RECORD OF TECHNICAL CHANGE

Technical Change No. CAIP-1 Page 1 of 2

Project/Job No. Industrial Sites/ IS05 – 490 Date: 02/22/2005

Project/Job Name Corrective Action Investigation Plan for CAU 551, Area 12 Muckpiles:

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

Alfred N. Wickline	Industrial Sites Task Manager
(Name)	(Title)

Description of Change

1. **Section 1.1 Purpose**. To the end of the third sentence of the last paragraph on page 4 add:
   - "and in down-slope drainages. "

2. **Section 4.2.2 Muckpiles**. To the 2nd paragraph, add after the last sentence:
   - "Extended sampling for Decision II would be in the wash below this intersection."

3. **Section A.1.8.2 Detailed Investigation Strategy**. In Figure A.1-12:
   - Eliminate "Hold Area", the arrow beneath "Hold Area", and the circle, and extend the lowermost of the joined arrows to the point just below where the access road leaves the photograph at the lower right side.

3. **Section A.1.8.2 Detailed Investigation Strategy**. To the first full sentence on page A-58 replace with:
   - "The furthest down-slope sampling for Decision II is expected to be in the wash along the E-Tunnel muckpile (CAU 383) (Figure A.1-12)."

Justification for change

Validated results for CAU 551 Decision II samples taken in the portion of the main wash from where it intersects the access road to a point near the culverts running beneath the turnoff road to E-Tunnel have found PALs exceeded for Am-241, Cs-137, and Pu-239. Additionally, a sample taken north of the access road, about midway along this part of the access road, gave a result for TPH-DRO above the PAL. All four contaminants of concern were also found higher up in the wash at levels above PALs, as well as in samples taken from the CAU 551 muckpiles, leading to the conclusion that contamination has migrated further down the wash than first estimated (the TPH-DRO finding in the portion of the wash of present concern, though, may be attributed to a generator pad that was located near the sample location).

Validated results for the CAU 383 CAI (E-Tunnel Muckpile, investigated in 2004) in the wash, taken from approximately the lower half of the reach of the wash that runs alongside the muckpile to the ponds in that area, have shown Cs-137 levels above PALs, but not Pu-239. These samples, however, were not analyzed for Am-241 or TPH-DRO.

The pertinent sections of the CAIP for CAU 551 are being changed to reflect the need to extend the investigation into that part of the wash that may be affected by runoff coming from CAU 551 which combines with runoff coming from the E-Tunnel area.

The CAU 551 CAI will be expanded to delineate the extent of contamination that may likely be originating from the muckpile CASs and transported to the wash beneath the E-Tunnel muckpile. This additional information will be evaluated in the Corrective Action Decision Document to select the corrective action alternative.

The project time will be **Unchanged**

Applicable Project-Specific Document(s): **Corrective Action Investigation Plan for Corrective Action Unit 551: Area 12 Muckpiles, Nevada Test Site, Nevada Rev. 0, February, 2005**

CC:

Approved By: for Kevin Cabble, Acting Project Manager, Industrial Sites Project — Date 2-22-05

Janet Appenzeller-Wing, Acting Division Director, Environmental Restoration Division — Date 2-22-05

NDEP Concurrence Yes__ No __ Date ______

NDEP Signature ______

Contract Change Order Required Yes__ No ____

Contract Change Order No. ______

The project time will be **Unchanged**

Applicable Project-Specific Document(s):	**Corrective Action Investigation Plan for Corrective Action Unit 551: Area 12 Muckpiles, Nevada Test Site, Nevada Rev. 0, February, 2005**

CC:

Approved By: for Kevin Cabble, Acting Project Manager, Industrial Sites Project — Date 2-22-05

Janet Appenzeller-Wing, Acting Division Director, Environmental Restoration Division — Date 2-22-05

NDEP Concurrence Yes X No ___ Date 2/22/05

NDEP Signature ______

Contract Change Order Required Yes___ No ____

Contract Change Order No. ______

RECORD OF TECHNICAL CHANGE

Technical Change No. CAIP-2 Page 1 of 5

Project/Job No. Industrial Sites/IS05-490 Date April 14, 2005

Project/Job Name Corrective Action Investigation Plan for CAU 551, Area 12 Muckpiles

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

Alfred N. Wickline (Name) Industrial Sites Task Manager (Title)

Description of Changes:

Description of Change

1. **Executive Summary, page ES-2**. To the end of the carry-over paragraph at the top of the page add after last sentence:

   "For all CASs in CAU 551, upslope areas may also be a source of radiological contamination."

2. **Section 1.2 Scope**. Change the 4th bulleted item to read:

   "Perform radiological land area surveys at CAU 551 to document the radiological condition of land in and around the site boundary."

3. **Section 1.2 Scope**. To the 1st full paragraph on page 6 beginning with "Soil contamination originating …", replace the second sentence with:

   "This CAI recognizes the potential existence of upslope contamination. Contamination originating from upslope areas will not be considered for sample locations. Contamination that may originate from upslope sources may add to total contamination present on the muckpile and impact CAU 551 CASs. Sampling may be necessary to identify the nature of the upslope contamination, however, only the down slope area COCs will be considered for Decision II."

4. **Section 2.1 Physical Setting, Figure 2-2**. Replace the figure, which depicts CAS 12-06-08 as extending to nearly the B-Tunnel Portal, and does not depict the Neptune crater, with the attached figure

5. **Section 3.1 Conceptual Site Models**. After the last sentence of the first full paragraph on page 19 add:

   "This scope does not include contamination areas upslope from the Muckpiles other than contamination that may have migrated into CAU 551 CASs."

6. **Section 3.1.2 Contaminant Sources**. Following the last paragraph of the section, add the following new paragraph:

   "Upslope areas that drain into the CAU 551 area may be sources of potential contamination found in the four CASs. One example of a potential upslope source is the Neptune crater and surrounding areas affected by the Neptune Test. Though listed as having slightly vented, with no radioactivity being detected off site (DOE/NV, 20001), the Neptune Test did have a yield of 115 tons, vented to the southeast (LRL, 1962) and the resultant cloud eventually moved west-northwest (DNA, 1958). Fallout contours, depicted as gamma intensities in mr/hr at 12 hours after the test, included all of the CAU 551 CAS footprints as well as many areas west and north of Neptune's ground zero (LRL, 1960). This event is expected to have released gamma-emitting radionuclides as well as residual plutonium into CAU 551 and the upslope areas."

7. **Section 3.1.4 Migration Pathways**. To the carry over paragraph at the top of the page, second sentence that begins "The wash is a few hundred feet …." change to read:

"The wash joins the access road a few hundred feet up gradient from the E-Tunnel muckpile (i.e. CAU 383)."

8. **Section 8.0 References**. Add the following references in appropriate alphabetical order:

"DNA, see Defense Nuclear Agency."
"Defense Nuclear Agency. 1958. *Operation Hardtack II*, DNA 6026F."
"LRL, see Lawrence Radiation Laboratory"
"Lawrence Radiation Laboratory. 1960. *The Neptune Event: A Nuclear Explosive Cratering Experiment*, UCRL-5766. Prepared by A.V. Shelton, M.D. Nordyke, and R.H. Goeckermann. Livermore, CA.
"Lawrence Radiation Laboratory. 1962. *Postshot Geologic Studies of the Excavations in Neptune Crater*, UCRL 6812-T. Prepared by J.W. Skrove and R.D. McArthur. Livermore, CA.

9. **Section A.1 Seven-Step DQO Process for CAU 551 Investigation**. To the first paragraph on the page, last sentence, change to:

"Existing information about the nature and extent of contamination at the four CASs in CAU 551 is not sufficient for evaluation and selection of preferred corrective actions; therefore a CAI will be conducted."

10. **Section 1.1 CAS-Specific Information, Figure A.1-2**. Replace the figure, which depicts CAS 12-06-08 as extending to nearly the B-Tunnel Portal, and does not depict the Neptune crater, with the attached figure

11. **Section A.1.1.4 Specific Information for the Four CAU 551 CASs**. To the first full paragraph at the top of page A-10, add to the end of the first sentence:

", other than contamination that may have migrated into CAU 551 CASs."

12. **Section A.1.1.4 Specific Information for the Four CAU 551 CASs**. After the first paragraph at the top of page A-12 add the following new paragraph:

"Upslope areas that drain into the CAU 551 area may be sources of potential contamination found in the four CASs. One example of a potential upslope source is the Neptune crater and surrounding areas affected by the Neptune Test. Though listed as having slightly vented, with no radioactivity being detected off site (DOE/NV, 20001), the Neptune Test did have a yield of 115 tons, vented to the southeast (LRL, 1962) and the resultant cloud eventually moved west-northwest (DNA, 1958). Fallout contours, depicted as gamma intensities in mr/hr at 12 hours after the test, included all of the CAU 551 CAS footprints as well as many areas west and north of Neptune's ground zero (LRL, 1960). This event is expected to have released gamma-emitting radionuclides as well as residual plutonium into CAU 551 and the upslope areas.""

13. **Section A.1.3.1.2 Decision Statements for CASs 12-06-05, 12-06-07, and 12-06-08, Muckpiles**. To the carry over paragraph at the top of page A-27, change the last sentence beginning "The exp-COCs are the same as the …." to:

"The exp-COCs are a subset of the critical COPCs."

14. **Section A1.7.1 False Negative (Rejection of the null hypothesis) Decision Error**. To the first numbered three bullet on page A-49, change sentence to:

"Concurrent, with Decision I sampling, collection, and analysis (full suite), Decision II samples will be collected for the muckpile CASs."

15. **Section A.1.7.1 False Negative (Rejection of the null hypothesis) Decision Error**. To the first paragraph at the top of page A-51, delete the second sentence (which is a near repeat of the first sentence):

"To satisfy the third criterion, the entire dataset as well as individual sample results will be assessed against the DQIs of precision, accuracy, comparability, and completeness defined in the Industrial Sites QAPP (NNSA/NV, 2002)."

16. **Section A.1.8.2 Detailed Investigation Strategy**. To the first bulleted item listed under "Muckpiles", second sentence, delete:

"and Figure A.1-11"

17. **Section A.1.8.2 Detailed Investigation Strategy**. To the second bulleted item listed under "Muckpiles", last sentence, change "Figure A.1-12 to:

"Figure A.1-11"

18. **Section A.1.8.2 Detailed Investigation Strategy**. To the carry over paragraph at the top of page A-58, last sentence change "(Figure 2-1)" to:

"(Figure A.1-12)."

19. **Section A.1.8.2 Detailed Investigation Strategy**. Following the carry over paragraph at the top of page A-58, add the following paragraph:

"Sampling upslope will be conducted if indications are found that upslope contamination from another source might be migrating into the CAU 551 area. The purpose for the sampling is to attempt to define the boundary between CAU 551 CASs and the possible upslope source."

20. **Section A.1.9 References**. Add the following references in appropriate alphabetical order:

"DNA, see Defense Nuclear Agency."
"Defense Nuclear Agency. 1958. *Operation Hardtack II*, DNA 6026F."
"LRL, see Lawrence Radiation Laboratory"
"Lawrence Radiation Laboratory. 1960. *The Neptune Event: A Nuclear Explosive Cratering Experiment*, UCRL-5766. Prepared by A.V. Shelton, M.D. Nordyke, and R.H. Goeckermann. Livermore, CA.
"Lawrence Radiation Laboratory. 1962. *Postshot Geologic Studies of the Excavations in Neptune Crater*, UCRL 6812-T. Prepared by J.W. Skrove and R.D. McArthur. Livermore, CA.

21. **Add the following paragraph to the end of Section A.2.4.1.**

In addition to the time frame in which the tests were conducted, similarities or differences in the type or purpose of the experiments conducted in the tunnels may have impacted the nature of potential contamination in the Muckpiles. Each of the experiments conducted in the tunnels associated with the previously investigated NTS Muckpiles (i.e., N-, P-, T-, 15a and e-, and 16a-Tunnels) were conducted as weapons effects or weapons related experiments or as part of the Vela uniform program (DOE/NV, 2000) and thus can be expected to have produced a fission reaction consuming much of the plutonium. Each of the experiments conducted in the B-Tunnel were weapons related (DOE/NV, 2000) and can also have been expected to have produced a fission reaction. The six experiments conducted in the C-, D-, and F-Tunnels were safety experiments in which the nuclear device is exploded using conventional explosives; resulting in no fission reaction or a negligible fission reaction (very low yield) (DOE/NV, 2000). Therefore, there is an increased potential for plutonium to be present in the C-, D-, and F-Tunnel muckpile if muck was generated from re-entry operations. No documentation was identified that described the extent of re-entry activities; therefore, it is unknown how much, if any, plutonium contaminated material may be present in the CAS 12-06-07 muckpile. If re-entry activities were conducted, it can be expected that re-entry muck was some of the last muck deposited on the muckpile and it would have been deposited on the surface of the sloped area of the muckpile where it would be less accessible to site workers.

22. **Add the following sentences to the end of the first paragraph in Section A.2.4.4**

Another impact on comparability of the data from the previously investigated NTS Muckpiles is that the experiments conducted in the C-, D-, and F-Tunnels were safety experiments, which may have resulted in higher levels of plutonium in the muck associated with re-entry into these tunnels.

23. **Add the following paragraph to the end of Section A.2.4.4**

The safety experiments conducted in the C-, D-, and F-Tunnels may have contributed higher levels of plutonium to the muck in CAS 12-06-07 than found in the previously investigated NTS muckpiles. This difference has been accounted for in the investigation strategy. Previous investigations of areas where safety experiments were conducted have shown that the associated contamination can be identified with portable survey instruments. Accessible portions of the muckpile will be surveyed and bias sample locations will be selected at locations where the higher survey readings are identified. Surface/near-surface soil samples will be collected at these locations.

24. **Make the following change in Section A.2.6**

Add the following to the end of the third sentence in the first paragraph "..., and safety experiments may have contributed to higher levels of some contaminants."

Justification:

For sections pertaining to potential upslope contamination, validated results for CAU 551 samples taken from around the AST & Stain, and from background sampling several hundred feet up the mesa access road indicated radionuclides outside and upslope from the muckpile CAS boundaries. From an interview and a search of additional literature provided by the interviewee, a possible upslope source for the radionuclide contamination was identified as the Neptune test, the resulting crater, and surrounding areas.

For sections pertaining to safety experiments conducted at C-, D-, and F-Tunnels, as described in the CAU 551 CAIP the majority of the CAU 551 muckpiles are not accessible to mechanized (e.g., drill rig or backhoe) sampling equipment; therefore, a strategy was developed to use process knowledge and data from previously investigated NTS muckpiles to aid in the characterization of the CAU 551 muckpiles. This strategy, as described in the CAIP, is based in part on the assumption that the activities that contributed to the placement of wastes in the CAU 551 muckpiles were similar to the activities that contributed to the placement of wastes in the previously investigated NTS muckpiles. Information to support this assumption is documented in Appendix A.2 of the CAIP. In addition, Appendix A.2 also provides a discussion on the similarities and differences between the CAU 551 muckpiles and the previously investigated NTS muckpiles, and the potential impacts of these similarities and/or differences on the investigation strategy. One difference not discussed in the CAIP is that the various purposes or types of nuclear experiments conducted in the various tunnels could impact the nature of potential contamination in the associated muckpiles. The experiments conducted at the C, D, and F-Tunnels were "safety experiments" in which the nuclear device is exploded using conventional explosives; resulting in no fission reaction or a negligible fission reaction (very low yield). As such there may be a higher potential for plutonium to be present in the muckpile associated with these tunnels. The potential for higher levels of plutonium is discussed in the third paragraph on page A-12; however, it is not discussed in the context of the potential impact on the strategy developed for the investigation.

The two identical figures are being changed to both depict the location of the Neptune crater and more accurately reflect the boundaries between CASs 12-06-05 and 12-06-08.

The pertinent sections of the CAIP for CAU 551 are being changed to reflect the possibility of an upslope source of radiological contamination, to add additional language concerning the safety experiments conducted at C-, D-, and F-Tunnels, and to correct several errors in the text, some of which refer to the incorrect figures.

The project time will be Unchanged.

Applicable Project-Specific Document(s): **Corrective Action Investigation Plan for Corrective Action Unit 551: Area 12 Muckpiles, Nevada Test Site, Nevada Rev. 0, June 2004**

Approved By: Kevin Cabble Date 4-7-05
NNSA/NSO Project Manager for

Robert M. Bangerter Jr. Date 4/7/05
NNSA/NSO Environmental Restoration Division Director

________________ Date ________
NDEP

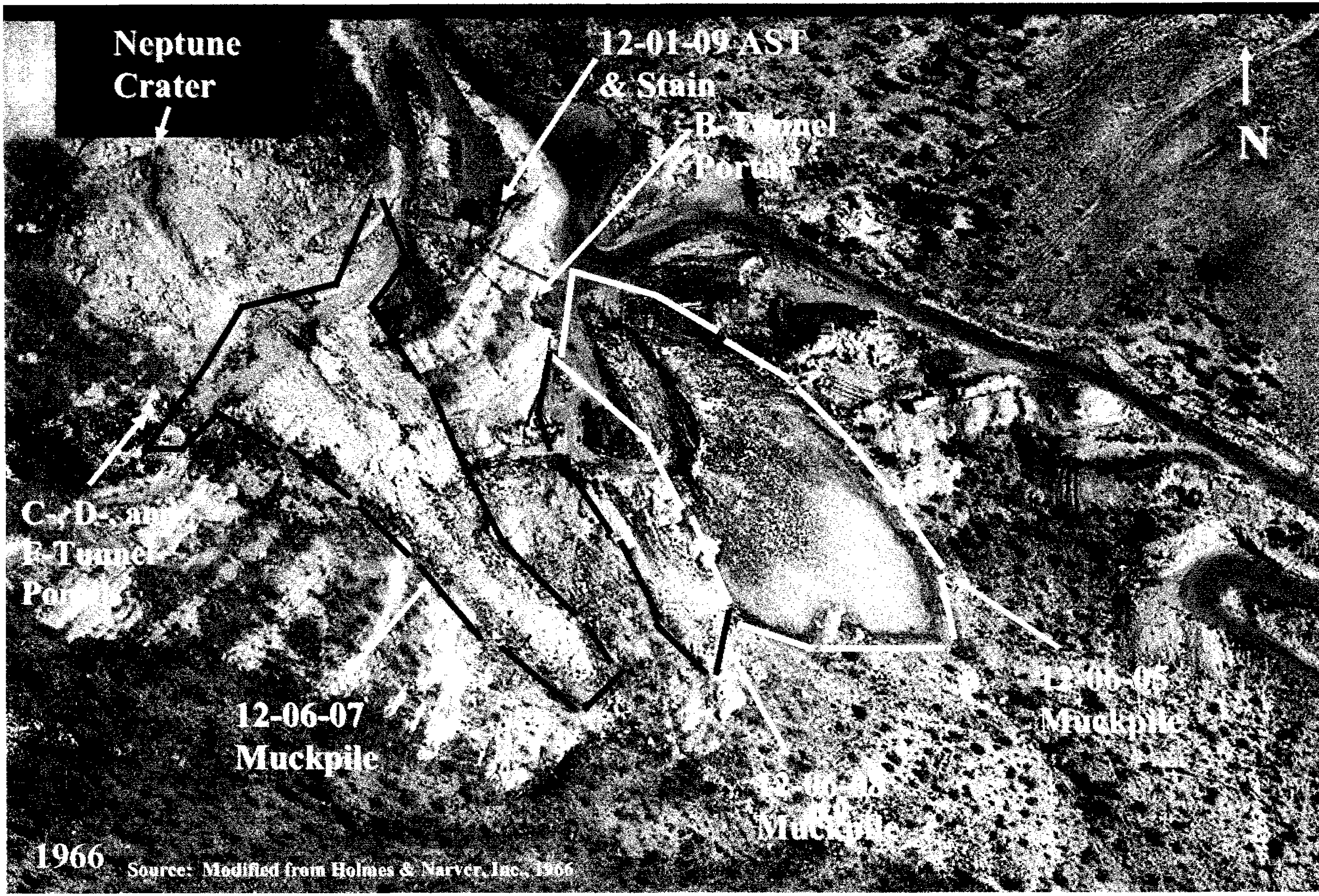
The project time will be Unchanged.

Applicable Project-Specific Document(s): Corrective Action Investigation Plan for Corrective Action Unit 551: Area 12 Muckpiles, Nevada Test Site, Nevada Rev. 0, June 2004

Approved By: [signature] Date 4-7-05
NNSA/NSO Project Manager /s/

[signature] Date 4/7/05
NNSA/NSO Environmental Restoration Division Director

[signature] Date 4/12/05
NDEP


Neptune
Crater
12-01-09 AST
& Stain
N
12-06-07
Muckpile
Muckpile
1966
Source: Modified from Holmes & Narver, Inc., 1966

RECORD OF TECHNICAL CHANGE

Technical Change No. CAIP-3 | Page 1 of 2

Project/Job No. IS05-490 | Date 05/26/2005

Project/Job Name CAIP for CAU 551: Area 12 Muckpiles, June 2004 Rev. 0

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

Alfred Wickline (Name) | Task Manager – Industrial Sites (Title)

Description of Changes:

Section 3.3.3 Radiological PALs, Page 25 of 65, 1st paragraph second sentence: Change text from, "The PALs are based on a scaling of the NCRP 25 millirem per year (mrem/yr) dose-based levels to a conservative 15 mrem/yr dose and the generic guidelines for residual concentration of radionuclides in DOE Order 5400.5 (DOE, 1993)" to "The PALS are based on the NCRP 25 millirem per year (mrem/yr) dose-based levels and the generic guidelines for residual concentration of radionuclides in DOE Order 5400.5 Change 2 (DOE, 1993)."

Section 3.3.3 Radiological PALs, Page 26 of 65, Table 3-3. Change the soil PAL column as follows: Americium-241 (soil) – 12.7 pCi/g; Cesium-137 (soil) – 12.2 pCi/g; Cobalt-60 (soil) – 2.7 pCi/g; Plutonium-238 (soil) 13.0 pCi/g; Plutonium 239/240 (soil) – 12.7 pCi/g; Strontium-90 (soil) – 838 pCi/g; Uranium-234 (soil) – 143 PCi/g; Uranium-235 (soil) – 17.5 pCi/g; Uranium-238 (soil) – 105 pCi/g.

Change footnote "b"" to, " The PALs for soil are based on the National Council on Radiation Protection and Measurement (NCRP) Repot No. 129 "Recommended Screening Limits for contaminated Surface soil and Review of Factors Relevant to Site-Specific Studies" (NCRP, 1999) and the guidelines for residual concentration of radionuclides in DOE Order 54000.5 Change 2 (DOE, 1993).

Section A.1.4.2, Page A-38 of 87, 5th bullet: Change text from, "scaled from 25 to 15 mrem/yr dose" to…" to "are based on 25 mrem/yr dose, and …"

Section A.1.4.2, Page A-38 of 87, last paragraph, first sentence: Change sentence to read, "Radiochemistry PALs are based on the NCRP 25 mrem/yr dose-based levels (NCRP, 1999) and the recommended levels for certain radionuclides in DOE Order 5400.5, Change 2 (DOE, 1993).

Justification:

The Preliminary Action Levels (PALs) for radiological isotopes in the environment are calculated based on 25 mrem/yr exposure level as agreed between NNSA/NSO, NDEP and SNJV for the Industrial Sites project. The previous PALs were based on a 15 mrem/yr dose.

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

Applicable Project-Specific Document(s):
Corrective Action Investigation Plan for Corrective Action Unit 551: Area 12 Muckpiles, Nevada Test Site, Nevada. Rev. 0, June 2004

Approved By: [signature] Date 5/23/05
NNSA/NSO Project Manager

Robert M. Bangerter Jr. Date 5/23/05
NNSA/NSO Environmental Restoration Division Director

______________________ Date ________
NDEP

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

Applicable Project-Specific Document(s):
Corrective Action Investigation Plan for Corrective Action Unit 551: Area 12 Muckpiles, Nevada Test Site, Nevada. Rev. 0, June 2004

Approved By: [signature] Date 5/23/05
NNSA/NSO Project Manager

Robert M. Bangerter Jr. Date 5/23/05
NNSA/NSO Environmental Restoration Division Director

[signature] Date 5/24/05
NDEP

ERRATA SHEET

The Following Corrections Apply to: *Corrective Action Investigation Plan for Corrective Action Unit 551: Area 12 Muckpiles, Nevada Test Site, Nevada*

DOE Document Number: DOE/NV--976

Revision: 0

Original Document Issuance Date: June 2004

Subsequent to the distribution of the *Corrective Action Investigation Plan for Corrective Action Unit 551: Area 12 Muckpiles, Nevada Test Site, Nevada*, Revision 0, DOE/NV--96 one typographical error was identified.

Section A.1.8.2, last paragraph (middle of page A-58): In the middle of the first sentence the number "60" appears followed by a blank line. Delete the number "60" and the blank line so that the sentence reads "… sample locations may be relocated based upon the information obtained during the site visit."

Nevada
Environmental
Restoration
Project

DOE/NV--976

National Nuclear Security Administration

Corrective Action Investigation Plan for Corrective Action Unit 551: Area 12 Muckpiles, Nevada Test Site, Nevada

Controlled Copy No.: ___
Revision No.: 0

June 2004

Approved for public release; further dissemination unlimited.

Environmental Restoration
Division

U.S. Department of Energy
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DOE/NV--976

CORRECTIVE ACTION INVESTIGATION PLAN FOR CORRECTIVE ACTION UNIT 551: AREA 12 MUCKPILES, NEVADA TEST SITE, NEVADA

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

Controlled Copy No.: ___

Revision No.: 0

June 2004

CORRECTIVE ACTION INVESTIGATION PLAN
FOR CORRECTIVE ACTION UNIT 551:
AREA 12 MUCKPILES, NEVADA TEST SITE, NEVADA

Approved by: Signature Approved Date: 06/07/04

Janet Appenzeller-Wing, Project Manager
Industrial Sites Project

Approved by: Signature Approved Date: 06/07/04

Monica Sanchez, Acting Division Director
Environmental Restoration Division

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List of Acronyms and Abbreviations

Am	Americium
amsl	Above mean sea level
AST	Above ground storage tank
bgs	Below ground surface
BN	Bechtel Nevada
CADD	Corrective Action Decision Document
CAI	Corrective Action Investigation
CAIP	Corrective Action Investigation Plan
CAS	Corrective Action Site
CAU	Corrective Action Unit
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
Co	Cobalt
COC	Contaminant of concern
COPC	Contaminant of potential concern
Cs	Cesium
CSM	Conceptual site model
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DQI	Data quality indicator
DQO	Data quality objective
DRO	Diesel-range organics
EPA	U.S. Environmental Protection Agency
exp-COC	Expected contaminant of concern

List of Acronyms and Abbreviations *(Continued)*

FFACO	*Federal Facility Agreement and Consent Order*
FSL	Field-screening level
FSR	Field-screening result
ft	Foot (feet)
ft/yr	Feet per year
FWP	Field work plan
GRO	Gasoline-range organics
HASP	Health and Safety Plan
IDW	Investigation-derived waste
in.	Inch(es)
IRIS	Integrated Risk Information System
ISMS	Integrated Safety Management System
K-40	Potassium-40
LCS	Laboratory control sample
MDC	Minimum detection limit
mg/kg	Milligram per kilogram
mi	Mile
mrem/yr	Millirem per year
MRL	Minimum reporting limit
MS	Matrix spike
MSD	Matrix spike duplicate
NAC	*Nevada Administrative Code*
NCRP	National Council on Radiation Protection and Measurement
ND	Normalized difference

List of Acronyms and Abbreviations *(Continued)*

NDEP	Nevada Division of Environmental Protection
NEPA	*National Environmental Policy Act*
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NTS	Nevada Test Site
NTSWAC	*Nevada Test Site Waste Acceptance Criteria*
PA	Preliminary assessment
PAL	Preliminary action level
PCB	Polychlorinated biphenyl
PID	Photoionization detector
PPE	Personal protective equipment
ppm	Part(s) per million
PRG	Preliminary remediation goal
Pu	Plutonium
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RadCon	Radiological Control
RCRA	*Resource Conservation and Recovery Act*
RPD	Relative percent difference
SDWS	*Safe Drinking Water Standard*
SNJV	Stoller-Navarro Joint Venture
Sr	Strontium
SVOC	Semivolatile organic compound
TPH	Total petroleum hydrocarbon

List of Acronyms and Abbreviations *(Continued)*

TSCA	*Toxic Substance Control Act*
VOC	Volatile organic compound

Executive Summary

This Corrective Action Investigation Plan (CAIP) for Corrective Action Unit (CAU) 551, Area 12 Muckpiles, Nevada Test Site (NTS), Nevada, has been developed in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) that was agreed to by the State of Nevada, the U.S. Department of Energy, and the U.S. Department of Defense. The general purpose of the investigation is to ensure that adequate data are collected to provide sufficient and reliable information to identify, evaluate, and select technically viable corrective actions.

Corrective Action Unit 551 is comprised of the following four corrective action sites (CASs) in Area 12 of the Nevada Test Site:

- 12-01-09, Aboveground Storage Tank and Stain
- 12-06-05, Muckpile
- 12-06-07, Muckpile
- 12-06-08, Muckpile

This CAIP provides investigative details for CAU 551, whereas programmatic aspects of this project are discussed in the *Project Management Plan*. General field and laboratory quality assurance and quality control issues are presented in the *Industrial Sites Quality Assurance Project Plan*. Health and safety aspects of the project are documented in the current version of the *Environmental Architect-Engineer Services Contractor's Health and Safety Plan*, and will be supplemented with a site-specific health and safety plan.

Corrective Action Site 12-01-09 is located in Area 12 and consists of a 550-gallon above ground storage tank (AST) and diesel stain. Corrective Action Site 12-06-05 is located in Area 12 and consists of a muckpile associated with the B-Tunnel. Corrective Action Site 12-06-07 is located in Area 12 and consists of a muckpile associated with the C-, D-, and F-Tunnels. Corrective Action Site 12-06-08 is located in Area 12 and consists of a muckpile associated with the B-Tunnel.

The source of potential contamination for the stain in CAS 12-01-09 is believed to be leakage from the AST which was used to support a nearby generator station. The sources of possible contamination in CAS 12-06-05 and CAS 12-06-08 include reentry mining which followed the six nuclear tests and one confirmed conventional high-explosives test conducted in B-Tunnel. This

mining produced muck, some of which may contain chemical and/or radioactive contaminants. Other sources include possible fuel or oil spills as a result of equipment operating on the muckpile, or chemical spills from products stored on the muckpile. The sources of possible contamination in CAS 12-06-07 include reentry mining, which followed the six nuclear tests conducted in the C-, D-, and F-Tunnels, that produced muck, some of which may contain chemical and/or radioactive contaminants. Other sources include possible fuel or oil spills as a result of equipment operating on the muckpile, or chemical spills from products stored on the muckpile.

One conceptual site model was developed for CAS 12-01-09, and one conceptual site model for CASs 12-06-05, 12-06-07, and 12-06-08, to address possible contamination migration pathways associated with CAU 551. The data quality objective (DQO) process was used to identify and define the type, quantity, and quality of data needed to complete the investigation phase of the corrective action process. The DQO process addresses the primary problem that sufficient information is not available to determine the appropriate corrective action for the CAU. Due to the practical constraints posed by steep slopes on and around the CAU 551 muckpiles, a conservative, simplifying strategy was developed to resolve the presence and nature of contaminants. This strategy includes the use of historical data from similar sites (i.e., previously investigated NTS muckpiles) and the collection of samples from accessible areas of the muckpiles.

Based on site history, process knowledge, and previous investigations of similar sites, contaminants of potential concern for CAU 551 collectively include radionuclides, total petroleum hydrocarbons, polychlorinated biphenyls, *Resource Conservation and Recovery Act* metals, beryllium, volatile organic compounds, and semivolatile organic compounds.

The general technical approach for investigation of CAU 551 includes the following activities:

- Review historical data from similar NTS muckpile sites.
- Determine survey and sample locations that can be safely accessed.
- Perform field screening to aid in selection of soil sample locations.
- Perform radiological land area surveys at CAU 551 to document the radiological condition of land within the site boundary.

- Collect and submit environmental samples for laboratory analysis from accessible, biased locations to determine the nature of potential contamination.
- Collect and submit a sample of source material from the AST at CAS 12-01-09.
- Collect and submit environmental samples for laboratory analysis to determine the nature and extent of potential contamination.
- Remove and properly dispose of the source material in the AST to prevent further leakage.
- Collect required quality control samples.
- Collect additional samples, as necessary, to estimate volumes and determine disposal options for potential corrective action waste streams.
- Collect samples from native soils and analyze for geotechnical/hydrologic parameters, if necessary.
- Collect and analyze bioassessment samples, if appropriate (e.g., if volatile organic compound concentrations exceed field-screening levels in a pattern that suggests that a plume may be present).
- Stake or flag sample locations and record coordinates.

Under the *Federal Facility Agreement and Consent Order*, the CAIP will be submitted to the Nevada Division of Environmental Protection for approval. Field work will be conducted following approval of the plan. The results of the field investigation will support a defensible evaluation of corrective action alternatives that will be presented in the Corrective Action Decision Document.

1.0 Introduction

This Corrective Action Investigation Plan (CAIP) contains project-specific information including facility descriptions, environmental sample collection objectives, and criteria for conducting site investigation activities at Corrective Action Unit (CAU) 551, Area 12 muckpiles, Nevada Test Site (NTS), Nevada.

This CAIP has been developed in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) (1996) that was agreed to by the State of Nevada, the U.S. Department of Energy (DOE), and the U.S. Department of Defense.

Corrective Action Unit 551 is located in Area 12 of the NTS, which is approximately 110 miles (mi) northwest of Las Vegas, Nevada (Figure 1-1). Area 12 is approximately 40 miles beyond the main gate to the NTS. Corrective Action Unit 551 is comprised of the four Corrective Action Sites (CASs) shown on Figure 1-1 and listed below:

- 12-01-09, Aboveground Storage Tank and Stain
- 12-06-05, Muckpile
- 12-06-07, Muckpile
- 12-06-08, Muckpile

Corrective Action Site 12-01-09 is located in Area 12 and consists of an above ground storage tank (AST) and associated stain. Corrective Action Site 12-06-05 is located in Area 12 and consists of a muckpile associated with the U12 B-Tunnel. Corrective Action Site 12-06-07 is located in Area 12 and consists of a muckpile associated with the U12 C-, D-, and F-Tunnels. Corrective Action Site 12-06-08 is located in Area 12 and consists of a muckpile associated with the U12 B-Tunnel.

In keeping with common convention, the U12B-, C-, D-, and F-Tunnels will be referred to as the B-, C-, D-, and F-Tunnels.

The corrective action investigation (CAI) will include field inspections, radiological surveys, and sampling of media, where appropriate. Data will also be obtained to support waste management decisions.

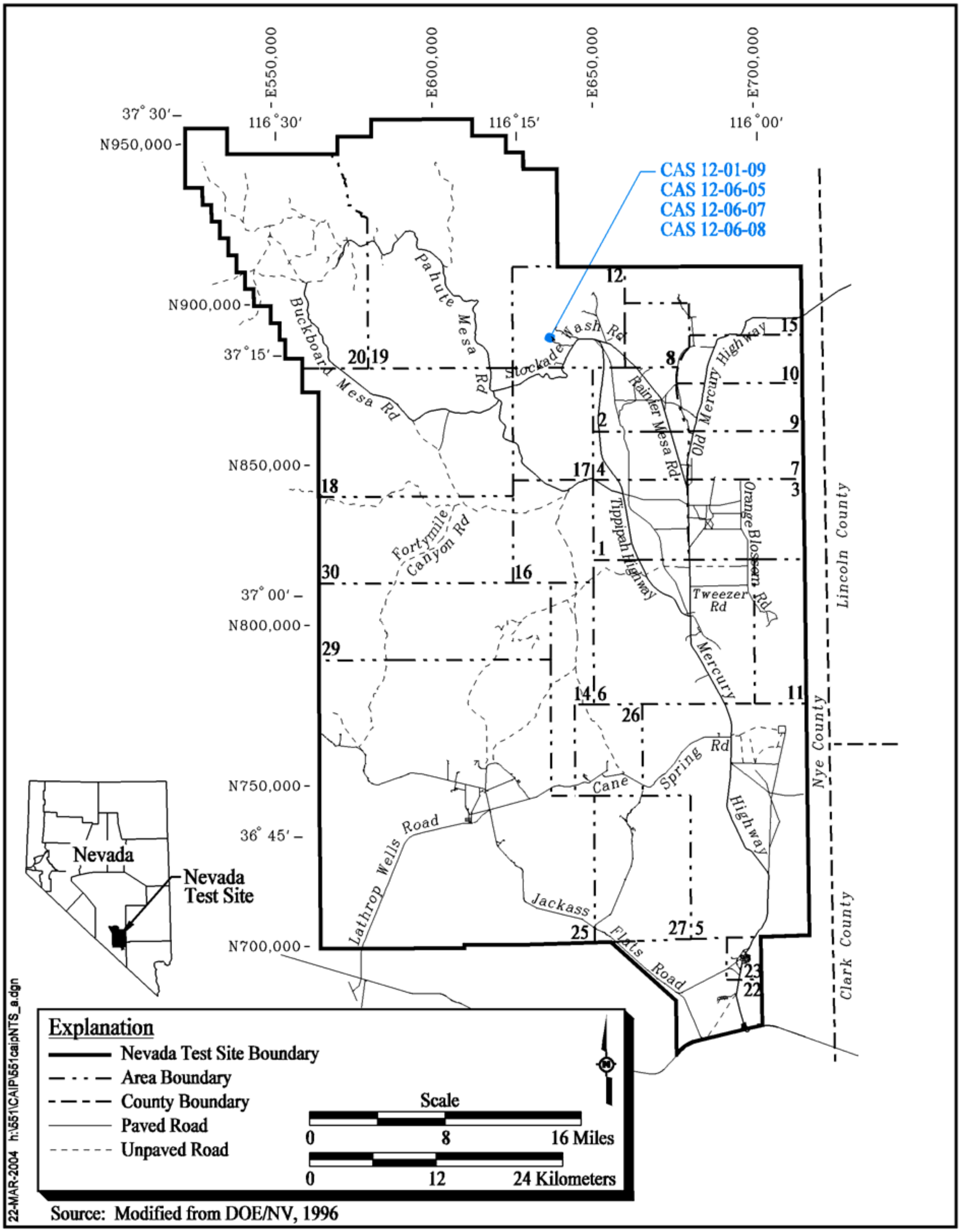


Figure 1-1
Nevada Test Site Map with CAU 551, Area 12 Muckpiles CAS Locations

1.1 Purpose

The CASs in CAU 551 are being investigated because hazardous and/or radioactive constituents may be present in concentrations that could potentially pose a threat to human health and/or the environment. Existing information on the nature and extent of potential contamination at these sites are insufficient to evaluate and recommend corrective action alternatives for the CASs. Therefore, additional information will be obtained by conducting a CAI prior to evaluating corrective action alternatives and selecting the appropriate corrective action for each CAS.

