DOE/NV/25946--691

2008 Annual Summary Report for the Area 3 and Area 5 Radioactive Waste Management Sites at the Nevada Test Site Nye County, Nevada

Review of the Performance Assessments and Composite Analyses

Prepared for

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

Prepared by

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Under Contract Number
DE-AC52-06NA25946

March 2009

DISCLAIMER

EXECUTIVE SUMMARY

The *Maintenance Plan for the Performance Assessments and Composite Analyses for the Area 3 and Area 5 Radioactive Waste Management Sites at the Nevada Test Site* (National Security Technologies, LLC [NSTec], 2006) requires an annual review to assess the adequacy of the Performance Assessments (PAs) and Composite Analyses (CAs) for each of the facilities, with the results submitted annually to U.S. Department of Energy (DOE) Headquarters. The Disposal Authorization Statements for the Area 3 and Area 5 Radioactive Waste Management Sites (RWMSs) also require that such reviews be made and that secondary or minor unresolved issues be tracked and addressed as part of the maintenance plan (DOE, 2000; 1999a).

The U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) performed an annual review in fiscal year (FY) 2008 by evaluating operational factors and research results that impact the continuing validity of the PAs and CAs. This annual summary report presents data and conclusions from the FY 2008 review, and determines the adequacy of the PAs and CAs. Operational factors (e.g., waste forms and containers, facility design, and waste receipts), closure plans, monitoring results, and research and development (R&D) activities were reviewed to determine the adequacy of the PAs. Likewise, the environmental restoration activities at the Nevada Test Site relevant to the sources of residual radioactive material that are considered in the CAs, the land-use planning, and the results of the environmental monitoring and R&D activities were reviewed to determine the adequacy of the CAs.

Waste operations, R&D, and monitoring results for FY 2008 were reviewed and compared with the assumptions and conceptual models of the PAs and CAs of the Area 3 and Area 5 RWMSs. Important developments include the following:

- Development of new closure inventory estimates based on disposals through FY 2008
- Evaluation of new or revised waste streams by special analysis
- Approval of a new institutional control policy for the Nevada Test Site
- Issuance of a new closure plan for the Area 5 RWMS
- Development of version 4.102 of the Area 5 RWMS GoldSim PA model

Analysis of the latest available data using the Area 5 RWMS v4.102 GoldSim PA model indicates that all performance objectives can be met. The results and conclusions of the Area 5 RWMS PA are judged valid, and there is no need to the revise the PA.

The Area 3 RWMS has been in inactive status since July 1, 2006, with the last shipment received in April 2006. In FY 2008, there were no operational changes, monitoring results, or R&D results for the Area 3 RWMS that would impact PA validity. Despite the increase in waste volume and inventory at the Area 3 RWMS since 1996 when the PA was approved, the facility performance evaluated with the Area 3 RWMS PA GoldSim model, version 2.0 (with the final closure inventory), remains well below the DOE Order 435.1, “Radioactive Waste

Management," performance objectives (DOE, 2001). The conclusions of the Area 3 PA remain valid. A revision to the combined PA/CA document will be developed in FY 2010.

The continuing adequacy of the CAs was evaluated with the new models, and no significant changes that would alter CA results or conclusions were found. Inclusion of the Frenchman Flat Underground Test Area (UGTA) results in the Area 5 RWMS CA is scheduled for FY 2012, pending the completion of the Corrective Action Decision Document (CADD) for the Frenchman Flat UGTA Corrective Action Unit (CAU), scheduled for FY 2011. The revision of the Area 3 RWMS CA, which will include the UGTA source terms, is expected in FY 2021, following the completion of the Yucca Flat CAU CADD, scheduled for FY 2020.

Near-term R&D efforts will focus on continuing development of the Area 3 and Area 5 RWMS GoldSim PA/CA and inventory models. The consequences of potential subsidence of the disposal units that may impact the Area 3 RWMS will be incorporated into the Area 3 RWMS GoldSim model in FY 2009.

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ACRONYMS AND ABBREVIATIONS

ac	acre
ALARA	as low as reasonably achievable
BN	Bechtel Nevada
Bq	becquerel
Bq m^{-2} s^{-1}	becquerel per square meter per second
Bq m^{-3}	becquerel per cubic meter
CA	composite analysis
CADD	Corrective Action Decision Document
CAU	Corrective Action Unit
CFR	Code of Federal Regulations
Ci	curie
cm	centimeter
DAS	Disposal Authorization Statement
DOE	U.S. Department of Energy
ER	environmental restoration
ET	evapotranspiration
ETTP	East Tennessee Technology Park
FFACO	*Federal Facility Agreement and Consent Order*
ft	foot
ft^3	cubic foot
FY	fiscal year
GCD	Greater Confinement Disposal
ha	hectare
ICMP	Integrated Closure and Monitoring Plan
in.	inch
INEL	Idaho National Engineering Laboratory
ISC	Industrial Source Complex
KAPL	Knolls Atomic Power Laboratory
LFRG	Low-Level Waste Disposal Facility Federal Review Group
LHS	Latin hypercube sampling
LLNL	Lawrence Livermore National Laboratory
LLWMU	Low-Level Waste Management Unit

ACRONYMS AND ABBREVIATIONS (continued)

m	meter
m^3	cubic meter
mSv	millisievert
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NSTec	National Security Technologies, LLC
NTS	Nevada Test Site
PA	performance assessment
R&D	research and development
RaBe	radium-beryllium
RaDU	radium disposal unit
RTG	radioisotope thermoelectric generator
RWAP	Radioactive Waste Acceptance Program
RWMS	Radioactive Waste Management Site
Se K_d	selenium distribution coefficient
SLB	shallow land burial
SNL	Sandia National Laboratory
TBq	terabecquerel
TDR	time-domain reflectometer
TEDE	total effective dose equivalent
TLD	thermoluminescent dosimeter
UGTA	Underground Test Area
WAC	waste acceptance criteria
yr	year

1.0 INTRODUCTION

This report summarizes the results of an annual review of conditions affecting the operation of the Area 3 and Area 5 Radioactive Waste Management Sites (RWMSs) and a determination of the continuing adequacy of the performance assessments (PAs) and composite analyses (CAs). The Area 5 RWMS PA documentation consists of the original PA (Shott et al., 1998), referred to as the 1998 Area 5 RWMS PA, and supporting addenda (Bechtel Nevada [BN], 2001a; 2006). The Area 5 RWMS CA was issued as a single document (BN, 2001b) and has a single addendum (BN, 2001c). The Area 3 PA and CA were issued in a single document (Shott et al., 2001).

The Disposal Authorization Statements (DASs) for the Area 3 and 5 RWMSs (U.S. Department of Energy [DOE], 1999a; 2000) require preparation of an annual summary report and a determination of the continuing adequacy of the PAs and CAs. The annual summary report is submitted to DOE Headquarters. Activities to maintain and review the PAs and CAs are conducted under the Maintenance Plan for the PAs and CAs (National Security Technologies, LLC [NSTec], 2006).

Following the annual report format in the DOE PA/CA Maintenance Guide (DOE, 1999b), this report presents the annual summary for the PAs in Section 2.0 and the CAs in Section 3.0. The annual summary for the PAs includes the following:

- Section 2.1 summarizes changes in waste disposal operations.
- Section 2.1.3 provides an evaluation of the new estimates of the closure inventories derived from the actual disposals through fiscal year (FY) 2008.
- Section 2.2 summarizes the results of the monitoring conducted under the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office's (NNSA/NSO's) Closure and Monitoring Plans for the Area 3 and Area 5 RWMSs (NSTec, 2007a; 2008a), and the research and development (R&D) activities.
- Section 2.3 is a summary of changes in facility design, operation, or expected future conditions; monitoring and R&D activities; and the maintenance program.
- Section 2.4 discusses the recommended changes in disposal facility design and operations, monitoring and R&D activities, and the maintenance program.
- Section 2.5 addresses the key review questions addressing the continuing validity of the PA.

Similarly, the annual summary for the CAs (presented in Section 3.0) includes the following:

- Section 3.1 presents an assessment of the relevant site activities at the Nevada Test Site (NTS) that would impact the sources of residual radioactive material considered in the CAs.
- Section 3.2 updates the CA results using the FY 2008 inventories and models.
- Section 3.3 summarizes the monitoring and R&D results that were reviewed in FY 2008.

- Section 3.4 presents a summary of changes in relevant site programs (including monitoring, R&D, and the maintenance program) that occurred since the CAs were prepared.
- Section 3.5 summarizes the recommended changes to these programs.
- Section 3.6 addresses the key review questions addressing the continuing validity of the PA.
- Appendix A is a self evaluation of the Low-Level Waste Disposal Facility Federal Review Group (LFRG) checklist for review of the annual summary.

