent UCL of the average maximum dose measured at CAU 374, a receptor would have to be exposed to the location of maximum dose for 336 hours to receive a dose of 25 millirem (mrem). Thus, a receptor at the site for 96 hr/yr over 25 years (Remote Work scenario) would not exceed the 25-mrem/yr dose limit at either of the two crater CASs. As the most exposed worker under current land usage will not be exposed to site contamination for more than the time assumed for the Remote Work Area scenario (336 hr/yr), it was decided to base the FALs on the Remote Work Area use scenario (see Appendix C).

3.0 Recommendation

Corrective actions were based on the risk assessment presented in Appendix C and the corrective action evaluation presented in Appendix E. In the risk assessment, it was determined to use the Remote Work Area exposure scenario (with an exposure duration of 336 hr/yr of site worker exposure) as the radiological FAL for DQO decisions.

Schooner radiological contamination exceeds the FAL of 25 mrem/RW-yr at six sample locations. It is also assumed that radioactivity within the crater and in ejecta field around the crater exceeds the FAL due to direct injection of radionuclides from the nuclear test, and it is assumed that the lead-acid batteries exceed the FAL. Therefore, a corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is closure in place with a UR and corrective action removal of the lead-acid batteries. The FFACO UR was established to encompass the default contamination boundary (see Section A.3.3) as shown on Figure A.3-4 and in Attachment D-1.

Danny Boy radiological contamination exceeds the FAL of 25 mrem/RW-yr at one sample location. It is also assumed that radioactivity within the crater and ejecta around the crater exceeds the FAL due to direct injection of radionuclides from the nuclear test. Therefore, corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is closure in place with a UR. The FFACO UR was established to encompass the default contamination boundary (see Section A.4.3) as shown on Figure A.4-4 and in Attachment D-2.

The FAL of 25 mrem-RW/yr was not exceeded at CASs 18-22-06 and 18-22-08; therefore, no corrective action was required. The empty drums at CAS 18-22-08, and the drums and soil at CAS 18-22-06, were removed as a BMP. The selected corrective action (based on the corrective action evaluation presented in Appendix E) for these two CASs is no further action. The selected corrective action for CAS 18-22-05 was pre-determined in the CAIP to be no further action (NNSA/NSO, 2010).

In accordance with the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006) and Section 3.3 of the CAU 374 CAIP (NNSA/NSO, 2010), any area at any CAS where an industrial land use of the area could cause a future site worker to receive a dose exceeding 25 mrem/yr (assuming the worker would be exposed to site contamination for a period of 2,250 hr/yr) was identified and administratively use restricted (administrative UR). The administrative URs at Danny Boy and Schooner are not part of the corrective action but were implemented as BMPs. To determine the extent of this area, a correlation of radiation survey values to the 95 percent UCL of Industrial Area TED values was conducted for the 1994 radiation survey (BN, 1999) and the site-specific GWS. The radiation survey with the best correlation was the GWS. The GWS values were then interpolated using a kriging technique and isopleths established over the entire area of the GWS. The administrative UR boundary was established to encompass the GWS isopleth corresponding to a dose of 25 mrem/IA-yr. This would restrict any future industrial land use activities that would result in a site worker exceeding the exposure time assumed under current land usage. The administrative URs will be recorded and controlled in the same manner as the FFACO URs, but will not require postings or inspections. Any proposed activity within this use restricted area that would change the current land use scenario to a more intensive use of the site would require NDEP approval.

At Schooner, the TED from surface soils exceeded a dose of 25 mrem/IA-yr at 25 locations. An administrative UR boundary was established to encompass the GWS isopleth value corresponding to 25 mrem/IA-yr (see Section A.3.3 and Figure A.3-4). The administrative UR is presented in Attachment D-1.

At Danny Boy, the TED from surface soils exceeded a dose of 25 mrem under the Industrial Area scenario (25 mrem/IA-yr) at 13 locations. An administrative UR boundary was established to encompass the GWS isopleth value corresponding to 25 mrem/IA-yr (see Section A.4.3 and Figure A.4-4). The administrative UR is presented in Attachment D-2.

No further corrective action is required at CAU 374 based upon implementation of corrective actions at the CAU 374 CASs. These corrective actions are evaluated in Appendix E based on technical merits focusing on reduction of toxicity, mobility and/or volume; reliability; short and long-term feasibility; and cost. The FFACO URs implemented at each CAS will protect site workers from inadvertent exposure. These FFACO URs require annual inspections to assure that postings are in place, intact, and readable. Maintenance or replacement of postings may be conducted without prior

NDEP approval. The corrective actions for CAU 374 are based on the assumption that activities on the NNSS will be limited to those that are industrial in nature and that the NNSS will maintain controlled access (i.e., restrict public access and residential use). Should the future land use of the NNSS change such that these assumptions are no longer valid, additional evaluation may be necessary.

The URs are recorded in the FFACO database; the DOE, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) Facility Information Management System; and the NNSA/NSO CAU/CAS files.

The NNSA/NSO requests that NDEP issue a Notice of Completion for this CAU and approve transferring the CAU from Appendix III to Appendix IV of the FFACO.

4.0 References

BN, see Bechtel Nevada.

Bechtel Nevada. 1999. *An Aerial Radiological Survey of the Nevada Test Site*, DOE/11718--324. Prepared for U.S. Department of Energy, Nevada Operations Office. Las Vegas, NV: Remote Sensing Laboratory.

CFR, see *Code of Federal Regulations*.

Code of Federal Regulations. 2010. Title 10 CFR, Part 835, "Occupational Radiation Protection." Washington, DC: U.S. Government Printing Office.

DOE/NV, see U.S. Department of Energy, Nevada Operations Office.

FFACO, see *Federal Facility Agreement and Consent Order.*

Federal Facility Agreement and Consent Order. 1996 (as amended March 2010). Agreed to by the State of Nevada; U.S. Department of Energy, Environmental Management; U.S. Department of Defense; and U.S. Department of Energy, Legacy Management. Appendix VI, which contains the Soils Strategy, was last modified May 2011, Revision No. 4.

Gilbert, R.O., E.H. Essington, D.N. Brady, P.G. Doctor, and L.L Eberhardt. 1977. "Statistical Activities during 1976 and the Design and Initial Analysis of Nuclear Site Studies." In *Transuranics in Desert Ecosystems*, NVO-181. pp. 331–366. November. Las Vegas, NV: U.S. Department of Energy, Nevada Operations Office.

McArthur, R.D., and J.F. Kordas. 1983. *Radionuclide Inventory and Distribution Program: The Galileo Area*, DOE/NV/10162-14; Publication No. 45035. Las Vegas, NV: Desert Research Institute, Water Resources Center.

McArthur, R.D., and J.F. Kordas. 1985. *Nevada Test Site Radionuclide Inventory and Distribution Program: Report #2. Areas 2 and 4*, DOE/NV/10162-20; Publication No. 45041. Las Vegas, NV: Desert Research Institute, Water Resources Center.

NAC, see *Nevada Administrative Code*.

N-I GIS, see Navarro-Intera Geographic Information Systems.

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

NNSA/NV, see U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office.

Navarro-Intera Geographic Information Systems. 2011. ESRI ArcGIS Software.

Nevada Administrative Code. 2008. NAC 445A, "Water Controls." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 25 October 2009.

REECo, see Reynolds Electrical and Engineering Co., Inc.

Reynolds Electrical and Engineering Co., Inc. 1991. *Nevada Test Site Inventory of Inactive and Abandoned Facilities and Waste Sites, Volumes 1-4*, DOE/NV/10630-18. Prepared for U.S. Department of Energy, 27 November. Las Vegas, NV.

Reynolds Electrical and Engineering Co., Inc. 1992. *Detailed Site Activity Summary NTS Cleanup and Restoration*.

Tamura, T. 1977. "Plutonium Distribution in a Desert Pavement–Desert Mound Soil System in Area 11." In *Environmental Plutonium on the Nevada Test Site and Environs*, NVO-171. June. Las Vegas, NV: Energy Research and Development Administration, Nevada Applied Ecology Group.

U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office. 2002. *Industrial Sites Quality Assurance Project Plan, Nevada Test Site, Nevada*, Rev. 3, DOE/NV--372. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2006. *Industrial Sites Project Establishment of Final Action Levels*, Rev. 0, DOE/NV--1107. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2010. *Corrective Action Investigation Plan for Corrective Action Unit 374: Area 20 Schooner Unit Crater, Nevada Test Site, Nevada*, Rev. 0, DOE/NV--1361. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1996. *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada*, DOE/EIS-0243. Las Vegas, NV.

Yu, C., A.J. Zielen, J.-J. Cheng, D.J. LePoire, E. Gnanapragasam, S. Kamboj, J. Arnish, A. Wallo III, W.A. Williams, and H. Peterson. 2001. *User's Manual for RESRAD Version 6*, ANL/EAD-4. Argonne, IL: Argonne National Laboratory, Environmental Assessment Division. (Version 6.4 released in December 2007.)

Appendix A

Corrective Action Investigation Results

A.1.0 Introduction

This appendix presents the CAI activities and analytical results for CAU 374. Corrective Action Unit 374 consists of five CASs located in Areas 18 and 20 of the NNSS (Figure A.1-1):

- 18-22-05, Drum
- 18-22-06, Drums (20)
- 18-22-08, Drum
- 18-23-01, Danny Boy Contamination Area
- 20-45-03, U-20u Crater (Schooner)

Corrective Action Site 20-45-03 (referred to as Schooner in this document) consists of the deposition of radioactive contamination as a result of the Schooner Plowshare test.

Corrective Action Site 18-23-01 (referred to as Danny Boy in this document) consists of the deposition of radioactive contamination as a result of the Danny Boy weapons-effects test.

Corrective Action Sites 18-22-06 and 18-22-08 both contain drums located adjacent to the Danny Boy crater and consist of releases to surrounding soil from potential source material (PSM) within the drums.

Corrective Action Site 18-22-05 is located at the Danny Boy crater and consists of four crushed drums inside the crater. No investigation was required at CAS 18-22-05 as predetermined in the DQOs and CAIP (NNSA/NSO, 2010a) due to the inaccessibility of the drums in the crater.

Additional information regarding the history of each site, planning, and the scope of the investigation is presented in the CAU 374 CAIP.

A.1.1 Project Objectives

The objective of the investigation was to provide sufficient information to complete corrective actions and support the recommendation for closure of each CAS in CAU 374. This objective was achieved by identifying the nature and extent of COCs; and by evaluating, selecting, and implementing acceptable CAAs.

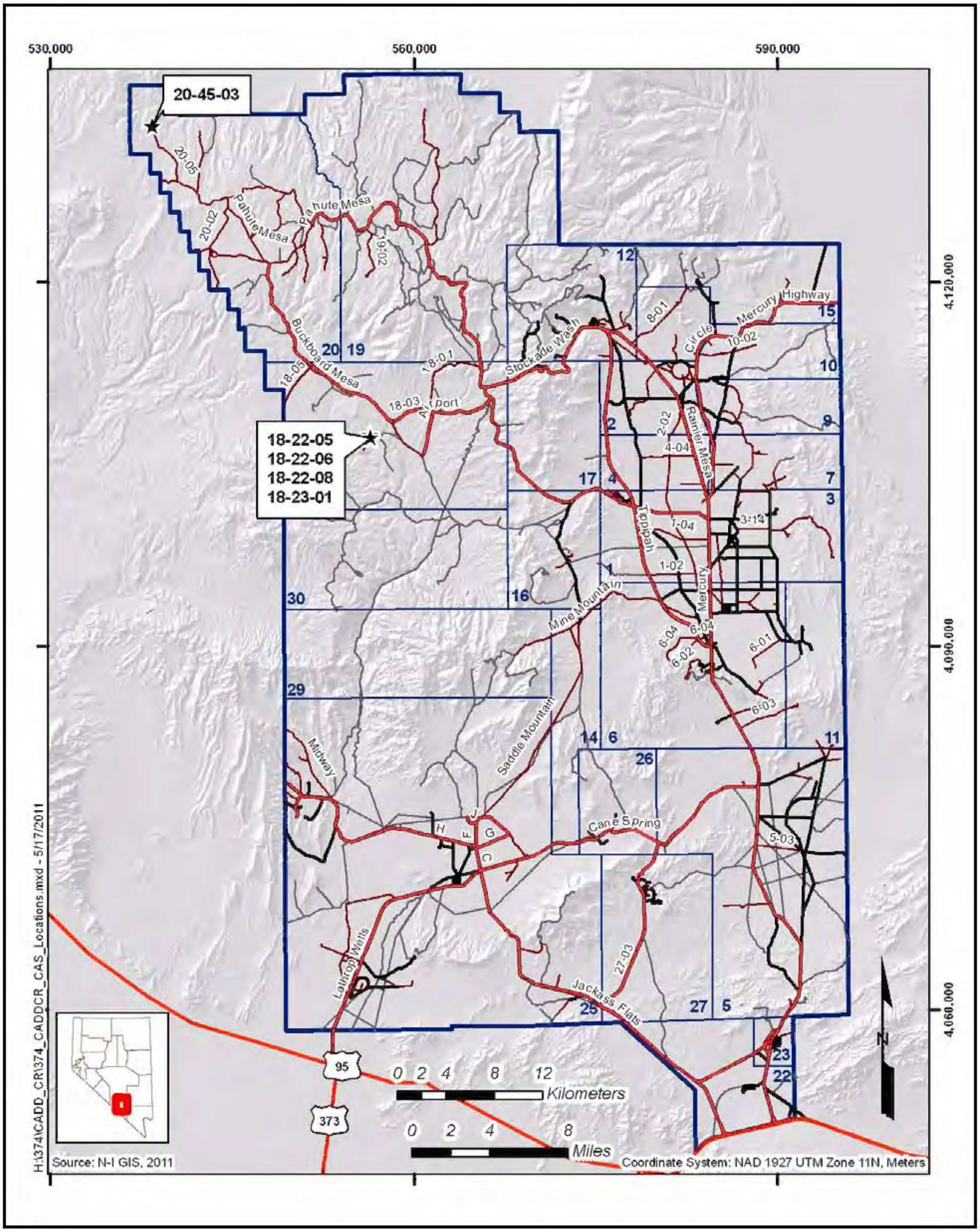


Figure A.1-1
CAU 374, CAS Location Map

For radiological contamination, a COC is defined as the presence of radionuclides that jointly present a dose to a receptor exceeding the FAL of 25 mrem/yr. For other types of contamination, a COC is defined as the presence of a contaminant at a concentration exceeding its corresponding FAL concentration (see Section A.2.5).

A.1.2 Contents

This appendix describes the investigation and presents the results. The contents of this appendix are as follows:

- Section A.1.0 describes the investigation background, objectives, and contents.
- Section A.2.0 provides an investigation overview.
- Sections A.3.0 through A.7.0 provide CAS-specific information regarding the field activities, sampling methods, and laboratory analytical results from investigation sampling.
- Section A.8.0 summarizes waste management activities.
- Section A.9.0 discusses the QA and QC processes followed and the results of QA/QC activities.
- Section A.10.0 provides a summary of the investigation results.
- Section A.11.0 lists the cited references.

The complete field documentation and laboratory data—including field activity daily logs, sample collection logs (SCLs), analysis request/chain-of-custody forms, soil sample descriptions, laboratory certificates of analyses, and analytical results—are retained in project files as hard copy files or electronic media.

A.2.0 Investigation Overview

The following field investigation and sampling activities for the CAU 374 CAI were conducted from May 4 through October 6, 2010:

- Inspected and verified the CAS components identified in the CAIP (NNSA/NSO, 2010a).
- Performed site walkovers to look for biased sampling locations.
- Conducted GWSs.
- Established sample plots and composite sample aliquot locations.
- Staged TLDs at soil sample plots, background locations, and additional locations of interest.
- Collected and submitted TLDs for analysis.
- Collected soil samples at sample plots and biased sampling locations.
- Submitted soil samples for offsite laboratory analysis.
- Collected Global Positioning System (GPS) coordinates of sample locations, TLD locations, and points of interest.
- Collected QC samples.

The investigation and sampling program adhered to the requirements set forth in the CAU 374 CAIP (NNSA/NSO, 2010a). Samples were collected, documented, and analyzed as prescribed in the CAIP. Quality control samples (e.g., duplicate samples) were collected as required by the Industrial Sites QAPP (NNSA/NV, 2002a) and the CAU 374 CAIP.

To facilitate site investigation and the evaluation of DQO decisions for different CSM components, the releases at each CAS were classified into one of the following two categories:

- **Primary releases –** This release category is specific to the atmospheric deposition of radionuclide contamination onto the soil surface outside the default contamination boundary that has not been displaced through excavation or migration. The contamination associated with the primary releases is limited to the top 5 cm of undisturbed soil. Sampling surface soils to a depth of 5 cm is appropriate for areas that have not been disturbed, as numerous studies of soils contaminated by atmospheric deposition after nuclear testing at the NNSS have shown that more than 90 percent of the radioactivity in undisturbed soil is contained within the top 5 cm of soil (McArthur and Kordas, 1983 and 1985; Gilbert et al., 1977; Tamura, 1977). Therefore, for the purposes of this CADD/CR, surface is defined as the upper 5 cm of soil.

- **Other releases –** This release category includes any radionuclide contamination from test activities that is not limited to the surface 5 cm of soil. This includes radionuclide contaminants that were initially deposited onto the soil surface (as in the primary release category) but have subsequently been displaced through excavation or migration. This category also includes radionuclides that were deposited under mechanisms other than atmospheric deposition. This includes the injection of radionuclides into native material from the nuclear detonation (such as in the Danny Boy and Schooner craters), the deposition of ejecta piles around the two craters, and any other chemical or radiological contamination discovered during the investigation through the identification of biasing factors that are not a part of a previously identified release. The depth of radiological contamination from other releases is dependent upon the nature of the release or subsequent movement through excavation or migration. Investigation of other releases was accomplished through measurements of soil contamination using a judgmental sampling scheme at depths dependent upon the nature of the release, or by conservative assumptions that contamination is present at depth based on process knowledge.

The CASs were investigated by collecting radiological dose measurements by posting TLDs and sampling of soils. The data collected at the site that contribute to the decisions made for site closure include (1) radiological walkover surveys of selected areas of the CASs, (2) laboratory analysis of the soil samples (i.e., internal dose component of the TED), and (3) analysis of the TLDs (i.e., external dose component of the TED).

The CAU 374 sampling locations were accessible and remained within anticipated spatial boundaries.

Sections A.2.1 through A.2.5 provide the general investigation and evaluation methodologies used at both CASs.

A.2.1 Sample Locations

Investigation locations selected for sampling were based on interpretation of site-specific GWSs and historical investigations (1994 aerial radiological survey [BN, 1999] and Radionuclide Inventory and Distribution Program (RIDP) data [DRI, 1988; Gray et al., 2007]). Soil sampling for the primary releases at CAU 374 consisted of collecting surface soil samples (as defined in Section A.2.0) within sample plots. Four composite samples were collected within each sample plot, and TLDs were located at the center of each sample plot. Each composite sample was composed of nine randomly located aliquots. The randomly located aliquot locations were identified using a predetermined random-start, triangular grid pattern. The random sample location coordinates were generated in Visual Sample Plan (VSP) software (PNNL, 2007).

Sample locations for other releases were selected based on visual identification of sediment collection areas in washes. Actual environmental sample locations are shown on the figures included in Sections A.3.0 and A.4.0.

Each sample location was recorded with a GPS instrument. Appendix G presents these data in a tabular format. The environmental sample and TLD sample locations for the CASs in CAU 374 are shown on Figures A.3-2 and A.4-2.

A.2.2 Investigation Activities

The investigation activities as listed in Section A.2.0 performed at CAU 374 were consistent with the field investigation activities stipulated in the CAU 374 CAIP (NNSA/NSO, 2010a). The investigation strategy provided the necessary information to establish the nature and extent of contamination associated with four of the five CAU 374 CASs. The following sections describe the specific investigation activities that took place at CAU 374.

A.2.2.1 Radiological Surveys

Aerial and ground-level radiological surveys were conducted at the Danny Boy and Schooner CASs. Aerial radiological surveys were performed at these sites in 1994 at an altitude of 200 feet (ft) with 500-ft flight-line spacing (BN, 1999).

Ground-level GWSs were performed to identify specific locations for sample plots and biased sample locations. Count-rate data were collected with a TSA Systems PRM-470 model plastic scintillator. Count-rate and position data were collected and recorded at 1-second intervals, via a Trimble Systems GeoXT GPS unit. The walkover speed was approximately 1 to 2 meters per second with the radiation detector held at a height of approximately 18 inches (in.) above the ground surface.

A.2.2.2 Field Screening

The CAS-specific sections of this document identify the locations where field screening was conducted and how the field-screening levels were used to aid in the selection of samples submitted for analysis. Field-screening results are recorded on SCLs that are retained in project files.

A.2.2.3 Soil Sampling

Soil sampling for the primary releases at CAU 374 consisted of collecting surface soil samples (as defined in Section A.2.0) within sample plots. Within each soil sampling plot, four composite samples were collected. Each sample comprised nine randomly located aliquots, resulting in a total of 36 randomly located aliquots collected from each plot. The randomly located aliquot locations were identified using a predetermined random-start, triangular grid pattern. Each aliquot was collected using a "vertical-slice cylinder and bottom-trowel" method. This required the vertical insertion of the 3.5-in. inside diameter cylinder to a depth of 5 cm, excavation of the outside soil along one side of the cylinder (to permit trowel placement), and horizontal insertion of a trowel along the bottom of the cylinder. This method captured a cylindrical-shaped section of the soil from 0 to 5 cm bgs.

After collection, each aliquot was carefully placed atop a sieve (#4 mesh) fitted into a bottom pan (with a plastic bag lining the pan, which limited dust generation during transfer to a sample container [1-gallon (gal) metal can]). Each aliquot was slowly sieved, and oversized material left atop the sieve was returned to the original sample location. After field screening, each sample was then transferred to an empty metal can. Each metal can was then sealed with a lid and a locking ring, and then shaken using a paint shaker for three minutes to homogenize the soil.

For sampling other release locations, the sampling locations were selected at sediment accumulation areas in the certain washes outside the Schooner and Danny Boy default contamination boundaries. These other release locations were sampled vertically from the surface to a maximum depth of 30 cm at 5-cm intervals. These samples were radiologically field screened, and the interval with the greatest FSR was to be sent to the laboratory for analysis.

A.2.2.4 Internal Dose Estimates

Internal dose was estimated using the radionuclide analytical results from soil samples and the corresponding RRMG (see Attachment C-1). The internal dose RRMG concentration for a particular radionuclide is that concentration in surface soil that would cause an internal dose to a receptor of 25 mrem/yr (under the appropriate exposure scenario) independent of any other radionuclide (assumes that no other radionuclides contribute dose). The internal dose RRMG for each detected radionuclide (in picocuries per gram [pCi/g] of soil) was derived using RESRAD computer code (Yu et al., 2001) under the appropriate exposure scenario (see Attachment C-1).

The total internal dose corresponding to each surface sample was calculated by adding the dose contribution from each radionuclide. For each sample, the radionuclide-specific analytical result was divided by its corresponding internal RRMG to yield a fraction of the 25-mrem/yr dose. The fractions for all radionuclides detected in a soil sample were summed to yield a total fraction for that sample. The sum of fractions was then multiplied by 25 to yield an internal dose estimate (in mrem/yr) at that sample location. For the primary release samples, a 95 percent UCL was calculated for the internal dose in a sample plot using the results of all soil samples collected in that plot. For other release sample locations where only one sample was collected, statistical inferences could not be calculated, and the single analytical result was used to calculate the internal dose.

For TLD locations where soil samples were not collected, the internal dose was estimated using the external dose measurement from the TLD and the internal to external dose ratio from the CAS-specific plot with the maximum internal dose. The internal dose for each of these locations was calculated by multiplying this ratio (from the plot with the maximum internal dose) by the external dose value specific to each location.

A.2.2.5 External Dose Measurements

Thermoluminescent dosimeters (Panasonic UD-814) were staged at Schooner and Danny Boy with the objective of collecting *in situ* measurements to determine the external radiological dose. The TLDs were placed in background areas (beyond the influence of CAS releases), at the approximate center of each sample plot, and at other biased locations. Each TLD was placed at a height of 1 m above the ground surface to be consistent with TLD placement in the NNSS Environmental

Monitoring Program (see Section A.9.0). Once retrieved from the field locations, the TLDs were submitted to the Environmental Technical Services group for analysis. The TLD results are discussed in Sections A.3.2.1 and A.4.2.1

The TLDs were analyzed using automated TLD readers that are calibrated and maintained by the NNSS management and operating (M&O) contractor. This approach allowed for the use of existing QC procedures for TLD processing. Details of the environmental monitoring TLD program and TLD QC are presented in Section A.9.0. All readings conformed to the approved QC program and are considered representative of the external radiological dose at each location.

The Panasonic UD-814 TLD used in the CAU 374 investigation contains four individual elements. The readings from each element are compared as part of the routine QA checks during the TLD processing. External dose at each TLD location is then determined using the readings from TLD elements 2, 3, and 4. Each of these elements is considered to be an independent measurement of external dose. A 95 percent UCL of the average was calculated for each TLD location. Element 1 is designed to measure dose to the skin and is not relevant to the determination of the external dose for the purpose of this investigation.

Estimates of external dose, in mrem/IA-yr, at the CAU 374 sites are presented as net values (i.e., the dose from control TLDs and from the natural or “field” background has been subtracted from the raw result). The control TLDs measured the amount of dose received by the TLDs before being deployed in the field. The “field” background TLDs measured the amount of dose received by TLDs in areas unaffected by the CASs.

A.2.3 Total Effective Dose

The TED represents the sum of the internal dose (calculated from soil sample results) and the external dose (calculated from TLD measurements) for each sample location. The average TED calculated from sample results is an estimate of the true (unknown) TED. It is uncertain how well the average TED represents the true TED. If an average TED were directly compared to the FAL, any significant difference between the true TED and the sample TED could lead to decision errors. To reduce the probability of a false negative decision error, a conservative estimate of the true TED is used to compare to the FAL. This conservative estimate of the true TED was calculated as the 95 percent

UCLs of the TED calculated as the sum of the 95 percent UCLs of the internal and external doses. By definition, there will be a 95 percent probability that the true TED is less than the 95 percent UCL of the calculated average TED.

A.2.4 Laboratory Analytical Information

Radiological analyses of the collected soil samples were performed by GEL Laboratories, LLC, of Charleston, South Carolina. The analytical suites and laboratory analytical methods used to analyze investigation samples are listed in Table A.2-1. Analytical results are reported in this appendix if they were detected above the minimum detectable concentrations (MDCs). The complete laboratory data packages are available in the project files.

Validated analytical data for CAU 374 investigation samples have been compiled and evaluated to determine the presence of COCs and to define the extent of COC contamination if present. The validated results of the radiochemical analyses were evaluated for only those radionuclides that contribute to an internal dose (see Appendix C). The analytical results for Schooner and Danny Boy are presented in Sections A.3.0 and A.4.0.

The analytical parameters were selected through the application of site process knowledge as described in the CAIP (NNSA/NSO, 2010a).

A.2.5 Comparison to Action Levels

The radiological PALs and FALs are based on an annual dose limit of 25 mrem/yr. This dose limit is specific to the annual dose a receptor could potentially receive from a CAU 374 release. As such, it is dependent upon the cumulative annual hours of exposure to site contamination. The PALs were established in the CAIP (NNSA/NSO, 2010a) based on a dose limit of 25 mrem/yr over an annual exposure time of 2,250 hours (i.e., the Industrial Area exposure scenario that a site worker would be exposed to site contamination for 225 day/yr and 10 hr/day). The FALs were established in Appendix C based on a dose limit of 25 mrem/yr over an annual exposure time of 336 hours (i.e., the Remote Work Area exposure scenario that a site worker would be exposed to site contamination for 42 day/yr and 8 hr/day).

Table A.2-1
Laboratory Analyses and Methods, CAU 374 Investigation Samples[a]

Analysis	Analytical Method[b]
Isotopic U	Aqueous/Non-aqueous - DOE EML HASL-300[c] U-02-RC
Isotopic Pu	Aqueous - DOE EML HASL-300[c] Pu-10-RC Non-aqueous - DOE EML HASL-300[c] Pu-02-RC
Isotopic Am	Aqueous - DOE EML HASL-300[c] Am-03-RC Non-aqueous - DOE EML HASL-300[d] Am-01-RC
Gamma Spectroscopy	Aqueous - EPA 901.1[d] Non-aqueous - DOE EML HASL-300[c] Ga-01-R
Sr-90	Aqueous - EPA 905.0[d] Non-aqueous - DOE EML HASL-300[c] Sr-02-RC
VOCs	EPA SW-846 8260B[e]
SVOCs	EPA SW-846 8270C[e]
TPH-DRO	EPA SW-846 8015B[e] (modified)
RCRA Metals[f]	EPA SW-846 6010B/7470A/7471A[e]
PCBs	EPA SW-846 8082[e]
TCLP Metals[f]	EPA SW-846 1311/6010B/7470A[e]

[a]Investigation samples include both environmental and associated QC samples.
[b]The most current EPA, DOE, ASTM, NIOSH, or equivalent accepted analytical method may be used, including approved Laboratory Standard Operating Procedures (NNES, 2009).
[c]*The Procedures Manual of the Environmental Measurements Laboratory* (DOE, 1997).
[d]*Prescribed Procedures for Measurement of Radioactivity in Drinking Water* (EPA, 1980).
[e]*Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, 3rd edition,* Parts 1-4, SW-846 CD-ROM (EPA, 1996).
[f]Arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver

Am = Americium
ASTM = ASTM International
DRO = Diesel-range organics
EML = Environmental Measurements Laboratory
EPA = U.S. Environmental Protection Agency
HASL = Health and Safety Laboratory
NIOSH = National Institute for Occupational Safety and Health
PCB = Polychlorinated biphenyl
Pu = Plutonium
RCRA = *Resource Conservation and Recovery Act*
TCLP = Toxicity Characteristic Leaching Procedure
TPH = Total petroleum hydrocarbons
Sr = Strontium
SVOC = Semivolatile organic compound
U = Uranium
VOC = Volatile organic compound

Results for both the primary releases and other releases are presented in Sections A.3.2 and A.4.2. Radiological results are reported as doses that are comparable to the dose-based FAL as established in Appendix C. Chemical results are reported as individual concentrations that are comparable to the individual chemical action levels as established in Appendix C. Results that are equal to or greater than FALs are identified by bold text in the CAS-specific results tables (see Sections A.3.0 and A.4.0).

A COC is defined as any contaminant present in environmental media exceeding a FAL. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple constituent analysis (NNSA/NSO, 2006). If COCs are present, corrective action must be considered for the CAS.

A corrective action may also be required if a waste present within a CAS contains contaminants that, if released, could cause the surrounding environmental media to contain a COC. Such a waste would be considered PSM. To evaluate wastes for the potential to result in the introduction of a COC to the surrounding environmental media, the conservative assumption was made that any physical waste containment would fail at some point, and the contaminants would be released to the surrounding media. The following will be used as the criteria for determining whether a waste is PSM:

- A waste, regardless of concentration or configuration, may be assumed to be PSM and handled under a corrective action.

- Based on process knowledge and/or professional judgment, some waste may be assumed to not be PSM if it is clear that it could not result in soil contamination exceeding a FAL.

- If assumptions about the waste cannot be made, then the waste material will be sampled, and the results will be compared to FALs based on the following criteria:

    - For non-liquid wastes, the concentration of any chemical contaminant in soil (after degradation of the waste and release of contaminants into soil) would be equal to the mass of the contaminant in the waste divided by the mass of the waste. If the resulting soil concentration exceeds the FAL, then the waste would be considered to be PSM.

    - For non-liquid wastes, the dose resulting from radioactive contaminants in soil (after degradation of the waste and release of contaminants into soil) would be calculated using the activity of the contaminant in the waste divided by the mass of the waste (for each radioactive contaminant) and calculating the combined resulting dose using the RESRAD code (Murphy, 2004). If the resulting soil concentration exceeds the FAL, then the waste would be considered to be PSM.

    - For liquid wastes, the resulting concentration of contaminants in the surrounding soil will be calculated based on the concentration of contaminants in the waste and the liquid holding capacity of the soil. If the resulting soil concentration exceeds the FAL, then the liquid waste would be considered to be PSM.

A.3.0 CAS 20-45-03, Schooner

Corrective Action Site 20-45-03 is located in the north-central portion of Area 20 of the NNSS and consists of the deposition of radioactive contamination as a result of the Schooner test, a Plowshare test. Additional detail on the history of Schooner is provided in the CAIP (NNSA/NSO, 2010a).

A.3.1 Corrective Action Investigation Activities

A total of 47 environmental samples and 2 FDs (primary release samples from 12 sample plots), and 5 other release samples from runoff sedimentation areas (4 environmental samples and 1 FD) were collected during investigation activities at Schooner. Plot BX could not be sampled as described in Section A.2.2.3 for plot sampling due to the rocky (boulder-like) nature of the substrate. A single grab sample was collected at this plot. All primary release samples and the other release samples from the sedimentation areas were analyzed for gamma spectroscopy, Am-241, Sr-90, isotopic Pu, and isotopic U. The sedimentation area samples were also analyzed for SVOCs, VOCs, PCBs, DRO, and total metals. The sample locations, numbers, depth, matrix, and purpose are listed in Table A.3-1. A total of 68 TLDs (4 "field" background locations and 64 CAS locations) were collected during investigation activities at Schooner to measure external dose. The TLD locations, numbers, dates placed and removed, and purpose are listed in Table A.3-2. The specific CAI activities conducted to satisfy the CAIP requirements at this CAS (NNSA/NSO, 2010a) are described in the following sections.

Table A.3-1
Soil Samples Collected at Schooner
(Page 1 of 3)

Sample Plot or Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
BA	374BA01	0 - 5	Soil	Environmental
	374BA02	0 - 5	Soil	Environmental
	374BA03	0 - 5	Soil	Environmental
	374BA04	0 - 5	Soil	Environmental

Table A.3-1
Soil Samples Collected at Schooner
(Page 2 of 3)

Sample Plot or Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
BB	374BB01	0 - 5	Soil	Environmental
	374BB02	0 - 5	Soil	Environmental
	374BB03	0 - 5	Soil	Environmental
	374BB04	0 - 5	Soil	Environmental
BC	374BC01	0 - 5	Soil	Environmental
	374BC02	0 - 5	Soil	Environmental
	374BC03	0 - 5	Soil	Environmental
	374BC04	0 - 5	Soil	Environmental
	374BC05	0 - 5	Soil	FD of 374BC04
BD	374BD01	0 - 5	Soil	Environmental, Full Lab QC
	374BD02	0 - 5	Soil	Environmental
	374BD03	0 - 5	Soil	Environmental
	374BD04	0 - 5	Soil	Environmental
BE	374BE01	0 - 5	Soil	Environmental
	374BE02	0 - 5	Soil	Environmental
	374BE03	0 - 5	Soil	Environmental
	374BE04	0 - 5	Soil	Environmental
BF	374BF01	0 - 5	Soil	Environmental, Full Lab QC
	374BF02	0 - 5	Soil	Environmental
	374BF03	0 - 5	Soil	FD of 374BF02
	374BF04	0 - 5	Soil	Environmental
	374BF05	0 - 5	Soil	Environmental
BG	374BG01	0 - 5	Soil	Environmental
	374BG02	0 - 5	Soil	Environmental
	374BG03	0 - 5	Soil	Environmental
	374BG04	0 - 5	Soil	Environmental

Table A.3-1
Soil Samples Collected at Schooner
(Page 3 of 3)

Sample Plot or Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
BH	374BH01	0 - 5	Soil	Environmental
	374BH02	0 - 5	Soil	Environmental
	374BH03	0 - 5	Soil	Environmental
	374BH04	0 - 5	Soil	Environmental
BX	374BX004	0 - 5	Soil	Environmental
BK	374BK01	0 - 5	Soil	Environmental
	374BK02	0 - 5	Soil	Environmental
	374BK03	0 - 5	Soil	Environmental
	374BK04	0 - 5	Soil	Environmental
BL	374BL01	0 - 5	Soil	Environmental
	374BL02	0 - 5	Soil	Environmental
	374BL03	0 - 5	Soil	Environmental
	374BL04	0 - 5	Soil	Environmental, Full Lab QC
BM	374BM01	0 - 5	Soil	Environmental
	374BM02	0 - 5	Soil	Environmental
	374BM03	0 - 5	Soil	Environmental
	374BM04	0 - 5	Soil	Environmental
BT65 (sedimentation sample)	374BX003	0 - 5	Soil	Environmental, Full Lab QC
BT66 (sedimentation sample)	374BX001	5 - 10	Soil	Environmental
	374BX002	5 - 10	Soil	FD of 374BX01
BT67 (sedimentation sample)	374BX006	10 - 15	Soil	Environmental
BT68 (sedimentation sample)	374BX005	0 - 5	Soil	Environmental

Table A.3-2
TLDs at Schooner
(Page 1 of 3)

TLD Location	TLD No.	Date Placed	Date Removed	Purpose
BT01	4969	05/04/2010	08/19/2010	TLD only
BT02	4692	05/04/2010	08/24/2010	TLD only
BT03	5281	05/05/2010	08/24/2010	TLD only
BT04	4943	05/05/2010	08/24/2010	TLD only
BT05	5119	05/05/2010	08/24/2010	TLD only
BT06	5282	05/04/2010	08/19/2010	TLD only
BT07	4925	05/05/2010	08/24/2010	TLD only
BT08	5153	05/05/2010	10/05/2010	TLD only
BT09	4854	05/05/2010	10/05/2010	TLD only
BT10	4959	05/03/2010	10/05/2010	TLD only
BT11	5125	05/06/2010	10/05/2010	TLD only
BT12	4425	05/04/2010	08/24/2010	TLD and sample plot BG
BT13	4744	05/04/2010	08/24/2010	TLD and sample plot BF
BT14	4622	05/04/2010	08/24/2010	TLD and sample plot BE
BT15	4919	05/04/2010	08/24/2010	TLD only
BT16	5069	05/05/2010	08/24/2010	TLD only
BT17	4728	05/05/2010	08/24/2010	TLD only
BT18	4944	05/05/2010	08/24/2010	TLD only
BT19	4393	05/05/2010	08/24/2010	TLD only
BT20	5285	05/05/2010	08/24/2010	TLD and sample plot BM
BT21	5261	05/05/2010	08/24/2010	TLD and sample plot BL
BT22	4431	05/05/2010	08/24/2010	TLD and sample plot BK
BT23	5170	05/05/2010	08/24/2010	TLD and sample plot BX
BT24	4360	05/03/2010	08/19/2010	TLD only
BT25	4500	05/03/2010	08/19/2010	TLD only
BT26	4501	05/03/2010	08/19/2010	TLD only
BT27	5287	05/03/2010	08/19/2010	TLD only
BT28	4660	05/03/2010	08/19/2010	TLD only
BT29	4570	05/03/2010	08/19/2010	TLD only

Table A.3-2
TLDs at Schooner
(Page 2 of 3)

TLD Location	TLD No.	Date Placed	Date Removed	Purpose
BT30	4413	05/03/2010	08/19/2010	TLD only
BT31	4523	05/03/2010	08/19/2010	TLD only
BT32	4365	05/03/2010	08/19/2010	TLD and sample plot BC
BT33	4486	05/03/2010	08/19/2010	TLD and sample plot BB
BT34	4795	05/03/2010	08/19/2010	TLD and sample plot BA
BT35	4621	05/03/2010	08/19/2010	TLD only
BT36	4452	05/04/2010	08/19/2010	TLD only
BT37	4735	05/04/2010	08/19/2010	TLD only
BT38	4642	05/04/2010	08/19/2010	TLD only
BT39	4426	05/04/2010	08/19/2010	TLD only
BT40	5087	05/04/2010	08/19/2010	TLD only
BT41	4322	05/04/2010	08/19/2010	TLD only
BT42	4463	05/04/2010	08/19/2010	TLD only
BT43	4412	05/04/2010	08/19/2010	TLD only
BT44	5290	05/05/2010	08/24/2010	Field Background TLD
BT45	4896	05/06/2010	08/24/2010	Field Background TLD
BT46	4624	05/05/2010	10/05/2010	Field Background TLD
BT47	4324	05/05/2010	10/05/2010	Field Background TLD
BT48	1942	06/22/2010	10/05/2010	TLD and sample plot BH
BT49	3714	06/22/2010	10/05/2010	TLD only
BT50	3557	06/21/2010	10/05/2010	TLD only
BT51	1868	06/21/2010	10/05/2010	TLD only
BT52	3710	06/21/2010	10/05/2010	TLD only
BT53	1463	06/21/2010	10/05/2010	TLD only
BT54	3877	06/21/2010	10/05/2010	TLD only
BT55	3693	06/21/2010	10/05/2010	TLD only
BT56	1462	06/18/2010	10/05/2010	TLD only
BT57	4076	06/18/2010	10/05/2010	TLD only
BT58	4088	06/18/2010	10/05/2010	TLD and sample plot BD

Table A.3-2
TLDs at Schooner
(Page 3 of 3)

TLD Location	TLD No.	Date Placed	Date Removed	Purpose
BT59	4139	06/18/2010	10/05/2010	TLD only
BT60	3925	06/21/2010	10/05/2010	TLD only
BT61	3819	06/21/2010	10/05/2010	TLD only
BT62	1691	06/21/2010	10/05/2010	TLD only
BT63	1616	06/22/2010	10/05/2010	TLD only
BT64	3659	06/21/2010	10/05/2010	TLD only
BT65	3431	06/28/2010	10/05/2010	TLD and sedimentation sample location
BT66	4067	06/28/2010	10/05/2010	TLD and sedimentation sample location
BT67	1318	06/28/2010	10/05/2010	TLD and sedimentation sample location
BT68	4286	06/28/2010	10/05/2010	TLD and sedimentation sample location

A.3.1.1 Visual Inspections

Visual inspections of the Schooner site were conducted over the course of the field investigation including site walks, sampling efforts, and radiological surveys. While walking over the site, four intact lead-acid batteries were found and collected for recycling. There were no biasing factors at the site, and no additional samples were collected as a result of the visual inspection.