Corrective Action Unit 551 is located in the immediate vicinity of the B-, C-, D-, and F-Tunnel portals in Area 12 of the NTS, and was created to address concerns about potential contamination of the muckpiles associated with those tunnels. The three muckpiles within the unit are designated CASs 12-06-05, 12-06-07, and 12-06-08. A fourth CAS, a 550-gallon AST and underlying stain, was added as CAS 12-01-09, AST and Stain, to CAU 551 through an FFACO modification approved April 26, 2004. CAU 551 lies on the eastern slopes of Rainier Mesa at approximately 6,600 feet (ft) above mean sea level (amsl), and encompasses the tunnels that hosted twelve of the earliest underground nuclear tests. The terrain is very steep, and consists of rock outcroppings and thin patches of soil and alluvium. All drainages within CAU 551 flow to a common wash, several hundred feet up slope from the U12 E-Tunnel (i.e., E-Tunnel) muckpile (CAU 383).

The CASs which comprise CAU 551 will be investigated based on data quality objectives (DQOs) developed by representatives of the Nevada Division of Environmental Protection (NDEP); DOE National Nuclear Security Administration Nevada Site Office (NNSA/NSO); Stoller-Navarro Joint Venture (SNJV); and Bechtel Nevada (BN). The DQO process is used to identify and define the type, amount, and quality of data needed to develop and evaluate appropriate corrective actions for CAU 551. This CAIP will describe the investigation strategy developed to satisfy the data needs identified in the DQO process. While a detailed discussion of the DQO methodology and the DQOs specific to each CAS are presented in Appendix A.1 of this document, a summary of the results of the DQO process is provided below.

The DQO problem statement for CAU 551 is: "Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives for the CASs in CAU 551." To address this problem statement, the resolution of two decision statements is required:

- Decision I: "Is any contaminant of concern (COC) present in environmental media within the CAS at a concentration that could pose an unacceptable risk to human health and the environment?" A COC is defined as any contaminant associated with a CAS activity that is present at concentrations exceeding its corresponding preliminary action level (PAL). If a COC is detected, then Decision II must be resolved. Otherwise, the investigation for that CAS is complete.
- Decision II: "If a COC is present, is sufficient information available to evaluate appropriate corrective action alternatives?" Sufficient information is defined as the data needs identified in the DQO process to include data needed to define the maximum lateral and vertical extent of any COC within each CAS.

The informational inputs and data needs to resolve the problem statement and the decision statements were defined as part of the DQO process for this CAU and are documented in Appendix A.1. The strategy developed to obtain the information necessary to resolve the DQO decisions for CAS 12-01-09 differs from the strategy developed for the CAU 551 muckpiles.

For CAS 12-01-09, AST and Stain, the information necessary to resolve the decision statements will be generated by collecting and analyzing samples gathered during a field investigation. The presence and nature of contamination at CAS 12-01-09 will be determined by sampling locations that are identified as the most probable to contain COCs. If while defining the nature of contamination it is determined that COCs are present at CAS 12-01-09, that CAS will be further addressed by determining the extent of contamination before evaluating corrective action alternatives.

For CASs 12-06-05, 12-06-07, and 12-06-08, muckpiles, it is impractical to resolve the decision statements based solely on collecting and analyzing samples gathered at CAU 551. Slopes on and around the muckpiles present a climbing hazard to samplers and surveyors, and limit accessibility to mechanical sampling equipment. Therefore, necessary information will be obtained from two sources, data generated from previous NTS muckpile investigations and samples collected from accessible areas on the muckpiles. This approach is based on the assumption that the conceptual site model (CSM) for the CAU 551 muckpiles is sufficiently similar to those of previously investigated NTS muckpiles, and the explicit assumption that the operational histories and environmental settings are similar enough that contaminants of potential concern (COPCs) and their fates can be expected to be similar. Validated data generated from previous NTS muckpile investigations at CAUs 475, 476, 477, 482, and 504 has been used to generate a list of expected COCs for CAU 551. Expected COCs are defined as contaminants identified in muck sample(s) from any one of the five previously investigated NTS muckpile CAUs. The data used to generate the list of expected COCs is published in the Corrective Action Decision Documents (CADDs) for CAUs 476, 477, 482, and 504 (DTRA, 2000, 2001, 2002, and 2003). For CAU 475, the data has been validated but has not yet been published in a Corrective Action Decision Document (CADD). The corrective action investigation at the E-Tunnel Muckpile (CAU 383) has not been completed; therefore, no data from the E-Tunnel Muckpile was considered during the review of the historical data from previously investigated NTS muckpiles. Data was obtained from the SNJV analytical services data base. Uncertainty about the presence and nature of other contamination at CASs 12-06-05, 12-06-07, and 12-06-08 will be reduced through the collection and laboratory analysis of samples from locations on CAU 551 muckpiles that are determined to be the most probable to contain COCs and that are safely accessible.

If while defining the nature of contamination it is determined that COCs are present at a CAS, that CAS will be further addressed by determining the extent of contamination before evaluating corrective action alternatives.

1.2 Scope

To generate information needed to resolve the decision statements identified in the DQO processes, the scope of the CAI for CAU 551 includes the following activities:

- Review historical data from similar NTS muckpile sites.
- Determine survey and sample locations that can be safely accessed.
- Perform field screening to aid in selection of soil sample locations.
- Perform radiological land area surveys at CAU 551 to document the radiological condition of land within the site boundary.
- Collect and submit environmental samples for laboratory analysis from accessible, biased locations to determine the nature of potential contamination.
- Collect and submit a sample of source material from the AST at CAS 12-01-09.

- Collect and submit environmental samples for laboratory analysis to determine the nature and extent of potential contamination.
- Remove and properly dispose of the source material in the AST to prevent further leakage.
- Collect required quality control samples.
- Collect additional samples, as necessary, to estimate volumes and determine disposal options for potential corrective action waste streams.
- Collect samples from native soils and analyze for geotechnical/hydrologic parameters, if necessary.
- Collect and analyze bioassessment samples, if appropriate (e.g., if volatile organic compound concentrations exceed field-screening levels in a pattern that suggests that a plume may be present).
- Stake or flag sample locations and record coordinates.

Soil contamination originating from activities not identified in the conceptual site model of any CAS or identified as originating from outside of CAU 551 (e.g., venting or breaches from other tunnels) will not be considered as part of this CAU unless the conceptual site model and DQOs are modified to include the associated release. As such, contamination originating from these sources will not be considered for sample location selection, and/or will not be considered COCs for Decision II. If such contamination is present, the contamination will be identified as part of a new or other existing CAS.

1.3 CAIP Contents

Section 1.0 presents the purpose and scope of this CAIP, while Section 2.0 provides background information about CAU 551. Objectives of the investigation, including conceptual site models, are presented in Section 3.0. Field investigation and sampling activities are discussed in Section 4.0, and waste management issues for this project are discussed in Section 5.0. General field and laboratory quality assurance (QA) and quality control (QC) requirements (including collection of QC samples) are presented in Section 6.0 and in the *Industrial Sites Quality Assurance Project Plan* (QAPP) (NNSA/NV, 2002a). The project schedule and records availability are discussed in Section 7.0, and Section 8.0 provides a list of references.

Appendix A.1 provides a detailed discussion of the DQO methodology and the DQOs specific to each CAS, while Appendix A.2 contains information supporting the assumptions derived and presented in Appendix A.1. Appendix A.3 contains information on the project organization.

The health and safety aspects of this project are documented in the project-specific health and safety documents that will be written prior to the start of field work.

Public involvement activities are documented in the "Public Involvement Plan" contained in Appendix V of the FFACO (1996). The managerial aspects of this project are discussed in the *Project Management Plan* (DOE/NV, 1994) and will be supplemented with a site-specific field management plan that will be developed prior to field activities.

2.0 Facility Description

Corrective Action Unit 551 is comprised of four CASs, three of which were grouped together based on the geographical location of the sites, technical similarities (muckpiles), and the agency responsible for closure. The fourth CAS, an AST and stain, was added during the DQO development process, and is included due to its proximity. The muckpiles within the three initial CASs were derived from similar geological material, lie within a few hundred yards of each other, were created from and managed through similar tunnel activities (e.g., safety experiments, weapons- related tests, weapons effects tests, and conventional high-explosives tests) during the same time period (1957 through 1963), and have been subjected to the same environmental conditions. The muckpiles are located in Area 12 of the NTS and include CASs 12-06-05, 12-06-07, and 12-06-08. The fourth CAS, 12-01-09, appears in engineering drawings of the same time frame, lies within a few hundred yards of the other three CASs, affects the same geological material, and has also been subjected to the same environmental conditions.

2.1 Physical Setting

The CAU 551 CASs are located on the eastern slope of Rainier Mesa within Area 12 of the NTS. General background information pertaining to topography, geology, hydrogeology, and climatology are provided for these specific areas or the NTS region in the *Geologic Map of the Nevada Test Site, Southern Nevada* (USGS, 1990); *CERCLA Preliminary Assessment for DOE's Nevada Operations Office Nuclear Weapons Testing Areas* (DRI, 1988); the *Nevada Test Site Final Environmental Impact Statement* (ERDA, 1977); and the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE/NV, 1996).

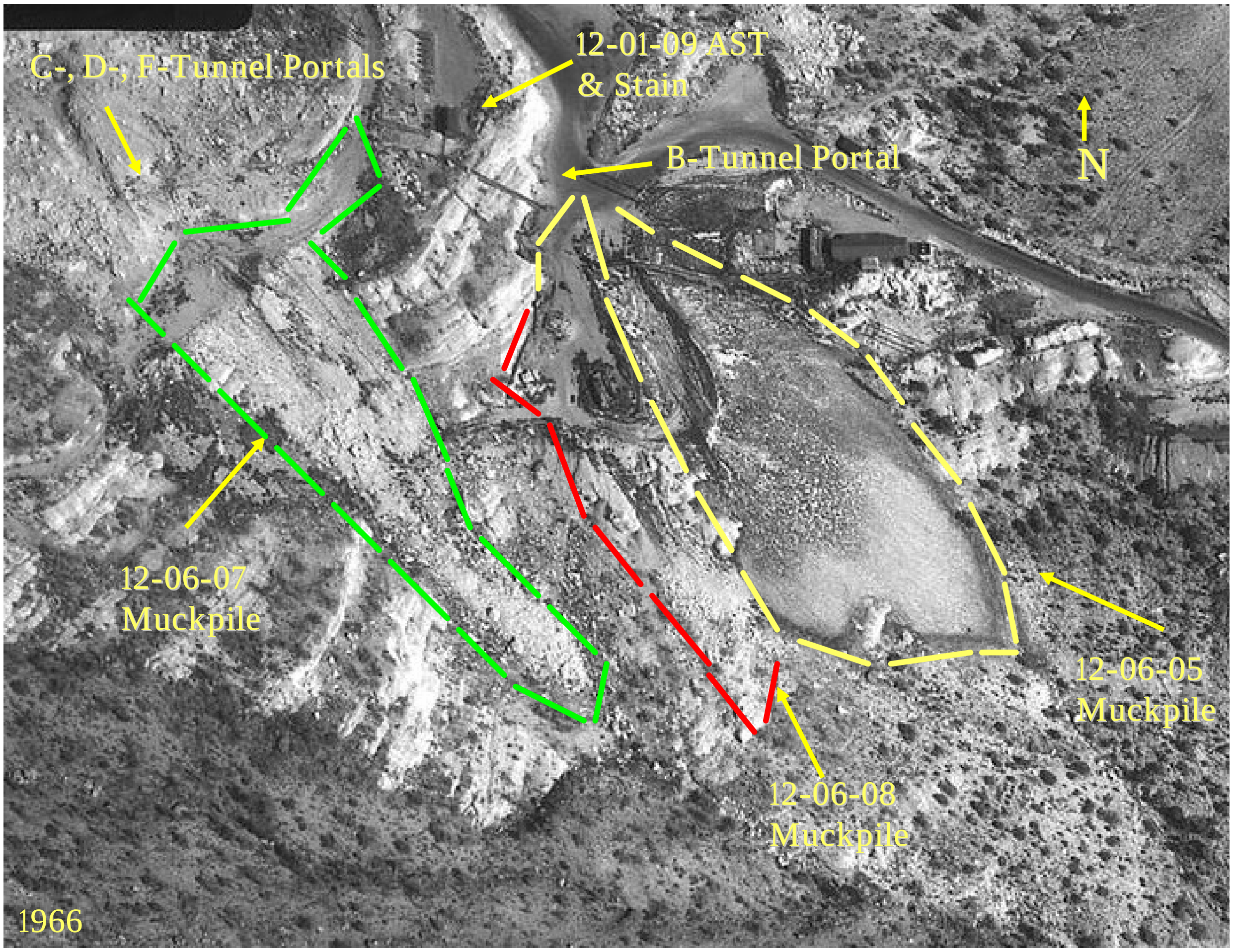
Corrective Action Sites 12-01-09, 12-06-05, 12-06-07, and 12-06-08 are located on a south-southeast facing slope along the eastern side of the Rainier Mesa within Area 12 of the NTS. CAS 12-06-07 lies approximately 300 ft up slope and slightly to the west of CAS 12-06-08; CAS 12-06-05 is immediately northeast of CAS 12-06-08. CAS 12-01-09 lies approximately 200 yards north-northwest of CAS 12-06-05. The E-Tunnel muckpile is not a member of this CAU but is in close proximity (several hundred feet down gradient from CAU 551). Overall views of the location of the unit and nearby features are shown in aerial photographs (Figure 2-1 and Figure 2-2) and in an oblique photograph (Figure 2-3).

The general topography consists of rock outcroppings of bedded tuff aquitard, welded tuff aquitard, and talus slopes, upon which thin patches of soil have developed. Several small gullies are present in the CAU, joining further down slope to form a larger wash. The talus slope angles are estimated to be from 20 to 30 degrees; some portions of the CAS muckpiles may be closer to, or slightly above, the angle of repose (i.e., the angle of slope that a pile of granular material forms under the force of gravity and when at rest, ranging from 35 degrees for fine sand to 45 degrees for angular gravel). Corrective Action Unit 551 is at an elevation of approximately 6,600 ft amsl (DRI, 1988).

Geologically, Rainier Mesa is comprised of a welded tuff overlying friable-bedded tuff and zeolitized-bedded tuffs of the Piapi Canyon Group and Indian Trail Formation of the Tertiary age (USGS, 1965; Winograd and Thordarson, 1975). Rainier Mesa is the highest of a group of mesas, ridges, and low mountains which compose the Belted Range, and is the remnant of a volcanic plateau uplifted during an episode of tectonic extension during the middle to late Cenozoic (DRI, 1987). The tuff is up to 5,000 ft thick, and soda rhyolitic in composition. The tuff includes the Grouse Canyon Member, the most densely welded tuff; many outcrops resemble a lava rather than a welded tuff (GSA, 1968). The tuff originated from a series of calderas.

Rainier Mesa serves as part of a drainage divide that separates westerly surface drainage to the Fortymile Canyon from the easterly surface drainage to Yucca Flat (DRI, 1987). Drainage from CAU 551 is to Yucca Flat. Within the subsurface, the regional zone of saturation occurs in the Paleozoic strata several thousand feet beneath the surface. At Rainier Mesa, perched water occurs only within the tuff aquitard, the top of which occurs at about 6,600 ft amsl. The perched water table that exists in fractures within the aquitard occurs between 6,033 and 6,184 feet amsl in the east-central portion of Rainier. In tunnels, perched water was found in poorly connected fractures. The water table within the underlying lower carbonate aquifer exists at about 2,000 ft below the perched water table (Winograd and Thordarson, 1975). Groundwater beneath Rainier Mesa may flow westward or southward within the Alkali Flat-Furnace Creek Ranch subbasin, or some part may flow eastward (USGS, 1996).

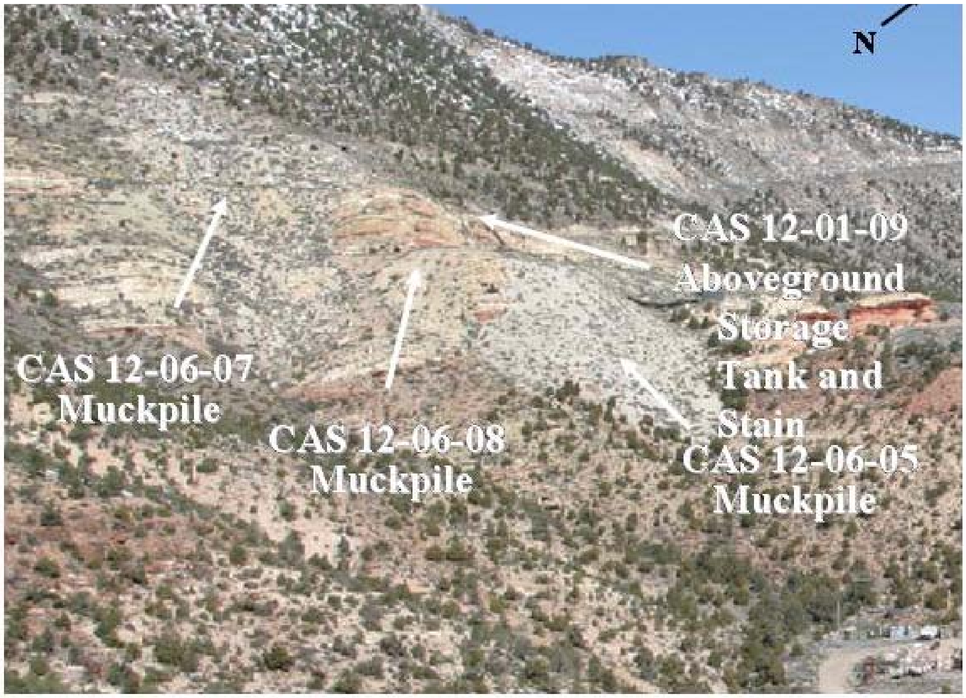
Figure 2-1 CAU 551, CAS Site Locations



Source: Modified from Holmes & Narver, Inc., 1966.

Figure 2-2
CAU 551, Area 12 Muckpiles, CASs 12-01-09, 12-06-05, 12-06-07, and 12-06-08

Precipitation rates for this region (i.e., Rainier Mesa to Yucca Flat) averages from 6 to 12 inches (in.) as indicated on isohyetal maps (USGS, 1965). Precipitation deposited on Rainier Mesa either infiltrates into soil and rock, runs off in gullies and washes, or is lost to evapotranspiration. Precipitation that infiltrates into the overlying soil and exposed rock percolates through unsaturated rock material, locally recharging the groundwater system (USGS, 1996). Recharge on top of the Mesa is estimated at 140-acre feet per year (ft/yr) based on a proportional percentage of precipitation. It should be noted that distribution, rate, and quantity of recharge are only estimates (USGS, 1996).



Digital photograph of CAU 551 (SNJV, 2004)

Figure 2-3
Overall View of CAU 551, Area 12 Muckpiles, and Surrounding Area

Well ER-12-1 is located near the base of the eastern slope of Rainier Mesa, alongside the U-12e Tunnel access road at the base of Dolomite Hill in Area 12, within two miles of CAU 551. Well ER-12-1 is at 5,817 ft amsl, and was drilled to a depth of 3,588 ft in 1991. The purpose of Well ER-12-1 was to determine the hydrogeology of Paleozoic carbonate rocks and the Eleana Formation (a regional aquitard in an area potentially down gradient from underground nuclear testing). Since 1997, Well ER-12-1 has been used as a monitoring well for the E-Tunnel evaporation ponds. Only the uppermost sleeve (1,757 ft) within ER-12-1 is open and accessing formational groundwater for the purposes of sampling (DRI, 1996). Groundwater in Well ER-12-1 was measured in September 2003 at 1,526.41 ft below ground surface (bgs) (USGS and DOE, 2003).

2.2 Operational History

The following subsections provide a description of the use and history of each CAS in CAU 551. The CAS-specific summaries are designed to illustrate all significant, known activities. A site visit was conducted on December 4, 2003, and included representatives from NDEP, NNSA/NSO, and

NNSA/NSO contractors. Information gathered during this and other site visits has been added to the individual CAS operational histories.

2.2.1 Corrective Action Site 12-01-09, Aboveground Storage Tank and Stain

Corrective Action Site 12-01-09, AST and Stain, consists of an aboveground fuel storage tank and underlying soil stain located next to a generator building. The tank appears on a 1959 engineering drawing (Holmes & Narver, 1959b), and was likely used during the operational period for the B-, C-, D-, and F-Tunnels (1957 to 1963). The stain lies beneath the north end of the tank and likely resulted from fuel released either by spillage during refuelling activities or from a leak in the tank. The location of CAS 12-01-09 is shown in Figure 2-2.

2.2.2 Corrective Action Sites 12-06-05, and 12-06-08, Muckpiles

Corrective Action Sites 12-06-05 and 12-06-08 consist of the muckpile located outside of B-Tunnel. The muckpile was created from operations in and around B-Tunnel from 1957 to 1963. It is unclear exactly why the muckpile was given two CAS designations; however, it is assumed the split was done based on a physical separation of two lobes of the muckpile. This split appears to have been caused by a drainage that presently flows between them and/or from muck dumping practices. Aside from the different radiological postings on the two muckpiles, there is no reason to suspect that the two CASs contain material from different sources. For the purposes of this investigation the two CASs that make up the B-Tunnel Muckpile will be treated as one site.

B-Tunnel was the site of six confirmed nuclear tests, one high-explosives test (AEC, 1958; name of test not provided in document) and one confirmed accidental explosion (Holmes & Narver, 1959a). The muck and debris in both CASs resulted from the activities conducted at the tunnel, including drilling, tunnel development, cutback operations, and reentry mining. Reentry mining and excavation activities produced muck, which consists of rock debris, cabling, scrap metal, and cementitious mixtures, and may contain radioactive contaminants. The location of CASs 12-06-05 and 12-06-08 are shown in Figure 2-2.

A physical separation exists between the two CASs. This split appears to have been caused by a drainage that presently serves as an intermittent gulley during rain events and/or muck dumping at two distinct locations.

2.2.3 Corrective Action Site 12-06-07, Muckpile

Corrective Action Site 12-06-07, Muckpile, consists of one muckpile created from operations in and around C-, D-, and F-Tunnels during 1957 and 1958. C-Tunnel was the site of three nuclear tests, D-Tunnel was the site of one nuclear test, and F-Tunnel was the site of two nuclear tests. The muck and debris in this CAS resulted from the activities conducted at the tunnels, including drilling, tunnel development, cutback operations, and reentry mining. Reentry mining and excavation activities produced muck, which may contain radioactive contaminants. The location of CAS 12-06-07 is shown in Figure 2-2.

2.3 Waste Inventory

Available documentation, interviews with former site employees, process knowledge, and general historical NTS practices were used to identify wastes that may be present. These sources did not indicate that this CAU was or was not used to dispose of material considered to be hazardous waste as defined by current standards. Although no known occurrences of hazardous waste disposal have been identified for CAU 551, materials remaining from past activities conducted at, or near, this CAU may be considered hazardous and/or radioactive waste by current standards.

2.3.1 CAS 12-01-09, Aboveground Storage Tank and Stain

The AST is labeled as a 550-gallon fuel tank in engineering drawings of the site (Holmes & Narver, 1959b). Petroleum fuel, to supply a nearby generator, may be present in the tank and underlying soil stain. Waste types have not been identified at this site, but likely include total petroleum hydrocarbons (TPH), diesel-range organics (DRO).

2.3.2 CASs 12-06-05, 12-06-07, and 12-06-08, Muckpiles

The muckpiles contain material consisting primarily of mining debris (rock) generated during the excavation phase of shaft construction; therefore, the bulk of the muckpile is assumed to be uncontaminated material. The post-test portion, which includes disturbed geologic materials and construction/reentry debris, comprises a small fraction of the muckpile. Past surface activities of concern include equipment maintenance and storage of equipment and petroleum products. Releases to the muckpile from surface activities may be locally significant, but vertical infiltration of contaminants is probably limited to less than five feet into native material, based on findings at previous NTS muckpile investigations (see Section A.1.1.4).

Hazardous and radioactive waste from tunnel operations may be present in the muckpiles or on the ground surface in the area of the B-, C-, D-, and F-Tunnels. Specific waste types have not been identified at this site, but likely include radionuclides based on the contamination postings on the muckpiles. CASs 12-06-05 and 12-06-08 are posted with "Caution Radioactive Contamination Area" and "Underground Radioactive Material Area" signs; CAS 12-06-08 is further posted with an "Alpha Contamination - Access Prohibited" sign. CAS 12-06-07 is posted with "Caution Radioactive Contamination Area," "Underground Radioactive Material Area," and "Alpha Contamination - Access Prohibited" signs.

2.4 Release Information

The CAS-specific release information, migration routes, exposure pathways, and affected media are discussed in this section. Based on historical information and process knowledge, the primary sources of potential environmental contaminants released to the soil within CAU 551 consist of potentially contaminated muck from the muckpiles and TPH-DRO from the aboveground storage tank and underlying stain.

No analytical data that documents the current contamination levels of CAU 551 were identified. If contamination is present, it is expected that vertical migration of contaminants would be very limited due to the low annual rate of precipitation and high annual evapotranspiration rate at the site. The limited recharge to groundwater from precipitation does not provide a significant mechanism for vertical migration of contaminants to groundwater (DOE/NV, 1992). Also, process knowledge from previous muckpile investigations shows the native material underlying these muckpiles has been largely uncontaminated (Section A.1.1.4). However, lateral migration of contaminants may be an important transport mechanism due to the steep slopes of the area.

Potentially affected media for all CASs include surface and shallow subsurface soil. Exposure routes to site workers include ingestion, inhalation, and/or dermal contact (absorption) from disturbance of contaminated soils, debris, and/or structures. Site workers may be exposed to radiation by performing activities in proximity to radiologically contaminated materials.

At CAU 551, surface soils may have been impacted by contamination associated with atmospheric testing and/or venting or breaching of radioactive contaminants from nearby tunnels. As discussed in Section 1.2, this contamination will not drive the CAU 551 investigation.

The following subsections contain CAS-specific descriptions of known or potential releases associated with CAU 551.

2.4.1 CAS 12-01-09

The stain in CAS 12-01-09 may contain petroleum fuel released from the AST either through spillage or a leak via a rusted weld. Historical documentation identifies a 550-gallon fuel tank at the present day location of CAS 12-01-09 (Appendix A.1, Figure A.1-3, Figure A.1-4, and Figure A.1-5). During a site visit to CAU 551 on December 4, 2003, a stain was noted beneath the north end of the tank and hydrocarbon odor was detected. On a subsequent field visit, it was noted that the tank appears to be approximately half full. It was also observed that the bottom of the north end of the tank was wet, suggesting that it may be actively leaking.

2.4.2 CASs 12-06-05, 12-06-07, and 12-06-08

Corrective Action Sites 12-06-05, 12-06-07, and 12-06-08 consist of potentially contaminated muck and debris removed from nearby tunnels. Historical documentation identifies contaminated dumps (i.e., muckpiles) in the present day locations of CASs 12-06-05 and 12-06-07, and identifies activities involving the bulldozing of contaminated muck over a dump (Appendix A.2). The nature of this contamination was not defined. The present day status of contamination at the dump is unknown. Alpha contamination signs are present on the muckpiles within CASs 12-06-07 and 12-06-08. Potential release of contamination from these muckpiles into the surrounding environment is unknown, although the most likely means would be from overland transport in stormwater runoff to drainages down-slope from the muckpiles.

2.5 National Environmental Policy Act

The *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE/NV, 1996) includes site investigation activities such as those proposed for CAU 551.

In accordance with the NNSA/NSO *National Environmental Policy Act* (NEPA) Compliance Program, a NEPA checklist will be completed prior to commencement of site investigation activities at CAU 551. This checklist compels NNSA/NSO project personnel to evaluate their proposed project activities against a list of potential impacts that include, but are not limited to: air quality, chemical use, waste generation, noise level, and land use. Completion of the checklist results in a determination of the appropriate level of NEPA documentation required by the NNSA/NSO NEPA Compliance Officer.

3.0 Objectives

This section presents an overview of the DQOs for CAU 551 and formulation of the conceptual site models (CSMs). Also presented is a summary listing of the COPCs and PALs for the investigation. Additional details and figures depicting the CSMs are located in Appendix A.1.

3.1 Conceptual Site Models

A CSM describes the most probable scenario for current conditions at a site and defines the assumptions that are the basis for identifying appropriate sampling strategy and data collection methods. Two CSMs have been developed for CAU 551 using information from the physical setting, potential contaminant sources, knowledge from similar sites, release information, historical background information, and physical and chemical properties of the potentially affected media and COPCs. Table 3-1 identifies the CSMs that apply to each CAS. Conceptual site model number 1 describes potential contamination of soil as a result of leakage from an AST, while conceptual site model number 2 represents contamination associated with the disposal of tunnel muck and other possibly contaminated materials.

Table 3-1
CSMs and Associated CASs

Conceptual Site Model (CSM)	AST and Stain	Muckpiles		
	12-01-09	12-06-05	12-06-07	12-06-08
CSM #1	X	--	--	--
CSM #2	--	X	X	X

As discussed in Appendix A.1, the CSM for the muckpiles contains an assumption that the CAU 551 muckpiles are comparable to previously investigated NTS muckpiles and contain COCs identified during those investigations above current PALs.

If during the course of the investigation, contamination exceeding the scope of the CSMs is identified (i.e., unexpected contaminants, unexpected contaminant concentrations, unexpected contaminant migration), the validity of the CSM will be reviewed and a recommendation made as to how best to proceed. In such cases, identified decision makers will be notified and given the opportunity to comment on and/or concur with the recommendation.

The scope of this investigation is limited to the CAU 551 muckpiles, aboveground storage tank, stain, and potential contamination of the environment contiguous to the CASs within CAU 551. This scope does not include potential contamination of the environment from CASs down gradient from CAU 551, such as the muckpile outside of the E-Tunnel.

The following sections discuss future land use and the identification of exposure pathways (i.e., combination of source, release, migration, exposure point, and receptor exposure route) for the CAU.

3.1.1 Future Land Use

The future land-use scenario, as a Nuclear Test Zone, limits uses of CAU 551 to various nonresidential uses (i.e., industrial uses) including defense and nondefense research, development, and testing activities. The Nuclear Test Zone is defined as "...reserved for dynamic experiments, hydrodynamic tests, and underground nuclear weapons and weapons effects tests..." (DOE/NV, 1998).

3.1.2 Contaminant Sources

The source contaminant for CSM #1 is material from the AST. The material has not been analyzed but is believed to be diesel fuel, and likely entered the environment through either spillage during refueling operations or leakage through a rusted weld above the stain.

The source contaminants for CSM #2 is potential contamination present within each muckpile. The potential contamination would have resulted from operations in and around the tunnels next to the muckpiles. Those operations include nuclear testing, conventional high-explosives tests, maintenance and decontamination procedures, and related tunnel activities.

3.1.3 Release Mechanisms

As depicted in CSM #1, a hydrocarbon substance, likely diesel fuel, was released to the environment through either spillage or a leaking weld in the AST. Further potential releases of contaminants from CAS 12-01-09 can come from spills and leaks from the AST onto surface soils.

For CSM #2, the original release of potentially contaminated muck and debris onto native surfaces resulted from operations associated with the creation and use of the B-, C-, D-, and F-Tunnels. Potential releases of contaminants from the muckpiles themselves to the surrounding environment can arise from two transport mechanisms. The first mechanism involves overland transport of contaminants primarily through the movement of runoff during storm events. The second mechanism is through leaching of dissolved contaminants in soil moisture and groundwater.

3.1.4 Migration Pathways

Infiltration and percolation of precipitation can serve as a driving force for downward migration of contaminants. However, potential evapotranspiration (the evaporative capacity of the atmosphere at the soil surface) at the NTS is significantly greater than precipitation; thus, limiting vertical migration of contaminants. The annual average precipitation for this region (i.e., Rainier Mesa to Yucca Flat) is only 6 to 12 in. per year (USGS, 1965). The amount of precipitation falling on this unit, which is approximately 1,000 ft below the mesa top, is greatly exceeded by the evapotranspiration rates of these areas, estimated to be from 24 to 70 in. of water per year (NBMG, 1996). Lower elevations generally receive less precipitation and are subjected to atmospheric conditions that are conducive to higher evaporation and transpiration rates. Little if any moisture would be available to carry dissolved contaminants through the muckpiles. Therefore, recharge to groundwater from precipitation is not significant at the NTS and does not provide a significant mechanism for migration of contaminants to groundwater.

The predominant migration pathway shown in CSM #1 for CAS 12-01-09 is expected to be downward through soil adjacent to the stain. Lateral migration over natural material may also occur due to stormwater runoff.

These CASs have very steep surface gradients and are located in drainage channels; therefore, the predominant migration pathway shown in CSM #2 for CASs 12-06-05, 12-06-07, and 12-06-08 is expected to be lateral migration over soils and talus material. The drainage channels are confined within the same watershed, and flow to a common wash near the E-Tunnel access road. The wash is a few hundred feet up gradient from the E-Tunnel muckpile (CAU 383). This wash eventually joins other washes and flows out to Yucca Flat (DRI, 1987). The other possible migration pathway for this CSM, vertical transport, is considered unlikely due to the average annual evapotranspiration rate exceeding the average annual precipitation rate.

3.1.5 Exposure Points

Exposure points for both CSMs are expected to be locations of surface contamination where visitors and site workers will come in contact with soil surface. Contamination, if present, is expected to be contiguous to the release site, with possible contaminated spots down gradient from the CASs in drainages. Concentrations of contaminants are generally expected to decrease with increasing horizontal and vertical distance from the locations of release. A possible exception would be an increase in concentration at down gradient sediment traps due to scouring and flushing of contaminants with stormwater runoff events.

3.1.6 Exposure Routes

Exposure routes to site workers include oral ingestion, inhalation, and/or dermal contact (absorption) from disturbance of contaminated soils. Site workers may also be exposed to radiation by performing activities in proximity to radiologically contaminated materials.

3.1.7 Additional Information

Information concerning topography, climatic conditions, hydrogeology, floodplains, and infrastructure at the CAU 551 CASs are available and are presented in Section 2.1 as they pertain to the investigation. This information has been addressed in the CSM and will be considered during the evaluation of corrective action alternatives, as applicable. No additional information on these topics is required to complete the investigation and the evaluation of corrective action alternatives.

However, climatic and site conditions (e.g., surface and subsurface soil descriptions) as well as specific structure descriptions will be observed and recorded during the CAI.

3.2 Contaminants of Potential Concern

Potential contaminants for CAU 551 were identified through a review of site history documentation, process knowledge information, personal interviews, past investigation results (when available), and inferred activities associated with the CAU or CASs. Types or categories of contaminants suspected to be present at CAU 551 include, but are not limited to:

- Petroleum hydrocarbons
- Degreasers from decontamination and wash-down activities
- Hydraulic fluids and used oils
- Radioactive material

Because complete information regarding activities performed at the CAU 551 CASs as well as throughout the NTS is unavailable, some uncertainty as to potential contaminants exists. To reduce this uncertainty, additional constituents have been included in the Decision I analytical program to define the nature of contamination for the CAU 551 investigation.

Chemical COPCs listed in Table 3-2 are defined as the analytes reported from the analytical methods for which the U.S. Environmental Protection Agency (EPA) Region IX has established Preliminary Remediation Goals (PRGs) (EPA, 2002b) or for which toxicity data are listed in the EPA Integrated Risk Information System (IRIS) database (EPA, 2001b). Radiological COPCs listed in Table 3-2 are defined as the radionuclides reported from the analytical methods.

Potassium-40 (K-40) is not considered a COPC due to its natural occurrence and predominance in the environment. The only mechanism for K-40 to be considered an environmental contaminant is through concentration. There are no known activities reported at the NTS that would have concentrated K-40 or released it as a contaminant. The CAI will not be expanded to delineate the extent of K-40, nor will K-40 be evaluated in the CADD.

In addition, the radionuclides resulting from the atmospheric nuclear testing are not intended to drive the nature and extent determinations under this investigation. For CAU 551, source delineation is the focus of the sampling and analysis.

To support the efficient decision-making activities, the COPCs for CAU 551 have been divided into critical and noncritical categories. The critical COPCs for Decision I sampling are chemical and

Table 3-2
COPCs and Analytical Requirements for CAU 551

CAS / Analyses	CAS 12-01-09, Aboveground Storage Tank and Stain	CAS 12-06-05, Muckpile	CAS 12-06-07, Muckpile	CAS 12-06-08, Muckpile
Organic COPCs				
TPH (DRO)	C	C[c]		
VOCs[a, b]	X	See Table A.2-1 for critical COPCs[c]		
SVOCs[a, b]	X	See Table A.2-1 for critical COPCs[c]		
PCBs[a]	X	X		
Metal COPCs				
RCRA Metals[a, b]	X	See Table A.2-1 for critical COPCs[c]		
Beryllium	X	X		
Radionuclide COPCs				
Gamma-Emitting Radionuclides[a]	N	C for Cs-137, Co-60, and Am-241[c]		
Sr-90	--	C[c]		
Isotopic-Pu	--	C for Pu-238 and Pu-239/240[c]		
Isotopic-Uranium	--	X		

C = Critical COPC
X = Noncritical COPC-COPCs are the analytes reported from the analytical methods listed.
N = Results of gamma spectroscopy will be used to determine if further radiochemical analyses are necessary.
-- = COPCs have not been identified for this class of potential contaminants.

[a]The contaminants of potential concern are the analytes reported from the analytical methods listed.
[b]May also include toxicity characteristic leaching procedure if sample is collected for waste management purposes.
[c]Critical COPCs are all the analytes listed in Table A.2-1 which have positive detects, except for gasoline. Gasoline is not included as a critical COPC because its components are covered in the organic analyses.

radiological constituents that are reasonably suspected to be present at the site based on documented use, previous analytical results, or process knowledge. Because information such as documented use or process knowledge exists for critical analytes, these analytes are given greater importance in the decision-making process relative to other COPCs. For the critical analytes, more stringent performance criteria are specified during the data quality assessment (Section 6.0).