1.1 STATUS OF DISPOSAL AUTHORIZATION STATEMENT CONDITIONS

The Area 3 RWMS was issued a DAS on October 20, 1999 (DOE, 1999a). The Area 3 RWMS DAS contained one PA condition and two CA conditions (Tables 1 and 2). The DAS conditions were resolved with the revision of the PA/CA document (Shott et al., 2001).

Table 1. Status of the Area 3 RWMS DAS PA Conditions

Condition	Status
"*Provide to LFRG, within eight months of the date of issuance of this disposal authorization statement, a revision to the performance assessment that includes resolution of the following secondary issues: 1) Lack of justification for excluding particular exposure scenarios based on exhumed waste, 2) Inadequate justification for omission of surface water, 3) Lack of sensitivity analysis regarding the assumed 250 years of institutional control, 4) Need for clarification of the RCRA/CERCLA regulatory involvement, if any, in low-level waste disposal at Area 3, 5) Need for clarification of the location of the point of maximum exposure, 6) Need for better explanation of the borehole and field data within the framework of the no-recharge conceptual model."*	A revised Area 3 RWMS PA/CA was issued in December of 2001 (Shott et al., 2001). The DAS conditions were closed in 2002 (DOE, 2002a).

Table 2. Status of the Area 3 RWMS DAS CA Conditions

Condition	Status
"Provide to LFRG, within eight months of the date of issuance of this disposal authorization statement, a revision to the composite analysis that includes: 1) a qualitative assessment including an options analysis of the effect of groundwater contamination resulting from underground nuclear testing. Before any portion of the Nevada Test Site is considered for a reduction in institutional control, Nevada Operations Office will have quantified the potential dose from the underground testing residues and taken measures to mitigate the dose, as appropriate."	A revised Area 3 RWMS PA/CA was issued in December of 2001 (Shott et al., 2001). The DAS conditions were closed in 2002 (DOE, 2002a).
"*Resolution of the following secondary issues identified in the review of the composite analysis: Need for a better explanation of the borehole and field data within the framework of the no-recharge conceptual model."*	A revised Area 3 RWMS PA/CA was issued in December of 2001 (Shott et al., 2001). The DAS conditions were closed in 2002 (DOE, 2002a).

The Area 5 RWMS DAS was issued on December 5, 2000 (DOE, 2000). The PA and CA each had two conditions (Tables 3 and 4). The DAS conditions were closed on May 23, 2002.

Table 3. Status of the Area 5 RWMS DAS PA Conditions

Condition	Status
"The specific radionuclide concentration or inventory limits shall be imposed on Pit 6 to ensure that performance objectives will not be exceeded. A quantitative dose estimate shall be calculated using the reduced inventory to determine compliance with the performance objective."	An addendum to the Area 5 RWMS PA was issued in November 2001 (BN, 2001a). The DAS conditions were closed in 2002 (DOE, 2002b).
"The closure plan shall require a closure cap thickness of at least 4 meters as stated in Section 5.1 of the 1998 PA to ensure that performance objectives for the agricultural scenario will not be exceeded. A quantitative dose estimate shall be calculated using the 4 meter cap to demonstrate compliance with the performance objectives."	An addendum to the Area 5 RWMS PA was issued in November 2001 (BN, 2001a). The DAS conditions were closed in 2002 (DOE, 2002b).

Table 4. Status of the Area 5 RWMS DAS CA Conditions

Condition	Status
"The CA for the RWMS shall either be revised or an addendum issued within one year of the date of the issuance of this DAS to incorporate the Supplemental Information. The revised CA or addendum shall be submitted to the LFRG. Nevada Operations Office shall address all secondary issues and issues identified in Appendix B of the Review Team Report through the maintenance program."	An addendum to the Area 5 RWMS CA was issued in November 2001 (BN, 2001c). The DAS conditions were closed in 2002 (DOE, 2002b).
"Consistent with the sites Land Use Plan and the conditions identified in the Area 3 DAS before any portion of the Nevada Test Site is considered for a reduction in institutional controls, Nevada Operations Office will have quantified the potential dose from the underground testing residues."	An addendum to the Area 5 RWMS CA was issued in November 2001 (BN, 2001c). The DAS conditions were closed in 2002 (DOE, 2002b).

1.2 TRACKING OF MINOR ISSUES

Tracking and resolution of all minor or secondary issues identified in the LFRG review reports for the Area 3 and Area 5 RWMS PAs and CAs continued in FY 2008. Table 5 lists the minor issues that are being tracked and resolved through the maintenance program. The resolution pathway for each issue is included in the third column of Table 5.

Table 5. Minor Issues Identified in the LFRG Review Reports for the Area 3 and Area 5 RWMS PAs and CAs

Identified Issue	Source Document for Issue	Resolution Pathway
An engineered barrier will be added, and the assurance requirements of Title 40 Code of Federal Regulations (CFR) Part 191 must be met for the Greater Confinement Disposal (GCD) boreholes.	GCD PA	An engineered barrier will be added, and the assurance requirements will be met at the time of closure of the Area 5 RWMS in FY 2028.
Inconsistencies between conceptual models for the Area 5 RWMS PA and CA, the Area 3 RWMS PA and CA, and the GCD PA.	Area 5 RWMS PA, Area 5 RWMS CA, Area 3 RWMS PA/CA, GCD PA	The continuous development of probabilistic performance assessment models using the GoldSim software system is systematically eliminating inconsistencies; this work will continue to be described in annual summary reports.
Conduct site monitoring and site characterization studies, as required, to increase confidence in the results of the PAs.	Area 3 RWMS PA/CA	Monitoring programs at both Area 5 and Area 3 RWMSs are ongoing; data are being incorporated into the GoldSim models to increase confidence in the PA results.
The maintenance program must include periodic assessment of changes in potentially interacting sources (underground test areas [UGTAs], industrial sites) and impacts on the CAs	Area 5 RWMS CA, Area 3 RWMS PA/CA	Changes in potentially interacting sources will be evaluated through the maintenance program, and results will be presented in the annual summary reports.
The maintenance program must include periodic assessment of changes in land-use restrictions and impacts on the CAs.	Area 5 RWMS CA; Area 3 RWMS PA/CA	Changes in land-use restrictions will be reviewed through the maintenance program, and results will be presented in the annual summary reports.
Monitoring systems need to be deployed and data gathered and evaluated to distinguish between interacting sources at the Area 3 RWMS.	Area 3 RWMS PA/CA	The monitoring systems deployed at the disposal facilities are described in the site closure plans (NSTec, 2007a; 2008a); monitoring results will be evaluated and presented in the annual summary reports.

2.0 PERFORMANCE ASSESSMENT

2.1 WASTE DISPOSAL OPERATIONS

The PA maintenance plan requires an annual review of waste operations including evaluation of waste forms, waste containers, facility design, waste acceptance criteria (WAC), closure design, and waste inventory. The assumptions and conceptual models of the PAs are compared with current operations to assess three key questions:

1. Are changes to the PAs required?
2. Are the conclusions of the PAs still valid?
3. Are the disposal facilities in compliance with all performance objectives and all DAS conditions?

Changes in waste inventory, facility design, WAC, institutional controls, and closure design occurring during FY 2008 are noted and described below. The impacts of these changes are assessed in Section 2.1.7.

2.1.1 Waste Form and Containers

The Area 3 and Area 5 RWMS PAs do not explicitly model the performance of waste forms and containers. Radionuclides are assumed to be fully available for release and transport at closure. These assumptions continue to apply for waste disposed through FY 2008.

2.1.2 Facility Design and Operations

The PAs use assumptions about disposal unit volume, area, and depth of burial that may affect performance. Historical information about these parameters for disposed waste remains unchanged.

The Area 3 RWMS was placed in inactive status in July 2006, with the last waste disposed in April 2006. The two post-1988 disposal units, U-3ah/at and U-3bh, are currently operationally closed. No wastes were disposed at the Area 3 RWMS and no new disposal units were opened in FY 2008.

No new disposal cells were opened at the Area 5 RWMS in FY 2008. The two Area 5 RWMS radium disposal units (RaDUs), Pit 6 (P06U) and Pit 13 (P13U), had PA derived disposal conditions on inventory and the depth of burial. In FY 2008, PA models were revised to reflect as-built conditions for the two RaDUs. The disposed inventories and as-built depth of burial was found to be consistent with or more limiting than PA requirements.

