RECORD OF TECHNICAL CHANGE

Technical Change No. DOE/NV--1538 Rev. 1 ROTC-1 Page 1 of 8

Activity Name Underground Test Area (UGTA) – CAU 98: Frenchman Flat Date August 1, 2016

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

Ken Rehfeldt	UGTA Project Manager
(Name)	(Title)

Description of Change:

1) Page 29, Section 4.1.1.1, 1st paragraph, last sentence insert "when sampled" between the words "and" and "will" to read: This well is currently classified as an inactive well according to the Sampling Plan (NNSA/NFO, 2014) and when sampled will only be sampled for low-level tritium because of the low water production from the sampled confining unit.

2) Page 30 of 52 (Section 4.1.1.3, 1st paragraph, 2nd sentence) change NNSA/NFO, 2014a to NNSA/NFO, 2014.

3) Page 50 of 52, last reference change U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office, 2014a, to U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office, 2014.

4) Attachment D-1 Use Restriction Forms and Map updated (see attached revised forms).

Justification:

Removal of the "a" for the NNSA/NFO 2014 reference is a correction because only a single NNSA/NFO 2014 reference is included in this Closure Report (an "a" extension is only used when multiple references for the organization and year are included). Introduction of "when sampled" provides clarification for sampling the inactive well, ER-11-2. Changes 1, 2 and 3 are being made as requested in the July 11, 2016 Closure Report Approval letter from NDEP to DOE. New Use Restriction Forms are included to correct errors on the Use Restriction Forms in the Closure Report, Revision 1 document.

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

Applicable Activity-Specific Document(s):

Closure Report for Corrective Action Unit 98: Frenchman Flat, Nevada National Security Site, Nevada, Rev. 1, June 2016 DOE/NV--1538-Rev. 1

Approved By: /s/ Robert F. Boehlecke Date 8/3/16
Activity Lead for Bill Wilborn

/s/ Robert F. Boehlecke Date 8/3/16
EM Operations Manager

/s/ Chris Andres Date 8/3/16
NDEP

Use Restriction Information

CAU Number/Description: CAU 98: Frenchman Flat
Applicable CAS Number/Description: 05-57-001: U-5a Cavity; 05-57-002: U-5b Cavity; 05-57-003: U-5e Cavity

Contact (DOE AL/Activity): NNSA/NFO Underground Test Area Federal Activity Lead

FFACO Use Restriction Physical Description:

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

UR Points	Northing	Easting
FF Central – 1	4,073,424	594,092
FF Central – 2	4,075,453	591,693
FF Central – 3	4,076,439	592,504
FF Central – 4	4,074,433	594,937

Depth: No excavation, drilling, and/or removal of materials below a depth of 100 feet.

Survey Source (GPS, GIS, etc): GIS

Basis for FFACO UR(s):

Summary Statement: The Use Restriction (UR) boundary was established to protect site workers from inadvertently contacting contaminated groundwater, or site activities affecting the flow path of contaminated groundwater. These boundaries encompass the Contaminant Boundary forecasts as per the FFACO requirements (Appendix VI, Section 3).

Contaminants Table:

Maximum Concentration of Contaminants for CAU 98 CAS: 05-57-001 Title: U-5a Cavity CAS: 05-57-002 Title: U-5b Cavity CAS: 05-57-003 Title: U-5e Cavity			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
Tritium	153,000	20,000	pCi/L
Strontium-90	8.9	8	pCi/L
Carbon-14	2.44	2,000	pCi/L
Chlorine-36	0.00044	700	pCi/L
Cesium-137	0.68	200	pCi/L
Iodide-129	4.2E-05	1	pCi/L
Neptunium-237	2.7E-05	15	pCi/L
Plutonium	0.006	15	pCi/L
Technetium-99	7.2E-05	900	pCi/L

Contaminant concentration is based on groundwater samples collected from wells within the use restriction boundary. However, three underground tests were conducted within this UR and the contaminant levels likely exceed the measured levels in the groundwater wells. The Bowen inventory, adjusted for radioactive decay is an estimate of contamination present in and near test cavities. The tritium concentration is from a sample collected on 06/12/2014 from UE-5n and the strontium-90 concentrations are from a sample collected from RNM-1 on 04/08/2014. Carbon-14 is from a sample collected from RNM-1 on 06/03/2004. Others are from a sample collected from RNM-1 on 03/06/2007.

Use Restriction Information

Site Controls: **1. Land-use and real property controls, notifications, and restrictions:** All subsurface activities-including drilling, pumping, and testing of wells-shall be communicated to the NNSA/NFO UGTA Federal Activity Lead before field activities begin. These controls are administered through NNSA/NFO orders establishing requirements for use of and operations on the Nevada National Security Site (NNSS). The current order, NFO Order 410.X1, describes the screening and siting process and Real Estate/Operations Permit (REOP) processes (NNSA/NSO, 2013 and 2009a).
2. Groundwater control: Groundwater used for human consumption, irrigating crops, and any industrial use (such as dust control) must be preceded by laboratory analysis for contaminants of concern (COCs), and must meet the Safe Drinking Water Act (SDWA) standards (CFR, 2015b). In addition, effects of pumping on contaminant migration will be evaluated to verify UR boundaries are protective.

Administrative Use Restriction Physical Description*:

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

UR Points	Northing	Easting
N/A		

Depth: _____

Survey Source (GPS, GIS, etc): _____

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

Basis for Administrative UR(s):

Summary Statement:_____

Contaminants Table:

Maximum Concentration of Contaminants for CAU 98 CAS: Title			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
N/A			

Use Restriction Information

Site Controls: _____

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

Description: **An evaluation of the Use Restrictions will be performed and documented in the Frenchman Flat Annual Closure Monitoring Report.**

Inspection/Maintenance Frequency: Annual

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: ______

Submitted By: /s/ Bill R. Wilborn **Date:** 7/27/2016

Use Restriction Information

CAU Number/Description: CAU 98: Frenchman Flat
Applicable CAS Number/Description: 05-57-004: U-5i Cavity; 05-57-005: U-5k Cavity; 11-57-001: U-11b Cavity; 11-57-002: U-11c Cavity; 11-57-003: U-11e Cavity; 11-57-004: U-11f Cavity; 11-57-005: U-11g Cavity

Contact (DOE AL/Activity): NNSA/NFO Underground Test Area Federal Activity Lead

FFACO Use Restriction Physical Description:

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

UR Points	Northing	Easting
FF Northern – 1	4,079,457	595,991
FF Northern – 2	4,079,449	594,981
FF Northern – 3	4,081,350	594,981
FF Northern – 4	4,081,350	593,287
FF Northern – 5	4,081,695	593,289
FF Northern – 6	4,081,710	594,104
FF Northern – 7	4,082,971	594,109
FF Northern – 8	4,082,976	594,458
FF Northern – 9	4,082,131	594,453
FF Northern – 10	4,082,126	595,997

Depth: No excavation, drilling, and/or removal of materials below a depth of 100 feet.

Survey Source (GPS, GIS, etc): GIS

Basis for FFACO UR(s):

Summary Statement: The Use Restriction (UR) boundary was established to protect site workers from inadvertently contacting contaminated groundwater, or site activities affecting the flow path of contaminated groundwater. These boundaries encompass the Contaminant Boundary forecasts as per the FFACO requirements (Appendix VI, Section 3).

Contaminants Table:

Maximum Concentration of Contaminants for CAU 98 **CAS: 05-57-004 Title: U-5i Cavity** **CAS: 05-57-005 Title: U-5k Cavity** **CAS: 11-57-001 Title: U-11b Cavity** **CAS: 11-57-002 Title: U-11c Cavity** **CAS: 11-57-003 Title: U-11e Cavity** **CAS: 11-57-004 Title: U-11f Cavity** **CAS: 11-57-005 Title: U-11g Cavity**			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
Tritium	1.1	20,000	pCi/L

Contaminant concentration is based on groundwater samples collected from wells within the use restriction boundary. However, seven underground tests were conducted within this UR and the contaminant levels likely exceed the measured levels in the groundwater wells. The Bowen inventory, adjusted for radioactive decay is an estimate of contamination present in and near test cavities.

Note: Effective upon acceptance of closure documents by NDEP

Use Restriction Information

Site Controls: **1. Land-use and real property controls, notifications, and restrictions:** All subsurface activities-including drilling, pumping, and testing of wells-shall be communicated to the NNSA/NFO UGTA Federal Activity Lead before field activities begin. These controls are administered through NNSA/NFO orders establishing requirements for use of and operations on the Nevada National Security Site (NNSS). The current order, NFO Order 410.X1, describes the screening and siting process and Real Estate/Operations Permit (REOP) processes (NNSA/NSO, 2013 and 2009a).
2. Groundwater control: Groundwater used for human consumption, irrigating crops, and any industrial use (such as dust control) must be preceded by laboratory analysis for contaminants of concern (COCs), and must meet the Safe Drinking Water Act (SDWA) standards (CFR, 2015b). In addition, effects of pumping on contaminant migration will be evaluated to verify UR boundaries are protective.

Administrative Use Restriction Physical Description*:

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

UR Points	Northing	Easting
N/A		

Depth: _____

Survey Source (GPS, GIS, etc): _____

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

Basis for Administrative UR(s):

Summary Statement:______

Contaminants Table:

Maximum Concentration of Contaminants for CAU: 98 CAS: Title			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
N/A			

Use Restriction Information

Site Controls: ____

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

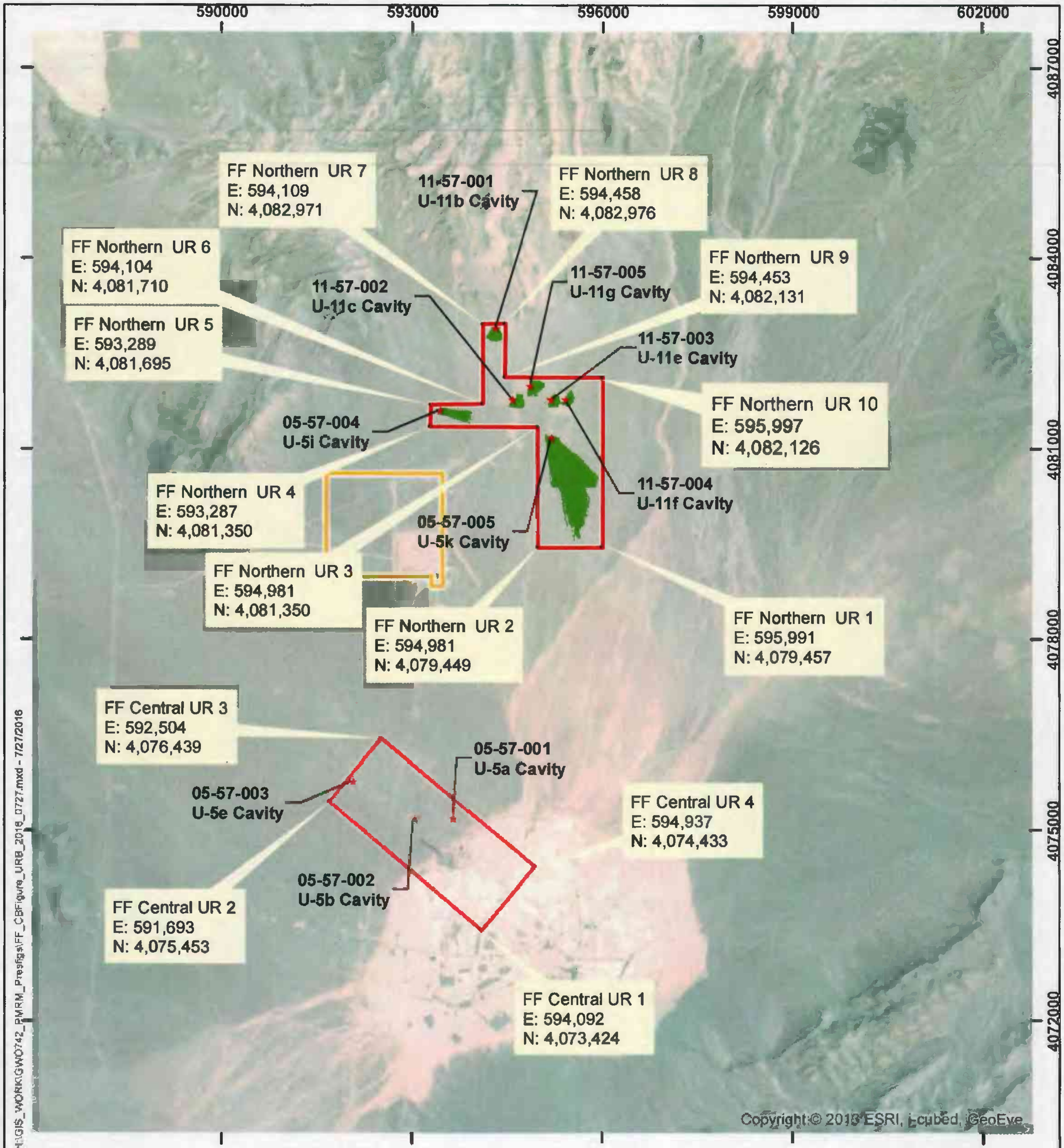
Description: **An evaluation of the Use Restrictions will be performed and documented in the Frenchman Flat Annual Closure Monitoring Report.**

Inspection/Maintenance Frequency: Annual

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: _____

Submitted By: /s/ Bill R. Wilborn **Date:** 7/27/2016



Source: Navarro GIS, 2016

CAU 98, Frenchman Flat
CAS 05-57-001, 05-57-002, 05-57-003, 05-57-004, 05-57-005, 11-57-001, 11-57-002, 11-57-003, 11-57-004, 11-57-005
FFACO UR Boundary

Explanation

FFACO UR Boundary

CAS Location

0 1,000 2,000 3,000
Meters

0 1 2
Miles

N

Coordinate System: NAD 1983, UTM Zone 11N, Meters

Nevada
Environmental
Management
Operations Activity

DOE/NV--1538-Rev. 1

National Nuclear Security Administration

Underground Test Area (UGTA) Closure Report for Corrective Action Unit 98: Frenchman Flat Nevada National Security Site, Nevada

Controlled Copy No.: ___
Revision No.: 1

June 2016

UNCLASSIFIED

/s/ Joseph P. Johnston 06/27/2016
Joseph P. Johnston, Navarro CO Date

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

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DOE/NV--1538-Rev. 1

UNDERGROUND TEST AREA (UGTA) CLOSURE REPORT FOR CORRECTIVE ACTION UNIT 98: FRENCHMAN FLAT NEVADA NATIONAL SECURITY SITE, NEVADA

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

Controlled Copy No.: ___

Revision No.: 1

June 2016

UNDERGROUND TEST AREA (UGTA)
CLOSURE REPORT FOR
CORRECTIVE ACTION UNIT 98: FRENCHMAN FLAT
NEVADA NATIONAL SECURITY SITE, NEVADA

Approved by: /s/ Bill R. Wilborn Date: 06/27/2016

Bill R. Wilborn
Underground Test Area Activity Lead

Approved by: /s/ Robert F. Boehlecke Date: 06/27/2016

Robert F. Boehlecke
Environmental Management Operations Manager

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List of Acronyms and Abbreviations

General Acronyms and Abbreviations

2-D	Two-dimensional
3-D	Three-dimensional
amsl	Above mean sea level
ASTM	ASTM International
bgs	Below ground surface
BLM	Bureau of Land Management
°C	Degrees Celsius
CADD	Corrective action decision document
CAI	Corrective action investigation
CAIP	Corrective action investigation plan
CAP	Corrective action plan
CAS	Corrective action site
CAU	Corrective action unit
CB	Contaminant boundary
COC	Contaminant of concern
CP	Control Point
CR	Closure report
CS	Carbon steel
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOECAP	U.S. Department of Energy Consolidated Audit Program
DOE/NV	U.S. Department of Energy, Nevada Operations Office
EERF	Eastern Environmental Radiation Facility
ES	Electric submersible
FAWP	Field activity work package
FFACO	*Federal Facility Agreement and Consent Order*
FMP	Fluid Management Plan
ft	Foot
GIS	Geographic Information Systems

List of Acronyms and Abbreviations (Continued)

gpm	Gallons per minute
HASL	Health and Safety Laboratory
HFM	Hydrostratigraphic framework model
HSU	Hydrostratigraphic unit
ICP-AES	Inductively coupled plasma-atomic emission spectrometry
ICP-MS	Inductively coupled plasma-mass spectrometry
in.	Inch
IT	IT Corporation
kt	Kiloton
L	Liter
m	Meter
mg/L	Milligrams per liter
mL	Milliliter
M&O	Management and operating
m/yr	Meters per year
NAD	North American Datum
NDEP	Nevada Division of Environmental Protection
NDWR	Nevada Division of Water Resources
N-I	Navarro-Intera, LLC
NNES	Navarro Nevada Environmental Services, LLC
NNSA/NFO	U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office
NNSS	Nevada National Security Site
NSPC	Nevada State Plane Coordinates
NTS	Nevada Test Site
NTTR	Nevada Test and Training Range
pCi/L	Picocuries per liter
PER	Pre-emptive review
QAP	Quality Assurance Plan
R_c	Cavity radius
REECo	Reynolds Electrical & Engineering Co., Inc.

List of Acronyms and Abbreviations *(Continued)*

RWMC	Radioactive waste management complex
SDWA	*Safe Drinking Water Act*
SOW	Statement of work
SS	Stainless steel
UDI	United Drilling, Inc.
UGTA	Underground test area
UR	Use Restriction
USAF	U.S. Air Force
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VOIA	Value of information analysis
WT	Water table
µm	Micrometer
µmhos	Micromhos
µmhos/cm	Micromhos per centimeter

Stratigraphic, Hydrostratigraphic, Hydrogeologic, and Lithologic Unit Abbreviations and Symbols

AA	Alluvial aquifer
AA3	Alluvial aquifer 3
BLFA	Basalt lava-flow aquifer
LCA	Lower carbonate aquifer
LTCU	Lower tuff confining unit
LVTA	Lower vitric-tuff aquifer
OAA	Older alluvial aquifer
OAA 1	Older alluvial aquifer 1
PCU	Playa confining unit
Pz	Paleozoic
QTa	Quaternary and Tertiary alluvium
Tcb	Bullfrog tuff

List of Acronyms and Abbreviations (Continued)

TCU	Tuff confining unit
Th	Calico Hills formation
Tmab	Bedded Ammonia Tanks tuff
Tmar	Mafic-rich Ammonia Tanks tuff
TM-LVTA	Timber Mountain lower vitric-tuff aquifer
Tmr	Rainier Mesa tuff
Tmrh	Tuff of Holmes Road
Tmrp	Mafic-poor Rainier Mesa tuff
Tmrr	Mafic-rich Rainier Mesa tuff
TM-WTA	Timber Mountain welded-tuff aquifer
Tpt	Topopah Spring tuff
TSA	Topopah Spring aquifer
Tw	Wahmonie formation
Tybf	Basalt of Frenchman Flat
UTCU	Upper tuff confining unit
WTA	Welded-tuff aquifer

Symbols for Elements and Compounds

Ag	Silver
Al	Aluminum
Am	Americium
As	Arsenic
Ba	Barium
Br	Bromide
C	Carbon
Ca	Calcium
$CaCO_3$	Calcium carbonate
Cd	Cadmium
Cl	Chlorine

List of Acronyms and Abbreviations *(Continued)*

Cr	Chromium
Cs	Cesium
Eu	Europium
F	Fluorine
Fe	Iron
^3H	Tritium
HNO_3	Nitric acid
I	Iodine
K	Potassium
Li	Lithium
Mg	Magnesium
Mn	Manganese
Na	Sodium
Nb	Niobium
Pb	Lead
Pu	Plutonium
Se	Selenium
Si	Silicon
SO_4	Sulfate
Tc	Technetium
U	Uranium

Executive Summary

This Closure Report (CR) has been prepared for Corrective Action Unit (CAU) 98, Frenchman Flat, Nevada National Security Site (NNSS), Nevada. The Frenchman Flat CAU was the site of 10 underground nuclear tests, some of which have impacted groundwater near the tests. This work was performed as part of the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) Underground Test Area (UGTA) Activity in accordance with the *Federal Facility Agreement and Consent Order* (FFACO). This CR describes the selected corrective action to be implemented during closure to protect human health and the environment from the impacted groundwater.

The CR stage is the fourth and final stage in the FFACO UGTA Strategy. The first two stages—the Corrective Action Investigation Plan (CAIP) and the Corrective Action Investigation (CAI)—were completed in 2010. The CAI stage was followed by model evaluation—the Corrective Action Decision Document (CADD)/Corrective Action Plan (CAP) stage—which tested the groundwater flow and contaminant transport model. The CADD/CAP stage was completed on November 18, 2014, with Nevada Division of Environmental Protection (NDEP) approval of the final model evaluation report.

The selected corrective action is closure in place with long-term monitoring and institutional controls as described in the *Nevada Test Site Environmental Management End State Vision* and recommended in the CADD/CAP. This is the only feasible corrective action because (1) cost-effective groundwater technologies have not been developed to effectively remove or stabilize the subsurface contaminants of concern; and (2) exposure to the potential risks from radiological groundwater contamination to workers, the public, and the environment requires access to groundwater, which can be restricted using institutional controls. The selected corrective action includes establishing a monitoring program, use restrictions (URs), and other institutional controls. The corrective action will be periodically evaluated to verify that it remains viable and protective of human health and the environment.

During the first five years after the CR is approved, six wells will be sampled annually for contaminants of concern and other constituents. In addition, groundwater levels will be measured quarterly in 16 wells. Results from the first five years of monitoring will be used by NDEP and

NNSA/NFO to determine the path forward with respect to the monitoring program. Thresholds and triggers will be established and used to assess whether the corrective action continues to be adequate for protecting public health and safety.

The CR describes the final contaminant boundaries (CBs), UR boundaries, and regulatory boundaries agreed upon by NNSA/NFO and NDEP. During the CAI stage, CB forecasts were determined based on groundwater flow and contaminant transport modeling. A CB is a model forecast perimeter and lower hydrostratigraphic unit boundary that encompasses the extent of radionuclide-contaminated groundwater from underground testing over 1,000 years. The CB for one test, PIN STRIPE, was revised in response to model evaluation studies conducted during the CADD/CAP stage. UR boundaries were established that encompass the CBs. URs, associated with the UR boundaries, were identified to protect onsite workers and the public from inadvertent exposure to contaminated groundwater as forecasted to occur assuming current conditions. These restrictions include control of drilling, pumping, and testing of wells; and limited groundwater use. In addition to the URs, other institutional controls are established to monitor and limit access to groundwater. These include federal ownership and management in perpetuity, controlled access of the NNSS and surrounding areas, and monitoring water use applications in the vicinity of the CAU.

The regulatory boundary is established to protect receptors downgradient of the Rock Valley fault system from radionuclide contamination. The basis for the objective is that although contaminants resulting from underground nuclear testing are not forecasted to migrate out of the basin within the next 1,000 years, the Rock Valley fault system is the expected groundwater flow pathway from the Frenchman Flat basin.

An annual long-term monitoring report, based on the federal fiscal year, will be published documenting the groundwater monitoring analytical results, monitoring system inspections, institutional control verifications, consistency of results with models and CBs, and adherence to UR and regulatory boundaries. The annual report will be used to document NNSA/NFO verification of the corrective action effectiveness.

1.0 Introduction

This Closure Report (CR) has been prepared for Corrective Action Unit (CAU) 98, Frenchman Flat, Nevada National Security Site (NNSS), Nevada. Frenchman Flat is one of five CAUs on the NNSS (formerly the Nevada Test Site [NTS]) assigned to the U.S. Department of Energy (DOE), National Nuclear Security Administration Nevada Field Office (NNSA/NFO) Underground Test Area (UGTA) Activity (Figure 1-1). Ten underground nuclear tests were conducted at Frenchman Flat from 1965 to 1971. Seven tests were detonated in the northern part of the CAU (informally called the Northern Testing Area), and three were detonated in the central part (informally called the Central Testing Area) (Figure 1-2). Table 1-1 lists these tests and identifies the corrective action site (CAS) number, location, and other information related to these tests. All 10 tests were detonated in the alluvium except for PIN STRIPE, which was detonated within vitric tuff. All but the CAMBRIC test were conducted above but near the water table; CAMBRIC was conducted below the water table. The announced yield for CAMBRIC is 0.75 kilotons (kt), and the announced yield for DERRINGER is 7.8 kt. The remaining eight test yields are specified as less than 20 kt (DOE/NV, 2000).

1.1 Purpose

This CR describes the selected corrective action to be implemented during closure to protect human health and the environment from groundwater impacted by the underground nuclear testing within the Frenchman Flat CAU. The CR purpose is as follows:

- Summarize previous activities and conclusions that support CAU closure.
- Describe the selected corrective action.
- Establish long-term modeling objectives and requirements.
- Provide an implementation plan for long-term monitoring and well network maintenance.
- Identify the approaches and policies for institutional controls.
- Present final contaminant boundaries (CBs), use restriction (UR) boundaries, and regulatory boundaries.