A.3.1.2 Radiological Surveys

Global Positioning System-assisted GWSs were performed at Schooner during the CAI. The GWSs were conducted in the fallout plume area outside the default contamination boundary surrounding the crater, and along washes leading away from crater to identify the spatial distribution of the radiological readings, identify the locations of the highest radiological readings, and to confirm the location of the fallout plume. Data were post-processed, loaded into a geographical information system, color-coded, and displayed on a map of Schooner. The results of the GWS showed that the gamma radiation readings are higher closer to the crater and confirmed that the fallout plume was positioned as expected. Figure A.3-1 provides the results of the GWSs.

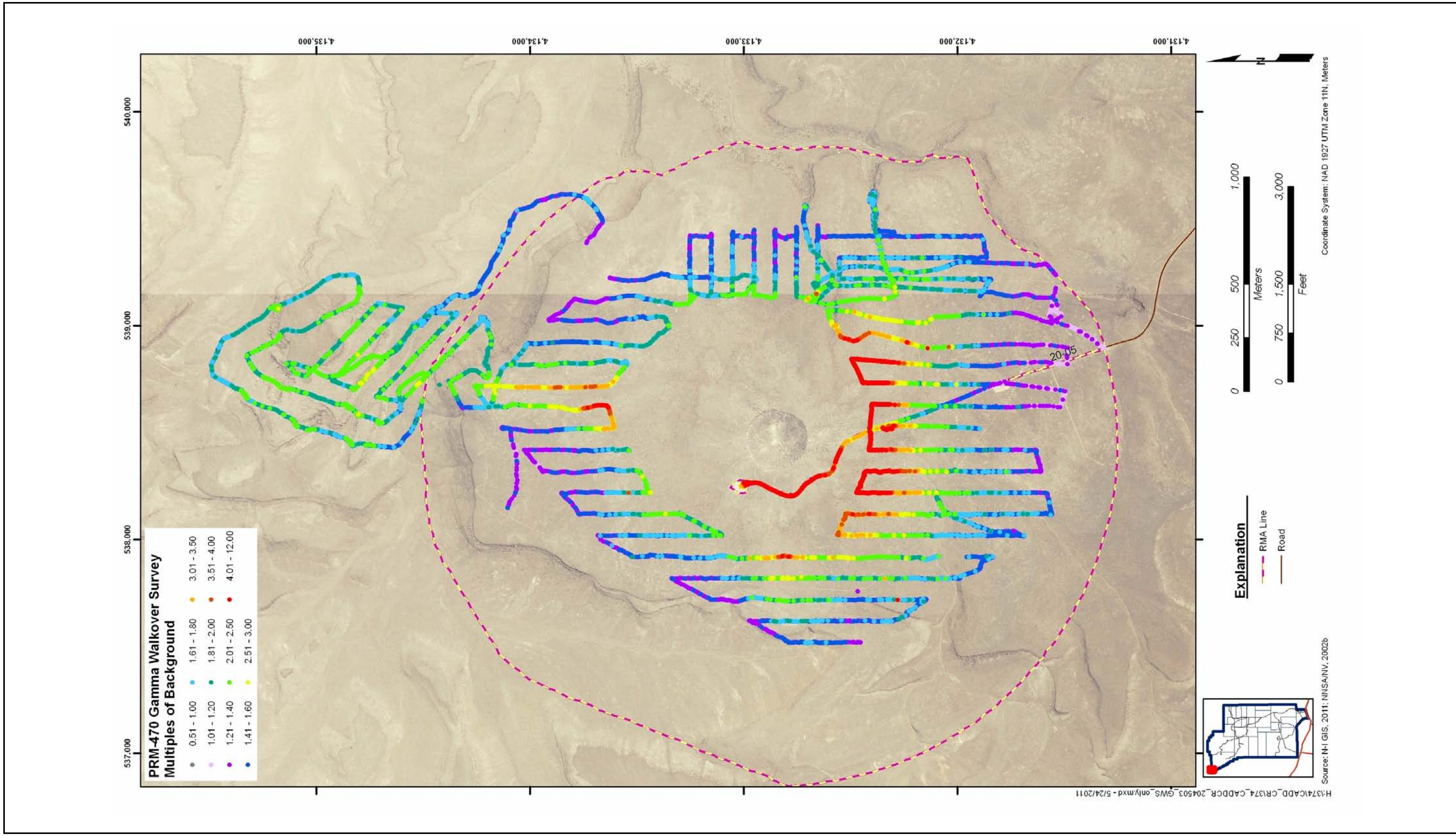


Figure A.3-1
Gamma Walkover Surveys of Selected Locations at Schooner

The GWSs were conducted across the fallout plume and were used in addition to the 1994 aerial radiological survey (BN, 1999) to determine the locations of the vector soil sample plots at Schooner. Sample locations were selected along the plume and in the washes (Figure A.3-2).

A.3.1.3 TLD Samples

The TLDs were installed at 68 locations (BT01 through BT68) at Schooner as listed in Table A.3-2. Four of these TLDs (BT44 through BT47) were placed to measure "field" background. The TLDs BT01 through BT43 and BT48 through BT64 were used at Schooner to measure external doses. Four other TLDs (BT65 through BT68) were located at sediment areas. All TLDs were included in the routine quarterly read of the NNSS environmental monitoring TLDs. Details of the environmental monitoring TLD program and TLD QC are presented in Section A.9.0. See Figure A.3-2 for all TLD locations and Figure A.3-3 for the four background TLD locations in relationship to naturally occurring background. Sample plots were placed at 12 TLD locations as shown in Figure A.3-2 and discussed in the following subsection.

A.3.1.4 Soil Samples

Sampling activities at Schooner for the determination of internal dose at the sample plot consisted of collecting 4 primary release composite surface soil (defined in Section A.2.0) samples at 11 plots (BA, BB, BC, BD, BE, BF, BG, BH, BK, BL, BM). A 12th plot (Plot BX) was not sampled by combining aliqouts, but was represented by a single sample instead due to the rocky (boulder-like) nature of the substrate. All sample locations (Table A.3-1) are shown on Figure A.3-2.

A total of 45 environmental samples and 2 FDs (primary release samples from the 12 sample plots), and 5 other release samples from runoff sedimentation areas (4 environmental samples and 1 FD) were collected during investigation activities at Schooner. All primary release samples and the other release samples from the sedimentation areas were analyzed for gamma spectroscopy, Am-241, Sr-90, isotopic Pu, and isotopic U. The sedimentation area samples were also analyzed for SVOCs, VOCs, PCBs, DRO, and total metals.

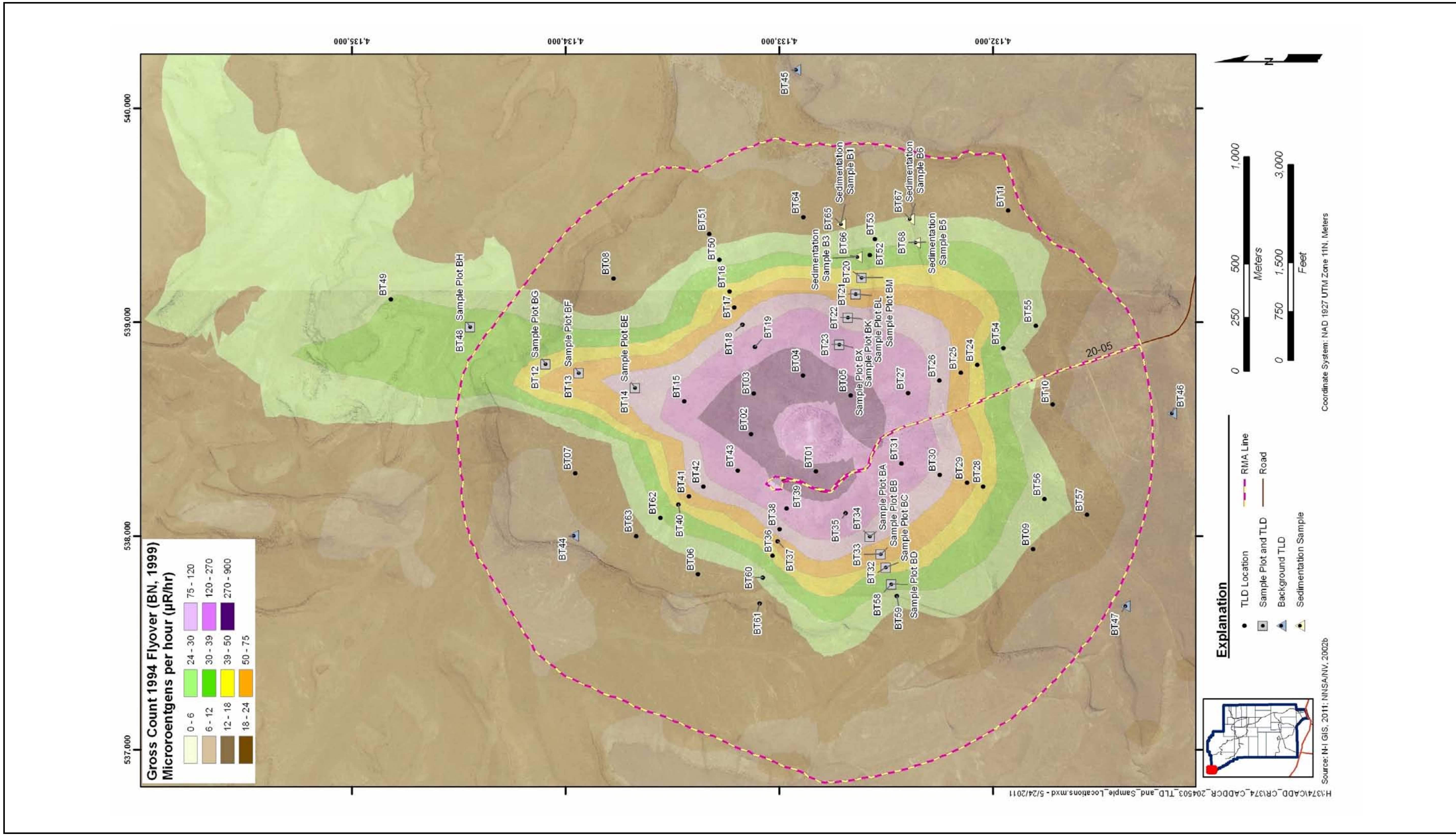


Figure A.3-2
Schooner TLD and Sample Locations

A.3.1.5 Field Screening

The FSRs were used for selection of the vertical samples collected from the sediment accumulation areas (locations BT65, BT66, BT67, and BT68). Screening samples were collected in 5-cm intervals from 0 to 30 cm bgs from each of the four locations except for location BT65, where refusal was encountered during the 15- to 20-cm screening interval. Because the samples collected at 0 to 5 cm exhibited the highest values, the 0- to 5-cm interval samples were submitted to the laboratory for analysis at sediment accumulation area locations BT65 and BT68. The 5- to 10-cm interval was selected and submitted for BT66, and the 10- to 15-cm interval was selected and submitted for BT67, as they exhibited the highest field-screening values. These field-screening data were recorded on SCLs, which are retained in the project files.

A.3.1.6 Deviations

Plot BX was not sampled per plot sampling methods but was represented by a single judgmental sample instead due to the rocky (boulder-like) nature of the substrate. No other deviations to the CAU 374 CAIP (NNSA/NSO, 2010a) were noted.

A.3.2 Investigation Results

The following sections present the analytical and computational results for soil and TLD samples. All sampling and analyses were conducted as specified in the CAU 374 CAIP (NNSA/NSO, 2010a). The radiological results are reported as doses that are comparable to the dose-based FALs as established in Appendix C. Chemical results are reported as individual concentrations for comparison to FALs. Results that are equal to or greater than FALs are identified by bold text in the results tables.

A minimum number of samples is required to assure sufficient confidence in the calculation of the 95 percent UCL (EPA, 2006). As stated in the CAIP, if the minimum sample size criterion cannot be met, it must be assumed that contamination exceeds the FAL. The calculation of minimum sample size is described in Section B.1.1.1.1.

The internal dose calculated from the analytical results from the soil samples, and the external dose calculated from TLD measurements were combined to provide the TED for each sample location.

External doses for TLD locations are summarized in Section A.3.2.1. Internal doses for each sample plot are summarized in Section A.3.2.2. The TEDs for each sampled location are summarized in Section A.3.2.3. Results for other releases are summarized in Section A.3.2.4.

A.3.2.1 External Radiological Dose Measurements

The external dose estimates at each sample location were derived from the TLDs. The external dose for each TLD location was calculated for the Industrial Worker exposure scenario and then scaled, based on exposure duration, to the Remote Work Area and Occasional Use exposure scenarios. The minimum sample size was met for all TLD locations. The values for the individual elements in each TLD are presented in Appendix F. The 95 percent UCL of external dose for each exposure scenario is presented in Table A.3-3.

Table A.3-3
Schooner 95% UCL External Dose for Each Exposure Scenario
(Page 1 of 3)

Plot or Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
BT01	**203.8**	**30.4**	7.24
BT02	**268.6**	**40.1**	9.55
BT03	**375.0**	**56.0**	13.3
BT04	**242.1**	**36.2**	8.61
BT05	**141.0**	21.1	5.01
BT06	5.91	0.883	0.210
BT07	5.23	0.781	0.186
BT08	1.61	0.241	0.057
BT09	7.26	1.08	0.258
BT10	4.98	0.743	0.177
BT11	4.14	0.619	0.147
BT12/Plot BG	20.2	3.02	0.718
BT13/Plot BF	**47.6**	7.10	1.69
BT14/Plot BE	**85.9**	12.8	3.05
BT15	**92.0**	13.7	3.27
BT16	14.2	2.12	0.504
BT17	**33.0**	4.93	1.17

Table A.3-3
Schooner 95% UCL External Dose for Each Exposure Scenario
(Page 2 of 3)

Plot or Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
BT18	**48.8**	7.28	1.73
BT19	**73.9**	11.0	2.63
BT20/Plot BM	15.2	2.28	0.542
BT21/Plot BL	21.1	3.15	0.751
BT22/Plot BK	**25.1**	3.75	0.892
BT23/Plot BX	**57.8**	8.63	2.06
BT24	14.8	2.21	0.526
BT25	**25.3**	3.78	0.900
BT26	**36.6**	5.46	1.30
BT27	**97.5**	14.6	3.47
BT28	23.9	3.56	0.849
BT29	**25.0**	3.74	0.889
BT30	**50.6**	7.55	1.80
BT31	**118.1**	17.6	4.20
BT32/Plot BC	20.2	3.01	0.717
BT33/Plot BB	**39.4**	5.89	1.40
BT34/Plot BA	**47.6**	7.11	1.69
BT35	**254.1**	**37.9**	9.04
BT36	11.3	1.68	0.401
BT37	20.3	3.04	0.723
BT38	27.0	4.03	0.959
BT39	**104.4**	15.6	3.71
BT40	**28.4**	4.24	1.01
BT41	**59.9**	8.95	2.13
BT42	**82.8**	12.4	2.94
BT43	**153.4**	22.9	5.45
BT48/Plot BH	4.77	0.712	0.169
BT49	7.70	1.15	0.274
BT50	0[a]	0[a]	0[a]
BT51	0[a]	0[a]	0[a]

Table A.3-3
Schooner 95% UCL External Dose for Each Exposure Scenario
(Page 3 of 3)

Plot or Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
BT52	0[a]	0[a]	0[a]
BT53	0[a]	0[a]	0[a]
BT54	0[a]	0[a]	0[a]
BT55	0[a]	0[a]	0[a]
BT56	0[a]	0[a]	0.0
BT57	0[a]	0[a]	0[a]
BT58/Plot BD	2.2	0.32	0.1
BT59	0[a]	0[a]	0[a]
BT60	0[a]	0[a]	0[a]
BT61	0[a]	0[a]	0[a]
BT62	0[a]	0[a]	0[a]
BT63	0[a]	0[a]	0[a]
BT64	0[a]	0[a]	0[a]
BT65	0[a]	0[a]	0[a]
BT66	4.50	0.672	0.160
BT67	3.20	0.477	0.114
BT68	15.8	2.35	0.561

[a]Where the net reading was less than zero, a value of zero was used.

Bold indicates the values exceeding 25 mrem/yr.

The area affected by the Schooner detonation is quite large. The large area encompasses a land mass with varied geology and notable changes in elevation, both of which may impact the exposure that would be recorded on a TLD due to the effects of naturally occurring radiation. To aid in determining the proper background dose to be used to correct the site investigation TLD readings, a background isopleth map was generated from the 1994 aerial radiation survey (BN, 1999). This map was used to select and emplace the background TLDs (Figure A.3-3).

Figure A.3-3 is interesting in that it shows that the count-rate from naturally occurring radionuclides in the area immediately surrounding the Schooner crater *is less than* the count-rates over the more distant areas. This suggests that the detonation excavated, and deposited around the crater, a geologic

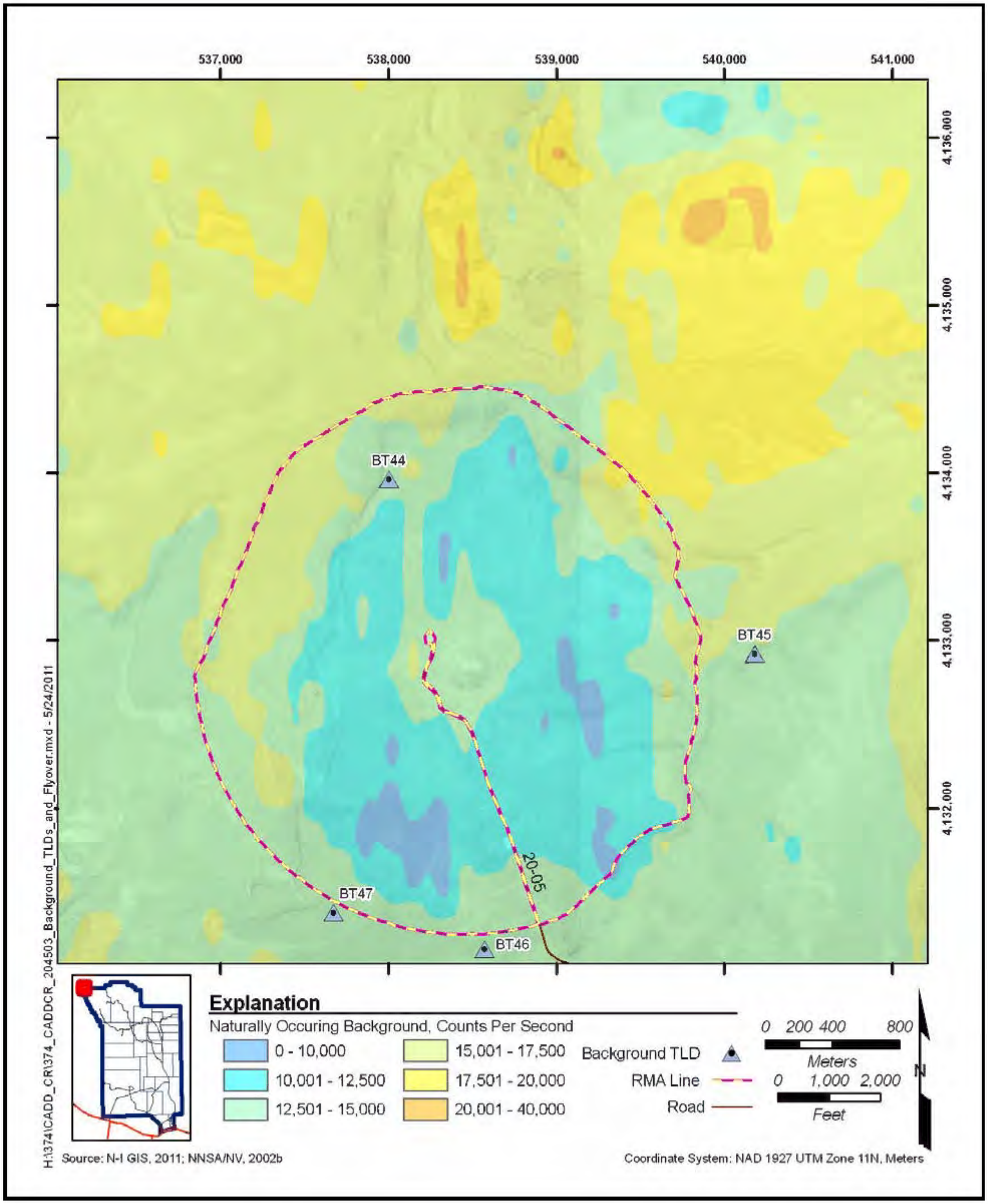


Figure A.3-3
Schooner TLD and Sample Locations

material with a composition that is lower in naturally occurring radioactive material. This is further supported by a review of the soil sample analytical data, which shows that some soil samples have a higher activity-concentration of potassium (K)-40 (a naturally occurring radionuclide in soils). Because the deposition of geologic material with a lower level of naturally occurring radioactive material is an artificial condition and does not reflect the actual undisturbed site conditions, background TLDs were emplaced at locations that were not affected by this phenomena. Figure A.3-3 shows the selected locations for the background TLDs.

The background TLD locations are representative of the undisturbed area and can be used as a good estimate of true average background dose for all of the environmental TLDs. The background dose at CAU 374 was determined to be the average of the background TLD results from locations BT44 through BT47, which is 3.4 mrem/IA-yr.

At Schooner, several site investigation TLDs were emplaced at locations that were within the area of lower naturally occurring radioactive material but outside the radioactive plume from the detonation (Figure A.3-2). The consequence of this condition is that, after the subtraction of the background, several site investigation TLDs yielded negative values. These values are valid and mathematically correct. Negative values were, however, reported as zero values for the ease of data interpretation (Table A.3-3).

A.3.2.2 Internal Radiological Dose Estimations

Estimates for the internal dose that a receptor would receive at each sample plot at Schooner were determined as described in Section A.2.2.4. For TLD locations where soil samples were not collected, the internal to external dose ratio from the plot with the maximum amount of internal dose was used to estimate internal dose. The maximum internal dose was at plot BA, and the internal to external dose ratio at this site was 0.109.

Data tables listing the analytical results for individual radionuclides in each composite sample is presented in Appendix F. The 95 percent UCL of internal dose for each exposure scenario is presented in Table A.3-4.

Table A.3-4
Schooner 95% UCL Internal Dose for Each Exposure Scenario
(Page 1 of 3)

Plot or Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
BT01	22.2	3.87	1.37
BT02	**29.2**	5.10	1.80
BT03	**40.8**	7.12	2.52
BT04	**26.3**	4.59	1.63
BT05	15.3	2.68	0.947
BT06	0.643	0.112	0.040
BT07	0.569	0.099	0.035
BT08	0.176	0.031	0.011
BT09	0.789	0.138	0.049
BT10	0.541	0.094	0.033
BT11	0.451	0.079	0.028
BT12/Plot BG	1.47	0.256	0.091
BT13/Plot BF	2.11	0.368	0.130
BT14/Plot BE	4.57	0.797	0.282
BT15	10.0	1.75	0.618
BT16	1.54	0.269	0.095
BT17	3.59	0.627	0.222
BT18	5.30	0.926	0.328
BT19	8.03	1.40	0.496
BT20/Plot BM	0.621	0.108	0.038
BT21/Plot BL	1.49	0.260	0.092
BT22/Plot BK	1.64	0.287	0.101
BT23/Plot BX	11.7	2.04	0.721
BT24	1.61	0.281	0.099
BT25	2.75	0.480	0.170
BT26	3.98	0.694	0.246
BT27	10.6	1.85	0.655
BT28	2.60	0.453	0.160
BT29	2.72	0.475	0.168
BT30	5.50	0.960	0.340

Table A.3-4
Schooner 95% UCL Internal Dose for Each Exposure Scenario
(Page 2 of 3)

Plot or Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
BT31	12.8	2.24	0.793
BT32/Plot BC	3.01	0.525	0.186
BT33/Plot BB	1.91	0.334	0.118
BT34/Plot BA	7.54	1.32	0.47
BT35	**27.6**	4.82	1.71
BT36	1.23	0.214	0.076
BT37	2.21	0.386	0.137
BT38	2.93	0.512	0.181
BT39	11.4	1.98	0.701
BT40	3.09	0.539	0.191
BT41	6.52	1.14	0.402
BT42	9.00	1.57	0.556
BT43	16.7	2.91	1.03
BT48/Plot BH	0.615	0.107	0.038
BT49	0.838	0.146	0.052
BT50	0[a]	0[a]	0[a]
BT51	0[a]	0[a]	0[a]
BT52	0[a]	0[a]	0[a]
BT53	0[a]	0[a]	0[a]
BT54	0[a]	0[a]	0[a]
BT55	0[a]	0[a]	0[a]
BT56	0[a]	0.0	0[a]
BT57	0[a]	0[a]	0[a]
BT58/Plot BD	0.406	0.071	0.025
BT59	0[a]	0[a]	0[a]
BT60	0[a]	0[a]	0[a]
BT61	0[a]	0[a]	0[a]
BT62	0[a]	0[a]	0[a]
BT63	0[a]	0[a]	0[a]
BT64	0[a]	0[a]	0[a]

Table A.3-4
Schooner 95% UCL Internal Dose for Each Exposure Scenario
(Page 3 of 3)

Plot or Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
BT65	0.637	0.111	0.039
BT66	0.744	0.130	0.046
BT67	0.327	0.057	0.020
BT68	0.662	0.115	0.041

[a]Where the reading was less than zero, a value of zero was used.

Bold indicates the values exceeding 25 mrem/yr.

A.3.2.3 Total Effective Dose

The TED for each sample plot, sediment sample location, or TLD location was calculated by summing the external dose values and the internal dose values. Values for both the average TED and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table A.3-5. The TED for sample locations exceeds the FAL (the 95 percent UCL of the average TED exceeding 25 mrem/RW-yr) at locations BT01, BT02, BT03, BT04, BT35, and BT43.

Table A.3-5
Schooner TED at Sample Locations (mrem/yr)
(Page 1 of 3)

Plot or Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
BT01	**202.8**	**225.9**	**30.8**	**34.3**	7.73	8.61
BT02	**256.4**	**297.8**	**38.9**	**45.2**	9.77	11.4
BT03	**351.0**	**415.8**	**53.3**	**63.1**	13.4	15.9
BT04	**247.1**	**268.4**	**37.5**	**40.7**	9.42	10.2
BT05	**146.2**	**156.4**	22.2	23.7	5.57	5.96
BT06	2.05	6.56	0.312	0.995	0.078	0.250
BT07	2.11	5.80	0.320	0.880	0.080	0.221
BT08	0.10	1.79	0.015	0.272	0.004	0.068
BT09	4.47	8.04	0.679	1.22	0.171	0.307

Table A.3-5
Schooner TED at Sample Locations (mrem/yr)
(Page 2 of 3)

Plot or Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
BT10	0.63	5.52	0.095	0.837	0.024	0.210
BT11	1.50	4.59	0.227	0.697	0.057	0.175
BT12/Plot BG	16.7	21.7	2.53	3.27	0.628	0.809
BT13/Plot BF	**47.0**	**49.7**	7.06	7.47	1.71	1.82
BT14/Plot BE	**80.2**	**90.5**	12.1	13.6	2.94	3.34
BT15	**94.0**	**102.0**	14.3	15.5	3.58	3.89
BT16	14.1	15.7	2.14	2.39	0.537	0.599
BT17	**32.6**	**36.6**	4.95	5.56	1.24	1.40
BT18	**48.9**	**54.1**	7.43	8.21	1.87	2.06
BT19	**72.2**	**81.9**	11.0	12.4	2.75	3.12
BT20/Plot BM	11.4	15.9	1.71	2.38	0.416	0.580
BT21/Plot BL	16.4	22.6	2.47	3.41	0.612	0.843
BT22/Plot BK	20.4	**26.7**	3.09	4.03	0.762	0.993
BT23/Plot BX	**62.8**	**69.5**	9.67	10.7	2.54	2.78
BT24	13.0	16.4	1.97	2.49	0.494	0.625
BT25	24.2	**28.1**	3.67	4.26	0.921	1.07
BT26	**32.6**	**40.6**	4.95	6.16	1.24	1.55
BT27	**97.1**	**108.1**	14.7	16.4	3.70	4.12
BT28	22.5	**26.5**	3.41	4.02	0.858	1.01
BT29	**25.8**	**27.7**	3.91	4.21	0.982	1.06
BT30	**44.4**	**56.1**	6.75	8.51	1.69	2.14
BT31	**114.4**	**131.0**	17.4	19.9	4.36	4.99
BT32/Plot BC	19.1	23.2	2.89	3.54	0.720	0.903
BT33/Plot BB	**35.5**	**41.3**	5.34	6.22	1.30	1.52
BT34	**45.0**	**55.1**	6.84	8.42	1.72	2.16
BT35	**250.1**	**281.8**	**38.0**	**42.8**	9.54	10.7
BT36	11.0	12.5	1.67	1.90	0.420	0.477
BT37	18.0	22.5	2.73	3.42	0.684	0.859
BT38/Plot BA	22.4	**29.9**	3.39	4.54	0.852	1.14
BT39	**108.9**	**115.7**	16.5	17.6	4.15	4.41
BT40	**26.1**	**31.5**	3.96	4.78	0.996	1.20

Table A.3-5
Schooner TED at Sample Locations (mrem/yr)
(Page 3 of 3)

Plot or Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
BT41	**57.4**	**66.4**	8.72	10.1	2.19	2.53
BT42	**85.0**	**91.8**	12.9	13.9	3.24	3.50
BT43	**154.2**	**170.0**	23.4	**25.8**	5.88	6.48
BT48/Plot BH	3.59	5.38	0.547	0.82	0.139	0.207
BT49	4.37	8.54	0.664	1.30	0.167	0.326
BT50	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT51	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT52	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT53	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT54	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT55	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT56	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT57	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT58/Plot BD	0[a]	2.57	0[a]	0.394	0[a]	0.102
BT59	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT60	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT61	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT62	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT63	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT64	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT65	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT66	1.75	5.25	0.279	0.802	0.081	0.206
BT67	1.14	3.52	0.178	0.534	0.049	0.134
BT68	8.54	16.4	1.29	2.47	0.321	0.601

[a]Where the net reading was less than zero, a value of zero was used.

Bold indicates the values exceeding 25 mrem/yr.

The radionuclide mixture from sample plot BX was input into the RESRAD computer modeling system to examine the radioactive decay characteristics and effective half-life for the external radiation exposure at Schooner. Considering radioactive decay only, the effective half-life is 15.8 years and is being driven by europium (Eu)-152 and Eu-154. Based on this information, the dose at the maximum location (BT03) should decay to 25 mrem in about 64 years.

A.3.2.4 Results for Other Release at Schooner

Analytical results exceeding MDCs from the five other release samples collected from runoff sedimentation areas (four environmental samples and one FD) were collected during investigation activities at Schooner. The other release samples from the sedimentation areas were analyzed for gamma spectroscopy; Am-241, Sr-90, isotopic Pu, isotopic U, SVOCs, VOCs, PCBs, DRO, and total metals.

A.3.2.4.1 VOCs

Analytical results for VOCS in the environmental samples collected at the sedimentation areas that were detected above MDCs are presented in Table A.3-6. No VOCS were detected at concentrations exceeding their respective PALs.

A.3.2.4.2 DRO, SVOCs, and PCBs

Analytical results for DRO, SVOCs, and PCBs in the environmental samples collected at the sedimentation areas revealed no contaminant concentrations above MDCs.

A.3.2.4.3 RCRA Metals

Analytical results for RCRA metals in the environmental samples collected at the sedimentation areas that were detected above MDCs are presented in Table A.3-7. No metals were found in concentrations that exceeded their respective PALs.

Table A.3-6
Sedimentation Sample Results for VOCs Detected above MDCs at Schooner

Sample Location	Sample Number	Depth (cm bgs)	COPCs (mg/kg)										
			1,2,4-Trimethylbenzene	1,4-Dichlorobenzene	2-Butanone	Acetone	Benzene	Chlorobenzene	Dichlorodifluoromethane	Methylene Chloride	Toluene	Total Xylenes	Trichlorofluoromethane
FALs			**260**	**12**	**200,000**	**630,000**	**5.4**	**1,400**	**780**	**53**	**45,000**	**2,700**	**3,400**
BT66	374BX001	5 - 10	--	--	--	--	--	0.0014	--	--	0.000552 (J)	--	--
BT66	374BX002	5 - 10	--	0.000301 (J)	--	--	--	0.00259	--	0.00324 (J)	0.00122	0.000311 (J)	--
BT65	374BX003	0 - 5	--	--	--	--	0.000501 (J)	0.00717	--	0.00633	0.00277	0.000682 (J)	0.000702 (J)
BT67	374BX006	10 - 15	--	--	--	--	--	0.00162	--	--	0.000735 (J)	--	--
BT68	374BX005	0 - 5	0.000452 (J)	0.000904 (J)	0.0139	0.0775	0.00103	0.00122	0.000472	0.0161	0.00443	0.000396 (J)	--

J = Estimated value
-- = Not detected above MDCs.

COPC = Contaminant of potential concern
mg/kg = Milligrams per kilogram

Table A.3-7
Sedimentation Sample Results for Metals Detected above MDCs at Schooner

Sample Location	Sample Number	Depth (cm bgs)	COPCs (mg/kg)						
			Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Silver
FALs			**23**	**190,000**	**800**	**450**	**800**	**34**	**5,100**
BT66	374BX001	5 - 10	2.23	86.3 (J)	0.236 (J)	2.57	12.6 (J+)	0.0111	0.339 (J)
	374BX002	5 - 10	2.4	93.3 (J)	0.225 (J)	3.24	12.9 (J+)	0.0103 (J)	0.44 (J)
BT65	374BX003	0 - 5	2.18	95.6 (J)	0.241 (J)	2.03	13.9 (J+)	0.0135	0.384 (J)
BT68	374BX005	0 - 5	2.93	106 (J)	0.35 (J)	5	15.4 (J+)	0.00903 (J)	0.345 (J)
BT67	374BX006	10 - 15	2.33	58.7 (J)	0.157 (J)	1.64	16.3 (J+)	0.00655 (J)	0.344 (J)

J = Estimated value
J+ = Result is an estimated quantity, but may be biased high.

A.3.2.4.4 Total Effective Dose

The TED for each sediment sample location/TLD location was calculated by summing the external dose values and the internal dose values. Values for both the average TED and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area are presented in Table A.3-8. The TEDs for the sedimentation sample locations did not exceed the FAL.

Table A.3-8
Schooner TED at Sedimentation Sample Locations (mrem/yr)

Plot or Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
BT65	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]
BT66	1.75	5.25	0.279	0.802	0.081	0.206
BT67	1.14	3.52	0.178	0.534	0.049	0.134
BT68	8.54	16.4	1.29	2.47	0.321	0.601

[a]Where the net reading was less than zero, a value of zero was used.

A.3.3 Nature and Extent of Contamination

Based on the data evaluation and the proposed scenario, TED from surface soils exceeded a dose of 25 mrem under the Remote Work Area scenario (FAL) at sample locations BT01, BT02, BT03, BT04, BT35, and BT43. Additionally, it is assumed that contamination is present within the entire default contamination area that exceeds the FAL. Therefore, a corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is closure in place with a UR and a corrective action removal of the lead-acid batteries. The FFACO UR established encompasses the area of the default contamination boundary to include the crater and ejecta field (Figure A.3-4). The areas exceeding the 25-mrem/RW-yr dose are encompassed by the default decontamination boundary, and thus no additional protective measures were needed.

As a BMP, it was determined to identify and administratively use restrict any area where the TED exceeds 25 mrem/IA-yr to prevent any future industrial land use activities that would cause a worker to be exposed to contamination. To determine the extent of this area, a correlation of GWS radiation survey values to the 95 percent UCL of the Industrial Area TED values was conducted for the CAS.