Twenty additional strontium-90 (^{90}Sr) radioisotope thermoelectric generators (RTGs) were disposed in FY 2008. All were disposed at least 2.8 meters (m) (9.2 feet [ft]) below grade, ensuring a 4-m (13-ft) depth of burial at closure. A separation of 3 to 7 m (9.8 to 21 ft),

depending on the RTG inventory, was maintained between the RTGs and other low-level waste to eliminate any thermal impacts on performance of low-level waste.

2.1.3 Waste Receipts

The Area 3 and Area 5 RWMS PAs analyze waste inventories that are estimated as the sum of past disposals and estimated future disposals. The closure inventory estimate changes over time as records of past disposals are revised or when future waste forecasts change. Estimates of past disposals may change as disposal records are reviewed, database records are revised, and assumptions used to revise historical records change. Closure inventory uncertainty, however, is dominated by uncertainty in future disposals. Experience has shown that future inventory estimates will change, perhaps significantly, over time as new generators or new waste streams are approved or wastes are sent to other alternative disposal sites.

2.1.3.1 New or Revised Waste Streams

Each new or revised waste stream is evaluated by the Radioactive Waste Acceptance Program (RWAP) for its potential impacts on the PA and conformance with WAC. Part of this evaluation includes a comparison of waste concentrations with the WAC action levels using a sum of fractions calculation. Waste streams with a sum of fractions greater than one or a potential to alter PA assumptions or conceptual models require a special analysis for acceptance. Waste streams exceeding inventory screening criteria are evaluated by adding the inventory to the Area 5 RWMS PA model and determining if all performance objectives can be met. Occasionally, waste streams may present issues other than inventory changes that require a special analysis. If the special analysis shows that all performance objectives can be met, the waste stream is recommended for approval.

In FY 2008, ten special analyses were performed for nine waste streams (Table 6). Two waste streams, the Idaho National Engineering Laboratory (INEL) Routinely Generated Contact Handled Low-Level Waste at Test Reactor Area and the East Tennessee Technology Park (ETTP) K-25/K-27 Whole Converters and Other Classified Gaseous Diffusion Equipment, were evaluated because their tritium (^{3}H) and technetium-99 (^{99}Tc) activity concentrations, respectively, exceeded the WAC action levels. Four Lawrence Livermore National Laboratory (LLNL) RTG waste streams, consisting of 20 RTGs, were evaluated for their impact on site inventory and potential heat generation effects. The LLNL RTG waste streams were accepted with conditions placed on the number and activity of RTGs, depth of burial, spacing between RTGs, and the spacing between the RTGs and adjacent low-level waste. The spacing conditions were implemented to control heat generation and eliminate the potential of RTG heat to impact other low-level waste. Three waste streams, the Sandia National Laboratories (SNL) Macropak Macroencapsulated Mixed Waste, Knolls Atomic Power Laboratory (KAPL) Radium-Beryllium (RaBe) Sealed Sources, and the INEL Material Fuels Complex Routinely Generated Remote Handled Low-Level Waste were evaluated due to their potential to generate radon-222 (^{222}Rn) gas. All were accepted without conditions, except the KAPL RaBe Sealed Sources, which was limited to the two sources described in the profile.

Table 6. Waste Streams Evaluated by Special Analysis in FY 2008

Waste Stream	Description	Issue	Result
INEL04TRA2328, Rev. 1, Rev. 2	INEL Routinely Generated Contact Handled Low-Level Waste at Test Reactor Area	^{3}H Inventory	Accepted
ORTN000000025, Rev. 5	ETTP K-25/K-27 Whole Converters and Other Classified Gaseous Diffusion Equipment	^{99}Tc Inventory	Accepted
BCLADOERG1RTG, Rev. 0	LLNL DOE RG-1 RTGs	^{90}Sr Inventory, Heat Generation	Accepted with Conditions
ASLA000001005, Rev. 0	SNL Macropak Macroencapsulated Mixed Waste	^{226}Ra Inventory	Accepted
DRTK000000010, Rev. 0	KAPL RaBe Sealed Sources	^{226}Ra Inventory	Accepted with Conditions
BCLAUSNRTG001, Rev. 0	LLNL DOE/U.S. Navy RTGs, Batch 1	^{90}Sr Inventory, Heat Generation	Accepted with Conditions
BCLAUSNRTG002, Rev. 0	LLNL DOE/U.S. Navy RTGs, Batch 2	^{90}Sr Inventory, Heat Generation	Accepted with Conditions
BCLAUSNRTG003, Rev. 0	LLNL DOE/U.S. Navy RTGs, Batch 3	^{90}Sr Inventory, Heat Generation	Accepted with Conditions
INEL08003010A, Rev. 1	INEL Material Fuels Complex Routinely Generated Remote Handled Low-Level Waste	^{234}U Inventory	Accepted

2.1.3.2 FY 2008 Closure Inventory Estimate for the Area 3 RWMS

The Area 3 RWMS was placed in inactive status July 1, 2006. The site may be used in the future for disposal of large volume bulk waste streams, but there are currently no waste streams designated for the Area 3 RWMS. The FY 2008 inventory, which is unchanged from the FY 2006 inventory, includes waste disposed through June 30, 2006, and assumes no future inventory.

The Area 3 RWMS inventory model estimates the inventory of wastes disposed before and after September 26, 1988. Pre-1988 waste was disposed mostly in U-3ax/bl, and a small amount was disposed in U-3ah/at (Table 7). The total pre-1988 inventory consists of approximately 326 terabecquerels (TBq) (8.9×10^3 curies [Ci]) in 2.3×10^5 cubic meters (m^3) (8.1×10^6 cubic feet [ft^3]) of waste.

Table 7. FY 2006 Estimate of the Area 3 RWMS Inventory Disposed before September 26, 1988 (Estimates are calculated from 500 Latin hypercube sampling [LHS] realizations and decayed to October 1, 2008)

Nuclide	U-3ax/bl		U-3ah/at	
	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
H-3	3.0E+14	2.95	1.8E+12	2.19
C-14	9.3E+10	3.08	9.3E+07	2.89
Al-26	3.4E+06	3.14	3.4E+03	3.06
Cl-36	2.0E+10	3.13	2.0E+07	2.98
Ar-39	9.6E+10	3.15	1.0E+08	2.85
K-40	5.2E+09	3.03	5.6E+06	2.73
Ca-41	1.4E+11	3.11	1.4E+08	2.88
Co-60	1.1E+11	2.85	*Negligible*	
Ni-59	3.7E+09	3.10	3.7E+06	2.96
Ni-63	3.3E+11	3.15	3.7E+08	2.99
Kr-85	1.7E+11	3.05	3.2E+08	2.76
Sr-90	7.0E+12	3.05	1.0E+10	2.60
Zr-93	4.8E+08	3.02	5.2E+05	2.72
Nb-93m	1.4E+11	3.24	2.1E+08	3.04
Nb-94	1.2E+11	3.13	1.1E+08	3.02
Tc-99	1.2E+10	2.22	1.1E+10	3.87
Pd-107	2.2E+07	3.05	2.3E+04	2.74
Cd-113m	1.3E+11	3.17	2.2E+08	2.98
Sn-121m	1.4E+12	3.09	1.7E+09	3.00
Sn-126	2.1E+08	3.03	2.3E+05	2.74
I-129	1.1E+07	3.05	1.2E+04	2.73
Cs-135	4.1E+08	3.03	4.1E+05	2.74
Cs-137	9.3E+12	3.00	1.2E+10	2.68
Sm-151	5.6E+11	3.04	6.3E+08	2.75
Eu-150	2.4E+11	3.35	3.0E+08	3.37
Eu-152	1.1E+12	3.24	1.7E+09	2.91
Eu-154	3.1E+11	3.18	6.7E+08	3.04
Gd-152	1.3E-01	3.20	1.1E-04	2.91
Ho-166m	4.4E+09	3.16	4.8E+06	2.88
Ra-226	5.6E+11	3.71	1.1E+05	2.15
Ra-228	1.3E+09	2.52	3.7E+05	2.73
Ac-227	4.4E+05	2.07	6.3E+05	2.19
Th-228	8.1E+09	2.79	7.4E+06	2.88
Th-229	8.5E+06	2.99	6.3E+03	2.71
Th-230	2.0E+07	1.84	2.5E+07	2.15
Th-232	1.4E+09	2.53	4.1E+05	2.73
Pa-231	1.6E+06	2.10	2.4E+06	2.19