Noncritical COPCs are defined as all the analytes reported from the respective methods (e.g., volatile organic compounds [VOCs], semivolatile organic compounds [SVOCs], polychlorinated biphenyls [PCBs], total *Resource Conservation and Recovery Act* [RCRA] metals). The noncritical COPCs also aid in reducing the uncertainty concerning the history and potential releases from the CAS and help in the accurate identification of potential contamination. Table 3-2 identifies the COPCs and critical analytes for the CAU 551 Decision I sampling and analysis. Each COPC detected in a sample at concentrations exceeding the corresponding PAL becomes a COC for subsequent sampling to define the extent of contamination (Decision II or step-out samples). These step-out (Decision II) samples will be collected and analyzed for the COCs identified by the Decision I sampling. If COPCs are detected in the Decision I sampling at a concentration that exceeds the respective PAL, whether critical or noncritical, it will become a COC and the extent will be determined with a 100 percent completeness goal.

If Decision II samples are collected prior to nature-of-contamination data becoming available, the step-out samples will be analyzed for the full list of parameters specified in Table 3-2.

The steepness of the slopes on and around CASs 12-06-05, 12-06-07, and 12-06-08 creates unsafe conditions for survey and sampling personnel; therefore, “expected COCs” for the muckpiles were established based on data from previously investigated NTS muckpiles. A more thorough discussion of this approach is presented in the DQOs (Section A.1.3).

3.3 Preliminary Action Levels

The comparison of laboratory results to PALs will be discussed in the CADD. Laboratory results above PALs indicate the presence of COCs that will require further evaluation. The evaluation of potential corrective actions and the justification for a preferred action will be included in the CADD based on the results of this field investigation. Proposed cleanup levels that differ from the PALs will be presented in the CADD, if applicable.

3.3.1 Chemical PALs

The organic and inorganic chemical PALs are based on the EPA *Region 9 Risk-Based Preliminary Remediation Goals* (PRGs) for chemical constituents in Industrial Soils (EPA, 2002b). The PRGs are risk-based contaminant concentrations in environmental media (i.e., soil, air, and water) that EPA considers protective of humans (including sensitive groups) over a lifetime. The industrial-use scenario is applicable to sites at the NTS based on future land-use scenarios as presented in Section 3.1.1 and agreements between NDEP and NNSA/NSO.

For detected chemical COPCs without established PRGs that are listed in the EPA IRIS database (EPA, 2001b), the protocol used by the EPA Region IX in establishing PRGs (or similar) will be used to establish the PALs. If used, this process will be documented in the investigation report.

Background concentrations for RCRA metals will be used instead of PRGs when natural background concentrations exceed the PRG, as is often the case with arsenic on the NTS. Background is considered the mean plus two standard deviations of the mean for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (formerly the Nellis Air Force Range) (NBMG, 1998; Moore, 1999).

3.3.2 TPH PALs

The PAL for TPH in soil is the TPH action limit of 100 parts per million (ppm) established by the *Nevada Administrative Code* (NAC) 445A.2272 (NAC, 2002e).

3.3.3 Radiological PALs

The radiochemistry PALs are based on the National Council on Radiation Protection and Measurement (NCRP) Report No. 129 (NCRP, 1999) recommended screening limits for Construction, Commercial, Industrial land-use scenario and are appropriate for the NTS based on the future land-use scenarios as presented in Section 3.1.1. The PALs are based on a scaling of the NCRP 25 millirem per year (mrem/yr) dose-based levels to a conservative 15 mrem/yr dose and the generic guidelines for residual concentration of radionuclides in DOE Order 5400.5 (DOE, 1993). The PALs for expected common radiological COPCs for CAU 551 are listed in Table 3-3. Other radiological PALs can be derived from NCRP and/or DOE Order 5400, as needed.

The PALs for material, equipment, and structures with residual surface contamination are the allowable total residual surface contamination values for unrestricted release of material and

Table 3-3
Analytical Requirements for Radionuclides for CAU 551

Parameter/Analyte	Matrix	Analytical Method	MDC[a]	PAL[b,c]	Laboratory Precision	Percent Recovery
Gamma Spectrometry						
Americium-241	water	EPA 901.1[d]	50 pCi/L[e]	50 pCi/L	Relative Percent Difference (RPD) 20% water 35% soil Normalized Difference -2<ND<2[g]	Laboratory Control Sample Recovery 80-120[h] Percent Recovery (%R)
	soil	HASL-300[f]	2.0 pCi/g[e]	7.62 pCi/g		
Cesium-137	water	EPA 901.1[d]	10 pCi/L[e]	10 pCi/L		
	soil	HASL-300[f]	0.5 pCi/g[e]	7.3 pCi/g		
Cobalt-60	water	EPA 901.1[d]	10 pCi/L[e]	10 pCi/L		
	soil	HASL-300[f]	0.5 pCi/g[e]	1.61 pCi/g		
Other Radionuclides						
Plutonium-238	water	ASTM D3865-02[i]	0.1 pCi/L	0.1 pCi/L	Relative Percent Difference (RPD) 20% water 35% soil Normalized Difference -2<ND<2[g]	Laboratory Control Sample Recovery 80-120[h] Percent Recovery (%R) Chemical Yield 30-105[j] %R
	soil	ASTM C1001-00[k]	0.05 pCi/g	7.78 pCi/g		
Plutonium-239/240	water	ASTM D3865-02[i]	0.1 pCi/L	0.1 pCi/L		
	soil	ASTM C1001-00[k]	0.05 pCi/g	7.62 pCi/g		
Strontium-90	water	ASTM D5811-00[n]	1.0 pCi/L	1.0 pCi/L		
	soil	HASL 300[f]	0.5 pCi/g	503.0 pCi/g		
Uranium-234	water	ASTM D3972-02[l]	0.1 pCi/L	0.1 pCi/L		
	soil	ASTM C1000-02[m]	0.05 pCi/g	85.9 pCi/g		
Uranium-235	water	ASTM D3972-02[l]	0.1 pCi/L	0.1 pCi/L		
	soil	ASTM C1000-02[m]	0.05 pCi/g	10.5 pCi/g		
Uranium-238	water	ASTM D3972-02[l]	0.1 pCi/L	0.1 pCi/L		
	soil	ASTM C1000-02[m]	0.05 pCi/g	63.2 pCi/g		

[a]The MDC is the lowest concentration of a radionuclide, if present in a sample, that can be detected with a 95 percent confidence level.
[b]The PALs for soil are based on the National Council for Radiation Protection and Measurement (NCRP) Report No. 129, *Recommended Screening Limits for Contaminated Surface Soil and Review of Factors Relevant to Site-Specific Studies* (NCRP, 1999), scaled from 25 to 15 mrem/yr dose and the guidelines for residual concentration of radionuclides in DOE Order 5400.5 (DOE, 1993).
[c]The PALs for liquids are set equal to the MDC.
[d]*Prescribed Procedures for Measurements of Radioactivity in Drinking Water*, EPA-600/4-80-032 (EPA, 1980)
[e]MDCs vary depending on the presence of other gamma-emitting radionuclides in the sample and are relative to the MDC for Cs-137.
[f]*The Procedures Manual of the Environmental Measurements Laboratory*, HASL-300 (DOE, 1997)
[g] ND is not RPD, it is another measure of precision used to evaluate duplicate analyses. The ND is calculated as the difference between two results divided by the square root of the sum of the squares of their total propagated uncertainties. *Evaluation of Radiochemical Data Usability* (Paar and Porterfield, 1997)
[h]EPA *Contract Laboratory Program Statement of Work for Inorganic Analysis* (EPA, 1988a; 1994a; and 1995)
[i]*Standard Test Method for Plutonium in Water* (ASTM, 2002b)
[j] *General Radiochemistry and Routine Analytical Services Protocol* (GRASP) (EG&G Rocky Flats, 1991). The chemical yield only applies to plutonium, uranium and strontium.
[k]*Standard Test Method for Radiochemical Determination of Plutonium in Soil by Alpha Spectroscopy* (ASTM, 2000a)
[l]*Standard Test Method for Isotopic Uranium in Water by Radiochemistry* (ASTM, 2002a)
[m]*Standard Test Method for Radiochemical Determination of Uranium Isotopes in Soil by Alpha Spectrometry* (ASTM, 2002c)
[n]*Standard Test Method for Strontium-90 in Water* (ASTM, 2000b).

ASTM = American Society for Testing and Materials
MDC = Minimum detectable concentration
PAL = Preliminary action level
pCi/g = Picocuries per gram
ND = Normalized difference
pCi/L = Picocuries per liter

equipment listed in the DOE Order 5400.5 (DOE, 1993), which is consistent with Table 4-2 of the *NV/YMP Radiological Control Manual* (RadCon) (DOE/NV, 2000).

3.4 DQO Process Discussion

This section contains a summary of the DQO process that is presented in Appendix A.1. The DQO process is a strategic planning approach based on the scientific method used to prepare for site characterization data collection. The DQOs are designed to ensure that the data collected will provide sufficient and reliable information to identify, evaluate, and technically defend the recommendation of viable corrective actions.

The DQO strategy for CAU 551 was developed at a meeting on February 25, 2004. The DQOs were developed to identify data needs, clearly define the intended use of the environmental data, and design a data collection program that will satisfy these purposes. During the DQO discussions for this CAU, the informational inputs or data needs to resolve problem statements and decision statements were documented.

The problem statement for CAU 551 is: “Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives for the CASs in CAU 551.” To address this question, the resolution of two decisions statements is required:

- The Decision I statement is: “Is a contaminant present within a CAS at a concentration that could pose an unacceptable risk to human health and the environment?” Any contaminant detected at a concentration exceeding the corresponding PAL, as defined in Section A.1.4.2, will be considered a COC. The presence of a contaminant within each CAS is defined as the analytical detection of a COC.

- The Decision II statement is: “If a COC is present, is sufficient information available to determine to what extent the contamination has migrated to the surrounding area?”

These two decision statements apply to all CASs within CAU 551. However, the steepness of the slopes on and around CAS 12-06-07 and CAS 12-06-08, and on the majority of CAS 12-06-05, drives the need to develop a specific strategy to gain the data necessary to answer Decision I at these sites. The sites present safety hazards to the field personnel who would be collecting samples on the muckpiles under sampling programs used during previous NTS muckpile investigations. The hazardous conditions also present a problem for rescue and treatment of injured personnel. The challenges of working in the steep terrain combined with required personnel protective equipment for potential hazards (e.g., alpha contamination) may further restrict access to some parts of the muck piles. Safe set up and staging areas for drilling equipment are also concerns, due to the limited amount of level ground, the steep slopes, and the stability of those slopes.

A site-specific strategy has been developed to generate data to answer Decision I while taking into account the practical constraints imposed by the slopes of the site. This strategy requires the further refinement of the Decision I statement for CASs 12-06-05, 12-06-07, and 12-06-08 into four supporting decision statements. These supporting decision statements and the issues that they address are discussed in detail in Section A.1.3 of Appendix A.1 and are listed below:

- Decision Ia statement is: Are COPCs present in muck samples collected during previous muckpile investigations at levels above current PALs?
- Decision Ib statement is: Are the COPCs identified in muck at concentrations above PALs in previous NTS muckpile investigations expected to be present at concentrations above PALs in the CAU 551 muckpiles?
- Decision Ic statement is: Are COCs present in the samples that can be collected at CAU 551 muckpiles?
- Decision Id statement is: Does the data acquired at CAU 551 muckpiles support the CSM, including the outputs of Decisions Ia and Ib?

Historical data generated from previous investigations of CAUs 475, 476, 477, 482, and 504 was reviewed to determine which COPCs detected at previous NTS muckpile investigations would exceed current PALs. Those COPCs that did exceed current PALs are defined as “expected COCs” (exp-COCs) for CAU 551 muckpiles. Expected COCs are assumed to exist in the CAU 551 muckpiles at a concentration of at least the highest level found at any of the previously investigated NTS muckpiles.

To reduce the uncertainty inherent in applying data from similar sites to the CAU 551 muckpiles, Decision I samples will be collected from safely accessible areas of the CAU 551 muckpiles. Data from these samples will be compared to the list of exp-COCs. If additional COCs are identified, these will be added to the list of COCs for the CAS. Data from these samples will be evaluated to determine if it supports the CSM developed for the muckpiles, including the presence and expected concentration of the exp-COCs.

At the same time that Decision I samples are to be taken from safely accessible areas of the muckpiles, initial Decision II samples will be taken from (1) areas below the foot of the muckpiles, (2) at the confluence of the drainages from the CAS 12-06-05 and 12-06-08 muckpiles and from the CAS 12-06-07 muckpile, and (3) at the point at which the main wash intersects the access road below.

Decision I samples will be submitted for analysis of COPCs listed in Table 3-2. The analytical requirements for the CAU 551 COPCs are listed in Table 3-4.

Table 3-4
Analytical Requirements for CAU 551
(Page 1 of 3)

Parameter	Medium or Matrix	Analytical Method	Minimum Reporting Limit	RCRA Hazardous Waste Regulatory Limit	Laboratory Precision (RPD)[a]	Percent Recovery (%R)[b]
ORGANICS						
Total Volatile Organic Compounds (VOCs)	Aqueous Soil	8260B[c]	Parameter-specific estimated quantitation limits (EQLs)[d]	Not Applicable (NA)	Lab-specific[e]	Lab-specific[e]
Toxicity Characteristic Leaching Procedure (TCLP) VOCs						
Benzene	Aqueous	1311/8260B[c]	0.050 mg/L[d]	0.5 mg/L[f]	Lab-specific[e]	Lab-specific[e]
Carbon Tetrachloride			0.050 mg/L[d]	0.5 mg/L[f]		
Chlorobenzene			0.050 mg/L[d]	100 mg/L[f]		
Chloroform			0.050 mg/L[d]	6 mg/L[f]		
1,2-Dichloroethane			0.050 mg/L[d]	0.5 mg/L[f]		
1,1-Dichloroethene			0.050 mg/L[d]	0.7 mg/L[f]		
Methyl Ethyl Ketone			1.000 mg/L[d]	200 mg/L[f]		
Tetrachloroethene			0.050 mg/L[d]	0.7 mg/L[f]		
Trichloroethene			0.050 mg/L[d]	0.5 mg/L[f]		
Vinyl Chloride			0.050 mg/L[d]	0.2 mg/L[f]		
Total Semivolatile Organic Compounds (SVOCs)	Aqueous Soil	8270C[c]	Parameter-specific (EQLs)[d]	NA	Lab-specific[e]	Lab-specific[e]
TCLP SVOCs						
o-Cresol	Aqueous	1311/8270C[c]	0.10 mg/L[d]	200 mg/L[f]	Lab-specific[e]	Lab-specific[e]
m-Cresol			0.10 mg/L[d]	200 mg/L[f]		
p-Cresol			0.10 mg/L[d]	200 mg/L[f]		
Cresol (total)			0.30 mg/L[d]	200 mg/L[f]		
1,4-Dichlorobenzene			0.10 mg/L[d]	7.5 mg/L[f]		
2,4-Dinitrotoluene			0.10 mg/L[d]	0.13 mg/L[f]		
Hexachlorobenzene			0.10 mg/L[d]	0.13 mg/L[f]		
Hexachlorobutadiene			0.10 mg/L[d]	0.5 mg/L[f]		
Hexachloroethane			0.10 mg/L[d]	3 mg/L[f]		
Nitrobenzene			0.10 mg/L[d]	2 mg/L[f]		
Pentachlorophenol			0.50 mg/L[d]	100 mg/L[f]		
Pyridine			0.10 mg/L[d]	5 mg/L[f]		
2,4,5-Trichlorophenol			0.10 mg/L[d]	400 mg/L[f]		
2,4,6-Trichlorophenol			0.10 mg/L[d]	2 mg/L[f]		
Polychlorinated Biphenyls (PCBs)	Aqueous Soil	8082[c]	Parameter-specific (EQLs)[g]	NA	Lab-specific[e]	Lab-specific[e]

Table 3-4
Analytical Requirements for CAU 551
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Parameter	Medium or Matrix	Analytical Method	Minimum Reporting Limit	RCRA Hazardous Waste Regulatory Limit	Laboratory Precision (RPD)[a]	Percent Recovery (%R)[b]
Total Petroleum Hydrocarbons (TPH) [C_6-C_{38}]	Aqueous Diesel	8015B modified[c]	0.5 mg/L[h]	NA	Lab-specific[e]	Lab-specific[e]
	Soil Diesel		25 mg/kg[h]			
INORGANICS						
Total *Resource Conservation and Recovery Act* (RCRA) Metals, and Beryllium						
Arsenic	Aqueous	6010B[c]	10 µg/L[h, i]	NA	20[i]	Matrix Spike Recovery 75-125[i] Laboratory Control Sample Recovery 80-120[i]
	Soil	6010B[c]	1 mg/kg[h, i]		35[h, o]	
Barium	Aqueous	6010B[c]	200 µg/L[h, i]		20[i]	
	Soil	6010B[c]	20 mg/kg[h, i]		35[h, o]	
Beryllium	Aqueous	6010B[c]	5 µg/L[h, i]		20[i]	
	Soil	6010B[c]	0.5 mg/kg[h, i]		35[h, o]	
Cadmium	Aqueous	6010B[c]	5 µg/L[h, i]		20[i]	
	Soil	6010B[c]	0.5 mg/kg[h, i]		35[h, o]	
Chromium	Aqueous	6010B[c]	10 µg/L[h, i]		20[i]	
	Soil	6010B[c]	1 mg/kg[h, i]		35[h, o]	
Lead	Aqueous	6010B[c]	3 µg/L[h, i]		20[i]	
	Soil	6010B[c]	0.3 mg/kg[h, i]		35[h, o]	
Mercury	Aqueous	7470A[c]	0.2 µg/L[h, i]		20[i]	
	Soil	7471A[c]	0.1 mg/kg[h, i]		35[h, o]	
Selenium	Aqueous	6010B[c]	5 µg/L[h, i]		20[i]	
	Soil	6010B[c]	0.5 mg/kg[h, i]		35[h]	
Silver	Aqueous	6010B[c]	10 µg/L[h, i]		20[i]	
	Soil	6010B[c]	1 mg/kg[h, i]		35[h]	
TCLP RCRA Metals						
Arsenic	Aqueous	1311/6010B[c] 1311/7470A[c]	0.10 mg/L[h, i]	5 mg/L[f]	20[i]	Matrix Spike Recovery 75-125[i] Laboratory Control Sample Recovery 80-120[i]
Barium			2 mg/L[h, i]	100 mg/L[f]		
Cadmium			0.05 mg/L[h, i]	1 mg/L[f]		
Chromium			0.10 mg/L[h, i]	5 mg/L[f]		
Lead			0.03 mg/L[h, i]	5 mg/L[f]		
Mercury			0.002 mg/L[h, i]	0.2 mg/L[f]		
Selenium			0.05 mg/L[h, i]	1 mg/L[f]		
Silver			0.10 mg/L[h, i]	5 mg/L[f]		

Table 3-4
Analytical Requirements for CAU 551
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Parameter	Medium or Matrix	Analytical Method	Minimum Reporting Limit	RCRA Hazardous Waste Regulatory Limit	Laboratory Precision (RPD)[a]	Percent Recovery (%R)[b]
RADIOCHEMISTRY						
Gamma Spectrometry	Aqueous	EPA 901.1[j]	10 pCi/L (Cs-137)	NA	Relative Percent Difference (RPD[a]) 20% (Water)[h] 35% (Soil)[h] Normalized Difference (ND) -2<ND<2[k]	Laboratory Control Sample Recovery 80-120[i]
	Soil	HASL-300[l]	0.5 pCi/g (Cs-137)			
Isotopic Uranium	Aqueous	HASL-300[l] ASTM D3972-02[m]	0.1 pCi/L	NA		Chemical Yield 30-105[n] Laboratory Control Sample Recovery 80-120[i]
	Soil	HASL-300[l] ASTM C1000-00[m]	0.05 pCi/g			
Isotopic Plutonium	Aqueous	D3865-02[m] ASTM	0.07 pCi/L	NA		
	Soil	HASL-300[l]	0.05 pCi/g			
Strontium - 90	Aqueous	ASTM D5811-00[m]	1.0 pCi/L	NA		
	Soil	HASL-300[l]	0.5 pCi/g			

[a] Relative percent difference (RPD) is used to calculate precision.
Precision is estimated from the relative percent difference of the concentrations measured for the matrix spike and matrix spike duplicate or of laboratory, or field duplicates of unspiked samples. It is calculated by: $RPD = 100 \times \{(|C_1 - C_2|)/[(C_1 + C_2)/2]\}$, where C_1 = Concentration of the parameter in the first sample aliquot, C_2 = Concentration of the parameter in the second sample aliquot.

[b] %R is used to calculate accuracy.
Accuracy is assessed from the recovery of parameters spiked into a blank or sample matrix of interest, or from the recovery of surrogate compounds spiked into each sample. The recovery of each spiked parameter is calculated by: percent recovery $(\%R) = 100 \times (C_s - C_u / C_n)$, where C_s = Concentration of the parameter in the spiked sample,
C_u = Concentration of the parameter in the unspiked sample, C_n = Concentration increase that should result from spiking the sample

[c] U.S. Environmental Protection Agency (EPA) *Test Methods for Evaluating Solid Wast*e, 3rd Edition, Parts 1-4, SW-846 CD ROM, Washington, DC (EPA,1996)

[d] Estimated Quantitation Limit as given in SW-846 (EPA, 1996)

[e] In-House Generated RPD and % R Performance Criteria
It is necessary for laboratories to develop in-house performance criteria and compare them to those in the methods. The laboratory begins by analyzing 15 to 20 samples of each matrix and calculating the mean % R for each parameter. The standard deviation (SD) of each % R is then calculated, and the warning and control limits for each parameter are established at ± 2 SD and ± 3 SD from the mean, respectively. If the warning limit is exceeded during the analysis of any sample delivery group (SDG), the laboratory institutes corrective action to bring the analytical system back into control. If the control limit is exceeded, the sample results for that SDG are considered unacceptable. These limits are reviewed after every quarter and are updated when necessary. The laboratory tracks trends in both performance and control limits by the use of control charts. The laboratory's compliance with these requirements is confirmed as part of an annual laboratory audit. Similar procedures are followed in order to generate acceptance criteria for precision measurements.

[f] Title 40 *Code of Federal Regulations* Part 261, "Identification and Listing of Hazardous Waste" (CFR, 2002)

[g] EPA *Contract Laboratory Program Statement of Work for Organic Analysis* (EPA, 1988b; 1991; and 1994b)

[h] *Industrial Sites Quality Assurance Project Plan* (NNSA/NV, 2002a)

[i] EPA *Contract Laboratory Program Statement of Work for Inorganic Analysis* (EPA, 1988a; 1994a; and 1995)

[j] *Prescribed Procedures for Measurements of Radioactivity in Drinking Water*, EPA-600/4-80-032 (EPA, 1980)

[k] Normalized Difference is not RPD, it is another measure of precision used to evaluate duplicate analyses. The normalized difference is calculated as the difference between two results divided by the square root of the sum of the squares of their total propagated uncertainties. *Evaluation of Radiochemical Data Usability* (Paar and Porterfield, 1997)

[l] *The Procedures Manual of the Environmental Measurements Laboratory*, HASL-300 (DOE, 1997)

[m] American Society for Testing and Materials (ASTM, 2000b; 2002a, b, c)

[n] *General Radiochemistry and Routine Analytical Services Protocol (GRASP)* (EG&G Rocky Flats, 1991)

[o] USEPA Contract Laboratory Program *National Functional Guidelines for Inorganic Data Review*, EPA 540/R-94/013, 2002 (EPA, 2002c)

Definitions:
Cs = Cesium
EQLS= Estimated quantitation limits
mg/L = Milligrams per liter
mg/kg = Milligrams per kilogram
NA = Not applicable
ND = Normalized difference
RPD = Relative percent difference
%R = Percent recovery
µg/L = Micrograms per liter

4.0 Field Investigation

This section contains the technical approach for the CAU 551 field investigation.

4.1 Technical Approach

Information necessary to resolve the DQO decisions will be generated for each CAU 551 CAS by collecting and analyzing samples generated during a field investigation. The presence and nature of contamination at each CAS will be evaluated by collecting samples at biased locations that are determined to be most probable to contain COCs. These locations will be determined based on their identification using biasing factors listed in Section 4.2.3. At the CAU 551 muckpiles, these locations may also be influenced by safety considerations.

Since this CAIP only addresses contamination originating from the CAU, it may be necessary to distinguish overlapping contamination originating from other sources. For example, widespread surface radiological contamination originating from atmospheric tests or releases from underground tests will not be addressed under CAU 551. To determine if contamination is from CAU 551 or from other sources, soil samples may be collected from background locations at selected CASs. The scope of this investigation is limited to the CAU 551 muckpiles and aboveground storage tank and stain, and potential contamination of the environment contiguous to the CASs within CAU 551. Not included in this scope is possible contamination of the environment from CASs down gradient from CAU 551, such as the muckpile outside of the E-Tunnel (Figure 2-1).

Modifications to the investigative strategy may be required should unexpected field conditions be encountered at any CAS. Significant modifications shall be justified and documented on a Record of Technical Change prior to implementation. If field observations indicate that conditions are significantly different than the corresponding CSM, the identified decision makers will be notified and the investigation may be rescoped.

Sample locations will be determined in the field based on site conditions, obvious debris or staining of soils, field-screening results, professional judgement, and the safety of the sampling crew. The Site Supervisor has the discretion to determine the biased locations that best meet the DQO decision needs and criteria stipulated in Appendix A.1.

4.1.1 CAS 12-01-09, Aboveground Storage Tank and Stain

For CAS 12-01-09, Aboveground Storage Tank and Stain, the information necessary will be generated by collecting and analyzing samples gathered during a field investigation. To prevent further release of tank contents to the surroundings, the tank contents will be removed prior to, or during, the investigation.

The presence and nature of contamination at CAS 12-01-09 will be determined by sampling the stained soil. One sample will be collected from 0 to 6 in. bgs from the center of the stain. An additional sample will be collected at 12 in. bgs, and further samples will be collected below that until either the depth of contamination has been determined by field screening, the soil/rock-surface has been contacted, or to the extent of hand augering (e.g., approximately 5 ft) has been reached.

If while defining the nature of contamination it is determined that COCs are present at CAS 12-01-09, the CAS will be further addressed by determining the extent of contamination before evaluating corrective action alternatives. Step-out samples for Decision II will be collected if COCs are identified in the Decision I sample(s) collected from the stain. Samples will be collected at step-out locations arranged in roughly a triangular pattern as determined by the Site Supervisor.

The present physical constraints of the site limit the use of drill rigs or other mechanized equipment in the vicinity of the stain. If the extent of contamination (either vertically or horizontally) can't be defined by hand sampling techniques, the primary decision makers will be consulted prior to determining how best to proceed.

As part of the investigation, the material remaining in the tank will be sampled to provide data for management and disposition.

4.1.2 CASs 12-06-05, 12-06-07, and 12-06-08, Muckpiles

For CASs 12-06-05, 12-06-07, and 12-06-08, the information necessary to resolve Decision I includes both data from similar sites and newly collected data. The samples to be obtained from accessible areas on the CAU 551 muckpiles will be gathered during a field investigation and analyzed for COPCs.

Because it is assumed that COCs exist at the CAU 551 muckpiles, initial Decision II samples will be collected at the same time as Decision I samples to determine if any COCs have migrated from the muckpiles.

For Decision I, soil samples will be collected from approximately 15 to 20 locations in accessible areas of muckpiles in CASs 12-06-05 and 12-06-08 (combined), and approximately 15 to 20 locations for Decision I in accessible areas of the muckpile in CAS 12-06-07. In addition, approximately 15 to 20 locations will be sampled (for all muckpiles) to provide initial information to resolve Decision II. Additional locations may be sampled, as necessary (Appendix A.1, Section A.1.8.2).

4.2 Field Activities

Activities to be conducted under this CAIP include:

- Site preparation
  - Set up staging areas
  - Sample contents of AST
  - Remove AST contents
- Sample location selection
  - Perform radiological surveys of accessible portions of the CAU 551 muckpiles.
  - Perform visual surveys at all CASs to identify any staining, discoloration, disturbance of native soils, sediment trap areas, or any other indication of potential contamination.
  - Stake or flag sample locations and record coordinates.
- Sample collection
  - Perform field screening for applicable COPCs, as necessary.
  - Collect and analyze samples from locations as described in this section.
  - Collect required QC samples.

- Collect waste management samples, as necessary.

- Collect soil samples from background locations, if necessary.

- Collect and analyze bioassessment samples, if appropriate (e.g., if VOC concentrations exceed field-screening levels in a pattern that suggests that a plume may be present).

For all CASs, if COCs are suspected or confirmed, step-out sampling may be necessary to properly define the extent of contamination (i.e., contaminant boundaries). Step-out (Decision II) sampling locations at each CAS will be selected based on the outer boundary sample locations where COCs were detected, the CSM, and other biasing factors listed in Section 4.2.3. In general, step-out sample locations will be arranged in a triangular pattern around the Decision I location at distances based on site conditions, process knowledge, and biasing factors. However, for the muckpiles the scale of decision making is defined as the CAS (e.g., if any part of the muckpile is contaminated, the whole muckpile is considered contaminated); therefore, step-outs will start from the edge of each CAS. If COCs extend beyond the initial step-outs, Decision II samples will be collected from incremental step-outs. If the field-screening results (FSRs) are not greater than field-screening levels (FSLs), a sample will be submitted to the laboratory for analysis. A minimum of one clean sample (i.e., COCs less than PALs) will be collected from each step-out location and submitted for laboratory analysis to define the extent of COC contamination. The lateral extent of COCs will be established based on validated laboratory analytical results. The number, location, and spacing of step-outs may be modified by the Site Supervisor, as warranted by site conditions.

Where sampling locations are modified by the Site Supervisor, the justification for these modifications will be documented in the field logbook. Section 3.4 provides the analytical methods and laboratory requirements (i.e., detection limits, precision, and accuracy requirements) to be used when analyzing for the COPCs. The analytical program for each CAS is presented in Table 3-3. All sampling activities and quality control requirements for field and laboratory environmental sampling will be conducted in compliance with the Industrial Sites QAPP (NNSA/NV, 2002a) and other applicable, approved procedures.

4.2.1 Aboveground Storage Tank & Stain

Consistent with CSM #1, a biased sampling strategy will be used for Decision I to target the area with the highest potential for contamination (i.e., the stained soil). The sample location will be determined based on the biasing factors listed in Section 4.2.3. If biasing factors are present in soil below the location where the Decision I sample was removed, subsurface Decision I soil samples will be collected by hand auguring. Decision I subsurface soil samples will be collected at depth intervals selected by the Site Supervisor based on biasing factors to a depth where the biasing factors are no longer present.

4.2.2 Muckpiles

Decision I surface soil samples (0 to 0.5 ft bgs) will be collected from selected locations based on the biasing factors listed in Section 4.2.3. An additional Decision I soil sample will be collected at depth (approximately 3 ft bgs) at each location, where possible. If biasing factors are present in soils below locations where Decision I samples were removed, subsurface Decision I soil samples will also be collected, as appropriate. Decision I subsurface soil samples will be collected at depth intervals selected by the Site Supervisor based on biasing factors to a depth where the biasing factors are no longer present. Expected areas of sampling for Decision I are presented in Section A.1.8 and include flat portions of the tops of the muckpiles near the portals, and lower and side portions that may be accessible.

To reduce the uncertainty associated with sampling, initial Decision II samples will be collected at the same time as Decision I samples from accessible areas on the muckpiles in CASs 12-06-05, 12-06-07, and 12-06-08 and analyzed for all COPCs. Given the assumption that the muckpiles are contaminated with expected COCs, these initial Decision II samples will begin the process to define the extent of contamination for the muckpiles. Consistent with CSM #2, expected areas of sampling for initial Decision II are presented in Section A.1.8, and include: (1) areas below the foot of the muckpiles; (2) at the confluence of the drainages from the CAS 12-06-05 and CAS 12-06-08 muckpiles, and from the CAS 12-06-07 muckpile; and (3) at the point at which the main wash intersects the access road below (Decision II).

Given the practical constraints of the site (e.g., steep slopes inaccessible to heavy equipment), it may not be possible to bound contamination in the vertical direction. Where possible, samples of the native material will be collected. However, based on past muckpile data (Appendix A.1), unless specific contrary evidence is identified, it is assumed that contamination has not migrated vertically from the muck into underlying native material.

4.2.3 Sample Location Selection

Biasing factors will be used to select the most appropriate sample locations from the accessible areas, and field screening may be used to select the most appropriate samples from a particular location for submittal to the analytical laboratory. Biasing factors to be used for selection of sampling locations will include the following:

- Visual evidence of discoloration, textural discontinuities, disturbance of native soils, or any other indication of potential contamination
- Presence of debris or equipment
- Presence of hot spots based on the results of radiological surveys
- Field-screening results
- Previous sampling or screening results
- Experience and data from investigations of similar sites
- Areas of erosion, where access to the lower level of the muckpile is available
- Areas of sediment traps within the washes

As other biasing factors are identified and used for selection of sampling locations, they will be documented in the appropriate field documents. The CAS-specific sampling strategy and the locations of the biased samples that were estimated for each CAS are presented in Appendix A.1.

4.3 Bioassessment Tests

If organic COCs are present and natural attenuation or biodegradation are included as corrective action alternatives, bioassessment may be conducted on the contaminated media. Bioassessment is a series of tests designed to evaluate the physical, chemical, and microbiological characteristics of a site. Bioassessment tests include determinants of nutrient availability, pH, microbial population density, and the ability of the microbial population to grow under enhanced conditions.

4.4 Safety

A current version of the Environmental Services Architect-Engineer Contractor's health and safety plan (HASP) or equivalent will accompany the field documents, and a site-specific field work plan (FWP) will be prepared and approved prior to the field effort. As required by the DOE Integrated Safety Management System (ISMS) (DOE/NV, 1997), these documents outline the requirements for protecting the health and safety of the workers and the public, and the procedures for protecting the environment. ISMS requires that site personnel reduce or eliminate the possibility of injury, illness, or accidents, and to protect the environment during all project activities. The following safety issues will be taken into consideration when evaluating the hazards and associated control procedures for field activities discussed in the HASP and FWP:

- Potential hazards to site personnel and the public include, but are not limited to: radionuclides, chemicals (e.g., heavy metals, VOCs, SVOCs, and petroleum hydrocarbons), adverse and rapidly changing weather, remote location, steep slopes on and around the muckpiles and AST, and motor vehicle and heavy equipment operations.
- Proper training of all site personnel to recognize and mitigate the anticipated hazards.
- Work controls to reduce or eliminate the hazards including engineering controls, substitution of less hazardous materials, limiting access to hazardous areas (e.g., slopes), and use of appropriate personal protective equipment (PPE).
- Occupational exposure monitoring to prevent overexposures to hazards such as radionuclides, chemicals, and physical agents (e.g., heat, cold, and high wind).
- Radiological surveying for alpha/beta and gamma emitters to minimize and/or control personnel exposures; use of the "as-low-as-reasonably-achievable" principle when dealing with radiological hazards.
- Emergency and contingency planning to include medical care and evacuation, decontamination, spill control measures, and appropriate notification of project management. The same principles apply to emergency communications.
- If potential asbestos-containing material is identified (CFR, 2003c; NAC, 2002d), it will be inspected and/or samples collected by trained personnel.

5.0 Waste Management

Management of investigation-derived waste (IDW) will be based on regulatory requirements, field observations, process knowledge, and the results of laboratory analysis of CAU 551 investigation samples.

Disposable sampling equipment, PPE, and rinsate are considered potentially contaminated waste only by virtue of contact with potentially contaminated media (e.g., soil) or potentially contaminated debris (e.g., construction materials). Therefore, sampling and analysis of IDW, separate from analyses of site investigation samples, may not be necessary for all IDW. However, if associated investigation samples are found to contain contaminants above regulatory levels, direct samples of IDW may be taken to support waste characterization.

Sanitary, hazardous, radioactive, and/or mixed waste, if generated, will be managed and disposed of in accordance with DOE Orders, U.S. Department of Transportation (DOT) regulations, state and federal waste regulations, and agreements and permits between DOE and NDEP.

5.1 Waste Minimization

Investigation activities are planned to minimize IDW generation. This will be accomplished by incorporating the use of process knowledge, visual examination, and/or radiological survey and swipe results. When possible, disturbed media (such as soil removed during trenching) or debris will be returned to its original location. Contained media (e.g., soil managed as waste) as well as other IDW will be segregated to the greatest extent possible to minimize generation of hazardous, radioactive, or mixed waste. Hazardous material used at the sites will be controlled in order to limit unnecessary generation of hazardous or mixed waste. Administrative controls, including decontamination procedures and waste characterization strategies, will minimize waste generated during investigations.

5.2 Potential Waste Streams

Waste generated during the investigation activities will include the following potential waste streams:

- PPE and disposable sampling equipment (e.g., plastic, paper, sample containers, aluminum foil, spoons, and bowls)
- Decontamination rinsate
- Environmental media (e.g., soil)
- Surface debris in investigation area (e.g., lead brick)
- Field-screening waste (e.g., soil, spent solvent, rinsate, disposable sampling equipment, and PPE contaminated by field-screening activities)

Office trash and lunch waste will be sent to the sanitary landfill by placing the waste in the dumpster.

5.3 Investigation-Derived Waste Management

The on-site management and ultimate disposition of IDW may be guided by several factors, including, but not limited to: the analytical results of samples either directly or indirectly associated with the waste, historical site knowledge, knowledge of the waste generation process, field observations, field-monitoring/screening results, and/or radiological survey/swipe results.

Each waste stream generated will be reviewed and segregated at the point of generation by the following waste types:

- Sanitary waste
- Hazardous waste
- Polychlorinated biphenyls
- Low-level waste
- Mixed waste

Table 4-2 of the NV/YMP RadCon Manual (DOE/NV, 2000) shall be used to determine if such materials can be released to uncontrolled areas (i.e., unrestricted release). On-site IDW management requirements by waste type are detailed in the following sections. Applicable waste management regulations and requirements are listed in Table 5-1.