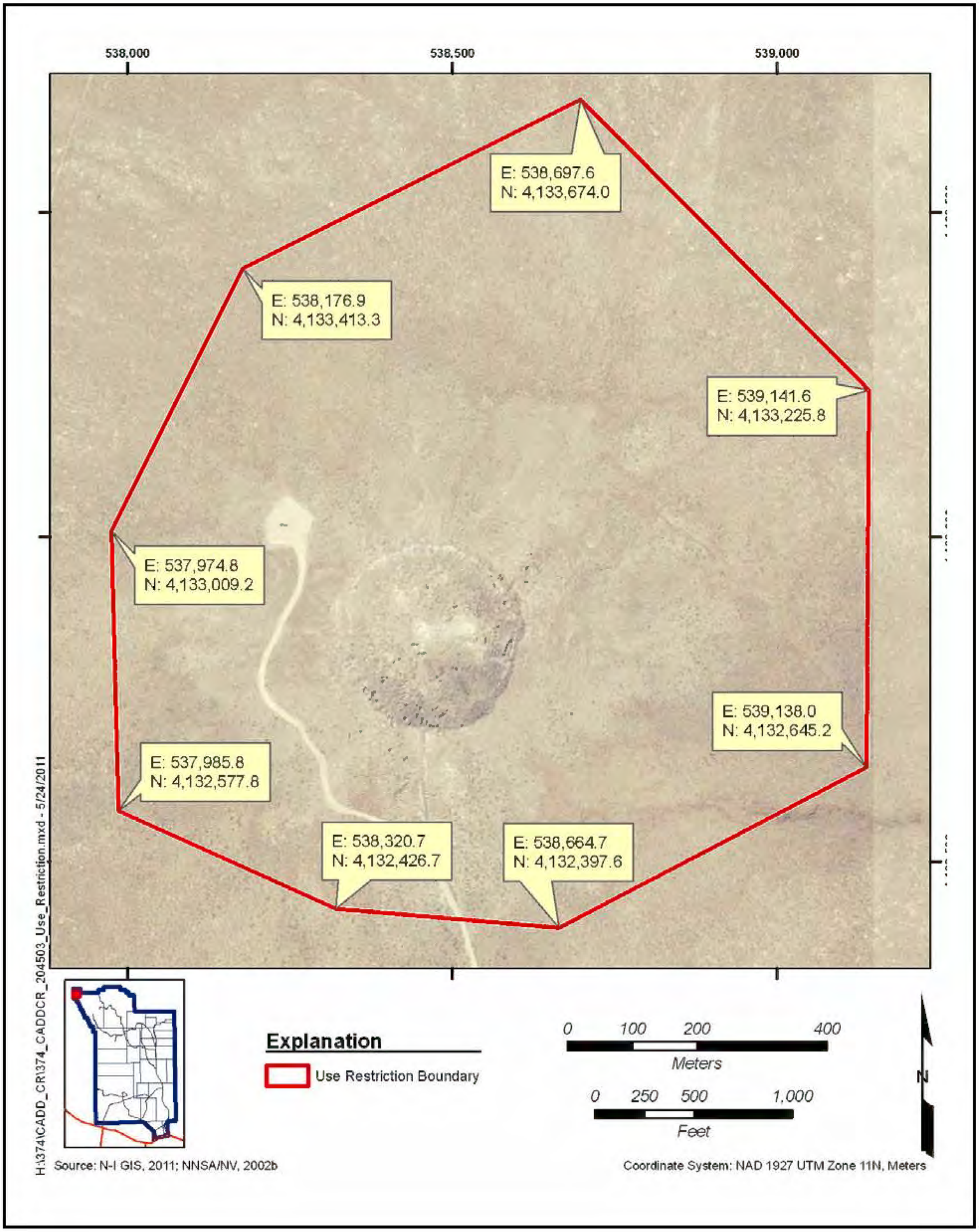


Figure A.3-4
Schooner UR Area

The GWS datasets were converted from point data into a continuous dataset (surface) using a kriging technique. The GWS dataset was then used to determine the GWS values at each TLD location as shown in Figure A.3-5. The relationship between the GWS and the 95 percent UCL IA-yr TED was determined by statistical correlation. The statistical relationship indicates that the radiation survey value that corresponds to 25 mrem/IA-yr is 1.95 multiples of background. The 1.95 multiples of background isopleths was created using the continuous GWS surface.

As a BMP, an administrative UR boundary was established that circumscribes this isopleth. The administrative UR boundary established to encompass this area is presented as Figure A.3-6 and in Attachment D-1.

A.3.4 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2010a) were met at this CAS. The information gathered during the CAI supports the CSM as presented in the CAIP for CAU 374. Therefore, no revisions to the CSM were necessary.

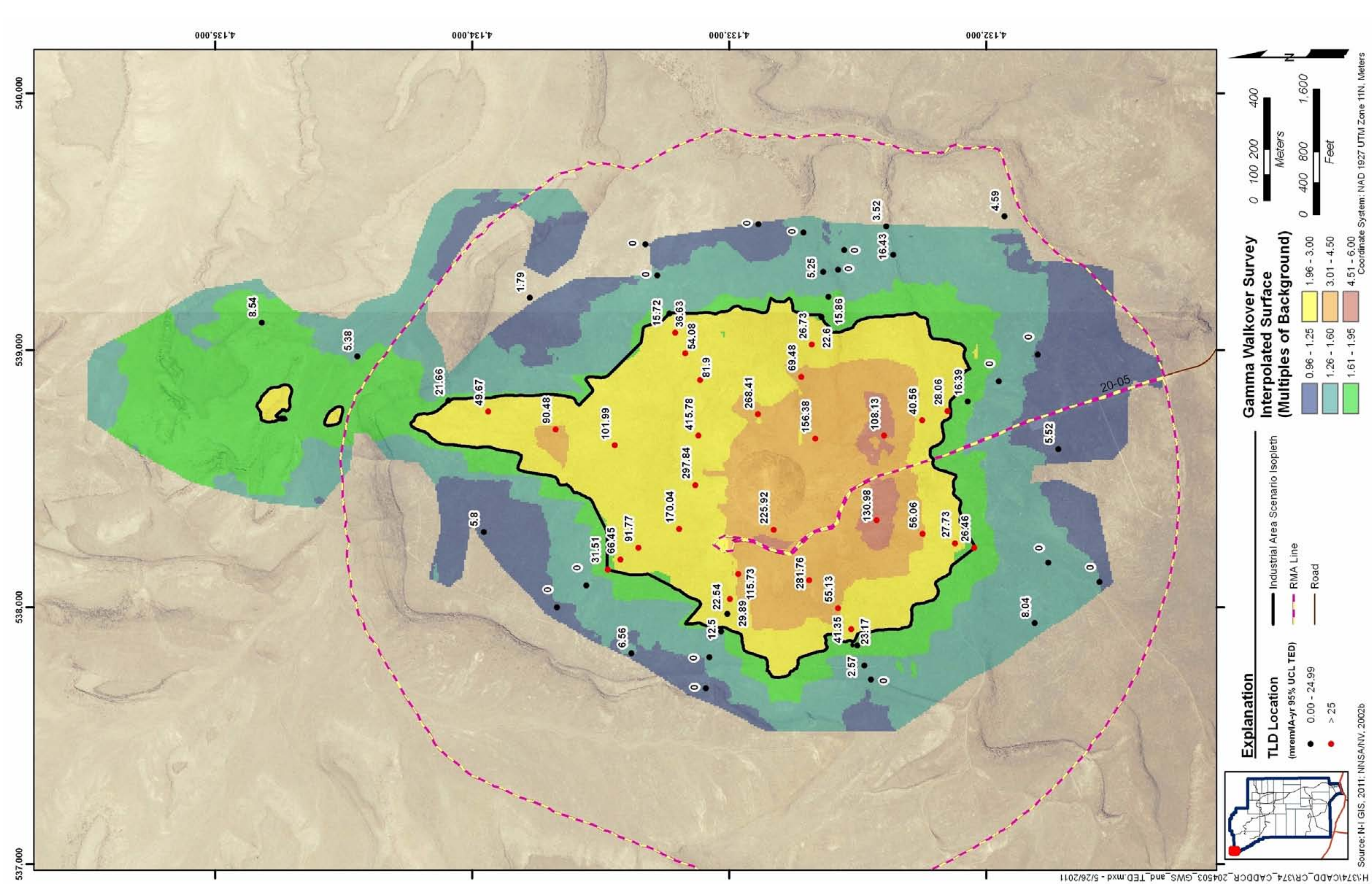


Figure A.3-5
TED and Interpolated Surface at Schooner

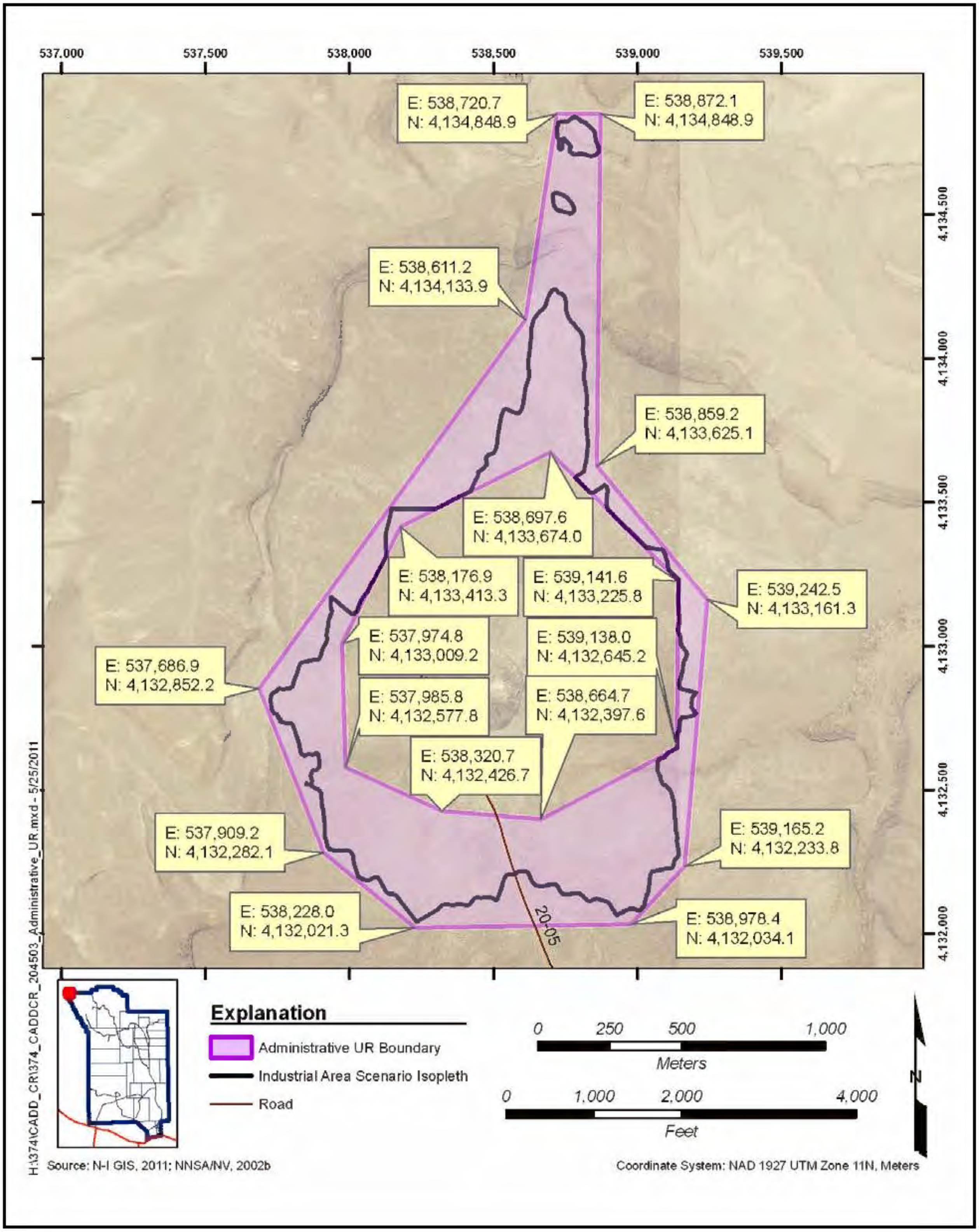


Figure A.3-6
Schooner Administrative UR

A.4.0 CAS 18-23-01, Danny Boy

Corrective Action Site 18-23-01 is located on the Buckboard Mesa in Area 18 and consists of the deposition of radioactive contamination as the result of the weapons-effect test. Additional detail on the history of Danny Boy is provided in the CAIP (NNSA/NSO, 2010a).

A.4.1 Corrective Action Investigation Activities

A total of 11 characterization samples (8 primary release samples from 2 plots and 2 other release samples from the sedimentation area [including 1 FD]) were collected during investigation activities at Danny Boy. Primary release and sedimentation samples (one regular and one duplicate) were analyzed for gamma spectroscopy; Sr-90; and isotopic U, Pu, and Am. The sedimentation samples were also analyzed for DRO, VOCs, SVOCs, PCBs, and total metals. The sample locations, numbers, depths, matrix, and purpose are listed in Table A.4-1.

Table A.4-1
Samples Collected at Danny Boy

Sample Plot or Location	Sample Number	Depth (cm bgs)	Matrix	Purpose
AA	374AA01	0 - 5	Soil	Environmental
	374AA02	0 - 5	Soil	Environmental
	374AA03	0 - 5	Soil	Environmental
	374AA04	0 - 5	Soil	Environmental
AB	374AB01	0 - 5	Soil	Environmental
	374AB02	0 - 5	Soil	Environmental
	374AB03	0 - 5	Soil	Environmental
	374AB04	0 - 5	Soil	Environmental
AT28 (sedimentation sample)	374AX001	5 - 10	Soil	Environmental, Full Lab QC
AT28 (sedimentation sample)	374AX002	5 - 10	Soil	FD of 374AX001

The TLDs were installed at 28 locations (AT01 through AT28) at Danny Boy as listed in Table A.4-2 and shown in Figure A.4-2. Three of these TLDs (AT24 through AT26) were placed to measure “field” background. The TLDs AT01 through AT23 and AT27 were used at Danny Boy to measure external dose. One TLD (AT28) was located at the sedimentation area in the wash.

Table A.4-2
TLDs at Danny Boy

Location	TLD No.	Date Placed	Date Removed	Purpose
AT01	1674	06/29/2010	10/06/2010	TLD and sample plot AB
AT02	3361	06/29/2010	10/06/2010	TLD only
AT03	3355	06/29/2010	10/06/2010	TLD only
AT04	3417	06/29/2010	10/06/2010	TLD only
AT05	3839	06/29/2010	10/06/2010	TLD and sample plot AA
AT06	4223	06/29/2010	10/06/2010	TLD only
AT07	3501	06/29/2010	10/06/2010	TLD only
AT08	4285	06/29/2010	10/06/2010	TLD only
AT09	1784	06/29/2010	10/06/2010	TLD only
AT10	3748	06/29/2010	10/06/2010	TLD only
AT11	3512	06/29/2010	10/06/2010	TLD only
AT12	1268	06/29/2010	10/06/2010	TLD only
AT13	3410	06/29/2010	10/06/2010	TLD only
AT14	1776	06/29/2010	10/06/2010	TLD only
AT15	3462	06/29/2010	10/06/2010	TLD only
AT16	3328	06/29/2010	10/06/2010	TLD only
AT17	3449	06/29/2010	10/06/2010	TLD only
AT18	3353	06/29/2010	10/06/2010	TLD only
AT19	3441	06/29/2010	10/06/2010	TLD only
AT20	3437	06/29/2010	10/06/2010	TLD only
AT21	3497	06/29/2010	10/06/2010	TLD only
AT22	3921	07/01/2010	10/06/2010	TLD only
AT23	4003	07/01/2010	10/06/2010	TLD only
AT24	3621	06/29/2010	10/06/2010	Background TLD location
AT25	3463	06/29/2010	10/06/2010	Background TLD location
AT26	3528	06/29/2010	10/06/2010	Background TLD location
AT27	3703	06/29/2010	10/06/2010	TLD only
AT28	3489	06/29/2010	10/06/2010	TLD and sedimentation sample location

The specific CAI activities conducted to satisfy the CAIP requirements at this CAS (NNSA/NSO, 2010a) are described in the following sections.

A.4.1.1 Visual Inspections

Visual inspections of Danny Boy were conducted over the course of the field investigation and included site walks, sampling efforts, and radiological surveys. No debris, equipment, nor the presence of biasing factors was identified requiring investigation other than the drums, which are addressed in CASs 18-22-05, 18-22-06, and 18-22-08.

In addition to the notable physical features, a wash is present flowing through and downgradient of the site and was identified as a potential route for migration of contaminated sediments. The wash was visually inspected, and a biased sample of the sedimentation area was collected. No additional biasing factors were noted at the CAS based on visual inspections. (See Figure A.4-2 for the sedimentation sample location.)

A.4.1.2 Radiological Surveys

Global Positioning System-assisted GWSs were performed at Danny Boy during the CAI. The GWSs were conducted in the fallout plume area outside the default contamination boundary surrounding the crater, and along the wash leading away from crater to identify the spatial distribution of the radiological readings, identify the locations of the highest radiological readings, and to confirm the location of the fallout plume. Data were post-processed, loaded into a geographical information system, color-coded, and displayed on a map of Danny Boy. The results of the GWS showed that the gamma radiation readings are higher closer to the crater, at background conditions along the wash, and confirmed that the fallout plume was positioned as expected. Figure A.4-1 provides the results of the GWS surveys.

The results of the GWS were used in the determination of the locations of the soil sample plots at the Danny Boy site. Two plots and associated TLD locations AT01 and AT05, were established at the areas having the highest anomalous radiological readings outside the default contamination boundary as determined from the GWS and 1994 aerial radiological survey (BN, 1999).

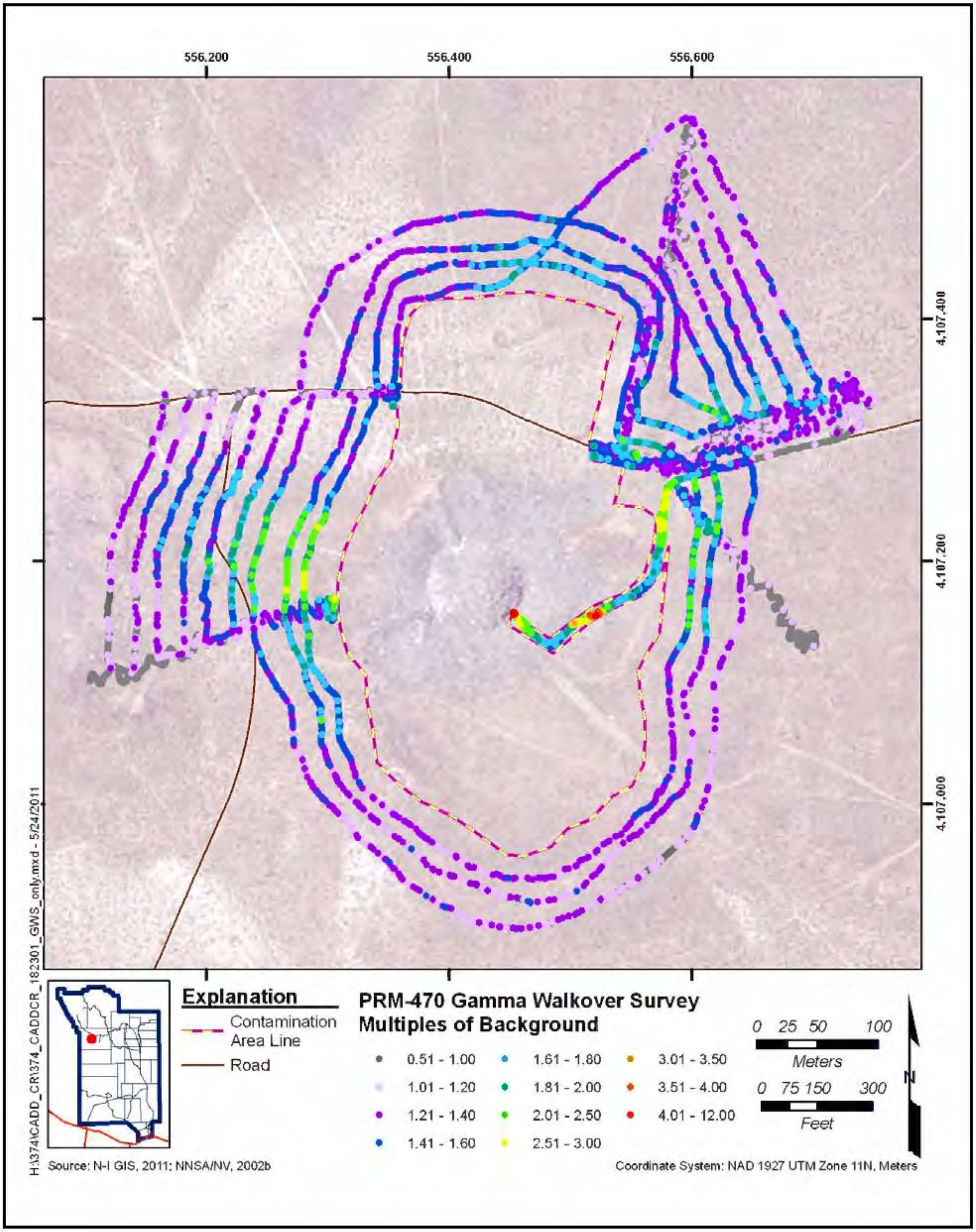


Figure A.4-1
Gamma Walkover Surveys of Selected Locations at Danny Boy

A.4.1.3 TLD Samples

The TLDs listed in Table A.4-2 were used at the Danny Boy site to measure external doses. Figure A.4-2 shows TLD locations. The TLDs at locations AT24, AT25, and AT26 were installed at “field” background locations. Sampling plots were placed at TLD locations AT01 and AT05.

A.4.1.4 Soil Samples

Sampling activities at Danny Boy for the determination of internal dose consisted of collecting four primary release composite surface soil samples at two sample plots (AA and AB). All sample locations are shown on Figure A.4-2.

A total of 10 environmental samples (8 primary release samples from the 2 sample plots, and 1 other release sample and associated FD from the TLD location AT28 wash/sedimentation area) were collected during investigation activities at Danny Boy. All primary release samples and the other release samples from the sedimentation areas were analyzed for gamma spectroscopy, Am-241, Sr-90, isotopic Pu, and isotopic U. The sedimentation area samples were also analyzed for SVOCs, VOCs, PCBs, DRO, and total metals. The sample locations, numbers, depths, matrix, and purpose are listed in Table A.4-1.

A.4.1.5 Field Screening

The FSRs were used for selection of the vertical samples collected from the sediment accumulation area (location AT8). Screening samples were collected in 5-cm intervals from 0 to 5 and 5 to 10 cm bgs , then halted due to refusal at the next interval. The 5- to 10-cm interval was selected and submitted to the laboratory as it exhibited the highest field-screening values. These field-screening data were recorded on SCLs, which are retained in the project files.

A.4.1.6 Deviations

No deviations to the CAU 374 CAIP (NNSA/NSO, 2010a) were noted.

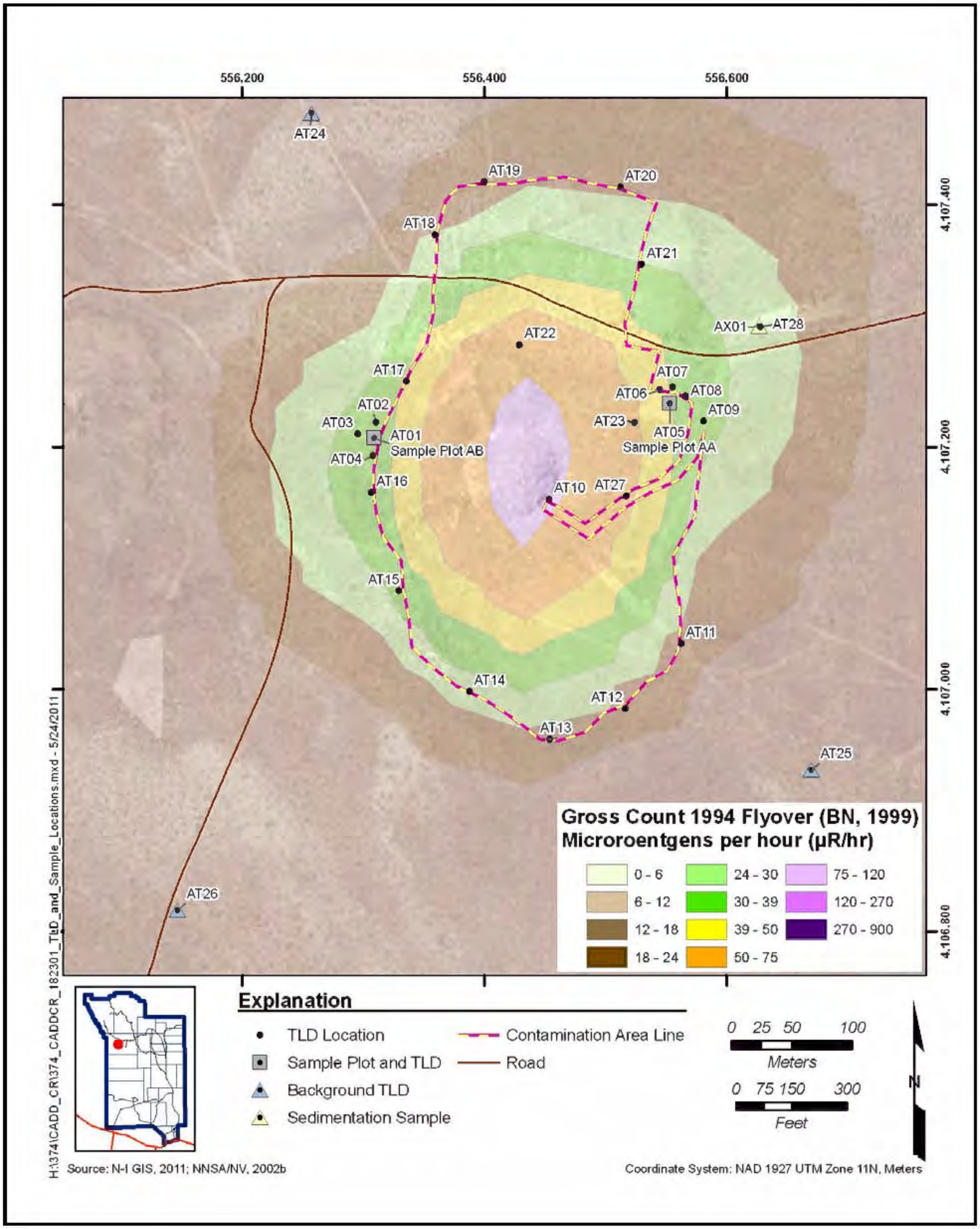


Figure A.4-2
Danny Boy Sample and TLD Locations

A.4.2 Investigation Results

The following sections present the analytical and computational results for soil and TLD samples. All sampling and analyses were conducted as specified in the CAU 374 CAIP (NNSA/NSO, 2010a). The radiological results are reported as doses that are comparable to the dose-based FALs as established in Appendix C. Chemical results are reported as individual concentrations for comparison to FALs. Results that are equal to or greater than FALs are identified by bold text in the results tables.

A minimum number of samples is required to assure sufficient confidence in the calculation of the 95 percent UCL (EPA, 2006). As stated in the CAIP, if the minimum sample size criterion cannot be met, it must be assumed that contamination exceeds the FAL. The calculation of minimum sample size is described in Section B.1.1.1.1.

The internal dose calculated from the analytical results from the soil samples, and the external dose calculated from TLD measurements were combined to provide the TED for each sample location. External doses for TLD locations are summarized in Section A.4.2.1. Internal doses for each sample plot are summarized in Section A.4.2.2. The TEDs for each sampled location are summarized in Section A.4.2.3. Results for other releases are summarized in Section A.4.2.4.

A.4.2.1 External Radiological Dose Measurements

Estimates of the external dose at each sample location were derived from the TLDs. The external dose for each TLD location was calculated for the Industrial Area exposure scenario and then scaled, based on exposure duration, to the Remote Work Area and Occasional Use exposure scenarios. The values for the individual elements in each TLD are presented in Appendix F. The minimum sample size was met for all TLD locations. The 95 percent UCL of external dose for each exposure scenario is presented in Table A.4-3.

A.4.2.2 Internal Radiological Dose Estimations

Estimates for the internal dose that a receptor would receive at each sample plot at Schooner were determined as described in Section A.2.2.4. For TLD locations where soil samples were not collected, the internal to external dose ratio from the plot with the maximum amount of internal dose

Table A.4-3
Danny Boy 95% UCL External Dose for Each Exposure Scenario

Plot or Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
AT01 (Plot AB)	24.6	3.67	0.874
AT02	**29.7**	4.44	1.06
AT03	21.6	3.23	0.769
AT04	**31.1**	4.65	1.11
AT05 (Plot AA)	**36.9**	5.52	1.31
AT06	**38.9**	5.80	1.38
AT07	**41.7**	6.23	1.48
AT08	**27.9**	4.17	0.994
AT09	16.8	2.50	0.596
AT10	**67.5**	10.1	2.40
AT11	6.68	0.997	0.237
AT12	4.65	0.695	0.165
AT13	0.653	0.098	0.023
AT14	0[a]	0[a]	0[a]
AT15	7.04	1.05	0.250
AT16	15.8	2.36	0.561
AT17	9.29	1.39	0.330
AT18	1.72	0.257	0.061
AT19	9.52	1.42	0.338
AT20	8.54	1.28	0.304
AT21	**36.9**	5.51	1.31
AT22	**62.7**	9.36	2.23
AT23	**266.8**	**39.8**	9.49
AT24	3.08	0.459	0.109
AT25	1.57	0.234	0.056
AT26	1.24	0.185	0.044
AT27	**46.0**	6.86	1.63
AT28	0.458	0.068	0.016

[a]Where the net reading was less than zero, a value of zero was used.

Bold indicates the values exceeding 25 mrem/yr.

was used to estimate internal dose. The maximum internal dose was at plot AA, and the internal to external dose ratio at this site was 0.17.

Data tables listing the analytical results for individual radionuclides in the composite sample is presented in Appendix F. The 95 percent UCL of internal dose for each exposure scenario is presented in Table A.4-4.

Table A.4-4
Danny Boy 95% UCL Internal Dose for Each Exposure Scenario

Plot or Location	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
AT01 (Plot AB)	5.25	0.916	0.324
AT02	5.10	0.889	0.315
AT03	3.71	0.647	0.229
AT04	5.34	0.931	0.329
AT05 (Plot AA)	5.73	1.00	0.354
AT06	6.66	1.16	0.411
AT07	7.15	1.25	0.441
AT08	4.79	0.836	0.296
AT09	2.88	0.502	0.178
AT10	11.6	2.02	0.715
AT11	1.14	0.200	0.071
AT12	0.798	0.139	0.049
AT13	0.112	0.020	0.007
AT14	0[a]	0[a]	0[a]
AT15	1.21	0.211	0.075
AT16	2.71	0.472	0.167
AT17	1.59	0.278	0.098
AT18	0.295	0.052	0.018
AT19	1.63	0.285	0.101
AT20	1.46	0.255	0.090
AT21	6.33	1.10	0.391
AT22	10.7	1.88	0.664
AT23	**45.7**	7.98	2.82
AT27	7.88	1.38	0.487
AT28	1.001	0.174	0.062

[a]Where the net reading was less than zero, a value of zero was used.

A.4.2.3 Total Effective Dose

The TED for each sample plot, sediment sample location, or TLD location was calculated by summing the external dose values and the internal dose values. Values for both the average TED and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios are presented in Table A.4-5. The TED for sample locations exceeds the FAL (the 95 percent UCL of the average TED exceeding 25 mrem/RW-yr) at location AT23.

The radionuclide mixture from sample plot AA was input into the RESRAD computer modeling system to examine the radioactive decay characteristics and effective half-life for the external radiation exposure at Danny Boy. Considering radioactive decay only, the effective half-life is 69.3 years and is being driven by cesium (Cs)-137 and Am-241. Based on this information, the dose at the maximum location (AT23) should decay to 25 mrem in about 253 years.

Table A.4-5
Danny Boy TED at the Sample Locations (mrem/yr)
(Page 1 of 2)

Plot or Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
AT01	**27.8**	**29.8**	3.92	4.58	0.999	1.20
AT02	**29.4**	**34.8**	4.50	5.33	1.16	1.37
AT03	19.4	**25.3**	2.96	3.87	0.763	0.997
AT04	**31.5**	**36.5**	4.82	5.58	1.24	1.44
AT05	**34.8**	**42.7**	5.32	6.52	1.37	1.67
AT06	**36.1**	**45.5**	5.52	6.96	1.42	1.79
AT07	**40.7**	**48.9**	6.22	7.48	1.60	1.92
AT08	**28.8**	**32.7**	4.41	5.01	1.14	1.29
AT09	15.0	19.6	2.30	3.01	0.593	0.774
AT10	**62.9**	**79.1**	9.63	12.1	2.48	3.11
AT11	5.07	7.82	0.775	1.20	0.200	0.308
AT12	2.59	5.45	0.396	0.834	0.102	0.215
AT13	0[a]	0.765	0[a]	0.117	0[a]	0.030
AT14	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]

Table A.4-5
Danny Boy TED at the Sample Locations (mrem/yr)
(Page 2 of 2)

Plot or Location	Industrial Area		Remote Work Area		Occasional Use Area	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
AT15	5.81	8.25	0.888	1.26	0.229	0.325
AT16	15.8	18.5	2.42	2.83	0.622	0.728
AT17	10.1	10.9	1.55	1.67	0.399	0.429
AT18	0.850	2.02	0.130	0.309	0.033	0.080
AT19	6.10	11.2	0.934	1.71	0.240	0.439
AT20	8.87	10.0	1.36	1.53	0.350	0.394
AT21	15.8	43.2	2.42	6.62	0.623	1.70
AT22	**65.0**	**73.4**	9.94	11.2	2.56	2.89
AT23	**252.1**	**312.6**	**38.6**	**47.8**	9.93	12.3
AT27	**38.7**	**53.8**	5.92	8.24	1.52	2.12
AT28	0[a]	1.46	0[a]	0.243	0[a]	0.078

[a]Where the reading was less than zero, a value of zero was used.

Bold indicates the values exceeding 25 mrem/yr.

A.4.2.4 Results for Other Release at Danny Boy

Analytical results from the samples collected from the sedimentation area within the wash at Danny Boy are presented in the following sections.

A.4.2.4.1 VOCs

Analytical results for VOCS in the environmental samples collected at the sedimentation area that were detected above MDCs are presented in Table A.4-6. No VOCS were detected at concentrations exceeding their respective PALs.

A.4.2.4.2 SVOCs, PCBs, and DRO

Analytical results for SVOCs, PCBS, and DRO in the environmental samples collected at the sedimentation area revealed no contaminant concentrations above MDCs.

Table A.4-6
Sedimentation Sample Results for VOCs Detected above MDCs at Danny Boy

Sample Location	Sample Number	Depth (cm bgs)	COPC (mg/kg)
			Toluene
FAL			45,000
AT28	374AX001	5 - 10	0.000899 (J)
	374AX002	5 - 10	0.000568 (J)

J = Estimated value

A.4.2.4.3 RCRA Metals

Analytical results for RCRA metals in the environmental samples collected at the sedimentation area that were detected above MDCs are presented in Table A.4-7. No metals were found in concentrations that exceeded their respective PALs.

Table A.4-7
Sedimentation Sample Results for Metals Detected above MDCs at Danny Boy

Sample Location	Sample Number	Depth (cm bgs)	COPCs (mg/kg)						
			Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Silver
FALs			23	190,000	800	450	800	34	5,100
AT28	374AX001	5 - 10	5.87 (J)	270	0.638	20.2 (J)	27.4 (J)	0.0562	0.563
	374AX002	5 - 10	5.33 (J)	292	0.463 (J)	20.6 (J)	34.2 (J)	0.0307	0.987

J = Estimated value

A.4.2.4.4 Total Effective Dose

The TED for the sedimentation sample/TLD location AT28 was calculated by summing the external dose values and the internal dose values. Values for both the average TED and the 95 percent UCL of the TED for the Industrial Area, Remote Work Area, and Occasional Use Area are presented in Table A.4-8. The TED for location AT28 did not exceed the FAL.

Table A.4-8
Danny Boy TED at the Sedimentation Sample Location (mrem/yr)

Location	Industrial Access		Remote Worker		Occasional Use	
	Average TED	95% UCL of TED	Average TED	95% UCL of TED	Average TED	95% UCL of TED
AT28	0[a]	1.46	0[a]	0.243	0[a]	0.078

[a]Where the reading was less than zero, a value of zero was used.

A.4.3 Nature and Extent of Contamination

Based on the data evaluation and the proposed scenario, TED from surface soils exceeded a dose of 25 mrem under the Remote Worker scenario (FAL) at sample location AT23 within the default contamination boundary. Additionally, it is assumed that contamination is present within the entire default contamination area that exceeds the FAL. Therefore, a corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is closure in place with a UR. The FFACO UR established encompasses the area of the default contamination boundary to include the crater and fenced contamination area (Figure A.4-3).

As a BMP, it was determined to identify and administratively use restrict any area where the TED exceeds 25 mrem/IA-yr to prevent any future industrial land use activities that would cause a worker to be exposed to contamination (2,250 hr/yr). To determine the extent of this area, a correlation of GWS radiation survey values to the 95 percent UCL of the Industrial Area TED values was conducted for the CAS. The GWS datasets were converted from point data into a continuous dataset (surface) using a kriging technique. The GWS dataset was then used to determine the GWS values at each TLD location. The relationship between the GWS and the 95 percent UCL IA-yr TED was determined by statistical correlation. The statistical relationship indicates that the radiation survey value that corresponds to 25 mrem/IA-yr is 1.72 multiples of background. The 1.72 multiples of background isopleths was created using the continuous GWS surface. As a BMP, an administrative UR boundary was established that circumscribes this isopleth and is shown on Figure A.4-4. The administrative UR boundary established to encompass this area is presented as Figure A.4-5 and in Attachment D-1.