Nuclide	U-3ax/bl		U-3ah/at	
	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
U-232	6.3E+09	3.14	6.7E+06	2.90
U-233	3.0E+09	3.02	3.2E+06	2.70
U-234	8.9E+10	1.99	1.3E+11	2.15
U-235	3.4E+09	2.14	5.6E+09	2.19
U-236	2.4E+09	2.85	2.6E+09	2.89
U-238	4.4E+10	2.07	1.1E+11	2.46
Np-237	4.8E+08	2.35	2.4E+08	2.33
Pu-238	2.0E+11	3.03	2.0E+10	2.53
Pu-239	1.0E+12	2.99	2.0E+09	2.22
Pu-240	2.8E+11	3.01	5.2E+08	2.16
Pu-241	9.3E+11	3.04	3.3E+09	2.05
Pu-242	1.0E+08	3.02	1.4E+05	2.36
Am-241	3.3E+11	2.98	5.6E+08	2.12
Am-243	4.4E+07	3.00	4.8E+04	2.74
Cm-244	1.6E+10	3.06	2.3E+07	2.75
Total	3.3E+14		2.1E+12	

Negligible – No disposal recorded, inventory assumed to be negligible

The post-1988 waste is disposed in U-3ah/at and U-3bh (Table 8). The post-1988 inventory is estimated to consist of approximately 3.2 x 10^4 TBq (8.6 x 10^5 Ci) in 3.3 x 10^5 m^3 (1.2 x 10^7 ft^3) of waste. On an activity basis, the inventory is predominantly ^{3}H.

Table 8. FY 2006 Estimate of the Area 3 RWMS Inventory Disposed after September 26, 1988 (Estimates are calculated from 500 LHS realizations and decayed to October 1, 2008)

Nuclide	U-3ah/at		U-3bh	
	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
H-3	1.8E+16	2.05	1.2E+16	2.24
C-14	1.0E+11	1.76	3.0E+07	2
Al-26	7.8E+04	3	*Negligible*	
Cl-36	5.2E+08	2.67	*Negligible*	
Ar-39	2.3E+09	2.86	*Negligible*	
Ar-42	6.3E+08	2.03	3.3E+08	2.68
K-40	2.6E+09	1.89	7.0E+08	2.45
Ca-41	3.3E+09	2.88	*Negligible*	
Ti-44	1.4E+10	2.04	7.0E+09	2.5
Co-60	3.3E+10	1.75	2.0E+10	2.15
Ni-59	9.6E+08	2.24	1.8E+08	2.18
Ni-63	2.3E+11	1.77	8.5E+09	2.12
Se-79	2.1E+07	2.47	*Negligible*	

Nuclide	U-3ah/at		U-3bh	
	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
Kr-85	9.3E+09	2.36	*Negligible*	
Sr-90	4.4E+14	2.58	6.7E+10	2
Zr-93	1.2E+07	2.66	*Negligible*	
Nb-93m	4.8E+09	2.93	*Negligible*	
Nb-94	2.7E+09	2.97	1.7E+08	2.17
Tc-99	2.1E+12	1.89	8.1E+10	2.06
Pd-107	5.2E+05	2.65	*Negligible*	
Cd-113m	5.2E+09	2.85	*Negligible*	
Sn-126	5.2E+08	2.38	8.9E+05	2.68
I-129	4.8E+08	1.93	2.4E+08	2.53
Ba-133	1.4E+10	1.98	4.4E+09	2.58
Cs-135	9.3E+06	2.63	*Negligible*	
Cs-137	2.6E+14	1.81	7.0E+10	1.77
Sm-151	1.4E+10	2.64	1.1E+06	2.64
Eu-150	6.3E+09	3.5	*Negligible*	
Eu-152	8.5E+10	1.93	3.0E+09	2.32
Eu-154	3.0E+10	2.18	6.3E+08	2.15
Gd-152	2.9E-03	2.44	3.7E-05	2.39
Ho-166m	1.1E+08	2.86	*Negligible*	
Bi-207	4.8E+05	2.69	2.1E+07	2.75
Pb-210	8.1E+10	2.18	7.4E+07	1.74
Ra-226	1.0E+11	2.03	3.7E+08	1.85
Ra-228	8.1E+09	1.56	1.1E+11	2.64
Ac-227	3.6E+09	2.33	8.5E+04	1.96
Th-228	6.7E+10	2.18	6.7E+10	2.63
Th-229	1.4E+07	2.21	1.1E+07	2.51
Th-230	4.4E+10	2.03	7.4E+10	2.65
Th-232	1.3E+10	1.63	2.2E+11	2.65
Pa-231	2.4E+08	2.03	1.1E+06	2.06
U-232	6.7E+10	2.38	*Negligible*	
U-233	1.6E+10	2.11	2.2E+10	2.5
U-234	7.4E+12	1.93	1.3E+11	2
U-235	3.4E+11	1.83	1.1E+10	2.14
U-236	3.6E+11	2.5	1.1E+08	2.63
U-238	1.2E+13	1.65	5.9E+11	2.4
Np-237	2.4E+11	2.03	1.5E+08	1.89
Pu-238	5.9E+11	2.05	1.7E+11	2.53
Pu-239	2.7E+12	1.64	5.2E+11	1.9
Pu-240	5.6E+11	1.69	8.9E+10	1.96
Pu-241	3.0E+12	1.69	3.7E+11	1.93

Nuclide	U-3ah/at		U-3bh	
	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
Pu-242	1.1E+08	1.66	4.1E+07	2.19
Pu-244	7.0E-01	2.71	2.5E-06	2.64
Am-241	4.4E+11	1.65	8.1E+10	1.81
Am-242m	2.4E+08	2.18	3.7E+06	2.63
Am-243	5.6E+08	1.89	4.8E+07	2.7
Cm-243	4.8E+06	1.9	1.4E+06	2.67
Cm-244	1.5E+10	1.72	2.2E+08	2.17
Cm-245	5.2E+08	2.12	8.5E+06	2.76
Cm-246	8.5E+07	2.21	*Negligible*	
Cm-247	6.7E+05	2.6	*Negligible*	
Cm-248	5.9E-12	2.83	*Negligible*	
Cf-249	3.5E+03	2.2	*Negligible*	
Cf-250	2.7E+03	2.58	*Negligible*	
Cf-251	1.7E+08	2.56	*Negligible*	
Total	1.9E+16		1.2E+16	

Negligible – No disposal recorded, inventory assumed to be negligible

The volume of waste disposed at the Area 3 RWMS is divided approximately equally between the pre- and post-1988 period (Figure 1). The total activity has been disposed predominately in the post-1988 period since 2000 (Figure 2).

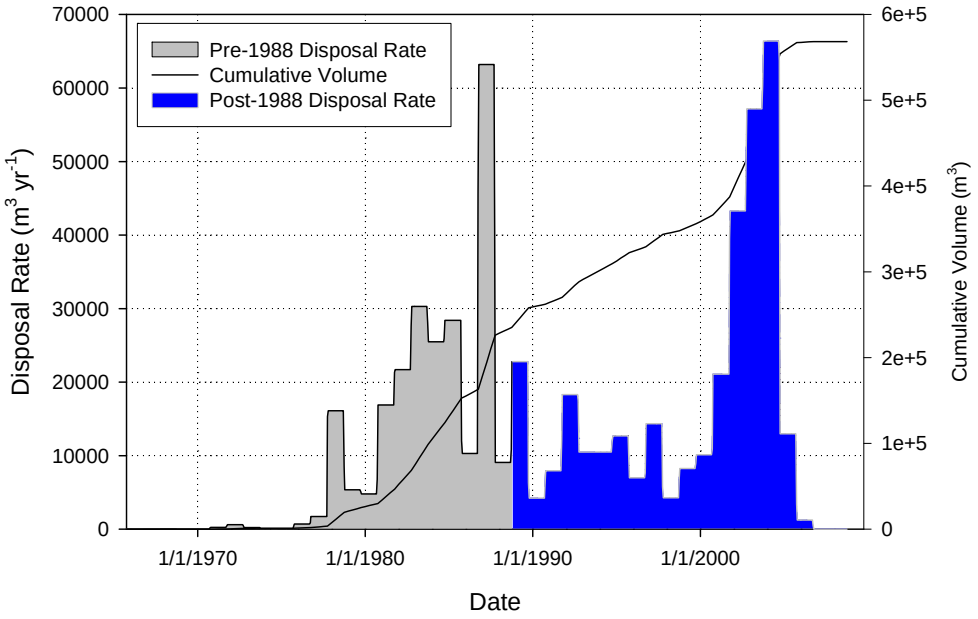

Figure 1. Volume Disposed per Year and the Arithmetic Mean of Cumulative Volume for the Area 3 RWMS