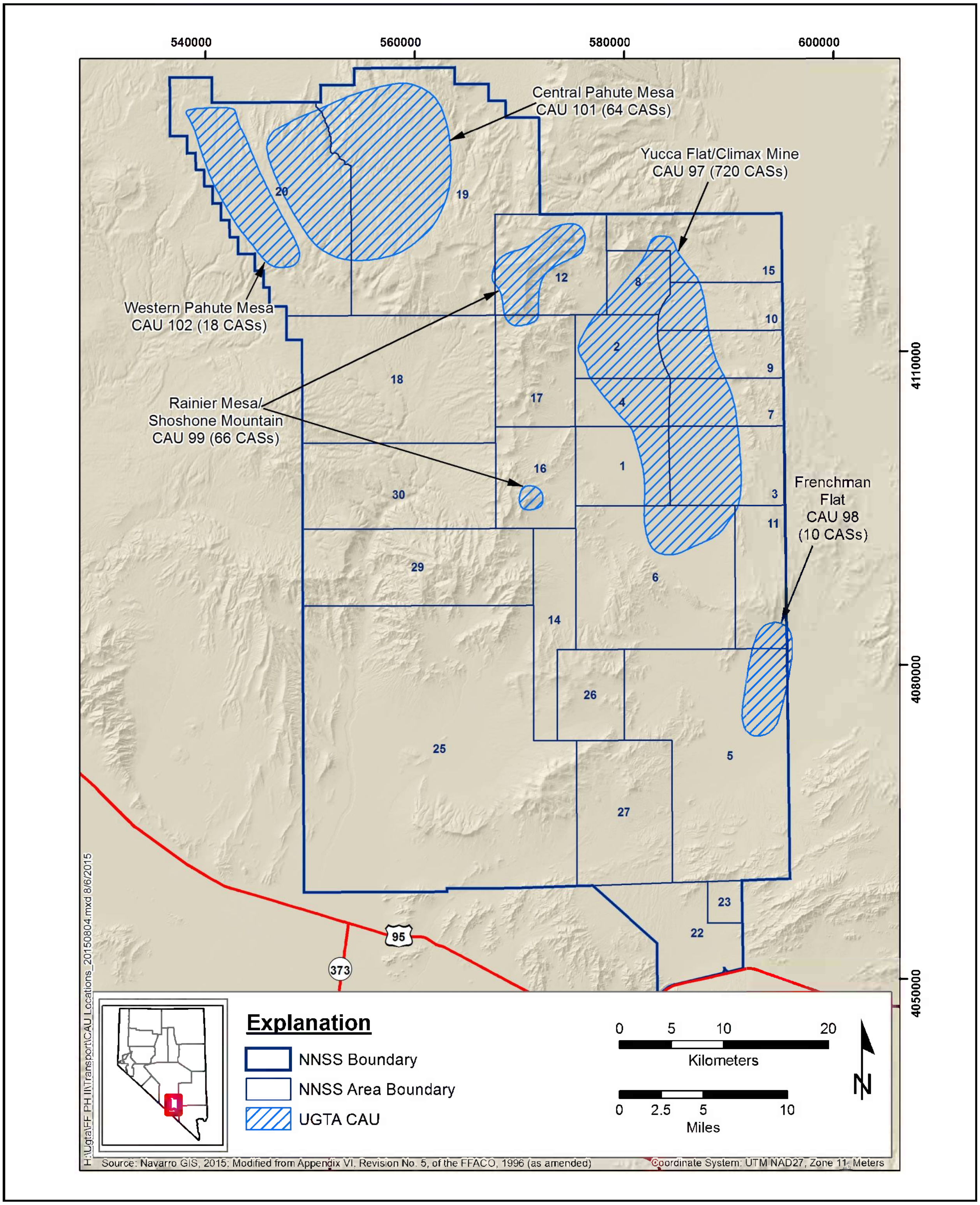

Figure 1-1
NNSS Site Map

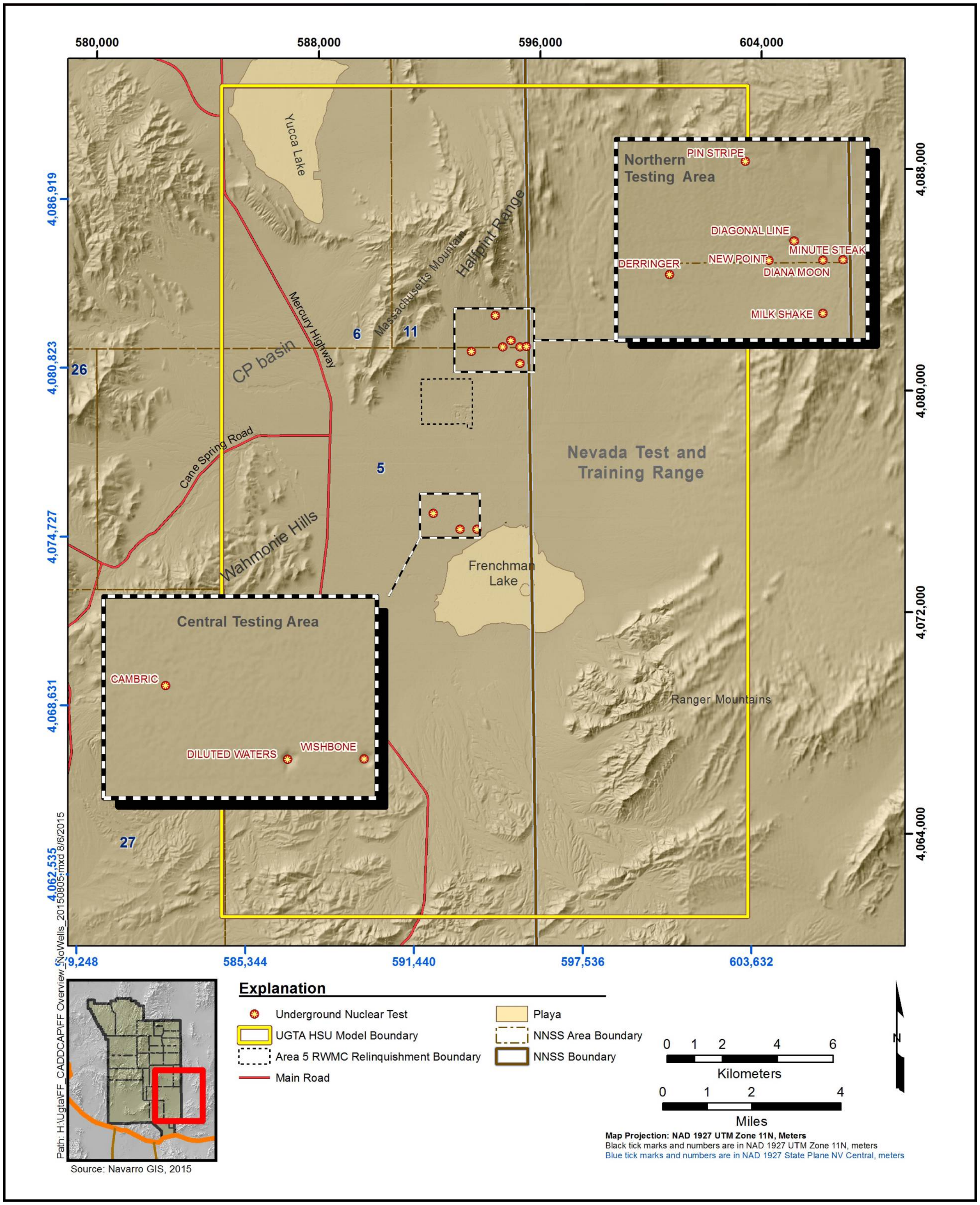

Figure 1-2
Frenchman Flat Underground Nuclear Test Locations

Table 1-1
CASs in the Frenchman Flat CAU

Test Name	CAS Number	Hole Name[a]	Test Date[a]	Latitude (NAD 27)	Longitude (NAD 27)	Yield Range[a] (kt)	Working Point HSU
Central Testing Area							
CAMBRIC	05-57-003	U5e	05/14/1965	36.823384	-115.966836	0.75	AA
DILUTED WATERS	05-57-002	U5b	06/16/1965	36.818049	-115.956061	<20	AA
WISHBONE	05-57-001	U5a	02/18/1965	36.818008	-115.949229	<20	AA
Northern Testing Area							
DERRINGER	05-57-004	U5i	09/12/1966	36.875888	-115.950695	7.8	OAA
DIAGONAL LINE	11-57-005	U11g	11/24/1971	36.879227	-115.934707	<20	OAA
DIANA MOON	11-57-003	U11e	08/27/1968	36.877213	-115.931075	<20	OAA
MILK SHAKE	05-57-005	U5k	03/25/1968	36.871719	-115.931131	<20	OAA
MINUTE STEAK	11-57-004	U11f	09/12/1969	36.877213	-115.92850	<20	OAA
NEW POINT	11-57-002	U11c	12/13/1966	36.877255	-115.937912	<20	OAA
PIN STRIPE	11-57-001	U11b	04/25/1966	36.887452	-115.940797	<20	TM-LVTA

Source: NNES, 2010

[a] DOE/NV, 2000

AA = Alluvial aquifer
HSU = Hydrostratigraphic unit
NAD = North American Datum
OAA = Older alluvial aquifer
TM-LVTA = Timber Mountain lower vitric-tuff aquifer

1.2 Background

The primary purpose of the UGTA Activity is to define perimeter boundaries over the next 1,000 years that encompass groundwater that potentially exceeds the radiological standards of the *Safe Drinking Water Act* (SDWA) (CFR, 2015b). These CBs are developed using numerical or conceptual models of groundwater flow and contaminant transport from the underground nuclear test locations. Assessments of the CBs are used to aid in identifying UR boundaries and developing a monitoring network for each CAU (FFACO, 1996; as amended).

The primary regulatory agreement governing the UGTA Activity is the Federal Facility Agreement and Consent Order (FFACO) (1996, as amended), which was agreed to by the State of Nevada acting by and through the Department of Conservation and Natural Resources, Division of Environmental Protection (NDEP); DOE, Environmental Management; U.S. Department of Defense (DoD); and

DOE, Legacy Management. The UGTA strategy, defined in Appendix VI of the FFACO, assumes that active remediation of underground nuclear tests is not feasible with current technology. As a result, the corrective action for each CAU is based on a combination of characterization and modeling studies, monitoring, and institutional controls. The FFACO UGTA strategy is implemented through a four-stage approach that comprises the following: (1) Corrective Action Investigation Plan (CAIP), (2) Corrective Action Investigation (CAI), (3) Corrective Action Decision Document (CADD)/Corrective Action Plan (CAP), and (4) Closure Report (CR). Figure 1-3 illustrates the individual steps and decision points within each strategy stage; major decisions between NDEP and NNSA/NFO are highlighted in yellow. Eight of the decision points are within the UGTA strategy; the ninth decision point is under long-term stewardship but still within the CR stage. Three of the UGTA decision points are at the transition between stages. Non-approval of decision points by NDEP affects the program progression and can lead to a reassessment of whether the UGTA strategy is achievable.

The first three stages of the strategy have been completed for the Frenchman Flat CAU. A value of information analysis (VOIA) was performed and documented (IT, 1997), and a CAIP was developed (DOE/NV, 1999) during the CAIP stage. The CAI stage required two phases of investigations (see Section 2.1). An external peer review (IT, 1999) and an internal review (IT, 2000) determined that additional data collection and model refinement was necessary following phase I of the CAI stage. A CAIP addendum (NNSA/NV, 2001) was developed to address the review comments; the data-collection and evaluation activities proposed in the CAIP and addendum were completed (NNES, 2010); and a second external peer review of the resultant groundwater flow and contaminant transport model was completed (N-I, 2010). The external peer review committee recommended advancement to the CADD/CAP stage. NDEP approval of Decision Point 4 in the FFACO UGTA Strategy Flowchart (*Is CAU Model Acceptable for CADD/CAP Studies?)* is the final step of the CAI stage. On November 30, 2010, NDEP approved proceeding to the CADD/CAP stage (NNSA/NSO, 2011).

During the CADD/CAP stage, regulatory boundary objectives and initial UR boundaries were negotiated with NDEP, and the CADD/CAP was prepared (NNSA/NSO, 2011). The CADD/CAP identified data collection activities that addressed specific model uncertainties to build confidence in the model results (see Section 2.2). A model evaluation report was prepared that describes the data

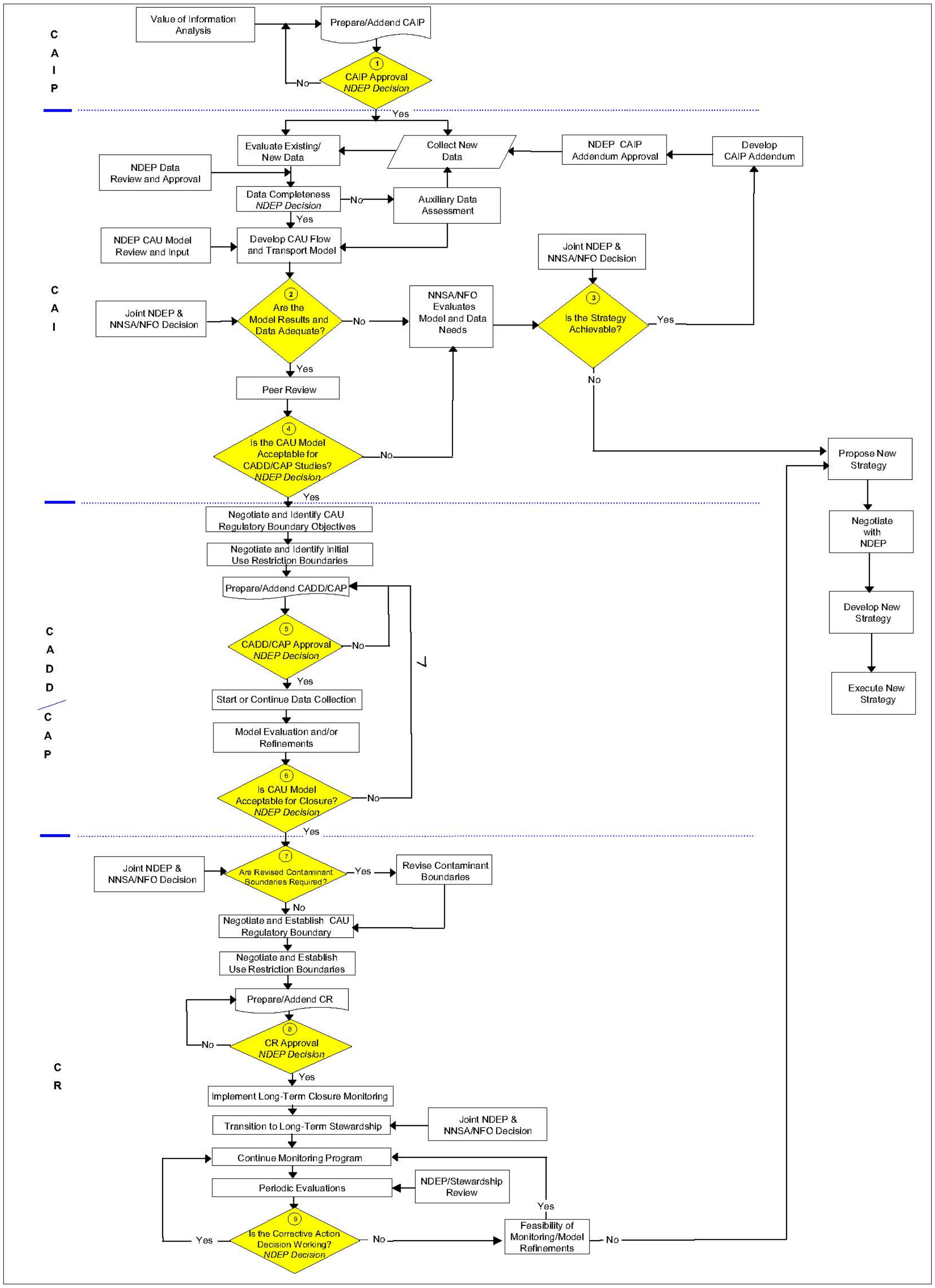

Figure 1-3
FFACO UGTA Strategy Flowchart

collection activity results and modeling refinements (N-I, 2014). Recommendations to advance to the CR stage by the modeling team and the preemptive review (PER) committee were also included. NDEP approval of Decision Point 6 in the FFACO Flowchart (*Is CAU Model Acceptable for Closure?)* is the final step of the CADD/CAP stage. On November 18, 2014, NDEP approved proceeding to the CR stage (see Appendix A).

The first step in the CR stage is the joint NDEP and NNSA/NFO Decision Point 7 (*Are Revised Contaminant Boundaries Required?*) followed by negotiations to establish the CAU regulatory and UR boundaries. Completion of these first steps are described in Section 3.0. The CR is then prepared (Figure 1-3). The eighth decision point requires NDEP approval of the CR before long-term monitoring is implemented. The ninth and final decision point is a recurring periodic evaluation of the long-term monitoring program under long-term stewardship, a joint evaluation conducted by NDEP and the long-term stewardship entity. The results of long-term monitoring are evaluated for consistency with the numerical model(s), conceptual models, and the closure strategy.

Additional regulatory agreements regarding the fluids produced during groundwater purging activities at the post-closure monitor wells are described in the *Underground Test Area Project Waste Management Plan* with *Attachment 1, Fluid Management Plan for the Underground Test Area Project* (NNSA/NSO, 2009b). Further discussion of NNSA/NSO (2009b) is presented in Section 4.1.6.

1.3 Selected Corrective Action

The selected corrective action is closure in place with long-term monitoring and institutional controls as described in the *Nevada Test Site Environmental Management End State Vision* (DOE, 2006) and recommended in the CADD/CAP (NNSA/NSO, 2011). This is the only feasible corrective action because (1) groundwater technologies for removal or stabilization of subsurface radiological contamination are not cost effective; and (2) exposure to the potential risks from radiological groundwater contamination to workers, the public, and the environment requires access to groundwater, which can be restricted using institutional controls. The selected corrective action, as described in the FFACO (1996, as amended), uses the tripartite approach by developing models and establishing a monitoring program, URs, and other institutional controls to protect human health and the environment. Activities will include the following:

- Identifying CBs, UR boundaries, and regulatory boundaries.
- Establishing institutional controls for the protection of workers and the public.
- Establishing monitoring well networks for water-level measurements and sample collection.
- Performing monitoring result evaluations to determine baseline levels and identify trends.
- Inspecting the monitoring well network.
- Siting new monitoring wells and replacing monitoring wells.
- Evaluating new data/information to verify the corrective action effectiveness.
- Evaluating adherence to the UR boundaries and the regulatory boundaries.
- Verifying institutional controls continue to be protective of the public and the environment.
- Monitoring water-use applications in the vicinity of the CAU.

1.4 Closure Report Contents

This CR presents a summary of the CAI and CADD/CAP activities (Section 2.0); final CBs, URs, UR boundaries, and regulatory boundaries (Section 3.0); a description of the corrective action and how it will be implemented (Section 4.0); reporting requirements (Section 5.0); records and data management (Section 6.0); quality assurance (Section 7.0); recommendations to transfer the Frenchman Flat CAU from Appendix III to Appendix IV of the FFACO (Section 8.0); and a list of the references cited in this document (Section 9.0).

2.0 Summary of Site CAI and CADD/CAP Activities

2.1 CAI Stage Activities

The activities performed during the CAI stage were accomplished through two phases. The Phase I CAI included hydrologic and transport data compilation, analysis, and model development. Phase I of the CAI was completed in 1999; however, an external peer review panel raised issues that necessitated a second characterization phase (IT, 1999). In 2001, an addendum to the CAIP (NNSA/NV, 2001) was approved by NDEP. Data-collection activities for the Phase II CAI were proposed, and the associated scientific objectives were developed. A specific objective of the Phase II CAI activities was to measure parameters governing potential vertical flow from the alluvial aquifer to the lower carbonate aquifer (LCA) to assess the potential for vertical migration from the contamination sources located in the alluvial and volcanic units to the LCA (NNSA/NV, 2001). The Phase II CAI ended in 2010 with a second external peer review recommending (N-I, 2010) and NDEP approving the advancement to the CADD/CAP stage. A CADD/CAP document was then developed and approved by NDEP (NNSA/NSO, 2011). Section 2.0 of the CADD/CAP provides a summary of the CAI activities.

Dominant features of all conceptual models for the Frenchman Flat basin are the high hydraulic heads in the Control Point (CP) basin northwest of Frenchman Flat (over 100 meters [m] higher than heads in the Frenchman Flat basin); the semiperched condition of groundwater in the alluvium and volcanic aquifers with higher heads in these aquifers than the regional LCA; and the documented southeastward thinning of the volcanic section away from volcanic centers located northwest of Frenchman Flat.

Figure 2-1 is a representation of groundwater flow directions and the Rock Valley fault system (Winograd and Thordarson, 1975; Laczniak et al., 1996; SNJV, 2006; Fenelon et al., 2010; NNES, 2010). Two main observations for the basin are (1) groundwater flow in the alluvial and volcanic aquifers is horizontal across the Frenchman Flat basin from northwest to south–southeast; and (2) there is limited leakage downward into the LCA from the alluvium and volcanic aquifers, as this section thins to the southeast across the Frenchman Flat basin and/or is offset by faults associated with the Rock Valley fault system. Particle track studies for Frenchman Flat originating at

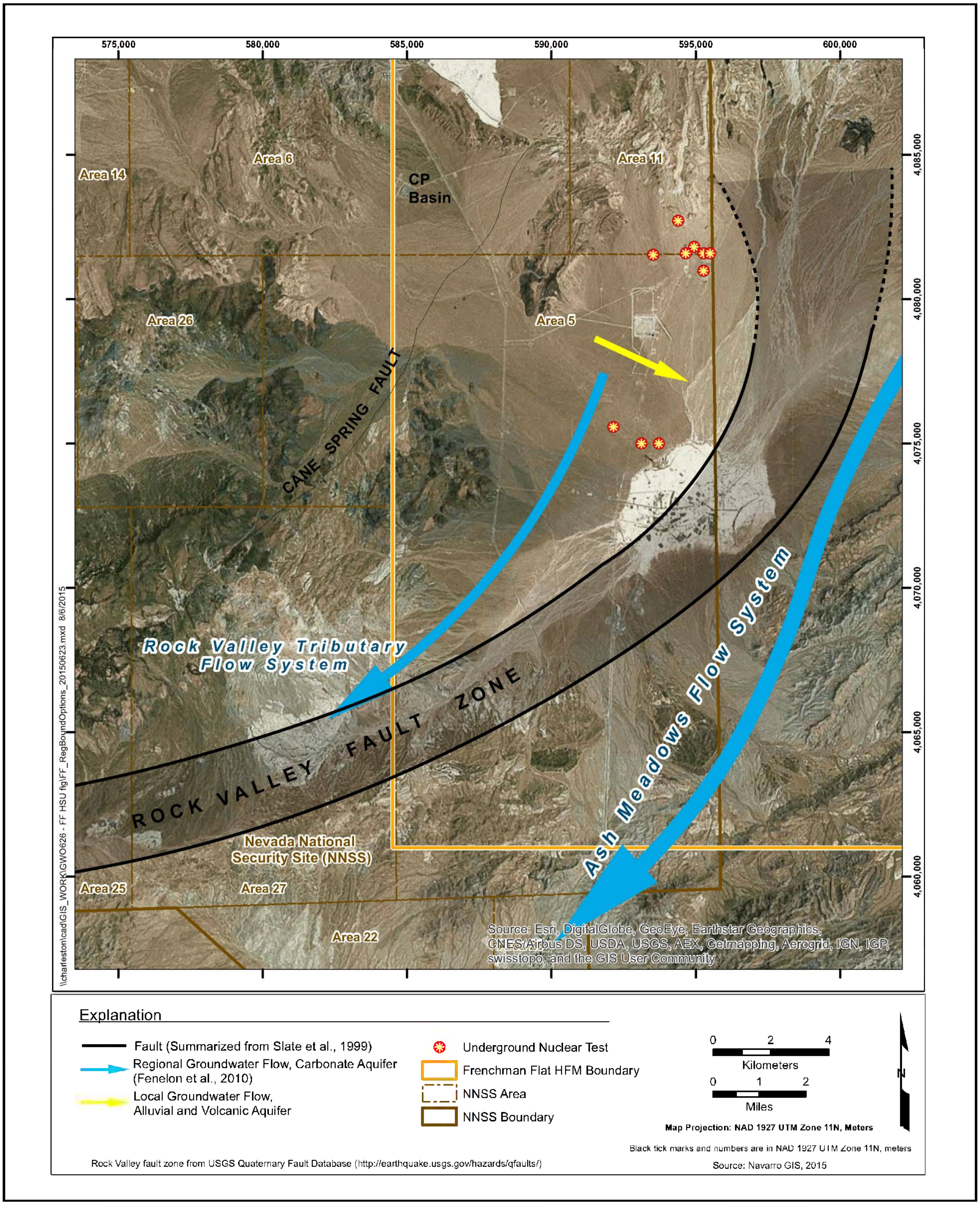

Figure 2-1
Representation of Rock Valley Fault System and Groundwater Flow Directions

underground test locations show southeast flow through the alluvial and volcanic aquifers changing to southwestward flow in the LCA following surface and subsurface faults associated with the basin-forming structure of the Frenchman Flat basin (BN, 2005; SNJV, 2006; NNES, 2010). These observations are consistent with groundwater flow converging into and following faults of the Rock Valley fault system in southern Frenchman Flat. Modeling results show radionuclide transport follows these groundwater flow directions, but only limited quantities of contaminants reach the LCA in 1,000 years (NNES, 2010). Contamination is dominated by tritium, which will decay to levels well below the SDWA standard within 200 years (Bowen et al., 2001); other nuclear test-related radionuclides have not been detected near the SDWA standard in locations other than those within a nuclear test cavity (Navarro, 2015).