Table 5-1
Waste Management Regulations and Requirements

Waste Type	Federal Regulation	Additional Requirements
Solid (nonhazardous)	NA	NRS[a] 444.440 - 444.620 NAC[b] 444.570 - 444.7499 NTS Landfill Permit SW13.097.04[c] NTS Landfill Permit SW13.097.03[d]
Liquid/Rinsate (nonhazardous)	NA	Water Pollution Control General Permit GNEV93001, Rev. 3iii[e]
Hazardous	RCRA[f], 40 CFR 260-282	NRS[a] 459.400 - 459.600 NAC[b] 444.850 - 444.8746 POC[g]
Low-Level Radioactive	NA	DOE Orders and NTSWAC[h]
Mixed	RCRA[f], 40 CFR 260-282	NTSWAC[h] POC[g]
Hydrocarbon	NA	NTS Landfill Permit SW13.097.02[i]
Polychlorinated Biphenyls	TSCA[j], 40 CFR 761	NRS[a] 459.400 - 459.600 NAC[b] 444.940 - 444.9555
Asbestos	TSCA[j], 40 CFR 763	NRS[a] 618.750-618.840 NAC[b] 444.965-444.976

[a] *Nevada Revised Statutes* (NRS, 2003a, b, c)
[b] *Nevada Administrative Code* (NAC, 2002a, b, c, d)
[c] Area 23 Class II Solid Waste Disposal Site (NDEP, 1997a)
[d] Area 9 Class III Solid Waste Disposal Site (NDEP, 1997c)
[e] Nevada Test Site Sewage Lagoons (NDEP, 1999)
[f] *Resource Conservation and Recovery Act* (CFR, 2003a)
[g] *Nevada Test Site Performance Objective for the Certification of Nonradioactive Hazardous Waste* (BN, 1995)
[h] *Nevada Test Site Waste Acceptance Criteria*, Revision 5 (NNSA/NV, 2003)
[i] *Area 6 Class III Solid Waste Disposal Site for Hydrocarbon Waste* (NDEP, 1997b)
[j] *Toxic Substance Control Act* (CFR, 2003b, c)

CFR = *Code of Federal Regulations*
DOE = U.S. Department of Energy
NA = Not applicable
NAC = *Nevada Administrative Code*
NDEP = Nevada Division of Environmental Protection
NRS = *Nevada Revised Statutes*
NTS = Nevada Test Site
NTSWAC = *Nevada Test Site Waste Acceptance Criteria*
POC = Nevada Test Site Performance Objective for the Certification of Nonradioactive Hazardous Waste
RCRA = *Resource Conservation and Recovery Act*
TSCA = *Toxic Substance Control Act*

5.3.1 Sanitary Waste

Sanitary IDW generated during the investigation of this CAU will be collected and disposed in accordance with the permits for operation of the sanitary landfills at the NTS.

5.3.1.1 Special Sanitary

Soil and solid waste generated at the NTS will be managed as hydrocarbon-burdened when it is directly impacted by hydrocarbons or associated with environmental samples exceeding 100 milligrams per kilogram (mg/kg) of TPH. Hydrocarbon waste will be managed on site in a drum or other appropriate container until fully characterized. Hydrocarbon waste may be disposed of at a designated hydrocarbon landfill (NDEP, 1997b), an appropriate hydrocarbon waste management facility (e.g., recycling facility), or other method in accordance with Nevada regulations.

Asbestos-containing materials that may be encountered or generated during this investigation will be managed and disposed of in accordance with appropriate federal (CFR, 2003c) and State of Nevada (NAC, 2002d) regulations.

Materials that are thought to potentially contain the hantavirus will be managed and disposed in accordance with appropriate health and safety procedures.

5.3.2 Hazardous Waste

Corrective Action Unit 551 will have waste storage areas established according to the needs of the project. Satellite accumulation areas and hazardous waste accumulation areas will be managed consistent with the requirements of federal and state regulations (CFR, 2003a; NAC, 2002b). They will be properly controlled for access and equipped with spill kits and appropriate spill containment. Suspected hazardous wastes will be placed in DOT-compliant containers. All containerized waste will be handled, inspected, and managed in accordance with Title 40 *Code of Federal Regulations* (CFR) 265, Subpart I (CFR, 2003a). These provisions include managing the waste in containers compatible with the waste type, and segregating incompatible waste types so that in the event of a spill, leak, or release, incompatible wastes shall not contact one another.

Hazardous Waste Accumulation Areas will be covered under a site-specific emergency response and contingency action plan until such time that the waste is determined to be nonhazardous or all containers of hazardous waste have been removed from the storage area. Hazardous wastes will be characterized in accordance with the requirements of Title 40 CFR 261 (CFR, 2003a). No RCRA "listed" wastes have been identified at CAU 551. Any waste determined to be hazardous will be managed and transported in accordance with RCRA and DOT to a permitted treatment, storage, and disposal facility (CFR, 2003a).

5.3.2.1 Management of Personal Protective Equipment

Personal protective equipment and disposable sampling equipment will be visually inspected for stains, discoloration, and gross contamination as the waste is generated. Any IDW that meets this description will be segregated and managed as potentially "characteristic" hazardous waste. This segregated population of waste will either be: (1) assigned the characterization of the muck, tank liquid, or stained soil that was sampled; (2) sampled directly; or (3) undergo further evaluation using the muck, tank liquid, or stained soil sample results to determine how much muck, tank liquid, or stained soil would need to be present in the waste to exceed regulatory levels. Waste that is determined to be hazardous will be entered into an approved waste management system, where it will be managed and dispositioned according to RCRA requirements or subject to agreements between NNSA/NSO and the State of Nevada. The PPE and equipment that is not visibly stained, discolored, or grossly contaminated and that is within radiological unrestricted criteria will be managed as nonhazardous sanitary waste.

5.3.2.2 Management of Decontamination Rinsate

Rinsate at this CAU will not be considered hazardous waste unless there is evidence that the rinsate would display a RCRA characteristic. Evidence may include such things as the presence of a visible sheen, pH, or association with equipment/materials used to respond to a release/spill of a hazardous waste/substance. Decontamination rinsate that is potentially hazardous (using associated sample results and/or process knowledge) will be managed as "characteristic" hazardous waste (CFR, 2003a). The regulatory status of the potentially hazardous rinsate will be determined through the application of associated sample results or through direct sampling. If determined to be hazardous, the rinsate will be entered into an approved waste management system, where it will be managed and dispositioned according to RCRA requirements or subject to agreements between NNSA/NSO and the State of Nevada. If the associated samples do not indicate the presence of hazardous constituents, the rinsate will be considered to be nonhazardous.

The disposal of nonhazardous rinsate will be consistent with guidance established in current NNSA/NSO Fluid Management Plans for the NTS as follows:

- Rinsate that is determined to be nonhazardous and contaminated to less than 5x *Safe Drinking Water Standards* (SDWS) is not restricted as to disposal. Nonhazardous rinsate which is contaminated at 5x to 10x SDWS will be disposed of in an established infiltration basin or solidified and disposed of as sanitary waste or low-level waste in accordance with the respective sections of this document.

- Nonhazardous rinsate which is contaminated at greater than 10x SDWS will be disposed of in a lined basin or solidified and disposed of as sanitary waste or low-level waste in accordance with the respective sections of this document.

5.3.2.3 Management of Muck and Soil

This waste form consists of muck/soil produced during muck/soil sampling, excavation, and/or drilling. This waste form is considered to have the same COPCs as the material remaining in the ground. The preferred method for managing this waste form is to place the material back into the borehole/excavation in the same appropriate location from which it originated. If this cannot be accomplished, the material will either be managed on site by berming and covering next to the excavation, or by placement in a container(s). The disposal of the muck/soil may be deferred until implementation of corrective action at the site.

5.3.2.4 Management of Tank Contents

This waste form consists of tank liquid. The tank contents will be sampled and managed in accordance with the sample analytical data once removed from the tank. The disposal of tank liquid may be deferred until implementation of corrective action at the site.

5.3.2.5 Management of Debris

The management plan for debris can vary depending on site conditions. Debris that requires disposal must be characterized for proper management and disposition. Historical site knowledge, knowledge of the waste generation process, field observations, field-monitoring/screening results, radiological survey/swipe results, and/or the analytical results of samples either directly or indirectly associated with the waste will be used to characterize the debris. Debris will be visually inspected for stains, discoloration, and gross contamination. Debris may be deemed reusable, recyclable, sanitary waste, hazardous waste, PCB waste, or low-level waste. Waste that is not sanitary will be entered into an approved waste management system, where it will be managed and dispositioned according to federal, state requirements, and agreements between NNSA/NSO and the State of Nevada. The debris may either be managed on site by berming and covering next to the excavation, or by placement in a container(s). The disposal of debris may be deferred until implementation of corrective action at the site.

5.3.2.6 Field-Screening Waste

The use of field test kits and/or instruments may result in the generation of small quantities of hazardous wastes. If hazardous waste is produced by field screening, it will be segregated from other IDW and managed in accordance with the hazardous waste regulations (CFR, 2003a). On radiological sites, this may increase the potential to generate mixed waste; however, the generation of a mixed waste will be minimized as much as practicable. In the event a mixed waste is generated, the waste will be managed in accordance with Section 5.3.5 of this document.

5.3.3 Polychlorinated Biphenyls

The management of PCBs is governed by the *Toxic Substances Control Act* (TSCA) (USC, 1976) and its implementing regulations at 40 CFR 761 (CFR, 2003b). Polychlorinated biphenyls contamination may be found as a sole contaminant or in combination with any of the types of waste discussed in this document. For example, PCBs may be a co-contaminant in soil that contains a RCRA “characteristic” waste (PCB/hazardous waste), or in soil that contains radioactive wastes (PCB/radioactive waste), or even in mixed waste (PCB/radioactive/hazardous waste). The IDW will be initially evaluated using analytical results for media samples from the investigation. If any type of PCB waste is generated, it will be managed according to 40 CFR 761 (CFR, 2003b) as well as State of Nevada requirements (NAC, 2002c), guidance, and agreements with NNSA/NSO.

5.3.4 Low-Level Waste

Radiological swipe surveys and/or direct-scan surveys may be conducted on reusable sampling equipment and the PPE and disposable sampling equipment waste streams exiting a radiologically controlled area. This allows for the immediate segregation of radioactive waste from waste below the unrestricted release criteria. Removable surface contamination limits, as defined in Table 4-2 of the NV/YMP RadCon Manual (DOE/NV, 2000), will be used to determine if waste can be released to uncontrolled areas (i.e., unrestricted release). Direct sampling of the waste may be conducted to aid in determining if a particular waste unit (e.g., drum of soil) contains low-level radioactive waste, as necessary. Waste that is determined to be below the values of Table 4-2, by either direct radiological survey/swipe results or through process knowledge, will not be managed as potential radioactive waste but will be managed in accordance with the appropriate section of this document. Wastes in excess of Table 4-2 values will be managed as potential radioactive waste and be managed in accordance with this section and any other applicable sections of this document.

Low-level radioactive waste, if generated, will be managed in accordance with the contractor-specific waste certification program plan, DOE Orders, and the requirements of the current version of the *Nevada Test Site Waste Acceptance Criteria* (NTSWAC) (NNSA/NV, 2003). Potential radioactive waste drums containing muck, soil, PPE, disposable sampling equipment, and/or rinsate may be staged at a radiologically controlled area when full or at the end of an investigation phase. The waste drums will remain in a controlled area until disposed of under NTSWAC requirements (NNSA/NV, 2003).

5.3.5 Mixed Waste

Mixed waste, if generated, shall be managed and dispositioned according to the requirements of RCRA (CFR, 2003a) or subject to agreements between NNSA/NSO and the State of Nevada, as well as DOE requirements for radioactive waste. The waste will be marked with the words "Hazardous Waste Pending Analysis and Radioactive Waste Pending Analysis." Waste characterized as mixed will not be stored for a period of time that exceeds the requirements of RCRA unless subject to agreements between NNSA/NSO and the State of Nevada. The mixed waste shall be transported via an approved hazardous waste/radioactive waste transporter to the NTS transuranic waste storage pad for storage pending treatment or disposal. Mixed waste with hazardous waste constituents below

Land Disposal Restrictions may be disposed of at the NTS Area 5 Radioactive Waste Management Site if the waste meets the requirements of the NTSWAC (NNSA/NV, 2003). Mixed waste not meeting Land Disposal Restrictions will require development of a treatment and disposal plan under the requirements of the Mutual Consent Agreement between DOE and the State of Nevada (NDEP, 1995).

6.0 Quality Assurance/Quality Control

The overall objective of the characterization activities described in this CAIP is to collect accurate and defensible data to support the selection and implementation of a closure alternative for each CAS in CAU 551. Section 6.1 and Section 6.2 discuss the collection of required QC samples in the field and QA requirements for laboratory/analytical data to achieve closure. Section 6.3 provides QA/QC requirements for radiological survey data. Unless otherwise stated in this CAIP or required by the results of the DQO process (see Appendix A.1), this investigation will adhere to the Industrial Sites QAPP (NNSA/NV, 2002).

6.1 Quality Control Field Sampling Activities

Field QC samples will be collected in accordance with established procedures. Field QC samples are collected and analyzed to aid in determining the validity of environmental sample results. The number of required QC samples depends on the types and number of environmental samples collected. The minimum frequency of collecting and analyzing QC samples for this investigation, as determined in the DQO process, include:

- Trip blanks (one per sample cooler containing VOC environmental samples)
- Equipment blanks (one per sampling event for each type of decontamination procedure)
- Source blanks (one per lot of source material that contacts sampled media)
- Field duplicates (one per twenty environmental samples or one per CAS per matrix, if less than twenty collected)
- Field blanks (one per twenty environmental samples)
- Full QC (e.g., matrix spike (MS)/matrix spike duplicate [MSD]) (one per twenty environmental samples or one per CAS per matrix, if less than twenty collected)

Additional QC samples may be submitted based on site conditions at the discretion of the Site Supervisor. Field QC samples shall be analyzed using the same analytical procedures implemented for associated environmental samples. Additional details regarding field QC samples are available in the Industrial Sites QAPP (NNSA/NV, 2002).

6.2 Laboratory/Analytical Quality Assurance

Criteria for the investigation, as stated in the DQOs (Appendix A.1) and except where noted, require laboratory analytical quality data be used for making critical decisions. Rigorous QA/QC will be implemented for all laboratory samples including documentation, data verification and validation of analytical results, and an assessment of data quality indicators (DQIs).

6.2.1 Data Validation

Data verification and validation will be performed in accordance with the Industrial Sites QAPP (NNSA/NV, 2002), except where otherwise stipulated in this CAIP. All nonradiological laboratory data from samples collected and analyzed will be evaluated for data quality according to *EPA Functional Guidelines* (EPA, 2002a and 2002c). Radiological laboratory data from samples that are collected and analyzed will be evaluated for data quality according to company-specific procedures. The data will be reviewed to ensure that all critical samples were appropriately collected, analyzed, and the results passed data validation criteria. Validated data, including estimated data (i.e., J-qualified), will be assessed to determine if they meet the DQO requirements of the investigation and the performance criteria for the DQIs. The results of this assessment will be documented in the CADD. If the DQOs were not met, corrective actions will be evaluated, selected, and implemented (e.g., refine CSM or resample to fill data gaps).

6.2.2 Data Quality Indicators

Data quality indicators are qualitative and quantitative descriptors used in interpreting the degree of acceptability or utility of data. The principal DQIs are precision, accuracy, representativeness, comparability, and completeness. A sixth DQI, sensitivity, has also been included for the CAU 551 investigation. Data quality indicators are used to evaluate the entire measurement system and laboratory measurement processes (i.e., analytical method performance) as well as to evaluate individual analytical results (i.e., parameter performance).

Precision and accuracy are quantitative measures used to assess overall analytical method and field sampling performance as well as to assess the need to “flag” (qualify) individual parameter results when corresponding QC sample results are not within established control limits. Therefore, performance metrics have been established for both analytical methods and individual analytical results. Data qualified as estimated for reasons of precision or accuracy may be considered to meet the parameter performance criteria based on assessment of the data.

Representativeness and comparability are qualitative measures, and completeness is a combination of both quantitative and qualitative measures. Representativeness, comparability, and completeness are used to assess the measurement system performance. The DQI parameters are individually discussed in Section 6.2.3 through Section 6.2.8.

Table 6-1 provides the established analytical method/measurement system performance criteria for each of the DQIs and the potential impacts to the decision if the criteria are not met. The Industrial Sites QAPP (NNSA/NV, 2002) documents the actions required to correct conditions that adversely affect data quality both in the field and the laboratory. All DQI performance criteria deficiencies will be evaluated for data usability and impacts to the DQO decisions. These evaluations will be discussed and documented in the data assessment section of the CADD. The following subsections discuss each of the DQIs that will be used to assess the quality of laboratory data.

6.2.3 Precision

Precision is used to assess the variability of a population of measurements with the variability of the analysis process. The method used to calculate relative percent difference (RPD) is presented in the Industrial Sites QAPP (NNSA/NV, 2002).

Determinations of precision will be made for field duplicate samples and laboratory duplicate samples. Field duplicate samples will be collected simultaneously with samples from the same source under similar conditions in separate containers. The duplicate sample will be treated independently of the original sample in order to assess field impacts and laboratory performance on precision through a comparison of results. Laboratory precision is evaluated as part of the required laboratory internal QC program to assess performance of analytical procedures. The laboratory sample duplicates are an aliquot, or subset, of a field sample generated in the laboratory. They are not a separate sample but a split, or portion, of an existing sample. Typically, laboratory duplicate QC samples include MSD and laboratory control sample (LCS) duplicate samples for organic, inorganic, and radiological analyses.

Table 6-1
Laboratory and Analytical Performance Criteria for CAU 551 Data Quality Indicators

Data Quality Indicator	Performance Criteria	Potential Impact on Decision if Performance Criteria Not Met
Precision	Variations between duplicates (laboratory and field) and original sample should not exceed analytical method-specific criteria discussed in Section 6.2.3.	Data that do not meet the performance criteria will be evaluated for purposes of completeness. Decisions may not be valid if analytical method performance criteria for precision are not met.
Accuracy	Laboratory control sample, matrix spike, and surrogate results should be within specified acceptance windows.	Data that do not meet the performance criteria will be evaluated for purposes of completeness. Decisions may not be valid if analytical method performance criteria for accuracy are not met.
Sensitivity	Laboratory detection limits must be less than or equal to respective PALs.	Cannot determine if COCs are present or migrating at levels of concern; therefore, the affected data will be assessed for usability and potential impacts on meeting site characterization objectives.
Comparability	Equivalent samples analyzed using the same analytical methods; the same units of measurement and detection limits must be used for like analyses.	Inability to combine data with data obtained from other sources and/or inability to compare data to regulatory action levels.
Representativeness	Correct analytical method performed for appropriate COPC; valid data reflects appropriate target population.	Cannot identify COC or estimate concentration of COC; therefore, cannot make decision(s) on target population.
Nature Completeness	80% of the CAS-specific analytes identified in the CAIP. 90% of critical analytes are valid.	Cannot make decision on whether COCs are present.
Extent Completeness	100% of COCs used to define extent of COCs are valid.	Extent of contamination cannot be determined.
Clean Closure Completeness	100% of COCs are valid.	Cannot determine if COCs remain in soil.

6.2.3.1 Precision for Chemical Analysis

The RPD criteria to be used for assessment of precision are the parameter-specific criteria listed in Table 3-4. No review criteria for field duplicate RPD comparability have been established; therefore, the laboratory sample duplicate criteria will be applied to the review of field duplicates.

The parameter performance criteria for precision will be compared to RPD results of duplicate samples. This will be accomplished as part of the data validation process. Precision values for organic and inorganic analyses that are within the established control criteria indicate that analytical results for associated samples are valid. The RPD values that are outside the criteria for organic analysis do not necessarily result in the qualification of analytical data. It is only one factor in making an overall judgement about the quality of the reported analytical results. Inorganic laboratory sample duplicate RPD values outside the established control criteria result in the qualification of associated analytical results as estimated; however, qualified data does not necessarily indicate that the data are not useful for the purpose intended. This qualification is an indication that data precision should be considered for the overall assessment of the data quality and potential impact on data applicability in meeting site characterization objectives.

The criteria to evaluate analytical method performance for precision will be assessed based on the analytical method-specific (e.g., VOCs) precision measurements. Each analytical method-specific precision measurement will be assessed for potential impacts on meeting site characterization objectives, and results of the assessment will be documented in the CADD.

6.2.3.2 Precision for Radiochemical Analysis

The parameter performance criteria for precision will be compared to the RPD or normalized difference (ND) results of duplicate samples. The criteria for assessment of the radiochemical precision are parameter-specific criteria (see Table 3-4). This assessment will be accomplished as part of the data validation process. Precision values that are within the established control criteria indicate that analytical results for associated samples are valid. Out of control RPD or ND values do not necessarily indicate that the data are not useful for the purpose intended; however, it is an indication that data precision should be considered for the overall assessment of the data quality and the potential impact on data applicability in meeting site characterization objectives.

If the RPD or ND criteria are exceeded, samples will be qualified. Field duplicates will be evaluated, but field samples will not be qualified based on their results. The MSD results outside of the control limits may not result in qualification of the data. An assessment of the entire analytical process, including the sample matrix, will be conducted to determine if qualification is warranted.

Each analytical method-specific precision measurement will be assessed for potential impacts on meeting site characterization objectives, and results of the assessment will be documented in the CADD.

6.2.4 Accuracy

Accuracy is a measure of the closeness of an individual measurement or the average of a number of measurements to the true value. It is used to assess the performance of laboratory measurement processes as well as to evaluate individual groups of analyses (i.e., sample delivery groups).

Accuracy is determined by analyzing a reference material of known parameter concentration or by reanalyzing a sample to which a material of known concentration or amount of parameter has been added (spiked).

6.2.4.1 Accuracy for Chemical Analyses

The criteria to be used for assessment of accuracy are the parameter-specific criteria listed in Table 3-4. Accuracy for chemical analyses will be evaluated based on results from three types of spiked samples: MS, LCS, and surrogates.

For organic analyses, laboratory control limits are used for evaluation of percent recovery. The acceptable control limits for organic analyses are established in the EPA *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA, 2002c).

The percent recovery parameter performance criteria for accuracy will be compared to percent recovery results of spiked samples. This will be accomplished as part of the data validation process. The percent recovery values that are outside the criteria do not necessarily result in the qualification of analytical data. It is only one factor in making an overall judgment about the quality of the reported analytical results. Factors beyond the laboratory's control, such as sample matrix effects, can cause the measured values to be outside of the established criteria. Therefore, the entire sampling and analytical process must be evaluated when determining the quality of the analytical data provided.

The criteria to evaluate analytical method performance for accuracy will be based on the analytical method-specific (e.g., VOCs) accuracy measurements. Each analytical method-specific accuracy measurement will be assessed for potential impacts on meeting site characterization objectives, and results of the assessment will be documented in the CADD.

6.2.4.2 Accuracy for Radiochemical Analysis

Accuracy for radiochemical analyses will be evaluated based on results from LCS and MS samples. The LCS sample is analyzed with the field samples using the same sample preparation, reagents, and analytical methods employed for the samples. One LCS will be prepared with each batch of samples for analysis by a specific measurement.

The MS samples are analyzed to determine if the measurement accuracy is affected by the sample matrix. The MS samples are analyzed with sample batches, when requested.

The percent recovery criteria to be used for assessment of accuracy will be the control limits for radiochemical analyses listed in Table 3-4.

The criteria to evaluate analytical method performance for accuracy will be assessed based on the analytical method-specific (e.g., gamma spectrometry) accuracy measurements. Each analytical method-specific accuracy performance will be assessed for potential impacts on meeting site characterization objectives, and results of the assessment will be documented in the CADD.

6.2.5 Representativeness

Representativeness is the degree to which sample data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, or an environmental condition (EPA, 1987). Representativeness is assured by a carefully developed sampling strategy, collecting the specified number of samples from proper sampling locations, and analyzing them by the approved analytical methods. An evaluation of this qualitative criterion will be presented in the CADD.

6.2.6 Completeness

Completeness is a quantitative and qualitative evaluation of measurement system performance. The criterion for meeting completeness is defined as generating sufficient data of the appropriate quality to satisfy the data needs identified in the DQOs. An evaluation of this qualitative criterion will be presented in the CADD.

The quantitative measurement to be used to evaluate completeness is presented in Table 6-1 and is based on the percentage of measurements made that are judged to be valid. If these criteria are not achieved, the dataset will be assessed for potential impacts on making DQO decisions.

6.2.7 Comparability

Comparability is a qualitative parameter expressing the confidence with which one dataset can be compared to another (EPA, 1987). To ensure comparability, all samples will be subjected to the same sampling, handling, preparation, analysis, reporting, and validation criteria. Approved standard methods and procedures will also be used to analyze and report the data (e.g., Contract Laboratory Program [CLP] and/or CLP-like data packages). This approach ensures that the data from this project can be compared to regulatory action levels. An evaluation of this qualitative criterion will be presented in the CADD.

6.2.8 Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest (EPA, 2001a). The evaluation criteria for this parameter will be that measurement sensitivity (detection limits) will be less than or equal to the corresponding PALs. To ensure that the minimum reporting limits (MRLs) are consistent with the corresponding PALs, the MRLs from requested analytical methods for each COPC are compared to the EPA Region IX PRGs. Equally, the minimum detection concentration (MDC) from radiochemistry analytical methods are compared with the accepted established PALs based on NCRP (1999) and DOE (1993) established levels. If this criterion is not achieved, the affected data will be assessed for usability and potential impacts on meeting site characterization objectives.

6.3 Radiological Survey Quality Assurance

Radiological surveys will be performed and data collected in accordance with approved standard operating procedures.

7.0 Duration and Records Availability

7.1 Duration

Table 7-1 provides a tentative duration of activities (in calendar days) for corrective action investigation activities.

Table 7-1
Tentative Activity Durations

Duration (days)	Activity
10	Site Preparation
76	Field Work Preparation and Mobilization
55	Sampling
160	Data Assessment
180	Waste Management

7.2 Records Availability

Historic information and documentation referenced in this plan are retained in the NNSA/NSO project files in Las Vegas, Nevada, and can be obtained through written request to the NNSA/NSO Project Manager. This document is available in the DOE public reading rooms located in Las Vegas and Carson City, Nevada, or by contacting the DOE Project Manager. The NDEP maintains the official Administrative Record for all activities conducted under the auspices of the FFACO.

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Appendix A.1

Data Quality Objectives

A.1 Seven-Step DQO Process for CAU 551 Investigation

The DQO process described in this appendix is a seven-step strategic planning approach based upon the scientific method used to plan data collection activities for CAU 551, Area 12 muckpiles. These DQOs are designed to ensure that data collected will provide sufficient and reliable information to identify, evaluate and technically defend the recommended corrective actions (e.g., no further action, closure in place, or clean closure). Existing information about the nature and extent of contamination at the three current and one proposed CAS in CAU 551 is not sufficient for evaluation and selection of preferred corrective actions; therefore, a CAI will be conducted.

The CAU 551 investigation will be based on the DQOs presented in this appendix as developed by representatives of NDEP and NNSA/NSO. The seven steps of the DQO process developed for CAU 551, as presented in Section A.1.2 through Section A.1.8, were developed based on the CAS-specific information contained in Section A.1.1, and in accordance with EPA *Guidance for Quality Assurance Project Plans*, EPA QA/G-5 (EPA, 2002a) and EPA *Guidance for the Data Quality Objectives Process*, EPA QA/G-4 (EPA, 2000b). This document identifies and references the associated EPA Quality System Documents entitled *Data Quality Objectives for Hazardous Waste Site Investigation*, EPA QA/G-4HW (EPA, 2000a), and *Guidance on Choosing a Sampling Design for Environmental Data Collection*, EPA QA/G-5S (EPA, 2002b), upon which the DQO process presented herein is based.

A.1.1 CAS-Specific Information

Corrective Action Unit 551 is located in the immediate vicinity of the B-, C-, D-, and F-Tunnel portals in Area 12 of the NTS. The four CASs within CAU 551 are depicted in Figure A.1-1. The portals for the C-, D-, and F-Tunnels are directly up-slope from the B-Tunnel portal. CAU 551 consists of the following four CASs:

- 12-01-09, Aboveground Storage Tank and Stain
- 12-06-05, Muckpile
- 12-06-07, Muckpile
- 12-06-08, Muckpile

Six documented nuclear tests were conducted inside the B-Tunnel complex from September 1957 through June 1963. Three documented nuclear tests were conducted inside C-Tunnel from

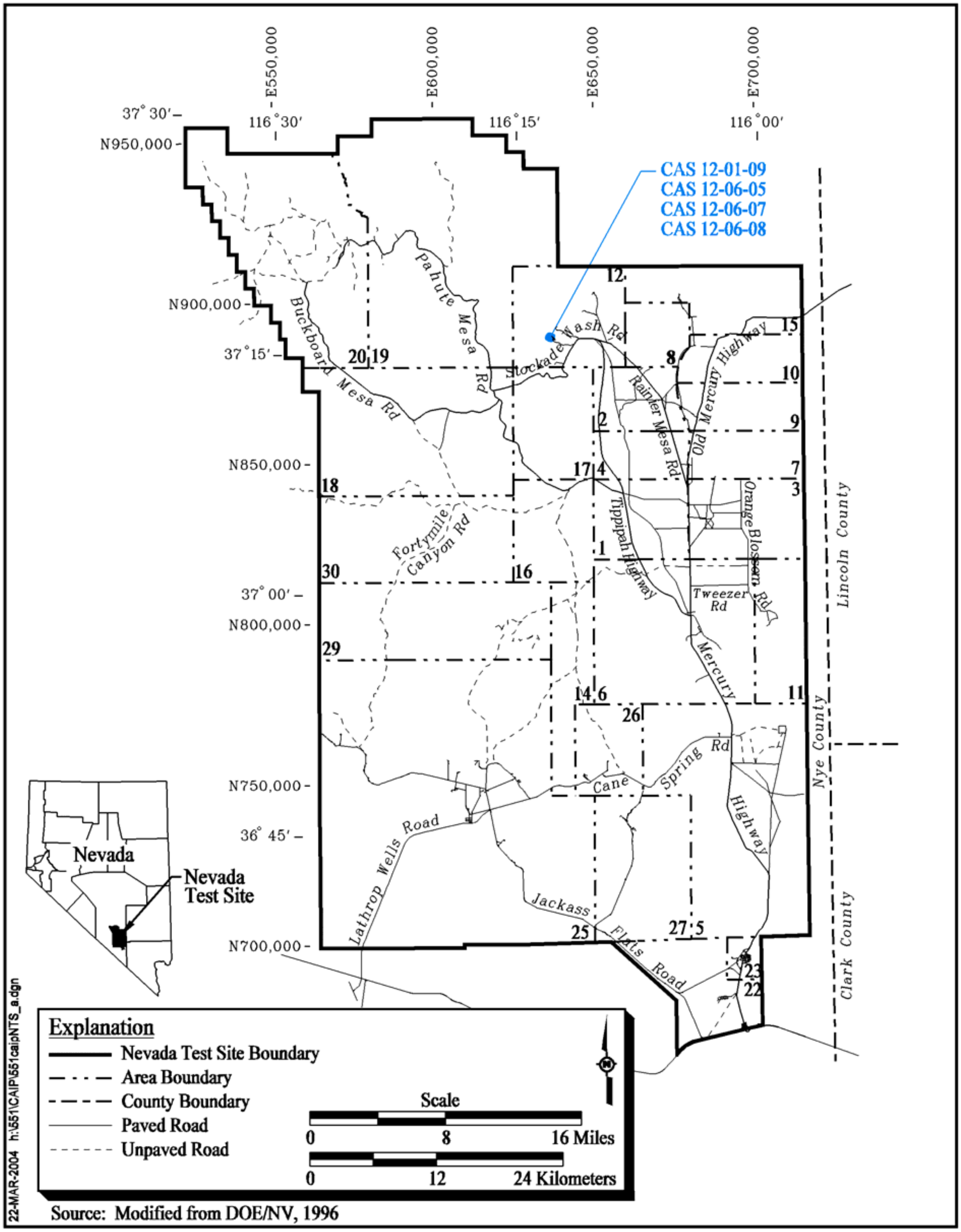


Figure A.1-1
CAU 551, CAS 12-01-09, CAS 12-06-05, CAS 12-06-07, and CAS 12-06-08 Location Map

August 1957 through October 1958. One documented nuclear test was conducted inside D-Tunnel in February 1958, and two documented nuclear tests were conducted in F-Tunnel during September 1958.

All COPCs identified for CAU 551 are included in various types of analyses (e.g., VOC, SVOC, and PCB). The COPCs are the analytes reported from the respective analytical methods that have PALs. These analytes are listed in Table A.1-1 for the various analytical methods proposed for this CAI. The critical COPCs are given greater importance in the decision-making process relative to noncritical COPCs. For this reason, more stringent performance criteria (i.e., completeness) are specified for the critical analyte DQIs (Section 6.0). The noncritical COPCs also aid in reducing the uncertainty concerning the history and potential release from the CASs and help in the accurate evaluation of potential contamination. If a COPC, either critical or noncritical, is detected in any sample at a concentration above the respective PAL, the COPC will be identified as a COC.

The four CAS locations are depicted on Figure A.1-2.

A.1.1.1 CAS 12-01-09, Aboveground Storage Tank and Stain

Corrective Action Site 12-01-09 consists of a 550-gallon fuel storage tank and underlying stain located at a former mid-level parking area between the parking areas for B-Tunnel portal and C-, D-, and F-Tunnel portals. The AST and stain are directly east of generator station 12-65 (Figure A.1-3, Figure A.1-4, and Figure A.1-5). The aboveground storage tank and stain were identified during a site visit in December 2003 by a Stoller-Navarro Joint Venture field crew. The tank is approximately half full and appears to be actively leaking through a rusted weld above the stain. The stain is estimated to be 3 to 4 ft in diameter, and is located directly beneath the north end of the tank. Corrective Action Site 12-01-09 was added through an FFACO Database Modification Request on April 26, 2004, to produce a CAS grouping that is close in proximity and of suitable size to maximize efficiencies of the CAI.

A.1.1.2 CAS 12-06-05, Muckpile, and CAS 12-06-08, Muckpile

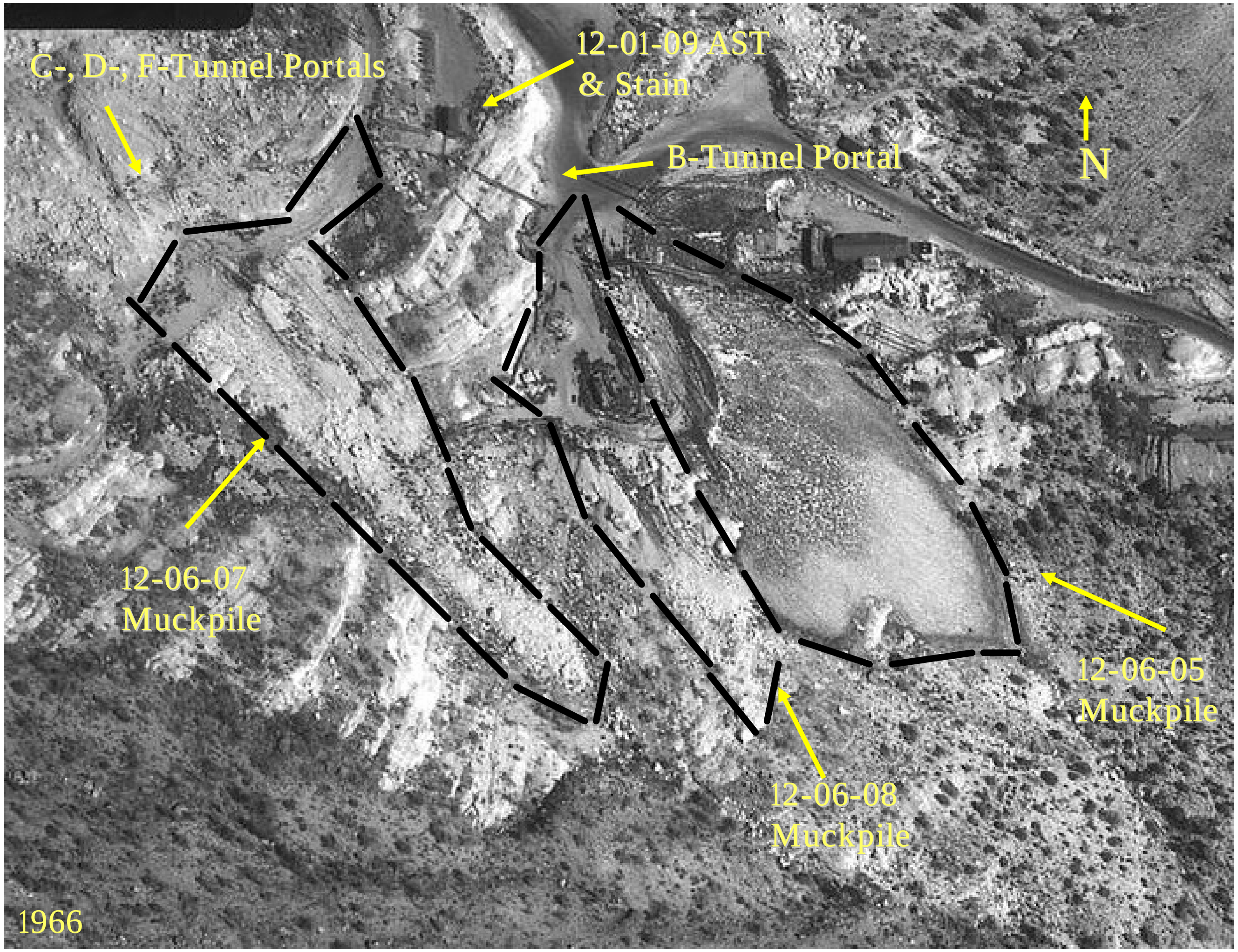
Corrective Action Sites 12-06-05 and 12-06-08 consist of the muckpile located outside of B-Tunnel. The muckpiles of the CASs are delineated in Figure A.1-2. It is unclear exactly why the muckpile

Table A.1-1
COPCs and Analytical Requirements for CAU 551

CAS / Analyses	CAS 12-01-09, Aboveground Storage Tank and Stain	CAS 12-06-05, Muckpile	CAS 12-06-07, Muckpile	CAS 12-06-08, Muckpile
Organic COPCs				
TPH (DRO)	C	C[c]		
VOCs[a, b]	X	See Table A.2-1 for critical COPCs[c]		
SVOCs[a, b]	X	See Table A.2-1 for critical COPCs[c]		
PCBs[a]	X	X		
Metal COPCs				
RCRA Metals[a, b]	X	See Table A.2-1 for critical COPCs[c]		
Beryllium	X	X		
Radionuclide COPCs				
Gamma-emitting radionuclides[a]	N	C for Cs-137, Co-60, and Am-241[c]		
Sr-90	--	C[c]		
Isotopic-Pu	--	C for Pu-238 and Pu-239/240[c]		
Isotopic-Uranium	--	X		

C = Critical COPC
X = Noncritical COPC, COPCs are the analytes reported from the analytical methods listed.
N = Results of gamma spectroscopy will be used to determine if further radiochemical analyses are necessary.
-- = COPCs have not been identified for this class of potential contaminants.

[a]The contaminants of potential concern are the analytes reported from the analytical methods listed.
[b]May also include a toxicity characteristic leaching procedure if sample is collected for waste management purposes.
[c]Critical COPCs are all the analytes listed in Table A.2-1 which have positive detects, except for gasoline. Gasoline is not included as a critical COPC because its components are covered in the organic analyses.