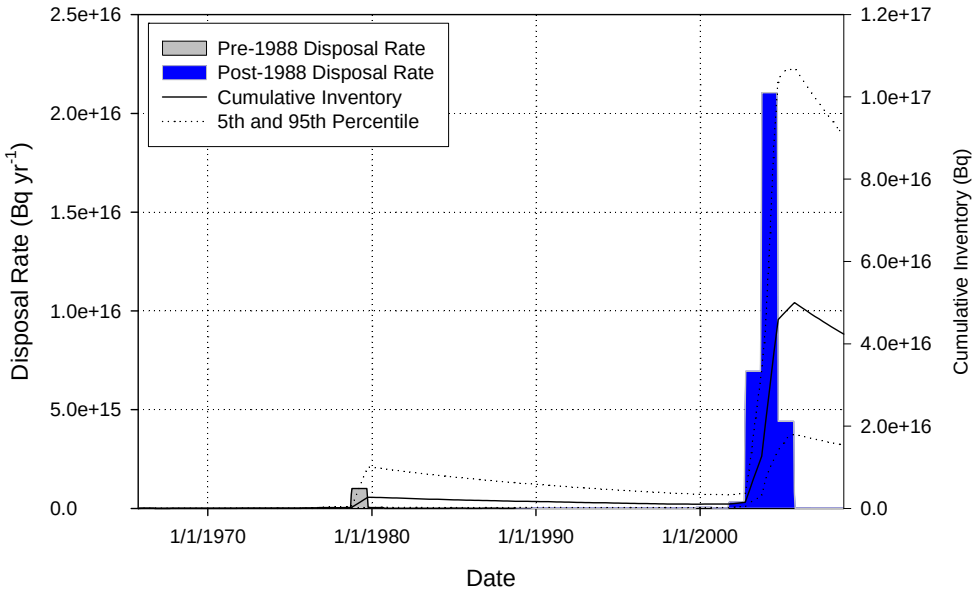

Figure 2. Activity Annual Disposal and Inventory for the Area 3 RWMS

2.1.3.3 FY 2008 Closure Inventory Estimate for the Area 5 RWMS

The Area 5 RWMS PA GoldSim model divides the site inventory into three virtual disposal units based on the depth of burial. Most wastes are disposed in the shallow land burial (SLB) disposal units below a cover currently planned to be 4 m (13 ft) thick. Wastes capable of producing significant ^{222}Rn flux densities are disposed below thicker covers in two RaDUs, the lower cell of Pit 6 (P06U) and Pit 13 (P13U). High specific activity wastes have been disposed in Greater Confinement Disposal (GCD) boreholes. The inventory of the three virtual disposal units is further divided into pre-1988, post-1988 disposed, and future portions.

The FY 2008 estimate of the Area 5 RWMS closure inventory was prepared using the Area 5 Inventory v2.104 GoldSim model. The model sums past disposals, revisions, and future inventory estimates probabilistically. Probability distributions representing uncertainty in annual activity disposed are sampled each FY during operations. Radioactive decay and ingrowth during the operational period are explicitly included in the model. The estimated inventories are decayed until the assumed date of closure on September 30, 2028.

Changes to the Area 5 Inventory model and its input data result in slight changes to the SLB inventory estimates (Table 9). The statistical distribution used to characterize uncertainty for pre-1988 waste was changed from loguniform to lognormal to reflect the greater consistency of the lognormal support, 0 to ∞, with the possible range of the variable. The loguniform distribution was judged unrealistic because it assigns zero probability beyond its upper and lower limits. The new distribution slightly shifts the pre-1988 SLB inventory geometric mean to higher values and increases the standard deviation. An increase in the waste volume forecast in FY 2008 increases the future inventory estimate. The addition of waste characterization uncertainty to the future waste inventory significantly increases the uncertainty in the future inventory for some radionuclides. No new long-lived radionuclides were disposed in FY 2008.

Table 9. FY 2008 Estimate of the Area 5 RWMS SLB Inventory (Estimates are calculated from 500 LHS realizations and decayed to October 1, 2028)

Nuclide	Pre-1988 SLB		Post-1988 SLB		Future SLB	
	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
H-3	3.2E+16	1.86	3.1E+16	1.70	3.2E+16	2.54
C-14	2.6E+11	2.01	9.2E+11	1.91	1.6E+11	2.83
Al-26	8.2E+06	2.08	3.0E+04	2.95	*Negligible*	
Cl-36	4.7E+10	2.06	1.9E+08	2.56	1.3E+06	8.42
Ar-39	2.1E+11	2.09	7.9E+08	2.75	*Negligible*	
K-40	1.2E+10	2.02	1.3E+10	1.68	3.5E+09	3.18
Ca-41	3.3E+11	2.07	1.2E+09	2.67	4.0E+04	186
Co-60	1.9E+12	2.81	1.8E+14	2.20	4.2E+13	6.41
Ni-59	8.8E+09	2.04	8.6E+11	2.06	6.3E+10	9.96
Ni-63	6.6E+11	2.09	6.7E+13	2.09	6.5E+12	6.91

Nuclide	Pre-1988 SLB		Post-1988 SLB		Future SLB	
	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
Se-79	*Negligible*		3.2E+12	2.23	7.3E+10	175
Kr-85	4.0E+11	2.86	4.5E+09	1.97	7.0E+08	4.60
Sr-90	1.6E+15	3.66	1.5E+16	2.33	6.5E+14	15.3
Zr-93	1.1E+09	2.04	7.1E+07	2.17	2.6E+06	30.9
Nb-93m	1.1E+11	2.09	8.9E+08	2.62	4.5E+06	9.53
Nb-94	2.8E+11	2.13	1.7E+11	2.65	2.3E+09	34.9
Tc-99	1.2E+13	2.61	3.5E+14	1.88	3.8E+13	3.88
Pd-107	5.1E+07	2.02	7.1E+05	1.97	2.0E+04	15.5
Ag-108m	*Negligible*		2.5E+11	2.54	4.4E+08	204
Cd-113m	9.3E+10	2.10	2.8E+10	2.50	2.3E+08	98.8
Sn-121m	2.5E+12	2.09	1.1E+10	2.74	5.5E+04	20.5
Sn-126	4.9E+08	2.02	3.5E+10	2.10	1.7E+09	19.7
I-129	3.6E+07	2.01	3.2E+09	1.68	6.2E+08	3.35
Ba-133	1.4E+08	3.62	1.1E+09	2.24	6.6E+08	8.89
Cs-135	8.9E+08	2.03	3.2E+07	2.15	7.1E+05	20.9
Cs-137	2.7E+15	4.12	7.5E+14	2.20	7.2E+13	4.76
Pm-145	*Negligible*		7.0E+04	2.63	4.3E+03	46.5
Pm-146	*Negligible*		1.4E+05	1.88	5.0E+04	7.04
Sm-151	1.0E+12	2.03	1.8E+10	1.98	7.0E+08	8.57
Eu-150	3.7E+11	2.20	1.6E+09	3.36	6.7E-01	26.1
Eu-152	2.3E+12	2.57	4.4E+13	2.23	2.8E+12	16.5
Eu-154	3.0E+11	2.42	3.4E+13	2.13	2.8E+12	30.5
Gd-148	*Negligible*		1.4E+04	1.98	3.5E+03	5.18
Ho-166m	1.1E+10	2.06	4.1E+07	2.77	1.7E+00	15.2
Bi-207	4.5E+05	3.94	1.1E+07	2.19	9.8E+05	8.33
Pb-210	8.6E+11	3.40	5.4E+10	1.51	2.6E+10	2.70
Ra-226	1.1E+12	3.41	7.3E+10	1.55	4.1E+10	2.68
Ra-228	4.8E+10	2.28	6.4E+11	1.52	2.7E+11	2.35
Ac-227	1.2E+10	2.05	5.1E+09	1.50	1.4E+10	6.05
Th-228	6.5E+10	2.03	2.2E+12	1.81	4.9E+11	2.39
Th-229	1.5E+08	2.33	5.5E+11	2.08	2.5E+10	7.56
Th-230	4.3E+10	1.87	2.5E+11	1.64	1.2E+11	3.27
Th-232	4.9E+10	2.28	6.7E+11	1.51	3.3E+11	2.32
Pa-231	7.3E+09	1.91	8.6E+09	1.56	1.9E+09	2.03
U-232	1.1E+10	2.08	1.4E+12	2.26	1.2E+11	4.91
U-233	3.2E+10	2.41	1.1E+14	2.62	3.9E+12	11.5
U-234	8.4E+13	2.04	9.7E+13	1.44	3.7E+13	1.94