Subsequent southwest groundwater flow along the Rock Valley fault system outside the Frenchman Flat model domain may remain in the Rock Valley tributary flow system (Fenelon et al., 2010) and discharge into the Alkali Flat-Furnace Creek Ranch Flow system (Laczniak et al., 1996, pg. 19; DOE/NV, 1997; Fenelon et al., 2010, plate 5) and/or may move southward across the Rock Valley fault system and discharge into the Ash Meadows flow system.

2.2 CADD/CAP Model Evaluation Results and Recommendations

During the CADD/CAP (model evaluation) stage, the reliability of the flow and contaminant transport results are assessed through data collection and model refinement. The goal of the model evaluation process is to build confidence that the modeling results can be used for the regulatory decisions required to establish a monitoring network and institutional controls that are protective of human health and the environment. Selection of the data-collection activities was based on expert evaluation of the Frenchman Flat models to identify model confidence-building targets (Chapman and Pohlmann, 2011). The uncertainties identified in the Phase II transport model document (NNES, 2010) were reviewed; 10 model evaluation targets that cover the three primary components of the Frenchman Flat CAU models (hydrostratigraphic framework model [HFM], groundwater flow model, and contaminant transport model) were selected; and data-collection activities that could address the targets were identified. The model evaluation targets, a description of the uncertainties they represent, and the associated data collection activity are presented in Table 2-1. The activities included conducting surface ground magnetic surveys, and installing and collecting data from two model evaluation wells (one well near PIN STRIPE and one near MILK SHAKE) (NNSA/NSO, 2011). In addition, a water-level measurement program was implemented during the CADD/CAP stage that addressed a peer-review panel recommendation.

Model evaluation focused solely on the PIN STRIPE and MILK SHAKE underground nuclear tests' CBs because they had the largest extent and associated uncertainty (NNES, 2010). The CAMBRIC test also had a relatively large CB resulting from the radionuclide migration experiment (Bryant, 1992), but because it was constrained by transport data (notably, Well UE-5n), there was little uncertainty, and radioactive decay reduced concentrations before much migration could occur. Each model evaluation target and the associated data-collection activity were assessed in turn to determine whether the new data support, or demonstrate conservatism of, the CB forecasts (NNSA/NSO, 2011, p. 55). The model evaluation results are presented in *Model Evaluation Report for Corrective Action Unit 98: Frenchman Flat, Nevada National Security Site, Nye County, Nevada* (N-I, 2014) and summarized in Table 2-1. The uncertainty associated with the models for the seven remaining tests, and their CB extent, are sufficiently low that further model evaluation activities is considered unnecessary.

Two wells were drilled during the CADD/CAP stage. Well ER-11-2 was drilled near the PIN STRIPE test, and Well ER-5-5 was drilled near the MILK SHAKE test. Completion data from Well ER-11-2 showed that the Topopah Spring aquifer (TSA) has been disrupted by faulting to the east of the PIN STRIPE test. The faulting has resulted in the TSA being in the vadose zone to the east of the test, thereby eliminating this potential migration pathway. Based on this new insight, the PIN STRIPE conceptual model was refined to reflect migration southward rather than eastward. The potential migration is now estimated to extend no more than about 200 m to the south of the test. The MILK SHAKE CB was not refined but was shown to be a very conservative estimate of the potential for migration of test related contaminants because of the low tritium concentration (1.1 picocuries per liter [pCi/L]) present at Well ER-5-5 (N-I, 2014).

The results of model evaluation confirmed that Frenchman Flat groundwater flow velocity is slow, and any potential migration of test-related contaminants will be confined to regions near the tests, with the exception of the CAMBRIC test. Although contaminants from the CAMBRIC test are projected to migrate further than contaminants from the other tests, they are predicted to remain well

Table 2-1
Model Evaluation Results Summary
(Page 1 of 2)

Model Evaluation Target	Description of Uncertainty	Data-Collection Activity	Results
Internal continuity of TSA	The TSA in the vicinity of PIN STRIPE is represented as a continuous, well-connected HSU. However, even modest vertical displacement on north–south-striking normal faults could completely disrupt the relatively thin TSA and significantly reduce the continuity of this potential flow path.	Geologic logging of subsurface rock type, geophysical logging to determine rock type, bed dip, and fracture characteristics. Surface magnetic geophysical survey.	Well ER-11-2 shows TSA is not continuous due to faulting, and the flow path to the east does not exist.
Spatial extent of TSA in the north	The saturated lateral extent of the TSA at the water table along the flow path downgradient of PIN STRIPE may be underestimated. If subsurface bed dips in the structural block on the north side of the detachment fault are steeper than assumed, then the width of saturated TSA would increase along the flow path.	Geologic logging of subsurface rock type, geophysical logging to determine rock type, bed dip, and fracture characteristics. Surface magnetic geophysical survey.	Overall spatial extent could not be evaluated by ground magnetic survey due to ground noise and complexity. Well ER-11-2 showed that the eastward saturated extent was less than the base interpretation.
Hydraulic conductivity of WTA (TSA)	The parametric distribution of hydraulic conductivity in the WTA could not be determined with confidence owing to the limited availability of pumping-test-scale estimates in Frenchman Flat. Although considerably more data are available for regional HSUs and hydrogeologic unit, the distributions are not specific to WTAs in Frenchman Flat, and therefore, the data are subject to issues of transferability. In addition, it is unclear whether high simulated hydraulic conductivity values in TM-WTA, which have the effect of draining water from other HSUs, are real or a function of model construction.	Aquifer testing.	Well ER-11-2 showed saturated TSA does not exist at this location; eastward pathway is severed, and target cannot be evaluated.
Continuity of BLFA	The fractured BLFA lies within the alluvial section at or near the water table near MILK SHAKE in northern Frenchman Flat. The BASE HFM depicts the BLFA as three isolated bodies. However, aeromagnetic data, ground magnetic data, and borehole coverage are insufficient to fully delineate BLFA geometry.	Geologic logging of subsurface rock type, geophysical logging to determine rock type, bed dip, and fracture characteristics. Surface magnetic geophysical survey.	Continuity is similar to extended case in Phase II HFM.
Conceptual model of basin drainage to the southeast	As with the boundary flows, large uncertainty exists because there are very limited data to determine flow directions and velocities with the low gradients.	Measurement of hydraulic head in new wells and in existing wells as part of a water-level measurement program.	New data are consistent with conceptual model.

Table 2-1
Model Evaluation Results Summary
(Page 2 of 2)

Model Evaluation Target	Description of Uncertainty	Data-Collection Activity	Results
Source release conservative assumptions	The source release model for the vadose zone tests was deliberately unrealistic, projecting the full source to the water table. More accurate portrayal of a slower release and possible loss of mass to the vadose zone would reduce the contaminant mass moving with the groundwater.	Analysis of radionuclides in groundwater samples.	Although radionuclide data from Well ER-5-5 are consistent with this conservative assumption, this target could not be effectively evaluated because the hydrogeologic conditions were found to dominate contaminant transport (i.e., contaminant boundary extent) at PIN STRIPE and MILK SHAKE.
Hydraulic conductivity of the BLFA	There are no pumping-test-scale estimates of hydraulic conductivity in Frenchman Flat and few relevant NNSS-wide pumping-scale estimates in the BLFA.	Aquifer testing.	Results are consistent with the values used in the flow and transport modeling.
Flow boundary conditions	Groundwater flow boundary conditions, particularly inflow from the north through semiperched alluvial and volcanic aquifers, are highly uncertain owing to the absence of field observations in this area and minimal constraints provided by the regional model.	Measurement of hydraulic head in new wells and in existing wells as part of a water-level measurement program.	New data are consistent with conceptual model and boundary conditions.
Size of exchange volume	The exchange volume is assumed to intersect the water table—when, in fact, it may not—thereby artificially increasing contaminant access to the saturated zone in the model.	None	Hydrogeologic conditions dominate source release at PIN STRIPE and MILK SHAKE.
Geochemical age and velocity constraints	Using ^{14}C ages, a single groundwater velocity was estimated for each of five well pairs. Uncertainty arises from the few ^{14}C ages upon which to estimate groundwater velocity, uncertainties related to corrections for dead carbon, and assumptions about how the well pairs are positioned with respect to flow directions.	Analysis of ^{14}C, stable isotopes, and major ions in groundwater samples.	Geochemical data are consistent with pluvial-age groundwater and low groundwater velocity. Velocities derived from hydraulic data are less than 1 m/yr, consistent with CAI interpretations.

BFLA = Basalt lava-flow aquifer
^{14}C = Carbon-14
m/yr = Meters per year
TM-WTA = Timber Mountain welded-tuff aquifer
WTA = Welded-tuff aquifer

within the NNSS boundaries and reach no further than a point below Frenchman Lake. The direction of groundwater flow is to the south–southeast in the alluvial and volcanic aquifers.

Several issues were identified in the peer review report (N-I, 2010) that NNSA/NFO agreed to assess either in the CADD/CAP or CR stages or both. The issues included (1) seismic activity, (2) climate change, (3) groundwater age studies, (4) water budgets, (5) and water-level gradients. Groundwater ages, water budgets, and water-level gradients were evaluated with the new data collected during the CADD/CAP stage and reported in the model evaluation report (N-I, 2014). The evaluation supports the conceptualization of slow (less than 1 m/yr) southeast groundwater flow in central Frenchman Flat basin. NNSA/NFO proposed responses to each issue in a letter to NDEP dated September 16, 2014. NDEP concurred with these responses in a letter to NNSA/NFO (see Appendix A).
NDEP agreed that by continued execution of the UGTA strategy (FFACO, 1996, as amended) that any assessment of seismic events or regional-scale climate change will occur when monitoring indicates a need for this action.

The Frenchman Flat PER committee agreed with the modeling team that there is sufficient confidence in the Frenchman Flat model to advance to the CR stage. No major issues were recognized by the PER committee that require additional data analysis, model refinements, or data collection before closure. As presented in N-I (2014), the committee concluded that “the current understanding is sufficiently reliable to design a monitoring system and develop effective institutional controls.”

3.0 Boundaries and Objectives

The first step in the CR stage is a joint decision by NDEP and NNSA/NFO on whether revised CBs are required. If revision is required, the new boundaries are established using the accepted model or models from the CADD/CAP stage. This decision is followed by negotiations to establish the UR boundaries and regulatory boundary. These boundaries are described within this section.

3.1 Contaminant Boundaries

A CB is formally defined as a probabilistic model-forecast perimeter and a lower HSU boundary that delineates the extent of radionuclide-contaminated groundwater from underground testing over 1,000 years. The contaminated groundwater is a volume (three-dimensional [3-D]), and this volume is projected upward to the ground surface to define a two-dimensional (2-D) CB perimeter (FFACO, 1996 as amended). During the CAI stage, transport modeling simulations are used to compute radionuclide concentrations in time and space within a CAU (NNES, 2010). These 3-D concentration data are integrated into probabilistic forecasts of the likelihood of groundwater exceeding or remaining below the SDWA radiological standards (CFR, 2015b). Once in the CADD/CAP stage, revised CBs may be based upon conceptual model refinements, using non-3-D numerical model(s) and/or any other quantitative approaches acceptable to NDEP and NNSA/NFO. These refinements will be included in the numerical model at an appropriate time as agreed upon by NDEP and NNSA/NFO (FFACO, 1996 as amended).

The 2-D CB perimeters for the Frenchman Flat CAU are shown in Figure 3-1. With the exception of the PIN STRIPE CBs, Figure 3-1 represents the maximum footprint of the CB ensemble presented in the CADD/CAP (NNSA/NSO, 2011). NDEP agreed that the CB for the PIN STRIPE test should be revised, as shown on the figure, to reflect the refined conceptual model presented in the model evaluation report (N-I, 2014) and that the CBs associated with the other Frenchman Flat tests were adequate (see Appendix A).

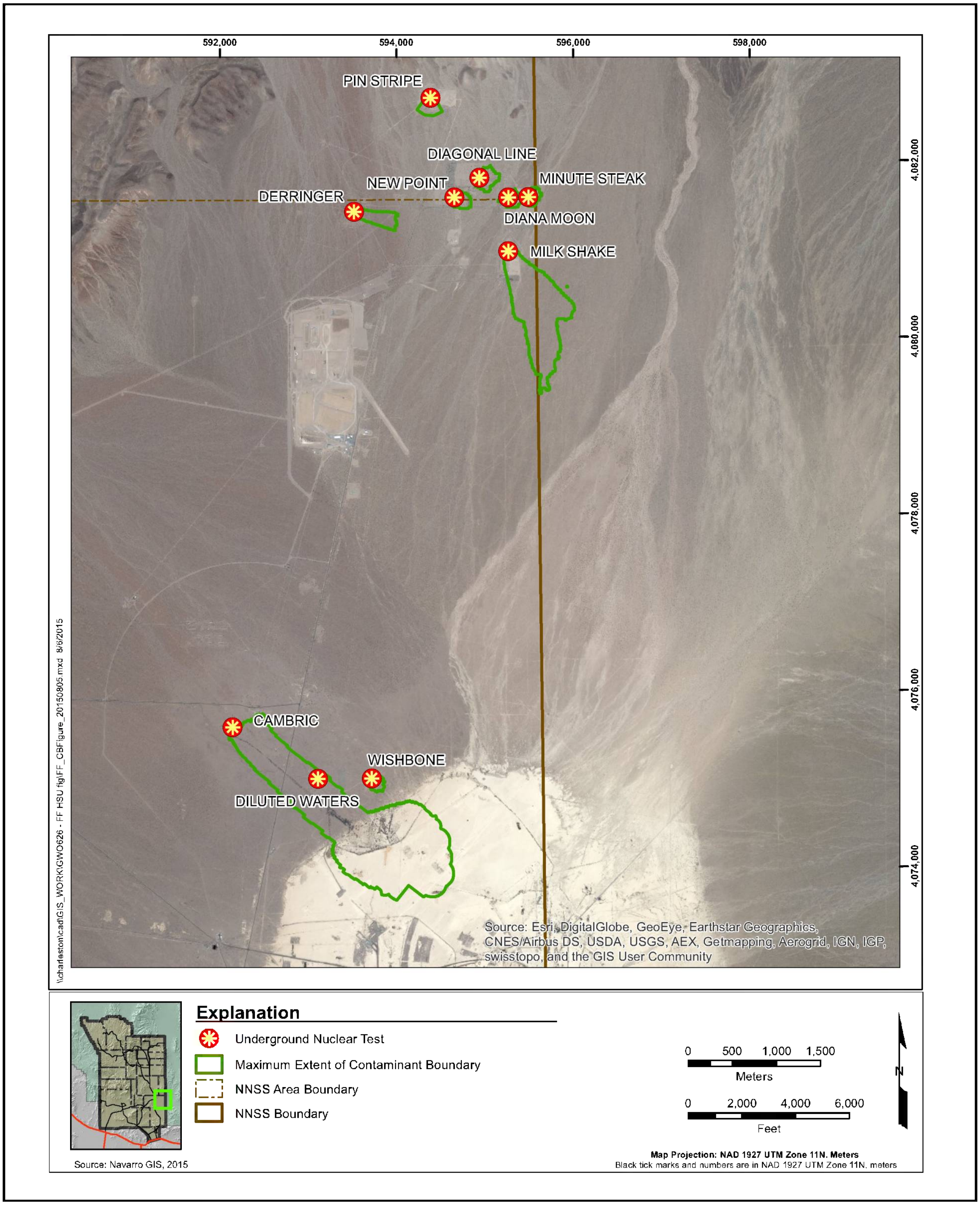

Figure 3-1
Frenchman Flat Contaminant Boundaries

The refined conceptual model near the PIN STRIPE underground nuclear test has the following elements (N-I, 2014):

- A tuff confining unit (TCU) to the east and north essentially prevents groundwater flow in those directions.
- Recharge on the mountains and leakage from CP basin suggest groundwater flow also cannot be strongly westward or northward.
- Flow to the east is also precluded by the higher head at Well ER-11-2.
- Recharge on the mountains, southeast-trending land surface, and water-level observations suggest flow should be approximately south.
- Low recharge, small horizontal hydraulic gradients, and old groundwater ages suggest very limited inflow to the Frenchman Flat basin.
- Low (less than 0.2 m/yr) horizontal groundwater velocities are estimated in all saturated tuff lithologies in the TSA under PIN STRIPE. The conceptual model of an ash-flow tuff is that a densely welded tuff is fractured. Very little of this densely welded tuff is saturated in the exchange volume, potentially limiting outflow.
- The potential TSA flow path is truncated about 200 m south by a detachment fault, which juxtaposes older altered alluvium against the TSA.

This conceptual model includes radionuclides transported slowly southward in the TSA reaching the detachment fault within 1,000 years and crossing laterally into the OAA through the detachment fault where groundwater flow will still be very slow (less than 1 m/yr). The CB is calculated using the saturated 2 cavity radius (R_c) exchange volume radius at the water table, the maximum velocity of 0.2 m/yr over 1,000 years (resulting in 200 m of transport), and moving it 200 m in the estimated flow direction and plus and minus one standard deviation in direction. This yields an upper-bound estimate of potentially contaminated TSA groundwater in 1,000 years. Table 3-1 summarizes the CB maximum lateral distance, width, and depth from each test. With the exception of PIN STRIPE, the maximum extents presented in Table 3-1 are calculated from the CB ensembles forecasted using the numerical models; a detailed description of these CB calculations is presented in NNES (2010).

Following publication of NNES (2010), the CAS associated with CAMBRIC ditch surface contamination (CAS 05-22-33) was transferred to CAU 56 (FFACO, 1996 as amended). The CB associated with the CAMBRIC ditch groundwater contamination (i.e., the CAMBRIC ditch CB) was added to the CAMBRIC (CAS 05-57-003) CB. Therefore, the maximum CB extent associated with the CAMBRIC ditch is now assigned to CAS 05-57-003 (CAMBRIC) as shown in Table 3-1. For PIN STRIPE, the maximum vertical distance was determined as the distance from the water table (358 m) reported by Dixon et al. (1965) to the TSA base (378 m). The maximum width is the distance from the southeastern to southwestern CB corners. This distance was calculated using Navarro Geographic Information Systems (GIS) to be 288 m (Navarro GIS, 2015). The 2 R_c sphere was estimated using the maximum announced yield (20 kt) from DOE/NV (2000) and the equation in Pawloski (1999).

Table 3-1
Maximum Saturated Zone CB Dimensions for Each Source

Test	Maximum Lateral Distance (m)	Maximum Vertical Distance (m)	Maximum Width (m)	Intersected HSUs
Central Testing Area				
CAMBRIC	2,860	110	1,110	AA
DILUTED WATERS	160	45	120	AA
WISHBONE	180	30	130	AA
Northern Testing Area				
DERRINGER	500	5	200	OAA, BLFA
DIAGONAL LINE	220	35	200	OAA, BLFA
DIANA MOON	150	30	190	OAA, BLFA
MILK SHAKE	1,650	60	625	OAA, BLFA
MINUTE STEAK	140	35	190	OAA
NEW POINT	180	20	175	OAA
PIN STRIPE	200	20	288	TM-LVTA, TSA

Source: Modified from NNES, 2010

3.2 UR Boundaries

UR boundaries are established based primarily on CB forecast assessments. The areas inside the UR boundaries are expected to require institutional controls to restrict access to potentially contaminated groundwater. The final UR boundaries as negotiated by NDEP and NNSA/NFO are shown in Figure 3-2. The UR boundaries were established to protect site workers from inadvertently contacting, or site activities affecting, the flow path of contaminated groundwater. These boundaries encompass the 95th percentile of the CB forecasts. A UR form and map, the official records documenting sites where contamination remains in place after closure, is included in Appendix D.

NNSA/NFO, the Bureau of Land Management (BLM), and the U.S. Air Force (USAF) maintain UR records for as long as the land is under their jurisdiction. These URs are documented on a UR form and map and filed in the management and operating (M&O) contractor's GIS, the FFACO database, the NNSA/NFO CAU/CAS files, and the USAF GIS files.

Institutional controls, within the UR boundaries, are required to prevent the use of and exposure to potentially contaminated groundwater for purposes other than environmental investigations. These restrictions protect the public, workers, and environment while maintaining the ability to conduct environmental investigations to evaluate the conceptual and numerical models of flow and transport. Because the UR boundaries are within the NNSS and the Nevada Test and Training Range (NTTR) boundaries, and because the groundwater is several hundred meters below the ground surface, URs will be administrative and not require onsite postings or physical barriers other than those already in place for the Radioactive Waste Management Complex (RWMC), NNSS, and NTTR. The nearest existing UR (FFACO) is associated with the Area 5 Retired Mixed Waste Pits at the RWMC.

The following restrictions apply to activities conducted within the UR boundaries:

1. **Land-use and real property controls, notifications, and restrictions:** All subsurface activities-including drilling, pumping, and testing of wells-shall be communicated to NNSA/NFO UGTA Federal Activity Lead before field activities begin. These controls are administered through NFO orders establishing requirements for use of and operations on the NNSS. The current order, NFO Order 410.X1, describes the screening and siting process and REOP processes (NNSA/NSO, 2013 and 2009a).
2. **Groundwater control:** Groundwater used for human consumption, irrigating crops, and any industrial use (such as dust control) must be preceded by laboratory analysis for contaminants of concern (COCs), and must meet SDWA standards (CFR, 2015b). In addition, effects of pumping on contaminant migration will be evaluated to verify UR boundaries are protective.

These controls are monitored through a series of databases previously described as well as the screening and siting and REOP processes (NNSA/NSO, 2013 and 2009a).

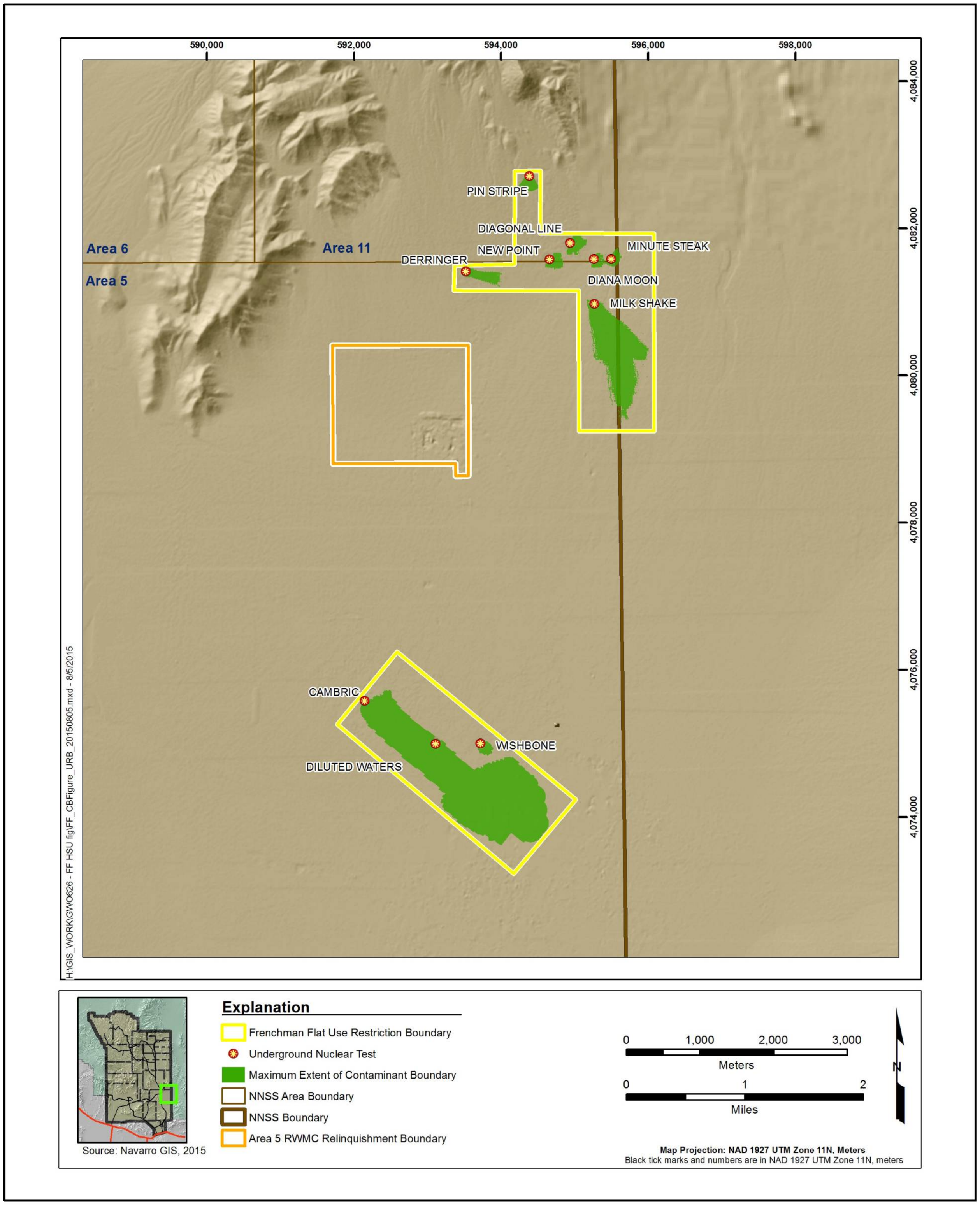

Figure 3-2
Frenchman Flat CAU 98 Groundwater UR Boundaries

3.3 Regulatory Boundary

The regulatory boundary objective for the Frenchman Flat CAU is to protect receptors downgradient of the Rock Valley fault system from radionuclide contamination. Although contaminants resulting from underground nuclear testing are not forecasted to migrate out of the basin within the next 1,000 years, the Rock Valley fault system is the expected groundwater pathway out of the Frenchman Flat basin. The negotiated regulatory boundary is shown in Figure 3-3. If radionuclides reach this boundary, NNSA/NFO will be required to submit a plan to NDEP, for approval, to meet the specific CAU regulatory boundary objectives.