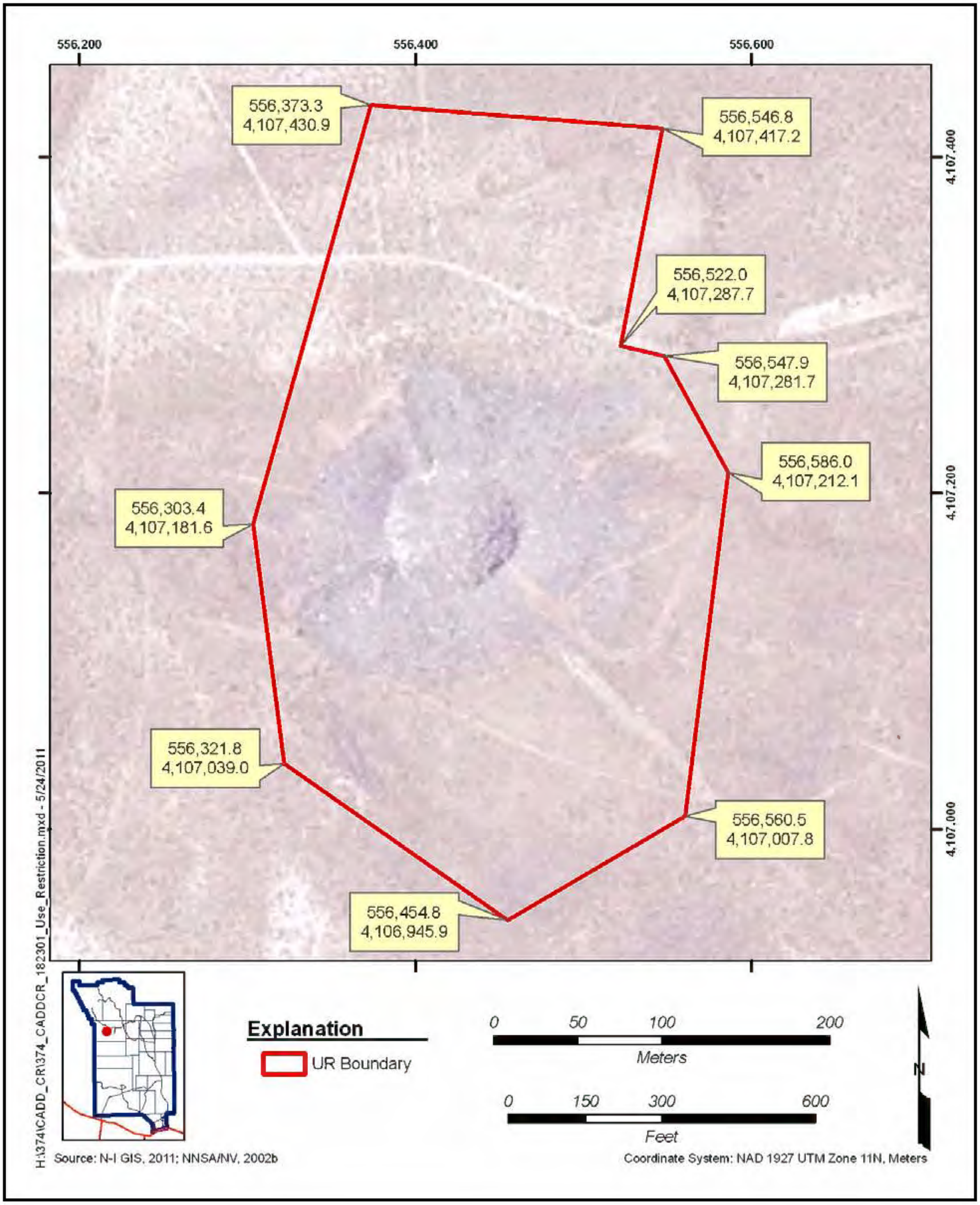


Figure A.4-3
Danny Boy FFACO UR Area

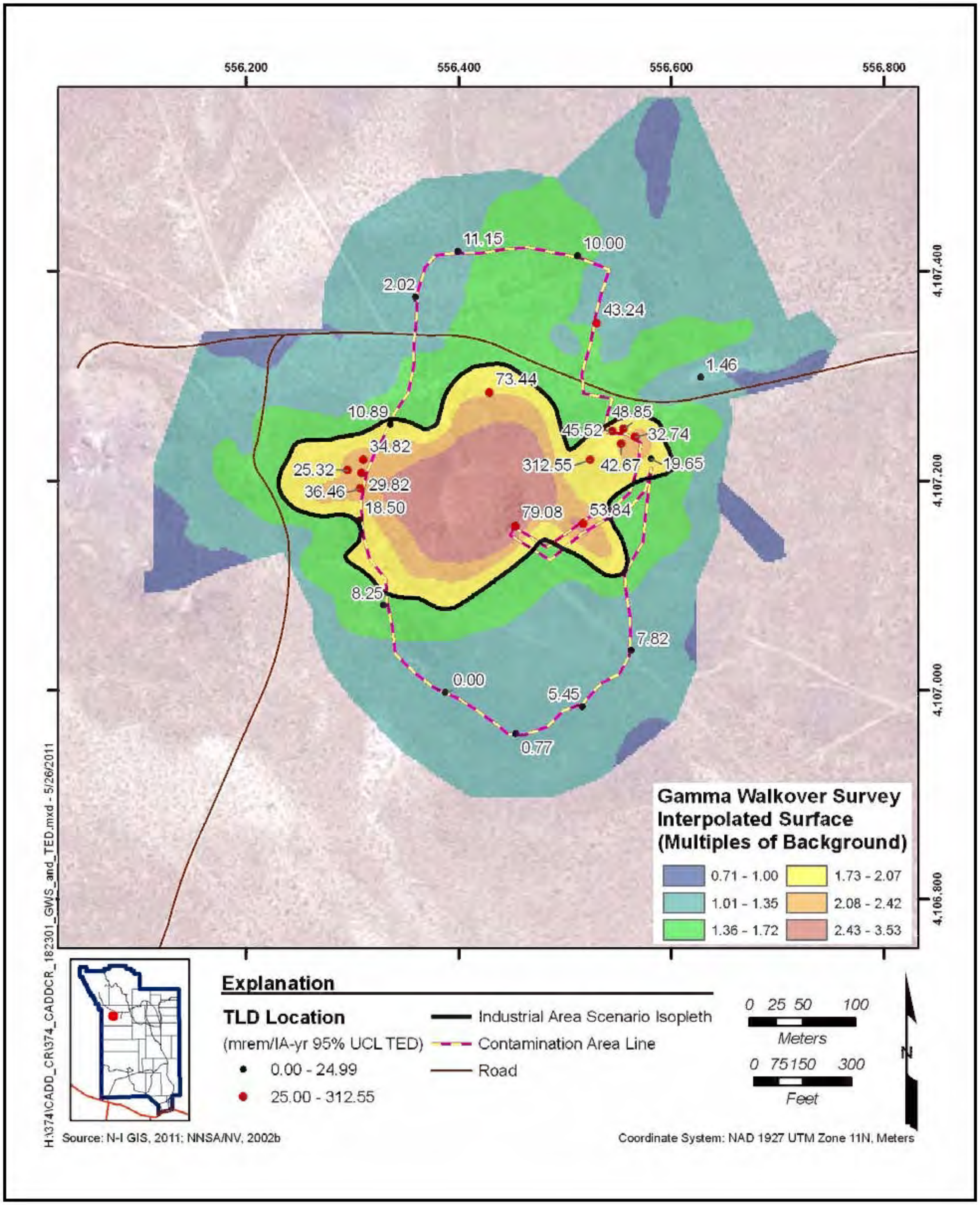


Figure A.4-4
TED and Interpolated Surface at Danny Boy

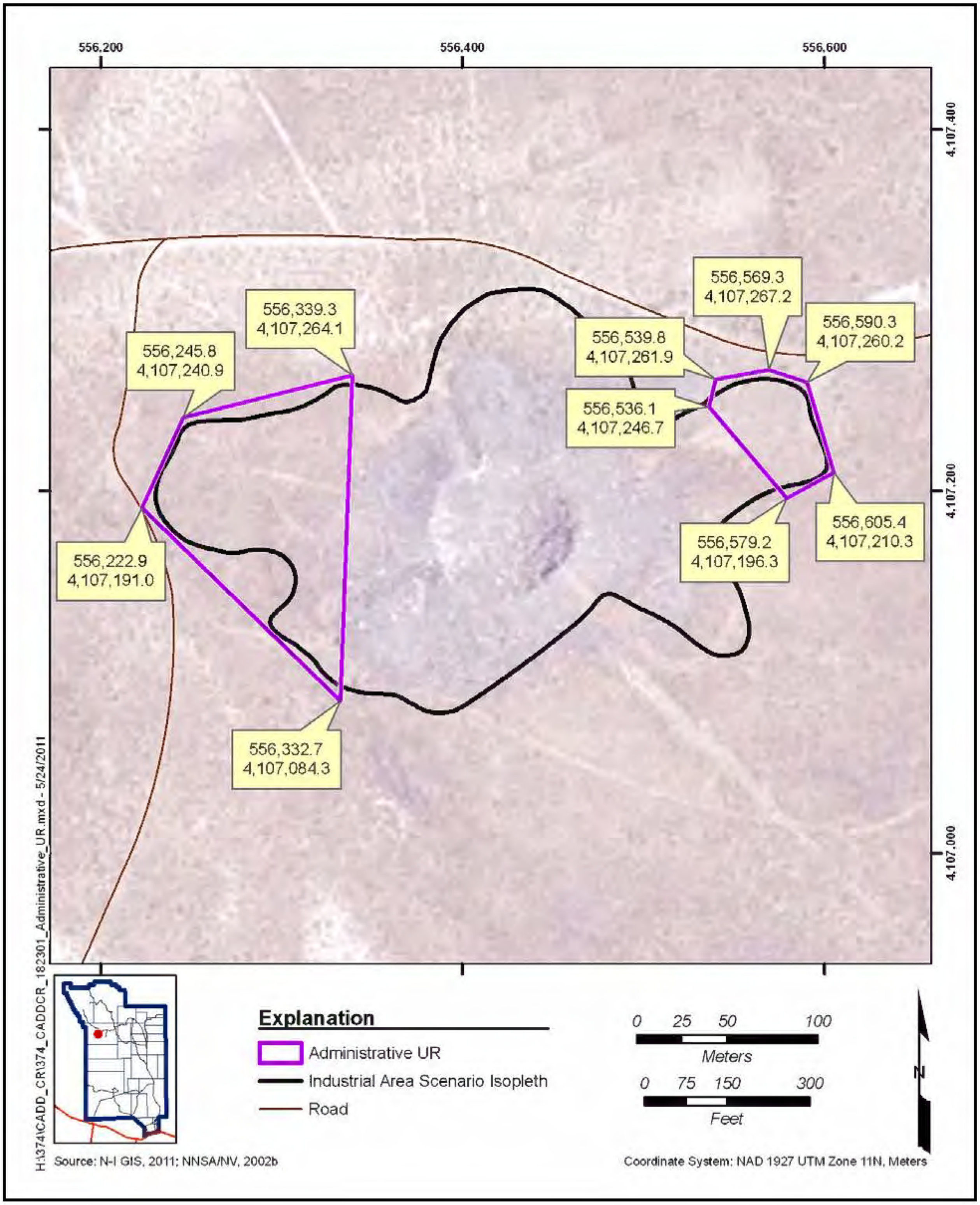


Figure A.4-5
Danny Boy Administrative UR Area

At Danny Boy, the TED from surface soils exceed a dose of 25 mrem/yr under the Industrial Area scenario based on TED values at two areas outward from the east and west sides of the fenced area and does not include the area within the fence, even though a portion of the fenced area exceeded a dose of 25 mrem/yr under the Industrial Area scenario.

A.4.4 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2010a) were met at this CAS. The information gathered during the CAI supports the CSM as presented in the CAIP for CAU 374. Therefore, no revisions were necessary to the CSM.

A.5.0 CAS 18-22-06, Drums (20)

A.5.1 Corrective Action Investigation Activities

Historical information about the CAS (REECo, 1991) stated that 20 drums were originally identified, all reported to be empty. A similar document (REECo, 1992) reported that 20 drums were removed, with three drums containing "rad contaminated sand and rocks" remaining at the site. The CAI focused on investigating these three remaining drums and soil.

Four characterization samples (3 samples and 1 duplicate of drummed test-related soil) were collected during investigation activities at CAS 18-22-06. The samples were analyzed for gamma spectroscopy; Sr-90; isotopic U, Pu, and Am; RCRA metals; VOCs; SVOCs; and PCBs. The sample identifications (IDs), locations, and types are listed in Table A.5-1.

Table A.5-1
Samples Collected at Drums (20)

Drum Label	Sample Number	Matrix	Purpose
06-A	374CX002	Soil	Environmental
06-B	374CX003	Soil	Environmental
06-D	374CX004	Soil	Environmental
	374CX005	Soil	Environmental (FD of 374CX004)

The specific CAI activities conducted to satisfy the CAIP requirements at this CAS (NNSA/NSO, 2010a) are described in the following sections.

Specific steps to remove, containerize, and dispose of the waste is discussed in Section A.8.0 and in Appendix D. No verification sampling to investigate any potential release from the drums was conducted as the surrounding soil belongs to the primary release of CAS 18-23-01, Danny Boy.

A.5.1.1 Visual Inspections

Visual inspections of CAS 18-22-06 were conducted over the course of the field investigation and included site walks, sampling efforts, and radiological surveys. No other debris or equipment was identified requiring investigation. No biasing factors (e.g., stains or odors) were noted on or adjacent to any of the objects.

A.5.1.1.1 Analytical Results for the CAS 18-22-06 Soil

Analytical results for the soil samples collected from within the three drums that were detected are presented in Tables A.5-2 and A.5-3.

Table A.5-2
Chemical Sample Results for CAS 18-22-06
(Page 1 of 3)

Drum Label	Sample Number	Sample Matrix	Parameter	Result	Unit	FAL
06-A	374CX002	Soil	Aroclor-1260	0.0016 (J)	mg/kg	0.74
			Arsenic	3.14		23
			Barium	116		190,000
			Cadmium	1.07		800
			Chromium	20.5		N/A
			Lead	279 (J)		800
			Mercury	0.0827		34
			Selenium	1.02 (J)		5,100
			Silver	0.681		5,100
			Acetone	0.00496 (J)		630,000
			Methylene Chloride	0.0254		53
			Styrene	0.000457 (J)		36,000
			Toluene	0.00699		45,000
			Total Xylenes	0.000487 (J)		2,700
			Trichlorofluoromethane	0.00148		3,400

Table A.5-2
Chemical Sample Results for CAS 18-22-06
(Page 2 of 3)

Drum Label	Sample Number	Sample Matrix	Parameter	Result	Unit	FAL
06-B	374CX003	Soil	Aroclor-1260	0.002 (J)	mg/kg	0.74
			Aroclor-1268	0.0021 (J)		0.74
			Arsenic	3.16		23
			Barium	116		190,000
			Cadmium	1.01		800
			Chromium	21.7		N/A
			Lead	122 (J)		800
			Mercury	0.0385		34
			Selenium	0.965 (J)		5,100
			Silver	0.775		5,100
			2-Butanone	0.00201 (J)		200,000
			Acetone	0.0026 (J)		630,000
			Methylene Chloride	0.0157		53
			Toluene	0.00322		45,000
			Trichlorofluoromethane	0.00131		3,400
06-D	374CX004	Soil	Arsenic	2.98	mg/kg	23
			Barium	120		190,000
			Cadmium	0.258 (J)		800
			Chromium	19.4		N/A
			Lead	9.58 (J)		800
			Mercury	0.0622		34
			Selenium	0.982 (J)		5,100
			Silver	0.816		5,100
			Methylene Chloride	0.00655		53
			Toluene	0.00157		45,000

Table A.5-2
Chemical Sample Results for CAS 18-22-06
(Page 3 of 3)

Drum Label	Sample Number	Sample Matrix	Parameter	Result	Unit	FAL
06-D	374CX005	Soil	Aroclor-1260	0.0017 (J)	mg/kg	0.74
			Arsenic	3.05		23
			Barium	106		190,000
			Cadmium	0.384 (J)		800
			Chromium	18.7		N/A
			Lead	10.4 (J)		800
			Mercury	0.0394		34
			Selenium	0.955 (J)		5,100
			Silver	0.539		5,100
			Methylene Chloride	0.0161		53
			Styrene	0.000325 (J)		36,000
			Toluene	0.00443		45,000
			Total Xylenes	0.000396 (J)		2,700

J = Estimated value

N/A = Not applicable

Table A.5-3
TED for CAS 18-22-06, Drums (20)

Drum Label	Sample Number	Industrial Area (mrem/IA-yr)	Remote Work Area (mrem/RW-yr)	Occasional Use Area (mrem/OU-yr)
06-A	374CX002	**145.3**	23.4	7.67
06-B	374CX003	**125.9**	20.4	6.69
06-D	374CX004	**80.8**	13.0	4.25
06-D	374CX005	**78.2**	12.6	4.11

Bold indicates the values exceeding 25 mrem/yr.

A.5.2 Nature and Extent of Contamination

Based on analytical results, contaminated soil within the three drums did not exceed the 25-mrem/RW-yr FAL and did not contain chemical COCs. Therefore, no corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is no further action. However, the drums and soil were removed as a BMP.

A.5.3 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2010a) were met at this CAS. The information gathered during the CAI supports the CSM as presented in the CAIP for CAU 374. Therefore, no revisions were necessary to the CSM.

A.6.0 CAS 18-22-08, Drum

Corrective Action Site 18-22-08 consists of five empty drums outside the Danny Boy crater, and any potential releases to surrounding soil. Additional detail is provided in the CAIP (NNSA/NSO, 2010a).

A.6.1 Corrective Action Investigation Activities

Five empty drums were identified, inspected, and removed.

A.6.1.1 Visual Inspections

Visual inspections of the CAS 18-22-08 drums were conducted over the course of the field investigations. The drums were empty. No other debris or equipment was identified requiring investigation. No biasing factors (e.g., stains or odors) were noted on or adjacent to any of the objects; therefore, no sampling was required nor conducted.

A.6.2 Nature and Extent of Contamination

No corrective action is required as no PSM nor was any contaminated material identified. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is no further action. As a BMP, it is recommended that the drums be removed and disposed of; therefore, the drums were removed.

A.6.3 Revised Conceptual Site Model

The CAIP requirements (NNSA/NSO, 2010a) were met at this CAS. The information gathered during the CAI supports the CSM as presented in the CAIP for CAU 374. Therefore, no revisions were necessary to the CSM.

A.7.0 CAS 18-22-05, Drum

Corrective Action Site 18-22-05, located in Area 18 at the Danny Boy Contamination Area crater, consists of four crushed drums inside the crater that are assumed to be empty, and did not require investigation or evaluation of CAAs. This CAS was predetermined during the DQOs to be closed with no further action required due to the drums being located inside the crater (NNSA/NSO, 2010a). The CAIP requirements were met at this CAS.

A.8.0 Waste Management

Waste management activities were conducted as specified in the CAIP (NNSA/NSO, 2010a).

A.8.1 Waste Streams

The waste streams discussed below and in Table A.8-1 were generated at CAU 374.

A.8.1.1 Investigation-Derived Low-Level Waste

Investigation-derived waste generated during the field activities inside the posted contamination area at Danny Boy included disposable personal protective equipment (PPE), disposable sampling equipment, and empty sample containers. The investigation-derived waste (IDW), which was collected daily, was field screened as generated to comply with the radiological release limits of Table 4-2 of the NTS Radiological Control Manual (NNSA/NSO, 2010b) to verify that removable contamination was not present at the site. The waste was bagged, labeled, and placed in a radioactive material area (RMA) at Building 23-153 and disposed as low-level waste (LLW) at the Area 5 Radioactive Waste Management Site (RWMS).

A.8.1.2 Low-Level Waste

Low-level waste (LLW) generated included 240 lb of soil and drums resulting from a BMP removal of the three CAS 18-22-06 drums and soil. Additionally, the five CAS 18-22-08 empty drums weighing a total of 135 lb were removed as a BMP and addressed along with the CAS 18-22-06 drums and soil as LLW, in order to minimize the number of waste stream and shipments. The eight drums and soil waste were bagged, screened out of the posted contamination area at Danny Boy, placed in an onsite RMA, containerized, shipped, and disposed of as LLW at the Area 5 RWMS.

A.8.1.3 Investigation-Derived Sanitary Waste

Other disposable sampling equipment and PPE was generated during sampling activities at the Schooner site and at Danny Boy when outside the posted contaminated area. The waste was placed in bags, properly labeled, and disposed of in the roll-off outside Building 23-153.

Table A.8-1
Waste Summary Table

CAS	Waste Items	Waste Characterization				Waste Disposition			
		Hazardous	Hydrocarbon	PCBs	Radioactive	Disposal Facility	Waste Volume	Disposal Date	Disposal Doc[a]
18-23-01, 20-45-03	PPE	No	No	No	No	Area 9, U10c Landfill	~15 5-gal bags	December 2010	LVF
18-22-06, 18-22-08, 18-23-01	PPE	No	No	No	Yes (LLW)	Area 5 RWMS	10 gal	May 4, 2011	CD
18-22-06, 18-22-08	Drums and soil	No	No	No	Yes (LLW)	Area 5 RWMS	375 lb	May 4, 2011	CD
20-45-03	Lead-acid batteries[b]	No	No	No	No	Recycled at TOXCO, Inc.	4 batteries (~150 lb)	N/A[c]	N/A[c]

[a]Copies of waste disposal documentation are included in Attachment D-2.
[b]This material is excluded from being solid waste when it is being recycled in accordance with 40 CFR 261.4 (CFR, 2010).
[c]This material is not being disposed as it is being recycled. Therefore, there is no disposal date or disposal documentation.

CD = Certificate of Disposal
LVF = Load Verification Form

A.8.1.4 Batteries

Four lead-acid batteries were removed from the Schooner site during the corrective action activities and are currently staged at Building 23-153 for future recycling at TOXCO, Inc., of Oak Ridge, Tennessee. All of the batteries were dry (i.e., no longer contained the electrolyte fluid), and there were no indications of a release of the fluid to the environment. The batteries were found outdoors, so it is presumed that the liquid evaporated over time from exposure to the desert climate. The lead plates in these batteries are considered scrap metal and will be recycled (i.e., the material is not considered waste and will not be disposed). Under the scrap metal exemption at 40 CFR 261.4(a)(13), the lead plates are not considered solid waste (or hazardous waste) when recycled (CFR, 2010). These batteries will be shipped off site when enough recyclable material is accumulated to make offsite shipment economical. It is anticipated that this material will be shipped off site by the end of fiscal year 2011.

A.8.2 Waste Characterization

All waste dispositions were based on process knowledge, radiological surveys, and direct samples of the waste, when necessary. Waste characterization and disposition was based on federal and state regulations, permit limitations, and disposal facility acceptance criteria.

A.9.0 Quality Assurance

This section contains a summary of QA/QC measures implemented during the sampling and analysis activities conducted in support of the CAU 374 CAI. The following sections discuss the data validation process, QC samples, and nonconformances. A detailed evaluation of the DQIs is presented in Appendix B.

Laboratory analyses were conducted for samples used in the decision-making process to provide a quantitative measurement of any COPCs present. Rigorous QA/QC was implemented for all laboratory samples, including documentation, verification and validation of analytical results, and affirmation of DQI requirements related to laboratory analysis. Detailed information regarding the QA program is contained in the Industrial Sites QAPP (NNSA/NV, 2002a).

A.9.1 Data Validation

Data validation was performed in accordance with the Industrial Sites QAPP (NNSA/NV, 2002a) and approved protocols and procedures. All laboratory data from samples collected and analyzed for CAU 374 were evaluated for data quality in a tiered process and are presented in Sections A.9.1.1 through A.9.1.3. Data were reviewed to ensure that samples were appropriately processed and analyzed, and the results were evaluated using validation criteria. Documentation of the data qualifications resulting from these reviews is retained in project files as a hard copy and electronic media.

All data analyzed as part of this investigation were subjected to Tier I and Tier II evaluations. A Tier III evaluation was performed on approximately 5 percent of the data analyzed.

A.9.1.1 Tier I Evaluation

Tier I evaluation for chemical and radiochemical analysis examines, but is not limited to, the following items:

- Sample count/type consistent with chain of custody.
- Analysis count/type consistent with chain of custody.
- Correct sample matrix.

- Significant problems and/or nonconformances stated in cover letter or case narrative.
- Completeness of certificates of analysis.
- Completeness of Contract Laboratory Program (CLP) or CLP-like packages.
- Completeness of signatures, dates, and times on chain of custody.
- Condition-upon-receipt variance form included.
- Requested analyses performed on all samples.
- Date received/analyzed given for each sample.
- Correct concentration units indicated.
- Electronic data transfer supplied.
- Results reported for field and laboratory QC samples.
- Whether or not the deliverable met the overall objectives of the project.

A.9.1.2 Tier II Evaluation

Tier II evaluation for radiochemical analysis examines, but is not limited to, the following items:

- Correct detection limits achieved.
- Blank contamination evaluated and, if significant, qualifiers are applied to sample results.
- Certificate of Analysis consistent with data package documentation.
- Quality control sample results (duplicates, laboratory control samples [LCSs], laboratory blanks) evaluated and used to determine laboratory result qualifiers.
- Sample results, uncertainty, and MDC evaluated.
- Detector system calibrated with National Institute of Standards and Technology (NIST)-traceable sources.
- Calibration sources preparation was documented, demonstrating proper preparation and appropriateness for sample matrix, emission energies, and concentrations.
- Detector system response to daily or weekly background and calibration checks for peak energy, peak centroid, peak full-width half-maximum, and peak efficiency, depending on the detection system.
- Tracers NIST-traceable, appropriate for the analysis performed, and recoveries that met QC requirements.
- Documentation of all QC sample preparation complete and properly performed.
- Spectra lines, photon emissions, particle energies, peak areas, and background peak areas support the identified radionuclide and its concentration.

A.9.1.3 Tier III Evaluation

The Tier III review is an independent examination of the Tier II evaluation. A Tier III review of 6.5 percent of the sample radiological data was performed by TLI Solutions, Inc., in Golden, Colorado. Tier II and Tier III results were compared and where differences are noted, data were reviewed and changes were made accordingly. This review included the following additional evaluations:

- Review
  - case narrative, chain of custody, and sample receipt forms,
  - lab qualifiers (applied appropriately),
  - method of analyses performed as dictated by the chain of custody,
  - raw data, including chromatograms, instrument printouts, preparation logs, and analytical logs,
  - manual integrations to determine whether the response is appropriate,
  - data package for completeness.
- Determine sample results qualifiers through the evaluation of (but not limited to)
  - tracers and QC sample results (e.g., duplicates, LCSs, blanks, matrix spikes) evaluated and used to determine sample results qualifiers,
  - sample preservation, sample preparation/extraction and run logs, sample storage, and holding time,
  - instrument and detector tuning,
  - initial and continuing calibrations,
  - calibration verification (initial, continuing, second source),
  - retention times,
  - second column and/or second detector confirmation,
  - mass spectra interpretation,

- interference check samples and serial dilutions,
- post-digestion spikes and method of standard additions,
- breakdown evaluations.

- Perform calculation checks of
  - at least one analyte per QC sample and its recovery,
  - at least one analyte per initial calibration curve, continuing calibration verification, and second source recovery,
  - at least one analyte per sample that contains positive results (hits); radiochemical results only require calculation checks on activity concentrations (not error).
- Verify that target compound detects identified in the raw data are reported on the results form.
- Document any anomalies for the laboratory to clarify or rectify. The contractor should be notified of any anomalies.

A.9.2 Field QC Samples

Field QC samples consisted of six full laboratory QCs collected and submitted for analysis by the laboratory analytical methods shown in Table A.2-1. The QC samples were assigned individual sample numbers and sent to the laboratory "blind." Full laboratory QC samples are used to measure accuracy and precision associated with the matrix (see Appendix B for further discussion).

During the CAI, five FDs were also sent as blind samples to the laboratory to be analyzed for the investigation parameters listed in Table A.2-1. For these samples, the duplicate results precision (i.e., relative percent differences [RPDs] between the environmental sample results and their corresponding FD sample results) were evaluated.

A.9.2.1 Laboratory QC Samples

Analysis of QC preparation blanks, LCSs, and laboratory duplicate samples was performed on each sample delivery group (SDG) for radionuclides. Initial and continuing calibration and LCSs were performed for each SDG. The results of these analyses were used to qualify associated environmental sample results. Documentation of data qualifications resulting from the application of these guidelines is retained in project files as both hard copy and electronic media.

A.9.3 Field Nonconformances

There were no field nonconformances identified for the CAI.

A.9.4 Laboratory Nonconformances

Laboratory nonconformances are generally due to inconsistencies in analytical instrumentation operations, sample preparations, extractions, missed holding times, spectral interferences, high or low chemical yields/matrix spikes, precision, or similar items. All laboratory nonconformances were reviewed for relevance and, where appropriate, data were qualified.

A.9.5 TLD Data Validation

The use of a TLD to determine an individual's external exposure is the standard in radiation safety and serves as the "legal dose of record" when other measurements are not available. Specifically, 10 CFR Part 835.402 (CFR, 2011) indicates that personal dosimeters shall be provided to monitor individual exposures and that the monitoring program that uses the dosimeters shall be accredited in accordance with a DOE Laboratory Accreditation Program, as was the case for the TLDs used at CAU 374.

The TLDs were exposed at the CAU 374 sample locations for exposure durations ranging from 2,328 to 2,664 hours. The measured dose from each TLD was then scaled based on the exposure durations defined for the Industrial Area and Remote Work Area exposure scenarios.

A.10.0 Summary

Radionuclide contaminants detected in environmental samples during the CAI were evaluated against FALs to determine the nature and extent of COCs for CAU 374. The following summarizes the results for each CAS where CAIs were performed.

CAS 20-45-03, U-20u Crater (Schooner)

Based on analytical results of soil samples, radiological contamination at the Schooner site exceeds the FAL for the radiological dose (25 mrem/RW-yr) at six sample locations. It is also assumed that radioactivity within the default decontamination boundary exceeds the FAL due to direct injection of radionuclides from the nuclear test. Therefore, corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is closure in place with a UR and a corrective action removal of the lead-acid batteries. The FFACO UR was established to encompass the locations exceeding 25-mrem/RW-yr TED and the default contamination boundary as shown on Figure A.3-4 and in Attachment D-1.

As a BMP, an administrative UR was established to include any area beyond the FFACO UR where an industrial land use of the area (2,250 hours of exposure per year) could cause a site worker to receive a dose exceeding 25 mrem/yr. This is presented in Section A.3.3 and shown on Figure A.3-6. The administrative UR is presented in Attachment D-1.

CAS 18-23-01, Danny Boy Contamination Area

Based on analytical results of soil samples, radiological contamination at the Danny Boy site exceed the FAL for the radiological dose (25 mrem/RW-yr) at one sample location within the default contamination boundary. It is also assumed that radioactivity within the default decontamination boundary exceeds the FAL due to direct injection of radionuclides from the nuclear test. Therefore, corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is closure in place with a UR. The FFACO UR was established to encompass the location exceeding 25-mrem/RW-yr TED and the default contamination boundary as shown on Figure A.4-3 and in Attachment D-1.

As a BMP, an administrative UR was established to include any area beyond the FFACO UR where an industrial land use of the area (2,250 hours of exposure per year) could cause a site worker to receive a dose exceeding 25 mrem/yr. This is presented in Section A.4.3 and shown on Figure A.4-5. The administrative UR is presented in Attachment D-1.

CAS 18-22-05, Drum

Based on a decision reached in the DQOs and presented in the CAIP (NNSA/NSO, 2010a), the corrective action for CAS 18-22-05 is no further action.

CAS 18-22-06, Drums (20)

Based on analytical results, contaminated soil within the three drums did not exceed FALs. Therefore, no corrective action is required. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is no further action. However, it is recommended that the drums and soil be removed as a BMP; therefore, the drums and soil were removed.

CAS 18-22-08, Drum

Based on inspections of the drums, no corrective action is required as no PSM nor was any contaminated material identified. The selected corrective action (based on the corrective action evaluation presented in Appendix E) is no further action. However, it is recommended that the drums be removed as a BMP; therefore, the drums were removed.

A.11.0 References

BN, see Bechtel Nevada.

Bechtel Nevada. 1999. *An Aerial Radiological Survey of the Nevada Test Site*, DOE/11718--324. Prepared for U.S. Department of Energy, Nevada Operations Office. Las Vegas, NV: Remote Sensing Laboratory.

CFR, see *Code of Federal Regulations*.

Code of Federal Regulations. 2010. Title 40 CFR Part 261, "Identification and Listing of Hazardous Waste." Washington, DC: U.S. Government Printing Office.

Code of Federal Regulations. 2011. Title 10 CFR, Part 835, "Occupational Radiation Protection." Washington, DC: U.S. Government Printing Office.

DOE, see U.S. Department of Energy.

DRI, see Desert Research Institute.

Desert Research Institute. 1988. *Nevada Test Site Radionuclide Inventory and Distribution Program: Report #4, Areas 18 and 20*, DOE/NV/10384-22. Prepared by R.D. McArthur and S.W. Mead. Las Vegas, NV.

EPA, see U.S. Environmental Protection Agency.

Gilbert, R.O., E.H. Essington, D.N. Brady, P.G. Doctor, and L.L Eberhardt. 1977. "Statistical Activities during 1976 and the Design and Initial Analysis of Nuclear Site Studies." In *Transuranics in Desert Ecosystems*, NVO-181. pp. 331-366. November. Las Vegas, NV: U.S. Department of Energy, Nevada Operations Office.

Gray, K.J., D.S. Shafer, K. Self, C. Martin, and R. McArthur. 2007. *Radionuclide Inventory and Distribution Program (RIDP) Database*, Rev. 2. April. Las Vegas, NV.

McArthur, R.D., and J.F. Kordas. 1983. *Radionuclide Inventory and Distribution Program: The Galileo Area*, DOE/NV/10162-14; Publication No. 45035. Prepared by R.D. McArthur and J.F. Kordas. Las Vegas, NV: Desert Research Institute, Water Resources Center.

McArthur, R.D., and J.F. Kordas. 1985. *Nevada Test Site Radionuclide Inventory and Distribution Program: Report #2, Areas 2 and 4*, DOE/NV/10162-20; Publication No. 45041. Las Vegas, NV: Desert Research Institute, Water Resources Center.

Murphy, T., Bureau of Federal Facilities. 2004. Letter to R. Bangerter (NNSA/NSO) titled "Review of Industrial Sites Project Document *Guidance for Calculating Industrial Sites Project Remediation Goals for Radionuclides in Soil Using the Residual Radiation (RESRAD) Computer Code*," 19 November. Las Vegas, NV.

N-I GIS, see Navarro-Intera Geographic Information Systems.

NNSS, see Navarro Nevada Environmental Services, LLC.

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

NNSA/NV, see U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office.

Navarro-Intera Geographic Information Systems. 2011. ESRI ArcGIS Software.

Navarro Nevada Environmental Services, LLC. 2009. *Statement of Work for Analytical Laboratories*, Section C. Las Vegas, NV.

PNNL, see Pacific Northwest National Laboratory.

Pacific Northwest National Laboratory. 2007. *Visual Sample Plan, Version 5.0 User's Guide*, PNNL-16939. Richland, WA.

REECo, see Reynolds Electrical and Engineering Co., Inc.

Reynolds Electrical and Engineering Co., Inc. 1991. *Nevada Test Site Inventory of Inactive and Abandoned Facilities and Waste Sites, Volumes 1-4*, DOE/NV/10630-18. Prepared for U.S. Department of Energy, 27 November. Las Vegas, NV.

Reynolds Electrical and Engineering Co., Inc. 1992. *Detailed Site Activity Summary NTS Cleanup and Restoration*.

Tamura, T. 1977. "Plutonium Distribution in a Desert Pavement–Desert Mound Soil System in Area 11." In *Environmental Plutonium on the Nevada Test Site and Environs*, NVO-171. June. Las Vegas, NV: Energy Research and Development Administration.

U.S. Department of Energy. 1997. *The Procedures Manual of the Environmental Measurements Laboratory*, HASL-300. 28th Ed., Vol. I. February. New York, NY.

U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office. 2002a. *Industrial Sites Quality Assurance Project Plan, Nevada Test Site, Nevada*, Rev. 3, DOE/NV--372. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office. 2002b. *Nevada Test Site Orthophoto Site Atlas*, DOE/NV/11718--604. Prepared by Bechtel Nevada. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2006. *Industrial Sites Project Establishment of Final Action Levels*, Rev. 0, DOE/NV--1107. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2010a. *Corrective Action Investigation Plan for Corrective Action Unit 374: Area 20 Schooner Unit Crater, Nevada Test Site, Nevada*, Rev. 0, DOE/NV--1361. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2010b. *Nevada Test Site Radiological Control Manual*, DOE/NV/25946--801, Rev. 1. Prepared by Radiological Control Managers' Council. Las Vegas, NV.

U.S. Environmental Protection Agency. 1980. *Prescribed Procedures for Measurement of Radioactivity in Drinking Water*, EPA 600/4-80-032. Cincinnati, OH: Environmental Monitoring and Support Laboratory Office of Research and Development.

U.S. Environmental Protection Agency. 1996. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, 3rd Edition, CD-ROM PB97-501928GEI. Washington, DC.

U.S. Environmental Protection Agency. 2006. *Data Quality Assessment: Statistical Methods for Practitioners*, EPA QA/G-9S. Washington, DC: Office of Environmental Information.

Yu, C., A.J. Zielen, J.J. Cheng, D.J. LePoire, E. Gnanapragasam, S. Kamboj, J. Arnish, A. Wallo III, W.A. Williams, and H. Peterson. 2001. *User's Manual for RESRAD Version 6*, ANL/EAD-4. Argonne, IL: Argonne National Laboratory, Environmental Assessment Division. (Version 6.4 released in December 2007.)

Appendix B

Data Assessment

B.1.0 Data Assessment

The DQA process is the scientific evaluation of the actual investigation results to determine whether the DQO criteria established in the CAU 374 CAIP (NNSA/NSO, 2010) were met and whether DQO decisions can be resolved at the desired level of confidence. The DQO process ensures that the right type, quality, and quantity of data will be available to support the resolution of those decisions at an appropriate level of confidence. Using both the DQO and DQA processes help to ensure that DQO decisions are sound and defensible.

The DQA involves five steps that begin with a review of the DQOs and end with an answer to the DQO decisions. The five steps are briefly summarized as follows:

Step 1: Review DQOs and Sampling Design – Review the DQO process to provide context for analyzing the data. State the primary statistical hypotheses; confirm the limits on decision errors for committing false negative (Type I) or false positive (Type II) decision errors; and review any special features, potential problems, or deviations to the sampling design.

Step 2: Conduct a Preliminary Data Review – Perform a preliminary data review by reviewing QA reports and inspecting the data both numerically and graphically, validating and verifying the data to ensure that the measurement systems performed in accordance with the criteria specified, and using the validated dataset to determine whether the quality of the data is satisfactory.

Step 3: Select the Test – Select the test based on the population of interest, population parameter, and hypotheses. Identify the key underlying assumptions that could cause a change in one of the DQO decisions.

Step 4: Verify the Assumptions – Perform tests of assumptions. If data are missing or are censored, determine the impact on DQO decision error.

Step 5: Draw Conclusions from the Data – Perform the calculations required for the test.

B.1.1 Review DQOs and Sampling Design

This section contains a review of the DQO process presented in Appendix A of the CAU 374 CAIP (NNSA/NSO, 2010). The DQO decisions are presented with the DQO provisions to limit false negative or false positive decision errors. Special features, potential problems, or any deviations to the sampling design are also presented.