Nuclide	Pre-1988 SLB		Post-1988 SLB		Future SLB	
	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
U-235	3.4E+12	2.07	4.6E+12	1.44	2.1E+12	1.88
U-236	1.1E+12	3.02	2.8E+12	1.55	6.2E+11	2.73
U-238	9.1E+13	2.18	2.0E+14	1.48	9.5E+13	1.84
Np-237	2.3E+11	1.99	1.4E+11	1.72	2.1E+10	2.90
Pu-238	6.7E+12	1.91	6.4E+12	1.63	2.5E+12	2.05
Pu-239	1.3E+13	1.96	1.2E+13	1.64	3.4E+12	2.03
Pu-240	3.0E+12	1.91	5.3E+12	1.84	1.0E+12	2.55
Pu-241	3.6E+12	1.95	3.3E+13	2.02	8.0E+12	2.92
Pu-242	6.8E+08	1.92	4.1E+11	2.67	1.8E+10	12.8
Pu-244	4.9E+09	3.99	4.0E+04	2.53	1.6E+03	10.6
Am-241	4.2E+12	1.91	7.7E+12	1.69	1.4E+12	2.34
Am-242m	*Negligible*		1.5E+09	1.82	2.1E+08	4.79
Am-243	3.9E+08	2.70	3.8E+10	2.19	2.8E+09	5.84
Cm-243	4.6E+09	2.83	3.2E+08	1.93	5.9E+07	3.57
Cm-244	7.9E+10	3.03	5.5E+11	1.89	1.1E+11	3.94
Cm-245	9.9E+04	3.72	4.9E+11	2.02	2.1E+10	15.4
Cm-246	6.6E+04	3.26	8.4E+10	2.18	3.3E+09	19.5
Cm-247	*Negligible*		1.0E+03	2.40	2.2E+01	97.4
Cm-248	6.3E+04	3.67	2.4E+05	2.61	8.3E+07	3.60
Cf-249	*Negligible*		1.0E+08	2.01	1.2E+07	5.12
Cf-250	2.2E+05	2.85	1.0E+05	2.74	1.9E+03	26.6
Cf-251	*Negligible*		6.4E+07	2.41	2.6E+06	25.1
Total	3.7E+16		4.8E+16		3.3E+16	

Negligible – Inventory less than 37 Bq

The arithmetic mean SLB volume estimate has increased approximately 9 percent from 6.4×10^5 to 7.2×10^5 m^3 (2.3×10^7 to 2.5×10^7 ft^3) between FY 2007 and FY 2008 (Figure 3). The arithmetic mean post-1988 SLB volume has increased from 4.7×10^5 to 5.5×10^5 m^3 (1.7×10^7 to 1.9×10^7 ft^3).

The FY 2008 geometric mean closure inventory estimate remains unchanged at 1.2×10^5 TBq (3.2×10^6 Ci) (Figure 4). The geometric mean post-1988 closure inventory estimate is also unchanged at 8.1×10^4 TBq (2.2×10^6 Ci). The FY 2008 SLB inventory shows notable increases in the inventory of ^{90}Sr, thorium-229 (^{229}Th), and uranium-233 (^{233}U).

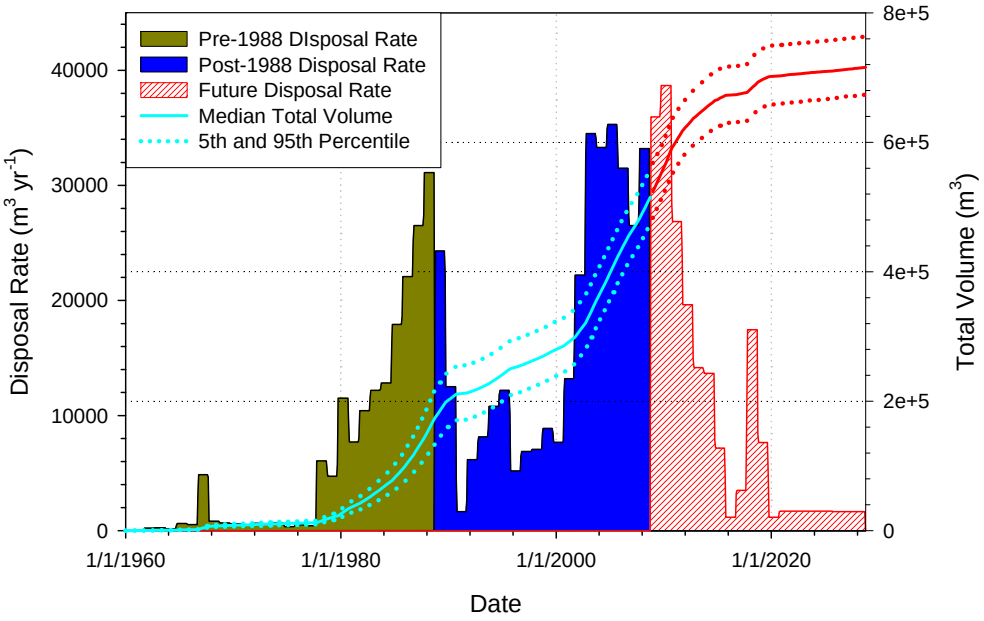

Figure 3. Annual Volume Disposal Rate and Median Cumulative Volume for the Area 5 RWMS Shallow Land Burial Disposal Units

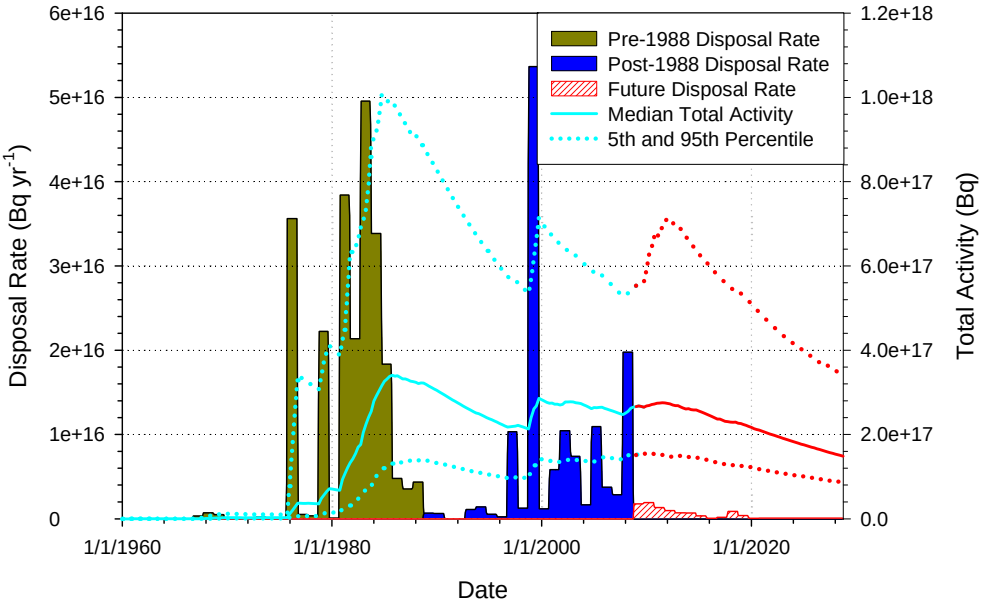

Figure 4. Annual Activity Disposal Rate and Median Inventory for the Area 5 RWMS Shallow Land Burial Disposal Units

RaDU Inventory

The lower cell of Pit 6 (P06U) and Pit 13 (P13U) were excavated to greater depth to contain thorium wastes that have the potential to generate ^{222}Rn in the future, as radium-226 (^{226}Ra) is produced by the decay of thorium-230 (^{230}Th). The inventory of both disposal units is predominately thorium-232 (^{232}Th). The lower cell of Pit 6 was operational from FY 1992 until FY 2002. The Pit 6 lower cell inventory remains unchanged from previous years. The upper cell of Pit 6 reached capacity in FY 2008, and an inventory for the upper cell is estimated (Table 10).

Pit 13 began operations in FY 2004 with disposal of the Defense National Stockpile Center thorium nitrate waste stream. The entire thorium nitrate waste stream was disposed in FY 2004 and 2005 in a single layer, 6.4 m (21 ft) below grade. In FY 2008 for PA modeling purposes, Pit 13 was partitioned into a RaDU portion containing the thorium nitrate waste below a 9.2 m (30 ft) cover and a SLB portion with low-level waste in multiple layers below a 4 m (13 ft) cover. The Pit 13 RaDU inventory is summarized in Table 10. The Pit 13 SLB inventory is included in the post-1988 SLB inventory.