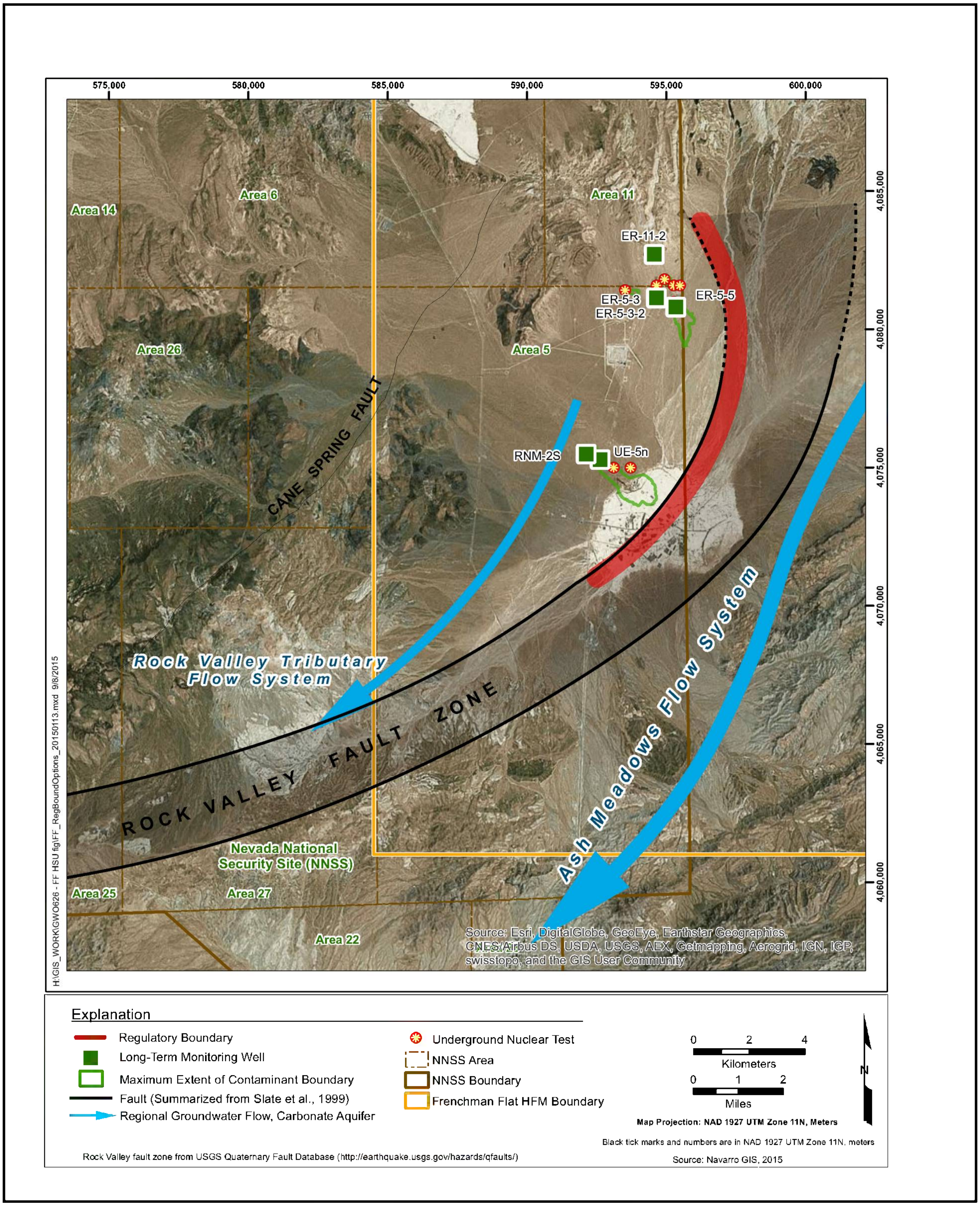

Figure 3-3
Frenchman Flat CAU 98 Groundwater Regulatory Boundary

Note: The regulatory boundary is established at the Alluvial/Volcanic-Rock Valley fault interface as conceptualized on this figure.

4.0 Corrective Action Implementation

Corrective action implementation includes long-term monitoring and institutional controls.

4.1 Long-Term Monitoring

The objective of long-term monitoring is to provide groundwater chemistry and water-level data to evaluate consistency with the groundwater flow and contaminant transport conceptual and numerical model, and with the UR boundaries to ensure the closure strategy remains protective of human health and the environment.

4.1.1 Groundwater Sampling and Analysis

Six wells were identified to monitor the groundwater for contaminants associated with past underground testing; five wells are completed in the shallow alluvial and volcanic aquifers, and one well is completed in the LCA. Table 4-1 lists the long-term monitoring wells, their locations, location categories, HSUs they monitor, and sample collection method. The monitoring wells are categorized as described in the NNSS Integrated Groundwater Sampling Plan (NNSA/NFO, 2014). The categories applicable for this CR are "Characterization," "Source/Plume," and "Inactive" wells. Characterization wells will be recategorized once a baseline is established (a minimum of three sample sets are acquired). The definitions of these categories are presented in Table 4-2. The category also determines the analytes for each location.

Table 4-1 contains the following information:

- **Borehole Index No.** is a unique number assigned to each well.
- **UGTA Well Name** identifies the well location. Wells installed under the Environmental Restoration program begin with "ER." The first number designates the NNSS area; (Frenchman Flat encompasses Areas 5 and 11). The second number is assigned chronologically as wells are installed.
- **Sample Location ID** identifies the well completion zone or interval, and whether the sample is collected from the main completion or a piezometer. To uniquely identify each of the multiple completion zones at a single well location, a labeling convention has been adapted. The convention is "Well Name" followed by "p" (if sampled from the piezometer) or "m"

Table 4-1
Frenchman Flat Long-Term Monitoring Well Locations by Category

Borehole Index No.	UGTA Well Name	Sample Location ID	Latitude (NAD 27)	Longitude (NAD 27)	HSU	Effective Open Interval (ft)[a]		Sample Method[b]
						Top	Bottom	
Characterization Wells								
5149	ER-5-3	ER-5-3_p2	36.873091	-115.937985	BLFA/OAA	WT	1,080	Bailer
5150	ER-5-3-2	ER-5-3-2_m1	36.873115	-115.938328	LCA	4,674	5,683	ES Pump
9713	ER-5-5	ER-5-5_m1	36.870096	-115.930288	BLFA/OAA	WT	1,088	ES Pump
Source/Plume Wells								
1922	RNM-2S	RNM-2S_m1	36.822561	-115.966916	AA	WT	1,156	ES Pump
1919	UE-5n	UE-5n_m1	36.820720	-115.961447	AA	WT	1,437	ES Pump
Inactive Wells								
9714	ER-11-2	ER-11-2_m1	36.887314	-115.938667	LTCU	WT	1,311	Bailer

[a]Depths measured below ground surface
[b]If well conditions prohibit using the listed sample method, an alternate method will be proposed to NDEP for approval.

ES = Electric submersible
ft = Foot
WT = Water table

(if sampled from the main completion) then the completion zone number (numbering begins with the deepest zone). For example, Well ER-5-3 has two piezometers outside the main well and two completion zones in the main well. The numbering system assigns a “1” to the deepest completion and a “2” to the next deepest completion. Starting from the bottom of the well, the piezometers would be designated “ER-5-3_p1” and “ER-5-3_p2.” Once again, starting from the bottom of the well, the completion zones in the main well would be designated “ER-5-3_m1” and “ER-5-3_m2.” Figure C-2 (see Appendix C) shows these Sample Location IDs.

- **Latitude** and **Longitude** give the NAD 27 decimal degree coordinates for the well locations.
- **HSU** designation is assigned to each geologic formation to describe its hydrogeologic characteristics.
- **Effective Open Interval** is the vertical portion of the well available to sample. The top depth is either the water table (WT) or the bottom of the cement above the screened interval. The bottom depth is the top of the cement below the screened interval.

Table 4-2
Sample Location Category Definitions and Analytes

Category	Definition	Analytes [a]
Characterization [b]	Used for system characterization, model evaluation, and baseline determination	• Alkalinity, pH, specific conductance • Anions (Br, Cl, F, SO_4) • Total metals (Ag, Al, As, Ba, Ca, Cd, Cr, Fe, K, Li, Mg, Mn, Na, Pb, Se, Si, Sr, U) • Gross alpha and gross beta • Gamma Emitters (^{26}Al, ^{94}Nb, ^{137}Cs, ^{152}Eu, ^{154}Eu, ^{235}U, ^{241}Am, ^{243}Am) • ^{3}H (standard and/or low-level) [c] • ^{14}C, ^{36}Cl, ^{99}Tc, ^{90}Sr, ^{129}I, $^{238/239/240}$Pu
Early Detection [d]	Located downgradient of an underground test or source/plume well, and no COCs detected above standard measurement levels (i.e., ^{3}H <300 pCi/L)	• ^{3}H (low-level)
Source/Plume	Located within the plume from an underground nuclear test (i.e., test-related contamination present), and COCs detected above standard measurement levels (i.e.,^{3}H >300 pCi/L)	• ^{3}H (standard), ^{14}C, ^{36}Cl, ^{99}Tc, ^{129}I
Inactive	Not currently sampled routinely, but available for sampling if conditions warrant	• ^{3}H (low-level)

[a] Required analyses performed by a commercial lab certified by NDEP. See Table 4-3 for more information. The required analyte suite for characterization samples collected using a bailer is limited to alkalinity, anions, total metals, and ^{3}H.
[b] Characterization locations will transition to another type when a sufficient baseline (a minimum of three samples) is established to support categorization.
[c] Standard ^{3}H analytical methods achieve a minimum detection limit of approximately 300 pCi/L; low-level ^{3}H analytical methods achieve detection limits as low as 1 pCi/L.
[d] The Early Detection area is defined as the area directly downgradient of an underground nuclear test where COCs have not been detected above levels detectable using standard analytical methods.

Ag = Silver
Al = Aluminum
Am = Americium
As = Arsenic
Ba = Barium
Br = Bromide
C = Carbon
Ca = Calcium
Cd = Cadmium
Cl = Chlorine
Cr = Chromium
Cs = Cesium
Eu = Europium
F = Fluorine
Fe = Iron
^{3}H = Tritium
I = Iodine
K = Potassium
Li = Lithium
Mg = Magnesium
Mn = Manganese
Na = Sodium
Nb = Niobium
Pb = Lead
Pu = Plutonium
Se = Selenium
Si = Silicon
SO_4 = Sulfate
Sr = Strontium
Tc = Technetium
U = Uranium

- **Sample Method.** There are three methods for collecting samples:
  - *Electric submersible pumps,* which have been the standard for the UGTA Activity for sampling. The ES Pump cannot be used to sample small-diameter wells (e.g., ER-11-2 and ER-5-3 piezometers).
  - *Pump jacks,* which are rod pumps operated using a lift jack. Pump jacks can be used for wells too small in diameter to allow for the placement of submersible pumps, but preclude obtaining water levels once installed. Because a water-level measurement can be made from ER-5-3 main, the pump jack is the method of choice for sampling ER-5-3 upper piezometer.
  - *Bailers,* which are used to collect depth-discrete samples and can be used to collect samples from small diameter wells. Bailers are not used to purge wells. They do not limit the ability to measure water levels and therefore are the method of choice for sampling Well ER-11-2.

Appendix C presents well construction diagrams that include measured water levels; and the hydrostratigraphic, lithologic, and stratigraphic units intercepted by the well and sampled by each screened interval. Chapman et al. (2015) provides a Frenchman Flat well sampling handbook.

4.1.1.1 Long-Term Monitoring Wells

The monitoring wells are divided between the Northern (4) and Central (2) testing area (Figure 4-1). The Northern Testing Area encompasses the northern part of Frenchman Flat to the southeast of the Massachusetts Mountains. Seven underground tests were conducted in this area. The Central Testing Area is northwest of Frenchman Lake. Three underground tests were conducted in this area.

Northern Test Area

Four wells are in the Northern Testing Area, where the majority of the testing at Frenchman Flat was conducted (Figure 4-1). Wells ER-5-3 and ER-5-3-2 are collocated on the same well pad, and thus appear as one location on Figure 4-1. Well ER-11-2 is completed in a TCU; Wells ER-5-3 and ER-5-5 are completed in the volcanic (basalt lava flow) and alluvial aquifers; and Well ER-5-3-2 is completed in the LCA.

Well ER-11-2 is located to the east of the PIN STRIPE underground test and was originally thought to be located along the flow path for contaminant migration to the east. However, faulting to the east of the PIN STRIPE test has displaced the TSA upward into the vadose zone, eliminating the potential for

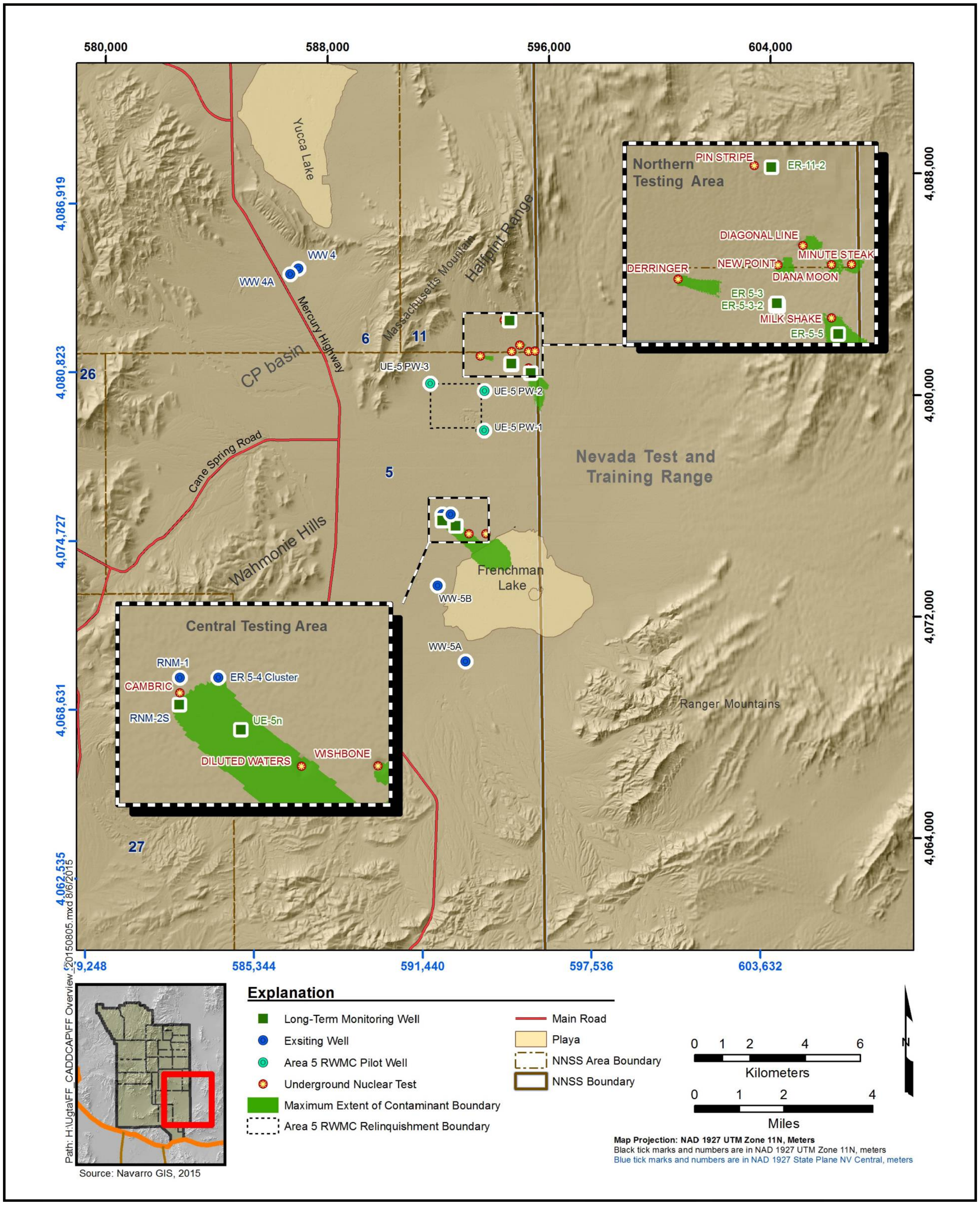

Figure 4-1
Frenchman Flat Long-Term Monitoring Network

it to act as a conduit for eastward migration. While contamination at Well ER-11-2 is not expected, it provides a monitoring point between the test location and the NNSS site boundary. As expected, no radionuclides from underground nuclear testing have been detected at this well (N-I, 2014). This well is currently classified as an inactive well according to the Sampling Plan (NNSA/NFO, 2014) and will only be sampled for low-level tritium because of the low water production from the sampled confining unit.

Well ER-5-3 is located northwest of the MILK SHAKE test, southeast of the DERRINGER test, and south of the NEW POINT test, as shown in Figure 4-1. The piezometer nearest the water table (ER-5-3_p2) will be used as a long-term monitoring point. This piezometer is completed in the alluvium of the older altered alluvial aquifer (OAA). ER-5-3 shallow piezometer is a water table monitoring point nearest to five underground tests, providing an early detection location. Because previous UGTA Activity sampling was limited to the main completion, the shallow piezometer has not yet been sampled. Because this piezometer has not yet been sampled, it is categorized as a characterization well.

Well ER-5-3-2 is one of the wells in the Well ER-5-3 Cluster (Figure 4-1). This well is completed below the volcanics, in the LCA, and will monitor the carbonate aquifer to detect vertical migration of contaminants from upgradient tests. Well ER-5-3-2 was last sampled in 2001 for a large suite of parameters including those associated with characterization wells in Table 4-2. No radionuclides from underground nuclear testing were detected.

Well ER-5-5 is located within the CB for MILK SHAKE and will be recategorized as an early detection location once a baseline is established as required for characterization wells. Tritium was reported as 1.1 pCi/L in groundwater of Well ER-5-5, and no other radionuclides from underground nuclear testing were detected; background levels were detected using the highly sensitive analytical methodology at Lawrence Livermore National Laboratory (N-I, 2014).

Central Test Area

Wells RNM-2S and UE-5n, completed in the alluvial aquifer, are located south and southeast of the CAMBRIC test (Figure 4-1). The CAMBRIC test was conducted in the alluvial aquifer below the water table. Groundwater from Well RNM-2S was pumped for 16 years and discharged into an unlined ditch to transport the water to Frenchman Flat Lake. Well UE-5n is located downgradient of the test and is completed in the alluvial aquifer. Well UE-5n has been monitoring water-level increases from ditch infiltration and breakthrough of tritium from the CAMBRIC radionuclide migration experiment for the last 20 years, and will be used to monitor the decay of tritium.

4.1.1.2 Groundwater Sampling

Groundwater samples from the six long-term monitoring wells will be collected once a year for five consecutive years to establish the initial post-closure conditions. Groundwater sampling will be conducted in compliance with the *Underground Test Area Activity Quality Assurance Plan* (QAP) (NNSA/NFO, 2015) and the associated required procedures and processes.

The Nevada National Security Site Integrated Groundwater Sampling Plan, Nevada National Security Site, Nevada (NNSA/NFO, 2014) will be used as a guidance document for identifying well types and the associated analytes, but any inconsistencies between the two documents will be resolved in favor of the CR.

NNSA/NFO will evaluate the optimal purge volume for each well to ensure representative samples are being collected while minimizing the potential for inducing additional contaminant transport due to pumping. Water quality parameters (pH, turbidity, specific conductivity, and temperature) will be measured according to established protocols during purging and sampling.

4.1.1.3 Sampling and Laboratory Analysis

The analytical suites for each well type (i.e. characterization, early detection, and source/plume) are defined in the NNSS Integrated Groundwater Sampling Plan (NNSA/NFO, 2014a). The analyses required for each well category are presented in Table 4-2, and the required analytical methods are presented in Table 4-3. Table 4-3 also identifies the required sample containers, preservatives, holding times, and detection limits.

An agreement between NNSA/NFO and NDEP regarding the use of certified laboratories is documented in Boehlecke (2014) and Murphy (2014). Required analyses (Table 4-2) will be performed by a commercial laboratory that is certified through the NDEP Bureau of Safe Drinking Water and meets National Environmental Laboratory Accreditation Program or equivalent

Table 4-3
Analytes, Analytical Procedures, and Sample Collection Information for Required Analyses
(Page 1 of 2)

Analyte	Preferred Analytical Method [a]	Title	Detection Limit	Number of Containers	Container Type	Preservative	Hold Time	Filtration
General Chemistry								
Alkalinity	EPA 310.2 [b]	Alkalinity (Colorimetric, Automated, Methyl Orange)	20 mg/L as $CaCO_3$	1	1-L polyethylene	Cool/Ice to 6 °C	14 days	Unfiltered
pH	EPA 150.1 [b]	pH (Electrometric)	0.01				24 hours	
Specific Conductance	EPA 120.1 [b]	Conductance (Specific Conductance, μmhos at 25 °C)	1.0 μmhos/cm				28 days	
Br, Cl, F, SO_4	EPA 300.0 [c]	Determination of Inorganic Anions in Drinking Water by Ion Chromatography	0.25–1 mg/L	1	1-L polyethylene		28 days	Filtered (0.45-μm)
Metals								
Ag, Al, As, Ba, Ca, Cd, Cr, Fe, K, Li, Mg, Mn, Na, Pb, Se, Si, Sr	EPA 6010 [d]	Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES)	0.001–1.0 mg/L	1	1-L polyethylene	HNO_3 to pH<2	6 months	Unfiltered
U	EPA 6020 [d]	Inductively Coupled Plasma-Mass Spectrometry (ICP-MS)	0.0001 mg/L					
Radioisotopes								
Gamma Emitters (^{26}Al, ^{94}Nb, ^{137}Cs, ^{152}Eu, ^{154}Eu, ^{235}U, ^{241}Am, ^{243}Am)	EPA 901.1 [e]	Gamma-Emitting Radionuclides in Drinking Water	10 pCi/L ^{137}Cs	1	1-L polyethylene	HNO_3 to pH<2	180 days	Unfiltered
Gross Alpha and Gross Beta	EPA 900.0 [e]	Gross Alpha/Beta Radioactivity in Drinking Water	3 pCi/L (Gross Alpha)	1	1-L polyethylene			
^{3}H	EPA 906.0 [e]	Tritium (^{3}H) in Drinking Water	300 pCi/L	1	250-mL amber glass	None		
^{3}H (Low Level)	HASL 300 3H-01-RC (prep)[f] EPA 906.0 [e] (analysis)	Tritium Assay in Water Samples using Electrolytic Enrichment; Tritium (^{3}H) in Drinking Water	3 pCi/L	3	1-L polyethylene			

Table 4-3
Analytes, Analytical Procedures, and Sample Collection Information for Required Analyses
(Page 2 of 2)

Analyte	Preferred Analytical Method [a]	Title	Detection Limit	Number of Containers	Container Type	Preservative	Hold Time	Filtration
^{90}Sr	EPA 905.0 [e]	Strontium-90 (^{90}Sr) in Water	1 pCi/L	1	1-L polyethylene	HNO_3 to pH<2	180 days (holding time is required by SOW but not analytical method)	Unfiltered
^{14}C	EERF C-01 [g] or equivalent	Radiochemical Determination of Carbon-14 (^{14}C) in Aqueous Samples	500 pCi/L	1	1-L (100-mL) amber glass	None		
^{36}Cl	Lab specific	Chlorine-36 (^{36}Cl)	4 pCi/L	2	1-L amber glass			
^{99}Tc	HASL 300 TC-01-RC [f] or equivalent	Technetium-99 (^{99}Tc) in Water	10 pCi/L	1	1-L polyethylene	HNO_3 to pH<2		
^{129}I	EPA 902.0 [e]	Radioactive Iodine in Drinking Water	<1 pCi/L	2	1-L amber glass	None		
$^{238/239/240}Pu$	HASL 300 Pu-10-RC [f] or ASTM D3865-09 [h] or equivalent	Isotopic Plutonium (Pu)	0.1 pCi/L	1	1-L polyethylene	HNO_3 to pH<2		

[a] Equivalent methods promulgated in 40 CFR 141 (CFR, 2015b) are also allowed, additional table entries (other than Analyte) are recommendations, not requirements.
[b] EPA, 1983
[c] EPA, 1993
[d] EPA, 2015
[e] EPA, 1980
[f] DOE, 1997
[g] EPA, 1984
[h] ASTM, 2009

ASTM = ASTM International
°C = Degrees Celsius
$CaCO_3$ = Calcium carbonate
EERF = Eastern Environmental Radiation Facility
HASL = Health and Safety Laboratory
HNO_3 = Nitric acid
L = Liter
mg/L = Milligrams per liter
mL = Milliliter
SOW = Statement of work
µm = Micrometer
µmhos = Micromhos
µmhos/cm = Micromhos per centimeter

requirements for those analytes not currently NDEP certified. Commercial laboratories must participate in the U.S. Department of Energy Consolidated Audit Program (DOECAP) or equivalent.