B.1.1.1 Decision I

The Decision I statement as presented in the CAU 374 CAIP is as follows: "Is any COC present in environmental media associated with the CAS?" For judgmental (biased) sampling design, any analytical result for a COPC above a FAL will result in that COPC being designated as a COC. For the probabilistic (unbiased) sampling design, any COPC that has a 95 percent UCL of the average concentration above the FAL will result in that COPC being designated as a COC. The DQO process resulted in the assumption that TED within the craters, crater rims, and related mounding around the craters (default decontamination boundaries) exceeds the FAL. Therefore, Decision I for the primary releases (referred to as "test releases" in the CAU 374 CAIP) is resolved within the areas of the default decontamination boundaries at Danny Boy and Schooner. However, Decision I needs to be resolved for these CASs relative to contamination beyond the boundaries of the default contamination boundaries. For the other releases (e.g., drums), Decision I will be resolved based on the presence of COCs in samples from the drums. The specific analyses from the other releases will be selected dependent upon the type and nature of the identified release (NNSA/NSO, 2010).

B.1.1.1.1 DQO Provisions To Limit False Negative Decision Error

A false negative decision error (determining that contamination above FALs is not present when it actually is) was controlled by meeting the following criteria:

1a. For Decision I, having a high degree of confidence that sample locations selected will identify COCs if present anywhere within the CAS.

1b. Maintenance of a false negative decision error rate of 0.05 (probabilistic sampling).

2. Having a high degree of confidence that analyses conducted will be sufficient to detect any COCs present in the samples.

3. Having a high degree of confidence that the dataset is of sufficient quality and completeness.

Criteria 1b, 2, and 3, were assessed based on the entire dataset. Therefore, these assessments apply to both Decision I and Decision II.

Criterion 1a

To resolve Decision I for the primary releases at CAU 374 (as stipulated in the DQOs), sample locations were selected at the Danny Boy and Schooner CAS locations based on GWS values. The results of the GWS conducted at the Danny Boy site (Section 2.5.4 of the CAIP [NNSA/NSO, 2010]) indicated two areas with elevated readings outside the default decontamination boundary and plots were placed at these locations. Four sample plots were placed along each of three vectors outside the default contamination boundary based on GWS values at the Schooner site. The Schooner vectors were chosen with one vector placed parallel to the central axis of the plume and the other two spaced at approximately 120 degree separations to cover the site (Sections A.4.1, A.5.1, A.5.2.1, A.5.2.1.1, and A.9.1.1 of the CAIP).

To resolve Decision I for the other releases at CAU 374 (as stipulated in the DQOs), a biased sampling strategy was used to target areas with the highest potential for contamination, if it is present anywhere in the CAS. Accordingly, sampling locations were established at the center of the two sedimentation areas in each of two washes outside the default decontamination boundary at Schooner and a single sampling location was established at the center of the only sedimentation area in the wash outside the default decontamination boundary at Danny Boy. Additionally, to address the CAU 374 drums, soil samples were collected for COC determinations in each of the three drums at CAS 18-22-06. The drums at CAS 18-22-08 did not contain PSM and therefore were not sampled (Sections A.4.1, A.5.1, A.5.2.1, and A.5.2.1.3 of the CAIP).

Criterion 1b

Control of the false negative decision error for the probabilistic samples was accomplished by ensuring the following:

- The samples are collected from random locations.
- A sufficient sample size was collected.
- A false rejection rate of 0.05 was used in calculating the 95 percent UCL and minimum sample size for probabilistic sampling

Selection of the sample aliquot locations within a sample plot was accomplished through use of the VSP software (PNNL, 2007). Each set of sample aliquot locations was derived using the random start, systematic triangular grid pattern for sample placement. Use of the VSP software permitted an unbiased, equal-weighted chance that any given location within the boundaries of the sample plot would be chosen. Although the TLD locations were not established at random locations (i.e., they were placed at the center of the sample plot), they provided an integrated, unbiased measurement of dose from the plot area.

The minimum number of samples required for each sample plot was calculated for both the internal (soil samples) and external (TLD elements) dose samples. The minimum sample size was calculated using the following EPA sample size formula (EPA, 2006):

$$n \geq \frac{s^2(z_{.95} + z_{.80})^2}{(\mu - C)^2} + \frac{z^2_{.95}}{2}$$

where:

s = the standard deviation
$z_{.95}$ = z score associated with the false negative rate of 5 percent
$z_{.80}$ = z score associated with the false positive rate of 20 percent
μ = dose level where false positive decision is not acceptable (12.5 mrem/yr)
C = FAL (25 mrem/yr)

The use of this formula requires the input of basic statistical values associated with the sample data. Data from a minimum of three samples are required to calculate these statistical values and, as such, the least possible number of samples required to apply the formula is three. Therefore, in instances where the formula resulted in a value less than three, three is adopted as the minimum number of samples required. The results of the minimum sample size calculations and the number of samples collected are presented in Tables B.1-1 through B.1-4. As shown in these tables, the minimum number of sample plot and TLD samples was met or exceeded. The minimum sample size calculations were conducted as stipulated in the CAU 374 CAIP (NNSA/NSO, 2010) based on the following parameters:

- A false rejection rate of 0.05
- A false acceptance rate of 0.20
- The maximum acceptable gray region set to one half the FAL (12.5 mrem/yr)
- The calculated standard deviation

The minimum number of samples criterion was met for all soil and TLD samples.

Table B.1-1
Input Values and Minimum Number of Soil Samples Required for the Remote Work Area Exposure Scenario at Danny Boy

Plot	Standard Deviation	Actual Number of Samples Collected	Minimum Number of Samples Required
AA	0.0950	4	3
AB	0.3031	4	3

Table B.1-2
Input Values and Minimum Number of Soil Samples Required for the Remote Work Area Exposure Scenario at Schooner

Plot	Standard Deviation	Actual Number of Samples Collected	Minimum Number of Samples Required
BA	0.4629	4	3
BB	0.0653	4	3
BC	0.2676	5	3
BD	0.0073	4	3
BE	0.1564	4	3
BF	0.0979	5	3
BG	0.0264	4	3
BH	0.0250	4	3
BK	0.0422	4	3
BL	0.0447	4	3
BM	0.0224	4	3

Table B.1-3
Input Values and Minimum Number of TLD Samples Required for the Remote Work Area Exposure Scenario at Danny Boy

Location	Standard Deviation	Actual Number of Samples Collected	Minimum Number of Samples Required
AT01	0.18	3	3
AT02	0.41	3	3
AT03	0.45	3	3
AT04	0.37	3	3
AT05	0.64	3	3
AT06	0.71	3	3
AT07	0.62	3	3
AT08	0.29	3	3
AT09	0.35	3	3
AT10	1.22	3	3
AT11	0.21	3	3
AT12	0.22	3	3
AT13	0.17	3	3
AT14	0.10	3	3
AT15	0.18	3	3
AT16	0.20	3	3
AT17	0.06	3	3
AT18	0.09	3	3
AT19	0.38	3	3
AT20	0.09	3	3
AT21	2.07	3	3
AT22	0.64	3	3
AT23	4.57	3	3
AT24	0.24	3	3
AT25	0.16	3	3
AT26	0.12	3	3
AT27	1.15	3	3
AT28	0.11	3	3

Table B.1-4
Input Values and Minimum Number of TLD Samples Required for the Remote Work Area Exposure Scenario at Schooner
(Page 1 of 3)

Location	Standard Deviation	Actual Number of Samples Collected	Minimum Number of Samples Required
BT01	1.85	3	3
BT02	3.31	3	3
BT03	5.18	3	3
BT04	1.71	3	3
BT05	0.81	3	3
BT06	0.36	3	3
BT07	0.29	3	3
BT08	0.13	3	3
BT09	0.29	3	3
BT10	0.39	3	3
BT11	0.25	3	3
BT12	0.42	3	3
BT13	0.19	3	3
BT14	0.82	3	3
BT15	0.64	3	3
BT16	0.13	3	3
BT17	0.32	3	3
BT18	0.41	3	3
BT19	0.77	3	3
BT20	0.39	3	3
BT21	0.53	3	3
BT22	0.53	3	3
BT23	0.60	3	3
BT24	0.27	3	3
BT25	0.31	3	3
BT26	0.63	3	3
BT27	0.88	3	3
BT28	0.32	3	3
BT29	0.16	3	3

Table B.1-4
Input Values and Minimum Number of TLD Samples Required for the Remote Work Area Exposure Scenario at Schooner
(Page 2 of 3)

Location	Standard Deviation	Actual Number of Samples Collected	Minimum Number of Samples Required
BT30	0.93	3	3
BT31	1.32	3	3
BT32	0.23	3	3
BT33	0.48	3	3
BT34	0.62	3	3
BT35	2.53	3	3
BT36	0.12	3	3
BT37	0.37	3	3
BT38	0.60	3	3
BT39	0.54	3	3
BT40	0.43	3	3
BT41	0.72	3	3
BT42	0.54	3	3
BT43	1.26	3	3
BT44	0.51	3	3
BT45	0.37	3	3
BT46	0.26	3	3
BT47	0.06	3	3
BT48	0.14	3	3
BT49	0.33	3	3
BT50	0.15	3	3
BT51	0.27	3	3
BT52	0.10	3	3
BT53	0.21	3	3
BT54	0.07	3	3
BT55	0.13	3	3
BT56	0.19	3	3
BT57	0.04	3	3
BT58	0.26	3	3

Table B.1-4
Input Values and Minimum Number of TLD Samples Required for the Remote Work Area Exposure Scenario at Schooner
(Page 3 of 3)

Location	Standard Deviation	Actual Number of Samples Collected	Minimum Number of Samples Required
BT59	0.27	3	3
BT60	0.17	3	3
BT61	0.22	3	3
BT62	0.17	3	3
BT63	0.15	3	3
BT64	0.25	3	3
BT65	0.11	3	3
BT66	0.31	3	3
BT67	0.21	3	3
BT68	0.70	3	3

Criterion 2

All samples were analyzed using the analytical methods listed in Tables 3-2 and 3-3 of the CAU 374 CAIP (NNSA/NSO, 2010) and for the following radiological analytes as listed in Section 3.2 of the CAIP: gamma spectroscopy; Sr-90; and isotopic Am, U, and Pu.

Sample results were assessed against the acceptance criterion for the DQI of sensitivity as defined in the Industrial Sites QAPP (NNSA/NV, 2002). The sensitivity acceptance criterion defined in the CAU 374 CAIP is that analytical detection limits will be less than the corresponding FAL (NNSA/NSO, 2010). Therefore, the criteria are that all detection limits are less than their corresponding remote work area internal dose RRMGs or chemical-specific FAL. As all of the analytical result detection limits were less than their corresponding RRMGs, the DQI for sensitivity has been met, and no data were rejected due to sensitivity.

Criterion 3

To satisfy the third criterion, the entire dataset, as well as individual sample results, were assessed against the acceptance criteria for the DQIs of precision, accuracy, comparability, completeness, and representativeness, as defined in the Industrial Sites QAPP (NNSA/NV, 2002). The DQI acceptance criteria are presented in Table 6-1 of the CAIP (NNSA/NSO, 2010). As presented in the following subsections, these criteria were met for each of the DQIs.

Precision

Precision was evaluated as described in Section 6.2.3 of the CAIP (NNSA/NSO, 2010). Table B.1-5 provides the sample results for all constituents that were qualified for precision.

Table B.1-5
Precision Measurements[a]

Parameter	Analyses	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria
U-234	Uranium	10	67	85.0746
Pu-238	Plutonium	3	67	95.5223
Pu-239/240	Plutonium	5	67	92.5373
Am-241	Americium	7	67	89.5522

[a]SW-846 Methods (EPA, 2004 and 2008)

As shown in Table B.1-5, the results met the CAIP criterion of 80 percent for precision (NNSA/NSO, 2010). As the precision rates for all constituents meet the acceptance criteria for precision, the database is determined to be acceptable for the DQI of precision.

Accuracy

Accuracy was evaluated as described in Section 6.2.4 of the CAIP (NNSA/NSO, 2010).

Table B.1-6 provides the chemical accuracy analysis results for all constituents qualified for accuracy. Accuracy rates are above the CAIP criterion of 80 percent—except for barium, selenium, and lead—and which have respective rates of 58.3, 41.7, and 16.7 percent. However, there is negligible potential for a false negative DQO decision error because all of the associated concentrations are small in comparison to the action level; as the highest impacted reported concentration [respective values of 292 mg/kg, 1.02 (J) mg/kg, and 279 (J) mg/kg for barium, selenium, and lead], with respective percentages of FALs equaling 0.2, 0.02, and 35. Because the results do not approach the FALs, these results have no reasonable impact on DQO decisions. The accuracy rate for all of the

Table B.1-6
Accuracy Measurements[a]

Parameter	Analyses	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria	Maximum (mg/kg)	FAL (mg/kg)	%
Arsenic	Metals	2	12	83.3	5.87	23	26
Barium	Metals	5	12	58.3	292	190,000	0.2
Selenium	Metals	7	12	41.7	1.02 (J)	5,100	0.02
Lead	Metals	10	12	16.7	279 (J)	800	35

[a]SW-846 Methods (EPA, 2004 and 2008)

J = Estimated

other constituents meets the acceptable criteria for accuracy, and the dataset is determined to be acceptable for the DQI of accuracy.

Representativeness

The DQO process as identified in Appendix A of the CAU 374 CAIP (NNSA/NSO, 2010) was used to address sampling and analytical requirements for CAU 374. During this process, appropriate locations were selected that enabled the samples collected to be representative of the population parameters identified in the DQO (the most likely locations to contain contamination [judgmental sampling] or that represent contamination of the sample plot [probabilistic sampling] and locations that bound COCs) (Section A.2.1). The sampling locations identified in the Criterion 1 discussion meet this criterion. Therefore, the analytical data acquired during the CAU 374 CAI are considered representative of the population parameters.

Comparability

Field sampling, as described in the CAU 374 CAIP (NNSA/NSO, 2010), was performed and documented in accordance with approved procedures that are comparable to standard industry practices. Approved analytical methods and procedures per DOE were used to analyze, report, and validate the data. These are comparable to other methods used not only in industry and government practices, but most importantly are comparable to other investigations conducted for the NNSS. Therefore, project datasets are considered comparable to other datasets generated using these same standardized DOE procedures, thereby meeting DQO requirements.

Standard, approved field and analytical methods also ensured that data were appropriate for comparison to the investigation action levels specified in the CAIP.

Completeness

The CAU 374 CAIP (NNSA/NSO, 2010) defines acceptable criteria for completeness to be that the dataset is sufficiently complete to be able to make the DQO decisions. This is initially evaluated as 80 percent of CAS-specific analytes identified in the CAIP having valid results. Out of 3,043 total measurements performed by the laboratory, only two (Pu-238) failed the DQO of sensitivity. Therefore, the acceptance criterion for the completeness of greater than 80 percent has been met.

B.1.1.1.2 DQO Provisions To Limit False Positive Decision Error

The false positive decision error was controlled by assessing the potential for false positive analytical results. Quality assurance/QC samples such as method blanks were used to determine whether a false positive analytical result may have occurred. No false positive analytical results were reported.

Proper decontamination of sampling equipment also minimized the potential for cross contamination that could lead to a false positive analytical result.

B.1.1.2 Decision II

Decision II as presented in the CAU 374 CAIP is as follows: "Is sufficient information available to evaluate potential corrective action alternatives?" Sufficient information is defined to include the following:

- Lateral and vertical extent of COC contamination
- Information needed to determine potential remediation waste types
- Information needed to evaluate the feasibility of remediation alternatives

Decision II extent of contamination was not needed at any of the CASs because TEDs above the 25-mrem/RW-yr FAL were not detected in surface soils outside the default contamination areas that were assumed to exceed the FAL.

B.1.1.3 Sampling Design

The CAIP (NNSA/NSO, 2010) made the following commitments for sampling:

1. Judgmental sampling will be conducted at other releases and at locations of potential contamination identified during the CAI.

   Result: Judgmental sampling was conducted at sediment accumulation areas within the major washes at Danny Boy and Schooner to determine whether migration from the site has occurred.

2. Sampling of primary releases will be conducted by a combination of judgmental and probabilistic sampling approaches.

   Result: The location of the plots were selected judgmentally, and samples were collected within each plot at all CASs within CAU 374 probabilistically as described in Section A.2.0.

B.1.2 Conduct a Preliminary Data Review

Laboratory nonconformances are generally due to fluctuations in analytical instrumentation operations, sample preparations, missed holding times, spectral interferences, high or low chemical yields/matrix spikes, precision, and similar items. All laboratory nonconformances were reviewed for relevance and where appropriate, data were qualified.

B.1.3 Select the Test and Identify Key Assumptions

The test for making DQO decisions for radiological contamination was the comparison of the TED to the FAL of 25 mrem/RW-yr. For other types of contamination, the test for making DQO decisions was the comparison of the maximum analyte concentration to the corresponding FAL. All FALs were based on an exposure duration to a site worker using the Remote Work Area exposure scenario.

The key assumptions that could impact a DQO decision are listed in Table B.1-7.

B.1.4 Verify the Assumptions

The results of the investigation support the key assumptions identified in the CAU 374 DQOs and Table B.1-7. All data collected during the CAI supported CSMs, and no revisions to the CSMs were necessary.

Table B.1-7
Key Assumptions

Exposure Scenario	The potential for contamination exposure is limited to industrial and construction workers, and military personnel conducting training. These human receptors may be exposed to COPCs through oral ingestion or inhalation of soil and/or debris due to inadvertent disturbance of these materials or irradiation by radioactive materials.
Affected Media	Surface and shallow subsurface soil, debris such as metal, vehicles, wood, and concrete.
Location of Contamination/Release Points	Surface soil (to 5-cm depth) (see Section 2.1).
Transport Mechanisms	Surface water runoff may provide for the transportation of some contaminants within or outside the boundaries of the CASs. Infiltration of precipitation through subsurface media serves as a minor intermittent driving force for vertical migration of contaminants.
Preferential Pathways	Washes.
Lateral and Vertical Extent of Contamination	Contamination, if present, is expected to be contiguous to the release points. Concentrations are expected to decrease with distance and depth from the source. Groundwater contamination is not expected. Lateral and vertical extent of COC contamination is assumed to be within the spatial boundaries of each CAS.
Groundwater Impacts	None.
Future Land Use	Nuclear Test.
Other DQO Assumptions	Subsurface contamination is present at Schooner and Danny Boy due to the prompt injection of material into each crater. Release is due to atmospheric deposition during testing. The DQIs were satisfactorily met as discussed in Section B.1.1.1.1. The rejected data because of sensitivity was due to the particulate nature of the rejected radionuclides and is not considered to adversely impact the ability for the data to support the DQO decisions. The data collected during the CAI are considered to accurately support the CSM and support the DQO decision; therefore, no revisions to the CSM were necessary.

B.1.4.1 Other DQO Commitments

The CAIP (NNSA/NSO, 2010) made the following commitments for sampling:

1. A Decision I plot will be established in at least one area likely to exceed a 25-mrem/IA-yr dose (Section A.5.2.1.1 of the CAU 374 CAIP).

   Result: Six of the 12 plot locations established at the Schooner CAS and both of the two plot locations established at the Danny Boy CAS exceeded the 25-mrem/IA-yr dose PAL.

2. If a predetermined location cannot be feasibly sampled, the Site Supervisor will determine an alternate location (Section A.9.1.1 of the CAU 374 CAIP).

   Result: The change from aliquot-based random sampling at Schooner to a grab sample at plot BX, due to boulders in the area, did not impact the DQO decisions because the sample was collected from within the plot representative of the elevated radiological conditions. Therefore, this sample is considered to be representative of internal dose derived from the plot location.

B.1.5 Draw Conclusions from the Data

This section resolves the two DQO decisions for each of the CAU 374 CASs.

B.1.5.1 Decision Rules for Decision I

Decision Rule: If the population parameter of any COPC in the Decision I population of interest exceeds the corresponding FAL, then that contaminant is identified as a COC, and Decision II samples will be collected, else no further investigation is needed for that COPC in that population. For the other release sample locations, additional Decision I samples will be collected if biasing factors are present.

Result: The TEDs were below the 25-mrem/RW-yr FAL outside the default decontamination boundaries (including the sediment-accumulation areas) at Danny Boy and Schooner, and also below the 25-mrem/RW-yr FAL and chemical FALs for the CAS 18-22-06 drums and soil. Therefore, Decision I was resolved, and Decision II was not required. Also, COCs (i.e., PSM) in the form of lead-acid batteries were identified at Schooner. No biasing factors were present in surface soils at drum CASs 18-22-06 and 18-22-08; therefore, Decision I was resolved.

Decision Rule: If COC contamination is inconsistent with the CSM or extends beyond the spatial boundaries identified in Section A.6.2 of the CAU 374 CAIP (NNSA/NSO, 2010), then work will be suspended and the investigation strategy will be reconsidered, else the decision will be to continue sampling to define the extent.

Result: The COC contamination was not found to be inconsistent with the CSM or extend beyond the spatial boundaries; therefore, work was not suspended.

Decision Rule: If a COC exists at any CAS, then a corrective action will be determined, else no further action will be necessary.

Result: Because COCs were identified (TEDs were above the 25-mrem/RW-yr FAL) within the default decontamination boundaries at Danny Boy and Schooner, and the lead-acid batteries at Schooner were assumed to exceed the FAL at Schooner, corrective actions were required.

Decision Rule: If a waste is present that, if released, has the potential to cause the future contamination of site environmental media, then a corrective action will be determined, else no further action will be necessary.

Result: Lead-acid batteries were identified at the Schooner site. This wastes requires corrective action.

B.1.5.2 Decision Rules for Decision II

Decision Rule: If COC contamination is inconsistent with the CSM or extends beyond the spatial boundaries identified in Section A.5.2 of the CAU 374 CAIP (NNSA/NSO, 2010), then work will be suspended and the investigation strategy will be reconsidered, else the decision will be to continue sampling to define the extent.

Result: The COC contamination was not found to be inconsistent with the CSM or extend beyond the spatial boundaries; therefore, there was no need to suspend work.

Decision Rule: If the population parameter (the observed concentration of any COC) in the Decision II population of interest exceeds the corresponding FAL in any bounding direction, or potential remediation waste types have not been adequately defined, then additional samples will be collected to complete the Decision II evaluation, else the extent of the COC contamination has been defined.

Result: For the primary releases, 6 of the 12 TLD/plot locations were below the 25-mrem/RW-yr FAL outward on the 3 vectors to effectively bound the COCs. At the other releases, the extent of the soil contamination was defined as within the drums. Therefore, additional samples were not collected.

Decision Rule: If a radiation survey isopleth exists that bounds all locations determined to exceed the 95 percent UCL of the 25-mrem/yr TED, then the isopleth will be established as the corrective action boundary, else the radiation survey area will be increased until that boundary is defined.

Result: The default contamination boundaries will serve as the respective corrective action boundaries at the Schooner and Danny Boy CASs, and contain the measured locations that exceeded and the primary release areas assumed to exceed the 25-mrem/RW-yr FAL.

B.2.0 References

EPA, see U.S. Environmental Protection Agency.

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

NNSA/NV, see U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office.

PNNL, see Pacific Northwest National Laboratory.

Pacific Northwest National Laboratory. 2007. *Visual Sample Plan, Version 5.0 User's Guide*, PNNL-16939. Richland, WA.

U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office. 2002. *Industrial Sites Quality Assurance Project Plan, Nevada Test Site, Nevada*, Rev. 3, DOE/NV--372. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2010. *Corrective Action Investigation Plan for Corrective Action Unit 374: Area 20 Schooner Unit Crater, Nevada Test Site, Nevada*, Rev. 0, DOE/NV--1361. Las Vegas, NV.

U.S. Environmental Protection Agency. 2004. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, OSWER 9240.1-45, EPA 540-R-04-004. October. Washington, DC: Office of Superfund Remediation and Technology Innovation.

U.S. Environmental Protection Agency. 2006. *Data Quality Assessment: Statistical Methods for Practitioners*, EPA QA/G-9S, EPA/240/B-06/003. Washington, DC: Office of Environmental Information.

U.S. Environmental Protection Agency. 2008. *USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review*, OSWER 9240.1-48, USEPA-540-R-08-01. June. Washington, DC: Office of Superfund Remediation and Technology Innovation.

Appendix C

Risk Assessment

C.1.0 Risk Assessment

The risk-based corrective action (RBCA) process used to establish FALs is described in the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). This process conforms with NAC Section 445A.227, which lists the requirements for sites with soil contamination (NAC, 2008a). For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2008b) requires the use of ASTM Method E1739 (ASTM, 1995) to "conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards (i.e., FALs) or to establish that corrective action is not necessary."

The ASTM Method E1739 defines three tiers (or levels) of evaluation involving increasingly sophisticated analyses:

- Tier 1 evaluation – Sample results from source areas (highest concentrations) are compared to risk-based screening action levels (RBSLs) based on generic (non-site-specific) conditions (i.e., the PALs established in the CAU 374 CAIP [NNSA/NSO, 2010]). The FALs may then be established as the Tier 1 action levels, or the FALs may be calculated using a Tier 2 evaluation.

- Tier 2 evaluation – Conducted by calculating Tier 2 site-specific target levels (SSTLs) using site-specific information as inputs to the same or similar methodology used to calculate Tier 1 action levels. The Tier 2 SSTLs are then compared to individual sample results from reasonable points of exposure (as opposed to the source areas as is done in Tier 1) on a point-by-point basis. Total concentrations of total petroleum hydrocarbons will not be used for risk-based decisions under Tier 2 or Tier 3. Rather, the individual chemicals of concern will be compared to the SSTLs.

- Tier 3 evaluation – Conducted by calculating Tier 3 SSTLs on the basis of more sophisticated risk analyses using methodologies described in Method E1739 that consider site-, pathway-, and receptor-specific parameters.

The risk-based corrective action decision process stipulated in the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006) is summarized in Figure C.1-1.

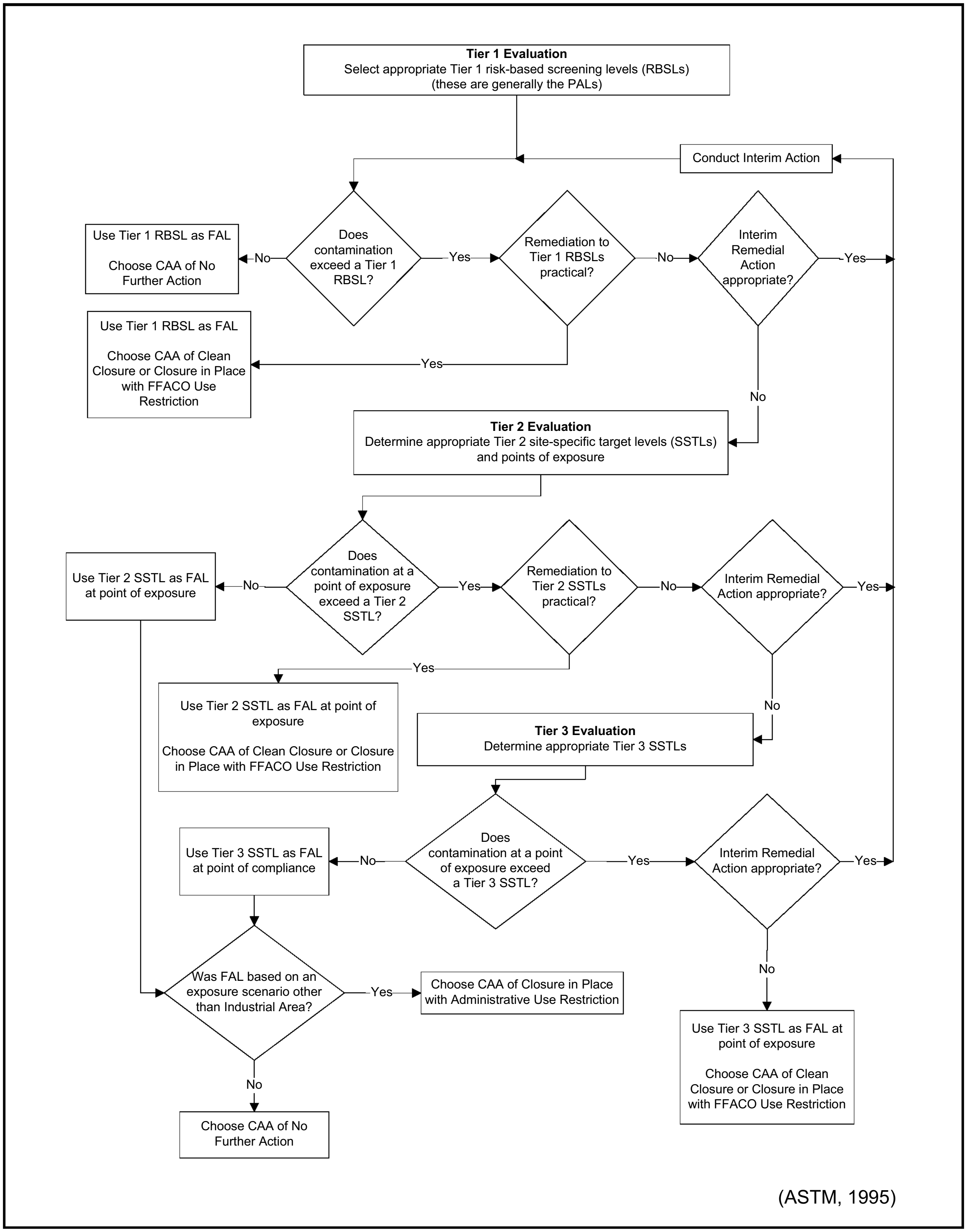


Figure C.1-1
Risk-Based Corrective Action Decision Process

C.1.1 A. Scenario

Corrective Action Unit 374, Area 20 Schooner Unit Crater, comprises the following five CASs within Areas 18 and 20 of the NNSS:

- 18-22-05, Drum
- 18-22-06, Drums (20)
- 18-22-08, Drum
- 18-23-01, Danny Boy Contamination Area
- 20-45-03, U-20u Crater (Schooner)

Both the Danny Boy site (CAS 18-23-01; and co-located CASs 18-22-05, 18-22-06, and 18-22-08) and the Schooner site (CAS 20-45-03) are located on relatively flat mesas (Buckboard Mesa in Area 18 and Pahute Mesa in Area 20, respectively). Both sites were the setting for nuclear tests conducted in the 1960s, and both tests were conducted in shallow subsurface rock (basalt at Danny Boy and tuff at Schooner).

Corrective Action Site 18-23-01 consists of the release of radionuclides to the surrounding rock and soil from the Danny Boy test. Corrective Action Sites 18-22-06 and 18-22-08 consist of unknown releases to the sites from material that either was or presently is held within drums assumed to be used during and/or after testing activities at the sites. Corrective Action Site 18-22-05 contains crushed drums located within the crater that were not investigated as predetermined in the CAIP (NNSA/NSO, 2010) and are not discussed further in this appendix.

C.1.2 B. Site Assessment

The Danny Boy site includes the area affected by the surface release of radioactivity associated with the Danny Boy underground nuclear test. A blowout crater is present at the site surrounded by mounds of ejected soil and rock. No testing related debris is present in the area. Thermoluminescent dosimeters and soil samples collected at various locations within this CAS were used to calculate TED to workers. (See Section A.3.2.3 for details on the calculation of the TED.) One location (AT23) at Danny Boy exceeded the Remote Work Area Scenario based FAL established in this appendix (25 mrem/RW-yr). This scenario was conservatively used as it is more protective than the actual current and projected site use. The maximum calculated TED (based on the Remote Work Area Scenario) was 47.8 mrem/yr at location AT23. However, it was shown that if site use were to change in the future to a continuous industrial work site, an industrial worker could potentially receive a TED in excess of 25 mrem/yr. The maximum calculated TED (based on the Industrial Area Scenario) was 312.6 mrem/yr. Also, subsurface contamination is assumed to be present inside the default contamination area that exceeds FALs. This includes the crater, ejecta field, and rock piles.

The Schooner site includes the area affected by the surface release of radioactivity associated with the Schooner crater underground nuclear test. A blowout crater is present at the site surrounded by mounds of ejected soil and rock. No testing-related debris was present in the area, except for the lead-acid batteries that were investigated and assumed to exceed the FAL. Thermoluminescent devices and soil samples collected at various locations within this CAS were used to calculate TED to workers. (See Section A.3.2.3 for details on the calculation of the TED.) No TEDs from surface soil plot and TLD locations at Schooner exceeded the Remote Work Area Scenario based FAL established in this appendix (25 mrem/RW-yr), at TLD locations; BT01, BT02, BT03, BT04, BT35, and BT43. These six locations are close to the crater and well within the default contamination boundary. The Remote Work Area Scenario was conservatively used as it is more protective than the actual current and projected site use. The maximum calculated TED (based on the Remote Work Area Scenario) was 63.1 mrem/yr. However, it was shown that if site use were to change in the future to a continuous industrial work site, an industrial worker could potentially receive a TED in excess of 25 mrem/yr. The maximum calculated TED (based on the Industrial Area Scenario) was 415.8 mrem/yr at location BT03. However, subsurface contamination is assumed to be present in the Schooner crater and surrounding ejecta field that exceeds FALs.

The other release scenario includes subsequent migration of radioactivity associated with atmospheric deposition under the primary release scenario, and other contamination that may be present at the CAU 374 CASs. Migration may be due to sheet and drainage channel erosion from stormwater runoff and/or movement through excavation and grading from past activities. The washes at Danny Boy and Schooner were investigated via TLDs, and soil samples were collected at various locations to calculate TED to workers. (See Section A.3.2.3 for details on the calculation of the TED.) No TEDs from the wash sample locations at Danny Boy or Schooner exceeded the Remote Work Area Scenario based FAL.

The other release scenario also includes the drums left in and around the Danny Boy crater, comprising CASs 18-22-06 and 18-22-08. Before the investigation, the contents of the drums were unknown and suspected to be related to post-test entry and drilling activities. Corrective Action Site 18-22-08 drums were inspected and found to be empty; therefore, no COCs were identified. The CAS 18-22-06 drums were sampled, and the contents did not exceed the 25-mrem/RW-yr FAL.

In addition, the lead-acid batteries found at Schooner are included in the other release scenario. They were intact, and no soil bias was noted; therefore, no sampling was conducted. However, because of the lead composition, they are assumed to contain contamination exceeding the FAL.

C.1.3 C. Site Classification and Initial Response Action

The four major site classifications listed in Table 3 of the ASTM Standard are (1) immediate threat to human health, safety, and the environment; (2) short-term (0 to 2 years) threat to human health, safety, and the environment; (3) long-term (greater than 2 years) threat to human health, safety, or the environment; and (4) no demonstrated long-term threats.

Based on the CAI, Danny Boy and Schooner site conditions do not present an immediate threat to human health, safety, and the environment; therefore, no interim response actions are necessary at these sites. However, corrective actions are required at the Danny Boy and Schooner sites due to the presence of contamination exceeding the 25-mrem/RW-yr FAL that could pose a short-term threat to human health, safety, or the environment if any excavation was done in the craters or ejecta fields. Lead-acid batteries are also present at Schooner that are assumed to exceed FALs and require corrective action. Thus Danny Boy, Schooner, and CAS 18-22-06 have been determined to be Classification 2 sites as defined by ASTM Method E1739. Corrective Action Sites 18-22-05 and 18-22-08 do not require corrective action.

C.1.4 D. Development of Tier 1 Lookup Table of RBSLs

Tier 1 RBSLs are defined as the PALs listed in the CAIP (NNSA/NSO, 2010) as established during the DQO process. The PALs for radionuclides are based on a dose of 25 mrem/yr using the Industrial Area exposure scenario. This represents a very conservative estimate of risk, is preliminary in nature, and is used for site screening purposes. Although the PALs are not intended to be used as FALs,

FALs may be defined as the Tier 1 RBSL (i.e., PAL) value if implementing a corrective action based on the Tier 1 RBSL would be appropriate.

The Industrial Area scenario assumes that a full-time industrial worker is present at a particular location for his entire career (225 day/yr, 10 hr/day for a duration of 25 years). The 25-mrem/yr dose-based Tier 1 RBSL for the primary release is implemented by calculating the dose a site worker would receive if exposed to the site contaminants over an annual exposure period of 2,250 hours.

The Tier 1 RBSLs for chemical contaminants are the following PALs as defined in the CAIP:

- EPA Region 9 Risk-Based Preliminary Remediation Goals (PRGs) for Industrial Soils (EPA, 2009).
- Background concentrations for RCRA metals will be evaluated when natural background exceeds the PAL, as is often the case with arsenic. Background is considered the mean plus two times the standard deviation of the mean based on data published in Mineral and Energy Resource Assessment of the Nellis Air Force Range (NBMG, 1998; Moore, 1999).
- For COPCs without established PRGs, a protocol similar to EPA Region 9 will be used to establish an action level; otherwise, an established PRG from another EPA region may be chosen.
- The PALs for radioactive contaminants are the RRMGs based on the NCRP Report No. 129 recommended screening limits for construction, commercial, industrial land-use scenarios (NCRP, 1999) scaled to 25-mrem/yr dose constraint (Appenzeller-Wing, 2004) and the generic guidelines for residual concentration of radionuclides in DOE Order 5400.5 (DOE, 1993).

The PALs were developed based on an industrial scenario. Because the CAU 374 CASs in Areas 18 and 20 are not assigned work stations and are considered to be in remote or occasional use areas, the use of industrial scenario based PALs is conservative.

C.1.5 E. Exposure Pathway Evaluation

For CAU 374, the DQOs stated that site workers would only be exposed to COCs through oral ingestion, inhalation, or dermal contact (absorption) of soil or debris due to inadvertent disturbance of these materials or irradiation by radioactive materials at the CASs. The potential exposure pathways would be through worker contact with the contaminated soil or various debris currently present within the site boundary. The limited migration demonstrated by the analytical results, elapsed time since the suspected release, and depth to groundwater supports the selection and evaluation of only surface and shallow subsurface contact as the complete exposure pathways. Ingestion of groundwater is not considered to be a significant exposure pathway.

C.1.6 F. Comparison of Site Conditions with Tier 1 RBSLs

The areas within the default contamination boundaries at the Danny Boy and Schooner sites are both assumed to contain significant contamination and require corrective action. Therefore, these areas are not included in the RBCA evaluations. Rather, these evaluations will be limited to the CAS areas outside the Danny Boy Contamination Area and Schooner default contamination boundaries. An exposure time based on the Industrial Area scenario (2,250 hr/yr) was used to calculate site radiological doses (TED). These values were compared to the Tier 1 RBSL (25-mrem/IA-yr dose) that is also based on an exposure time of 2,250 hr/yr.

The Industrial Area scenario based TED for all sampled locations at the Danny Boy and Schooner sites that exceed the Tier 1 RBSL (i.e., PAL) are listed in Table C.1-1. The CAS 18-22-06 drummed soil samples that exceed the Tier 1 RBSLs (as defined in the EPA Region 9 Risk-Based PRGs for Industrial Soils [EPA, 2009]) are also listed in Table C.1-1. The lead-acid batteries at Schooner are assumed to exceed the Tier 1 RBSLs (as defined in the EPA Region 9 Risk-Based PRGs for Industrial Soils [EPA, 2009]) value of 800 mg/kg, as the interior of the batteries contain lead.

Based on the conservative assumption that a site worker would be exposed to the maximum dose measured at any sampled location outside the Danny Boy and Schooner default contamination boundaries, this site worker would receive 25-mrem dose at each of these CAS locations in the exposure times listed in Table C.1-2.