Source: Modified from Holmes & Narver, Inc., 1966.

Figure A.1-2
Overhead Aerial Photograph Depicting CAS 12-01-09, CAS 12-06-05, CAS 12-06-07, and CAS 12-06-08

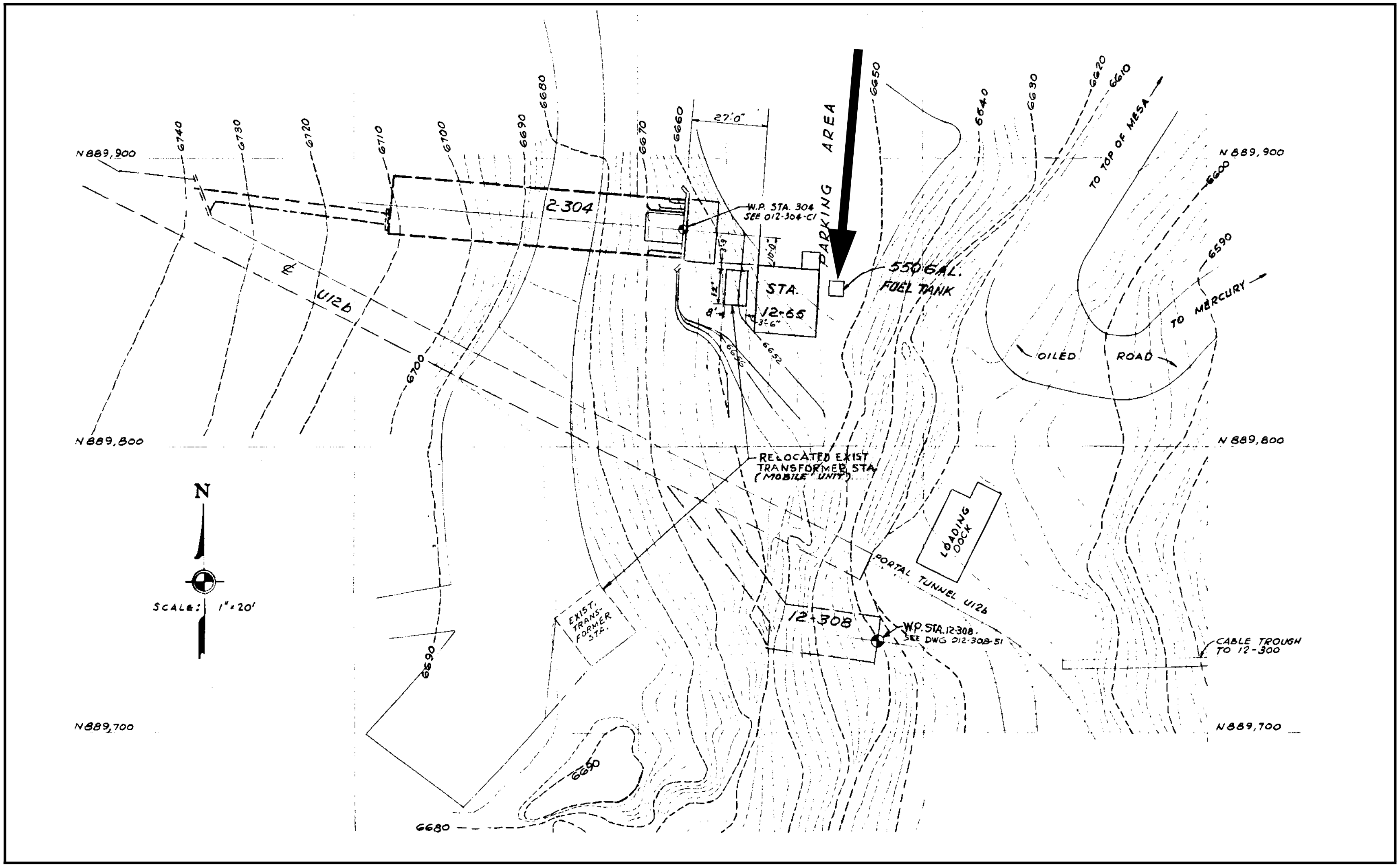


Figure A.1-3
Engineering Drawing Depicting Location of 550-Gallon Fuel Tank (Holmes & Narver, 1959b)

Figure A.1-4
Photograph of 550-Gallon Fuel Tank in CAU 551
Digital photograph of CAS 12-01-09, SNJV, 2004a

was given two CAS designations; however, it is assumed the split was done based on a physical separation of two lobes of the muckpile. This split appears to have been caused by a drainage that presently flows between them and/or from muck dumping practices. Aside from the different radiological postings on the two muckpiles, there is no reason to suspect that the two CASs contain material from different sources. For the purposes of this investigation, the two CASs that make up the B-Tunnel Muckpile will be treated as one site.

The muck in both CASs resulted from the activities conducted at the tunnel, including drilling, tunnel development, cutback operations, and reentry mining. The reentry mining excavated debris produced during nuclear tests, and possibly included radioactively contaminated muck.

A.1.1.3 CAS 12-06-07, Muckpile

Corrective Action Site 12-06-07 consists of the muckpile located outside of C-, D-, and F-Tunnels. The CAS is delineated in Figure A.1-2. The muck resulted from the activities conducted at the tunnel including drilling, tunnel development, cutback operations, and reentry mining. The reentry mining

Figure A.1-5
Photograph of 550-Gallon Fuel Tank and Underlying Stain in CAU 551
Digital photograph of CAS 12-01-09, SNJV, 2004b

excavated debris produced during nuclear tests, and possibly included radioactively contaminated muck.

A.1.1.4 Specific Information for the Four CAU 551 CASs

Because of the differences in approach to CAS 12-01-09, AST and Stain, from the three muckpiles, the discussions in several of the following subsections has been written to separate CAS 12-01-09 from the three muckpiles in CAU 551.

Scope of CAS - The scope of the AST and stain CAS consists of the corresponding tank and stain, and potential contamination that may be migrating from the tank and stain into the surrounding area. The scope of this CAS does not include the nearby generator station (Building 12-65 on Figure A.1-3) or additional support areas except where specifically called out.

The scope of each of the muckpile CASs consists of the corresponding muckpile and potential contamination that may be migrating from the muck into the area surrounding the muckpile. The scope of these CASs does not include the areas within the tunnel portals and/or support areas that are not on the muckpile except where specifically called out.

The determination of the nature and extent of possible contamination will be limited to releases from sources within the CAS boundary (i.e., footprint of the aboveground storage tank and stain, and the muckpiles). The investigation of widespread radiological contamination associated with fallout from activities conducted at the NTS, including radiological contamination beyond the footprint of the muckpiles for which the source of contamination is breaches of tunnel containment systems, will not be a part of this investigation.

Physical Setting and Operational History - Corrective Action Site 12-01-09, AST and Stain, was first identified during the field visit on December 4, 2003. The three muckpile CASs in CAU 551 were first identified in the 1991 Reynolds Electrical & Engineering Co., Inc. document entitled *Nevada Test Site Inventory of Inactive and Abandoned Facilities and Waste Sites* (REECo, 1991).

Corrective Action Site 12-01-09, AST and Stain, is located at a mid-level parking area between the B-Tunnel portal and the C-, D-, and F-Tunnel portals. The aboveground storage tank is located between a building identified in historical drawings as a generator building and the edge of the slope. The stain is approximately 3 to 4 ft in diameter and located under the north end of the AST. The operational dates for the AST are unknown; however, based on the historical drawings and the proximity to the B-, C-, D-, and F- Tunnels, it is assumed that the tank supported operations at these tunnels while they were active (e.g., approximately 1957 through 1963). Based on the drawings, it is believed the tank was used to supply fuel (i.e., diesel) to the nearby generators.

The B-, C-, D-, and F- Tunnels are located in Area 12 of the NTS along the eastern slopes of Rainier Mesa. From 1957 through 1963, B-Tunnel was the location of six confirmed nuclear tests (DOE/NV, 2000a), one high-explosives test (AEC, 1958; name of test not provided in document), and one confirmed accidental explosion (Holmes & Narver, 1959a). C-Tunnel hosted three confirmed nuclear tests in 1957 and 1958. D-Tunnel was home to one confirmed nuclear test, and F-Tunnel hosted two confirmed nuclear tests during 1958 (DOE/NV, 2000a). The tests conducted within these tunnels are noteworthy since they included the first experiment designed to contain a nuclear explosion completely underground (Rainier, in B-Tunnel, on September 19, 1957).

The B-, C-, D-, and F-Tunnels are located higher up on Rainier Mesa than previously investigated muckpiles (i.e., CAU 475 Muckpile, CAU 476 Muckpile, CAU 477 Muckpile, CAU 482 muckpiles, and CAU 504 Muckpile). At this altitude, the steep slopes of the natural terrain upon which the muckpiles and access road are built present challenging conditions for site investigation. Corrective Action Site 12-06-07 is especially challenging to reach because the access road to the C-, D-, and F-Tunnel portals was damaged following the creation of a 175-ft crater during the Neptune test in the C-Tunnel. The testing conducted within these tunnels consisted of safety experiments and weapons-related and effects tests. According to the *Nevada Test Site Contaminated Land Areas Report*, "some of these tests breached the tunnel containment systems" at B-, C-, D-, and F-Tunnels (DOE/NV, 2000b). Based on this information, the possibility exists that the areas outside the tunnels were contaminated.

Sources of Potential Contamination - Corrective Action Site 12-01-09 appears to have been created as a result of leakage from an AST which provided fuel to the nearby generator station, and/or activities associated with filling and maintaining the 550-gallon fuel tank. The tank is approximately half full with a liquid substance identified by its appearance and odor as diesel. The stain's location and appearance beneath a possible leak in the tank is consistent with diesel fuel contacting the soil surface as a result of the fuel tank leaking.

Corrective Action Sites 12-06-05 and 12-06-08 were created as a result of tunneling activities within B-Tunnel. Activities associated with the nuclear tests conducted within B-Tunnel are the potential sources of chemical and radioactive contamination. The muckpiles also contain debris removed from the tunnel following nuclear weapon tests, one high explosives test, and one accidental explosion of gases. These activities resulted in the potential for buried radioactive and/or hazardous material in the mudpits. Two nuclear tests released large quantities of tritium into the rock within the tunnel, leading to special ventilation problems. Following the tritium releases, B-Tunnel underwent decontamination prior to completion in preparation for a subsequent test (Nielsen, 1961). Debris, including one partially buried 55-gallon drum with unknown contents, is visible on the CAS 12-06-05 portion of the B-Tunnel Muckpile. Several rusted 55-gallon drums, a metal canister, and other debris are visible on the CAS 12-06-08 portion of the B-Tunnel Muckpile.

Corrective Action Site 12-06-07 was created as a result of tunneling activities within C-, D-, and F-Tunnels. The muckpile contains debris removed from the tunnels following nuclear weapon tests, resulting in the potential for buried radioactive material. Contamination of F-Tunnel occurred from the Mercury test, with "severe contamination" being found near the drift entrance. The entrance to the drift was sealed off, but no mention of decontamination of the main tunnel was given (Holmes & Narver, 1958). C-Tunnel was destroyed by the Neptune test, which led to the formation of a 175-ft diameter crater at the surface (Holmes & Narver, 1958). No indication was found of follow-up activities that may have contributed to the muckpile, although removal of damaged rail cars strewn on the muckpile after the Neptune test may have involved heavy equipment. The Neptune Crater is not considered part of CAS 12-06-07. Presently, crushed drums and other debris are spread over the CAS 12-06-07 Muckpile.

In an assessment of nonnuclear tests that may have left residual "unburned" plutonium, the document entitled *Plutonium at NTS* (Hendricks, 1971) lists two tests conducted within B-Tunnel (Tamalpais and Evans) and six tests conducted within C-, D-, and F-Tunnels (Saturn, Venus, Uranus, Mars, Neptune, and Mercury). Most, perhaps all, of these tests resulted in plutonium being detected either on the ground or in air samplers following the tests. Therefore, plutonium and/or its various decay daughter products are a potential source of the alpha contamination in the CAU 551 muckpiles. Previous muckpile investigations found that plutonium isotopes were the only alpha emitting radionuclides present in the muck at concentrations above PALs. The alpha contamination warning signs on CAS 12-06-08 can be reasonably expected to indicate the plutonium originated from B-Tunnel (Deshler, 2004a). All nuclear tests are likely to leave some quantity of "unburned" plutonium. Therefore, the "unburned" plutonium associated with tests that may have impacted CAU 551 is not unique to this unit.

Chemical and radiological COCs identified during previous NTS muckpile investigations have been found within the muck but not at the surface, and have not migrated from within the muckpile (Appendix A.2) to the native material underlying the muckpile, although they have been found in areas down stream at Tunnels U15a and e, and U16a as a result of overland transport (DTRA, 2002; DTRA, 2003). Preliminary data from the U12 P-Tunnel Muckpile (CAU 475) characterization indicates that plutonium may be present under the muckpile (Deshler, 2004b). The data is presently being evaluated; however, initial analysis indicates that the plutonium was present on the ground surface at the site prior to starting construction on the U12 P-Tunnel complex (circa 1986). It is theorized that the plutonium was mixed into the native material during initial site construction and the muckpile was subsequently deposited over it. Other muckpile investigations on the NTS have not found plutonium, or any other contaminant, below the muckpiles even when it was found in the muck.

As a general rule, approximately 10 ft of uncontaminated muck is placed atop radioactively contaminated muck for the purpose of providing an adequate cover to the muckpiles (DOE, 1988). No historical records were located to confirm or dispute this practice for the CAU 551 muckpiles.

The B-, C-, D-, and F-Tunnel portals are presently addressed in CAU 187, and are not included in this investigation. The tunnels and drifts themselves are addressed as Underground Test Area Project sites. Effluent, if present, from the tunnels may possibly reach the muckpiles. However, no effluent was observed during the field visit. Standing water and effluent in B-Tunnel was not observed during installation of a bulkhead (for prevention of an unidentified gas leaking from a test in U12 N-Tunnel) (Griffin, 2004), nor does any of the historical documentation indicate there was ever any effluent from these tunnels. If necessary, potential effluent will be considered in the CADD.

Previous Investigation Results - No previous sample results have been identified for CAU 551.

Previous investigations of CAS 12-01-09, AST and Stain, have not been identified. Previous investigations of similar ASTs and stains involving TPH DRO (CAU 127) have found vertical migration of contamination from stains from two 1,000-gallon ASTs to have migrated vertically 8 to 16.5 ft bgs before TPH concentrations were less than the regulatory action level of 100 mg/kg, and lateral migration to 10 ft at both sites before TPH concentrations were below 100 mg/kg (DOE/NV, 2003). Several investigations of muckpiles similar to the CAU 551 muckpiles have been completed at the NTS. Sample analytical results for detections of COPCs during CAIs conducted at CAUs 475, 476, 477, 482, and 504 have been summarized in Appendix A.2. The operational similarities and differences that affected the material that was deposited in muckpiles at previously investigated CAUs and the muckpiles in CAU 551 are discussed in Appendix A.2. Data from the CAIs for the previously investigated CAUs is evaluated to aid in the development of the CSM for CAU 551. The DQO approach documented here for the muckpiles employs the explicit assumption for similarities that exist between the CAU 551 muckpiles and previously investigated NTS muckpiles, both in terms of activities that contributed to the muckpiles and environmental conditions affecting the muckpiles. The evaluation of the physical setting, waste generating activities and analytical data found that sufficient similarities exist to support the assumption. Refer to Appendix A.2 for further discussion and documentation supporting this assumption.

The document entitled *Radiological Effluents Released from U.S. Continental Tests 1961 Through 1992* (DOE/NV, 1996) describes several breaches of radioactive isotopes through the portal and tunnel vent system at B-Tunnel, and provides data on the amount and types of radioactive material released in breaches that occurred during three of the six tests and during a post-test drillback. The fission products released during these breaches and drillback activities (e.g., krypton-88, ruthenium-103, iodine-131/-133/-135, xenon-133/-135, cesium-138/-141, and lanthanum-140) would have decayed to undetectable levels since their release.

Testing within C-, D-, and F-Tunnels led to venting. Venting is generally accepted not to occur instantaneously, and appears as a slower release of radioactive gases and other vaporized materials than observed in breaching (Deshler, 2004a). In the report *United States Nuclear Tests, July 1945 through September 1992* (DOE/NV, 2000a), both the Mars and Neptune tests were listed as having vented slightly, although no radioactivity was detected off site. Specific isotopes that may have been released through the venting were not listed.

Potential Contamination - CAS 12-01-09, AST and Stain, consists of liquid in the tank and an organic substance in the stain that has the appearance and odor consistent with diesel fuel. Therefore, TPH-DRO is identified as a critical COPC for this CAS. The presence of other COPCs in the CAS is unknown.

Potential contamination at the three muckpile CASs is expected to be similar due to the similarity of the operational backgrounds of the three muckpiles (12-06-05, 12-06-07, and 12-06-08). The chemical COPCs are RCRA metals, beryllium, TPH, VOCs, SVOCs, and PCBs that may exist at the sites as a result of industrial activities associated with B-, C-, D-, and F-Tunnels. Although high explosives were used in one or more tests at these sites (AEC, 1958), explosives materials generally go "high order," a very efficient process in which the majority if not all of the explosive is fully consumed by the explosion (USAESC, 2001). Therefore, explosives are not considered COPCs. Debris and effluent created during the nuclear tests within the tunnels are the sources of the radiological COPCs (i.e., cesium-137 [Cs-137], cobalt-60 [Co-60], plutonium-238 and -239 [Pu-238 and -238, strontium-90 [Sr-90], and other man-made radionuclides). The source of the accidental explosion in B-Tunnel was unidentified explosive gases (Holmes & Narver, 1959a). Contaminants of potential concern were not identified for this event.

The scope of this investigation is to determine the nature and extent of contamination at CAU 551.

A.1.2 Step 1 – State the Problem

This initial step of the DQO process identifies the planning team members and decision makers, describes the problem that has initiated the CAU 551 CAI, and develops the CSMs.

A.1.2.1 Planning Team Members

The DQO planning team consists of representatives from NDEP, NNSA/NSO, SNJV, and BN. The primary decision makers include NDEP and NNSA/NSO representatives. Table A.1-2 lists representatives from each organization in attendance at the February 25, 2004, DQO planning meeting.

A.1.2.2 Describe the Problem

Corrective Action Unit 551 is being investigated because the four CASs within the CAU may contain chemical and radiological contaminants which could potentially pose a threat to human health and the environment.

The problem statement for CAU 551 is: "Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives for CASs 12-01-09, 12-06-05, 12-06-07, and 12-06-08."

A.1.2.3 Develop Conceptual Site Models

Two separate CSMs have been developed, one for CAS 12-01-09, AST and Stain, and one for CASs 12-06-05, 12-06-07, and 12-06-08, muckpiles. The applicability of the following CSMs to each of the four CASs is discussed below. A CSM describes the most probable scenario for current conditions at a CAS and defines the expectations that are the basis for identifying appropriate

Table A.1-2
DQO Meeting Participants

Participant	Affiliation
Kevin Cabble	NNSA/NSO
Greg Raab	NDEP
Allison Urbon	BN
Mike Kinney	SNJV
Brian Hoenes	SNJV
Jeanne Wightman	SNJV
Dave Schrock	SNJV
Syl Hersh	SNJV
Joe Hutchinson	SNJV
Rob Boehlecke	SNJV
Thomas Murarik	SNJV

BN – Bechtel Nevada
SNJV – Stoller-Navarro Joint Venture
NDEP – Nevada Division of Environmental Protection
NNSA/NSO – U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office

sampling strategies and data collection methods. It is the basis for assessing how contaminants could reach receptors both in the present and future by addressing contaminant nature and extent, transport mechanisms and pathways, potential receptors, and potential exposures to those receptors. Accurate CSMs are important because they serve as the starting point for all subsequent inputs and decisions throughout the DQO process.

Conceptual Site Model #1 has been developed for CAS 12-01-09, AST and Stain, using information from the physical setting, potential contaminant sources, knowledge from similar sites, release information, historical background information, and physical and chemical properties of the potentially affected media and COPCs. The CSM is shown in Figure A.1-6, and discussed in the following paragraphs.

The 550-gallon fuel tank in CAS 12-01-09 was constructed for, and operated in support of, the nearby generator station (Figure A.1-4). The environmental fate for the components of the tank and stain include lateral and vertical movement outward from the point of contact where droplets of diesel fuel

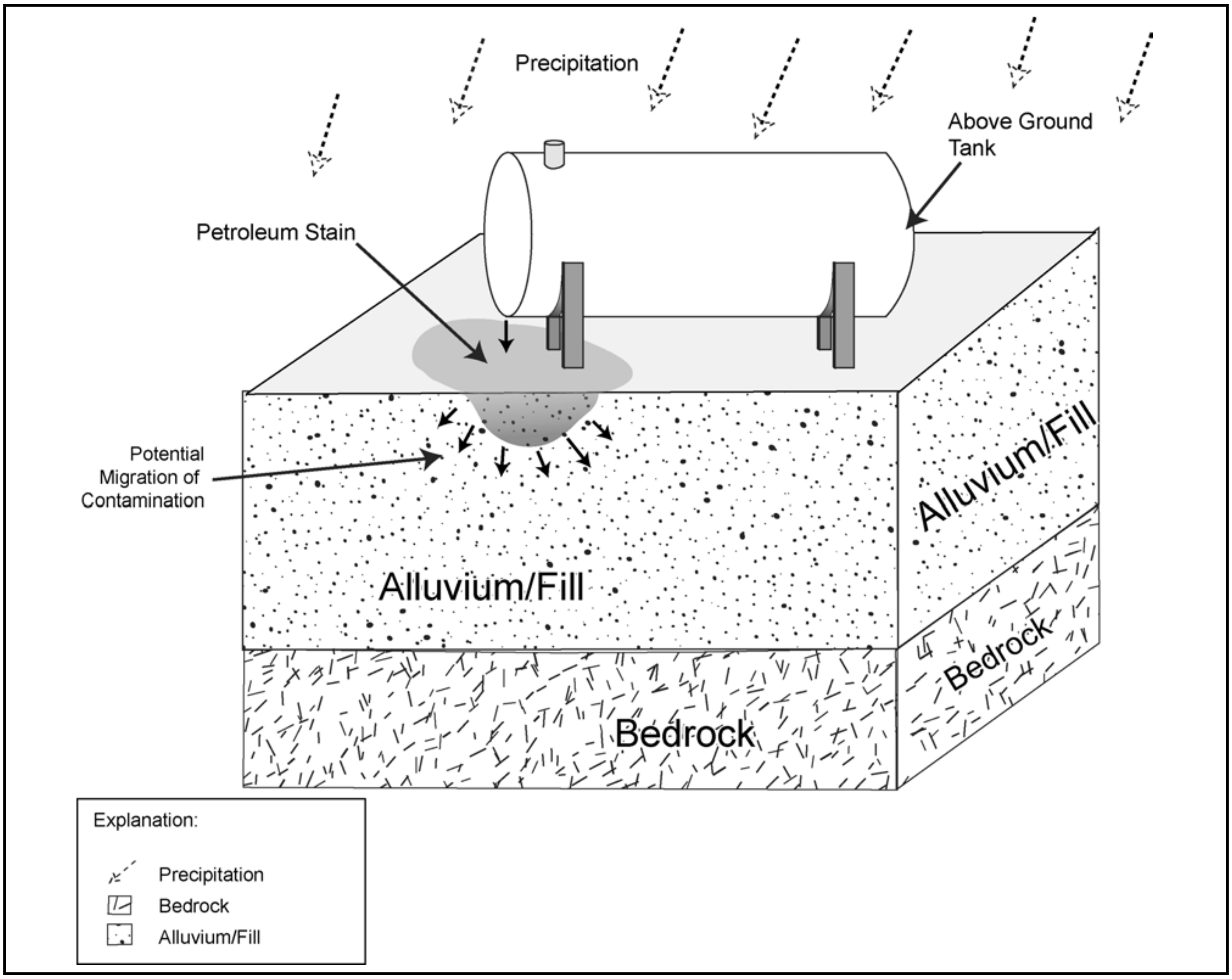


Figure A.1-6
CAU 551, CAS 12-01-09, Aboveground Storage Tank and Stain, Conceptual Site Model

from the tank contact the underlying soil, and from the present extent of the stain itself. Nonpolar organic liquids such as diesel fuel, comprised of several types of molecular compounds, can move through porous media such as soil and unconsolidated alluvium under both the force of gravity and as a film across interconnecting surfaces of soil/alluvium particles. The diesel fuel components could potentially migrate towards an aquifer.

Conceptual Site Model #2 has been developed for the three CAU 551 muckpiles using information from the physical setting, potential contaminant sources, knowledge from similar sites, release information, historical background information, and physical and chemical properties of the potentially affected media and COPCs. The CSM is shown in Figure A.1-7 and Figure A.1-8, and discussed in the following paragraphs.

The two CASs (12-06-05 and 12-06-08) adjacent to B-Tunnel in CAU 551 appear to have been originally created side by side, if not as one unit. CAS 12-06-07, adjacent to C-, D-, and F-Tunnels, and up-slope from the B-Tunnel area, is the only muckpile created for those tunnels. The proximity both in time of use and in location for the three CAS muckpiles and their similar operational histories supports similar creation factors and environmental fates for the three muckpiles. Additionally, the gullies below all three muckpiles join a main wash within a few hundred feet, giving the CASs a similar down-slope migration route for COPCs. Therefore, a single CSM has been developed for these three CASs within CAU 551. It should be noted that the main wash, down gradient of all three CASs, eventually flows past the E-Tunnel muckpile (CAU 383) (Figure 2-1). Therefore, if contamination is found in the wash below the level of the E-Tunnel muckpile, the source of the contamination may not be discernible.

An important element of a CSM is the expected fate and transport of contaminants, which imply how contaminants move through site media and where they can be expected in the environment. The expected fate and transport is based on distinguishing physical and chemical characteristics of the critical contaminants and media. Contaminant characteristics include solubility, ion formation and charge magnitude, density, and particle size. Media characteristics include permeability, saturation, sorting, chemical composition, clay surface charge, and adsorption coefficients. In general, contaminants with low solubility, high susceptibility to surface sorption, and/or high density can be expected to be found relatively close to release points. Contaminants with high solubility, low susceptibility to surface sorption, and/or low density are more susceptible to factors that can move them through various media, and can be expected to be found further from release points.

Contaminants migrating to regional aquifers are not considered a likely scenario at CAU 551 based on the low annual average precipitation rates, high potential evapotranspiration, and low mobility of expected COPCs. Past investigations of muckpiles at the NTS have indicated that contamination has not migrated vertically into the native material underlying the muckpile, but has migrated laterally due to erosion. The CSM for the CAU 551 muckpiles has been constructed based on the assumption that the conditions present at CAU 551 are sufficiently similar to those at the previously investigated

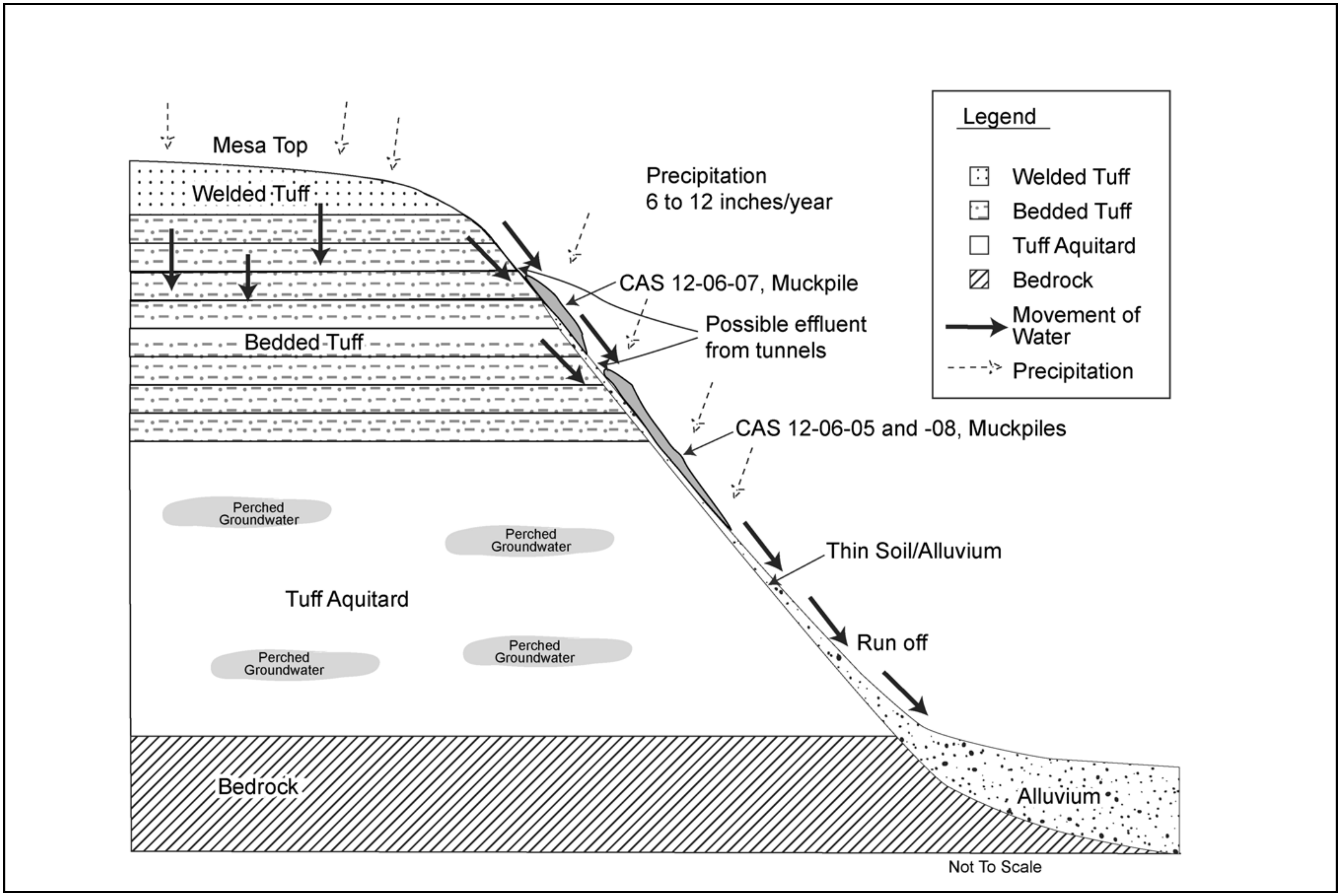


Figure A.1-7
CAU 551, CASs 12-06-05, 12-06-07, and 12-06-08, Muckpiles Conceptual Site Model (Profile Model)

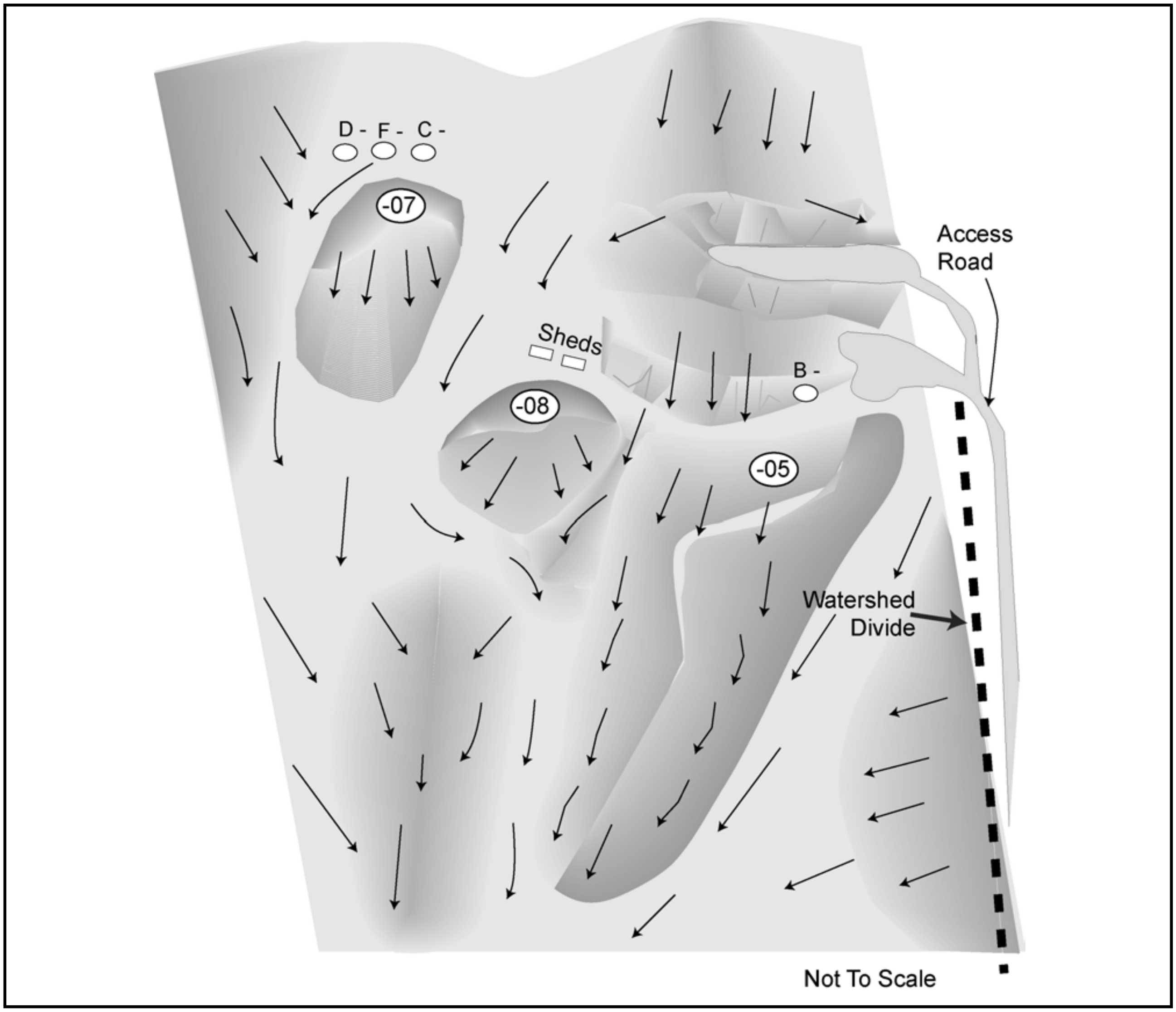


Figure A.1-8
CAU 551, CASs 12-06-05, 12-06-07, and 12-06-08, Muckpiles Conceptual Site Model (Drainage Model)

muckpiles to assume that COPCs will have a similar fate. Therefore, lateral migration is expected to dominate over vertical migration.

If additional areas or elements are identified during the CAI that go beyond the area or situation identified for investigation in the CSMs, the situation will be reviewed and recommendations will be made to revise Step 4 (Define the Study Boundaries) of the DQO process and/or revise the sampling approach. The DQOs will be reviewed and any significant deviation from the planned approach will be presented to the decision makers for approval.

The following discussion of CSM parameters provides additional details to supplement these models.

Exposure Scenario - The potential for exposure to contamination at the CAU 551 CASs is limited to industrial and construction workers as well as military personnel conducting training (DOE/NV, 1998). These human receptors may be exposed to COPCs through ingestion, inhalation, dermal contact (absorption) from soil and/or debris (e.g., equipment, concrete) due to inadvertent disturbance of these materials. The future land-use scenario limits uses of the CAU to various nonresidential uses (i.e., industrial uses) including defense and nondefense research, development, and testing activities (Table A.1-3). The Nuclear Test Zone referenced in the table is defined as "reserved for dynamic experiments, hydrodynamic tests, and underground nuclear weapons and weapons effects tests (DOE/NV, 1998)."

Table A.1-3
Future Land-Use Scenarios for CAU 551

Land Use Zone	Zone Description
Nuclear and High Explosives Test Zone	This area is designated within the Nuclear Test Zone for additional underground nuclear weapons tests and outdoor high explosives tests. This zone includes compatible defense and nondefense research, development, and testing activities (DOE/NV, 1998).

Affected Media - The potentially affected media at CAS 12-01-09 are the surface soils and shallow subsurface soils. The potentially affected media at CASs 12-06-05, 12-06-07, and 12-06-08 are the muck, surface soils, and shallow subsurface soils. Deep subsurface soils and groundwater are not believed to have been affected by the COPCs.

Contamination/Release - Contamination at CAS 12-01-09, AST and Stain, could potentially be found in any contiguous part of the soil around the stain. Based on the observation that the tank is approximately one-half full, up to 200 gallons or more may have leaked from the tank. Contamination at CASs 12-06-05, 12-06-07, and 12-06-08 could potentially be found in any part of the muckpiles. There is also a potential for contamination in the shallow subsurface soils around the AST and stain, at the muckpile/native soil interface, at the base of the muckpiles, and down-slope from the muckpiles due to erosion and contaminant transport. The AST and the muckpiles were constructed on top of native soil and rock outcroppings.

Transport Mechanisms - The degree of contaminant migration at this site is unknown but is expected to be limited based on the affinity of the COPCs for soil particles, and the low precipitation and high evapotranspiration rates typical of the NTS environment. Runoff from the muckpiles down one of several washes could cause lateral migration of contaminants from the muckpiles over the ground surface. Contaminants may also have been transported by infiltration and percolation of precipitation through soil, which would serve as the primary driving force for downward migration. The migration of organic constituents (e.g., petroleum hydrocarbons, chlorinated solvents) can be controlled to some extent by their affinity for organic material present in soil. However, this mechanism is considered insignificant because of the lack of organic carbon in the desert soil, and the muck in Area 12. Migration of certain inorganic constituents (e.g., metals in waste oil) is controlled by geochemical processes such as adsorption, ion exchange, and precipitation of solids from solution.

Because of the low volatility of the critical contaminants in the muckpiles, an airborne release subsequent to the initial contaminant release is not considered a significant release pathway. The main process of migration through the air would be through windblown dust. If VOCs, SVOCs, metals, radioactive contaminants, or petroleum hydrocarbons sorbed to the fine soil particles, a small amount of migration could be expected via the airborne pathway. This process could allow for the deposition of contaminants beyond the site boundaries. For all transport mechanisms, it would be expected that contaminant levels decrease with distance from the point of release. If present, contamination from the muckpiles is expected to be contiguous to the release site, with possible contaminated spots down gradient from the muckpiles in drainages.

As previously discussed, data from previous NTS muckpile investigations indicates little to no migration of contaminants into the native material underlying the muckpile.

Preferential Pathways - Preferential pathways for contaminant migration at CAS 12-01-09 may be present in the form of soil and loose alluvium underlying the aboveground storage tank and stain, which could permit the lateral and vertical migration of the TPH-DRO.