4.1.2 Water-Level Measurements

The objective of measuring water levels is to verify groundwater conditions have not changed—in particular, due to pumping, seismic events, or climate change. Water-level data will be collected in and around the Frenchman Flat CAU to support long-term monitoring activities for the UGTA Activity. For the first five years, water levels will be measured in 16 wells on a quarterly basis. Table 4-4 lists each of the wells to be monitored, the U.S. Geological Survey (USGS) site ID, latitude and longitude, and the primary aquifer type monitored; and also provides an explanation of the purpose for which monitoring will be conducted. Wells within this network are located within and adjacent to the Frenchman Flat basin (Figure 4-2).

Quarterly water-level measurements will be collected within a narrow timeframe and will be coordinated with the NNSS M&O contractor's quarterly monitoring of the Area 5 RWMC pilot wells (UE-5 PW-1, UE-5 PW-2, and UE-5 PW-3). For data comparison, the responsible NNSS contractor will collect water-level data during the annual post-closure sampling at ER-5-3 piezometer, ER-5-3-2, ER-5-5, ER-11-2, RNM-2S, and UE-5n. All water-level data collected by the USGS and other agencies will be reviewed and uploaded to the USGS National Water Information System (USGS, 2015) and USGS/DOE web page (USGS and DOE, 2015). Well inspections will be performed concurrently with water-level measurements. After five years of long-term monitoring, the measurement network and frequency will be evaluated.

4.1.3 Monitoring Network Maintenance and Inspections

The monitoring network wells are designed to have a service life of at least 50 years; however, they will be inspected during water-level measurements, and a more detailed inspection will be performed annually before sampling. The monitoring network will be maintained to correct deficiencies such as erosion around well heads and to ensure well security. Water-level monitoring wells will be inspected for damage that would impair use of the well for its stated long-term monitoring function. In addition, the wells, sumps, discharge areas, and areas surrounding the wells will be inspected for damage before groundwater sampling begins.

Table 4-4
Frenchman Flat CAU Post-Closure Water-Level Network
(Page 1 of 2)

USGS Site ID	USGS Well Name	Latitude (NAD 27)	Longitude (NAD 27)	Primary Unit	Well Purpose
365223115561702	ER-5-3 deep piezometer	36.873091	-115.937985	Alluvium/ Volcanic	Monitors deep alluvial-volcanic system in northern testing area; provides data on possible impacts from southern Frenchman Flat pumping.
365223115561701	ER-5-3 main (upper zone)	36.873091	-115.937985	Alluvium	Monitors alluvial system in northern testing area; provides data on possible impacts from southern Frenchman Flat pumping and local gradients.
365223115561801	ER-5-3-2	36.873115	-115.938328	Carbonate	Monitors regional carbonate in northern testing area; provides data on impacts from any carbonate pumping and regional hydraulic gradients.
365223115561704	ER-5-3-3	36.873339	-115.938130	Alluvium	Monitors alluvial system in northern testing area; provides data on possible impacts from southern Frenchman Flat pumping and local gradients.
364928115574801	ER-5-4 main	36.824271	-115.963453	Alluvium/ Volcanic	Monitors alluvial-volcanic system in central testing area; provides data on impacts from southern Frenchman Flat pumping and local gradients near CAMBRIC.
364928115574802	ER-5-4 piezometer	36.824271	-115.963453	Alluvium	Monitors alluvial system in central testing area; provides data on impacts from southern Frenchman Flat pumping and local gradients near CAMBRIC.
364927115574801	ER-5-4-2	36.823996	-115.963457	Volcanic	Monitors deep volcanic confining unit in central testing area; provides data confirming an upward gradient and no vertical pathway for contaminants to enter LCA.
365212115554901	ER-5-5	36.870096	-115.930288	Alluvium	Monitors alluvial system in northern testing area; provides data on possible impacts from southern Frenchman Flat pumping and local gradients near MILKSHAKE.
364928115580101	RNM-1	36.824488	-115.966819	Alluvium	Monitors alluvial system in central testing area; provides data on impacts from southern Frenchman Flat pumping and local gradients near CAMBRIC.
364922115580101	RNM-2S	36.822561	-115.966916	Alluvium	Monitors alluvial system in central testing area; provides data on impacts from southern Frenchman Flat pumping and local gradients near CAMBRIC.

Table 4-4
Frenchman Flat CAU Post-Closure Water-Level Network
(Page 2 of 2)

USGS Site ID	USGS Well Name	Latitude (NAD 27)	Longitude (NAD 27)	Primary Unit	Well Purpose
364915115574101	UE-5n	36.820720	-115.961447	Alluvium	Monitors alluvial system in central testing area; provides data on impacts from southern Frenchman Flat pumping and local gradients near CAMBRIC.
364635115572901	WW-5A	36.776477	-115.958100	Alluvium	Monitors impacts from pumping of alluvial aquifer in southern Frenchman Flat.
364805115580801	WW-5B	36.801257	-115.968977	Alluvium	Monitors impacts from pumping of alluvial aquifer in southern Frenchman Flat.
365418116012601	WW-4	36.904952	-116.024001	Volcanic	Monitors impacts from pumping of volcanic aquifer in CP basin, directly south of Yucca Flat and Northeast of Frenchman Flat.
365412116013901	WW-4A	36.903195	-116.027433	Volcanic	Monitors impacts from pumping of volcanic aquifer in CP basin, directly south of Yucca Flat and Northeast of Frenchman Flat.
365314115561901	ER-11-2	36.887315	-115.938664	Volcanic	Monitors volcanic confining unit in northern testing area; provides data on possible impacts from southern Frenchman Flat pumping and local gradients near PIN STRIPE.

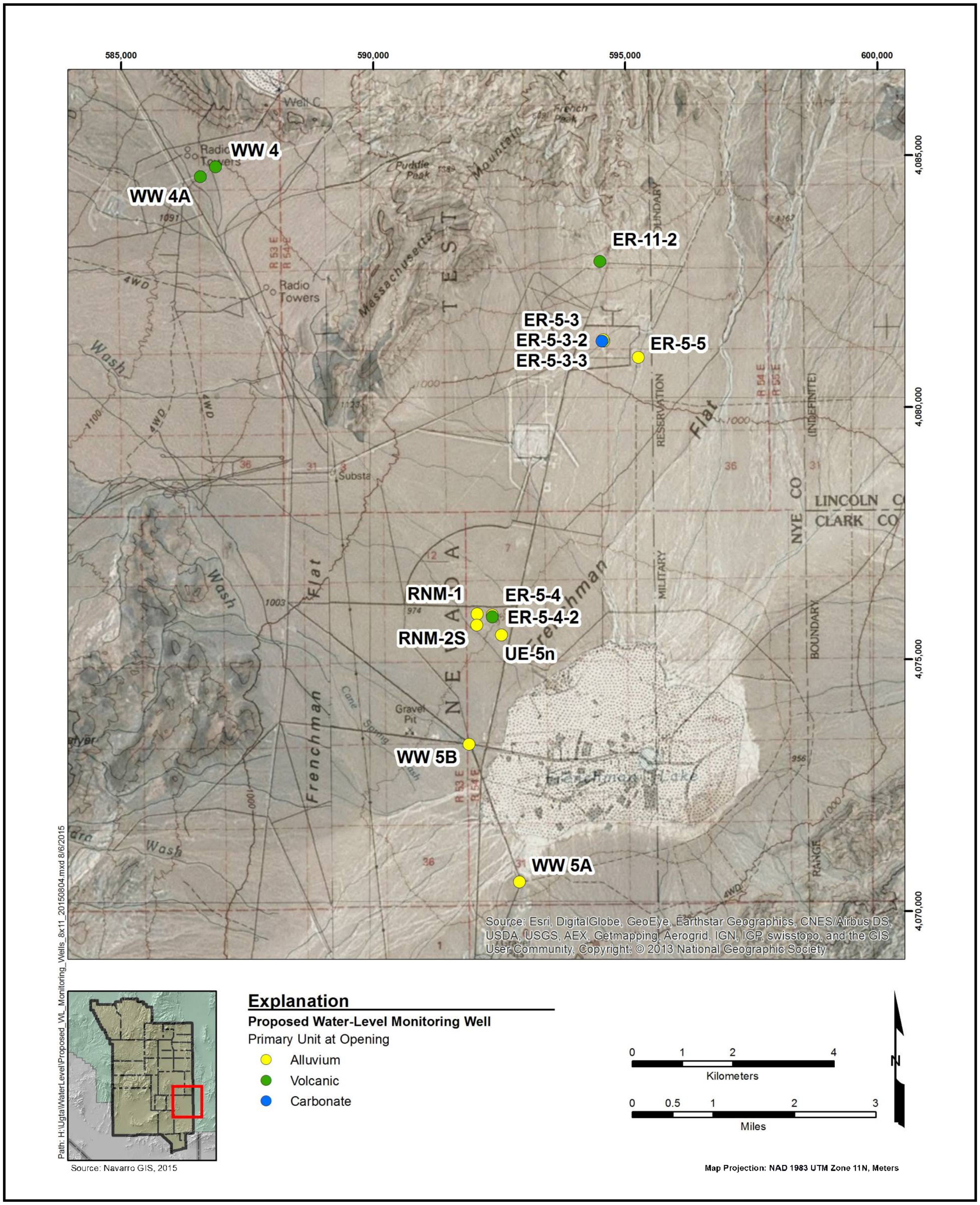

Figure 4-2
Frenchman Flat Long-Term Water-Level Monitoring Network

The following items will be checked when measuring water levels:

- Wells and piezometers are locked.
- Wells are properly marked.
- Well pad is clear and in good condition.
- Any damage to the well, piezometers, and well pad is noted.
- Survey point is clearly marked and undamaged.
- Pad around well is undamaged (e.g., no erosion or potential for standing water).

Pre-sampling long-term monitoring well annual inspections will include the items listed above in addition to the following:

- Is the infiltration area still viable?
- Have any new roads or facilities been constructed?
- Have there been any changes to the drainage pattern or area?

Any condition that affects the serviceability of a well will be noted in the field logbook and reported for corrective action.

4.1.4 Use Restriction Verifications

UR verifications will be performed annually and will document the following three items:

- Have there been encroachments due to drilling or new uses for the groundwater within and adjacent to the UR boundary that could conceivably impact the CB or be a potential threat to human health or the environment within one year of the inspection?

- Are there any changes to or new Real Estate/Operations Permits (REOPs) that affect the UR?

- Do monitoring data suggest that URs should be modified? (UR boundaries are based on the CBs.)

Verification of URs will be presented in the annual long-term monitoring report.

4.1.5 Corrective Action Thresholds/Triggers

No thresholds/triggers will be established during the first five years of monitoring. Results from the first five years of monitoring will be used by NNSA/NFO and NDEP to establish corrective action thresholds/triggers, which will be used to assess whether the corrective action decision specified in the CR continues to be adequate for protecting the health and safety of the public. The initial five years of data will provide a baseline to evaluate future data and make recommendations regarding the monitoring strategy. The evaluation will consider the method and frequency of groundwater sampling, laboratory analyses, frequency of water level measurements, and number of wells requiring monitoring.

4.1.6 Waste Disposition

This section discusses fluid and waste management during sampling activities at Wells ER-5-3, ER-5-3-2, ER-5-5, ER-11-2, RNM-2S, and UE-5n. The fluid and waste management analytical results will be reported in the long-term monitoring report.

4.1.6.1 Fluid Management Plan

Fluids produced during groundwater purging activities at the post-closure monitor wells will be managed in accordance with the *Underground Test Area Project Waste Management Plan* with *Attachment 1, Fluid Management Plan for the Underground Test Area Project* (NNSA/NSO, 2009b); t and with associated NDEP fluid management strategy letters and field instructions. Based on previous site knowledge, NDEP approved the management of discharged fluids from Wells ER-5-5, ER-11-2, and UE-5n using the far-field fluid management strategy as described in the Fluid Management Plan (FMP) (NNSA/NSO, 2009b). Discharge from Wells ER-5-3 and ER-5-3-2 was approved by NDEP under a waiver in 2001. Fluid Management Strategy letters proposing discharge from these wells under a far-field fluid management strategy will be prepared and submitted to NDEP before groundwater sampling is initiated at the post-closure monitoring wells.

Under the far-field fluid management strategy, fluids generated during groundwater sampling activities may be discharged to either the ground surface, an unlined infiltration basin, or an aboveground storage vessel (a tank). The far-field fluid management strategy requires the daily collection of grab samples for tritium analysis and a discharge fluid sample from the sump used to capture the discharge upon the completion of groundwater sampling. The results of tritium analyses govern the fluid containment requirements and reporting requirements to NDEP. More specifically, if tritium activity exceeds 200,000 pCi/L, appropriate NDEP representatives are notified as a courtesy, and operations are continued under the far-field strategy. If tritium activity exceeds 400,000 pCi/L, notification of NDEP representatives is required, and operations are transitioned to the near-field fluid management strategy.

4.1.6.2 Fluid Containment and Disposition

Sumps, constructed to receive the fluids produced, are present at Wells ER-5-3, ER-5-3-2, ER-5-5, and ER-11-2. Fluids produced from these wells will be discharged to the sumps. No sumps are present at Well UE-5n. Fluids produced from this well will be directed to a surface infiltration area approximately 100 ft south of the wellhead. Fluid volumes produced from the wells will be monitored using calibrated flowmeters and reported in the long-term monitoring report.

4.1.6.3 Tritium Monitoring

In accordance with Section 4.2, "Other Well-Site Activities," of Attachment 1, the FMP (NNSA/NSO, 2009b), and the approved Fluid Management Strategy letters (NNSA/NSO, 2012), one sample per day for tritium analysis will be collected from the wellhead sampling ports during the sampling operations. Samples will be stored on site and delivered daily to Radiological Services (Building 23-310) for tritium analysis using a liquid scintillation counter. Samples will be processed and analyzed in accordance with standard operating procedures and processes compliant with the UGTA QAP (NNSA/NFO, 2015). The results of these analyses will be reported in the long-term monitoring report.

4.1.6.4 Fluid Management Plan Samples

FMP samples will be collected and analyzed as described in the Fluid Management Plan (FMP) (NNSA/NSO, 2009b).

4.1.6.5 Waste Management

Waste materials generated during groundwater sampling activities have historically consisted of sanitary and hydrocarbon waste. The waste will be managed in accordance with the UGTA Waste Management Plan (NNSA/NSO, 2009b), the applicable field instructions, and the FAWP governing the work. Laboratory and onsite equipment decontamination rinsates will be disposed of in sumps or the discharge area (Well UE-5n). Hydrocarbon wastes will be stored in drums at the well site until completion of site operations. The waste will then be transported to temporary storage until disposal occurs.

4.2 Institutional Controls

Institutional controls will be established to limit access to areas of potentially contaminated groundwater. Future use of any land related to this CAU is restricted from any activity that may alter or modify the institutional controls as approved by NDEP, unless appropriate concurrence is obtained in advance. Institutional controls can either be active (which include controlling site access, performing inspections, and patrolling the area) or passive (such as land ownership or use requirements; markers; and public records, archives, or other methods of preserving knowledge of a site and its hazards). These controls will be monitored on an annual basis to verify performance.

1. **Government Ownership.** The NNSS and NTTR are federally controlled, secure sites. Identification and restriction records are present in multiple locations under different agencies. Once characterization and remediation work is complete, the remaining monitoring and long-term management activities revert to the respective organizations responsible for ongoing missions (currently DoD for the NTTR and NNSA/NFO for the NNSS). There are no plans to relinquish any land currently under federal responsibility (DOE, 2006).

2. **Access Control.** The NNSS encompasses approximately 1,360 square miles of land, and is surrounded by the NTTR and unpopulated land controlled by the BLM. Active and passive institutional controls have been in place at the NTS/NNSS and at NTTR for more than 50 years. Although the NNSS perimeter is not entirely fenced, it is posted as a restricted area and is actively patrolled; access is prohibited except at designated entrances. Access required for exposure to a member of the public or inadvertent human intrusion is prohibited by NSO Order NFO Order 410.X1, *Nevada National Security Site and North Las Vegas Facilities General Use and Operation Requirements* (NNSA/NFO, 2013). Beyond the perimeter, the NTTR provides a buffer zone of limited access. Barricades and security stations control the few roads that access NNSS boundaries. Inactive facilities and areas that are known to be radiologically contaminated and require access control are fenced and posted with warning signs in accordance with the Occupational Radiation Protection standards (CFR, 2015a).

3. **Federal Oversight.** The NNSA/NFO provides federal management and oversight for all activities conducted at the NNSS. Institutional controls and URs are considered in accordance with DOE P 454.1-1, *Use of Institutional Controls* (DOE, 2005), during the evaluation, siting, and control of projects planned for the NNSS. Projects must justify a need to be within the boundaries of the NNSS. Screening and siting of new projects are controlled by NFO Order 410.X1, *Nevada National Security Site and North Las Vegas Facilities General Use and Operation Requirements* (NNSA/NFO, 2013). In addition, all activities performed on the NNSS require a REOP (NNSA/NSO, 2009a). The REOP process ensures that work

performed under NNSA/NFO purview (1) is well defined and has well-defined geographical boundaries; (2) has identified the hazards and has established and implemented controls to mitigate those hazards; (3) is protective of the environment (e.g., includes archaeological survey requirements, land-disturbance minimization, and waste management); (4) is properly authorized; and (5) is managed effectively. Pumping of groundwater will be evaluated during the planning process to determine possible impact to contaminant migrations and to verify that UR boundaries continue to be effective.The considerable depth to groundwater throughout most areas of the NNSS and vicinity effectively restricts surface exposure to contaminated groundwater to onsite environmental workers via deep drill holes and water wells. A list of the current REOPs within the UR boundaries is provided in Appendix E.

4. **Water Use Applications.** The Nevada Division of Water Resources (NDWR) is responsible for managing water use through the appropriation and reallocation of the public waters. Thus among other actions, NDWR is responsible for quantifying existing water rights, monitoring water use, monitoring water resource data and records, and proving technical assistance to the public and governmental agencies. NDWR will be consulted annually to verify that no new permit applications of water use have been granted within the Frenchman Flat basin described on the NDWR website (NDWR, 2015). If permits have been issued, an evaluation will be performed to verify that UR boundaries are protective.

4.3 Periodic Evaluation

An annual evaluation will be performed during the first five years. The first five years of long-term monitoring data will be used to determine the optimum monitoring program for subsequent years; and to verify that the selected corrective action remains viable and protective of human health and the environment. The evaluation will include the following:

- A review of the monitoring network inspections to verify well functionality and effectiveness.
- A determination if water-level data are consistent with the conceptual model.
- A determination if the radiochemistry results are consistent with expected results (i.e., no revisions are required to the CBs, UR boundaries, and regulatory boundaries).
- A determination if current land URs, processes and procedures are effective and protective of human health and the environment.
- A determination if any new land use applications will threaten the effectiveness of the closure strategy.

After the first five years, NNSA/NFO and NDEP will evaluate the data and determine the frequency of inspections and monitoring events in the future. In the event that data indicate the CBs, URs, or regulatory boundaries are no longer effective and/or protective of human health and the environment, discussions will be held with NNSA/NFO and NDEP to develop a path forward. In addition, periodic evaluations will determine whether new technologies are available that may warrant investigation of a revised closure strategy.

5.0 Corrective Action Reporting

For the first five years, annual monitoring reports will present the measurements, inspections, analytical results, and data evaluations for the previous fiscal year. Each report will be submitted to NDEP by the end of the second quarter of each federal fiscal year. The monitoring results will be evaluated with respect to the conceptual model of flow and transport within the Frenchman Flat basin, to the CBs, and any potential impact to the regulatory boundary objectives. The annual report will describe sampling and water-level measurement results, data evaluation, maintenance, and inspections of the wells and the institutional controls. After the data are evaluated, NNSA/NFO and NDEP will determine whether the closure strategy is still viable and protective of human health and the environment, and whether the requirements of this document are being met. If it is determined that the closure strategy is not viable and/or protective, further evaluation will be performed and a mutually agreed-upon path forward will be developed. If it is determined that the closure strategy is viable and/or protective of human health and the environment, NNSA/NFO and NDEP will determine whether required sampling (e.g., frequencies, sampling methodologies, and/or analytes), water-level measurement, or reporting requirements for future monitoring may be revised. If revision is agreed upon, a CR revision or addendum will be completed.

6.0 Records/Data Management

Records and data will be managed in accordance with the UGTA QAP (NNSA/NFO, 2015). The QAP requires compliance with DOE Orders 243.1B, *Records Management Program* (DOE, 2013); 200.1A, *Information Technology Management* (DOE, 2008); and/or 241.1B, *Scientific and Technical Information Management* (DOE, 2010). A lifecycle approach will be maintained for hard-copy and electronic records that ensures protection and access to records until their disposition.

7.0 Quality Assurance

Work will be performed in according to the UGTA Quality Assurance Plan (NNSA/NFO, 2015) and according to applicable processes and procedures. The inspections and data evaluation will be conducted similar to a management assessment including a performance-based evaluation of compliance with technical and procedural requirements and corrective action effectiveness necessary to prevent defects in data quality. Assessment documentation will verify if work was conducted in accordance with the UGTA QAP requirements.

8.0 Recommendations

Upon approval and implementation of this CR, NNSA/NFO 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.

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Appendix A

Approval Correspondence for Moving to CR

(11 Pages)

Department of Energy
National Nuclear Security Administration
Nevada Field Office
P.O. Box 98518
Las Vegas, NV 89193-8518

SEP 16 2014

Christine Andres, Chief
Bureau of Federal Facilities
Division of Environmental Protection
2030 East Flamingo Road, Suite 230
Las Vegas, NV 89119-0818

STATUS OF ATTACHMENT B EXTERNAL REVIEW COMMENTS FOR CORRECTIVE ACTION UNIT (CAU) 98: FRENCHMAN FLAT, NEVADA NATIONAL SECURITY SITE

In response to NNSA/NSO's November 17, 2010, letter (Appendix A; NNSA/NSO, 2011) requesting NDEP acceptance of the Frenchman Flat flow and transport model (including as Attachment B *External Peer Review Team Report: Comments and Responses by the Underground Test Area Subproject [UGTA] of the Nevada Site Office*), NDEP wrote on November 30, 2010, (Appendix B; NNSA/NSO, 2011) that it accepted the model subject to a condition that "all planned actions in Attachment B of the above-referenced document be identified in the Frenchman Flat Corrective Action Decision Document/Corrective Action Plan. The results of all of these actions must be documented and presented to the NDEP via interim documents, letters, or presentations during the CADD/CAP stage." The attached table shows how the issues and actions from Attachment B have been resolved in the model evaluation report provided to you on August 8, 2014, or with other documentation.

NNSA/NFO believes all the planned actions associated with the issues in Attachment B have been satisfied with the exception of the following items based on discussions with NDEP (the rationale and proposed actions are also given):

1. **Issue Six:** No regional-scale climate models were assessed during the CADD/CAP. This work was not pertinent to evaluating the confidence in the groundwater flow and transport model as sufficient for establishing a monitoring system and institutional controls at this time. NNSA/NFO proposes that by continued execution of the UGTA strategy (FFACO, 1996, as amended) that any such assessment of regional-scale climate change will occur when monitoring indicates a need for this action.