C.1.7 G. Evaluation of Tier 1 Results

For all chemical contaminants at all CASs, the FALs were established as the Tier 1 RBSLs. It was determined that no further action is required for these contaminants at these CASs. For the radiological contaminants, it was determined by NNSA/NSO that remediation to the RBSL is not appropriate. The risk to receptors from contaminants at CAU 374 is due to chronic exposure to

Table C.1-1
Locations Where TED Exceeds the Tier 1 RBSL at CAU 374 (mrem/IA-yr)
(Page 1 of 2)

CAS	TLD Locations (Plot)	Average TED	95% UCL TED
18-23-01 (Danny Boy)	AT01	**27.8**	**29.8**
	AT02	**29.4**	**34.8**
	AT03	19.4	**25.3**
	AT04	**31.5**	**36.5**
	AT05	**34.8**	**42.7**
	AT06	**36.1**	**45.5**
	AT07	**40.7**	**48.9**
	AT08	**28.8**	**32.7**
	AT10	**62.9**	**79.1**
	AT21	15.8	**43.2**
	AT22	**65.0**	**73.4**
	AT23	**252.1**	**312.6**
	AT27	**38.7**	**53.8**
20-45-03 (Schooner)	BT01	**202.8**	**225.9**
	BT02	**256.4**	**297.8**
	BT03	**351.0**	**415.8**
	BT04	**247.1**	**268.4**
	BT05	**146.2**	**156.4**
	BT13	**47.0**	**49.7**
	BT14	**80.2**	**90.5**
	BT15	**94.0**	**102.0**
	BT17	**32.6**	**36.6**
	BT18	**48.9**	**54.1**
	BT19	**72.2**	**81.9**
	BT22	20.4	**26.7**
	BT23	**62.8**	**69.5**
	BT25	24.2	**28.1**
	BT26	**32.5**	**40.6**
	BT27	**97.1**	**108.1**

Table C.1-1
Locations Where TED Exceeds the Tier 1 RBSL at CAU 374 (mrem/IA-yr)
(Page 2 of 2)

CAS	TLD Locations (Plot)		Average TED	95% UCL TED
20-45-03 (Schooner)	BT28		22.5	**26.5**
	BT29		**25.8**	**27.7**
	BT30		**44.4**	**56.1**
	BT31		**114.4**	**131.0**
	BT33		**35.5**	**41.3**
	BT34		**45.0**	**55.1**
	BT35		**250.1**	**281.8**
	BT38		22.4	**29.9**
	BT39		**108.9**	**115.7**
	BT40		**26.1**	**31.5**
	BT41		**57.4**	**66.4**
	BT42		**85.0**	**91.8**
	BT43		**154.2**	**170.0**
	Drum Label	**Sample Number**	**TED**	**95% UCL TED**
18-22-06 Drums (20)	06-A	374CX002	**145.3**	**N/A**
	06-B	374CX003	**125.9**	
	06-D	374CX004	**80.8**	
	06-D	374CX005	**78.2**	

Bold indicates the values exceeding 25 mrem/yr.

Table C.1-2
Minimum Exposure Time to Receive a 25-mrem/yr Dose

CAS	Location of Maximum Dose	Maximum 95% UCL TED (mrem/IA-yr)	Minimum Exposure Time (hours)
Danny Boy	AT23	312.6	179.8
Schooner	BT03	415.8	135.9

radionuclides (i.e., receiving a dose over time). Therefore, the risk to a receptor is directly related to the amount of time a receptor is exposed to the contaminants. A review of the current and projected use of the Danny Boy and Schooner sites determined that workers may only be present at these sites for a few hours per year (see Section C.1.10), and it is not reasonable to assume that any worker would be present at this site for 2,250 hr/yr, the basis for the Tier I RBSLs (DOE/NV, 1996). Therefore, it was determined to conduct a Tier 2 evaluation.

C.1.8 H. Tier 1 Remedial Action Evaluation

The lead-acid batteries at Schooner were removed under a corrective action. As the batteries were intact, this removal was considered a complete removal of the PSM, and additional corrective action is not necessary. For the drummed soil at CAS 18-22-06, it was determined that remediation of the material was feasible, and it was removed as a BMP. This was a complete removal, and additional action/evaluation is not necessary.

C.1.9 I. Tier 2 Evaluation

No additional data were needed to complete a Tier 2 evaluation.

C.1.10 J. Development of Tier 2 Table of SSTLs

The Tier 2 action levels are typically compared to contaminant values that are representative of areas at which an individual or population may come in contact with a COC originating from a CAS. This concept is illustrated in the EPA's Human Health Evaluation Manual (EPA, 1989). This document states that "the area over which the activity is expected to occur should be considered when averaging the monitoring data for a hot spot. For example, averaging soil data over an area the size of a residential backyard (e.g., an eighth of an acre) may be most appropriate for evaluating residential soil pathways." When evaluating industrial receptors, the area over which an industrial worker is exposed may be much larger than for residential receptors. For a site that is limited to industrial uses, the receptor would be a site worker, and patterns of employee activity would be used to estimate the area over which the receptor is exposed. This can be very complicated to calculate, as industrial workers may perform routine activities at many locations where only a portion of these locations may be contaminated. A more practical measure of integrated risk to radiological dose for an industrial worker is to calculate the portion of total work time that the worker is in proximity to elevated radioactivity—and, therefore, able to receive a dose. For example, a site worker may have routine activities that require exposure to a radioactive location for 225 hours out of each year. If the worker's industrial work schedule was 10 hr/day for 225 day/yr—or 2,250 hr/yr (as is used for the Industrial Area exposure scenario)—the site worker would receive 10 percent of the potential annual dose that he or she would otherwise receive if exposed to the radioactive location for the entire work year.

For the development of radiological Tier 2 SSTLs, the annual dose limit for a site worker is 25 mrem/yr (the same as was used for the Tier 1 evaluation). The Tier 2 evaluation is based on a receptor exposure time that is more specific to actual site conditions. The maximum potential exposure time for the most exposed worker at any CAU 374 CAS was determined based on an evaluation of current and reasonable future activities that may be conducted at the site. Activities on the NNSS are strictly controlled through a formal work control process. This process requires facility managers to authorize all work activities that take place on the land or at the facilities within their purview. As such, these facility managers are aware of all activities conducted at the site. The facility managers responsible for the area of CAU 374 identified the general types of work activities that are currently conducted at the site, to include fencing/posting inspection and maintenance workers, and maintenance of the meteorological station. Site activities that may occur in the future were identified by assessing tasks related to maintenance of existing infrastructure and long-term stewardship of the site (e.g., inspection and maintenance of UR signs, trespasser). In order to estimate the amount of time a site worker might spend conducting current or future activities, the NNSA/NSO and/or M&O contractor departments responsible for these activities were consulted. Under the current land use at each of the CAU 374 CASs, the following workers were identified as being potentially exposed to site contamination:

- **Inspection and Maintenance Worker –** Workers sent to conduct the annual inspection of the postings and fencing around the CASs. The UR requires a periodic inspection to ensure that the fencing is intact and the signs are legible. This will require two people to spend up to 10 hours per year at each CAS.

- **Meteorological Station Maintenance –** Semi-annual preventative maintenance activities conducted adjacent to the Schooner crater. These workers typically spend 2 to 3 hours twice a year to perform calibrations, battery checks, and other preventative maintenance activities of their equipment positioned on site. It was conservatively assumed that this type of worker would spend up to 8 hours per year at the Schooner CAS.

- **Trespasser** – This would include workers or individuals that do not have a specific work assignment at one of the CASs. Although the sites will be posted with warning signs, there is a potential that they might inadvertently enter into these CAS areas and come in contact with site contamination. This is assumed to be an infrequent occurrence (i.e., once per year) that would result in a potential exposure of less than a day (8 hours).

Under the current land use at each of the CAU 374 CASs, the most exposed worker would be the Inspection and Maintenance Worker, who would not be exposed to site contamination for more than 10 hours per year. Based on the conservative assumption that the most exposed worker would be exposed to the maximum dose measured at any sampled location within the default contamination boundaries for the entire 10 hours, this worker would receive a maximum potential dose at each CAS as listed in Table C.1-3.

Table C.1-3
Maximum Potential Dose to Most Exposed Worker at CAU 374 CASs

CAS	Most Exposed Worker	Exposure Time	Maximum Potential Dose
Danny Boy	Inspection and Maintenance Worker	10 hr/yr	1.42 mrem/yr
Schooner	Inspection and Maintenance Worker	10 hr/yr	1.88 mrem/yr

In the CAU 374 DQOs, it was conservatively determined that the Occasional Use Area exposure scenario (as listed in Section 3.1.1 of the CAU 374 CAIP [NNSA/NSO, 2010]) would be appropriate in calculating receptor exposure time based on current land use at all CAU 374 CASs. This exposure scenario assumes exposure to site workers who are not assigned to the area as a regular work site but may occasionally use the site for intermittent or short-term activities. Site workers under this scenario are assumed to be on the site for an equivalent of 80 hours per year.

However, as the corrective action requirements at each of the CAU 374 CASs would not be significantly different if based on the Remote Work Area exposure scenario, it was conservatively determined to use the Remote Work Area exposure scenario. Therefore, the radiological FAL determined under this exposure scenario was based on the assumption that a worker would be exposed to site contamination for 336 hours per year.

C.1.11 K. Comparison of Site Conditions with Tier 2 Table SSTLs

The 25-mrem/yr dose-based Tier 2 SSTL for radionuclides based on the Remote Work Area exposure scenario was developed by calculating dose (i.e., TED) at the site over an annual exposure period of 336 hours (8 hr/day, 42 day/yr). The TEDs calculated using the Remote Work Area exposure scenario were then compared to the 25-mrem/RW-yr Tier 2 SSTL. Table C.1-4 provides the 95 percent UCL TED values that exceeded the 25-mrem/RW-yr Tier 2 SSTL at both Danny Boy and Schooner. All of the Table C.1-4 locations are inside the respective default contamination boundaries. Therefore, no corrective actions will be required for areas outside the default contamination boundaries at either Danny Boy or Schooner.

Table C.1-4
Remote Work Area Scenario Exceedances at Each CAS (mrem/RW-yr)

CAS	Plot/Location	Average TED	95% UCL TED
Danny Boy	AT23	**38.6**	**47.8**
Schooner	BT01	**30.8**	**34.3**
	BT02	**38.9**	**45.2**
	BT03	**53.3**	**63.1**
	BT04	**37.5**	**40.7**
	BT35	**38.0**	**42.8**
	BT43	23.4	**25.8**

C.1.12 L. Tier 2 Remedial Action Evaluation

Based on the Tier 2 evaluation, the contamination outside default contamination boundaries at Danny Boy and Schooner does not pose an unacceptable risk to human health and the environment. Therefore, no further corrective action is necessary for the radiological contamination of surface soils beyond the default contamination areas at these sites.

Evaluation of the contamination at Danny Boy and Schooner also needs to address the contamination within the default contamination boundaries that are assumed to exceed FALs. A corrective action of clean closure at these CASs would require extensive excavations (the corrective action areas at each CAS are presented in Table C.1-5) of up to depths of 25 ft at the Danny Boy and Schooner craters. This corrective action would not remove deeper contamination in the area of the craters, and a UR

Table C.1-5
Corrective Action Boundary Areas at CAU 374 CASs

CAS	Area (ft^2)
Danny Boy	951,200
Schooner	11,340,800

may still be required. Based on the extent of the corrective action boundaries and the infeasibility of removing the deep contamination at both sites that would expose remediation workers to high levels of contamination, the Tier 2 remedial action evaluation recommends implementing a corrective action of closure in place with URs for the areas encompassed by the Tier 2 SSTL corrective action boundaries. As this corrective action is practical for the contamination at these CASs, the Tier 2 SSTL is established as the FAL for the radiological contamination and corrective action will be implemented.

As the radiological FAL was established as the Tier 2 SSTL, a Tier 3 evaluation was not necessary.

C.2.0 Recommendations

Because all of the TED values for surface soils beyond the default contamination boundaries at both CAU 374 CASs were less than the FAL (using the Remote Work Area exposure scenario), it was determined that surface soil contamination at these locations do not warrant corrective actions. However, surface and subsurface contamination exists at the Danny Boy and Schooner CASs within the default contamination boundaries that is assumed to exceed the Remote Work Area exposure scenario based FAL or 25 mrem/RW-yr. Therefore, a corrective action is necessary for the contamination within the default contamination boundaries at both CAU 374 CASs.

The FAL was based on an exposure time of 336 hr/yr of site worker exposure to CAS surface soils. To prevent future industrial land use activities conducted at the site that may cause a site worker to be exposed to site contamination, an administrative UR was implemented at the Danny Boy and Schooner CASs as a BMP. The areas at the Danny Boy and Schooner CASs that provide sufficient dose to potentially cause a full-time industrial worker to receive an annual dose exceeding 25 mrem were conservatively defined in Section D.1.2.

The corrective actions for CAU 374 are based on the assumption that activities on the NNSS will be limited to those that are industrial in nature and that the NNSS will maintain controlled access (i.e., restrict public access and residential use). Should the future land use of the NNSS change such that these assumptions no longer are valid, additional evaluation may be necessary.

The FFACO and administrative URs for both CASs are recorded in the FFACO database, NNSA/NSO Facility Information Management System, and the NNSA/NSO CAU/CAS files. These URs are included in Attachment D-1.

C.3.0 References

ASTM, see ASTM International.

Appenzeller-Wing, J., U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2004. Letter to T.A. Maize (NDEP) entitled, "Submittal of Proposed Radiological Preliminary Action Levels (PALs) for the Industrial Sites Project," 15 January. Las Vegas, NV.

ASTM International. 1995 (reapproved 2002). *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites,* ASTM E1739 - 95(2002). Philadelphia, PA.

DOE, see U.S. Department of Energy.

DOE/NV, see U.S. Department of Energy, Nevada Operations Office.

EPA, see U.S. Environmental Protection Agency.

Moore, J., Science Applications International Corporation. 1999. Memorandum to M. Todd (SAIC), "Background Concentrations for NTS and TTR Soil Samples," 3 February. Las Vegas, NV.

NAC, see *Nevada Administrative Code.*

NBMG, see Nevada Bureau of Mines and Geology.

NCRP, see National Council on Radiation Protection and Measurements.

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

National Council on Radiation Protection and Measurements. 1999. *Recommended Screening Limits for Contaminated Surface Soil and Review of Factors Relevant to Site-Specific Studies*, NCRP Report No. 129. Bethesda, MD.

Nevada Administrative Code. 2008a. NAC 445A.227, "Contamination of Soil: Order by Director for Corrective Action; Factors To Be Considered in Determining Whether Corrective Action Required." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 25 October 2009.

Nevada Administrative Code. 2008b. NAC 445A.22705, "Contamination of Soil: Evaluation of Site by Owner or Operator; Review of Evaluation by Division." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 25 October 2009.

Nevada Bureau of Mines and Geology. 1998. *Mineral and Energy Resource Assessment of the Nellis Air Force Range*, Open-File Report 98-1. Reno, NV.

U.S. Department of Energy. 1993. *Radiation Protection of the Public and the Environment*, DOE Order 5400.5, Change 2. Washington, DC: U.S. Government Printing Office.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2006. *Industrial Sites Project Establishment of Final Action Levels*, Rev. 0, DOE/NV--1107. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2010. *Corrective Action Investigation Plan for Corrective Action Unit 374: Area 20 Schooner Unit Crater, Nevada Test Site, Nevada*, Rev. 0, DOE/NV--1361. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1996. *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada*, DOE/EIS-0243. Las Vegas, NV.

U.S. Environmental Protection Agency. 1989. *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)*, EPA/540/1-89/002. Washington, DC: Office of Emergency and Remedial Response.

U.S. Environmental Protection Agency. 2009. *Region 9: Superfund, Preliminary Remediation Goals, Screening Levels for Chemical Contaminants*. As accessed at http://www.epa.gov/region09/waste/sfund/prg/index.html on 25 October. Prepared by EPA Office of Superfund and Oak Ridge National Laboratory.

Attachment C-1

Derivation of Residual Radioactive Material Guidelines for Radionuclides in Soil at Corrective Action Unit (CAU) 374 Area 20 Schooner Unit Crater Nevada National Security Site, Nevada

(10 Pages)

Introduction

This appendix promulgates tables of Residual Radioactive Material Guidelines (RRMGs) for the Industrial Area, Remote Work Area, and Occasional Use Area exposure scenarios, for use in the evaluation of Soils Project sites. These exposure scenarios are described in the document *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006). Two sets of RRMGs were calculated for each of the three exposure scenarios: one set using only the inhalation and ingestion pathways (e.g., internal dose), and one set that added the external gamma pathway (e.g., internal and external dose). The second set is needed to evaluate “other release” soil samples where thermoluminescent dosimeters (TLDs) were not emplaced to measure the external dose.

Background

The *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006), provides a Nevada Division of Environmental Protection (NDEP)-approved process for the derivation of soil sampling final action levels that are congruent with the risk-based corrective action process. This document is used by the Navarro-Intera, LLC, Soils Project as well.

The Residual Radioactive (RESRAD) computer code, version 6.5 (Yu et al., 2001), and the guidance provided in NNSA/NSO (2006) were used to derive RRMGs for use in the Soils Project. The RRMGs are radionuclide-specific values for radioactivity in surface soils, expressed in units of picocuries per gram (pCi/g). A soil sample with a radionuclide concentration that is equal to the RRMG value for that radionuclide would present a potential dose of 25 millirem per year (mrem/yr) to a receptor under the conditions described in the exposure scenario. When more than one radionuclide is present, the potential dose must be evaluated by summing the fractions for each radionuclide (i.e., the measured concentration divided by the RRMG for the radionuclide). The resultant sum of the fractions value is then multiplied by 25.0 to obtain an estimate of the dose.

The RRMGs are specific to a particular exposure scenario. The dose estimates obtained from the use of RRMGs are valid only when the assumptions provided in the exposure scenario for the intended land-use hold true. In most cases at the Nevada National Security Site (NNSS), the Industrial Area exposure scenario is quite conservative and is bounding for most anticipated future land uses.

A recent revision to 10 *Code of Federal Regulations* (CFR) Part 835 (CFR, 2011) had adopted new, more sophisticated, dosimetric models and new dosimetric terms. Internal dose is now to be expressed in terms of the Committed Effective Dose (CED), and International Commission on Radiological Protection (ICRP) 72 dose conversion factors are to be used.

Methods

Calculations were performed using the RESRAD code, version 6.5 (Yu et al., 2001). The ICRP 72 dose conversion factors were used. The RESRAD input parameters were verified and checkprinted.

The radionuclide niobium (Nb)-94 was previously added to the RRMGs to accommodate work in Area 25 that is related to the Nuclear Rocket Development Station (NRDS). The radionuclides silver (Ag)-108m, curium (Cm)-243, and Cm-244 were recently detected on one or more Soils Project sites, and RRMGs were calculated to demonstrate that their contribution to the total effective dose (TED) is negligible.

The RESRAD calculations have identified that for all radionuclides evaluated, with one exception: The maximum potential dose occurs at time-zero. The RRMGs provided in this memorandum do reflect those for time-zero. The exception previously mentioned is the radionuclide thorium (Th)-232, which has several daughters with short half-lives. Because the daughter activity "grows in," and because RRMGs include the contributions from daughters, the maximum potential dose for Th-232 actually occurs at 10.21 years. A RRMG for Th-232 at 10.21 years was not selected, and the RRMG for time-zero was used, for the following reasons:

- RESRAD suggests a set of RRMGs for use when the overall total dose is at its maximum. Considering the contributions from all radionuclide contaminants of potential concern (COPCs), this would be at time-zero.
- The additional dose from the in-growth of Th-232 daughters is offset by the radioactive decay of other radionuclides that would be present (e.g., cesium [Cs]-137).
- The additional dose from the in-growth of Th-232 daughters is very small when compared to the basic dose limit of 25 mrem/yr. For example, if Th-232 were found at a concentration of 100 pCi/g, the increase in potential dose from time-zero to 10.21 years would only be 0.52 millirem (mrem). To date, Th-232 has only been seen on Soils Project sites at environmental levels of about 1.5 to 3 pCi/g.

Assumptions and Default Parameters

Appendix B to DOE/NV--1107 (NNSA/NSO, 2006) lists the RESRAD code variables (i.e., input parameters) for the three exposure scenarios. These pre-determined values were used to calculate the RRMGs, with a few exceptions as described in Table 1.

Results

The RRMGs are presented in Tables 2 to 7. The abbreviation "RRMG" in each of the six tables includes a subscript to indicate the scenario and the exposure pathways that are activated. When referencing a set of RRMGs, the subscripts should be included to avoid confusion and a potential misapplication of the RRMGs.

Table 1: RESRAD Input Parameters

Item #	RESRAD Parameter	Industrial Area	Remote Work Area	Occasional Use Area	Explanation
1	Area of CZ (m^2)	1,000			Appendix B states "Site Specific." Previously, 100 m^2 was selected to conform to the maximum area of contamination limitation in DOE Order 5400.5 (DOE, 1993). Going forward, 1,000 m^2 has been selected to add conservativism and realism to the RRMGs. The 1,000 m^2 RRMGs will be applied to 100-m^2 evaluation areas.
2	Thickness of CZ (m)	0.05			Appendix B states "Site Specific." This depth encompasses the bulk of the potential contamination and includes the maximum concentration.
3	Cover Depth	0.00			Appendix B states "Site Specific." Cover depth only affects the time delay before contamination becomes available for erosion and airborne suspension. Increasing the cover depth, in some cases, may lead to lower dose estimates.
4	Precipitation (m/yr)	0.144			Appendix B states "Site Specific." The selected value is the average annual rainfall as recorded at Camp Desert Rock.
5	Indoor Time Fraction	**[0.1712]**	**[0.0256]**	0	The stated value was 0, conservatively assuming no time is spent indoors. The new value more accurately reflects the Industrial Area scenario in which 66% of the time is spent indoors. $\left(\frac{2250\ hrs\ on-site}{8760\ hrs\ in\ a\ year}\right) 0.6666\ indoors = 0.1712$ The same correction was made for the Remote Work Area scenario.
6	Soil Ingestion Rate (g/yr)	**[43.43]**	20.2	4.8	The stated value was 108, assuming that all time is spent outdoors under a 480-mg/day soil ingestion rate. The new value more accurately reflects the soil ingestion rate of 193 mg/day when both indoor and outdoor time fractions are considered. Refer to page 14 of DOE/NV--1107 (NNSA/NSO, 2006).
7	Indoor Dust Filtration Factor	**[0.4]**	**[0.4]**	1	This is the RESRAD default value and is appropriate as, under the Industrial Area and Remote Work Area scenarios, 66% of the time is spent indoors.
8	Shielding Factor External Gamma	**[0.7]**	**[0.7]**	1	This is the RESRAD default value and is appropriate as, under the Industrial Area and Remote Work Area scenarios, 66% of the time is spent indoors.
9	Pathway 1 – External Gamma	Suppressed	Suppressed	Suppressed	In general, external dose at Soils Projects will be evaluated via TLDs or direct measurement with a dose-rate meter. Soil samples and RRMGs are used to determine the internal dose component only. The pathway was activated for the second set of RRMGs for each scenario to allow the evaluation of biased sample locations where TLDs were not emplaced.

Note 1: Items 1–4 above are site-specific default values that were selected for the Soils Project.
Note 2: Table B.1-1 in Appendix B contains several errors. The bold and bracketed values are corrections to those values.

CZ = Contamination zone — *m^2 = Square meter*
g/yr = Grams per year — *m/yr = Meters per year*
m = Meter — *mg/day = Milligrams per day*

Table 2: Soils Project – Industrial Area Exposure Scenario – Internal Dose Only

Radionuclide	**RRMG$_{(IA-I)}$** (pCi/g)
Ag-108m	2.737E+06
Am-241	2.816E+03
Cm-243	3.852E+03
Cm-244	4.735E+03
Co-60	5.513E+05
Cs-137	1.409E+05
Eu-152	1.177E+06
Eu-154	8.469E+05
Eu-155	5.588E+06
Nb-94	3.499E+06
Pu-238	2.423E+03
Pu-239/240	2.215E+03
Sr-90	5.947E+04
Th-232	2.274E+03
U-234	1.960E+04
U-235	2.089E+04
U-238	2.120E+04

A soil sample at this RRMG value would present an internal dose potential of 25 mrem under the Industrial Area exposure scenario.

Table 3: Soils Project – Industrial Area Exposure Scenario – Internal & External Dose

Radionuclide	**RRMG$_{(IA-IE)}$** (pCi/g)
Ag-108m	9.281E+01
Am-241	1.503E+03
Cm-243	3.155E+02
Cm-244	4.713E+03
Co-60	1.833E+01
Cs-137	7.290E+01
Eu-152	3.826E+01
Eu-154	3.571E+01
Eu-155	9.583E+02
Nb-94	9.653E+01
Pu-238	2.416E+03
Pu-239/240	2.207E+03
Sr-90	7.714E+03
Th-232	5.067E+02
U-234	1.865E+04
U-235	2.555E+02
U-238	1.423E+03

A soil sample at this RRMG value would present a TED potential of 25 mrem under the Industrial Area exposure scenario.

Table 4: Soils Project – Remote Work Area Exposure Scenario – Internal Dose Only

Radionuclide	**RRMG$_{(RWA\text{-}I)}$** (pCi/g)
Ag-108m	3.389E+07
Am-241	1.612E+04
Cm-243	2.223E+04
Cm-244	2.716E+04
Co-60	7.229E+06
Cs-137	1.955E+06
Eu-152	1.324E+07
Eu-154	9.741E+06
Eu-155	6.645E+07
Nb-94	3.966E+07
Pu-238	1.388E+04
Pu-239/240	1.268E+04
Sr-90	8.075E+05
Th-232	1.341E+04
U-234	1.379E+05
U-235	1.496E+05
U-238	1.554E+05

A soil sample at this RRMG value would present an internal dose potential of 25 mrem under the Remote Work Area exposure scenario.

Table 5: Soils Project – Remote Work Area Exposure Scenario – Internal & External Dose

Radionuclide	**$RRMG_{(RWA-IE)}$** (pCi/g)
Ag-108m	6.204E+02
Am-241	9.239E+03
Cm-243	2.083E+03
Cm-244	2.715E+04
Co-60	1.225E+02
Cs-137	4.874E+02
Eu-152	2.557E+02
Eu-154	2.387E+02
Eu-155	6.406E+03
Nb-94	6.452E+02
Pu-238	1.390E+04
Pu-239/240	1.269E+04
Sr-90	5.522E+04
Th-232	3.292E+03
U-234	1.314E+05
U-235	1.709E+03
U-238	9.572E+03

A soil sample at this RRMG value would present a TED potential of 25 mrem under the Remote Work Area exposure scenario.

Table 6: Soils Project – Occasional Use Area Exposure Scenario – Internal Dose Only

Radionuclide	**RRMG$_{(OUA-I)}$** (pCi/g)
Ag-108m	2.762E+08
Am-241	4.555E+04
Cm-243	6.307E+04
Cm-244	7.68E+04
Co-60	7.421E+07
Cs-137	2.756E+07
Eu-152	8.174E+07
Eu-154	6.353E+07
Eu-155	4.751E+08
Nb-94	2.492E+08
Pu-238	3.922E+04
Pu-239/240	3.582E+04
Sr-90	9.949E+06
Th-232	3.852E+04
U-234	4.470E+05
U-235	4.922E+05
U-238	3.361E+05

A soil sample at this RRMG value would present an internal dose potential of 25 mrem under the Occasional Use Area exposure scenario.

Table 7: Soils Project – Occasional Use Area Exposure Scenario - Internal & External Dose

Radionuclide	**RRMG$_{(OUA-IE)}$** (pCi/g)
Ag-108m	2.087E+03
Am-241	2.797E+04
Cm-243	6.886E+03
Cm-244	7.653E+04
Co-60	4.122E+02
Cs-137	1.640E+03
Eu-152	8.604E+02
Eu-154	8.031E+02
Eu-155	2.156E+04
Nb-94	2.171E+03
Pu-238	3.915E+04
Pu-239/240	3.573E+04
Sr-90	1.955E+05
Th-232	1.062E+04
U-234	4.252E+05
U-235	5.749E+03
U-238	3.219E+04

A soil sample at this RRMG value would present a TED potential of 25 mrem under the Occasional Use Area exposure scenario.

References

CFR, see *Code of Federal Regulations*.

Code of Federal Regulations. 2011. Title 10 CFR Part 835, "Occupational Radiation Protection." Washington, DC: U.S. Government Printing Office.

DOE, see U.S. Department of Energy.

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

U.S. Department of Energy. 1993. *Radiation Protection of the Public and the Environment,* DOE Order 5400.5, Change 2. Washington, DC.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2006. *Industrial Sites Project Establishment of Final Action Levels*, Rev. 0, DOE/NV--1107. Las Vegas, NV.

Yu, C., A.J. Zielen, J.J. Cheng, D.J. LePoire, E. Gnanapragasam, S. Kamboj, J. Arnish, A. Wallo III, W.A. Williams, and H. Peterson. 2001. *User's Manual for RESRAD Version 6*, ANL/EAD-4. Argonne, IL: Argonne National Laboratory, Environmental Assessment Division. (Version 6.5 released in October 2009.)

Appendix D

Closure Activity Summary (Use Restriction)

D.1.0 Closure Activity Summary

The following sections document closure activities completed for CAU 374. Surface soil samples, TLD measurements, and GWS measurements were collected to characterize the presence and lateral extent of radiological contamination at CASs 18-23-01 and 20-45-03. Corrective action removal of batteries was conducted at Schooner. A BMP of drum removal was conducted at CAS 18-22-08 (five empty drums), and three drums and soil were removed at CAS 18-22-06. *Federal Facility Agreement and Consent Order* UR signage was posted at Danny Boy and Schooner.

D.1.1 CAS 18-22-06, Drums (20) Closure Activities

The soils in the drums was sampled and did not exceed the 25-mrem/RW-yr FAL based on analytical results. A BMP was implemented to include removing the three drums and drummed soil. No verification sampling to investigate any potential release from the drums was conducted as the surrounding soil belongs to the primary release of CAS 18-23-01, Danny Boy. The results were evaluated for waste disposition and characterized as LLW, and then the soil in the drums and the drums themselves were removed and disposed at the NNSS RWMS.

D.1.2 CAS 18-23-01, Danny Boy Contamination Area Closure Activities

Based on analytical results for samples collected at this CAS, the surface radiological contamination at the site exceeds the FAL for the radiological dose (25 mrem/RW-yr) at one location. It is assumed that subsurface contamination present in the crater and ejecta mounds surrounding the crater exceeds the FAL due to direct injection of radionuclides into the subsurface soil from the nuclear test.

Based on the results of this investigation, a corrective action of closure in place with a UR was implemented for the default contamination area and also encompasses the area assumed to exceed a dose of 25 mrem/RW-yr (Figure A.4-4). As the area requiring the UR posting (the default decontamination boundary) is encompassed by the Danny Boy Contamination Area (CA) fence and the crater access road, the UR signs were installed on the CA fence and on the gate post at the entrance road to the crater area (i.e., the access road is included in the UR). If the CA changes at any time in the future, the UR signs may be moved, as long as they encompass the use restricted area.

The established FFACO UR for Danny Boy is defined by the coordinates listed in the FFACO UR form and as illustrated in Attachment D-1. Additionally, in accordance with the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006) and Section 3.3 of the CAU 374 CAIP (NNSA/NSO, 2010), an administrative UR was established around the area containing radioactivity at levels that can result in a dose exceeding the Industrial Area scenario to prevent more intensive use of the site in the future as discussed and illustrated in Attachment D-1. Both URs are recorded in the FFACO database, NNSA/NSO Facility Information Management System, and the NNSA/NSO CAU/CAS files. Any use of the area within the FFACO UR for activities that are restricted by the URs will require notification of the NDEP.

D.1.3 CAS 20-45-03, U-20u Crater (Schooner) Closure Activities

Based on analytical results for samples collected at this CAS, the surface radiological contamination at the site exceeds the FAL for the radiological dose (25 mrem/RW-yr) at six locations. It is assumed that subsurface contamination present in the crater and ejecta mounds surrounding the crater exceeds the FAL due to direct injection of radionuclides into the subsurface soil from the nuclear test. In addition, four lead-acid batteries were identified. As part of the corrective action, all four batteries have been removed and are scheduled for recycling by TOXCO, Inc. Disposal documentation for the removed batteries is pending and will be included within Attachment D-1.

Based on the results of this investigation, a corrective action of closure in place with a UR was implemented for the default contamination area and also encompasses the area assumed to exceed a dose of 25 mrem/RW-yr (Figure A.3-4). The UR encompasses the area of the Schooner crater as well as the ejecta field surrounding the crater (default contamination boundary). To facilitate inspection and maintenance, the UR signs were conservatively placed at locations further outward along an access road that basically encircles the site.

The established FFACO UR for Schooner is defined by the coordinates listed in the FFACO UR form and as illustrated in Attachment D-1. Additionally, in accordance with the *Industrial Sites Project Establishment of Final Action Levels* (NNSA/NSO, 2006) and Section 3.3 of the CAU 374 CAIP (NNSA/NSO, 2010), an administrative UR was established around the area containing radioactivity at levels that can result in a dose exceeding the Industrial Area scenario to prevent more intensive use of the site in the future, as discussed and illustrated in Attachment D-1. Both URs are recorded in the

FFACO database, NNSA/NSO Facility Information Management System, and the NNSA/NSO CAU/CAS files. Any use of the area within the FFACO UR for activities that are restricted by the URs will require notification of the NDEP.

D.2.0 References

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2006. *Industrial Sites Project Establishment of Final Action Levels*, Rev. 0, DOE/NV--1107. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2010. *Corrective Action Investigation Plan for Corrective Action Unit 374: Area 20 Schooner Unit Crater, Nevada Test Site, Nevada*, Rev. 0, DOE/NV--1361. Las Vegas, NV.

Attachment D-1

Use Restrictions

(10 Pages)

Use Restriction Information

CAU Number/Description: CAU 374, Area 20 Schooner Unit Crater

Applicable CAS Number/Description: CAS 18-23-01, Danny Boy Contamination Area

Contact (Federal Sub-Project Director/Sub-Project): NNSA/NSO Soils Sub-Project Director

FFACO Use Restriction Physical Description:

Surveyed Area (UTM, Zone 11, NAD 27, meters):

UR Points	Northing	Easting
Southeast	4,107,007.8	556,560.5
	4,106,945.9	556,454.8
	4,107,039.0	556,321.8
	4,107,181.6	556,303.4
	4,107,430.9	556,373.3
	4,107,417.2	556,546.8
	4,107,287.7	556,522.0
	4,107,281.7	556,547.9
	4,107,212.1	556,586.0

Depth: No depth limitations

Survey Method (GPS, GIS, etc): Heads-up digitizing

Basis for UR(s):

Summary Statement: This FFACO use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicates that a worker could potentially receive a 25 mrem dose in 176 hours of exposure to the surface location with the maximum detected radioactivity. Also, radioactivity is assumed to be present at similar or higher levels within the crater and ejecta piles. The analytical results and locations of all samples collected are presented in the CADD/CR for CAU 374.

Personnel are restricted from performing work in this area that would require personnel to be present for other than short term activitites. The permissible short term activities include site visits, maintenance of the fence, radiological surveys, short duration radiological training, and retrieval of objects within the use-restricted area. Any activities to be conducted within this area that are not consistent with these defined short term activities requires the prior notification and approval of the NDEP.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 374 CAS 18-23-01, Danny Boy Contamination Area			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED	47.8	25	mrem/336 hours

Site Controls: The use restricted area encompasses the area where surface soil contamination exceeds the final action level. It is established at the boundary identified by the coordinates listed above and depicted in the attached figure. Site controls include warning signs placed on the access road outward from the use-restricted area.

Use Restriction Information

CAU Number/Description: CAU 374, Area 20 Schooner Unit Crater

Applicable CAS Number/Description: CAS 18-23-01, Danny Boy Contamination Area

Contact (Federal Sub-Project Director/Sub-Project): NNSA/NSO Soils Sub-Project Director

Administrative Use Restriction Physical Description*:

Surveyed Areas (UTM, Zone 11, NAD 27, meters):

UR Points	Northing	Easting
Southeast	4,107,084.3	556,332.7
	4,107,191.0	556,222.9
	4,107,240.9	556,245.8
	4,107,264.1	556,339.3
Southeast	4,107,210.3	556,605.4
	4,107,196.3	556,579.2
	4,107,246.7	556,536.1
	4,107,261.9	556,539.8
	4,107,267.2	556,569.3
	4,107,260.2	556,590.3

Depth: To 5 cm below native soil surface

Survey Method (GPS, GIS, etc): Heads-up digitizing

*Coordinates for the Administrative Use Restriction exclude the area defined by the FFACO Use Restriction coordinates.

Basis for UR(s):

Summary Statement: This administrative use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicates that a worker could potentially receive a 25 mrem dose in 1,150 hours of exposure to the surface location with the maximum detected radioactivity. Current land use at this site does not require site workers to be present for this amount of exposure time. However, as a best management practice, this administrative use restriction will prevent a future (more intensive) use of the area. The analytical results and locations of all samples collected are presented in the CADD/CR for CAU 374.

Personnel are restricted from performing work in this location that would require any use of the area within the UR for activities that would result in a more intensive use of the site than the current land use. Activities included in the current land use would include short duration activities such as site visits, maintenance of the fence, radiological surveys, short duration radiological training, and retrieval of objects within the use-restricted area. Any activities to be conducted within this area that are not consistent with this defined current land use requires the prior notification and approval of the NDEP.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 374 CAS 18-23-01, Danny Boy Contamination Area			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED	48.9	25	mrem/2250 hours

Use Restriction Information

Site Controls: This administrative use restriction area is established at the boundary identified by the coordinates listed above and depicted in the attached figure but does not include the FFACO use restriction at this site.