Preferential pathways for contaminant migration at CAS 12-06-05, CAS 12-06-07, and CAS 12-06-08 may be present in the form of small gullies and washes that channelize the overland flow of runoff from the muckpiles that may increase lateral transport prior to infiltration. Rain may wash contaminants from the muckpile down into the main channel or the surrounding soil. The preferential pathways for contaminant migration will be considered in the development of sampling schemes and sampling contingencies discussed in Step 7, Optimize the Design for Obtaining Data, and the CAIP.

Lateral and Vertical Extent of Contamination - If contamination is present, it is expected to be confined to the surface and shallow subsurface at the site. Concentrations of contaminants are expected to decrease with distance (both horizontally and vertically) from the release points. Surface migration may occur as a result of storm events when precipitation rates exceed infiltration (stormwater runoff); however, these events are infrequent. Surface migration is a biasing factor considered in the selection of sampling points. As stated previously, downward contaminant transport is expected to be limited but is unknown because the quantities of hazardous material released are unknown. Vertical migration of COPCs out of muckpiles has not been identified at any previous NTS muckpile CAI except potentially at CAU 475 as described above. The steep terrain of CAU 551 would tend to drive the overland transport of water, rather than vertical migration, from rain events.

Migration of contamination for any potential release scenarios would be expected to be down-slope from the point of initial deposition. As shown in Figure A.1-8, all CAU 551 muckpiles are contained within one watershed. Potential contamination is not expected outside of this watershed.

Groundwater contamination is not considered a likely scenario at CAU 551 due to minimal precipitation, high evapotranspiration, strong attenuation of critical contaminants in the soil, and significant depths to groundwater. Depth to groundwater in nearby Well E-12-1 has been recorded at a depth of 1,527 ft bgs (USGS, 2003).

A.1.3 Step 2 – Identify the Decision

Step 2 of the DQO process identifies the decision statements and defines alternative actions. Also presented is this section is the decision logic for the entire process.

A.1.3.1 Develop Decision Statements

The primary problem statement is: "Existing information on the nature and extent of potential contamination is insufficient to evaluate and recommend corrective action alternatives for CASs 12-01-09, 12-06-05, 12-06-07, and 12-06-08." Because existing information at this CAU is insufficient to resolve the problem statement, the following two decision statements have been established as criteria for determining the adequacy of the data collected during the CAI.

The Decision I statement is: "Is a contaminant present within a CAS at a concentration that could pose an unacceptable risk to human health and the environment?" Any contaminant detected at a concentration exceeding the corresponding PAL, as defined in Section A.1.4.2, will be considered a COC. A COC is defined as a site-related constituent that exceeds the screening criteria (PAL). The presence of a contaminant within each CAS is defined as the analytical detection of a COC.

The Decision II statement is: "If a COC is present, is sufficient information available to determine to what extent the contamination has migrated to the surrounding area?" Sufficient information is defined as the data needs identified in this DQO process to include the lateral and vertical extent of all COCs within each CAS. Decision II samples are used to determine the lateral and vertical extent of the contamination as well as the likeliness of COCs to migrate outside of the site boundaries. The migration pattern can be derived from the Decision II samples since the analytical results of those samples will show how far the contamination has travelled in the time period since release of the contaminant.

A.1.3.1.1 Decision Statements for CAS 12-01-09, Aboveground Storage Tank and Stain

Because the investigation of CAS 12-01-09, AST and Stain, follow more typical CAIs for ASTs and stains, the Decisions I and II given above are precise as presented and no further development is needed.

A.1.3.1.2 Decision Statements for CASs 12-06-05, 12-06-07, and 12-06-08, Muckpiles

Because the investigation of the CAU 551 muckpiles cannot follow the model developed for previous muckpile CAIs, as explained in the following discussions, further development of the Decision I statement is required.

The steepness of the slopes on and around CAS 12-06-07 and CAS 12-06-08, and on the majority of CAS 12-06-05, presents safety hazards to the field personnel who would be collecting samples on the muckpiles under sampling programs used during previous NTS muckpile investigations. The hazardous conditions also present a problem for rescue and treatment of injured personnel, as well as challenges for crews scaling the natural terrain wearing PPE. The challenges of working in the steep terrain combined with required PPE for potential hazards (e.g., alpha contamination) may further restrict access to some parts of the muckpiles. Secure set up and staging areas for drilling equipment is also a concern due to the limited amount of level ground, the steep slopes, and the stability of those slopes. Therefore, the safety hazards in CAU 551 make significant portions of the muckpiles difficult to safely access for sampling, and prevent the collection of representative sample populations to answer Decision I directly. To address the CAU 551 hazards and other practical constraints associated with the topography of these CASs, this investigation will adopt an approach to the Decision I statement that conservatively infers the partial resolution of Decision I through the use of historical NTS muckpile data.

This investigation will include a review of data collected at similar sites to generate a list of expected COCs and the collection of data from accessible areas of the CAU 551 muckpiles. To contend with the two types of analytical data inputs (i.e., historical and newly acquired data), the Decision I statement has been further broken out into four supporting decision statements. The Decision I statements, their relationships to one another in the decision process, and the role of historical and new sample data for CAU 551 muckpiles are depicted in Figure A.1-9.

Decisions Ia and Ib address historical muckpile data only. The COCs that are identified by a review of historical muckpile data, during the Decisions Ia and Ib process, as exceeding current PALs will become the expected COCs for the CAU 551 CASs associated with the muckpiles, and are termed “exp-COCs.” To establish guidelines for the CSM, expected concentration ranges for these exp-COCs need to be set. These concentration ranges for each exp-COC will be set at twice the

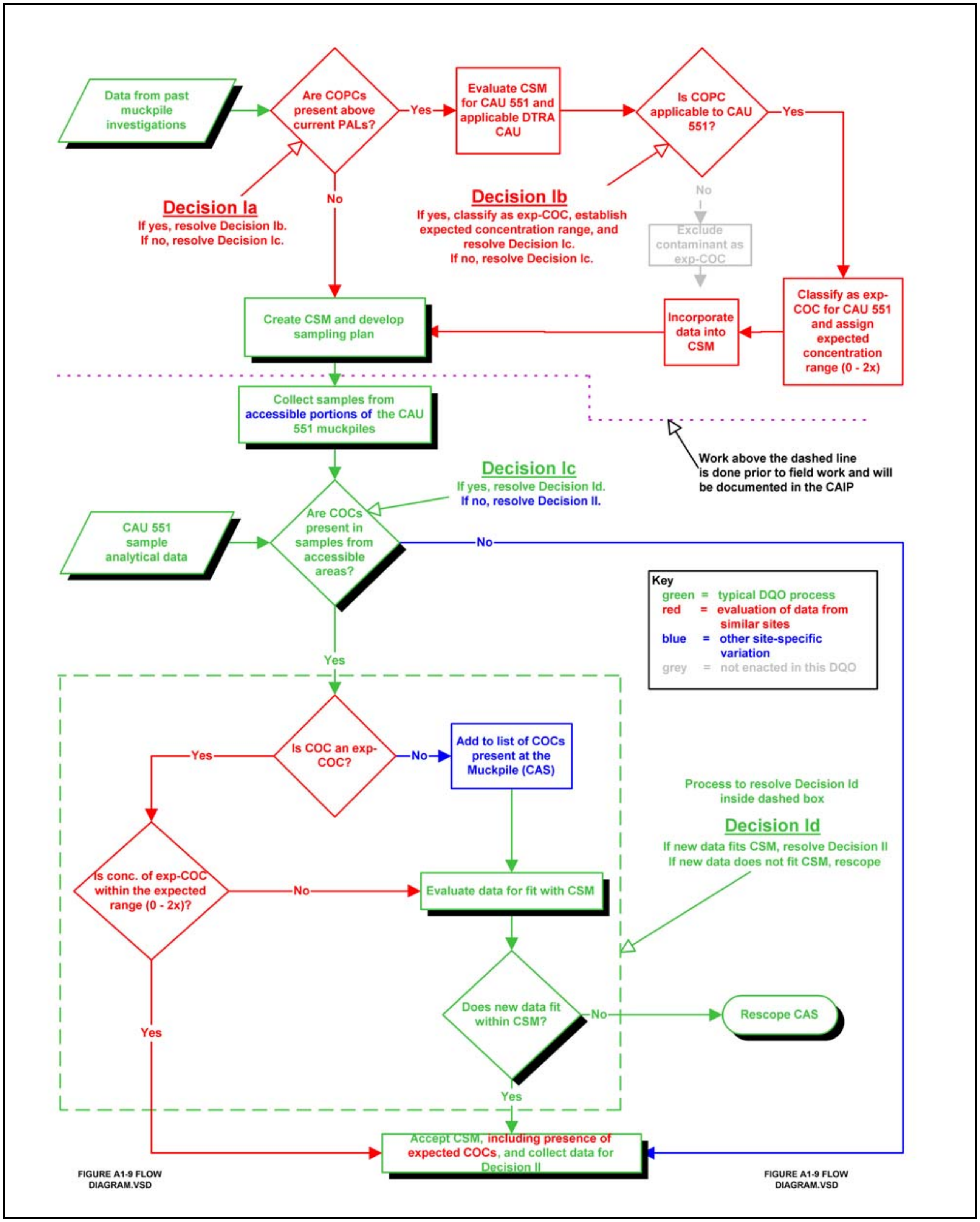


Figure A.1-9
CAU 551 Decision Flow Diagram

highest detected concentration that was determined from the CAIs conducted at CAUs 475, 476, 477, 482, and 504. The exp-COCs are the same as the critical COPCs for the purpose of this investigation, but are differentiated given the context in which they are discussed.

Decision Ic addresses the identification of COCs in the samples collected at the CAU 551 muckpiles.

Decision Id addresses the fit of the newly generated data into the CSM constructed for CAU 551, including the presence of exp-COCs. The convention for differentiating between the exp-COCs and the newly identified COCs found from Decision I sampling at CAU 551 muckpiles is to term the latter COCs as "newly identified COCs." The acronym "COC" will be used either generically or in reference to the sum of exp-COCs and newly identified COCs.

The two Decision I statements addressing historical muckpile data are:

- Decision Ia statement is: Are COPCs present in muck samples collected during previous muckpile investigations at levels above current PALs?
- Decision Ib statement is: Are the COPCs identified in muck at concentrations above PALs in previous NTS muckpile investigations expected to be present at concentrations above PALs in the CAU 551 muckpiles?

The two Decision I statements addressing newly acquired muckpile data are:

- Decision Ic statement is: Are COCs present in the samples that can be collected at CAU 551 muckpiles?
- Decision Id statement is: Does the data acquired at CAU 551 muckpiles support the CSM, including the outputs of Decisions Ia and Ib?

Decisions Ia and Ib, which only address historical data, can be answered by examining data from the previous muckpile investigations at the NTS. Using data from these investigations assumes that the CAU 551 CSM for muckpiles is consistent with the CSMs for the previously investigated muckpiles in several key areas including source of potential contamination, affected media, location of contamination/release points, and transport mechanisms. Based on the comparative evaluation of the CAU 551 muckpiles to the previously investigated muckpile in these key areas as presented in Appendix A.2, it was determined there is sufficient similarity in the CSMs to accept this assumption.

Specific areas where the CSMs for muckpiles differed and the potential impact on the CAU 551 investigation are also addressed in Appendix A.2.

To answer Decision Ia (which COPCs might become exp-COCs for CAU 551 muckpiles?), historical data from previous muckpile investigations were used to determine which COPCs were detected in previous muckpile investigations at concentrations above the current PALs (see Appendix A.2 and Table A.1-4). All COCs identified in previous muckpile investigations at concentrations above current PALs are listed as critical COPCs in Table A.1-1.

Table A.1-4
Expected COCs for CAU 551 Muckpile Investigation

COC	Summary of Detects for Previous Muckpile Investigation	Highest Concentration Detected	Two Times Highest Concentration	PAL	Units
Arsenic	1 detection above PAL at CAU 477	38.8	77.6	23	mg/kg
Lead	2 detections above PAL at CAU 477	59,700	119,400	750	mg/kg
TPH-DRO	Multiple detections above PAL at CAUs 475, 476, 477	10,000	20,000	100	mg/kg
Cesium-137	Multiple detections above PAL at CAUs 476, 477, 482, 504	3,050	6,100	7.3	pCi/g
Cobalt -60	2 detections above PAL at CAUs 476, 504	5.3	10.6	1.61	pCi/g
Plutonium-238	1 detection above PAL at CAU 504	20.2	40.4	7.78	pCi/g
Plutonium-239	6 detections above PAL at CAUs 476, 482, 504	122	244	7.62	pCi/g

To answer Decision Ib (which COPCs do become exp-COCs for CAU 551 muckpiles?), historical data from previous muckpile investigations were evaluated. Based on this evaluation (see Appendix A.2), the constituents listed in Table A.1-4 are all considered to be exp-COCs for the purpose of the CAU 551 muckpile CSM (i.e., there was no compelling evidence to eliminate any contaminant identified in muck during previous muckpile investigations at levels above current PALs from consideration as an exp-COC for the CAU 551 muckpiles). An applicable concentration range was assigned for use in the CAU 551 muckpile CSM, and a value of two times the highest detected concentration for each exp-COC was assigned as the upper limit of this range (Table A.1-4); the lower limit is fixed at zero for that exp-COC.

To answer Decision Ic (are COCs present in CAU 551 muckpiles from areas that can be sampled?), samples will be collected from accessible portions of the CAU 551 muckpiles, and evaluated against the PALs identified in Step 3.

To answer Decision Id (does the new data fit within the CSM?), the CAU 551 muckpile sample COC data will be evaluated against muckpile CSM parameters for both COC status and concentrations. Only within Decision Id would a rescoping of the CAI for the muckpile CAS be considered. If actual concentrations in samples collected from CAU 551 muckpiles are found to exceed the exp-COC range, the CSM will be reevaluated.

To determine the concentration of COCs for purposes of selecting, designing, and implementing potential corrective actions, the following rules will be applied. For exp-COCs detected at concentrations above the highest detected concentration in muck samples from previous NTS muckpile investigations, the highest concentration detected in the applicable CAU 551 muckpile will be assigned, or else the highest previous detected concentration will be assigned. For newly identified COCs, the highest concentration detected in the applicable CAU 551 muckpile sample will be assigned.

The potential recommended corrective actions for the CAU 551 muckpiles are likely to be limited to closure in place with administrative controls. Therefore, the conservative approach to the investigation and designation of exp-COCs and concentrations is not anticipated to lead to an overly restrictive burden on potential corrective actions.

A.1.3.2 Alternative Actions to the Decision

An alternative decision statement has been developed for each decision identified in the previous section.

A.1.3.2.1 Alternative Actions to Decision I for CAS 12-01-09

If no COCs are present, further assessment of the CAS is not required. If COCs are present, resolve Decision II.

A.1.3.2.2 Alternative Actions to Decision I for CASs 12-06-05, 12-06-07, and 12-06-08

The alternatives for Decision Ia are: If no COPCs are present in samples of muck collected during previous NTS muckpile investigations at concentrations above current PALs, no exp-COCs will be identified for this CAU. Because COPCs are present in samples of muck collected during previous NTS muckpile investigations at concentrations above current PALs, those COPCs will be evaluated to determine if they will be identified as exp-COCs for CAU 551.

The alternatives for Decision Ib are: If a COPC was detected in samples of muck collected during previous NTS muckpile investigations at concentrations above current PALs, and evidence indicates the COPC was unique to the CAU at which it was detected, it will not be considered an exp-COC for CAU 551 muckpiles. If a COPC was detected in samples of muck collected during previous NTS muckpile investigations at concentrations above current PALs, and there is no evidence that indicates the COPC was unique to the CAU at which it was detected, it will be considered an exp-COC for the CAU 551 muckpiles.

Decision Ib was answered during the DQO process and is presented in this discussion for completeness. No compelling evidence was identified to conclude that site-specific factors differed (e.g., a spill of a material used only at one previously investigated muckpile and not at the CAU 551 muckpiles). Therefore, no reason exists to suggest that any COPC detected at previously investigated muckpiles in concentrations above current PALs would not be present in the CAU 551 muckpiles. As a result, all COPCs detected in samples of muck collected during previous NTS muckpile investigations at concentrations above current PALs will be considered exp-COCs for the CAU 551 muckpiles.

The alternatives for Decision Ic are: If the new data does not identify any COCs, resolve Decision II for the exp-COCs. If the new data identifies COCs, resolve Decision Id for the exp-COCs and the newly identified COCs.

The alternatives for Decision Id are: If the new data from a CAU 551 muckpile does not fit within the CSM, rescope the CAS. If the new data does fit within the CSM, then resolve Decision II.

A.1.3.2.3 Alternative Actions to Decision II for CAU 551 CASs

The alternative for Decision II is: "If the extent and migration of a COC is defined in both the lateral and vertical direction, further assessment of the CAS is not required. If the extent of a COC is not defined, reevaluate site conditions and collect additional samples."

Regardless of the outcome for the analysis of Decision I samples, Decision II samples will be taken immediately around the stain for CAS 12-01-09, and for the muckpiles at (1) areas below the foot of the muckpiles, (2) at the confluence of the drainages from the CASs 12-06-05 and 12-06-08 muckpiles, and from the CAS 12-06-07 muckpile, and (3) at the point at which the main wash intersects the access road below.

A.1.4 Step 3 – Identify the Inputs to the Decisions

This step identifies the information needed, determines sources for information, determines the basis for establishing action levels, and identifies sampling and analysis methods that can meet the data requirements. To determine if a COC is present, each sample result or population parameter (Section A.1.6.1) is compared to a PAL (Section A.1.4.2). This approach does not use a statistical mean/average for comparison to the PAL, but rather a point-by-point comparison to the established screening criteria to identify COCs. Regardless of the Decision I sampling results (e.g., exceeding the PAL), each of the muckpile CASs will be advanced to Decision II.

A.1.4.1 Information Needs and Information Sources

The information needs for each of the two CSMs are detailed in the following sections.

A.1.4.1.1 CAS 12-01-09, Aboveground Storage Tank and Stain

In order to determine if a COC is present at CAS 12-01-09, sample data must be collected and analyzed following these two criteria: (1) samples must be collected in areas most likely to contain a COC; and (2) the analytical suite selected must be sufficient to detect any COCs present in the samples.

A.1.4.1.2 CAS 12-06-05, 12-06-07, and 12-06-08, Muckpiles

Decision Ia and Ib entail the use of historical data derived from previous NTS muckpile investigations. The input, therefore, for Ia and Ib can be obtained prior to field sampling and is presented in this document. The use of historical data is carried out under the implicit assumption that previous muckpile data was generated using a properly implemented DQO process, thus the data generated from these investigations provides an accurate representation of the conditions at the applicable CAU.

In order to determine if COCs other than exp-COCs are present at a muckpile CAS, sample data must be collected and analyzed following these two criteria: (1) samples must be collected in accessible areas most likely to contain a COC and (2) the analytical suite selected must be sufficient to detect any COCs present in the samples.

A.1.4.1.3 All CAU 551 CASs

Biasing factors to support criteria #1 include:

- Documented process knowledge on source and location of release
- Field observations (e.g., staining, areas of erosion)
- Field-screening results (radiological and chemical)
- Experience and data from investigations of similar sites
- Professional sampling, and health and safety judgement

In order to determine the extent of a COC for Decision II, samples will be collected from locations to bound the lateral extent. Due to the hazards present in CAU 551, determination of the vertical boundary is not feasible; drill rigs could not be set up and operated around any of the steep slopes at CASs 12-01-09, 12-06-05, 12-06-07, and 12-06-08. Initial Decision II samples, however, will be analyzed for the full suite of COPCs to reduce the uncertainty inherent in the proposed resolution to Decision I. For subsequent Decision II sampling, analytical suites may be limited to those COCs that exceed PALs in prior Decision II samples. The data required to satisfy the information needs for Decision II for each COC is a sample concentration that is below the corresponding PAL. Step-out locations will be selected based on the CSM, biasing factors, and previous analytical results.

When analytical results or other biasing factors suggest that the COC concentrations at the step-out location(s) may still exceed the PAL, an additional step-out distance may be used to define the lateral extent of contamination. If a location where the PAL is exceeded is surrounded by clean locations, lateral step-outs may not be necessary. In that case, sampling may consist only of sampling from deeper intervals at or near the original location to determine the vertical extent of contamination. If possible, vertical extent samples will be collected from depth intervals that will meet DQO objectives, and in a manner that will conserve resources during possible remediation. In most cases, vertical sampling beyond the limit of hand sampling techniques (approximately 2 to 5 ft bgs) will not be possible based on the practical constraints imposed by the topography of the site.

Sampling locations may be moved due to access problems, underground utilities, or safety issues; however, the modified locations must meet the decision requirements and criteria necessary to fulfill the information needs.

Table A.1-5 lists the information needs, the source of information for each need, and the proposed methods to collect the data needed to resolve Decisions I and II. The last column addresses the QA/QC data type and associated metric. The data type is determined by the intended use of the resulting data in decision making.

Data types are discussed in the following text. All data to be collected are classified into one of three measurement quality categories: quantitative, semiquantitative, and qualitative. The categories for measurement quality are defined below.

Where that vertical sampling is not possible, vertical contaminants may be estimated using decreasing trends or contaminant migration data from similar investigations.

Quantitative Data

Quantitative data results from direct measurement of a characteristic or component within the population of interest. These data require the highest level of QA/QC in collection and measurement systems because the intended use of the data is to resolve primary decisions (i.e., Decision I or Decision II) and/or verifying closure standards have been met. Laboratory analytical data are generally considered quantitative.

Table A.1-5
Information Needs to Resolve Decisions I and II
(Page 1 of 3)

Information Need	Information Source	Collection Method	Biasing Factors to Consider	Data Type/Metric
Decisions Ia and Ib: Determine the presence of COCs in previous NTS muckpile investigations above current PALs, and the applicability of this data to CAU 551. Criteria I: The historical data must address muckpile investigations only.				
Historical data that indicates COCs above current PALs in previous NTS muckpile investigations	CADDs for CAU 476, 477, 482, and 504 CAU 475 validated data	Review	Only samples taken from muckpiles	Data is quantitative (i.e., went through DQO and validation process); however, in its application to CAU 551, the data is viewed as being semiquantitative
Decision I for CAS 12-01-09, Decisions Ic and Id for CASs 12-06-05, 12-06-07, and 12-06-08: Determine if a COC is present. Criteria I: Samples must be collected in areas most likely to contain a COC.				
Source and Location of Release Points	Process knowledge, historical documentation, and previous investigations of similar sites	Information documented in CSM and public reports – no additional data needed	None	Semiquantitative - CSM has not been shown to be inaccurate
	Field observations	Conduct site visits and document field observations	Visible evidence of contamination, topographic lows, gullies	Qualitative - CSM has not been shown to be inaccurate
	Aerial photographs	Review and interpret aerial photographs	Disturbed areas, visible evidence of contamination, location of possible sources	Semiquantitative - Sampling based on biasing criteria stipulated in DQO Step 3
	Field screening	Review and interpret field-screening results (FSRs)	Bias sample locations/ intervals based on elevated FSRs	Semiquantitative - Sampling based on biasing criteria stipulated in DQO Step 3

Table A.1-5
Information Needs to Resolve Decisions I and II
(Page 2 of 3)

Information Need	Information Source	Collection Method	Biasing Factors to Consider	Data Type/Metric
Nature of Contamination	Biased samples	Collect samples from locations/depths based on biasing factors and statistical model	Send samples for analysis to laboratory	Quantitative - Sampling based on statistical modeling and biasing factors
	Biased samples	Collect samples from additional locations near CAS features	Worst-case locations such as stained areas	Quantitative - Sampling based on CAS features
	Process knowledge, historical documentation, and previous investigations of similar sites	Information documented in CSM and public reports – no additional data needed	None	Semiquantitative - CSM has not been shown to be inaccurate
Decision I for CAS 12-01-09, Decisions Ic and Id for CASs 12-06-05, 12-06-07, and 12-06-08: Determine if a COC is present. Criteria 2: Analyses must be sufficient to detect any COCs in samples.				
Identification of All Potential Contaminants (exp-COCs)	Process knowledge and previous investigations of similar sites; use analytical suite in Table A.1-7	Information documented in CSM and public reports – no additional data needed; comprehensive analytical suite developed to account for uncertainty	None	Qualitative - CSM has not been shown to be inaccurate
Analytical Results	Data packages from biased samples	Appropriate sampling techniques and approved analytical methods will be used; MRLs are sufficient to provide quantitative results for comparison to PALs	None	Quantitative - Validated analytical results will be compared to PALs
Decision II: Determine the extent of a COC. Criteria: Sample collection and analysis methods must be sufficient to bound extent of COC.				
Identification of Applicable COCs	Data packages of Decision I samples	Review analytical results and compare to PALs to select COCs	None	Quantitative - Only COCs identified will be analyzed in future sampling events

Table A.1-5
Information Needs to Resolve Decisions I and II
(Page 3 of 3)

Information Need	Information Source	Collection Method	Biasing Factors to Consider	Data Type/Metric
Extent of Contamination	Field observations	Document field observations	Visible evidence of contamination	Qualitative - CSM has not been shown to be inaccurate
	Field screening	Conduct field screening using appropriate methods	Bias sample locations/ intervals based on FSRs	Semiquantitative - FSRs will be compared to field-screening levels
	Step-out sample locations	Generate locations based on previous sampling results and biasing factors	Locations selected based on the initial sampling results for both horizontal and vertical sampling	Semiquantitative - Sampling based on previous results and biasing factors
	Data packages of analytical results	Appropriate sampling techniques and approved analytical methods will be used to bound COCs; MRLs are sufficient to provide quantitative results for comparison to PALs	None	Quantitative - Validated analytical results will be compared to PALS to determine COC extent
Decision: Determine if sufficient information exists to characterize waste. Criteria: Analyses must be sufficient to allow disposal options to be accurately identified and estimated.				
Analytical Results	Data packages of analytical results; use analytical suite in Table A.1-7; TCLP results may be required if total results are > 20X TCLP limits	Appropriate sampling techniques and approved analytical methods will be used; MRLs and minimum detectable activities are sufficient to provide quantitative results for comparison to disposal requirements	Sufficient material must be available for analysis	Quantitative - Validated analytical results will be compared to disposal criteria

Analytical data used to resolve Decisions Ia and Ib for CAU 551 muckpiles is derived from previous NTS muckpile investigations. The input, therefore, for Ia and Ib can be obtained prior to field sampling. The use of historical data is carried out under the implicit assumption that previous muckpile data was generated using a properly implemented DQO process; thus, the data generated from these investigations provides an accurate representation of the conditions at the applicable CAU.

Therefore, it is considered quantitative in regards to the CAU it represents; however, the data is considered semiquantitative in its application to CAU 551.

Semiquantitative Data

Semiquantitative data is generated from a measurement system that indirectly measures the quantity or amount of a characteristic or component. Inferences are drawn about the quantity or amount of a characteristic or component because a correlation has been shown to exist between the indirect measurement and the results from a quantitative measurement. The QA/QC requirements on semiquantitative collection and measurement systems are high but not as rigorous as a quantitative measurement system. Semiquantitative data contribute to decision making but are not generally used alone to resolve primary decisions.

Due to the reliance on previous muckpile data for establishing exp-COC concentrations in the CAU 551 muckpiles, that data is considered herein to be semiquantitative in its application to the CAU 551 muckpiles investigation; portions of the Decision I question will be resolved with this data. Field-screening data are generally considered semiquantitative. The data are often used to guide investigations toward quantitative data collection.

Qualitative Data

Qualitative data identify or describe the characteristics or components of the population of interest. The QA/QC requirements are the least rigorous for data collection methods and measurement systems. The intended use of the data is for information purposes, to refine conceptual models, and guide investigations rather than resolve primary decisions. This measurement of quality is typically assigned to historical information and data where QA/QC may be highly variable or not known. Professional judgement is often used to generate qualitative data.

Metrics provide a tool to determine if the collected data support decision making as intended. Metrics tend to be numerical for quantitative and semiquantitative data, and descriptive for qualitative data.

A.1.4.2 Determine the Basis for the Preliminary Action Levels

Industrial site workers, construction/remediation workers, and military personnel may be exposed to contaminants through ingestion, inhalation, external (radiological), or dermal contact (absorption) of soil. Laboratory analytical results for soils will be compared to the following PALs to determine if COCs are present:

- EPA Region IX Risk-Based PRGs for chemical constituents in industrial soils (EPA, 2002c).
- For detected COPCs without established PRGs, a similar protocol to that used by EPA Region IX will be used in establishing an action level for those COPCs listed in IRIS (EPA, 2002d).
- Background concentrations for RCRA metals will be used instead of PRGs when natural background exceeds the PRG, as is often the case with arsenic on the NTS. Background is considered the mean plus two times the standard deviation of the mean for sediment samples collected by the Nevada Bureau of Mines and Geology throughout the Nevada Test and Training Range (NBMG, 1998; Moore, 1999).
- The TPH action limit of 100 ppm per the NAC 445A.2272 (NAC, 2002).
- The PALs for radiological contaminants are based on the NCRP Report No. 129: recommended screening limits for construction, commercial, and industrial land-use scenario (NCRP, 1999) scaled from 25 to 15 mrem/yr dose, and the generic guidelines for residual concentration of radionuclides in DOE Order 5400.5 (DOE, 1993).
- The PALs for material, equipment, and structures with residual surface contamination are: the allowable total residual surface contamination values for unrestricted release of material and equipment listed in the DOE Order 5400.5 (DOE, 1993), which is consistent with Table 4-2 of the *NV/YMP Radiological Control Manual* (DOE/NV, 2000c).

The selected PALs for chemical COPCs are based on the EPA Region IX Industrial Land Use PRGs for soil. In general, the PRGs are risk-based tools for evaluating and cleaning up contaminated sites. The values are estimates of contaminant concentrations in environmental media that EPA considers protective of humans over a lifetime. The toxicity-based PALs for Industrial Soils are calculated based on soil ingestion for an outdoor worker. The selected PALs are applicable to sites at the NTS based on future land-use scenarios as presented in Section A.1.5.2 and agreements between NDEP and NNSA.

Radiochemistry PALs are based on a scaling of the NCRP 25 mrem/yr dose-based levels (NCRP, 1999) to a conservative 15 mrem/year, and the recommended levels for certain radionuclides in DOE Order 5400.5, Change 2 (DOE, 1993). These PALs are based on the Construction, Commercial, Industrial land-use scenarios provided in the guidance, and are appropriate for the NTS based on future land-use scenarios as presented in Section A.1.5.2. These established PALs have been accepted by the regulatory agency for use.

Potassium-40 is not considered to be a contaminant of potential concern due to its predominance in the environment. In addition, the only mechanism for K-40 to be a contaminant is through concentration. There are no reported activities at the NTS that would have concentrated K-40 or released it as a contaminant.

A.1.4.3 Potential Sampling Techniques and Appropriate Analytical Methods

As discussed in Section A.1.4.1, the collection, measurement, and analytical methods will be selected so results will be generated for all potential contaminants at CAS 12-01-09, CAS 12-06-05, CAS 12-06-07, and CAS 12-06-08. This effort will include field screening, soil sampling, and laboratory analysis to determine the presence of COPCs and extent of identified COCs.

Waste characterization sampling and analysis has been included to support the decision-making process for waste management, and to ensure an efficient field program.

A.1.4.3.1 Field Screening

Based on site conditions and available analytical data, field-screening activities may be conducted for the following analytes and/or parameters:

- Alpha and Beta/Gamma Radiation - a handheld radiological survey instrument or method, may be used based on the possibility that radiologically contaminated soil may be present at CAS 12-01-09, or contaminated soil or muck may be present CAS 12-06-05, CAS 12-06-07, and/or CAS 12-06-08. If determined appropriate, on-site gamma spectrometry may also be used to screen samples. The FSLs for radionuclides are CAS-specific and will be calculated prior to sample collection, based on background levels.

- VOCs - a photoionization detector (PID), or an equivalent instrument or method, may be used to conduct headspace analysis because VOCs are a common concern at the NTS and have not been ruled out based upon process knowledge at CAU 551. The FSL for VOCs is established as 20 ppm or 2.5 times background, whichever is greater.

- TPH - a gas chromotograph, or equivalent equipment or method, may be used because TPH is a common concern at the NTS, and a specific concern for CAS 12-01-09, and has not been ruled out for the other CAU 551 CASs based upon process knowledge. The FSL for TPH is established as 75 ppm.

Based on the results of previous CAU investigations and common NTS practices, the aforementioned field-screening techniques may be applied during the Decisions I and II sampling at CAU 551. These field-screening techniques will provide semiquantitative data that can be used to guide confirmatory soil sampling and waste management activities. Field screening will not be used to arrive at corrective action decisions.

A.1.4.3.2 Soil Sampling and Measurement Methods

Hand sampling and hand augering will be the primary method used to collect soil samples. Sample collection and handling activities will only be conducted in accordance with approved procedures. It may be appropriate to use excavation by hand (e.g. shovel) in selected areas to determine if contaminated soil has been covered with clean fill. Mechanical means of sampling such as direct push, drilling, or excavation are not possible on the majority of the CAU 551 CASs. Therefore, based on current knowledge, it is not planned to use mechanical means to collect samples at CAU 551.

A.1.4.3.3 Analytical Program

The analytical program for CAU 551 shown in Table A.1-6 has been developed based on the list of COPCs presented in Section A.1.1.

The critical COPCs for CAU 551 are the expected COCs (i.e., TPH, arsenic, lead, Co-60, Cs-137, and Pu-238 and -239), and all the analytes listed in Table A.2-1 which have positive detects, except for gasoline. Gasoline is not included as a critical COPC because its components are covered in the organic analyses. The critical COPCs are given greater importance in the decision-making process relative to possible COPCs. For this reason, more stringent performance criteria are specified for suspected analyte DQIs (Section 6.0 of the CAIP). Possible COPCs are defined as classes of contaminants that include all the analytes reported from the respective analytical methods that have PALs. The possible COPCs also aid in reducing the uncertainty concerning the history and potential releases from the CASs and help in the accurate evaluation of potential contamination. If a COPC, either critical or possible, is detected in any sample at a concentration above the respective PAL, the

Table A.1-6
Analytical Program for CAU 551

Analytical Parameter	Analytical Method	
	Liquid	Soil/Sediment/Sludge
Total Volatile Organic Compounds	SW-846 8260B[a]	SW-846 8260B[a]
Total Semivolatile Organic Compounds	SW-846 8270C[a]	SW-846 8270C[a]
Total RCRA Metals, plus Beryllium	SW-846 6010B[a] (mercury - 7470A[a])	SW-846 6010B[a] (mercury - 7471A[a])
Polychlorinated Biphenyls	SW-846 8082[a]	SW-846 8082[a]
Total Petroleum Hydrocarbons, DRO (C_6 - C_{38})	SW-846 8015B[a] (modified)	SW-846 8015B[a] (modified)
Gamma Spectrometry (gamma emitters, e.g., Cs-137)	EPA Procedure 901.1[b]	HASL-300[c]
Strontium-90	ASTM D5811-00[d]	HASL-300[c]
Isotopic Plutonium	ASTM D3865-02[e]	ASTM C1001-00[f]
Isotopic Uranium	ASTM D3972-02[g]	ASTM E1000-00[h]

ASTM = American Society of Testing and Materials
DRO = Diesel-range organics
RCRA = *Resource Conservation and Recovery Act*
SW = Solid Waste

[a]*EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* 3rd Edition, Parts 1-4, SW-846 (EPA, 1996)
[b]*Prescribed Procedure for Measurements of Radioactivity in Drinking Water* (EPA, 1980)
[c]*The Procedures Manual of the Environmental Measurements Laboratory* (DOE, 1997)
[d]*Standard Test Method for Strontium-90 in Water* (ASTM, 2000c)
[e]*Standard Test Method for Plutonium in Water* (ASTM, 2000b)
[f]*Standard Test Method for Radiochemical Determination of Plutonium in Soil by Alpha Spectroscopy* (ASTM, 2000a)
[g]*Standard Test Method for Isotopic Uranium in Water by Radiochemistry* (ASTM, 2002)
[h]*Standard Test Method for Radiochemical Determination of Uranium Isotopes in Soil by Alpha Spectrometry* (ASTM, 2000b)

Note: All Decision I samples will be analyzed for gamma-emitting isotopes. Isotopic Uranium analysis will be conducted if any Uranium is detected in the Gamma Spectrometry. Isotopic Plutonium analysis will be conducted if any Americium-241 is detected in the Gamma Spectrometry. Strontium-90 analysis will be conducted if any Cesium-137 is detected above the PAL in the Gamma Spectrometry.

COPC will be identified as a newly identified COC. During Decision II sampling and analysis, all COCs are considered suspected parameters.

Section 3.0 and Section 6.0 of the CAIP provide the analytical methods and laboratory requirements (e.g., detection limits, precision, and accuracy) to be followed during this CAI. Sample volumes are laboratory- and method-specific and will be determined in accordance with laboratory requirements. Analytical requirements (e.g., methods, detection limits, precision, and accuracy) are specified in the Industrial Sites QAPP (NNSA/NV, 2002), unless superseded by the CAIP. These requirements will ensure that laboratory analyses are sufficient to detect contamination in samples at concentrations exceeding the minimum reporting limit (MRL). Specific analyses, if any, required for the disposal of IDW are identified in Section 5.0 of the CAIP.

Table A.1-7 lists the analytes reported by the various analytical methods that are considered to be COPCs.

For sampling performed to define the extent of contamination (Decision II) at CAS 12-01-09, CAS 12-06-05, CAS 12-06-07, and CAS 12-06-08, samples may be collected and analyzed only for COCs identified in previous samples. However, initial Decision II samples will be analyzed for the full suite of COPCs to reduce the uncertainty inherent in the proposed Decision I sampling plan. For samples collected to define the extent of contamination, suspected analytes are the sum of exp-COCs and newly identified COCs identified during Decision I activities that exceed PALs.

A.1.5 Step 4 - Define the Study Boundaries

The purpose of this step is to define the target population of interest, specify the spatial and temporal features of that population that are pertinent for decision making, determine practical constraints on data collection, and define the scale of decision making relevant to target populations for Decision I and Decision II.

A.1.5.1 Define the Target Population

The target populations for CASs 12-06-05, 12-06-07, and 12-06-08 Decisions Ia and Ib are the highest detected concentrations of COPCs in sample analytical data for samples of muck collected during previous NTS muckpile investigations. The use of historical data is carried out under the implicit assumption that previous muckpile data was generated using a properly implemented DQO process; therefore, the data generated from these investigations provides an accurate representation of the conditions at the applicable CAU.