2. **Issue Six:** No sensitivity analysis of the effects of discrete sets of plausible seismic events has been considered in consultation with NDEP during the CADD/CAP. This was not pertinent to evaluating the confidence in the groundwater flow and transport model as sufficient for establishing a monitoring system and institutional controls at this time. NNSA/NFO proposes that by continued execution of the UGTA strategy (FFACO, 1996, as amended) that any such assessment of seismic events will occur when monitoring indicates a need for this action.

3. **Issue Eight:** A refined model of water-level response to pumping near Frenchman Lake playa was not developed. This was because it is not an evaluation task relevant to establishing a monitoring system and institutional controls at this time. Additionally, modeling analysis showed that projecting the current pumping rates from the production wells for the regulatory period does not impact groundwater contamination from the CAMBRIC ditch and, by extension, DILUTED WATERS and WISHBONE. With the refined understanding of the low groundwater flow and transport velocities developed during the model evaluation NNSA/NFO believes that, other than continued water-level surveillance, no further work is necessary on this issue at this time.

NNSA/NFO requests NDEP approval that the actions associated with Attachment B have been sufficiently documented and presented.

References:

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 Underground Test Area Strategy, was last modified June 2014, Revision No. 5.
U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office, 2014.

Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 98: Frenchman Flat Nevada National Security Site, Nevada, DOE/NV--1455, Las Vegas, NV.

Please direct comments and questions to Bill R. Wilborn, of my staff, at (702) 295-3188.

/s/ Signature on file

Robert F. Boehlecke, Manager
Environmental Management Operations

EMO:10804.CD

As stated

cc w/encl. via e-mail:
E. A. Jacobson, NDEP
N-I Central Files

cc w/o encl. via e-mail:
Mark McLane, NDEP
J. T. Fraher, DTRA/CXTS
NSTec Correspondence Control, M/S NLV008
W. R. Wilborn, NFO
FFACO Group, NFO
NFO Read File

Attachment B: Peer Review Issues	Action	Response Documentation
Issue One: Evaluation and use of water-level gradients from the Pilot Wells at the Area 5 Radioactive Waste Management Complex in model calibration.	Update the RWMC pilot well head data, and evaluate during CADD/CAP.	Section 3.5 of the Model Evaluation Report discusses the pilot wells (Table 3-1; Figures 3-2, 3-3, 3-4, and 3-10). Additionally, Section 3.10 shows (Figure 3-23) computed groundwater flow directions using the pilot wells (Figure 3-23).
Issue Two: Re-evaluation of the use of geochemical age-dating data to constrain model calibrations.	Groundwater age information will be interpreted recognizing data uncertainties, but this information will continue to be assessed in CADD/CAP and CR studies.	Section 3.10 of the Model Evaluation Report explicitly documents the assessment of groundwater age and associated uncertainties at the model evaluation wells.
Issue Three: Development of water budgets for the alluvial and upper volcanic aquifer system in Frenchman Flat.	Continuing studies for the CADD/CAP and CR stages will attempt to use parameters and assumptions that are more representative of the expected case including assumptions for inflow terms.	The groundwater velocity computations in Section 3.7 of the Model Evaluation Report use properties from the test and the hydraulic gradients computed from new and existing data. Appendix A uses best available data for all PIN STRIPE conceptual computations. These computations are representative of expected conditions including inflow.
Issue Four: Consideration of modeling approaches in which calculated groundwater flow directions near the water table are not predetermined by model boundary conditions and areas of recharge, all of which are very uncertain.	The core of the problem is the level of confidence in model estimation of flow directions, a question that will be emphasized in the model evaluation of the CADD/CAP stage.	Section 3.5 of the Model Evaluation Report comprehensively evaluated groundwater flow directions using new data since 2006, and also determined that the flow models are consistent with the new groundwater elevation data. Section 3.7 showed that the direction estimated with new data is consistent with that simulated near MILK SHAKE. Considerably more confidence in groundwater flow direction determined by data now exists.
Issue Five: Evaluation of local-scale variations in hydraulic conductivity on the calculation contaminant boundaries.	The potential for local-scale variations in permeability will be considered in evaluations of new data collected during the CADD/CAP stage.	Section 3.7 of the Model Evaluation Report discusses OAA and BLFA heterogeneity.

Issue Six: Evaluation of the effects on non-steady state flow conditions on calculated contaminant boundaries including the effects of long-term declines in water levels, climate change and disruption of the groundwater system by potential earthquake faulting along either of the two major controlling fault zones in the flow system, the Cane Springs and Rock Valley faults.	NNSA/NFO agrees that the potential effects of non-steady state flow should be considered and will implement a water-level monitoring program during model evaluations for the CADD/CAP with continuation into the CR stage.	The quarterly monitoring conducted by the USGS and NSTec satisfies this requirement.
	With respect to climate change, the UGTA subproject will continue to follow the scientific literature on anthropogenic driving forces for climate change particularly for the topic of abrupt climate change which could affect climate assumptions during the next 1,000 years. The UGTA subproject, in consultation with NDEP, will periodically assess progress in development of regional scale models for the arid southwest United States and reassess the need for further studies during the CADD/CAP and CR stages.	NNSA/NFO proposes that by continued execution of the UGTA strategy (FFACO, 1996, as amended) that any such assessment of regional-scale climate change will occur when monitoring indicates a need for this action.
	Sensitivity analysis of the effects of discrete sets of plausible seismic events will be considered in consultation with NDEP during future studies (CADD/CAP or CR stages).	NNSA/NFO proposes that by continued execution of the UGTA strategy (FFACO) (1996, as amended) that any such assessment of seismic events will occur when monitoring indicates a need for this action.
Issue Seven: Consideration of the use of less-complex modeling approaches.	NNSA/NFO will provide information to NDEP on changes in modeling approaches in future briefings, and these changes will be described in CAU-specific model documents submitted for NDEP review. The first descriptions of the refined modeling approaches will be in the CADD/CAP document for Frenchman Flat and in the Phase II modeling for the western and center Pahute Mesa. These descriptions will be developed in consultation and agreement with the NDEP.	Section 3.5 and 3.7, and Appendix A of the Model Evaluation Report illustrate simpler approaches to groundwater velocity, direction, and conservative radionuclide transport.
Issue Eight: Evaluation the large change in water levels in the vicinity of the Frenchman Flat playa and development of a conceptual model to explain these water-level changes.	This issue will be evaluated in two stages. First, the existing data will be assessed during the CADD/CAP stage to ensure the water level measurements and resulting water-level differences are not in error. This will be combined with continued long-term monitoring of water levels for all wells (see response to Issue nine).	Section 3.5 of the Model Evaluation Report fulfills this obligation.

	Second, if the large changes in water levels are verified as part of CADD/CAP water-level monitoring studies, the potential effects of local structure will be evaluated and local models of geologic structure revised, if required.	With the refined understanding of the low groundwater flow and transport velocities developed during the model evaluation NNSA/NFO believes that, other than continued water-level surveillance, no further work is necessary on this issue at this time.
Issue Nine: Development of a long-term groundwater level monitoring program for Frenchman Flat with regular monitoring of water levels at key monitoring wells.	A groundwater level monitoring program for Frenchman Flat is planned to begin with the installation of the first two model evaluation wells. This program will include: 1. Re-surveying of well head elevations, 2. Developing a standardized protocol for measurement of water levels, 3. Resurveying of water levels in all wells in Frenchman Flat during a short interval (days to weeks) to minimize possible effects of barometric pressure, water temperature, and earth tides on water levels, and 4. Routine monitoring of water levels on an established schedule. The details and schedule for this monitoring program will be described in the CADD/CAP document.	With a partial resurvey of the wells and the existing USGS and NSTec water-level programs, this obligation is fulfilled. Documentation of all monitoring wells and the best available reference data are provided in the June 20, 2014, memo and in Section 2.4 of the Model Evaluation Report.

September 17, 2014

Mr. Robert F. Boehlecke
Manager
Environmental Management Operations
National Nuclear Security Administration
Nevada Field Office
P.O. Box 98518
Las Vegas, Nevada 89193-8518

RE: STATUS OF ATTACHMENT B EXTERNAL REVIEW COMMENTS FOR CORRECTIVE ACTION UNIT (CAU) 98: FRENCHMAN FLAT, NEVADA NATIONAL SECURITY SITE

Dear Mr. Boehlecke:

The Nevada Division of Environmental Protection, Bureau of Federal Facilities staff (NDEP) has received and reviewed the above-referenced letter and enclosure dated September 16, 2014. The NDEP is aware that it accepted the Frenchman Flat flow and transport model subject to a condition that "all planned actions in Attachment B of the *External Peer Review Team Report: Comments and Responses by the Underground Test Area Subproject of the Nevada Site Office*, be identified in the Frenchman Flat Corrective Action Decision Document/Corrective Action Plan" (CADD/CAP). Furthermore, "the results of all of these actions must be documented and presented to the NDEP via interim documents, letters or presentations during the CADD/CAP stage".

The NDEP agrees the requirements placed on all the planned actions associated with the issues in Attachment B have been satisfied with the exception of the three issues identified in the above -referenced letter. The NDEP however concurs with the rationale and proposed actions that are given for those three issues and will hold the National Nuclear Security Administration /Nevada Field Office responsible to address and complete these actions if the need arises. Therefore, construe this letter as approval that the actions associated with Attachment B have been sufficiently documented and presented.

If you have questions regarding this matter, please contact me at (702) 486-2850 ext. 232.

Sincerely

/s/ Signature on file

Christine Andres
Chief
Bureau of Federal Facilities

CDA/MM

ec: EM Records, AMEM, Las Vegas, NV (1 electronic copy, 1 hard copy)
N-I Central Files, MS NSF 156, Las Vegas, NV
Mark McLane, NDEP

cc: FFACO Group, PSG, NNSA/NFO, Las Vegas, NV
J. T. Fraher, DTRA/CXTS, Kirkland AFB, NM
NSTec Correspondence Control. MS NLV008, Las Vegas, NV
W. R. Wilborn, ERP, NNSA/NFO, Las Vegas, NV

Department of Energy
National Nuclear Security Administration
Nevada Field Office
P.O. Box 98518
Las Vegas, NV 89193-8518

NOV 17 2014

Christine Andres, Chief
Bureau of Federal Facilities
Division of Environmental Protection
2030 East Flamingo Road, Suite 230
Las Vegas, NV 89119-0818

REQUEST FOR APPROVAL TO PROCEED TO THE CLOSURE REPORT (CR) STAGE FOR CORRECTIVE ACTION UNIT (CAU) 98: FRENCHMAN FLAT, NEVADA NATIONAL SECURITY SITE, NYE COUNTY, NEVADA

The National Nuclear Security Administration Nevada Field Office (NNSA/NFO) requests approval from the Nevada Division of Environmental Protection (NDEP) to proceed to the CR stage for Frenchman Flat CAU 98. The basis for this request is documented in the *Model Evaluation Report for Corrective Action Unit 98: Frenchman Flat, Nevada National Security Site, Nye County, Nevada, Revision 1 (N-I, 2014)*. This report describes the data collection, data analysis, and model refinements completed during the Corrective Action Decision Document/ Corrective Action Plan (CADD/CAP) stage and documents that sufficient confidence exists in the Frenchman Flat model to support advancement to the next stage of the Federal Facility Agreement and Consent Order Strategy (FFACO). The NNSA/NFO Underground Test Area (UGTA) Frenchman Flat Modeling Team and Pre-Emptive Review Committee recommendations to proceed to the CR stage are also included in the report.

The NDEP, Bureau of Federal Facilities stated in an October 15, 2014 letter (Andres to Boehlecke) that Revision 1 of the Model Evaluation Report satisfactorily addressed all NDEP comments and in a November 4, 2014 letter (Andres to Boehlecke) that all requested CADD/CAP stage activities are now complete. The NNSA/NFO therefore requests NDEP's acceptance of the model for closure and approval to proceed to the CR stage (Decision 6 of the FFACO UGTA Strategy).

Please direct comments and questions to Bill Wilborn, of my staff, at (702) 295-3188.

/s/ Signature on file

Robert F. Boehlecke, Manager
Environmental Management Operations

EMO:10914.CD

cc via e-mail:
E. A. Jacobson, NDEP
Mark McLane, NDEP
J. T. Fraher, DTRA/CXTS
N-I Central Files
NSTec Correspondence Management
W. R. Wilborn, NFO
FFACO Group, NFO
NFO Read File

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

November 18, 2014

Mr. Robert F. Boehlecke
Manager
Environmental Management Operations
National Nuclear Security Administration
Nevada Field Office
P.O. Box 98518
Las Vegas, Nevada 89193-8518

RE: REQUEST FOR APPROVAL TO PROCEED TO THE CLOSURE REPORT (CR) STAGE FOR CORRECTIVE ACTION UNIT (CAU) 98: FRENCHMAN FLAT, NEVADA NATIONAL SECURITY SITE, NYE COUNTY, NEVADA
Federal Facility Agreement and Consent Order Strategy (FFACO)

Dear Mr. Boehlecke:

The Nevada Division of Environmental Protection, Bureau of Federal Facilities staff (NDEP) has received and reviewed the National Nuclear Security Administration Nevada Field Office, Underground Test Area (UGTA) Frenchman Flat Modeling Team and Pre-Emptive Review Committee recommendations in the above-referenced letter dated November 17, 2014. The NDEP agrees that Revision 1 of the Frenchman Flat CAU Model Evaluation Report satisfactorily addressed all NDEP comments and that all requested CADD/CAP stage activities for Frenchman Flat are now complete, as stated in NDEP letters (Andres to Boehlecke) dated October 15, 2014 and November 4, 2014 respectively. Therefore, the NDEP agrees, the Frenchman Flat CAU model is acceptable for closure and approves proceeding to the CR stage (Decision 6 of the FFACO UGTA Strategy) for Frenchman Flat CAU 98.

If you have questions regarding this matter, please contact me at (702) 486-2850 ext. 232 or Mark McLane at ext. 226.

Sincerely

/s/ Signature on file

Christine Andres
Chief
Bureau of Federal Facilities

CDA/MM

ec: EM Records, AMEM, Las Vegas, NV
N-I Central Files, MS NSF 156, Las Vegas, NV
Mark McLane, NDEP

cc: J. T. Fraher, DTRA/CXTS, Kirkland AFB, NM
NSTec Correspondence Control, MS NLV008, Las Vegas, NV
EM Records, AMEM, Las Vegas, NV
FFACO Group, PSG, NNSA/NFO, Las Vegas, NV
W. R. Wilborn, ERP, NNSA/NFO, Las Vegas, NV

Appendix B

Correspondence for Negotiating Boundaries

(5 Pages)

Department of Energy
National Nuclear Security Administration
Nevada Field Office
P.O. Box 98518
Las Vegas, NV 89193-8518

DEC 23 2014

Christine Andres, Chief
Bureau of Federal Facilities
Division of Environmental Protection
2030 East Flamingo Road, Suite 230
Las Vegas, NV 89119-0818

DECISION POINT 7 OF THE UNDERGROUND TEST AREA (UGTA) STRATEGY, "ARE REVISED CONTAMINANT BOUNDARIES REQUIRED?" FOR CORRECTIVE ACTION UNIT (CAU) 98: FRENCHMAN FLAT

This letter addresses Decision Point 7 of the UGTA Strategy, "Are Revised Contaminant Boundaries Required?" for CAU 98: Frenchman Flat. This decision depends on whether the Corrective Action Decision Document/Corrective Action Plan (CADD/CAP) stage data collection and analysis results require changes to the conceptual model, such as a different direction of contaminant transport (lateral or vertical), or significantly greater distances of contaminant transport than forecasted.

The CADD/CAP stage data collection and analysis results are presented in *Model Evaluation Report for Corrective Action Unit 98: Frenchman Flat, Nevada National Security Site, Nye County, Nevada* (N-I, 2014). CADD/CAP activities were designed to address the key uncertainties associated with the Phase II flow and transport model and primarily focused on the two tests, MILK SHAKE and PIN STRIPE. Navarro-Intera (2014) evaluation results show that the contaminant boundaries associated with MILK SHAKE are represented conservatively (i.e., the actual extent of potential groundwater contamination is much less than forecast) and the nearby model evaluation well, ER-5-5, is properly located to monitor future radionuclide migration. Model evaluation data associated with the PIN STRIPE test revealed the presence of a fault that disrupts the flow path to the east of PIN STRIPE. The contaminant boundaries associated with the PIN STRIPE test, shown in Figure 1 (enclosed), must therefore be revised to reflect the very slow (less than 1 meter/year) southerly groundwater flow determined from the model evaluation data analysis (N-I, 2014, Appendix A).

The National Nuclear Security Administration Nevada Field Office therefore requests the Nevada Division of Environmental Protection concurrence that contaminant boundary revision for the PIN STRIPE test is required and that the contaminant boundaries associated with the other Frenchman Flat tests are adequate.

Please direct comments and questions to Bill Wilborn, of my staff, at (702) 295-3188.

/s/ Signature on file

Robert F. Boehlecke, Manager
Environmental Management Operations

EMO:10969.CD

Enclosure:
As stated

cc w/encl. via e-mail:
J. T. Fraher, DTRA/CXTS
E. A. Jacobson, NDEP
Mark McLane, NDEP
N-I Central Files
NSTec Correspondence Management
W. R. Wilborn, NFO
FFACO Group, NFO
NFO Read File

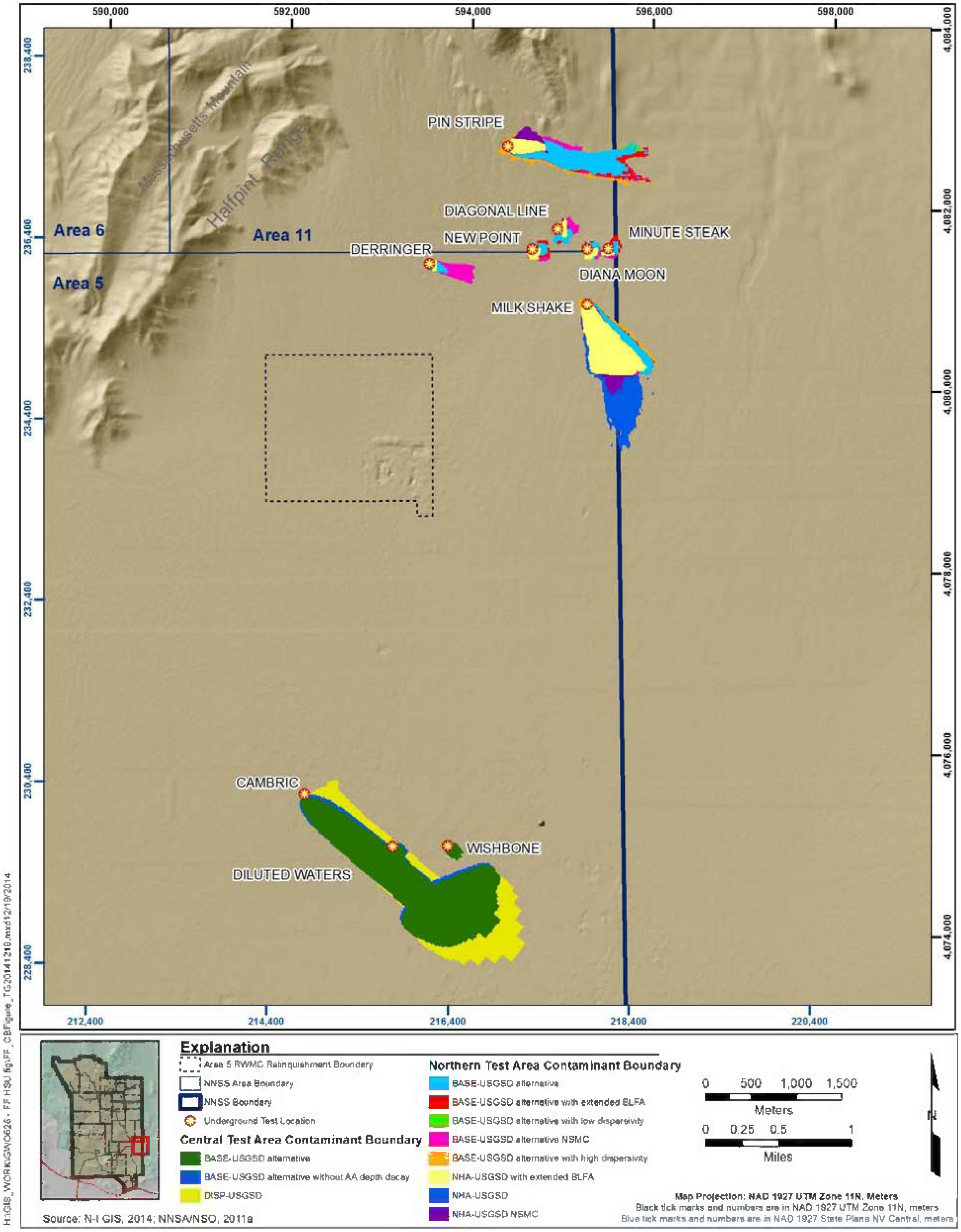


Figure 1
Contaminant boundaries forecasted by multiple Phase II Frenchman Flat groundwater flow and contaminant transport models (NNSA/NSO, 2011).

December 24, 2014

Mr. Robert F. Boehlecke
Manager
Environmental Management Operations
National Nuclear Security Administration
Nevada Field Office
P.O. Box 98518
Las Vegas, Nevada 89193-8518

RE: DECISION POINT 7 OF THE UNDERGROUND TEST AREA (UGTA) STRATEGY,"ARE REVISED CONTAMINANT BOUNDARIES REQUIRED?" FOR CORRECTIVE ACTION UNIT (CAU) 98: FRENCHMAN FLAT
Federal Facility Agreement and Consent Order Strategy (FFACO)

Dear Mr. Boehlecke:

The Nevada Division of Environmental Protection, Bureau of Federal Facilities staff (NDEP) has received and reviewed the National Nuclear Security Administration Nevada Field Office's above-referenced letter dated December 23, 2014. The NDEP concurs that contaminant boundary revision for the PIN STRIPE test is required and the contaminant boundaries associated with the other Frenchman Flat tests are adequate.

If you have questions regarding this matter, please contact me at (702) 486-2850 ext. 232 or Mark McLane at ext. 226.