Table 10. FY 2008 Estimate of the Area 5 RWMS RaDU Inventory Disposed (Estimates are calculated from 500 LHS realizations and decayed to October 1, 2028)

	P06UA (Upper Cell)		P06U (Lower Cell) RaDU		P13U RaDU	
Nuclide	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
H-3	9.8E+11	2.68	*Negligible*		1.3E+09	2.44
K-40	8.9E+02	2.64	*Negligible*		3.6E+03	2.90
Co-60	3.6E+02	2.51	*Negligible*		5.7E+06	2.62
Ni-63	*Negligible*		*Negligible*		4.5E+07	2.59
Sr-90	3.8E+07	2.48	1.8E+07	2.64	5.3E+09	2.70
Tc-99	5.8E+08	2.66	1.1E+09	2.74	1.4E+10	2.09
Sn-126	*Negligible*		*Negligible*		1.3E+07	2.77
I-129	3.4E-02	2.70	*Negligible*		*Negligible*	
Ba-133	3.8E+04	2.81	*Negligible*		*Negligible*	
Cs-135	0.0E+00	1.01	*Negligible*		*Negligible*	
Cs-137	3.2E+08	2.65	*Negligible*		7.2E+09	2.65
Eu-152	3.3E+05	2.75	*Negligible*		9.5E+06	2.68
Eu-154	*Negligible*		*Negligible*		1.3E+07	2.66
Gd-152	2.3E-08	2.75	*Negligible*		7.6E-07	2.68
Pb-210	6.4E+07	2.55	6.9E+09	1.69	6.8E+10	1.69
Ra-226	1.2E+08	2.46	1.9E+10	1.70	1.4E+11	1.70
Ra-228	1.1E+09	2.60	6.0E+12	1.60	5.5E+12	1.06
Ac-227	9.9E+04	1.96	2.3E+06	1.93	1.6E+05	2.44
Th-228	1.1E+09	2.60	5.9E+12	1.60	5.4E+12	1.06
Th-229	1.5E+04	2.70	5.2E+09	2.17	1.8E+02	2.43

Nuclide	P06UA (Upper Cell)		P06U (Lower Cell) RaDU		P13U RaDU	
	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
Th-230	9.4E+08	2.36	1.5E+12	1.72	1.8E+12	2.56
Th-232	1.1E+09	2.61	6.1E+12	1.61	5.9E+12	1.06
Pa-231	3.2E+05	1.95	6.1E+06	1.94	5.6E+05	2.43
U-232	*Negligible*		*Negligible*		1.6E+08	2.68
U-233	6.3E+06	2.70	2.0E+12	2.16	1.6E+05	2.42
U-234	1.5E+10	2.05	1.8E+11	1.94	9.9E+09	2.08
U-235	6.0E+08	1.94	9.1E+09	1.94	1.1E+09	2.42
U-236	9.5E+08	2.15	1.9E+08	2.16	4.9E+08	2.67
U-238	3.1E+10	1.90	2.1E+11	1.86	1.0E+11	2.42
Np-237	1.2E+08	2.55	7.9E+05	2.75	1.6E+09	2.42
Pu-238	1.1E+09	1.96	1.3E+10	1.94	3.3E+08	2.51
Pu-239	5.6E+10	1.81	3.3E+06	2.23	8.4E+09	2.15
Pu-240	1.2E+10	1.83	*Negligible*		3.9E+07	2.53
Pu-241	2.1E+10	1.94	1.2E+10	2.14	5.0E+09	2.71
Pu-242	1.1E+06	1.86	*Negligible*		*Negligible*	
Am-241	1.1E+10	1.71	1.1E+09	2.15	1.3E+09	2.18
Cm-244	7.3E+01	2.78	*Negligible*		*Negligible*	
Total	1.1E+12		2.2E+13		1.9E+13	

Negligible – Inventory less than 37 Bq

GCD Inventories

The GCD boreholes have received high specific activity wastes, including TRU waste regulated under Title 40 Code of Federal Regulations (CFR) Part 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level, and Transuranic Radioactive Waste" (CFR, 1994). The GCD boreholes were active from FY 1984 through FY 1991. The PA divides the GCD inventory into pre- and post-1988 portions. The majority of the waste on an activity and volume basis was disposed in the pre-1988 period. The current GCD inventory estimates are summarized Table 11. The GCD inventories are not significantly different from previous estimates.

Table 11. FY 2008 Estimate of the Area 5 RWMS GCD Borehole Inventory (Estimates are calculated from 500 LHS realizations and decayed to October 1, 2028)

Nuclide	Pre-1988 GCD		Post-1988 GCD	
	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
H-3	2.1E+16	2.59	1.7E+14	2.66
C-14	6.4E+04	3.01	*Negligible*	
Cl-36	1.4E+04	3.01	*Negligible*	
Ar-39	6.3E+04	3.10	*Negligible*	
K-40	3.6E+03	2.89	*Negligible*	
Ca-41	9.5E+04	3.03	*Negligible*	
Co-60	7.8E+11	2.62	*Negligible*	
Ni-59	2.5E+03	2.98	*Negligible*	
Ni-63	2.1E+05	3.03	*Negligible*	
Kr-85	5.6E+04	2.88	*Negligible*	
Sr-90	4.8E+15	4.09	7.9E+07	5.08
Zr-93	3.4E+02	2.90	*Negligible*	
Nb-93m	5.7E+04	3.02	*Negligible*	
Nb-94	7.8E+04	3.04	*Negligible*	
Tc-99	6.7E+09	3.65	4.5E+09	5.04
Cd-113m	5.1E+04	3.13	*Negligible*	
Sn-121m	8.9E+05	3.08	*Negligible*	
Cs-137	2.6E+14	3.62	*Negligible*	
Sm-151	3.4E+05	2.90	*Negligible*	
Eu-150	1.3E+05	3.43	*Negligible*	
Eu-152	4.0E+05	2.97	*Negligible*	
Eu-154	8.3E+04	2.96	*Negligible*	
Gd-152	9.8E-08	2.97	*Negligible*	
Ho-166m	3.2E+03	3.10	*Negligible*	
Pb-210	2.3E+12	3.98	3.5E+04	2.57
Ra-226	3.0E+12	3.98	1.1E+05	2.57
Ra-228	8.1E+08	3.99	2.4E-08	4.94
Ac-227	7.3E+10	3.95	4.9E+05	2.69
Th-228	8.1E+08	3.99	2.0E-08	4.94
Th-230	5.4E+07	3.08	1.3E+07	2.57
Th-232	8.2E+08	3.99	3.5E-08	4.94
Pa-231	4.6E+06	3.03	1.1E+06	2.69
U-232	3.8E+03	3.01	*Negligible*	
U-233	4.0E+04	2.09	2.3E+04	2.52
U-234	1.3E+11	3.06	3.6E+10	2.57
U-235	5.0E+09	3.02	1.4E+09	2.69

Nuclide	Pre-1988 GCD		Post-1988 GCD	
	Geometric Mean (Bq)	Geometric Standard Deviation	Geometric Mean (Bq)	Geometric Standard Deviation
U-236	3.4E+08	3.84	*Negligible*	4.94
U-238	3.3E+10	3.12	6.7E+10	2.52
Np-237	2.4E+08	2.10	1.3E+08	2.52
Pu-238	3.1E+11	2.87	2.6E+06	4.94
Pu-239	1.6E+13	2.94	1.5E+08	4.98
Pu-240	3.8E+12	2.84	3.1E+07	4.94
Pu-241	4.3E+12	3.14	4.3E+07	5.17
Pu-242	3.6E+08	2.86	*Negligible*	
Am-241	6.0E+12	2.34	2.7E+07	4.98
Cm-244	6.9E+03	2.91	*Negligible*	
Total	2.7E+16		1.7E+14	

Negligible – Inventory less than 37 Bq

2.1.4 Institutional Control Policy

In 2008, NNSA/NSO approved Policy NSO-P-454.X, "Institutional Controls for the Nevada Test Site" (NNSA/NSO, 2008a). The policy states that NNSA/NSO will implement, maintain, and enforce institutional controls that restrict access to, and use of, the NTS and ensure the continuity of appropriate institutional controls in the future.