UR Maintenance Requirements:

Description: **The UR is recorded in the FFACO database, NNSA/NSO Facility Management System, and the NNSA/NSO CAU/CAS files.**

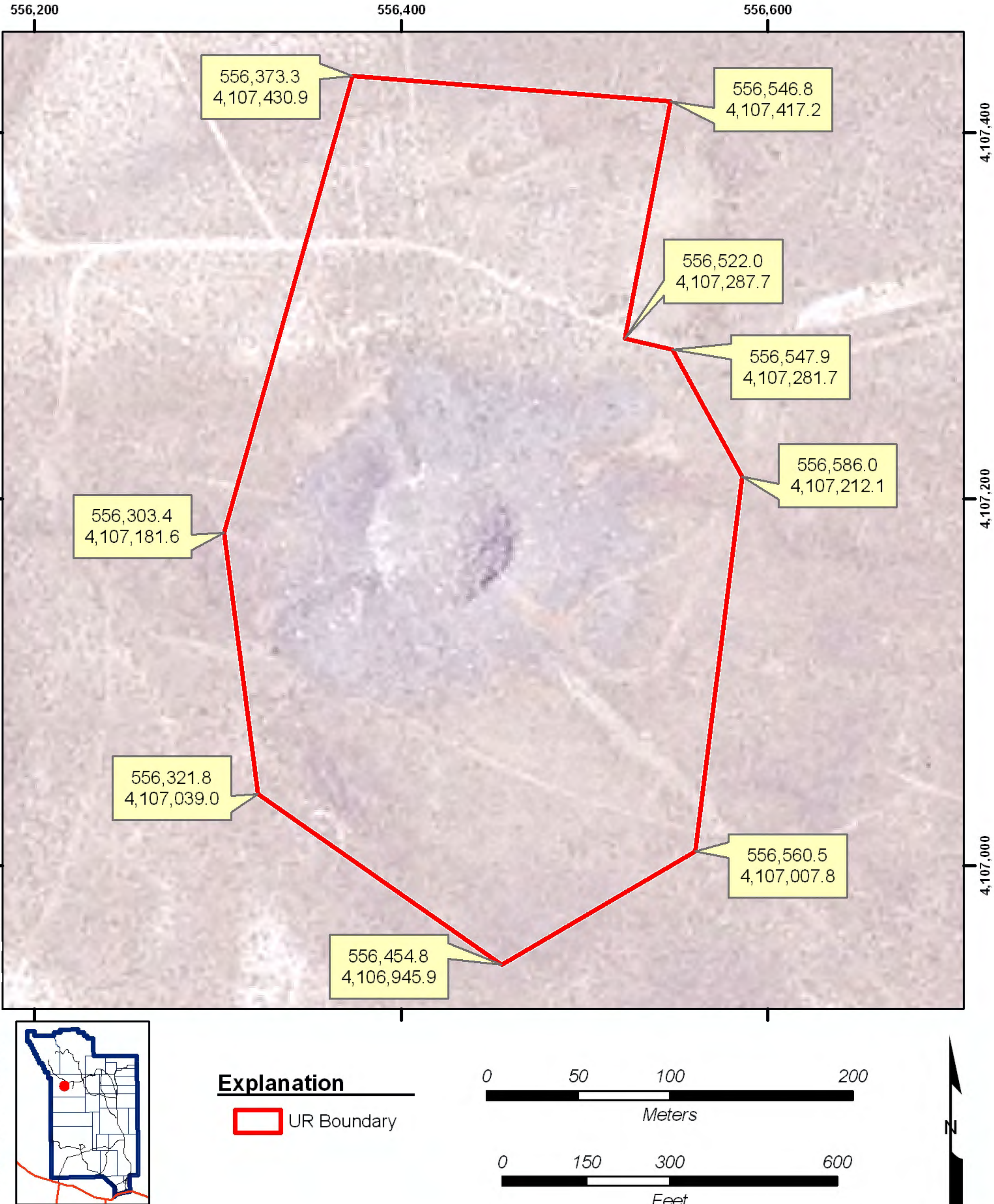
Inspection/Maintenance Frequency: N/A

The future use of any land related to this Corrective Action Unit (CAU), as described by the above surveyed location, is restricted from any DOE or Air Force activity that may alter or modify the containment control as approved by the state and identified in the CAU CR or other CAU documentation unless appropriate concurrence is obtained in advance.

Comments: Personnel are restricted from performing work in this location that would require any use of the area within the UR for activities that would result in a more intensive use of the site than the current land use (i.e., activities consistent with the occasional use exposure scenario). Activities included in the current land use would include short duration activities such as site visits, maintenance of the fence, radiological surveys, short duration radiological training, and retrieval of objects within the use-restricted area. Permission to conduct any restricted activities within this area requires notification of the NDEP.

Submitted By: /s/ Kevin Cabble **Date:** 7/7/11

Note: Effective upon acceptance of closure documents by NDEP

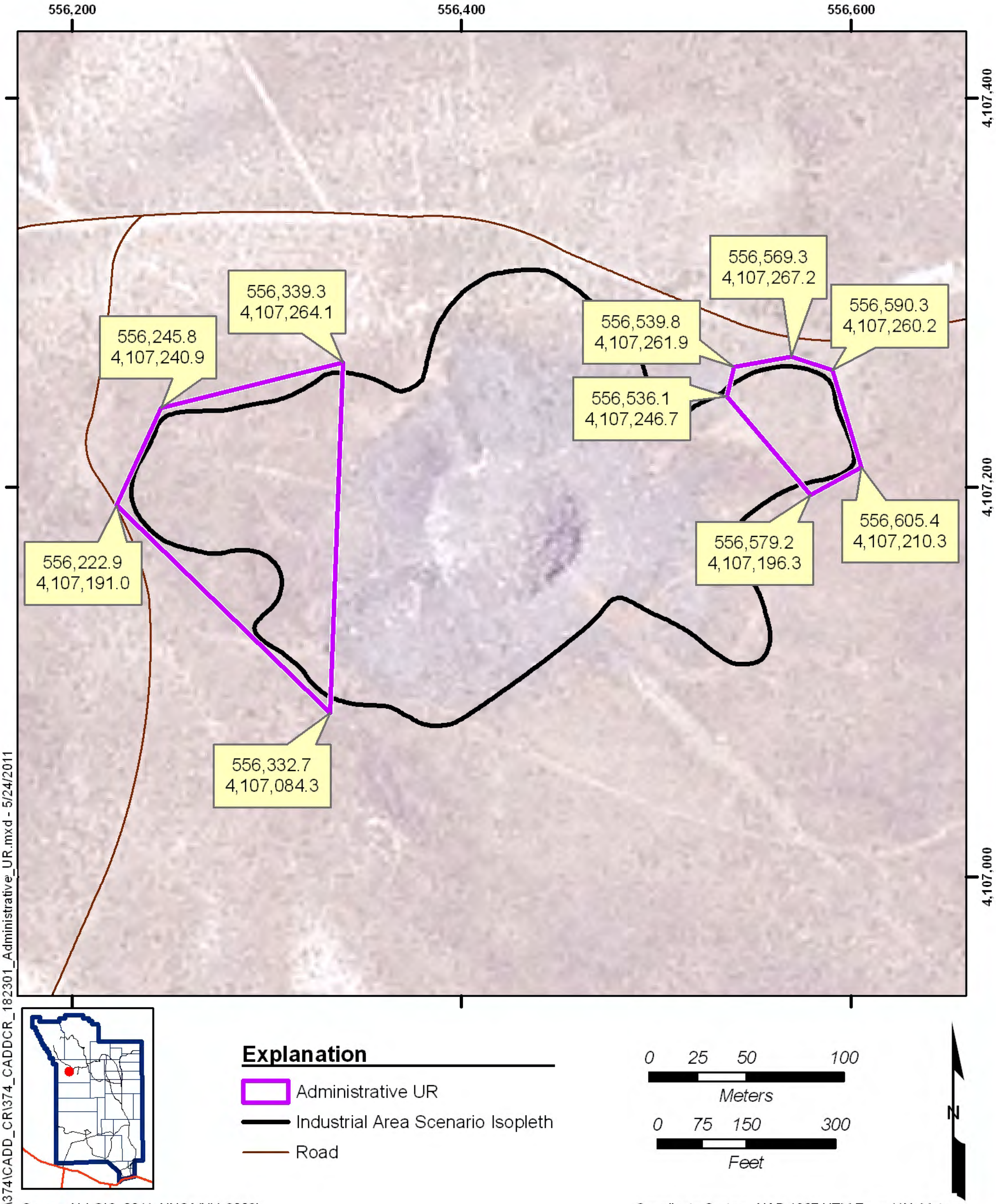


H:\374\CADD_CR\374_CADDCR_182301_Use_Restriction.mxd - 5/24/2011

Source: N-I GIS, 2011; NNSA/NV, 2002b

Coordinate System: NAD 1927 UTM Zone 11N, Meters

UNCONTROLLED When Printed



H:\3741\CADD_CR\374_CADDCR_182301_Administrative_UR.mxd - 5/24/2011

Source: N-I GIS, 2011; NNSA/NV, 2002b

Coordinate System: NAD 1927 UTM Zone 11N, Meters

UNCONTROLLED When Printed

Use Restriction Information

CAU Number/Description: CAU 374, Area 20 Schooner Unit Crater

Applicable CAS Number/Description: CAS 20-45-03, U-20u Crater (Schooner)

Contact (Federal Sub-Project Director/Sub-Project): NNSA/NSO Soils Sub-Project Director

FFACO Use Restriction Physical Description:

Surveyed Area (UTM, Zone 11, NAD 27, meters):

UR Points	Northing	Easting
Southeast	4,132,645.2	539,138.0
	4,132,397.6	538,664.7
	4,132,426.7	538,320.7
	4,132,577.8	537,985.8
	4,133,009.2	537,974.8
	4,133,413.3	538,176.9
	4,133,674.0	538,697.6
	4,133,225.8	539,141.6

Depth: No depth limitations

Survey Method (GPS, GIS, etc): Heads-up digitizing

Basis for UR(s):

Summary Statement: This FFACO use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicates that a worker could potentially receive a 25 mrem dose in 133 hours of exposure to the surface location with the maximum detected radioactivity. Also, radioactivity is assumed to be present at similar or higher levels within the crater and ejecta piles. The analytical results and locations of all samples collected are presented in the CADD/CR for CAU 374.

Personnel are restricted from performing work in this area that would require personnel to be present for other than short term activitites. The permissible short term activities include site visits, maintenance of the fence, radiological surveys, short duration radiological training, and retrieval of objects within the use-restricted area. Any activities to be conducted within this area that are not consistent with these defined short term activities requires the prior notification and approval of the NDEP.

Contaminants Table:

Maximum Concentration of Contaminants for CAU 374 CAS 20-45-03, U-20u Crater (Schooner)			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED	63.1	25	mrem/336 hours

Site Controls: The use restricted area encompasses the area where surface soil contamination exceeds the final action level. It is established at the boundary identified by the coordinates listed above and depicted in the attached figure. Site controls include warning signs placed on the access road outward from the use-restricted area.

Use Restriction Information

CAU Number/Description: CAU 374, Area 20 Schooner Unit Crater

Applicable CAS Number/Description: CAS 20-45-03, U-20u Crater (Schooner)

Contact (Federal Sub-Project Director/Sub-Project): NNSA/NSO Soils Sub-Project Director

Administrative Use Restriction Physical Description*:

Surveyed Area (UTM, Zone 11, NAD 27, meters):

UR Points	Northing	Easting
Southeast - Exterior	4,132,034.1	538,978.4
	4,132,021.3	538,228.0
	4,132,282.1	537,909.2
	4,132,852.2	537,686.9
	4,134,133.9	538,611.2
	4,134,848.9	538,720.7
	4,134,848.9	538,872.1
	4,133,625.1	538,859.2
	4,133,161.3	539,242.5
	4,132,233.8	539,165.2
Interior (region within not included)		
	4,132,645.2	539,138.0
	4,132,397.6	538,664.7
	4,132,426.7	538,320.7
	4,132,577.8	537,985.8
	4,133,009.2	537,974.8
	4,133,413.3	538,176.9
	4,133,674.0	538,697.6
	4,133,225.8	539,141.6

Depth: No depth limitations

Survey Method (GPS, GIS, etc): Heads-up digitizing

*Coordinates for the Administrative Use Restriction exclude the area defined by the FFACO Use Restriction coordinates.

Basis for UR(s):

Summary Statement: This administrative use restriction is to protect site workers from inadvertent exposure. Data from surface sampling indicates that a worker could potentially receive a 25 mrem dose in 429 hours of exposure to the surface location with the maximum detected radioactivity. Current land use at this site does not require site workers to be present for this amount of exposure time. However, as a best management practice, this administrative use restriction will prevent a future (more intensive) use of the area. The analytical results and locations of all samples collected are presented in the CADD/CR for CAU 374.

Personnel are restricted from performing work in this location that would require any use of the area within the UR for activities that would result in a more intensive use of the site than the current land use. Activities included in the current land use would include short duration activities such as site visits, maintenance of the fence, radiological surveys, short duration radiological training, and retrieval of objects within the use-restricted area. Any activities to be conducted within this area that are not consistent with this defined current land use requires the prior notification and approval of the NDEP.

Use Restriction Information

Contaminants Table:

Maximum Concentration of Contaminants for CAU 374 CAS 20-45-03, U-20u Crater (Schooner)			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
TED	131.0	25	mrem/2250 hours

Site Controls: This administrative use restriction area is established at the boundary identified by the coordinates listed above and depicted in the attached figure but does not include the FFACO use restriction at this site.

UR Maintenance Requirements:

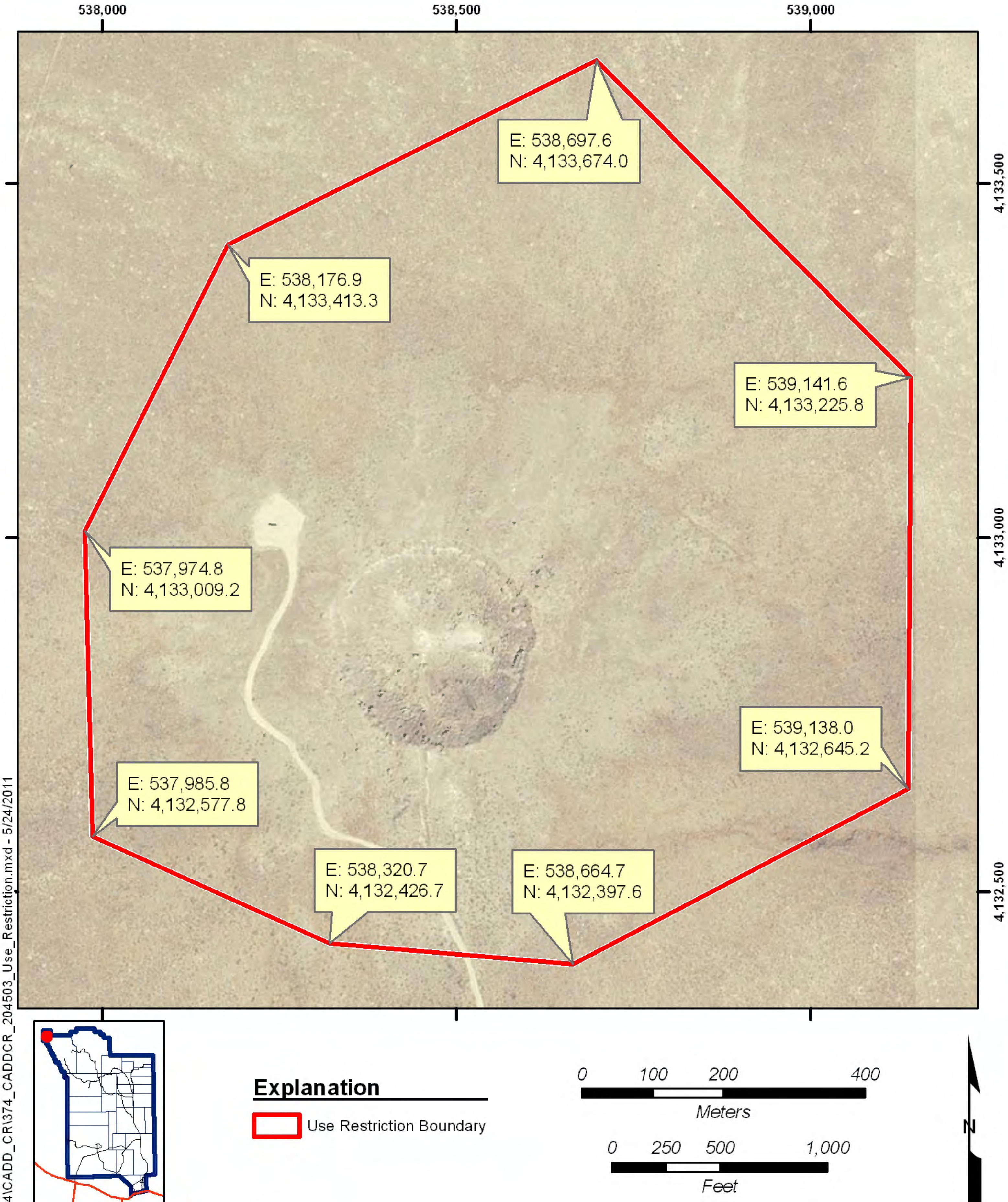
Description: The UR is recorded in the FFACO database, NNSA/NSO Facility Management System, and the NNSA/NSO CAU/CAS files.

Inspection/Maintenance Frequency: N/A

The future use of any land related to this Corrective Action Unit (CAU), as described by the above surveyed location, is restricted from any DOE or Air Force activity that may alter or modify the containment control as approved by the state and identified in the CAU CR or other CAU documentation unless appropriate concurrence is obtained in advance.

Comments: Personnel are restricted from performing work in this location that would require any use of the area within the UR for activities that would result in a more intensive use of the site than the current land use (i.e., activities consistent with the occasional use exposure scenario). Activities included in the current land use would include short duration activities such as site visits, maintenance of the fence, radiological surveys, short duration radiological training, and retrieval of objects within the use-restricted area. Permission to conduct any restricted activities within this area requires notification of the NDEP.

Submitted By: /s/ Kevin Cabble **Date:** 7/7/11

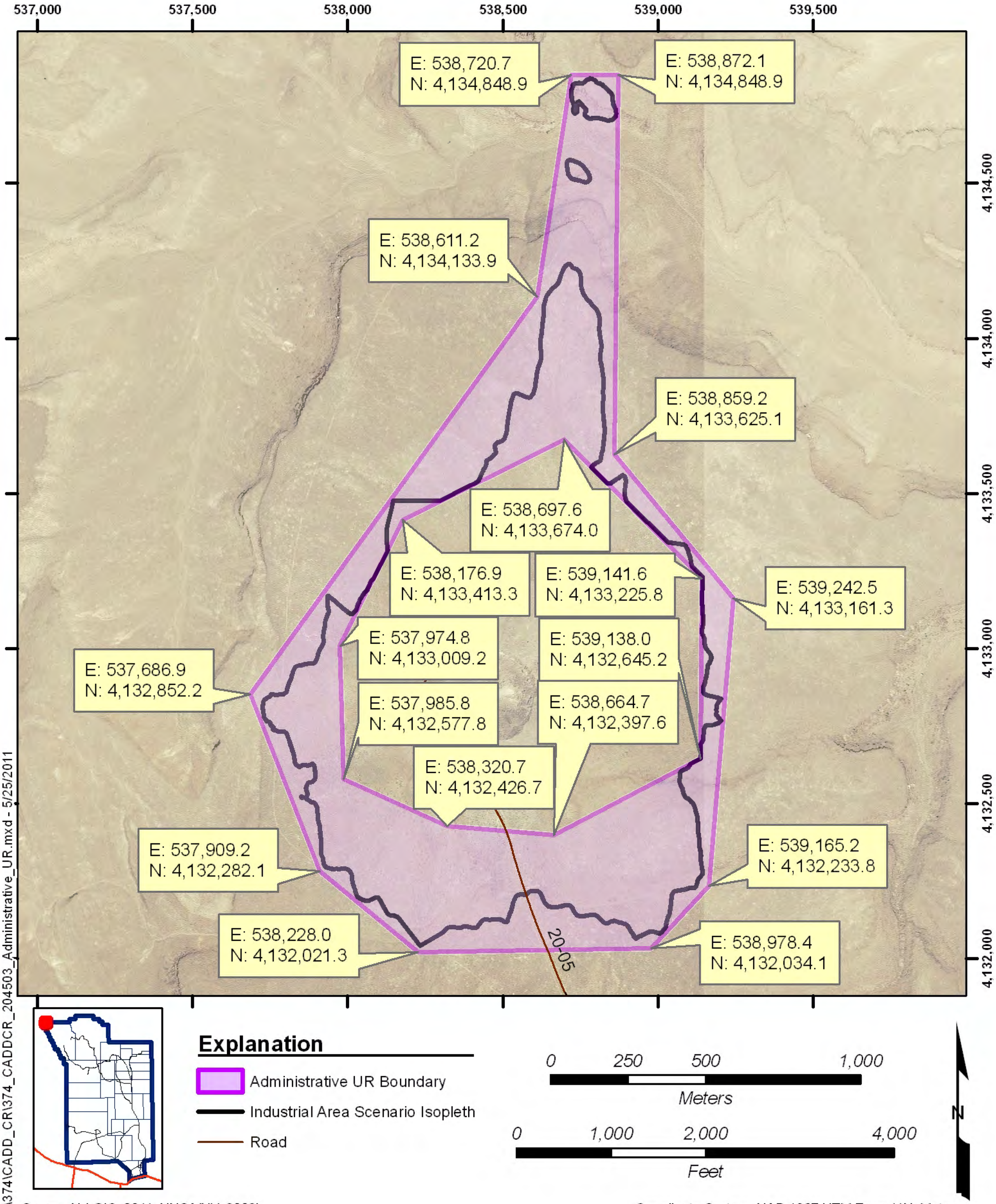


H:\3741\CADD_CR1374_CADDCR_204503_Use_Restriction.mxd - 5/24/2011

Source: N-I GIS, 2011; NNSA/NV, 2002b

Coordinate System: NAD 1927 UTM Zone 11N, Meters

UNCONTROLLED When Printed



H:\3741CADD_CR1374_CADDCR_204503_Administrative_UR.mxd - 5/25/2011

Source: N-I GIS, 2011; NNSA/NV, 2002b

UNCONTROLLED When Printed

Coordinate System: NAD 1927 UTM Zone 11N, Meters

Attachment D-2

Waste Disposition Documentation

(3 Pages)

NSTec Form FRM-0918

NTS LANDFILL LOAD VERIFICATION

06/23/06 Rev. 0 Page 1 of 2

SWO USE (Select One) AREA ☐ 23 ☐ 6 ☒ 9 ☒ LANDFILL

For waste characterization, approval, and/or assistance, contact Solid Waste Operation (SWO) at 5-7898.

REQUIRED: WASTE GENERATOR INFORMATION

(This form is for rolloffs, dump trucks, and other onsite disposal of materials.) Fax 5-2241

Waste Generator: Mark Heser (NI, WO) (M/S - NSF 179) (Fax 5-2241) Phone Number: (o)5-2124; (c)498-0150

Location / Origin: NTS - Mercury, Building 23-153 - Bulk debris collected in 20 yd3 roll-off (Container ID 153R10).

Waste Category: (check one) ☐ Commercial ☒ Industrial

Waste Type: (check one) ☐ NTS ☐ Non-Putrescible ☐ Putrescible ☐ Asbestos Containing Material ☒ FFACO-onsite ☐ FFACO-offsite ☐ WAC Exception ☐ Historic DOE/NV

Pollution Prevention Category: (check one) ☒ Environmental management ☐ Defense Projects ☐ YMP

Pollution Prevention Category: (check one) ☐ Clean-Up ☒ Routine

Method of Characterization: (check one) ☒ Sampling & Analysis ☒ Process Knowledge ☐ Contents

Prohibited Waste at all three NTS landfills: Radioactive waste; RCRA waste; Hazardous waste; Free liquids, PCBs above TSCA regulatory levels, and Medical wastes (needles, sharps, bloody clothing).

Additional Prohibited Waste at the Area 9 U10C Landfill: Sewage Sludge, Animal carcasses, Wet garbage (food waste); and Friable asbestos

REQUIRED: WASTE CONTENTS ALLOWABLE WASTES

Check all allowable wastes that are contained within this load:

NOTE: Waste disposal at the Area 6 Hydrocarbon Landfill must have come into contact with petroleum hydrocarbons or coolants, such as: gasoline (no benzene, lead); jet fuel; diesel fuel; lubricants and hydraulics; kerosene; asphaltic petroleum hydrocarbon; and ethylene glycol.

Acceptable waste at any NTS landfill: ☐ Asphalt ☒ Metal ☒ Wood ☒ Paper ☐ Soil ☐ Cloth ☒ Plastic ☐ Wire ☐ Cable ☐ Rocks / unaltered geologic materials ☐ Rubber (excluding tires) ☐ Insulation (non-Asbestosform) ☒ Empty containers ☐ Demolition debris ☐ Cement & concrete

☒ Manufactured Items: (swamp coolers, furniture, rugs, carpet, electronic components, PPE, etc.)

Additional waste accepted at the Area 23 Mercury Landfill: ☐ Office Waste ☐ Food Waste ☐ Animal Carcasses ☐ Asbestos ☐ Friable ☐ Non-Friable (contact SWO if regulated load) Quantity: ______

Additional waste accepted at the Area 9 U10c Landfill:

☐ Non-friable asbestos ☐ Drained automobiles and military vehicles ☐ Solid fractions from sand/oil/water

☐ Light ballasts (contact SWO) ☐ Drained fuel filters (gas & diesel) ☐ Deconned Underground and Above Ground Tanks

☐ Hydrocarbons (contact SWO) ☐ Other ______

Additional waste accepted at the Area 6 Hydrocarbon Landfill: ☐

☐ Septic sludge ☐ Rags ☐ Drained fuel filters (gas & diesel) ☐ Crushed non-terne plated oil filters

☐ Plants ☐ Soil ☐ Sludge from sand/oil/water separators ☐ PCBs below 50 parts per million

REQUIRED: WASTE GENERATOR SIGNATURE

Initials: _____ **(If initialed, no radiological clearance is necessary.)**

The above mentioned waste was generated outside of a Controlled Waste Management ... knowledge, does not contain radiological materials.

To the best of my knowledge, the waste described above contains only those materials ... site. I have verified this through the waste characterization method identified above ... prohibited and allowable waste items. I have contacted Property Management and ha... is approved for disposal in the landfill.

Radiological Survey Release for Waste Disposal
RCT Initials
____ This container/load meets the criteria for no added man-made radioactive material
____ This container/load meets the criteria for Radcon Manual Table 4.2 release limits.
[initials] This container/load is exempt from survey due to process knowledge and origin.
SIGNATURE: /s/ Signature on File DATE: 11/24/10

Print Name: Mark Heser 12-8-2010

Signature: /s/ Mark Heser Date: 11/4/10

Note: "Food waste, office trash and animal carcasses do not require a radiological clearance. Freon-containing appliances must have signed removal certification statement with Load Verification."

SWO USE ONLY

Load Weight (net from scale or estimate): 4,080 12/8/10 Signature of Certifier /s/ Signature on File

Waste Category Definitions	
Commercial Waste:	Office waste, putrescible waste
Industrial Waste:	Waste generated from activities associated with the fabrication or demolition of on-site structures. Solid waste derived from industrial manufacturing processes (i.e., construction and demolition waste).
Waste Types Definitions	
NTS:	Waste generated from construction, demolition, and/or routine activities within the Nevada Test Site boundaries. Waste that does not meet another waste type definition listed below.
Non-Putrescible:	Waste that is not directly associated with construction or demolition activities, such as office waste
Putrescible:	Waste that will decompose, decay, and become putrid (i.e. food waste and animal carcasses).
Asbestos Containing Material:	Waste that contains asbestos. Regulated asbestos (friable) will not be accepted without a shipping paper.
FFACO-onsite:	Waste generated, within the NTS boundaries, from activities directed by the Federal Facilities Agreement and Consent Order.
FFACO-offsite:	Waste generated, outside of the NTS boundaries, from activities directed by the Federal Facilities Agreement and Consent order (e.g., CNTA, TTR, NLV, and some UGTA project locations).
WAC exception	Waste that does not meet the waste acceptance criteria, as defined within the current NTS landfill permits, and has been given approval from the NDEP for disposal into an NTS landfill.
Historic DOE/NV	Waste generated from historical releases associated with the DOE/NV Waste Management Project Office (precursor to the Yucca Mountain Project Office), which occurred prior to November 30, 1989.
Pollution Prevention Category Definitions	
Environmental Management:	Waste generated from an Environmental Management project (e.g., waste generated from Environmental Restoration or International Technologies projects).
Industrial Waste:	Defense Projects: Waste generated from Defense Projects (e.g., waste generated from DTRA, LANL, Sandia, and/or any other non-Environmental Management directed project.
Routine:	Routine operations waste generated from: any type of production, analytical, and/or research and development laboratory operation; "work-for-others," and/or any periodic and recurring work that is considered on-going processes, are also considered routine operations.
Clean-up:	Clean-up/stabilization waste generated from one-time operations. Waste generated from: environmental restoration projects-, decontamination and decommissioning/ transition operations-, and TSCA regulated wastes. Clean-up/stabilization activities may span several years. The waste is a direct result of past operations and activities, rather than a current process. Newly generated wastes produced during clean-up operations (usually resulting from common activities such as handling, sampling, treatment, repackaging, shipping, etc.) are considered clean-up waste.
Radiological Limitations	
Area 23 Landfill:	See "Performance Objective for Certification of Non-Radioactive Hazardous Waste".
Area 6 and Area 9 Landfills:	See permit limits.

Certificate of Disposal

This is to certify that the Waste Stream No. LITN-000000006, Revision 14, shipment number ITL11004, with container number 374001 was shipped and received at the Nevada National Security Site Radioactive Waste Management Complex in Area 5 for disposal as stated below.

Mark Heser	NI	Waste Coordinator
Shipped by	Organization	Title
/s/ Mark Heser		5-4-2011
Signature		Date
Jon Tanaka	NSTEC	Waste Specialist
Received by	Organization	Title
/s/ Jon Tanaka		05-05-2011
Signature		Date

Appendix E

Evaluation of Corrective Action Alternatives

E.1.0 Introduction

This appendix presents the corrective action objectives for CAU 374, describes the general standards and decision factors used to screen the various CAAs, and develops and evaluates a set of selected CAAs that will meet the corrective action objectives.

All CAAs for CAU 374 are based on the presumption that all areas within the current NNSS boundary will be controlled in perpetuity and restricted from release to the public. As such, only industrial activities are permitted and risks to receptors under residential scenarios will not be considered. Should the control of the NNSS change in the future to include public access or residential use, the selected CAAs may need to be reconsidered.

E.1.1 Corrective Action Objectives

On May 1, 1996, EPA issued an Advance Notice of Proposed Rulemaking (ANPR) for corrective action for releases from solid waste management units at hazardous waste management facilities (EPA, 1996). The EPA states that the ANPR should be considered the primary corrective action implementation guidance (Laws and Herman, 1997). The ANPR states that a basic operating principle for remedy selection is that corrective action decisions should be based on risk. Risk-based decisions are also stipulated in DOE policy (DOE, 2003). The ANPR and DOE policy emphasize that current and reasonably expected future land use should be considered when selecting corrective action remedies and encourages use of innovative site characterization techniques to expedite site investigations.

The ANPR provides the following EPA expectations for corrective action remedies (EPA, 1996):

- Treatment should be used to address principal threats wherever practicable and cost effective.
- Engineering controls, such as containment, should be used where wastes and contaminated media can be reliably contained, pose relatively low long-term threats, or for which treatment is impracticable.
- A combination of methods (e.g., treatment, engineering, and institutional controls) should be used, as appropriate, to protect human health and the environment.

- Institutional controls should be used primarily to supplement engineering controls as appropriate for short- or long-term management to prevent or limit exposure.

- Innovative technologies should be considered where such technologies offer potential for comparable or superior performance or implementability, less adverse impacts, or lower costs.

- Usable groundwater should be returned to maximum beneficial use wherever practicable.

- Contaminated soils should be remediated as necessary to prevent or limit direct exposure and to prevent the transfer of unacceptable concentrations of contaminants from soils to other media.

Implementing the corrective action will ensure that contaminants remaining at each release site will not pose an unacceptable risk to human health and the environment, and that conditions at each site are in compliance with all applicable laws and regulations.

E.1.2 Screening Criteria

The screening criteria used to evaluate and select the preferred CAA are identified in the *Guidance on RCRA Corrective Action Decision Documents* (EPA, 1991) and the *Final RCRA Corrective Action Plan* (EPA, 1994).

Corrective action alternatives are evaluated based on four general corrective action standards and five remedy selection decision factors. All CAAs must meet the four general standards to be selected for evaluation using the remedy selection decision factors.

The general corrective action standards are as follows:

- Protection of human health and the environment
- Compliance with media cleanup standards
- Control the source(s) of the release
- Comply with applicable federal, state, and local standards for waste management

The remedy selection decision factors are as follows:

- Short-term reliability and effectiveness
- Reduction of toxicity, mobility, and/or volume
- Long-term reliability and effectiveness
- Feasibility
- Cost

E.1.3 Corrective Action Standards

The following subsections describe the corrective action standards used to evaluate the CAAs.

Protection of Human Health and the Environment

Protection of human health and the environment is a general mandate of the RCRA statute (EPA, 1994). This mandate requires that the corrective action include any necessary protective measures necessary to ensure the requirements are met. These measures may or may not be directly related to media cleanup, source control, or management of wastes.

Compliance with Media Cleanup Standards

The CAAs are evaluated for the ability to meet the proposed media cleanup standards. The media cleanup standards are the FALs.

Control the Source(s) of the Release

The CAAs are evaluated for the ability to stop further environmental degradation by controlling or eliminating additional releases that may pose a threat to human health and the environment. Unless source control measures are taken, efforts to clean up releases may be ineffective or, at best, will involve a perpetual cleanup. Therefore, each CAA must provide effective source control to ensure the long-term effectiveness and protectiveness of the corrective action.

Comply with Applicable Federal, State, and Local Standards for Waste Management

The CAAs are evaluated for the ability to be conducted in accordance with applicable federal and state regulations (e.g., 40 CFR 260 to 282, "Hazardous Waste Management" [CFR, 2010a]; 40 CFR 761 "Polychlorinated Biphenyls," [CFR, 2010b]; and NAC 444.842 to 98, "Management of Hazardous Waste" [NAC, 2008]).

E.1.3.1 Remedy Selection Decision Factors

The following text describes the remedy selection decision factors used to evaluate the CAAs.

Short-Term Reliability and Effectiveness

Each CAA must be evaluated with respect to its effects on human health and the environment during implementation of the selected corrective action. The following factors will be addressed for each alternative:

- Protection of the community from potential risks associated with implementation, (e.g., fugitive dusts, transportation of hazardous materials, and explosion)
- Protection of workers during implementation
- Adverse environmental impacts that may result from implementation
- The amount of time until the corrective action objectives are achieved

Reduction of Toxicity, Mobility, and/or Volume

Each CAA must be evaluated for its ability to reduce the toxicity, mobility, and/or volume of the contaminated media. Reduction in toxicity, mobility, and/or volume refers to changes in one or more characteristics of the contaminated media by using corrective measures that decrease the inherent threats associated with that media.

Long-Term Reliability and Effectiveness

Each CAA must be evaluated in terms of risk remaining at the CAU after the CAA has been implemented. The primary focus of this evaluation is on the extent and effectiveness of the control that may be required to manage the risk posed by treatment of residuals and/or untreated wastes.

Feasibility

The feasibility criterion addresses the technical and administrative feasibility of implementing a CAA and the availability of services and materials needed during implementation. Each CAA must be evaluated for the following criteria:

- Construction and Operation – The feasibility of implementing a CAA given the existing set of waste and site-specific conditions.
- Administrative Feasibility – The administrative activities needed to implement the CAA (e.g., permits, URs, public acceptance, rights of way, offsite approval).

- Availability of Services and Materials – The availability of adequate offsite and onsite treatment, storage capacity, disposal services, necessary technical services and materials, and prospective technologies for each CAA.

Cost

Costs for each alternative are estimated for comparison purposes only. The cost estimate for each CAA includes both capital, and operation and maintenance costs, as applicable, and are provided in Section E.3.0. The following is a brief description of each component:

- Capital Costs – Costs that include direct costs that may consist of materials, labor, construction materials, equipment purchase and rental, excavation and backfilling, sampling and analysis, waste disposal, demobilization, and health and safety measures. Indirect costs are separate and not included in the estimates.

- Operation and Maintenance – Separate costs that include labor, training, sampling and analysis, maintenance materials, utilities, and health and safety measures. These costs are not included in the estimates.

E.1.4 Development of Corrective Action Alternatives

This section identifies and briefly describes the viable corrective action technologies and the CAAs considered for Danny Boy and Schooner. Contamination providing a dose exceeding the 25-mrem/RW-yr FAL was present in surface soils at these CASs but was assumed to be present in subsurface soils in the craters and surrounding ejecta fields (default contamination boundaries).

Based on the review of existing data, future use, and current operations at the NNSS, the following alternatives have been developed for consideration at CAU 374:

- Alternative 1 – No Further Action
- Alternative 2 – Clean Closure
- Alternative 3 – Closure in Place

E.1.4.1 Alternative 1 – No Further Action

Under the no further action alternative, no corrective action activities will be implemented. This alternative is a baseline case with which to compare and assess the other CAAs and their ability to meet the corrective action standards.

E.1.4.2 Alternative 2 – Clean Closure

Alternative 2 includes excavating and disposing of impacted soil and debris presenting a dose exceeding the 25-mrem/RW-yr FAL up to depths of 25 ft at the Danny Boy and Schooner craters. A visual inspection would be conducted to ensure that contaminated surface debris have been removed before the completion of the corrective action. Verification soil samples would also be collected and analyzed for the presence of a dose exceeding the 25-mrem/RW-yr FAL after removal of contaminated soil.

Contaminated materials removed would be disposed of at an appropriate disposal facility. Excavated areas will be returned to surface conditions compatible with the intended future use of the site.

E.1.4.3 Alternative 3 – Closure in Place

For radiological contamination, Alternative 3 includes implementing a UR where a radiological dose is present at levels that exceed the 25-mrem/RW-yr FAL. This UR will restrict inadvertent contact with contaminated media by prohibiting any activity that would cause a site worker to be exposed to a dose exceeding 25 mrem/yr. Under this alternative, debris within the 25-mrem/RW-yr FAL area will not be removed.

E.1.5 Evaluation and Comparison of Alternatives

Each CAA presented in Section E.1.4 will be evaluated based on the general corrective action standards listed in Section E.1.2. This evaluation is presented in Table E.1-1. Any CAA that does not meet the general corrective action standards will be removed from consideration.

Only CAAs 2 and 3 met the corrective action standard and will be further evaluated based on the remedy selection decision factors described in Section E.1.2. This evaluation is presented in Table E.1-2. For each remedy selection decision factor, the CAAs are ranked relative to one another. The CAA with the least desirable impact on the remedy selection decision factor will be given a ranking of 1. The CAAs with increasingly desirable impacts on the remedy selection decision factor will receive increasing rank numbers. The CAAs that will have an equal impact on the remedy selection decision factor will receive an equal ranking number. The scoring listed in this table represents the sum of the remedy selection decision factor rankings for each CAA.