Sincerely
/s/ Signature on file
FOR
Christine Andres
Chief
Bureau of Federal Facilities

CDA/MM

ec: EM Records, AMEM, Las Vegas, NV (1 electronic copy, 1 hard copy)
N-I Central Files, MS NSF 156, Las Vegas, NV
Mark McLane, NDEP

cc: FFACO Group, PSG, NNSA/NFO, Las Vegas, NV
J. T. Fraher, DTRA/CXTS, Kirkland AFB, NM
NSTec Correspondence Control. MS NLV008, Las Vegas, NV
W. R. Wilborn, ERP, NNSA/NFO, Las Vegas, NV

Appendix C

Well Descriptions

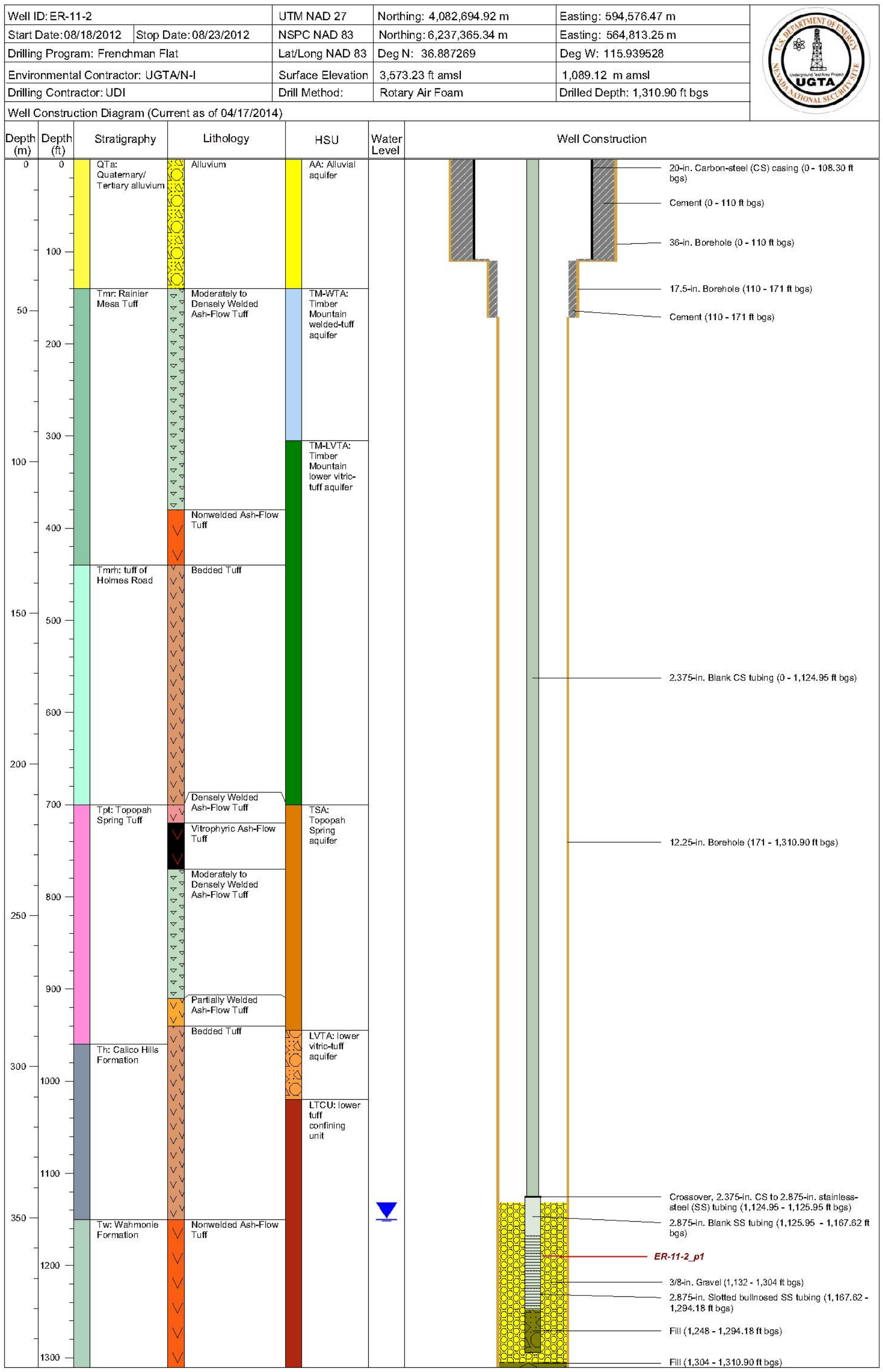


Figure C-1
Well ER-11-2 Construction Diagram

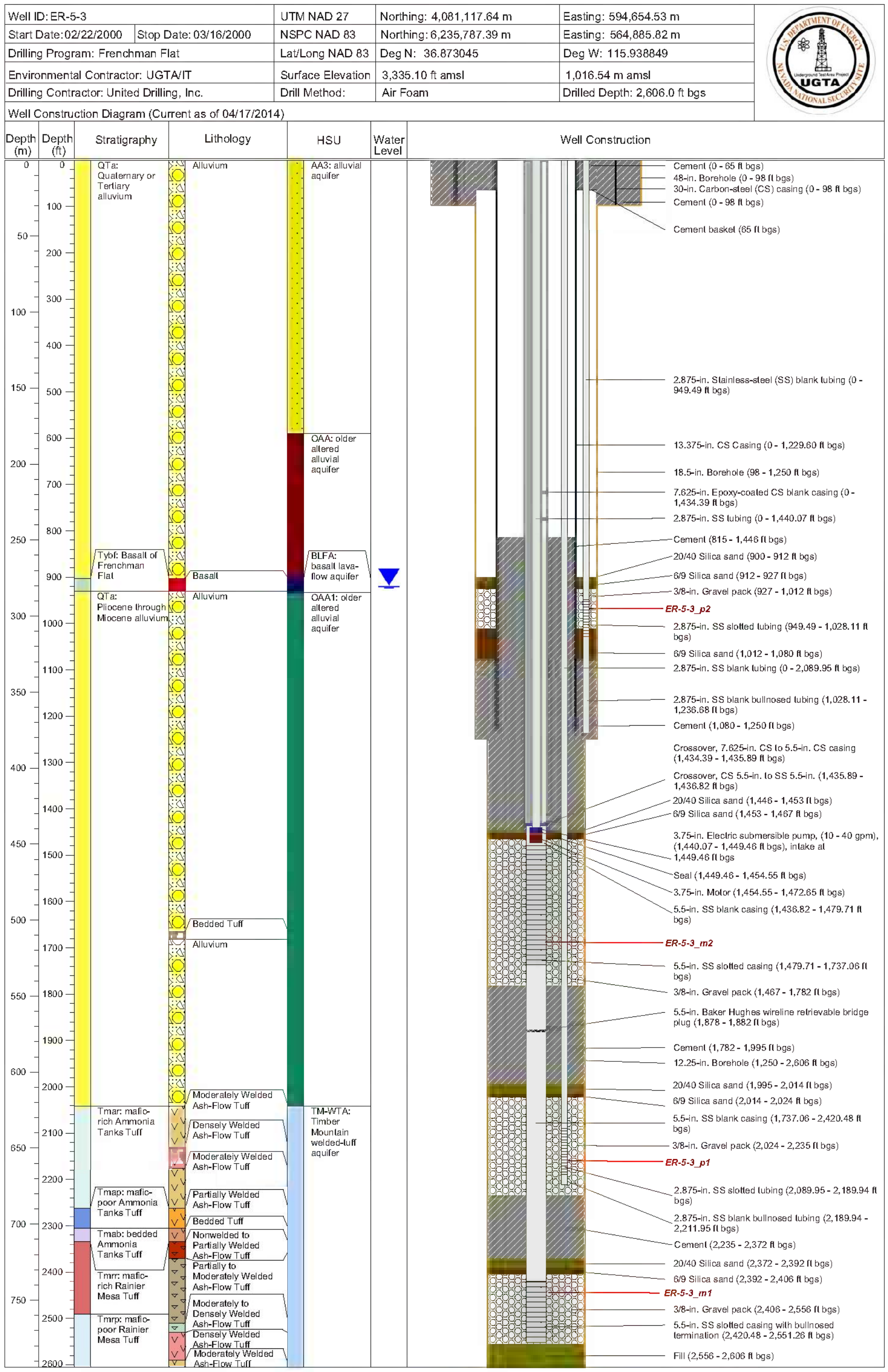


Figure C-2
Well ER-5-3 Construction Diagram

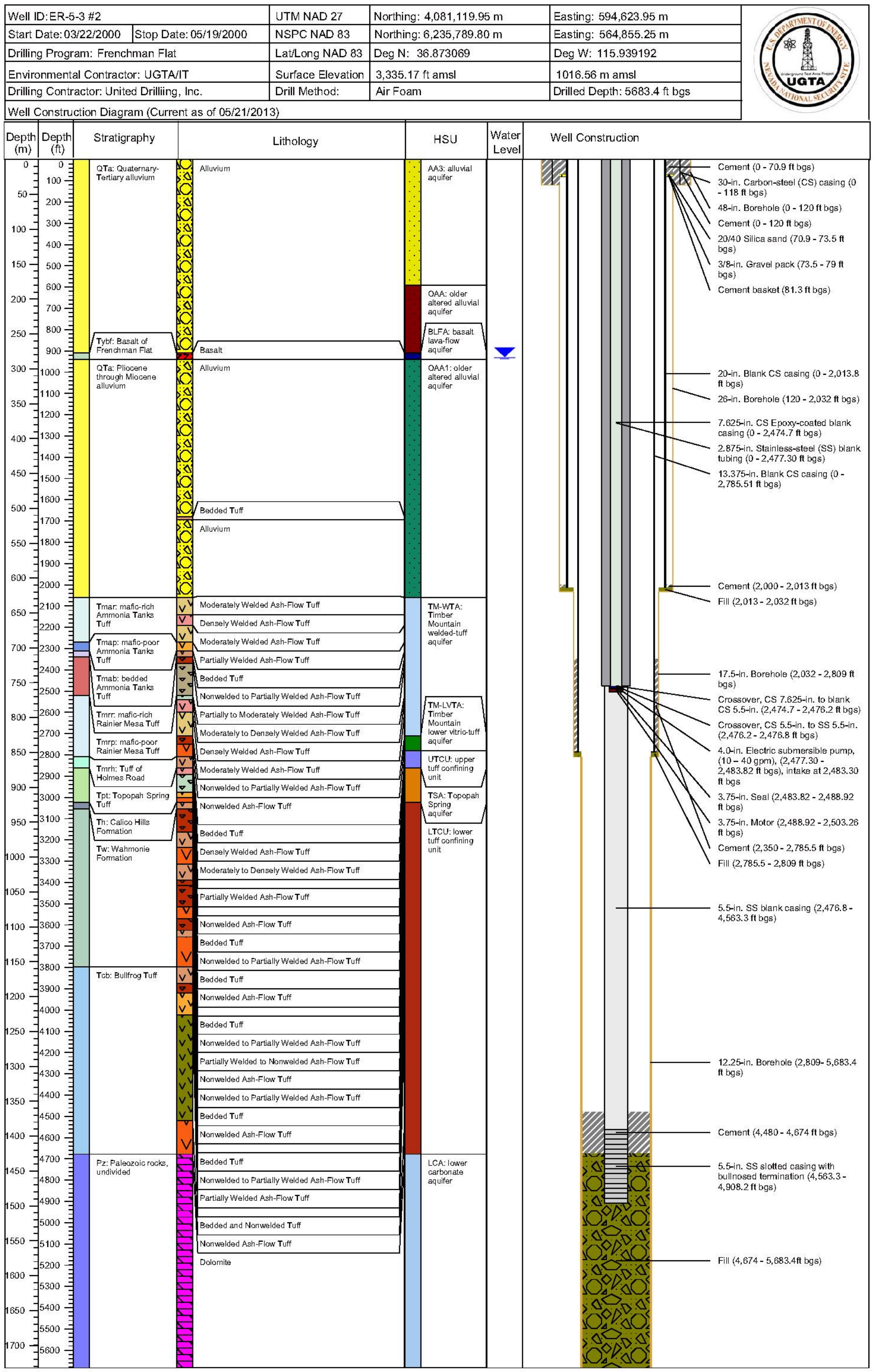


Figure C-3
Well ER-5-3-2 Construction Diagram

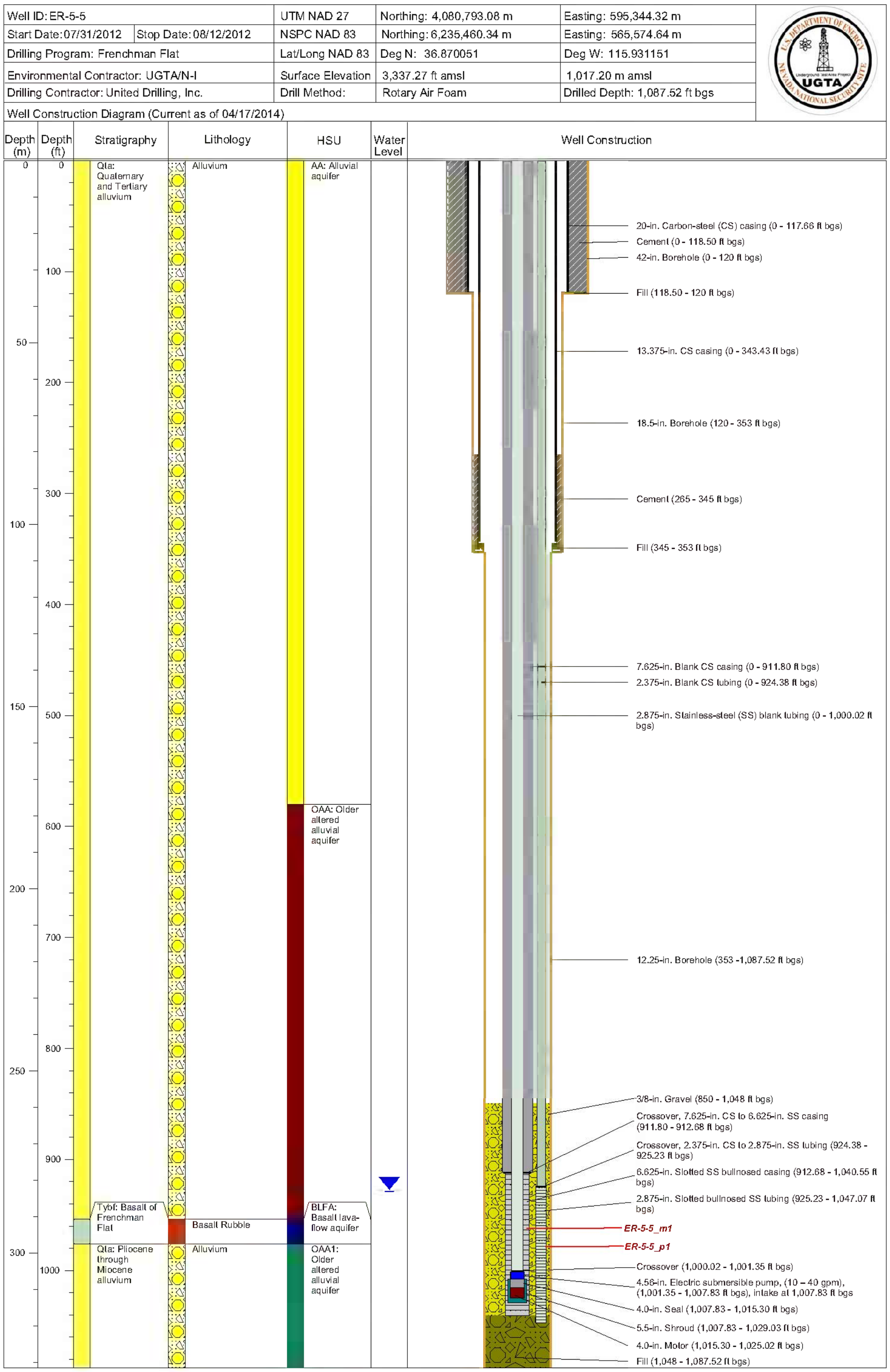


Figure C-4
Well ER-5-5 Construction Diagram

Well ID: RNM-2s		UTM NAD 27	Northing: 4,075,483.95 m	Easting: 592,136.58 m
Start Date: 03/22/1974	Stop Date: 04/01/1974	NSPC NAD 83	Northing: 6,230,161.02 m	Easting: 562,347.59 m
Drilling Program: Hydrologic Test Hole		Lat/Long NAD 83	Deg N: 36.822515	Deg W: 115.967780
Environmental Contractor: Fenix & Scission, Inc.		Surface Elevation	3,130.45 ft amsl	954.2 m amsl
Drilling Contractor: REECo		Drill Method:	Reverse Circulation	Drilled Depth: 1,156 ft bgs
Well Construction Diagram (Current as of 05/21/2013)				

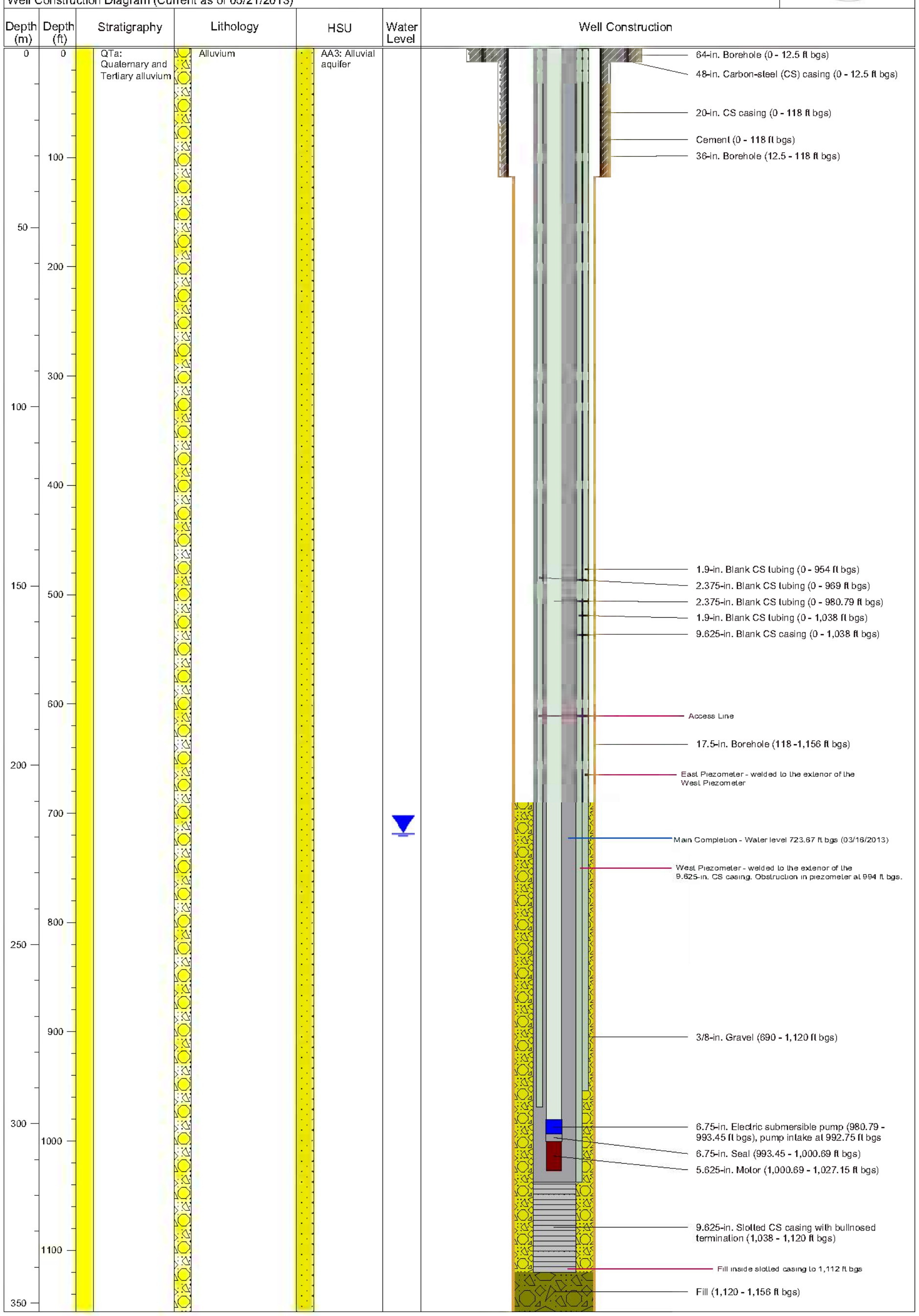


Figure C-5
Well RNM-2S Construction Diagram

Well ID: UE-5n	UTM NAD 27	Northing: 4,075,284.87 m	Easting: 592,626.39 m
Start Date: 02/09/1976 Stop Date: 03/01/1976	NSPC NAD 83	Northing: 6,229,960.18 m	Easting: 562,836.83 m
Drilling Program: Exploratory Borehole	Lat/Long NAD 83	Deg N: 36.820673	Deg W: 115.96231
Environmental Contractor: Fenix & Scission, Inc.	Surface Elevation	3,113.36 ft amsl	948.95 m amsl
Drilling Contractor: REECo	Drill Method:	Reverse Circulation	Drilled Depth: 1,687 ft bgs
Well Construction Diagram (Current as of 07/08/2014)			

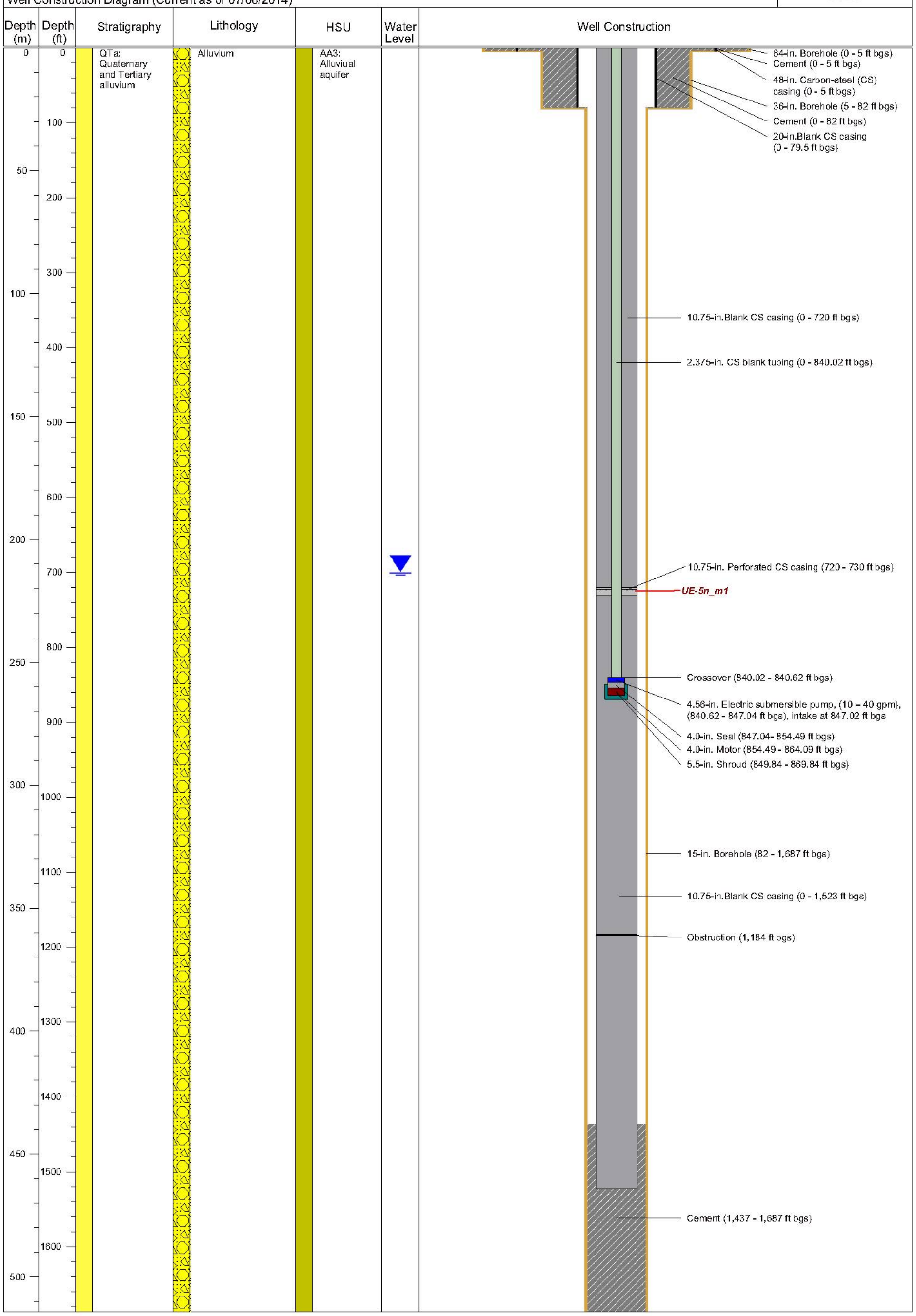


Figure C-6
Well UE-5n Construction Diagram

Appendix D

Use Restrictions

D.1.0 Use Restrictions

Sections D.1.1 and D.1.2 document URs completed for CAU 98 at the following CASs:

- CAS 05-57-001, U-5a Cavity
- CAS 05-57-002, U-5b Cavity
- CAS 05-57-003, U-5e Cavity
- CAS 05-57-004, U-5i Cavity
- CAS 05-57-005, U-5k Cavity
- CAS 11-57-001, U-11b Cavity
- CAS 11-57-002, U-11c Cavity
- CAS 11-57-003, U-11e Cavity
- CAS 11-57-004, U-11f Cavity
- CAS 11-57-005, U-11g Cavity

D.1.1 Northern CAS URs

Attachment D-1 of this appendix provides details of the UR and a figure of the UR boundary.

D.1.2 Central CAS URs

Attachment D-1 of this appendix provides details of the UR and a figure of the UR boundary.

Attachment D-1

Use Restriction Form and Map

(7 Pages)

Use Restriction Information

CAU Number/Description: CAU 98, Frenchman Flat Groundwater`

Applicable CAS Number/Description:
CAS 05-57-004, U-5i Cavity
CAS 05-57-005, U-5k Cavity
CAS 11-57-001, U-11b Cavity
CAS 11-57-002, U-11c Cavity
CAS 11-57-003, U-11e Cavity
CAS 11-57-004, U-11f Cavity
CAS 11-57-005, U-11g Cavity

Contact (DOE AL/Activity): NNSA/NFO Underground Test Area Federal Activity Lead

FFACO Use Restriction Physical Description:

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

UR Points	Northing	Easting
FF Northern - 1	595991	4079457
FF Northern - 2	594981	4079449
FF Northern - 3	594981	4081350
FF Northern - 4	593287	4081350
FF Northern - 5	593289	4081695
FF Northern - 6	594104	4081710
FF Northern - 7	594109	4082971
FF Northern - 8	594458	4082976
FF Northern - 9	594453	4082131
FF Northern - 10	595997	4082126

Depth: No Excavation, drilling, and/or removal of materials below a depth of 100 feet.

Survey Source (GPS, GIS, etc): GIS

Basis for FFACO UR(s):

Summary Statement: The Use Restriction boundaries were established to protect site workers from inadvertently contacting contaminated groundwater, or site activities affecting the flow path of contaminated groundwater. These boundaries encompass the Contaminant Boundary forecasts as per the FFACO requirements (Appendix VI, Section 3).

Contaminants Table:

Maximum Concentration of Contaminants for CAU 98			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
Tritium	1.1	20,000	pCi/L

Note: Effective upon acceptance of closure documents by NDEP

Use Restriction Information

Contaminant concentration is based on groundwater samples collected from wells within the use restriction boundary. However, 7 underground tests were conducted within this UR and the contaminant levels likely exceed the measured levels in the groundwater wells. The Bowen inventory, adjusted for radioactive decay is an estimate of contamination present in and near the test cavities.