Decision I target populations for CAS 12-01-09 and Decision Ic target populations for CASs 12-06-05, 12-06-07, and 12-06-08 represent locations within the CASs that contain COCs, if present. Decision II target populations for all CASs are areas within the CASs where COC concentrations are less than PALs and are contiguous to areas of COC contamination. The target populations are

Table A.1-7
List of Analytes Included in Each Analytical Method for CAU 551

Volatile Organic Compounds	Semivolatile Organic Compounds	Total Petroleum Hydrocarbons	Polychlorinated Biphenyls	Metals	Radionuclides
1,1,1-Trichloroethane	1,2,4-Trichlorobenzene[a]	Total Petroleum Hydrocarbons [C_6-C_{38}]	Aroclor-1016	Arsenic	Americum-241
1,1,2,2-Tetrachloroethane	1,2-Dichlorobenzene[a]	DRO	Aroclor-1221	Barium	Cesium-137
1,1,2-Trichloroethane	1,3-Dichlorobenzene[a]		Aroclor-1232	Cadmium	Plutonium-238
1,1-Dichloroethane	1,4-Dichlorobenzene[a]		Aroclor-1242	Chromium	Plutonium-239/240
1,1-Dichloroethene	2,4,5-Trichlorophenol		Aroclor-1248	Lead	Strontium-90
cis-1,2-Dichloroethene	2,4,6-Trichlorophenol		Aroclor-1254	Mercury	Uranium-234
cis-1,3-Dichloropropene	2,4-Dichlorophenol		Aroclor-1260	Selenium	Uranium-235
trans-1,2-Dichloroethene	2,4-Dimethylphenol			Silver	Uranium-238
1,2-Dichloroethane	2,4-Dinitrophenol			Beryllium	Cobalt-60
1,2-Dichloropropane	2,4-Dinitrotoluene				
2-Butanone	2,6-Dinitrotoluene				
4-Methyl-2-pentanone	2-Chloronaphthalene				
Acetone	2-Chlorophenol				
Benzene	2-Methylphenol				
Bromochloromethane	2-Nitroaniline				
Bromodichloromethane	3,3'-Dichlorobenzidine				
Bromoform	4-Bromophenyl phenyl ether				
Bromomethane	4-Chloroaniline				
Carbon disulfide	4-Methylphenol				
Carbon tetrachloride	4-Nitrophenol				
Chlorobenzene	Acenaphthene				
Chloroethane	Acenaphthylene				
Chloroform	Aniline				
Chloromethane	Anthracene				
Dibromochloromethane	Benzo(a)anthracene				
Dibromomethane	Benzo(a)pyrene				
Ethylbenzene	Benzo(b)fluoranthene				
Methyl tertiary butyl ether	Benzo(g,h,i)perylene				
Methylene chloride	Benzo(k)fluoranthene				
Styrene	Benzoic acid				
Tetrachloroethene	Benzyl alcohol				
Toluene	Bis(2-chloroethoxy) methane				
trans 1,3-Dichloropropene	Bis(2-chloroethyl)ether				
Trichloroethene	Bis(2-chloroisopropyl)ether				
Vinyl acetate	Bis(2-ethylhexyl) phthalate				
Vinyl chloride	Butyl benzyl phthalate				
Xylene	Carbazole				
1,1,1,2-Tetrachloroethane	Chrysene				
1,2,3-Trichloropropane	Dibenzo(a,h)anthracene				
1,2,4-Trimethyl-benzene	Dibenzofuran				
1,2-Dibromo-3-chloropropane	Diethyl phthalate				
1,2-Dibromoethane	Dimethyl phthalate				
1,3,5-Trimethylbenzene	Di-n-butyl phthalate				
1,3-Dichloropropane	Di-n-octyl phthalate				
Trichlorofluoromethane	Fluoranthene				
Trichlorotrifluoroethane	Fluorene				
n-propyl benzene	Hexachlorobenzene				
2-chlorotoluene	Hexachlorobutadiene[a]				
Bromobenzene	Hexachlorocyclopentadiene				
Dichlorodifluoromethane	Hexachloroethane				
Iodomethane	Indeno(1,2,3-cd)pyrene				
Isopropyl benzene	Isophorone				
n-Butylbenzene	Naphthalene[a]				
sec-butylbenzene	Nitrobenzene				
tert-butylbenzene	N-Nitroso-di-n-propylamine				
	N-Nitrosodimethylamine				
	N-Nitrosodiphenylamine				
	Pentachlorophenol				
	Phenanthrene				
	Phenol				
	Pyrene				
	Pyridine				

[a]May be reported with VOCs.

dependent upon the CSMs developed for CAU 551. These target populations represent locations within the CAS that, when sampled, will provide sufficient data to resolve the primary problem statement (Section A.1.3.1).

The target populations for the CAS 12-01-09 Decision I samples, and CASs 12-06-05, 12-06-07, and 12-06-08 Decision Ic samples, are:

- Stained soil at CAS 12-01-09
- The material in accessible areas of the muckpiles for CASs 12-06-05, 12-06-07, and 12-06-08.

The target populations for the Decision Id (CASs 12-06-05, 12-06-07, and 12-06-08) are:

- All COCs identified in Decisions Ib and Ic.

The target populations for the Decision II samples are:

- The native material in lateral areas around the stain, or contiguous to the muckpiles (contamination, if present, is expected to be contiguous to the release site, with possible contaminated spots down gradient from the muckpiles in drainages).

A.1.5.2 Identify the Spatial and Temporal Boundaries

Spatial (geographic) boundaries are defined as the vertical or horizontal boundaries beyond which the CSM and/or the scope of the investigation will require reevaluation. The horizontal boundaries for CAS 12-01-09, AST and Stain, are the edges of the stain with a buffer zone of 25 ft. The horizontal boundaries for the muckpile CASs are the edges of the muckpiles including all visible drainage and runoff to surrounding soil, with an additional buffer zone of 200 ft around each, where safely accessible to sampling personnel. The watershed to the immediate north of CAU 551, which does not receive runoff from the CAU, is not considered to have received contamination and will not be sampled. The vertical boundaries are defined by the limits of the hand sampling techniques, likely to not exceed 5 ft below the stain surface or the muck/native soil interface.

Temporal boundaries are time constraints due to time-related phenomena, such as weather conditions, seasons, and activity patterns. Significant temporal constraints due to weather conditions are not expected; however, snow events may affect site activities during winter months. Moist weather may place constraints on sampling and radiological field screening of contaminated soils because of the attenuating effect of moisture in samples. There are no time constraints on collecting samples.

A.1.5.3 Identify Practical Constraints

The primary practical constraint to be encountered at CAS 12-01-09 is the nearness of a steep slope, which precludes the use of mechanical sampling equipment (e.g., drilling rigs). The primary practical constraints to be encountered at CAS 12-06-05, CAS 12-06-07, and CAS 12-06-08 are the inability to collect samples by mechanical means from the muckpiles due to inaccessible conditions and safety considerations, and the safety hazards that hand-sampling personnel will encounter due to the steepness of the slopes in the CASs (e.g., unstable soil, steep slopes, and lack of staging areas for drill rigs). Additional practical constraints include the presence of underground utilities. Utility constraints are subject to change as additional information is collected prior to the commencement of investigation activities, and will be appropriately documented. Locations where intrusive activities are planned will be surveyed for utilities prior to field activities in accordance with the Site-Specific Health and Safety Plan.

For CASs 12-06-07 and 12-06-08, the combination of steep slopes on and around the muckpiles and the presence of signs designated “Alpha Contamination - Access Prohibited” on the muckpiles establish added potential constraints for field personnel to set up hot lines and travel across the rugged terrain while dressed out in PPE. Decisions on accessibility to potential samples locations made in the field will be documented.

Prior to samples being taken, the proposed locations will be examined by the Site Supervisor and Site Safety Officer for accessibility and to ensure that safe movement in the area is possible. Sampling will not be conducted in areas that expose workers to entrapment or engulfing hazards from unstable soil and/or excessive slopes. Also, any hazardous conditions that would endanger the individuals surveying or sampling shall be taken into consideration.

Nevada Test Site-controlled activities (e.g., military exercises) may affect the ability to investigate the CASs.

A.1.5.4 Define the Scale of Decision Making

The scale of decision making in Decision I for CAS 12-01-09, AST and Stain, is defined as the CAS. Any COC identified in the CAS 12-01-09 stain will lead to the entire stain being considered contaminated.

The scale of decision making in Decision I for CAS 12-06-05, CAS 12-06-07, and CAS 12-06-08 is defined as the muckpile. Any COC identified in a CAU 551 muckpile sample will lead to the entire muckpile being considered contaminated.

The scale of decision making for Decision II is defined as a contiguous area contaminated with a COC originating from the CAS.

A.1.6 Step 5 – Develop a Decision Rule

This step integrates outputs from the previous steps, with the inputs developed in this step into a decision rule ("*If..., then...")* statement. This decision rule describes the conditions under which possible alternative actions would be chosen.

A.1.6.1 Specify the Population Parameter

The population parameter for all Decision I data is the maximum observed concentration of each COPC within the target population. For the CAU 551 muckpiles, this maximum observed concentration will be the maximum value from previous muckpile investigations or the new COPC data values generated from sampling in accessible areas of the CAU 551 muckpiles.

For radiological surveys, the maximum observed concentration of each COPC will be the population parameter. If radiological sampling and analysis is performed to support the radiological survey results, the maximum observed concentration of each COC identified in the sample will be the population parameter. Radiological sampling and analysis will supersede radiological survey results.

The population parameter for Decision II data will be the observed concentration of each unbounded COC in any sample.

A.1.6.2 Choose an Action Level

Action levels are defined as the PALs, which are specified in Section A.1.4.2.

A.1.6.3 Decision Rule

If the concentration of any COPC in a target population exceeds the PAL for a COPC in a Decision I sample, either from previous NTS muckpile investigations (applicable only to the CAU 551 muckpiles) or from samples collected at CAU 551, then that COPC is identified as a COC and the extent of contamination sampling will be conducted.

If the Site Supervisor determines that an indicator of contamination is present, Decision II sampling may be conducted before the results of Decision I sampling are available. For CASs 12-06-05, 12-06-07, and 12-06-08, if all COPC concentrations in samples collected from the CAU 551 muckpiles are less than the corresponding PALs, the decision will be that only those COPCs considered exp-COCs will be assumed to be present at the CAU 551 muckpiles.

If the observed population parameter of any COC in a Decision II sample exceeds the PALs, additional samples will be collected to complete the Decision II evaluation. If all observed COC population parameters are less than PALs, the decision will be that the extent of contamination has been defined.

If contamination is inconsistent with the CSM or extends beyond the identified spatial boundaries, work will be suspended and the investigation strategy will be reevaluated. If contamination is consistent with the CSM and is within spatial boundaries, the decision will be to continue sampling to define extent.

A.1.7 Step 6 – Specify the Tolerable Limits on Decision Errors

The steepness of the slopes on and around the CAU 551 muckpiles creates hazardous conditions for sampling personnel. This severely limits the areas of the muckpiles from which samples can be collected. The approach for making DQO decisions is based on the results of individual samples (both historic from similar sites and newly acquired samples); therefore, statistical analysis of CAU 551 muckpile samples is not appropriate. The sampling strategy for CAS 12-01-09, AST and

Stain, includes collecting biased samples from the stained soil; therefore, statistical analysis of CAS 12-01-09 samples is not appropriate. Without statistical analysis, numerical limits cannot be generated for decision errors.

Confidence in the CAI results will be established qualitatively by:

- The development of and concurrence of conceptual site models (based on process knowledge) by stakeholder participants (NNSA/NSO and/or NDEP) during the DQO process

- Testing the validity of conceptual site models based on investigation results

- Evaluating the quality of the data based on Data Quality Indicator parameters

Only validated analytical results will be used to determine and/or verify which COCs are present (Decision I) or the extent of a COC (Decision II), unless otherwise stated. The baseline condition (i.e., null hypothesis) and alternative condition for Decision I are:

- Baseline condition – A COC is present in the stain or muckpiles.
- Alternative condition – A COC is not present in the stain or muckpiles.

The baseline condition (i.e., null hypothesis) and alternative condition for Decision II are:

- Baseline condition – The extent of a COC has not been defined.
- Alternative condition – The extent of a COC has been defined.

Decisions and/or criteria have an alpha probability error (false negative; rejection of the null hypothesis, when the null hypothesis is true) or beta probability error (false positive, or acceptance of the null hypothesis, when the null hypothesis is false) associated with their determination (discussed in the following subsections). This CAIP has been designed to minimize both types of errors.

A.1.7.1 False Negative (Rejection of the null hypothesis) Decision Error

The false negative (rejection of the null hypothesis error; alpha probability) decision error would mean either of the following:

- Deciding that a COC is not present when it actually is (Decision I), or
- Deciding that the extent of a COC has been defined when it actually has not (Decision II).

In both cases, this would result in an increased risk to human health and environment.

For CASs 12-06-05, 12-06-07, and 12-06-08 muckpiles, a false negative decision error is more improbable due to the assumption of a worst-case scenario (e.g. highest concentrations of COCs detected in previous muckpile investigations). However, some uncertainty does exist. The assumptions may not be correct (e.g., levels of exp-COCs could be higher, or non-expected COCs could be present). The CAI for CAU 551 muckpiles will protect against this type of error by collecting Decision I samples from the CAU 551 muckpiles to reduce the error inherent in using data from similar sites to characterize CAU 551 muckpiles.

For CAS 12-01-09, AST and Stain, a false negative decision error is made less probable by sampling the stained soil which lies directly beneath the tank.

For Decision I, a false negative decision error (where the consequences are more severe) is controlled by meeting the following criteria:

1. Having a high degree of confidence that historical data evaluations (Decisions Ia & Ib for muckpile investigations) combined with data generated from accessible portions of the CAU 551 muckpiles will identify COCs, if present, anywhere within the CASs.

2. Having a high degree of confidence that analyses of the newly obtained CAU 551 data will be sufficient to detect any COCs present in the sampled media and that the detection limits are adequate to ensure an accurate quantification of the COCs.

3. Concurrent, with Decision I sampling, collection, and analysis (full suite) of Decision II samples will be collected for the muckpile CASs.

For Decision II, the false negative decision error is reduced by:

1. Having a high degree of confidence that the sample locations selected will identify the extent of COCs.

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

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

To satisfy the first criterion for Decision I, for CAS 12-01-09, AST and stain only:

- Samples will be collected in areas most likely to be contaminated by COCs.

To satisfy the first criterion for Decision I, muckpiles only:

- The highest concentrations of COCs detected in previous muckpile investigations will be expected to occur in the CAU 551 muckpiles.

- Sample locations on accessible areas of the muckpiles will be chosen to bias the investigation towards the most likely contaminated accessible areas.

To satisfy the first criterion for Decision II, samples will be collected, where possible, in areas that represent extent of contamination.

The following characteristics are considered during both decisions to accomplish the first criterion:

- Source and location of release
- Chemical nature and fate properties
- Physical properties and migration/transport pathways
- Hydrologic drivers

These characteristics were considered during the development of the CSMs. The biasing factors listed in Table A.1-5 and Section A.1.8.1 will be used to further ensure that these criteria are met. The DQI of representativeness will be assessed to ensure that samples were collected from those locations that best represent the target populations as defined in Section A.1.5.1.

To satisfy the second criterion for all newly generated data, the DQI of sensitivity will be assessed for all analytical results to ensure that all analytical methods will have measurement sensitivity (detection limits) that are less than or equal to the corresponding PALs. If this criterion is not achieved, the affected data will be assessed for usability and potential impacts on meeting site characterization objectives will be evaluated.

To satisfy the second criterion for Decision II for CAS 12-01-09, AST and Stain, Decision II samples will be analyzed for those parameters that identified unbounded COCs. To satisfy the second criterion for Decision II for the muckpiles, initial Decision II samples will be analyzed for all COPCs and extended Decision II samples will be analyzed for those parameters that identified unbounded COCs.

To satisfy the third criterion for Decision II, the entire dataset as well as individual sample results will be assessed against the DQIs of precision, accuracy, comparability, completeness, and representativeness defined in the Industrial Sites QAPP (NNSA/NV, 2002). To satisfy the third criterion, the entire dataset as well as individual sample results will be assessed against the DQIs of precision, accuracy, comparability, and completeness defined in the Industrial Sites QAPP (NNSA/NV, 2002). The DQIs of precision and accuracy will be used to assess overall analytical method performance as well as to assess the need to potentially "flag" (qualify) individual analyte results when corresponding QC sample results are not within the established control limits for precision and accuracy. Data qualified as estimated for reasons of precision or accuracy may be considered to meet the analyte performance criteria based on an assessment of the data. The DQI of completeness will be assessed to ensure that all data needs identified in the DQO have been met. The DQI of comparability will be assessed to ensure that all analytical methods used are equivalent to standard EPA methods so that results will be comparable to regulatory action levels that have been established using these procedures. Site-specific DQIs are discussed in more detail in Section 6.0 of the CAIP. Strict adherence to established procedures and QA/QC protocol protects against false negatives.

A.1.7.2 False Positive (Acceptance of the null hypothesis) Decision Error

The false positive (acceptance of the null hypothesis, or beta probability) decision error would mean:

- Deciding that a COC is present when it actually is not (Decision I).
- Accepting that the extent of a COC has not been defined when it really has (Decision II).

These errors result in increased costs for unnecessary characterization or corrective actions.

The false positive decision error is controlled by protecting against false positive analytical results. False positive results are typically attributed to laboratory and/or sampling/handling errors. Quality assurance/quality control samples such as field blanks, trip blanks, laboratory control samples, and method blanks minimize the risk of a false positive analytical result. Other measures include proper decontamination of sampling equipment and using certified clean sample containers to avoid cross-contamination.

For the muckpile investigations, in taking the approach outlined in this DQO document for the investigation of CAU 551, the false positive decision error is further elevated for Decision I by assuming COCs found to be at or above PALs in previous NTS muckpile investigations are present in the CAU 551 muckpiles. This approach, through its conservative orientation, necessitates elevation of a false positive error in order that human and environmental health become more protected. The approach ultimately results in a higher potential for corrective action. However, because the expected corrective action is use restriction, the potential for increased costs due to the conservative assumption is limited (i.e., cost for placing a use restriction is the same regardless of the number of COCs).

A.1.7.3 Quality Assurance/Quality Control

Radiological survey instruments as well as field-screening equipment will be calibrated and checked in accordance with the manufacturer's instructions or approved procedures.

Quality control samples will be collected as required by the Industrial Site QAPP (NNSA/NV, 2002) and in accordance with established procedures. These procedures apply to both the quick-turnaround and standard analyses. The required QA field samples include:

- Trip blanks (one per sample cooler containing VOC environmental samples)
- Equipment blanks (one per sampling event for each type of decontamination procedure)
- Source blanks (one per lot of source material that contacts sampled media)
- Field duplicates (one per twenty environmental samples or one per CAS per matrix, if less than twenty collected)
- Field blanks (one per twenty environmental samples)
- MS/MSD (one per twenty environmental samples or one per CAS per matrix, if less than twenty collected, not required for all radioanalytical measurements)

Additional QC samples may be submitted based on site-specific conditions.

A.1.8 Step 7 – Optimize the Design for Obtaining Data

This section presents an overview of the resource-effective strategy planned to obtain the data required to meet the project DQOs developed in the previous six steps. Section A.1.8.1 provides general investigation strategy, and Section A.1.8.2 provides the detailed sampling approach to resolve the decision statements for CAU 551. As additional data or information is obtained, this step will be reevaluated and refined, if necessary, to reduce uncertainty and increase the confidence that the nature and extent of contamination is accurately defined.

A.1.8.1 General Investigation Strategy

The initial activities to be conducted will be a visual inspection and photodocumentation of the area of CAS 12-01-09, CAS 12-06-05, CAS 12-06-07, and CAS 12-06-08, as well as a walk-over radiation survey of accessible areas of the muckpiles. The visual inspection and radiation survey will provide biasing factors for locating soil samples and will be used to identify any potential conditions that may affect sampling and sample locations.

A.1.8.1.1 CAS 12-01-09, Aboveground Storage Tank and Stain

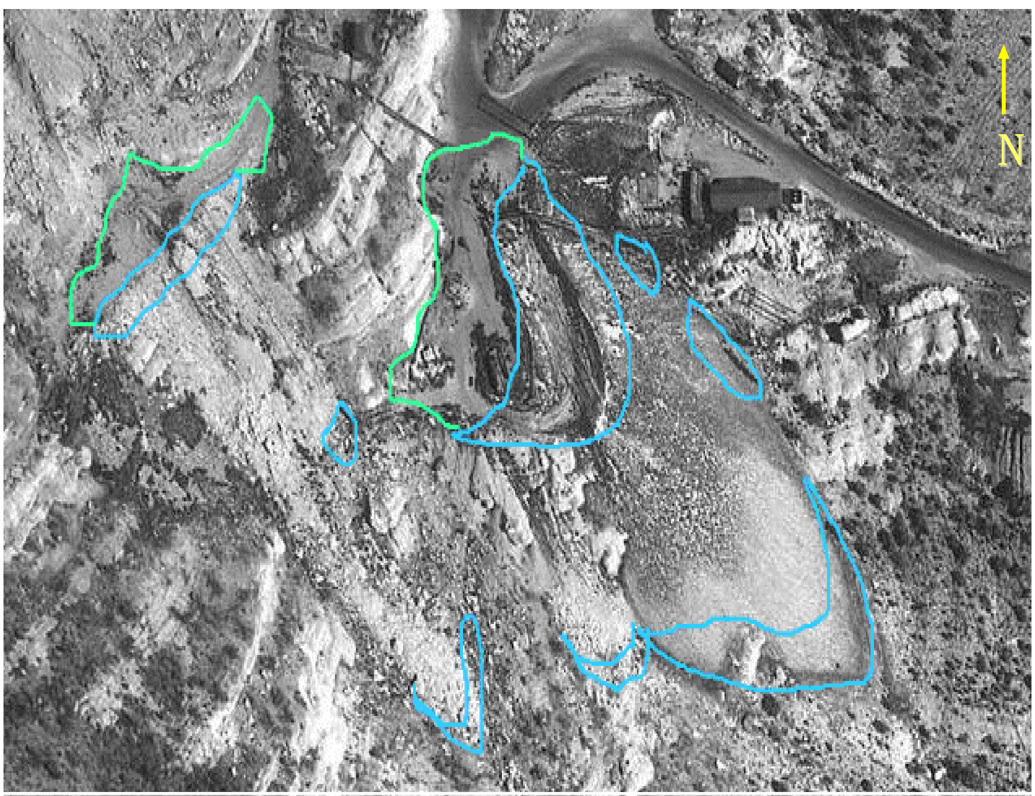
A biased sampling strategy will be used for Decision I to target the area with the highest potential for contamination (i.e., the stained soil). The sample location will be determined based on the biasing factors listed in Section A.1.4.1. If biasing factors are present in soil below the location where the Decision I sample was removed, subsurface Decision I soil samples will be collected by hand augering. Decision I subsurface soil samples will be collected at depth intervals selected by the Site Supervisor based on biasing factors to a depth where the biasing factors are no longer present.

To meet the DQI of representativeness step-out (Decision II) sample locations will be arranged in roughly a triangular pattern around the Decision I location at distances based on site conditions, process knowledge, and biasing factors. If COCs extend beyond the initial step-outs, Decision II samples will be collected at the maximum depth where COCs were encountered and from two additional depth intervals. If the FSRs are not greater than FSLs, one of these samples (typically the uppermost) will be submitted to the laboratory for analysis. A minimum of one clean sample (i.e., FSLs less than FSRs) will be collected from each lateral and vertical direction and submitted for laboratory analysis to define the extent of COC contamination. The lateral and vertical extent of

COCs will be established based on validated laboratory analytical results (not field screening). The number, location, and spacing of step-outs may be modified by the Site Supervisor as warranted by site conditions. This sampling approach is designed to bound the COCs both vertically and horizontally.

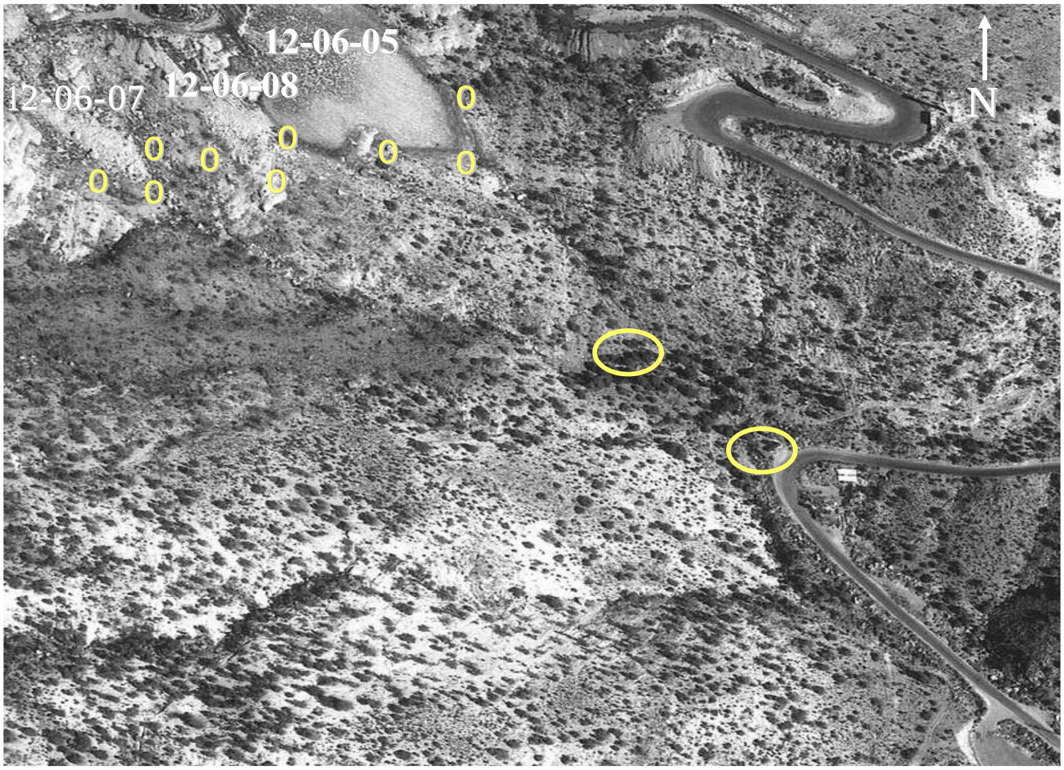
A.1.8.1.2 CASs 12-06-05, 12-06-07, 12-06-08, Muckpiles

The general sampling areas believed to be accessible within safety guidelines are shown in the sample area location drawings, Figure A.1-10 and Figure A.1-11. Additional Decision I confirmatory samples are not expected except in unusual circumstances. All expected sampling areas are based upon photographs and limited site reconnaissance. Final sampling decisions will be made in the field.



Source: Modified from Holmes & Narver, Inc., 1966.

Figure A.1-10
Estimated Sampling Areas for CASs 12-06-06, 12-06-07, and 12-06-08



Source: Modified from Holmes & Narver, Inc., 1966.

Figure A.1-11
CAU 551, Decision II Initial Sampling Locations

In general, samples submitted for off-site analysis will be those that best meet the DQI for representativeness and those that define the nature (Decision I) and extent (Decision II) of COCs.

A.1.8.2 Detailed Investigation Strategy

The initial activities to be conducted will be a visual inspection and photodocumentation of CAS 12-01-09, CAS 12-06-05, CAS 12-06-07, and CAS 12-06-08, and a walk-over radiological survey of the accessible areas of the three muckpile CASs. The visual inspection will focus on identifying evidence of contamination in the muckpiles, including any visible soil staining. The visual inspection will be conducted by walking on and around accessible areas. Areas of elevated radioactivity (twice background) identified during the radiological survey will be recorded and sampled as appropriate. The information generated during these initial activities will be used to provide additional biasing factors for the placement of field screening and confirmatory soil samples.

Following visual inspection and radiation survey, the following samples will be collected from the aboveground storage tank, the stain, and accessible areas of the muckpiles:

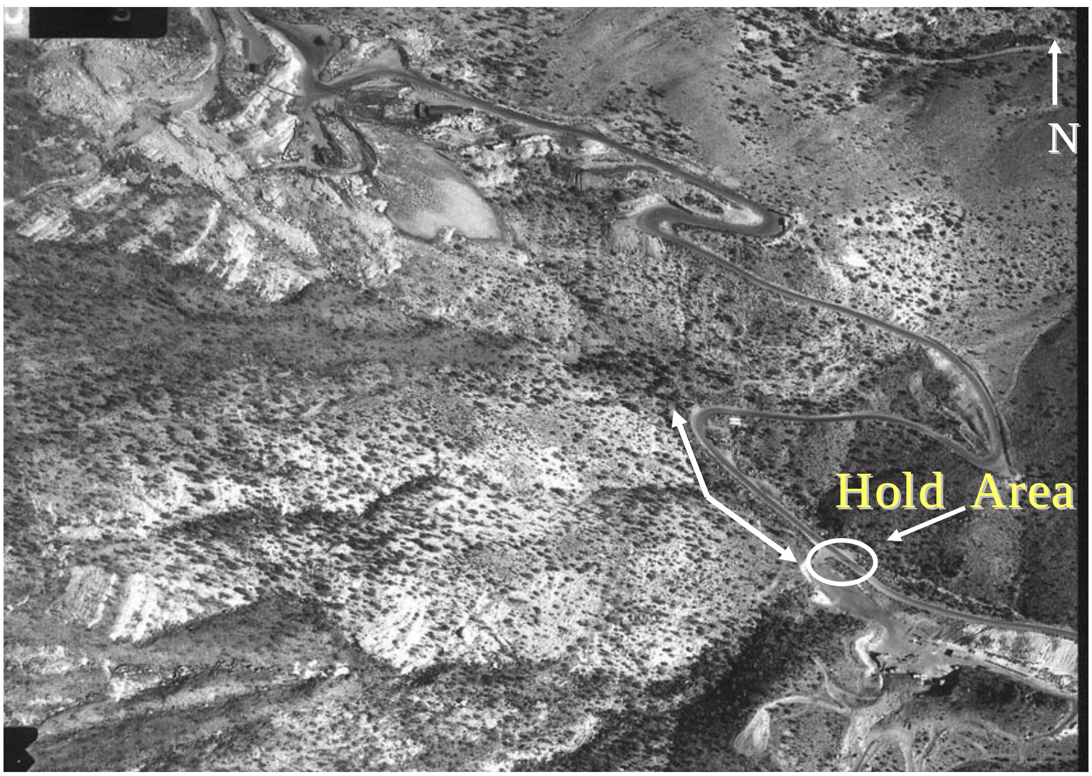
Aboveground Storage Tank and Stain

- One sample will be collected from the tank to identify the composition of the material for disposal purposes.
- One sample will be collected from 0 to 6 in. bgs from the center of the stain. An additional sample will be collected at 12 in. bgs, and further samples will be collected below that until either the depth of contamination has been determined by field screening, the soil/rock-surface has been contacted, or to the extent of hand augering (e.g., approximately 5 ft) has been reached.
- Step-out samples for Decision II will be collected if COCs are identified in the Decision I sample(s) collected from the stain. Samples will be collected at step-out locations arranged in roughly a triangular pattern, as determined by the Site Supervisor.

The present physical constraints of the site limit the use of drill rigs or other mechanized equipment in the vicinity of the stain. If the extent of contamination (either vertically or horizontally) can not be defined by hand-sampling techniques, the primary decision makers will be consulted prior to determining how best to proceed.

Muckpiles

- A range of approximately 15 to 20 soil samples will be collected for Decision I in accessible areas of the muckpiles for CAS 12-06-05 and CAS 12-06-08 (combined), and a range of approximately 15 to 20 soil samples will be collected for Decision I in accessible areas of the muckpile for CAS 12-06-07. The general areas estimated to be accessible to sampling are depicted in the hatched areas on the muckpiles in Figure A.1-10 and Figure A.1-11. One surface sample (0 to 0.5 ft bgs) will be collected at each location. Additionally, one sample will be collected at depth at each location, where possible. The depth of the second sample will be limited by the hand sampling techniques. It is anticipated the sample will be collected between 1 to 3 ft bgs.
- Approximately 15 to 20 additional samples for initial Decision II sampling will be taken from (1) areas below the foot of the muckpiles, (2) at the confluence of the drainages from the CASs 12-06-05 and 12-06-08 muckpiles, and from the CAS 12-06-07 muckpile, and (3) at the point at which the main wash intersects the access road below. These locations are estimated in Figure A.1-12.



Source: Modified from Holmes & Narver, Inc., 1966.

Figure A.1-12
CAU 551 Decision II Extended Sampling Areas

The following are the biasing factors that currently have been identified for consideration in the selection of the surface soil sample locations (all are limited by the accessibility issues):

- Aerial photograph review and evaluation
- Walk-over radiological surveys
- Visual indicators (e.g., staining, topography, areas of preferential surface runoff)
- Known or suspected sources and locations of release
- Process knowledge and experience at similar sites
- Geologic and/or hydrologic conditions
- Physical and chemical characteristics of critical contaminants
- Areas of erosion
- Areas of sediment collection in the wash

Initial Decision II samples will be collected in biased, accessible locations at the same time as Decision I samples. Step-out (extended) sampling may commence either up-slope or down-slope based on results. All data collected from initial sampling results and the other biasing factors listed above will be used to select extended Decision II sample locations. The furthest possible down-slope sampling for Decision II is expected to be at the confluence of the wash draining CAU 551 and the first point of contact for the drainage off of the E-Tunnel muckpile (CAU 383) (Figure 2-1).

Surface soil samples will be collected by hand. Handheld augers or other hand sampling techniques (e.g., shovel and scoop) will be used, as appropriate, to collect subsurface samples. Samples for IDW and waste characterization purposes may also be collected at CAS 12-01-09, CAS 12-06-05, CAS 12-06-07, and CAS 12-06-08.

Due to the nature of buried features possibly present beneath CAS 12-01-09, AST and Stain, or in the muckpiles (e.g., structures, buried debris, and utilities), sample locations may be relocated60

based upon the information obtained during the site visit. However, the new locations selected will meet the decision needs and criteria stipulated in Section A.1.4.1.

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Appendix A.2

Documentation to Support the Assumption that the CAU 551 Muckpiles are Similar to Previously Investigated NTS Muckpiles

A.2 Documentation to Support the Assumption that the CAU 551 Muckpiles are Similar to Previously Investigated NTS Muckpiles

For CASs 12-06-05, 12-06-07, and 12-06-08, muckpiles, it is impractical to resolve the Decision I and II statements based solely on collecting and analyzing samples gathered at CAU 551. Slopes on and around the muckpiles present a climbing hazard to samplers and surveyors, and limit accessibility to mechanical sampling equipment. Sampling only in safely accessible areas may not provide sufficient data to answer Decision I (i.e., is contamination present). Thus, necessary information was required to be obtained from a source other than samples taken from accessible areas of the muckpiles; the most pertinent source for this information was identified as previous muckpile investigations.

A strategy has been developed to help characterize the contents of the CAU 551 muckpiles by use of data from previous NTS muckpile investigations at CAUs 475, 476, 477, 482, and 504. This strategy is based on the assumption that similarities exist in the operational histories and environmental settings of previously investigated NTS muckpiles and the CAU 551 muckpiles. Given these similarities, the data and information obtained during the previous NTS muckpile investigations can be used to help characterize the CAU 551 muckpiles.

A.2.1 Purpose

Consistent with standard environmental investigations, the CAU 551 investigation is based on identifying COPCs and their expected fates at the site to be investigated. The purpose of this Appendix is to:

- Support the general assumption that findings at previously investigated NTS muckpiles can be applied to the investigation of the CAU 551 muckpiles
- Support the specific assumptions that sample analytical data from muck samples collected at previously investigated NTS muckpiles can be used to make determinations about which

COCs can be expected at CAU 551 and the fate of those COCs in the environment. The three general areas used as qualitative metrics to support these assumptions are:

1. Similarity of the physical settings and the impact of these settings on the fates of COPCs at the subject muckpiles based on site-specific conditions such as geology and topography.
2. Similarity of the historical waste-generating operations (i.e., tunnel operations), including related nuclear testing time lines for the subject muckpiles.
3. Usability of historical muckpile investigation analytical data.

The discussion presented in this Appendix focuses on the impact that similarities or differences in these three areas have on the acceptability of the assumptions and thus the investigation strategy. The information presented on the general environmental factors and fates of COPCs at NTS muckpiles is based on information on soil chemistry, site-specific geology, site-specific topography, and data from previously investigated NTS muckpiles. Information on historical tunnel operations was obtained by reviewing available documentation including tunnel logbooks and conducting interviews with personnel who worked at the NTS tunnels. Data from previously investigated NTS muckpiles was obtained from the CADDs for these sites or, as in the case of CAU 475, from preliminary data (i.e., the data has been validated but not yet presented in a CADD).

A.2.2 Objective

The objective for this Appendix is to present data and information to support the assumptions on which the CAU 551 investigation strategy is based. Achievement of this objective will produce the ability to make qualitative statements about the level of confidence that the investigation strategy provides in generating defensible data that can support closure recommendations for the CAU 551 muckpiles.

A.2.3 Similarity of Physical Settings

Physical settings may affect the nature and location of muckpile contaminants through translocation of the contaminants and the transformation of contaminants by physical and chemical processes. Significant differences in the geologic (chemical) properties of the muck could affect the mobility and/or degradation (transformation) of contaminants. Significant differences in the topography and climate at the different muckpiles could also affect the potential for migration and transformation of contaminants.

A.2.3.1 Geology

The CAU 551 muckpiles are located on Rainier Mesa as are the muckpiles associated with U12 N-, P- and T-Tunnels. The tunnels of CAU 551 are on or near the boundary of friable tuff beds and zeolitized tuff beds. The U12 N-, P-, and T-Tunnels lie either in a welded tuff sandwiched between zeolitized tuff beds, or in the zeolitized tuff beds (Russell, 1987).

In keeping with common convention, the U12N-, P-, and T-Tunnels will be referred to as the N-, P-, and T-Tunnels.

Tunnels U15a and e are constructed on the southeastern flank of the Belted Range in granitic rocks of the Cretaceous period (DTRA, 2002). These intrusive rocks consist of the gray, zoned, equigranular to porphyritic Climax stock, chiefly quartz monzonite and granodiorite (Winograd and Thordarson, 1975; USGS, 1999). Muck removed from these tunnels would consist of granitic mineral fragments, also of various size fractions. Tunnel U16a was constructed on the eastern slope of Shoshone Mesa in bedded and nonbedded tuffs (DTRA, 2001). The geology is similar in nature to that of the B-Tunnel.

In keeping with common convention, the U15a and e-, and 16a-Tunnels will be referred to as the 15a and e-, and 16a-Tunnels.