Table E.1-1
Evaluation of General Corrective Action Standards

CAS 18-23-01, Danny Boy Contamination Area, and CAS 20-45-03 , U20u Crater (Schooner)		
CAA 1, No Further Action		
Standard	Comply?	Explanation
Protection of Human Health and the Environment	No	Subsurface contamination is present that could provide an excavation worker a dose exceeding the 25-mrem/RW-yr FAL.
Compliance with Media Cleanup Standards	No	Subsurface contamination is present that could provide an excavation worker a dose exceeding the 25-mrem/RW-yr FAL.
Control the Source(s) of the Release	Yes	Only subsurface contamination is present exceeding the 25-mrem/RW-yr FAL and is not subject to significant migration.
Comply with Applicable Federal, State, and Local Standards for Waste Management	Yes	This alternative will not generate waste.
CAA 2, Clean Closure		
Standard	Comply?	Explanation
Protection of Human Health and the Environment	Yes	Contamination exceeding the risk-based action levels will be removed.
Compliance with Media Cleanup Standards	Yes	Contamination exceeding the risk-based action levels will be removed.
Control the Source(s) of the Release	Yes	Contamination exceeding the risk-based action levels will be removed.
Comply with Applicable Federal, State, and Local Standards for Waste Management	Yes	Excavated waste can be managed in compliance with all standards.
CAA 3, Closure in Place with Administrative Controls		
Standard	Comply?	Explanation
Protection of Human Health and the Environment	Yes	A UR will be implemented to protect excavation workers from inadvertant dose.
Compliance with Media Cleanup Standards	Yes	Although COCs will not be removed, site will be controlled to prevent workers from receiving a dose exceeding the 25-mrem/RW-yr FAL.
Control the Source(s) of the Release	Yes	Only subsurface contamination is present exceeding the 25-mrem/RW-yr FAL and is not subject to significant migration.
Comply with Applicable Federal, State, and Local Standards for Waste Management	Yes	This alternative will not generate waste.

Table E.1-2
Evaluation of Remedy Selection Decision Factors

CAS 18-23-01, Danny Boy Contamination Area, and CAS 20-45-03 , U20u Crater (Schooner)		
CAA 1, No Further Action		
Factor	Rank	Explanation
Not evaluated, as this CAA did not meet the General Corrective Action Standards		
CAA 2, Clean Closure		
Standard	Rank	Explanation
Short-Term Reliability and Effectiveness	1	This alternative is reliable and effective, but involves increased short-term exposure of site workers to COCs during soil removal, and significant physical hazards with excavation and transport during all operations.
Reduction of Toxicity, Mobility, and/or Volume	2	This alternative will result in a decrease of radioactivity and mobility, but will generate significant waste volumes.
Long-Term Reliability and Effectiveness	2	This alternative is reliable and effective at protecting human health and the environment because removal of the contaminated media will eliminate future exposure of site workers to COCs. However, the short-term exposure to site workers would increase.
Feasibility	1	Removal of deep subsurface contamination is not feasible.
Cost	1	Data required to estimate the cost for this alternative were not generated as in Section A.5-1 of the CAIP (NNSA/NSO, 2010); however, based on past Soils CAU estimates, the costs for Danny Boy and Schooner combined were estimated at $260 million.
Score	7	
CAA 3, Closure in Place with Administrative Controls		
Standard	Rank	Explanation
Short-Term Reliability and Effectiveness	2	This alternative is reliable and effective in providing increased protection of human health by preventing contact with COCs.
Reduction of Toxicity, Mobility, and/or Volume	1	This alternative will not reduce toxicity or mobility of the COCs that are present, but will not generate excavation waste volumes.
Long-Term Reliability and Effectiveness	1	This alternative is reliable in the long term with ongoing maintenance. It is effective in providing protection of human health by preventing inadvertent contact with COCs.
Feasibility	2	This alternative is easily implemented, but requires maintenance and long-term monitoring.
Cost	2	The installation costs are estimated at $20,000. Ongoing maintenance costs for this alternative are estimated at $2,000 annually.
Score	8	

The five EPA remedy selection decision factors are short-term reliability and effectiveness; reduction of toxicity, mobility, and/or volume; long-term reliability and effectiveness; feasibility; and cost. These factors are provided in Table E.1-2.

The first remedy selection decision factor—short-term reliability and effectiveness—is a qualitative measure of the impacts on human health and the environment during implementation of the CAA. While clean closure is both reliable and effective in the long term, this alternative involves increased, short-term exposure of site workers to radiological contamination during soil and debris removal. In contrast, closure in place does not require removal of soil, and there is no short-term exposure of site workers; signs are posted, and disturbance of contaminated soil and debris is not necessary.

The second remedy selection decision factor—reduction of toxicity, mobility, and/or volume—is a qualitative measure of changes in characteristics of contaminated media that result from implementation of the CAA. Under clean closure, contaminated media that exceed FALs (to depths of 25 ft bgs at the Danny Boy and Schooner craters) would be removed from the areas, thereby eliminating both mobility and the onsite volume of contaminated media. In contrast, closure in place does not reduce toxicity, mobility, or volume.

The third remedy selection decision factor—long-term reliability and effectiveness—is a qualitative evaluation of performance after site closure, and into the future. Removal of contaminated media for clean closure provides long-term reliability and effectiveness, whereas closure in place does not.

The fourth remedy selection decision factor—feasibility—includes an evaluation of the requirements for construction and operation as well as administrative constraints. For the closure in place alternative, no construction is required other than the installation of postings. Some maintenance and administrative requirements would be ongoing. For the clean-closure alternative, substantial construction, operation, and administrative actions consistent with soil removal and management of generated wastes are needed.

The fifth remedy selection decision factor—cost—includes assessment of both capital (direct) costs of implementation and costs for operation and maintenance of the corrective action. As shown in Table E.1-2, the cost for clean closure was estimated at $260 million, while the costs for closure in place are limited to those derived from acquiring, hanging, inspecting, and occasionally replacing UR signs (estimated to be $20,000 for the first year and $2,000 for each year thereafter).

E.2.0 Recommended Alternative

Three CAAs were evaluated for Danny Boy and Schooner: no further action (CAA 1), clean closure (CAA 2), and closure in place (CAA 3). Only CAA 2 and CAA 3 met all requirements for general corrective action standards (Section E.1.2). In general, for the clean-closure alternative, near-surface soils would be removed from the sites to maximum depths of 25 ft bgs for the Danny Boy and Schooner craters. For the closure in place alternative, potential worker exposure to radiological contamination would be controlled through the implementation of URs. Both CAAs would, therefore, be protective of human health and the environment, comply with media cleanup standards, and control the source of release. As supported by the following discussion, further examination of the two CAAs by the five EPA remedy selection decision factors resulted in the selection of closure in place as the preferred CAA for both Danny Boy and Schooner.

Based upon the five remedy selection decision factors, clean closure received an overall score of 7 (less desirable), whereas closure in place received an overall score of 8 (more desirable). This result was not only the product of an examination of the two CAAs by the five remedy selection decision factors, but also in consideration of the current NNSS administrative controls (e.g., NNSS access restrictions and control of site activities), the remoteness of the sites, no nearby structures or activities, no current or planned use of the sites, the present-day stability of the contaminated soil at the sites through the evolution of a mature plant community, and the development of soil surface durability (i.e., soil crust).

Therefore, selection of the CAA of closure in place for both Danny Boy and Schooner is consistent with past practices for CASs that contain COCs and where there would be significant costs and short-term health risks to workers involved in cleanup activities. However, if, the control of the NNSS should change in the future to include public access or residential use, the selected CAAs may need to be reconsidered.

E.3.0 Cost Estimates

The cost for clean closure of CAU 374 was estimated at $260 million to conduct the following activities:

- Preparation and procurement
- Grub surface contamination
- Excavate, load, and dispose contaminated soil
- Dispose of debris
- Equipment decontamination

The estimated cost for clean closure was based on removing contaminated soil within the 25-mrem/yr boundaries of the Danny Boy and Schooner CASs. Specifically, soil within the craters and ejecta fields would be removed. The cost for clean closure of the two sites was estimated to be $260 million. This includes excavation, loading and processing, transportation, disposal, site restoration, and site support.

The costs for closure in place, however, are limited to those derived from acquiring, hanging, inspecting, and occasionally replacing UR signs, and are estimated to be approximately $20,000 for the first year and $2,000 for each year thereafter.

E.4.0 References

CFR, see *Code of Federal Regulations*.

Code of Federal Regulations. 2010a. Title 40 CFR, Parts 260 to 282, "Hazardous Waste Management." Washington, DC: U.S. Government Printing Office.

Code of Federal Regulations. 2010b. Title 40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions." Washington, DC: U.S. Government Printing Office.

DOE, see U.S. Department of Energy.

EPA, see U.S. Environmental Protection Agency.

Laws, E.P., and S.A. Herman, U.S. Environmental Protection Agency. 1997. Memorandum to RCRA/CERCLA Senior Policy Managers Region I–X titled "Use of the Corrective Action Advance Notice of Proposed Rulemaking as Guidance," 17 January. Washington, DC: Offices of Solid Waste and Emergency Response, and Enforcement and Compliance Assurance.

NAC, see *Nevada Administrative Code*.

Nevada Administrative Code. 2008. NAC 444.842 to 444.980, Facilities for Management of Hazardous Waste. Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 13 December 2010.

U.S. Department of Energy. 2003. *Use of Risk-Based End States*, DOE Policy 455.1. Washington, DC.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2010. *Corrective Action Investigation Plan for Corrective Action Unit 374: Area 20 Schooner Unit Crater, Nevada Test Site, Nevada*, Rev. 0, DOE/NV--1361. Las Vegas, NV.

U.S. Environmental Protection Agency. 1991. *Guidance on RCRA Corrective Action Decision Documents: The Statement of Bases, Final Decision and Response to Comments*, EPA/540/G-91/011. Washington, DC: Office of Waste Programs Enforcement.

U.S. Environmental Protection Agency. 1994. *Final RCRA Corrective Action Plan,* EPA/520-R-94-004. Washington, DC: Office of Solid Waste and Emergency Response.

U.S. Environmental Protection Agency. 1996. "Corrective Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities," 1 May. In *Federal Register*, Vol. 61, No. 85: pp. 19432–19464. Washington, DC.

Appendix F

Composite Sample Plot Analytical Data

F.1.0 Sample Data for Danny Boy

F.1.1 Soil Analytical Data

Analytical results for radionuclides in environmental samples collected at the Danny Boy CAS that were detected above MDCs are presented in Tables F.1-1 and F.1-2. Although these individual radionuclide results were not used to make decisions, they are presented here for completeness.

F.1.2 TLD Element Data

Table F.1-3 presents the TLD element data for the environmental TLDs, and Table F.1-4 presents the TLD element data for the field background TLDs staged at Danny Boy. These data are the direct radiation measurements from each of the three TLD elements (i.e., the data have not been corrected for background).

Table F.1-1
Gamma Spectroscopy Sample Results for Radionuclides Detected above MDCs at CAS 18-23-01, Danny Boy Contamination Area

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)					
			Ac-228	Am-241	Co-60	Cs-137	Eu-152	Eu-154
AA1	374AA01	0 - 5	1.63	329	0.212	27.3	2.78	0.298
AA2	374AA02	0 - 5	1.74	308	0.228	26	2.69	0.379
AA3	374AA03	0 - 5	1.81	286	0.2	24.2	2.68	0.276
AA4	374AA04	0 - 5	1.74	255	0.175	22	2.09	--
AB1	374AB01	0 - 5	1.58	84.7	0.119	19.1	6.1	0.404
AB2	374AB02	0 - 5	1.58	318	0.416	47.3	18.8	1.36
AB3	374AB03	0 - 5	1.61	135	0.185	26.4	9.85	0.675
AB4	374AB04	0 - 5	1.59	202	0.272	44.5	14.5	1.13

-- = Not detected above MDCs.

Ac = Actinium
Co = Cobalt

Table F.1-2
Isotopic Sample Results for Radionuclides Detected above MDCs at CAS 18-23-01, Danny Boy Contamination Area

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)					
			Am-241	Pu-238	Pu-239/240	Sr-90	U-234	U-238
AA1	374AA01	0 - 5	117	9.47	430	6.94	0.559	0.461
AA2	374AA02	0 - 5	104 (J)	10.5	580	4.67	0.553	0.563
AA3	374AA03	0 - 5	50.8 (J)	5.9	273	4.01	0.593	0.572
AA4	374AA04	0 - 5	46.8	6.24	259	3.12	0.486	0.552
AB1	374AB01	0 - 5	38.8	5.2	234	5.29	0.726	0.702
AB2	374AB02	0 - 5	85.8 (J)	11.1	511	10.4	0.819	0.681
AB3	374AB03	0 - 5	98.2	13.3	633	8.84	0.717	0.649
AB4	374AB04	0 - 5	129	12.6	626	--	0.663	0.6

J = Estimated value
-- = Not detected above MDCs

Table F.1-3
TLD Results for Danny Boy (mrem)
(Page 1 of 2)

Sample Plot	TLD Location	Element		
		2	3	4
AB	AT01	58.6	56.5	56.3
No plot	AT02	62.7	56.9	59.9
No plot	AT03	54.2	50.3	47.9
No plot	AT04	64.4	61.7	59.1
AA	AT05	69.9	62.5	61.6
No plot	AT06	70.5	66.6	60.5
No plot	AT07	74.9	68.6	66.5
No plot	AT08	61.6	58.9	57.5
No plot	AT09	49.7	45.9	45.1
No plot	AT10	100	85.8	84.4
No plot	AT11	39.5	37.6	36.6
No plot	AT12	37.4	35.1	34.5

Table F.1-3
TLD Results for Danny Boy (mrem)
(Page 2 of 2)

Sample Plot	TLD Location	Element		
		2	3	4
No plot	AT13	33.2	30.8	32
No plot	AT14	32.4	31.7	31
No plot	AT15	39.8	38.7	37.2
No plot	AT16	48.3	48.5	45.9
No plot	AT17	42.9	42.4	42.1
No plot	AT18	33.4	34.6	34.3
No plot	AT19	41.5	38.9	36.1
No plot	AT20	41.9	40.7	41.4
No plot	AT21	40	64.5	38.3
No plot	AT22	95.1	89.7	86.3
No plot	AT23	292	241	234
No plot	AT27	77.4	65.1	62.1
AX	AT28	33.4	32.1	32

Table F.1-4
Background TLD Results for Danny Boy (mrem)

TLD Location	Element		
	2	3	4
AT24	35.3	31.9	33.9
AT25	34.4	32.4	32.6
AT26	33.9	33.4	32.2

F.2.0 Sample Data for Schooner

F.2.1 Soil Analytical Data

Analytical results for radionuclides in environmental samples collected at the Schooner CAS that were detected above MDCs are presented in Tables F.2-1 and F.2-2. Although these individual radionuclide results were not used to make decisions, they are presented here for completeness.

F.2.2 TLD Element Data

Table F.2-3 presents the TLD element data for the environmental TLDs, and Table F.2-4 presents the TLD element data for the field background TLDs staged at Schooner. These data are the direct radiation measurements from each of the three TLD elements (i.e., the data have not been corrected for background).

Table F.2-1
Gamma Spectroscopy Sample Results for Radionuclides Detected above MDCs at CAS 20-45-03, U-20u Crater (Schooner)
(Page 1 of 3)

Sample Location	Sample Number	Depth	COPCs (pCi/g)								
			Ac-228	Am-241	Co-60	Cs-137	Eu-152	Eu-154	Eu-155	Eu-150	Ag-108M
BA1	374BA01	0 - 5	--	129	4.14	5.48	50.1	33	--	--	--
BA2	374BA02	0 - 5	1.97	88.1	2.85	4.12	34.9	22.1	--	--	--
BA3	374BA03	0 - 5	1.67	113	3.64	4.72	47.1	30.5	--	--	--
BA4	374BA04	0 - 5	1.78	12.3	0.424	1.21	5.02	3.6	--	--	--
BB1	374BB01	0 - 5	1.89	24.1	0.917	1.71	11.5	7.76	--	--	--
BB2	374BB02	0 - 5	1.73	32.3	1.09	2.01	14.1	9.17	--	--	--
BB3	374BB03	0 - 5	1.9	20.3	0.686	1.39	8.26	5.45	--	--	--
BB4	374BB04	0 - 5	1.63	36.2	1.23	2.29	15	9.81	--	--	--
BC1	374BC01	0 - 5	2.01	21.7	0.713	1.88	8.7	5.8	--	--	--
BC2	374BC02	0 - 5	1.72	21	0.736	1.6	9.13	5.97	0.424	--	--
BC3	374BC03	0 - 5	1.8	12.4	0.371	1.52	4.96	3.26	--	--	--
BC4	374BC04	0 - 5	1.79	82.3	2.67	4.58	34.3	21.6	1.14	--	--
	374BC05	0 - 5	1.79	11	0.387	1.02	4.27	2.82	0.359	--	--
BD1	374BD01	0 - 5	1.77	7.48	0.25	1	2.99	1.87	--	--	--
BD2	374BD02	0 - 5	2.03	6.7	0.252	0.999	2.89	1.9	--	--	--
BD3	374BD03	0 - 5	1.93	6.38	0.205	0.967	2.54	1.73	--	--	--
BD4	374BD04	0 - 5	1.86	5.51	0.184	0.918	2.36	1.51	--	--	--
BE1	374BE01	0 - 5	1.95	89.6	2.54	3.71	24.9	15.6	0.837	--	--

Table F.2-1
Gamma Spectroscopy Sample Results for Radionuclides Detected above MDCs at CAS 20-45-03, U-20u Crater (Schooner)
(Page 2 of 3)

Sample Location	Sample Number	Depth	COPCs (pCi/g)								
			Ac-228	Am-241	Co-60	Cs-137	Eu-152	Eu-154	Eu-155	Eu-150	Ag-108M
BE2	374BE02	0 - 5	1.89	49.2	1.38	2.49	13.9	9.17	--	--	--
BE3	374BE03	0 - 5	1.67	73.1	2.09	3.2	20.6	13.5	0.565	--	--
BE4	374BE04	0 - 5	1.63	59.9	1.54	2.49	15.7	10.2	--	--	--
BF1	374BF01	0 - 5	1.97	40.7	1.07	2.21	8.86	5.66	--	--	--
BF2	374BF02	0 - 5	1.85	28.5	0.766	1.78	6.09	4.04	0.38	--	--
	374BF03	0 - 5	2.04	23.2	0.618	1.6	5.15	3.4	0.416	--	--
BF3	374BF04	0 - 5	2.13	41.7	1.16	2.39	9.79	6.35	--	--	--
BF4	374BF05	0 - 5	2.13	16.7	0.402	1.24	3.42	2.38	--	--	--
BG1	374BG01	0 - 5	1.49	21.5	0.558	1.65	4.28	2.84	--	--	--
BG2	374BG02	0 - 5	1.78	23.7	0.599	1.79	3.95	2.55	--	--	--
BG3	374BG03	0 - 5	2.43	25 (J)	0.726	2.23	4.62 (J)	3.01	--	--	--
BG4	374BG04	0 - 5	1.81	28.5	0.642	2.12	5.1	3.39	--	--	--
BH1	374BH01	0 - 5	2.24	6.78	0.167	0.689	1.37	0.917	--	--	--
BH2	374BH02	0 - 5	2.31	10.4	0.265	0.869	2.24	1.58	--	--	--
BH3	374BH03	0 - 5	2.28	4.94	0.126	0.619	1.16	0.729	--	--	--
BH4	374BH04	0 - 5	2.28	10.6	0.278	0.863	2.13	1.39	--	--	--
BK1	374BK01	0 - 5	1.67	24.7	0.736	1.29	7.78	4.98	--	1.06	0.244
BK2	374BK02	0 - 5	1.69	31.1	0.96	1.75	10.2	6.72	--	1.4	0.352

Table F.2-1
Gamma Spectroscopy Sample Results for Radionuclides Detected above MDCs at CAS 20-45-03, U-20u Crater (Schooner)
(Page 3 of 3)

Sample Location	Sample Number	Depth	COPCs (pCi/g)								
			Ac-228	Am-241	Co-60	Cs-137	Eu-152	Eu-154	Eu-155	Eu-150	Ag-108M
BK3	374BK03	0 - 5	1.84	28.1	0.784	1.56	8.51	5.6	--	1.11	0.257
BK4	374BK04	0 - 5	1.48	20.1	0.641	1.22	6.6	4.21	--	0.901	0.245
BL1	374BL01	0 - 5	1.69	22.9	0.7	1.8	7.67	4.82	--	1.01	0.305
BL2	374BL02	0 - 5	1.7	24.5	0.684	1.5	7.94	5.27	--	1.12	0.241
BL3	374BL03	0 - 5	1.47	27.7	0.934	1.78	11.8	7.59	0.44	1.67	0.301
BL4	374BL04	0 - 5	1.64	15.9	0.517	1.45	5.57	3.61	--	0.756	0.199
BM1	374BM01	0 - 5	1.82	12.3	0.376	1.38	3.99	2.73	0.351	0.55	0.18
BM2	374BM02	0 - 5	1.81	8.45	0.233	1.25	2.46	1.78	--	0.358	0.111
BM3	374BM03	0 - 5	1.74	6.66	0.215	1.07	2.21	1.4	--	0.341	0.118
BM4	374BM04	0 - 5	1.75	7.47	0.222	1.08	2.24	1.49	--	0.31	0.114
BX	374BX004	0 - 5	--	227	6.67	7.54	79.6	50.9	1.96	11.1	1.7

J = Estimated value
-- = Not detected above MDCs

Ag = Silver

Table F.2-2
Isotopic Sample Results for Radionuclides Detected above MDCs at CAS 20-45-03, U-20u Crater (Schooner)
(Page 1 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)					
			Am-241	Pu-238	Pu-239/240	U-234	U-235	U-238
BA1	374BA01	0 - 5	12.2 (J)	28.5	13.8	3.9	--	0.407
BA2	374BA02	0 - 5	11.3	0.675 (J)	0.372	4.66	--	0.594
BA3	374BA03	0 - 5	25.3 (J)	0.764 (J)	0.442	4.49	--	0.524
BA4	374BA04	0 - 5	3.42	9.42	4.69	1.49	--	0.605
BB1	374BB01	0 - 5	3.41	11.7	6.44	1.73	--	0.677
BB2	374BB02	0 - 5	5.18	12.9	6.52	1.75	--	0.464
BB3	374BB03	0 - 5	5.02	8	4.5	1.57	--	0.639
BB4	374BB04	0 - 5	6.2 (J)	0.666 (J)	0.448	2.05	--	0.612
BC1	374BC01	0 - 5	2.29	6.76	4.48	1.22	0.0683	0.424
BC2	374BC02	0 - 5	1.91	8.24	4.31	1.32	--	0.452
BC3	374BC03	0 - 5	3.24	8.9	4.91	1.55	--	0.559
BC4	374BC04	0 - 5	10.3	27.4	13.9	3.2	0.0871	0.491
	374BC05	0 - 5	2.58	8.9	4.19	1.79	--	0.412
BD1	374BD01	0 - 5	1.26	3.65	2.18	0.742	--	0.459
BD2	374BD02	0 - 5	1.07	3.14	1.93	0.857	0.0602	0.548
BD3	374BD03	0 - 5	1.06	3.78	2.37	0.939	--	0.513
BD4	374BD04	0 - 5	0.875	2.15	1.44	0.752	--	0.405
BE1	374BE01	0 - 5	4.7	15.8	8.4	1.38	--	0.731
BE2	374BE02	0 - 5	11.9	51.2	23.3	2.78	--	0.586
BE3	374BE03	0 - 5	3.64	9.07	4.41	1.05	--	0.739
BE4	374BE04	0 - 5	4.18	12.9	8.84	1.2	--	0.438
BF1	374BF01	0 - 5	4.28	9.9	6.21	1.16	--	0.623
BF2	374BF02	0 - 5	3.56	6.23	3.98	1.12	0.0951	0.8
	374BF03	0 - 5	1.02	4.5	2.54	1.27	--	0.805
BF3	374BF04	0 - 5	2.39	3.55	2.75	1.13	--	0.834
BF4	374BF05	0 - 5	2.56	5.66	4.42	0.774	--	0.857
BG1	374BG01	0 - 5	5.18	16.2	8.32	2.27	--	0.965

Table F.2-2
Isotopic Sample Results for Radionuclides Detected above MDCs at CAS 20-45-03, U-20u Crater (Schooner)
(Page 2 of 2)

Sample Location	Sample Number	Depth (cm bgs)	COPCs (pCi/g)					
			Am-241	Pu-238	Pu-239/240	U-234	U-235	U-238
BG2	374BG02	0 - 5	6.85	13.3	6.69	1.48	--	0.605
BG3	374BG03	0 - 5	0.645	1.03	0.586	0.866	--	0.645
BG4	374BG04	0 - 5	3.74	9.94	5.24	0.919	--	0.575
BH1	374BH01	0 - 5	0.306	0.769	0.51	0.582	--	0.495
BH2	374BH02	0 - 5	--	0.199	0.153	0.57	--	0.518
BH3	374BH03	0 - 5	3.09	7.99	3.83	1.06	--	0.672
BH4	374BH04	0 - 5	2.67	7.48	4.21	0.959	--	0.479
BK1	374BK01	0 - 5	10.1 (J)	18.8	9.24	1.05 (J)	--	0.516
BK2	374BK02	0 - 5	15.4	31.8	18.2	1.41 (J)	--	0.418
BK3	374BK03	0 - 5	14.3	22.3 (J)	10.4 (J)	1.11 (J)	--	0.465
BK4	374BK04	0 - 5	94.2	197	91.3	5.76 (J)	--	0.454
BL1	374BL01	0 - 5	8.48	26.1	13.7	1.12	--	0.448
BL2	374BL02	0 - 5	15.4	38.4	24.3	1.04	--	0.441
BL3	374BL03	0 - 5	8.55 (J)	2.58	1.3	1.17	--	0.536
BL4	374BL04	0 - 5	3.2	10.2	5.65	0.687	--	0.371
BM1	374BM01	0 - 5	2.71	9.59	4.74	0.78	--	0.452
BM2	374BM02	0 - 5	3.61	10.4	5.08	0.807	--	0.565
BM3	374BM03	0 - 5	3.06	6.98	4.87	0.962	--	0.694
BM4	374BM04	0 - 5	1.46	5.4	2.58	0.586	--	0.326
BX	374BX004	0 - 5	7.93	13.8	6.04	1.13 (J)	--	0.604

J = Estimated values
-- = Not detected above MDCs.

Table F.2-3
TLD Results for Schooner (mrem)
(Page 1 of 3)

Sample Plot	TLD Location	Element		
		2	3	4
No plot	BT01	271	254	243
No plot	BT02	351	325	298
No plot	BT03	463	425	381
No plot	BT04	326	299	311
No plot	BT05	209	207	197
No plot	BT06	52.1	49.3	46.6
No plot	BT07	50.9	52.5	47.9
No plot	BT08	63.2	63.8	61
No plot	BT09	72.4	66.2	68.7
No plot	BT10	68.5	63.4	59.9
No plot	BT11	66.4	65.6	61.4
BG	BT12	70.7	65.4	64.4
BF	BT13	104	103	101
BE	BT14	147	139	134
No plot	BT15	144	154	151
No plot	BT16	64.1	63.5	62.1
No plot	BT17	82.9	85.6	80.5
No plot	BT18	104	97.6	99.7
No plot	BT19	132	124	120
BM	BT20	63.4	62.2	57.6
BL	BT21	70	66.7	61.7
BK	BT22	75.6	68.9	67.8
BX	BT23	114	107	105
No plot	BT24	61.5	62.7	58.6
No plot	BT25	70.2	72.5	75
No plot	BT26	85.3	75.9	82.9
No plot	BT27	156	146	143
No plot	BT28	73.5	70.3	68.7

Table F.2-3
TLD Results for Schooner (mrem)
(Page 2 of 3)

Sample Plot	TLD Location	Element		
		2	3	4
No plot	BT29	75.6	73.3	73.8
No plot	BT30	101	93.2	86.7
No plot	BT31	178	159	162
BC	BT32	66.1	69.6	67.4
BB	BT33	90.9	85.1	84.1
BA	BT34	99.4	93.4	90
No plot	BT35	321	316	285
No plot	BT36	58.5	57.7	59.5
No plot	BT37	68.5	65.7	62.9
No plot	BT38	75.5	68.2	67
No plot	BT39	164	158	156
No plot	BT40	75.8	76.2	70.3
No plot	BT41	106	112	101
No plot	BT42	138	136	130
No plot	BT43	217	199	202
BH	BT48	55.4	54.8	53.3
No plot	BT49	57.4	56.2	52.6
No plot	BT50	44	44.3	42.2
No plot	BT51	44.8	42	40.8
No plot	BT52	45.3	43.8	44.8
No plot	BT53	44.7	44.5	41.9
No plot	BT54	46.5	45.4	46
No plot	BT55	44.2	43.1	42.2
No plot	BT56	49.5	48.5	46.6
No plot	BT57	46	45.4	45.6
BD	BT58	53.4	49.9	50
No plot	BT59	47.9	44.3	44.1
No plot	BT60	47	47.1	44.8

Table F.2-3
TLD Results for Schooner (mrem)
(Page 3 of 3)

Sample Plot	TLD Location	Element		
		2	3	4
No plot	BT61	41.1	38.9	37.8
No plot	BT62	47.8	47.2	45.3
No plot	BT63	43.3	43.1	41.2
No plot	BT64	41.2	39.8	37.4
B3	BT65	42.8	42.8	44.2
B1	BT66	52.5	51.1	48.2
B6	BT67	51.5	51	48.7
B5	BT68	63.4	56.3	53.9

Table F.2-4
Background TLD Results for Schooner (mrem)

TLD Location	Element		
	2	3	4
BT44	54.7	48.5	47
BT45	50.2	48	44.4
BT46	64.6	60.7	59.1
BT47	61.8	60.8	62

Appendix G

Borehole and Sample Location Coordinates

G.1.0 TLD and Sample Location Coordinates

The TLD locations where sample plots were not established, centers of sample plots where TLDs were established, and sedimentation sample locations collocated with TLDs for the CAU 374 CASs were surveyed using a GPS instrument. Survey coordinates for these locations are listed in Tables G.1-1 and G.1-2.

Table G.1-1
Location Coordinates for Danny Boy
(Page 1 of 2)

Easting[a]	Northing[a]	TLD, TLD/Sample Plot, or Sedimentation Sample Location	Purpose
556,309.0	4,107,207.0	AT01/Plot AB	TLD and sample plot
556,310.5	4,107,219.9	AT02	TLD only
556,295.7	4,107,210.3	AT03	TLD only
556,308.1	4,107,192.5	AT04	TLD only
556,553.1	4,107,235.4	AT05/Plot AA	TLD and sample plot
556,545.1	4,107,247.1	AT06	TLD only
556,555.5	4,107,249.2	AT07	TLD only
556,566.1	4,107,241.8	AT08	TLD only
556,580.9	4,107,220.9	AT09	TLD only
556,453.6	4,107,156.5	AT10	TLD only
556,562.7	4,107,037.5	AT11	TLD only
556,516.3	4,106,983.9	AT12	TLD only
556,453.9	4,106,958.4	AT13	TLD only
556,387.7	4,106,997.8	AT14	TLD only
556,329.3	4,107,080.8	AT15	TLD only
556,306.8	4,107,162.2	AT16	TLD only
556,335.7	4,107,253.8	AT17	TLD only
556,359.4	4,107,374.9	AT18	TLD only
556,399.7	4,107,418.6	AT19	TLD only
556,512.3	4,107,414.3	AT20	TLD only
556,530.1	4,107,350.4	AT21	TLD only

Table G.1-1
Location Coordinates for Danny Boy
(Page 2 of 2)

Easting[a]	Northing[a]	TLD, TLD/Sample Plot, or Sedimentation Sample Location	Purpose
556,429.0	4,107,284.0	AT22	TLD only
556,524.0	4,107,220.0	AT23	TLD only
556,257.5	4,107,475.4	AT24	Background TLD location
556,669.9	4,106,933.0	AT25	Background TLD location
556,146.9	4,106,817.3	AT26	Background TLD location
556,517.2	4,107,159.1	AT27	TLD only
556,627.8	4,107,298.9	AT28	TLD only

[a]Universal Transverse Mercator (UTM) Zone 11, North American Datum (NAD) 1927 (U.S. Western) in meters.

Table G.1-2
Sample Plot/Location Coordinates for Schooner
(Page 1 of 3)

Easting[a]	Northing[a]	TLD, TLD/Sample Plot, or Sedimentation Sample Location	Purpose
538,303.3	4,132,827.0	BT01	TLD only
538,477.2	4,133,130.5	BT02	TLD only
538,668.6	4,133,118.9	BT03	TLD only
538,752.0	4,132,887.0	BT04	TLD only
538,658.0	4,132,665.0	BT05	TLD only
537,822.1	4,133,379.5	BT06	TLD only
538,294.0	4,133,955.0	BT07	TLD only
539,206.0	4,133,775.0	BT08	TLD only
537,940.0	4,131,810.0	BT09	TLD only
538,617.0	4,131,719.0	BT10	TLD only
539,523.0	4,131,928.0	BT11	TLD only
538,804.9	4,134,092.4	BT12	TLD and sample plot BG
538,762.9	4,133,937.2	BT13	TLD and sample plot BF
538,692.6	4,133,674.5	BT14	TLD and sample plot BE
538,631.0	4,133,444.0	BT15	TLD only

Table G.1-2
Sample Plot/Location Coordinates for Schooner
(Page 2 of 3)

Easting[a]	Northing[a]	TLD, TLD/Sample Plot, or Sedimentation Sample Location	Purpose
539,144.4	4,133,232.4	BT16	TLD only
539,070.2	4,133,208.9	BT17	TLD only
538,988.9	4,133,170.7	BT18	TLD only
538,886.1	4,133,113.2	BT19	TLD only
539,209.2	4,132,613.2	BT20	TLD and sample plot BM
539,131.5	4,132,640.8	BT21	TLD and sample plot BL
539,023.1	4,132,678.0	BT22	TLD and sample plot BK
538,897.1	4,132,718.4	BT23	TLD and sample plot BX
538,801.7	4,132,071.5	BT24	TLD only
538,764.8	4,132,149.6	BT25	TLD only
538,728.4	4,132,249.0	BT26	TLD only
538,668.6	4,132,396.8	BT27	TLD only
538,233.2	4,132,045.5	BT28	TLD only
538,250.0	4,132,120.4	BT29	TLD only
538,287.0	4,132,247.0	BT30	TLD only
538,339.7	4,132,426.6	BT31	TLD only
537,853.4	4,132,500.3	BT32	TLD and sample plot BC
537,915.8	4,132,524.3	BT33	TLD and sample plot BB
537,998.2	4,132,575.8	BT34	TLD and sample plot BA
538,107.5	4,132,688.5	BT35	TLD only
537,908.0	4,133,031.1	BT36	TLD only
537,975.8	4,133,006.2	BT37	TLD only
538,032.9	4,132,996.8	BT38	TLD only
538,130.1	4,132,964.4	BT39	TLD only
538,148.7	4,133,471.8	BT40	TLD only
538,186.8	4,133,421.8	BT41	TLD only
538,232.6	4,133,353.6	BT42	TLD only
538,307.0	4,133,193.6	BT43	TLD only
538,002.0	4,133,962.0	BT44	Field Background TLD

Table G.1-2
Sample Plot/Location Coordinates for Schooner
(Page 3 of 3)

Easting[a]	Northing[a]	TLD, TLD/Sample Plot, or Sedimentation Sample Location	Purpose
540,182.6	4,132,921.6	BT45	Field Background TLD
538,574.0	4,131,162.0	BT46	Field Background TLD
537,672.0	4,131,379.0	BT47	Field Background TLD
538,977.9	4,134,446.3	BT48	TLD and sample plot BH
539,109.0	4,134,818.0	BT49	TLD only
539,293.0	4,133,280.0	BT50	TLD only
539,414.0	4,133,326.0	BT51	TLD only
539,315.0	4,132,576.0	BT52	TLD only
539,391.0	4,132,552.0	BT53	TLD only
538,880.0	4,131,950.0	BT54	TLD only
538,984.0	4,131,798.0	BT55	TLD only
538,174.3	4,131,757.0	BT56	TLD only
538,100.0	4,131,559.0	BT57	TLD only
537,774.6	4,132,474.2	BT58	TLD and sample plot BD
537,719.9	4,132,448.1	BT59	TLD only
537,807.0	4,133,077.0	BT60	TLD only
537,686.0	4,133,091.0	BT61	TLD only
538,086.0	4,133,556.0	BT62	TLD only
538,001.0	4,133,669.0	BT63	TLD only
539,493.0	4,132,886.0	BT64	TLD only
539,459.9	4,132,710.2	BT65	TLD and sedimentation sample location
539,306.5	4,132,634.4	BT66	TLD and sedimentation sample location
539,484.0	4,132,389.0	BT67	TLD and sedimentation sample location
539,373.0	4,132,361.0	BT68	TLD and sedimentation sample location

[a]UTM Zone 11, NAD 1927 (U.S. Western) in meters.

Appendix H

Nevada Division of Environmental Protection Comments

(2 Pages)

ndep
NEVADA DIVISION OF ENVIRONMENTAL PROTECTION
protecting the future for generations

STATE OF NEVADA
Department of Conservation & Natural Resources
DIVISION OF ENVIRONMENTAL PROTECTION

Brian Sandoval, Governor
Leo M. Drozdoff, P.E., Director
Colleen Cripps, Ph.D., Administrator

July 1, 2011

Robert F. Boehlecke
Federal Project Director
Environmental Restoration Project
National Nuclear Security Administration
Nevada Site Office
P. O. Box 98518
Las Vegas, NV 89193-8518

RE: Review of Draft Corrective Action Decision Document / Closure Report (CADD/CR) for Corrective Action Unit (CAU) 374: Area 20 Schooner Unit Crater, Nevada Test Site, Nevada, Revision 0, June 2011
Federal Facility Agreement and Consent Order

Dear Mr. Boehlecke,

The Nevada Division of Environmental Protection, Bureau of Federal Facilities (NDEP) staff has received and reviewed the draft CADD/CR for Corrective Action Unit (CAU) 374: Area 20 Schooner Unit Crater. NDEP's review of this document did not indicate any deficiencies.

If you have any questions regarding this matter contact me at (702) 486-2850 ext. 233.

Sincerely,

/s/ Jeff MacDougall

Jeff MacDougall, Ph.D, CPM
Supervisor
Bureau of Federal Facilities

JJM/JW/KC

cc: K. J. Cabble, ERP, NNSA/NSO, Las Vegas, NV
E. F. Di Sanza, WMP, NNSA/NSO, Las Vegas, NV
J. T. Fraher, DTRA/CXTS, Kirtland AFB, NM
A. L. Primrose NSTec, Las Vegas, NV
T. D. Taylor, N-I, Las Vegas, NV
P. K. Matthews, N-I, Las Vegas, NV
FFACO Group, PSG, NNSA/NSO, Las Vegas, NV

Library Distribution List

	Copies
U.S. Department of Energy National Nuclear Security Administration Nevada Site Office Technical Library P.O. Box 98518, M/S 505 Las Vegas, NV 89193-8518	1 (Uncontrolled, electronic copy)
U.S. Department of Energy Office of Scientific and Technical Information P.O. Box 62 Oak Ridge, TN 37831-0062	1 (Uncontrolled, electronic copy)
Southern Nevada Public Reading Facility c/o Nuclear Testing Archive P.O. Box 98521, M/S 400 Las Vegas, NV 89193-8521	2 (Uncontrolled, electronic copies)
Manager, Northern Nevada FFACO Public Reading Facility c/o Nevada State Library & Archives 100 N Stewart Street Carson City, NV 89701-4285	1 (Uncontrolled, electronic copy)