Site Controls:

1. Land-use and real property controls, notifications, and restrictions: All subsurface activities-including drilling, pumping, and testing of wells-shall be communicated to NNSA/NFO UGTA Federal Activity Lead before field activities begin. These controls are administered through NFO orders establishing requirements for use of and operations on the NNSS. The current order, NFO Order 410.X1, describes the screening and siting process and REOP processes (NNSA/NSO, 2013 and 2009a).

2. Groundwater control: Groundwater used for human consumption, irrigating crops, and any industrial use (such as dust control) must be preceded by laboratory analysis for contaminants of concern (COCs), and must meet SDWA standards (CFR, 2015b). In addition, effects of pumping on contaminant migration will be evaluated to verify UR boundaries are protective.

Administrative Use Restriction Physical Description*:

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

UR Points	Northing	Easting

UR Points	Northing	Easting

Depth: _____

Survey Source (GPS, GIS, etc): _____

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

Use Restriction Information

Basis for Administrative UR(s):

Summary Statement:

Contaminants Table:

Maximum Concentration of Contaminants for CAU XXX CAS XX-XX-XX, Title			
Constituent	**Maximum Concentration**	**Action Level**	**Units**

Site Controls: _____

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

Description: An annual evaluation of the Use Restrictions will be performed and documented in the Frenchman Flat Annual Closure Report.

Inspection/Maintenance Frequency: Annual

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: ______

Submitted By: /s/ Bill R. Wilborn **Date:** 06/27/2016

Note: Effective upon acceptance of closure documents by NDEP

Use Restriction Information

CAU Number/Description: CAU 98, Frenchman Flat Groundwater`

Applicable CAS Number/Description:
CAS 05-57-001, U-5a Cavity
CAS 05-57-002, U-5b Cavity
CAS 05-57-003, U-5e Cavity

Contact (DOE AL/Activity): NNSA/NFO Underground Test Area Federal Activity Lead

FFACO Use Restriction Physical Description:

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

UR Points	Northing	Easting
FF Central - 1	594092	4073424
FF Central - 2	591693	4075453
FF Central - 3	592504	4076439
FF Central - 4	594937	4074433

Depth: No Excavation, drilling, and/or removal of materials below a depth of 100 feet.

Survey Source (GPS, GIS, etc): GIS

Basis for FFACO UR(s):

Summary Statement: The Use Restriction boundary was established to protect site workers from inadvertently contacting contaminated groundwater, or site activities affecting the flow path of contaminated groundwater. These boundaries encompass the Contaminant Boundary forecasts as per the FFACO requirements (Appendix VI, Section 3).

Contaminants Table:

Maximum Concentration of Contaminants for CAU 98			
Constituent	**Maximum Concentration**	**Action Level**	**Units**
Tritium	153,000	20,000	pCi/L
Strontium-90	8.9	8	pCi/L
Carbon-14	2.44	2,000	pCi/L
Chlorine-36	0.00044	700	pCi/L
Cesium-137	0.68	200	pCi/L
Iodide-129	4.2E-05	1	pCi/L
Neptunium-237	2.7E-05	15	pCi/L
Plutonium	0.006	15	pCi/L
Technetium-99	7.2E-05	900	pCi/L

Use Restriction Information

Contaminant concentration is based on groundwater samples collected from wells within the use restriction boundary. However, three underground tests were conducted within this UR and the contaminant levels likely exceed the measured levels in the groundwater wells. The Bowen inventory, adjusted for radioactive decay is an estimate of contamination present in and near the test cavities. The tritium concentration is from a sample collected on 6/12/2014 from UE-5n and the strontium-90 **concentrations are from a sample collected from RNM-1 on 4/8/2014.** Carbon-14 **is from a sample collected from RNM-1 on 6/3/2004**. Others **are from a sample collected from RNM-1 on 3/6/2007.**

Site Controls:

1. Land-use and real property controls, notifications, and restrictions: All subsurface activities-including drilling, pumping, and testing of wells-shall be communicated to NNSA/NFO UGTA Federal Activity Lead before field activities begin. These controls are administered through NFO orders establishing requirements for use of and operations on the NNSS. The current order, NFO Order 410.X1, describes the screening and siting process and REOP processes (NNSA/NSO, 2013 and 2009a).

2. Groundwater control: Groundwater used for human consumption, irrigating crops, and any industrial use (such as dust control) must be preceded by laboratory analysis for contaminants of concern (COCs), and must meet SDWA standards (CFR, 2015b). In addition, effects of pumping on contaminant migration will be evaluated to verify UR boundaries are protective.

Administrative Use Restriction Physical Description*:

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

UR Points	Northing	Easting

UR Points	Northing	Easting

Depth: _____

Survey Source (GPS, GIS, etc): _____

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

Use Restriction Information

Basis for Administrative UR(s):

Summary Statement:

Contaminants Table:

Maximum Concentration of Contaminants for CAU XXX CAS XX-XX-XX, Title			
Constituent	**Maximum Concentration**	**Action Level**	**Units**

Site Controls: _____

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

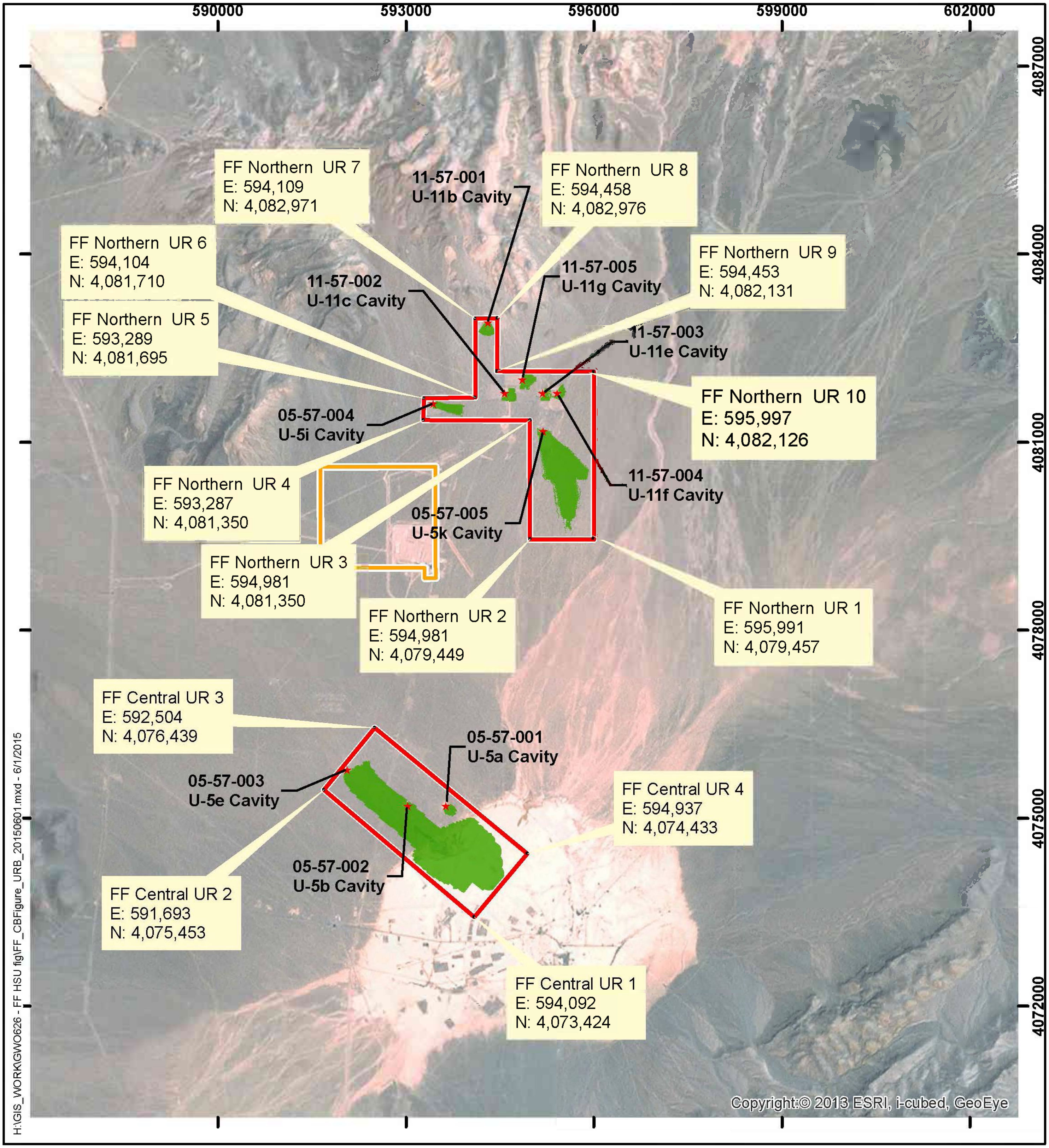
Description: An annual evaluation of the Use Restrictions will be performed and documented in the Frenchman Flat Annual Closure Report.

Inspection/Maintenance Frequency: Annual

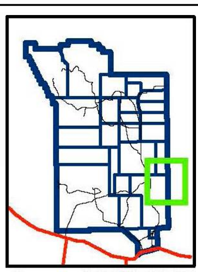
The future use of any land related to this Corrective Action Unit (CAU), as described by the above surveyed location, is restricted from any DOE or Air Force activity that may alter or modify the containment control as approved by the state and identified in the CAU CR or other CAU documentation unless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

Comments: ______

Submitted By: /s/ Bill R. Wilborn **Date:** 06/27/2016



H:\GIS_WORK\GWO626 - FF HSU fig\FF_CBFigure_URB_20150601.mxd - 6/1/2015



Source: N-I GIS, 2015

CAU 98, UGTA Frenchman Flat
CAS 05-57-001, 05-57-002,
05-57-003, 05-57-004,
05-57-005, 11-57-001,
11-57-002, 11-57-003,
11-57-004, 11-57-005
FFACO UR Boundary

Explanation

FFACO UR Boundary

★ CAS Location

0 1,000 2,000 3,000
Meters

0 1 2
Miles

N

Coordinate System: NAD 1983, UTM Zone 11N, Meters

Appendix E

DOE Notification to Bureau of Land Management and U.S. Air Force

E.1.0 DOE Notification

For URs associated with the Tonopah Test Range and the NTTR sites, NDEP will provide a letter of approval for the final CR following resolution of their comments on Revision 0. The UR information will then be provided to the M&O contractor and USAF to record in their GIS. DOE must submit monthly requests for recordation to USAF with a copy to NDEP. Once USAF acknowledges recordation, NDEP will issue the Notice of Completion for the CAU.

Appendix F

Nevada Division of Environmental Protection Comments

(7 Pages)

UGTA DOCUMENT REVIEW SHEET

1. Document Title/Number: Final Closure Report (CR) for Corrective Action Unit (CAU) 98: Frenchman Flat, Nevada National Security Site (NNSS)	2. Document Date: August 2015
3. Revision Number: 0	4. Originator/Organization: Navarro
5. Responsible DOE NNSA/NSO Activity Lead: Bill Wilborn	6. Date Comments Due: September 9, 2015
7. DRS Return Location: N/A	8. Review Criteria: Full Review
9. Reviewer Name/Organization/Phone No.: Christine D. Andres Bureau of Federal Facilities	

10. Comment No.	11. Location (Pg, Sect, Line)	12. Type[a]	13. Comment	14. Comment Response
1	Pg. v and ix	E	The acronym "Cs" is listed for both "Carbon steel" and "Cesium." The Carbon steel acronym should be changed.	The carbon steel acronym was changed to CS.
2	ES-1, P2, S1	E	"FFACO closure process" should be changed to "FFACO UGTA Strategy".	"FFACO closure process" was changed to "FFACO UGTA Strategy"
3	ES-2, P4, S1	T	It should be stated that the long-term monitoring report will be an Annual Report and whether it will be produced on a calendar year basis, a Federal Fiscal Year basis or a State Fiscal Year Basis.	Sentence was revised to read "An annual long-term monitoring report, based on the federal fiscal year, will be published ..."
4	ES-2, P4, S2	T	Who will "verify" the effectiveness of the corrective action"?	Sentence was revised to read "The annual report will be used to document NNSA/NFO verification of the corrective action effectiveness."
5	Pg. 4, Sect. 1.2, P2, S1	T	Following" ... by the State of Nevada," please add "acting by and through the Department of Conservation and Natural Resources, Division of Environmental Protection (NDEP)."	Text was added as requested.
6	Pg. 5, Sect. 1.2, P1, S2	E	"The strategy ..." Suggest changing to "The FFACO UGTA strategy ..." for clarity and completeness. Also, for consistency, please spell out "Closure Report" before the use of "CR" in this sentence.	Text was revised as suggested.
7	Pg. 5, Sect. 1.2, P1, S7	E	" ... Decision Point 4 in the FFACO Flowchart..." should be" ... FFACO UGTA Strategy Flowchart ...." for clarity.	Text was revised as suggested.
8	Pg. 6, Fig. 1-3	E	caption should read "FFACO UGTA Strategy Flowchart".	Text was revised as suggested.
9	Pg. 7, Sect. 1.2, P2, S5	T	"Site understanding" should be changed to "numerical model(s)."	Text was revised as suggested.

[a]Comment Types: T = Technical, E = Editorial.

10. Comment No.	11. Location (Pg, Sect, Line)	12. Type[a]	13. Comment	14. Comment Response
10	Pg. 8, Sect. 1.4	T	The content listed for Section 8.0 in this section are not what is listed in Section 8.0. Please make them consistent.	Revised the description to read “recommendations to transfer the Frenchman Flat CAU from Appendix III to Appendix IV of the FFACO”
11	Pg. 9, Sect. 2.1, P1, S3	T	The phrase "no new site characterization data were collected before groundwater flow and transport modeling." needs a brief explanation in the context of the phrase before it and the sentence after it.	This sentence was removed. It seemed to just confuse the reader. The last sentence in the paragraph references the CADD/CAP where a more thorough discussion is provided that lists and summarizes relevant documents.
12	Pg. 9, Sect. 2.1, P3, S1	E	The reference Fenelon et al., 2010 needs to be added to the list in this sentence because it is referenced in Figure 2-1.	Fenelon et al., 2010 was added.
13	Pg. 9, Sect. 2.1, P3, S2	T	It is not clear how the combined features support the second observation for the basin concerning limited leakage. Please add an explanation and clarify.	Sentence was revised to read “Two main observations for the basin are (1)….”
14	Pg. 11, Sect. 2.1, P1, S4	E	There is no Navarro, 2015d in the reference section. Please add this reference.	References were corrected in the reference section. Reference to Navarro specific procedures and plans was removed to prevent need for ROTC if revised.
15	Pg. 11, Sect. 2.1, P1, S4	T	The use of the phrase "highly unlikely" is subjective in nature. It is suggested this sentence be removed.	Sentence was removed as suggested.
16	Pg. 12, Sect. 2.2, P2	T	There should be a short, concise description of why the remaining seven underground nuclear tests did not warrant further investigation before the start of this paragraph.	Added the following sentence: “The uncertainty associated with the models for the seven remaining tests, and their CB extent, are sufficiently low that further model evaluation activities is considered unnecessary.”
17	Pg. 12, Sect. 2.2, P2, S3	T	"Completion of Well ER-11-2 ...." Suggest changing to "Completion data from Well ER-11-2 ...."	Sentence was revised as suggested.
18	Pg. 14, Table 2-1, First row	T	Results column: This statement is confusing; please explain it in more detail.	Result was revised to read “Although radionuclide data from Well ER-5-5 are consistent with this conservative assumption, this target could not be effectively evaluated because the hydrogeologic conditions were found to dominate contaminant transport (i.e., contaminant boundary extent) at PIN STRIPE and MILK SHAKE.”
19	Pg. 15, Sect. 2.2, P1, S1	T	Please state for which aquifer(s) the direction of groundwater flow is to the south-southeast.	Added “in the alluvial and volcanic aquifers”
20	Pg. 16, Sect. 3.1, P1, S1	T	CBs provide results or information used for planning purposes. Please revise this sentence.	This sentence was deleted.

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10. Comment No.	11. Location (Pg, Sect, Line)	12. Type[a]	13. Comment	14. Comment Response
21	Pg. 18, Sect. 3.1, P1	T	The description of how the maximum lateral distance, width, and depth from each test were calculated is not included in this paragraph. The fifth sentence in this paragraph indicates a detailed description of these data is presented in NNES (2010). From a review of chapter 10 of NNES (2010), where the source information for Table 3-1 (except for PIN STRIPE) was presented, there is no detailed description of how the maximum lateral distance, width, and depth from each test were calculated. As such, please include this description in this document.	The sentence was revised to read "With the exception of PIN STRIPE, the maximum extents presented in Table 3-1 are calculated from the CB ensembles forecasted using the numerical models; a detailed description of these CB calculations is presented in NNES (2010)."
22	Pg. 18, Sect. 3.1, P1, S 2 and 7	T	The description of the calculation of the maximum width for PIN STRIPE based on these two sentences is not clear. The seventh sentence indicates the maximum width is the diameter of the 2 Rc sphere that intercepts the water table, which yields 150 m as presented in Table 3-1 on Page 19. However, this does not include the plus and minus one standard deviation in direction (see second sentence) as shown in Figure A-7 in the Model Evaluation Report for CAU 98: Frenchman Flat, which yields a maximum width of approximately 275 m (based on a measurement from this figure). Figure 3-17 in the Model Evaluation Report for CAU 98: Frenchman Flat depicts the 2Rc sphere that intercepts the water table. This section needs to be clarified and the contradictions resolved.	Good point. The maximum width was recalculated to include the uncertainty in distance using GIS. The width is 288 m. The text was revised to make this correction.
23	Pg. 19, Table 3-1	T	Information for CAMBRIC in the Table is actually for Cambric Ditch when compared to Table 10-4 in NNES, 2010. In addition, information for CAMBRIC was not included in Table 3-1. Please correct Table 3-1 related to CAMBRIC, Cambric Ditch and maximum width for PIN STRIPE based on Comment No. 22, above.	Surface contamination of the CAMBRIC ditch (CAS 05-22-33) was transferred to CAU 56 (FFACO, 1996 as amended). The CB associated with the CAMBRIC ditch groundwater contamination (i.e., the CAMBRIC ditch CB) was added to the CAMBRIC (CAS 05-57-003) CB. Text was added to discuss this.
24	Pg. 19, Sect. 3.2, P1, S6	E	There is no Appendix D of the FF ACO. This sentence should be corrected to state Appendix D of this CR.	"of the FFACO (1996, as amended)" was deleted from the sentence.

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10. Comment No.	11. Location (Pg, Sect, Line)	12. Type[a]	13. Comment	14. Comment Response
25	Pg. 24, Sect. 4.1	T	The "objective of long-term monitoring" is not only to "evaluate consistency" with the conceptual model but also to evaluate consistency with the numerical model(s). Please revise this sentence.	“and numerical” was inserted between conceptual and model.
26	Pg. 25, Table 4-1	T	Well ER-11-2 is listed as an early detection well. However, in Table 4-2 on Page 26, the definition of early detection well is "Located down gradient of an underground test or source/plume well ..." Based on Figures 3-1 and 4-1 in the CR, Well ER-11-2 is to the east of the test and not in the down gradient direction. Please explain in the text how Well ER-11-2 can be considered to be an early detection well.	The categorization was changed to Inactive with respect to the Sampling Plan because it is currently not included in the Sampling Plan for routine monitoring. Text was added on pg. 29 to discuss this.
27	Pg. 27, Sect. 4.1.1.1, P2, S3/4.	T	Well RNM-2S is included in the third sentence and according to the fourth sentence this well is a characterization and early detection well. However, in Table 4-1, it is listed as a Source/Plume well. In addition, Well RNM-2S is located in the Central Testing Area according to Figure 4-1 on Page 28. Please correct these inconsistencies.	The sentence referring to well type has been deleted from this paragraph. Each individual well is described on the next page. RNM-2S discussion was removed from the Northern Testing Area discussion and “completed in the alluvial aquifer” was added to the RNM-2S and UE-5n discussion in the Central Testing Area section.
28	Pg. 27, Sect. 4.1.1.1, P2, S4	T	Well ER-11-2 is to the east of PIN STRIPE and is not located in the down gradient direction as indicated by the definition of an early detection well in Table 4-2. Please clarify the last sentence, such as, although this well is not down gradient of the test, it allows an additional measurement location near PIN STRIPE.	See response to Comment No. 26.
29	Pg. 29, Sect. 4.1.1.1, P3, S1	T	In Table 4-1, Well ER-5-5 is listed as a Characterization well not as an early detection location as indicated in the first sentence. Please clarify.	Once a baseline is established, ER-5-5 will be recategorized as an Early Detection well. Text was added to clarify this.

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10. Comment No.	11. Location (Pg, Sect, Line)	12. Type[a]	13. Comment	14. Comment Response
30	Pg. 30, Sect. 4.1.1.3, **P1**, S3	T	Due to possible future changes in some of the parameters listed in this sentence, which would then necessitate a Record of Technical Change, if the information is listed in NNSA/NFO, 2014a, perhaps just a reference to the NNSA/NFO document should be made in this sentence.	The CR supersedes the Integrated Sampling Plan (ISP). While the ISP will provide guidance to the CR, CR requirements will be specifically stated in the CR. For that reason, the following revisions to this document were made: 1) Only long-term monitoring wells are shown in Figure 3-3. 2) Section 4.1.1.2 was revised to state that groundwater sampling will be performed in accordance with the UGTA QAP and the associated required procedures and processes. 3) The following statement Was added to section 4.1.1.2: "*The Nevada National Security Site Integrated Groundwater Sampling Plan, Nevada National Security Site, Nevada* (NNSA/NFO, 2014) will be used as a guidance document for identifying well types and the associated analytes, but any inconsistencies between the two documents will be resolved in favor of the CR."
31	Pg. 33, Sect. 4.1.3, S2	T	What is the "monitoring network maintenance program"? Where can it be found? Is it a FFACO recognized program? Please explain.	"Program" was removed from this sentence. There is no official program. Maintenance requirements are described in this section.
32	Pg. 37, Sect. 4.1.4	E	The first sentence states there are four (4) items yet there are only three (3) listed. Please correct this discrepancy.	Four was changed to three.
33	Pg. 39, Sect. 4.1.6.3, P1, S3	E	The reference "Radiological Instrumentation and Calibration (Navarro, 2015c)" listed in this sentence does not appear to be the reference included in Section 9, References, Page 49. Please clarify.	Reference to this procedure was removed from the text. Text now reads: "Samples will be processed and analyzed in accordance with standard operating procedures and processes compliant with the UGTA QAP (NNSA/NFO, 2015).
34	Pg. 42, Sect. 4.3, Full sentence:	E	This sentence is not a complete sentence. Please clarify.	The sentence was revised to read: "In addition, periodic evaluations will determine whether new technologies are available that may warrant investigation of a revised closure strategy."

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10. Comment No.	11. Location (Pg, Sect, Line)	12. Type[a]	13. Comment	14. Comment Response
35	Pg. 43, Sect. 5.0, S1	T	Please state that they will be annual monitoring reports and when they will be produced.	The word “annual” was added before “monitoring reports. The following sentence was also added: “Each report will be submitted to NDEP by the end of the second quarter of each federal fiscal year.”
36	Pg. 43, Sect. 5.0, last two sentences	T	Explain what options will be followed if the closure strategy is viable and the requirements of the document are being met after the first five years.	The following text was added: “If it is determined that the closure strategy is viable and/or protective of human health and the environment, NNSA/NFO and NDEP will determine whether required sampling (e.g., frequencies, sampling methodologies, and/or analytes), water-level measurement, or reporting requirements for future monitoring may be revised. If revision is agreed upon, a CR revision or addendum will be completed.”
37	Pg. 49, Sect. 9.0	E	In this section, all four Navarro 2015 references, as well as other references, use a period before the year, not a comma as used in the text (for example, page 30). Please check the entire document and Reference Section for consistency.	The references will be checked and made consistent.
38	Appendix D, Attachment D-1 , Pg. 1,	T	Explain why the maximum concentration of Tritium is "???" (the existing note referencing Bowen does not explain this).	A tritium activity of 1.1 pCi/L was added. This is the only tritium detection we have observed in northern Frenchman Flat. Therefore, the Bowen reference is now quite applicable.
Comments identified by authors during final revision				
39	Pg. 7, Section 1.2	E	Discussion of the secondary driver “fluid and waste management” as stated in the FFACO CR Outline is not included.	The following text was added to the end of Section 1.2: “Additional regulatory agreements regarding the fluids produced during groundwater purging activities at the post-closure monitor wells are described in the *Underground Test Area Project Waste Management Plan* with *Attachment 1, Fluid Management Plan for the Underground Test Area Project* (NNSA/NSO, 2009b). Further discussion of NNSA/NSO (2009b) is presented in Section 4.1.6.”

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40	Pg. 40, Section 4.2	E	A distinct statement indicating that "future use of any land related to this CAU is restricted from any activity that may alter or modify the institutional controls as approved by NDEP, unless appropriate concurrence is obtained in advance" as stated in the FFACO CR Outline is not included.	This statement was added to Section 4.2

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