The muckpiles for B-, C-, D-, F-, N-, P-, T- and 16a-Tunnels were created from material made up of volcanic ash tuffs, whereas the muckpiles for 15a and e-Tunnels were created from granitic material.

Some beds of the tuffs are zeolitized; zeolites are a large group of complex aluminosilicates, having a high cation exchange capacity (Sparks, 1986). Muck derived from granitic material can contain micas, which may also have a measurable amount of cation exchange capacity. Cation exchange capacity can also originate from edges and corners of mineral grains, especially more noncrystalline, glassy minerals as would be found in volcanic tuffs. High cation exchange capacity, in general, impedes the movement of cationic contaminants.

Common to all geological material in the muckpiles are the distribution of particle sizes within the muck from drilling and blasting operations. The processes of drilling and blasting broke the geological material into smaller pieces, ranging from clay-size mineral grains up to boulders. In general, the more rock is pulverized into smaller particles, the greater the potential to retard the migration of contaminants through the material. Differences in the tunnel development and mucking operations (blasting versus drilling) may have affected the particle size distribution of the muck.

Because volcanic material is less crystalline (more structurally disordered) than granitic material, in general the muck created from tuffs can be expected to have broken into smaller particles, with the less crystalline material not maintaining its integrity as well as crystalline minerals. The geological material of the muckpiles at the 15a and e-Tunnels can be expected to have greater structural integrity than volcanic ash tuff, and can be expected to not be as susceptible to being pulverized as the tuff. Thus, the muck material from 15a and e-Tunnels can be expected to be larger grained.

A.2.3.2 Topography and Climate

The amount of precipitation falling annually on all areas under consideration is from 6 to 12 in. per year (USGS, 1965).

The CAU 551 muckpiles are at higher elevations and on steeper slopes than previously investigated muckpiles. Generally, lower elevation muckpiles will receive less precipitation, but have less of an altitude loss to nearby flats. In general, higher elevation muckpiles will receive greater amounts of precipitation, experience a greater incidence of freeze and thaw cycles, and have greater differences in altitude changes from nearby flat lands. The evapotranspiration rates for these areas exceed precipitation rates. Therefore, the CAU 551 muckpiles possess the greatest potential for possible translocation of contaminants via erosion.

A.2.3.3 Summary of Physical Setting Considerations

All of the muckpiles in consideration are located in the same general area and, with slight variations, are subject to the same general arid environment. They are not expected to have significant amounts of moisture moving through them due to the high evapotranspiration rates of the area. All of the muckpile material is expected to exhibit a slight to moderate capacity to sorb cationic contaminants. The muckpiles were all created from pulverized rock material, with all but the 15a and e-Tunnel muckpiles (granite derived) having come from the tunneling of volcanic tuffs. All have particle size distributions ranging from boulder to clay sizes. The most significant physical setting consideration is the greater potential for translocation of CAU 551 muckpile contaminants by erosion.

The potential for greater translocation of contaminants from CAU 551 was taken into account in the design of the CAU 551 sample plan. The accessible areas in the washes located down gradient of the CAU 551 muckpiles will be included in the radiological walk-over survey. Also, the collection of Decision II (extent of contamination) type samples will be conducted as part of the initial field investigation. Decision II samples will be collected from three areas during the initial field investigation: (1) the areas below the foot of the muckpiles, (2) at the confluence of the drainages from the muckpiles at CASs 12-06-05, 12-06-08, and CAS 12-06-07, and (3) at the point at which the main wash intersects the access road. At each of these locations, multiple samples will be collected. Additional Decision II sampling will proceed, as necessary, based on the results of the initial Decision II samples. Specific sample locations will be selected in the field based on the presence of biasing factors. Biasing factors pertinent to Decision II sampling include the presence of sediment traps, where contaminants are more likely to have settled.

A.2.4 Similarity of Waste-Generating Operations

Information on historical tunnel operations was obtained by reviewing available documentation including tunnel logbooks and conducting interviews with personnel who worked at the NTS tunnels.

The CAU 551 muckpiles, as well as other NTS muckpiles, were created by waste-generating activities related to preparation for nuclear testing, the testing itself, and tunnel re-entry and recovery following testing. Information on historical operations that contributed to potential COPCs in the muckpiles was gained through interviews with former tunnel workers familiar with historical muckpile operations, and a review of historical documentation (e.g., logbooks) and literature that provides some discussion on tunnel/muckpile operations recorded as they occurred.

Factors affecting the similarity of operations at the muckpiles that will be discussed in the following sections are:

- Muckpile nuclear testing time lines for the applicable tunnels

- Standard tunnel operations for the early days of underground testing
- Significant changes in tunnel operations and policies that may have affected muckpile waste

A.2.4.1 Nuclear Testing Time Lines

A time line for nuclear tests conducted at the B-, C-, D-, F-, N-, P-, T-, 15a- and e-, and 16a-Tunnels is presented in Figure A.2-1 (DOE/NV, 2000). Included in the time line are approximate periods of changes in practices and policies discussed in Section A.2.4.3.

The CAU 551 muckpiles were associated with the 12 nuclear tests conducted from 1957 to 1963 in B-, C-, D-, and F-Tunnels. These early operations would be most comparable to the nine tests conducted at Tunnels 15a and e and Tunnel 16a from 1962 to 1971. Eight of these tests were conducted in tunnel drifts; one test, Hard Hat, was conducted in a shaft at 15a-Tunnel. The material removed from the shaft was likely deposited in the 15a-Tunnel muckpile.

A.2.4.2 Standard Early Tunnel Operations

During the early days of tunnel operations, tunneling was typified by the "drill and blast" (followed by material-mucking) mining techniques. Most of the tunneling generated uncontaminated muck material. The contaminated muck material primarily came from re-entry mining following a nuclear test, and has been estimated to comprise less than one percent by volume of each muckpile (Fiore, 1991).

Construction and reentry operations noted from entries in site logbooks include "blocking set," "drilled & blasted," "smoke," "mucked--14 cars," "stood," and "straightened sets" ("sets" are the timber framing of the drift shafts, and "smoke" refers to the dust and smoke given off from the blasting operation). Other activities occasionally noted in the logbooks include bulldozing the dumps; "slushing" the tunnels, portals, and at least one road; the use, movement, and storage of "powder" (apparently primers, and sticks of dynamite); hauling trash to the "contamination dump"; "finding a little fused material in muck"; and policing, cleaning, and moving junk on the dump areas (REECo, 1957-1960).

Some uncommon events recorded in the B-Tunnel logbook (REECo, 1957-1960) that may have affected the muckpiles or COPCs include "...started wash down again from 01 towards Portal with detergent water," "...Started salvage of equipment on "C" tunnel dump," "...destroyed old powder at

Tunnel	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92
B[a]	1	2			2		1																													
C[a]	1	2																																		
D[a]		1																																		
F[a]		2																																		
N[a]											1	1		1		1	1	2		1		1		1		2	2		3		1	1		1[d]		1
P[a]																															1		1		1	1
T[a]														1		1			1									1		1	1					
15a & e[a]						1[e]			1	1																										
16a[a]						1			1	1		1		1	1																					

Numbers = No. tests per year per tunnel or shaft within a tunnel

Source: [a] DOE/NV, 2000; [b] Metcalf, 2004; [c] Griffin, 2004;

[d] Two separate devices were tested simultaneously in separate drifts; the volume of material removed from both drifts before and after the tests, and deposited in the N-Tunnel Muckpile, was likely twice that removed from a single test in one drift alone;

[e] The Hard Hat test was conducted in a shaft at the 15a-Tunnel; material removed from the shaft was likely deposited in the 15a-Tunnel Muckpile

Transition from slushing & washing contamination to painting contamination in place (~ 1969 – 1972) [b]

Start to use mechanical miners in addition to blasting (~ 1971 – 1973) [b]

Change over in tunnel wall & support system from sets and lagging to use of rock bolts, mesh and epoxy (~ 1971 – 1973) [b]

Start of storage of contaminated muck into drifts (~ 1971 – 1977) [b]

Discontinued decontamination of equipment and the drainage of oil on and near muckpiles (1983 – 1987) [b,c]

Figure A.2-1
Time Lines for Testing in Tunnels B, C, D, F, N, P, T, 15a and e, and 16a

C tunnel magazine," and "...mucked out Powder and Primer magazines." At the 15a-Tunnel, concerns about an "ammonia smell" on April 27, 1962, are raised (REECo, 1962a) and attributed in a May 16, 1962, entry to "residual gases resulting from powder shots -- mainly nitrides" (REECo, 1962b)."

No references to hazardous organic or metallic materials deposited on the muckpiles were found in the logbooks.

A.2.4.3 Significant Changes in Tunnel Operations and Policies

Changes in operations at the tunnels may have affected the nature of the wastes deposited in the muckpiles. Through interviews with former tunnel workers, five significant changes were identified in tunnel operations that may have impacted the muckpiles. The approximate periods of time for these changes, as estimated by interviewees, are given in Figure A.2-1. These changes are:

- A change from "washing" or "slushing" to painting contaminated material onto fixed surfaces.
- Use of machines for tunneling.
- A move from the use of sets and lagging to the use of rock bolts, mesh, and epoxy.
- The placing of contaminated muck into drifts instead of on muckpiles.
- A discontinuation of the decontamination of equipment and of equipment maintenance on or near the muckpiles.

In the late 1950s and early 1960s, several references to the practice of "slushing" and "washing" the B- and 15a-Tunnels appear in logbooks (Section A.2.4.2). No discrimination between washing fixed surfaces and loose material appears to have been made at the time, as both walls and unpaved roads were slushed/washed. Towards the late 1960s, the practice of slushing and washing appears to have become less commonplace, with the practice of painting alpha contamination on fixed surfaces beginning around 1971 or 1972 in the G-Tunnel (Metcalf, 2004). The approximate period of change from slushing and washing contaminated fixed surfaces to painting is represented in Figure A.2-1 by orange for the period of 1969 through 1971. It would be expected that once painting became common place less contamination was available for disposal in the muckpiles.

In the early 1970s, the use of machines to assist in the tunneling process began (Rowsell, 2004). These machines are believed to be of the "Alpine" mining type (Metcalf, 2004). In the 1980s, a boring machine was used in the E- and N-Tunnels (Griffin, 2004). Drill and blast techniques were still used up to the moratorium on underground testing in 1992 (Metcalf, 2004). Thus, while tunneling machines would have affected material going into the N-, P-, and T-Tunnel muckpiles, the use of blasting techniques would have affected all tunnel muckpiles; the impact on possible COPCs being placed into the muckpiles is unclear. The approximate period of implementation of tunneling machines is represented in Figure A.2-1 by yellow for the period of late 1970 through 1973.

In the early 1970s, a change also occurred in the tunnel wall and ceiling support systems, moving from mostly a "sets and lagging" approach (i.e., use of timber supports) to a "rock bolts, mesh, and epoxy" approach (Metcalf, 2004). Although wire mesh had been used to support the roof in at least one side drift (04) in the B-Tunnel in 1958 (Holmes & Narver, 1959), extensive use of meshing apparently occurred a decade or so later. The use of wire mesh may have affected the inclusion of COPCs into the muckpiles through providing greater stability to tunnel walls. With greater stability of tunnel walls, the ratio of potentially contaminated muck and materials to noncontaminated muck and materials might have been significantly altered until the change in muck dumping practices changed. This would have impacted N-, P-, and T-Tunnel muckpiles the greatest. The approximate period of change in tunnel wall and ceiling support systems is represented in Figure A.2-1 by blue for the period of 1971 through 1973.

Up until the mid-1970s, contaminated muck removed during mining and re-entry operations at NTS was placed in the muckpiles (Deshler, 2003; Rowsell, 2004; Seals, 2004), and bulldozed (Metcalf, 2004). Clean muck was then placed atop the contaminated muck (Metcalf, 2004), reportedly at a minimum of 10 ft deep (DOE, 1988). Logbook entries confirm that the upper muck layer atop muckpiles was apparently believed to be safe enough for workers to police the dump and move debris (Section A.2.4.2). In the mid-1970s, muck that was determined to be radioactively contaminated was stored in unused underground drifts (DOE, 1988; Griffin, 2004), with some drifts being created exclusively for that purpose (Metcalf, 2004). Only uncontaminated debris was then disposed of in the muckpiles (Deshler, 2003). This change in policy would have impacted the N-, P-, and T-Tunnel muckpiles the greatest (i.e., less potential for contaminated material being added to the muckpiles). This is reflected in the data presented in Table A.2-1 which indicates no radionuclide

COPCs were detected in the muck above MRLs. Lesser effects, primarily on the latter material placed on the muckpiles serving 15a and e- and 16a-Tunnel muckpiles would have occurred, with no impact occurring on the CAU 551 muckpiles. The approximate period of implementation of a change in muck dumping policies is represented in Figure A.2-1 by red for the period of mid-1973 through 1977.

Decontamination of equipment on a muckpile would occur if a decontamination station was set up at a tunnel portal, and sometimes a limited washdown would occur (Metcalf, 2004). Locomotives were sometimes left on a muckpile and the oil drained in place (Griffin, 2004). By the mid-1980s, both practices appear to have been discontinued. This change in practices would have resulted in less of a potential for COPCs being placed in the N-, P-, and T-Tunnel muckpiles, with the greatest impact occurring on the P-Tunnel muckpiles. The approximate period during which equipment was not decontaminated and oil was not drained on and near the muckpiles is represented in Figure A.2-1 by green for the period of late 1983 through 1987.

Other practices such as destroying powder at tunnel magazines, wash downs with detergent water, and mucking of powder and primer magazines (Section A.2.4.2) were not witnessed by interviewees.

The two significant changes relevant to the use of historical NTS muckpile investigation data for the CAU 551 investigation that would have affected COPCs in the muckpiles the greatest are: (1) the change towards placing contaminated muck into drifts instead of the muckpiles, and (2) a discontinuation of equipment decontamination and maintenance on or near the muckpiles.

A.2.4.4 Summary of Waste-Generating Operations Considerations

In general, the CAU 551 muckpiles were associated with early nuclear testing operations that would be most comparable with the tests conducted at Tunnels 15a and e and at Tunnel 16a from 1962 to 1971. Most of the nuclear tests conducted in the previously investigated NTS muckpiles were conducted in the later period (21 tests conducted in N-tunnel). Data from samples of muck generated in these later periods may not be as comparable. However, all operations conducted at the sites generating the muckpiles supported the same nuclear testing program and used similar procedures and materials. The biggest impact on the comparability of data from the previously investigated NTS muckpiles is that early testing activities (pre-1969), including those at the CAU 551 muckpiles, may have had less stringent control of hazardous and radioactive wastes. Therefore, muck resulting from the earlier testing may be more contaminated (e.g., higher concentrations and/or additional contaminants).

The investigation strategy for the CAU 551 muckpiles has been designed to address the potential differences in the nature of contamination. First, historical data from all the previously investigated NTS muckpiles has been reviewed and the highest previously detected results for contaminants have been used to determine the assumed level of contamination in the CAU 551 muckpiles for all six constituents which were detected at concentrations above current PALs. This is a conservative assumption. There is no direct evidence at this time that these contaminants are present in the CAU 551 muckpiles. Secondly, samples will be collected from the CAU 551 muckpiles and analyzed for all COPCs. Although these samples may not be fully representative of conditions at the CAU 551 muckpiles (because some areas are inaccessible to sampling), it lowers the potential of a false negative decision error by adding additional data points for all COPCs. It also lowers the potential for misidentifying the highest concentration of each COC. Thirdly, initial Decision II samples will be collected regardless of what is identified in the samples collected from the CAU 551 muckpiles. This further lowers the potential of a false negative decision error by providing still more data points for all COPCs.

A.2.5 Data From Comparable Muckpiles

Data from previously investigated NTS muckpiles was obtained from the CADDs for these sites, or in the case of CAU 475, from preliminary data (i.e., the data has been validated but not yet presented in a CADD).

Historical data derived from DTRA investigations of muckpiles at N-, P-, T-, 15a and e-, and 16a-Tunnels is presented in Table A.2-1 and Table A.2-2. This data has been broken into "Muck data," and "Native Soil data" (beneath muckpiles) to discern the existence and potential movement of contamination from the muckpiles into the surrounding environment.

In general, though COPCs below PALs have been identified in native soil beneath previously investigated muckpiles, significant vertical transport of contaminants has not been found at these sites

Table A.2-1
Analytical Detects above MRLs in Muck Samples Collected at Previously Investigated NTS Muckpiles
(Page 1 of 4)

Analyte	CAU 475 P-Tunnel		CAU 476 T-Tunnel		CAU 477 N-Tunnel		CAU 482 15a- and e-Tunnels		CAU 504 16a-Tunnel		PAL
	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	
Volatile Organic Compounds, μg/kg											
1,2,4-Trimethylbenzene	--	--	1	1	1	180	--	--	--	--	170,000
1,3,5-Trimethylbenzene	--	--	--	--	1	59	--	--	--	--	70,000
1,1-Dichloroethene	--	--	2	1.1-1.3	--	--	--	--	--	--	410,000
1,2-Dibromo-3-chloropropane	--	--	--	--	--	--	--	--	--	--	2,000
2-Butanone	1	240	--	--	13	2.2-11	1	11	--	--	27,000,000
4-Methyl-2-pentanone	2	16-270	1	2.7	--	--	--	--	--	--	2,800,000
Acetone	8	9.3-2,300	9	9.4-25	22	9.3-180	11	8.4-48	2	23-29	6,000,000
Bromodichloromethane	--	--	--	--	--	--	--	--	--	--	1,800
Bromoform	--	--	--	--	--	--	--	--	--	--	220,000
n-Butylbenzene	--	--	1	0.88	1	20	--	--	--	--	240,000
sec-Butylbenzene	--	--	--	--	1	15	--	--	--	--	220,000
tert-Butylbenzene	--	--	--	--	--	--	--	--	--	--	390,000
Carbon disulfide	--	--	--	--	--	--	--	--	--	--	720,000
Carbon tetrachloride	--	--	--	--	1	2	--	--	--	--	550
Chlorobenzene	--	--	--	--	--	--	--	--	--	--	530,000
Chloroform	--	--	--	--	1	1.8	--	--	--	--	12,000
Chloromethane	--	--	--	--	1	5.1	--	--	--	--	2,600

Table A.2-1
Analytical Detects above MRLs in Muck Samples Collected at Previously Investigated NTS Muckpiles
(Page 2 of 4)

Analyte	CAU 475 P-Tunnel		CAU 476 T-Tunnel		CAU 477 N-Tunnel		CAU 482 15a- and e-Tunnels		CAU 504 16a-Tunnel		PAL
	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	
Ethylbenzene	--	--	--	--	5	0.82-6.4	--	--	--	--	20,000
Isopropyl benzene	--	--	--	--	1	7.2	--	--	--	--	2,000,000
Methylene chloride	4	14-18	--	--	--	--	7	2.6-44	8	9.7-45	21,000
n-Propyl benzene	--	--	--	--	1	15	--	--	--	--	240,000
Tetrachloroethene	1	9.2	--	--	--	--	--	--	--	--	3,400
Toluene	--	--	1	0.9	2	1.2-1.7	1	3.6	--	--	520,000
Trichloroethene	--	--	2	0.49-0.76	1	1.2	--	--	--	--	110
Trichlorofluoromethane	--	--	--	--	--	--	--	--	--	--	2,000,000
Trichlorotrifluoroethane	--	--	2	1-1.1	--	--	--	--	--	--	5,600,000
Xylenes	--	--	--	--	9	0.94-35	--	--	--	--	420,000
Semivolatile Organic Compounds, μg/kg											
1,2,4-Trichlorobenzene	--	--	1	1.2	--	--	--	--	--	--	3,000,000
1,2-Dichlorobenzene	--	--	--	--	--	--	--	--	--	--	370,000
Benzo(a)anthracene	--	--	--	--	--	--	--	--	1	39	2,100
Benzo(a)pyrene	--	--	--	--	--	--	--	--	--	--	210
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	1	41	2,100
Benzo(g,h,I)perylene	--	--	--	--	--	--	--	--	--	--	N/A[#]
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	21,000

Table A.2-1
Analytical Detects above MRLs in Muck Samples Collected at Previously Investigated NTS Muckpiles
(Page 3 of 4)

Analyte	CAU 475 P-Tunnel		CAU 476 T-Tunnel		CAU 477 N-Tunnel		CAU 482 15a- and e-Tunnels		CAU 504 16a-Tunnel		PAL
	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	
Benzoic acid	--	--	--	--	--	--	--	--	--	--	100,000,000
Bis(2-ethylhexyl) phthalate	--	--	1	350	3	69-850	2	200-310	1	120	120,000
Chrysene	--	--	--	--	--	--	--	--	--	--	210,000
Dimethyl phthalate	--	--	--	--	4	96-2500	--	--	--	--	100,000,000
Di-n-butyl phthalate	--	--	1	26000	--	--	--	--	--	--	62,000,000
Fluoranthene	--	--	--	--	--	--	--	--	--	--	22,000,000
Indeno(1,2,3-cd)pyrene	--	--	--	--	--	--	--	--	--	--	2,100
Naphthalene	--	--	1	1.6	3	3.1-7000	--	--	--	--	190,000
Phenol	--	--	--	--	--	--	--	--	1	55	100,000,000
Pyrene	--	--	--	--	1	4300	--	--	--	--	29,000,000
Total Petroleum Hydrocarbons (DRO/GRO), mg/kg											
DRO	14	2-10000	11	22-1200	36	3.1-3300	17	4-510	5	1.7-82	100
GRO	--	--	--	--	1	0.68	--	--	--	--	100
Metals, mg/kg											
Arsenic	16	1.2-4.4	33	1.6-13	51	2.2-38.8	22	1.7-15	28	2.3-8.4	23
Barium	21	27-2100	33	19-4500	50	38.3-5300	25	46-230	28	34-4300	67,000
Beryllium	20	0.61-1.9	--	--	--	--	--	--	--	--	1,900
Cadmium	1	11	16	0.04-0.4	5	0.07-0.46	3	0.11-2.9	2	0.29-0.42	450

Table A.2-1
Analytical Detects above MRLs in Muck Samples Collected at Previously Investigated NTS Muckpiles
(Page 4 of 4)

Analyte	CAU 475 P-Tunnel		CAU 476 T-Tunnel		CAU 477 N-Tunnel		CAU 482 15a- and e-Tunnels		CAU 504 16a-Tunnel		PAL
	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	
Chromium	14	1.2-11	29	0.42-12	48	0.68-13.3	25	1.6-30	27	0.47-12	450
Lead	21	2.3-26	33	3-210	51	5.7-59700	25	2-57	28	4.2-32	750
Mercury	--	--	1	0.079	22	0.04-0.29	13	0.0026-0.047	17	0.023-0.12	310
Selenium	--	--	6	0.61-4.1	3	0.45-1.1	15	0.41-1.1	11	0.22-1.3	5,100
Silver	--	--	4	0.31-2.4	6	0.18-1.1	4	0.6-1.5	1	1.4	5,100
Radionuclides, pCi/g											
Americium-241	--	--	--	--	--	--	--	--	1	1.48	7.62
Cesium-137	--	--	8	0.58-382	8	0.4-1340	22	0.282-3050	24	0.5-1770	7.30
Cobalt-60	--	--	1	1.76	1	0.73	1	0.123	3	0.77-5.3	1.61
Plutonium-238	--	--	3	0.179-0.91	2	0.048-0.272	2	0.089-1.28	14	0.098-20.2	7.78
Plutonium-239/240	--	--	3	0.54-2.87	2	0.454-0.55	7	0.038-7.7	20	0.0168-122	7.62
Strontium-90	--	--	3	2.27-13	--	--	11	0.38-66	16	1.11-117	503

Table A.2-2
Analytical Detects above MRLs in Native Soil Samples Collected at Previously Investigated NTS Muckpiles
(Page 1 of 4)

Analyte	CAU 475 P-Tunnel		CAU 476 T-Tunnel		CAU 477 N-Tunnel		CAU 482 15a- and e-Tunnels		CAU 504 16a-Tunnel		PAL
	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	
Volatile Organic Compounds, µg/kg											
1,2,4-Trimethylbenzene	--	--	--	--	--	--	--	--	--	--	170,000
1,3,5-Trimethylbenzene	--	--	--	--	--	--	--	--	--	--	70,000
1,1-Dichloroethene	--	--	3	1.1-1.3	--	--	--	--	--	--	410,000
1,2-Dibromo-3-chloropropane	--	--	--	--	1	2.1	--	--	--	--	2,000
2-Butanone	--	--	--	--	6	2-5.9	--	--	--	--	27,000,000
4-Methyl-2-pentanone	--	--	1	2	--	--	--	--	--	--	2,800,000
Acetone	8	8.5-21	5	8.6-19	13	9.2-32	2	10	--	--	6,000,000
Bromodichloromethane	--	--	--	--	--	--	--	--	--	--	1,800
Bromoform	--	--	--	--	--	--	--	--	--	--	220,000
n-Butylbenzene	--	--	--	--	--	--	--	--	--	--	240,000
sec-Butylbenzene	--	--	--	--	--	--	--	--	--	--	220,000
tert-Butylbenzene	--	--	--	--	1	0.83	--	--	--	--	390,000
Carbon disulfide	--	--	--	--	--	--	--	--	--	--	720,000
Carbon tetrachloride	--	--	--	--	--	--	--	--	--	--	550
Chlorobenzene	--	--	--	--	1	0.69	--	--	--	--	530,000
Chloroform	--	--	--	--	--	--	--	--	--	--	12,000
Chloromethane	--	--	--	--	--	--	--	--	--	--	2,600

Table A.2-2
Analytical Detects above MRLs in Native Soil Samples Collected at Previously Investigated NTS Muckpiles
(Page 2 of 4)

Analyte	CAU 475 P-Tunnel		CAU 476 T-Tunnel		CAU 477 N-Tunnel		CAU 482 15a- and e-Tunnels		CAU 504 16a-Tunnel		PAL
	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	
Ethylbenzene	--	--	--	--	1	0.82	--	--	--	--	20,000
Isopropyl benzene	--	--	--	--	--	--	--	--	--	--	2,000,000
Methylene chloride	3	13-17	--	--	--	--	5	2.3-7.7	3	1.9-71	21,000
n-Propyl benzene	--	--	--	--	--	--	--	--	--	--	240,000
Tetrachloroethene	--	--	--	--	--	--	--	--	--	--	3,400
Toluene	--	--	--	--	1	0.78	--	--	1	1.2	520,000
Trichloroethene	--	--	--	--	1	0.83	--	--	--	--	110
Trichlorofluoromethane	--	--	--	--	--	--	--	--	--	--	2,000,000
Trichlorotrifluoroethane	--	--	2	0.8-0.96	--	--	--	--	--	--	5,600,000
Xylenes	--	--	--	--	1	1.9	--	--	--	--	420,000
Semivolatile Organic Compounds, μg/kg											
1,2,4-Trichlorobenzene	--	--	--	--	--	--	--	--	--	--	3,000,000
1,2-Dichlorobenzene	--	--	--	--	1	1	--	--	--	--	370,000
Benzo(a)anthracene	--	--	--	--	--	--	--	--	--	--	2,100
Benzo(a)pyrene	--	--	--	--	--	--	--	--	--	--	210
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	2,100
Benzo(g,h,I)perylene	--	--	--	--	3	120-140	--	--	--	--	N/A#
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	21,000

Table A.2-2
Analytical Detects above MRLs in Native Soil Samples Collected at Previously Investigated NTS Muckpiles
(Page 3 of 4)

Analyte	CAU 475 P-Tunnel		CAU 476 T-Tunnel		CAU 477 N-Tunnel		CAU 482 15a- and e-Tunnels		CAU 504 16a-Tunnel		PAL
	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	
Benzoic acid	--	--	1	270	--	--	--	--	--	--	100,000,000
Bis(2-ethylhexyl) phthalate	--	--	--	--	2	200-220	--	--	--	--	120,000
Chrysene	--	--	--	--	--	--	--	--	--	--	210,000
Dimethyl phthalate	--	--	--	--	3	94-100	--	--	--	--	100,000,000
Di-n-butyl phthalate	--	--	--	--	---	--	--	--	--	--	62,000,000
Fluoranthene	--	--	--	--	--	--	--	--	--	--	22,000,000
Indeno(1,2,3-cd)pyrene	--	--	--	--	--	--	--	--	--	--	2,100
Naphthalene	--	--	--	--	2	1.2-2.6	--	--	--	--	190,000
Phenol	--	--	--	--	--	--	--	--	--	--	100,000,000
Pyrene	--	--	--	--	--	--	--	--	--	--	29,000,000
Total Petroleum Hydrocarbons (DRO/GRO), mg/kg											
DRO	7	2-120	1	47	23	2.6-22	1	4.5	1	59	100
GRO	--	--	--	--	--	--	--	--	--	--	100
Metals, mg/kg											
Arsenic	16	1.9-6.4	20	1.2-7.2	35	1.3-6.6	13	0.81-12	16	1.9-7.2	23
Barium	17	37-750	21	30-200	35	22.9-1290	16	39-120	16	30-450	67,000
Beryllium	11	0.57-1.2	--	--	--	--	--	--	--	--	1,900
Cadmium	--	--	--	--	--	--	--	--	--	--	450

Table A.2-2
Analytical Detects above MRLs in Native Soil Samples Collected at Previously Investigated NTS Muckpiles
(Page 4 of 4)

Analyte	CAU 475 P-Tunnel		CAU 476 T-Tunnel		CAU 477 N-Tunnel		CAU 482 15a- and e-Tunnels		CAU 504 16a-Tunnel		PAL
	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	No. of Detects	Range	
Chromium	16	2.2-12	18	0.57-10	31	0.29-8.6	16	1.7-4.9	15	0.98-210	450
Lead	17	3.7-9.7	21	2.7-18	35	2.3-44.1	16	0.67-4.5	16	2.4-44	750
Mercury	--	--	--	--	26	0.04-0.8	6	0.0019-0.0066	1	0.046	310
Selenium	--	--	3	0.6-1.5	--	--	7	0.37-0.99	6	0.23-0.5	5,100
Silver	--	--	5	0.18-0.8	5	0.49-1.3	--	--	7	0.075-530	5,100
Radionuclides, pCi/g											
Americium-241	--	--	1	0.62	--	--	--	--	--	--	7.62
Cesium-137	1	0.173	--	--	2	0.37-1.54	2	0.202-0.246	2	0.83-9.9	7.30
Cobalt-60	--	--	--	--	--	--	--	--	--	--	1.61
Plutonium-238	2	0.184-0.66	--	--	--	--	--	--	1	0.071	7.78
Plutonium-239/240	2	0.54-1.29	--	--	--	--	--	--	1	0.439	7.62
Strontium-90	--	--	--	--	--	--	--	--	--	--	503

= Presently there is not a PRG for this contaminant. If this contaminant is detected, a PAL with a similar protocol to that used by the EPA Region 9 will be used in establishing an action level for those COPCs listed in the EPA IRIS database (EPA, 2002).

(see discussion in Section A.1.1.4). Transport of contaminants in the muckpiles at CAU 551 is not expected given the similarities in operations and environmental factors and fates.

The muck data was reviewed to determine which constituents detected in muck at previously investigated NTS muckpiles were detected at concentrations equal to or greater than current PALs (Decision Ia for the muckpiles). It was determined that the data included six constituents which met this criteria: lead, arsenic, TPH-DRO, Pu-239, Pu-239, and Cs-137. In accordance with the flow chart in Figure A.1-9, these COCs were further evaluated to determine which should be considered expected COCs for the CAU 551 investigation (Decision Ib). It was determined that all six constituents would be considered COCs for the CAU 551 muckpiles. This is a conservative assumption given that some of these six constituents were detected in only several samples (Table A.1-4) or were detected at only one previous muckpile (Table A.1-4) at concentrations above the PAL. However, since the assumption that even one COC is present in the CAU 551 muckpiles will lead to consideration of corrective actions, it was determined that considering all six constituents as COCs will likely not lead to an additional burden when considering potential corrective actions.

A.2.6 Conclusion

In general, the operations associated with the CAU 551 muckpiles were most closely associated with the tests conducted at Tunnels 15a and e and at Tunnel 16a. However, all operations conducted at the sites generating the muckpiles supported the same nuclear testing program and used similar procedures and materials. Early testing activities (pre-1969) may have had less stringent control of hazardous and radioactive wastes. However, a larger number of tests (and by extension, more waste contaminants) were conducted in the later period (e.g., 21 tests conducted in N-Tunnel).

All of the muckpiles in consideration are located in the same general area and, with slight variations, are subject to the same general arid environment. The muckpiles were all created from pulverized rock material and have particle size distributions ranging from boulder to clay sizes. The greater potential for translocation of the CAU 551 muckpile contaminants by erosion is the most significant consideration of the physical setting.

Since the highest concentrations of contaminants that occurred above current PALs in historical NTS muckpile investigations are being used, sufficient operational similarities and environmental factors exist to warrant the use of previous investigative results in identifying COCs for the CAU 551 investigation. Additionally, the slight differences in operational histories and physical settings have been taken into account in the design of the sampling plan for the CAU 551 muckpiles.

A.2.7 References

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

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Appendix A.3

Project Organization

A.3 Project Organization

The NNSA/NSO Project Manager is Janet Appenzeller-Wing. Her telephone number is (702) 295-0461.

The identification of the project Health and Safety Officer and the Quality Assurance Officer can be found in the appropriate plan. However, personnel are subject to change, and it is suggested that the appropriate DOE or DTRA Project Manager be contacted for further information. The Task Manager will be identified in the FFACO Biweekly Activity Report prior to the start of activities.

Appendix B

NDEP Comment Responses
(3 Pages)

NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

1. Document Title/Number Draft Corrective Action Investigation Plan for Corrective Action Unit 551: Area 12 Muckpiles, Nevada Test Site, Nevada
2. Document Date April 2004
3. Revision Number 0
4. Originator/Organization Stoller-Navarro Joint Venture
5. Responsible DOE/NV ERP Project Mgr. Janet Appenzeller-Wing
6. Date Comments Due May 7, 2004
7. Review Criteria Full
8. Reviewer/Organization/Phone No. Greg Raab, NDEP, 486-2867
9. Reviewer's Signature

10. Comment Number/ Location	11. Type[a]	12. Comment	13. Comment Response	14. Accept
1. Appendix A.1	M	In the section Appendix A.1 Data Quality Objectives (DQO), there is no reference to the EPA document *Guidance for the Data Quality Objectives Process*, EPA QA/G-4. As the seven step process is the foundation of the DQOs, this must be referenced.	A reference to the EPA document QA/G-4 has been added as requested.	Yes
2. Appendix A, Section A.1.3.2.2	M	The description of alternatives for Decision Ib is very difficult to understand. If the intent is to eliminate COPCs found in other muckpiles above current PALs from evaluation when they are not expected, NDEP does not concur. The whole intent of using other muckpiles that have been sampled and analyzed, is to establish expected COCs. This section must be re-written to better support the intent of the decisions.	We agree that this section is confusing. Decision Ib was a product of the initial DQO discussion that took place for this CAU. The intent of this statement was not to eliminate COPCs found in other muckpiles, above current PALs, from evaluation when they are not expected. In contrast, the intent of Decision Ib was to determine if there was compelling evidence to suggest that COPCs found in other muckpiles above current PALS were specific only to the muckpile in which they were found. If this was determined to be the case, they would not be considered expected COCs for the CAU 551 muckpile investigation. However, no evidence was identified to support such an assertion. Therefore, all COPCs found in other muckpiles above current PALs will be considered exp-COCs for the CAU 551 muckpile investigation. The Decision Ib discussion was presented in the DQO discussion for CASs 12-06-05, 12-06-07, and 12-06-08 to portray the complete thought process that went into development of the DQOs. However, to clarify this discussion point, the paragraph in question has been rewritten as provided below:	Yes

[a]Comment Types: M = Mandatory, S = Suggested.

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NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

Document Title/Number Draft Corrective Action Investigation Plan for Corrective Action Unit 551: Area 12 Muckpiles, Nevada Test Site, Nevada

Revision Number 0

Reviewer/Organization Greg Raab, NDEP, 486-2867

10. Comment Number/ Location	11. Type[a]	12. Comment	13. Comment Response	14. Accept
2. Appendix A, Section A.1.3.2.2 (continued)			"The alternatives for Decision Ib are: If a COPC was detected in samples of muck collected during previous NTS muckpile investigations at concentrations above current PALs, and evidence indicates the COPC was unique to the CAU at which it was detected, it will not be considered an exp-COC for CAU 551 muckpiles. If a COPC was detected in samples of muck collected during previous NTS muckpile investigations at concentrations above current PALs, and there is no evidence that indicates the COPC was unique to the CAU at which it was detected, it will be considered an exp-COC for the CAU 551 muckpiles. Decision Ib was answered during the DQO process and is presented in this discussion for completeness. No compelling evidence was identified to conclude that site-specific factors differed (e.g., a spill of a material used only at one previously investigated muckpile and not at the CAU 551 muckpiles). Therefore, no reason exists to suggest that any COPC detected at previously investigated muckpiles in concentrations above current PALs would not be present in the CAU 551 muckpiles. As a result, all COPCs detected in samples of muck collected during previous NTS muckpile investigations at concentrations above current PALs will be considered exp-COCs for the CAU 551 muckpiles."	

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NEVADA ENVIRONMENTAL RESTORATION PROJECT
DOCUMENT REVIEW SHEET

Document Title/Number Draft Corrective Action Investigation Plan for Corrective Action Unit 551: Area 12 Muckpiles, Nevada Test Site, Nevada

Revision Number 0

Reviewer/Organization Greg Raab, NDEP, 486-2867

10. Comment Number/ Location	11. Type[a]	12. Comment	13. Comment Response	14. Accept
3. Appendix A.2	M	In Appendix A.2 Documentation to Support the Assumption that the CAU 551 Muckpiles are Similar to Previously Investigated NTS Muckpiles there is no explanation in the introduction why it is necessary to compare the old muckpiles with CAU 551 muckpiles. The comparison is made because steep slopes prevent complete sampling of the CASs and the sites are very similar. For clarity, this explanation must be added.	Agree. A paragraph was added as the lead in paragraph for Appendix A.2 to explain the need for the comparison.	Yes
4. Appendix A.2, Figure A.2-1	M	This figure needs editing. The beige color does not have a definition in the key. The green colors are not the same. Enlarge the superscript definitions for readability. The cross-over colors from one test to another do not make sense. Above all, it is not readily obvious what the graph represents.	The figure has been changed to be more readable, to match the colors, and represent the approximate change-over times more explicitly through the added use of time-period bars. In addition, the explanation of the transition period represented in this figure has been reordered chronologically and additional text explains how the figure is used to support the conclusions presented in Appendix A.2.	Yes

[a]Comment Types: M = Mandatory, S = Suggested.

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