Based on the new institutional control policy, future PA/CA analyses will assume implementation of land-use restrictions consistent with the Underground Test Area (UGTA)/*Federal Facility Agreement and Consent Order* (FFACO) closure strategies for the NTS (NNSA/NSO, 2007). The planned land-use restrictions will prohibit public access to groundwater for 1,000 years within the compliance boundary negotiated with the State of Nevada. Although these boundaries have not been negotiated, it is very likely that the Area 3 RWMS and Area 5 RWMS will be within the compliance boundaries of the Yucca Flat Corrective Action Unit (CAU) and the Frenchman Flat CAU, respectively. The new institutional control policies will affect PA analyses in the following areas.

1) Long-term (i.e., chronic) exposure of intruders will not occur based on NTS land-use restrictions and planned UGTA groundwater-use restrictions.
2) Short-term or acute intruder exposure may occur.
3) Exposure of the member of public and short-term exposure of intruders will be possible after institutional controls end. The period of institutional control will be randomly sampled from a probability density function. The member of public will be located at the UGTA groundwater compliance boundary.
4) The new institutional control policy and the probabilistic period of institutional controls will not be applied to the 40 CFR 191.13 containment requirements, which do not allow performance assessments to assume institutional control is effective beyond 100 years.

The changes above are implemented in the current Area 5 RWMS PA GoldSim model except for changing the point of compliance to the UGTA groundwater compliance boundary. The UGTA groundwater compliance boundaries are not resolved at this time. The changes above are recommended for the Area 3 RWMS PA GoldSim model, again excluding the change in the member of public point of compliance.

2.1.5 Waste Acceptance Criteria

Revision 7 of the NTS Waste Acceptance Criteria (WAC) was issued in FY 2008 (NNSA/NSO, 2008b). Most changes are clarifications or elaborations of existing criteria, not affecting PA assumptions or conclusions. Waste concentration limits derived in the PA update (BN, 2006) are implemented as the Revision 7 action levels. The WAC action levels are used in the routine screening of waste streams for acceptance.

Compliance with the NTS WAC is ensured by the RWAP. The RWAP is a NNSA/NSO program (NNSA/NSO, 2006a). No significant changes occurred in RWAP in FY 2008.

2.1.6 Closure

The Area 3 RWMS PA/CA assumes that the disposal units will be closed with a vegetated monolayer evapotranspiration (ET) cover of native alluvium. The cover is assumed to be 3 m (10 ft) thick after subsidence. This was a limiting assumption consistent with closure plans for U-3ax/bl. The current cover design is for a 3-m (10-ft) monolayer ET cover, consistent with the Area 3 RWMS PA/CA (NSTec, 2007a). The Area 3 RWMS PA and CA assumptions continue to be consistent with the closure plans.

The 1998 Area 5 RWMS PA assumes that the site will be closed with a 2.4-m (8-ft) vegetated monolayer ET cover. This was a limiting assumption consistent with the operational covers that were installed when the PA was prepared. After 100 years of active institutional control, the integrity of the cover is assumed to degrade by erosion and subsidence. The 2006 Area 5 RWMS PA update and the Area 5 RWMS v4.102 GoldSim model assume that a 4-m (13-ft) thick closure cover, consistent with the Area 5 RWMS DAS requirements, will be installed.

The Interim Closure and Monitoring Plan (BN, 2005) was updated in FY 2008 with publication of the *Closure Plan for the Area 5 Radioactive Waste Management Site at the Nevada Test Site* (NSTec, 2008a). Closure of the Area 5 RWMS is planned in two phases with the 37-hectare (ha) (92-acre [ac]) Low-Level Waste Management Unit (LLWMU) closing in FY 2011 and the Northern Expansion Area closing in FY 2028. The engineering design for the 37-ha (92-ac) LLWMU closure cover is for a 3-m (9.8-ft) monolayer ET cover. The thinner cover is based on preliminary optimization studies which indicate that all regulatory requirements can be met while maintaining doses as low as reasonably achievable (ALARA). The final optimization results are expected in FY 2009. Construction of the optimized cover is contingent on publication and acceptance of the final optimization report by NNSA/NSO. A thinner closure cover will require updating the Area 5 RWMS PA model and updating PA results.

2.1.7 Updated PA Results for FY 2008

Revised PA models and inventories were issued for the Area 5 RWMS in FY 2008. The new models and inventories were used to update the Area 5 RWMS PA results. The Area 3 RWMS was in standby mode during FY 2008. The Area 3 RWMS inventory and PA model was not modified in FY 2008.

2.1.7.1 PA Results for the Area 3 RWMS

The Area 3 RMWS PA results were not updated in FY 2008. The FY 2006 results are still considered valid because no changes have occurred for the inventory and PA model (NSTec, 2007b). The FY 2006 results showed increases over the PA results and concluded that a PA update is needed.

2.1.7.2 PA Results for the Area 5 RWMS

The FY 2008 Area 5 RWMS inventory was analyzed using the Area 5 RWMS v4.102 GoldSim model to assess the continuing validity of PA conclusions. The geometric mean inventory and standard deviation data listed in Tables 9 through 11 were entered into the inventory elements for the SLB units, Pit 6, Pit 13, and GCD, respectively. The disposal unit area, disposal unit volume, and waste volumes were updated with FY 2008 data. All SLB disposal units were assumed to be closed with a 4-m (13-ft) thick cover. The model was run assuming an approximately 250-year median period of active institutional control, a 100-year period of passive institutional control, and a 1,000-year compliance period. The model was run in GoldSim version 9.6 with 5,000 LHS realizations.

The results for the FY 2008 inventory indicate that there is reasonable assurance of compliance with the member of public performance objectives (Table 12). The mean and 95th percentile for the atmospheric pathway for all scenarios is less than the 0.1 millisieverts per year (mSv yr^{-1}) limit. The mean and 95th percentile for the all-pathways scenarios are less than the 0.25 mSv yr^{-1} performance objective (Table 13). Each scenario shows minor increases or decreases reflecting the changing radionuclide composition of the inventory.

Table 12. Area 5 RWMS v4.102 GoldSim Model Member of Public TEDE Through the Air Pathway

Exposure Scenario	Mean (mSv yr^{-1})	95th Percentile (mSv yr^{-1})	Time of Maximum
Transient Visitor	3.6E-6	NA	100 years
Resident	2.1E-6	4.8E-6	1,000 years
Resident Farmer	2.8E-6	6.5E-6	1,000 years
Open Rangeland (Cane Spring)	2.1E-9	NA	100 years
Open Rangeland (NTS Boundary)	2.9E-8	NA	100 years

NA – not available, insufficient realizations to calculate 95th percentile

Table 13. Area 5 RWMS v4.102 GoldSim Model Member of Public TEDE Through All Pathways

Exposure Scenario	Mean (mSv yr^{-1})	95th Percentile (mSv yr^{-1})	Time of Maximum
Transient Visitor	8.4E-4	1.9E-3	1,000 years
Resident	3.4E-5	8.5E-5	1,000 years
Resident Farmer	2.7E-3	7.2E-3	1,000 years
Open Rangeland (Cane Spring)	6.8E-4	NA	100 years
Open Rangeland (NTS Boundary)	7.1E-4	NA	100 years

NA – not available, insufficient realizations to calculate 95th percentile

The mean and 95th percentile ^{222}Rn flux density is less than the 0.74 Becquerel per square meter per second (Bq m^{-2} s^{-1}) performance objective averaged over the entire site (Table 14). The same is true for all virtual disposal units, except for Pit 13, where the 95th percentile ^{222}Rn flux density exceeds the performance objective. The ^{222}Rn flux densities for the Pit 6 and Pit 13 RaDUs decreased significantly in FY 2008, due to updating of the PA model with as-built inventories and cover thicknesses. Previous model versions used estimated inventories and conceptual designs. The decrease for the RaDUs causes a decrease in the flux density averaged over the entire site.

Table 14. Area 5 RWMS v4.102 GoldSim Model Rn-222 Flux Density Results

Disposal Unit	Mean (Bq m^{-2} s^{-1})	95th Percentile (Bq m^{-2} s^{-1})	Time of Maximum
All	0.030	0.061	1,000 years
SLB	0.026	0.055	1,000 years
Pit 6 RaDU	0.014	0.029	1,000 years
Pit 13 RaDU	0.24	0.82	1,000 years
GCD	3.4E-9	9.8E-9	1,000 years

The mean of the probability weighted intruder total effective dose equivalent (TEDE) is less than the 1 mSv performance objective for the postdrilling and intruder-agriculture scenarios (Tables 15 and 16). The 95th percentile of all scenarios is less than the performance objective. Results for the Pit 6 and Pit 13 RaDUs show significant decreases due to use of the as-built data.

Table 15. Area 5 RWMS v4.102 GoldSim Model Postdrilling Intruder TEDE Weighted by the Probability of Occurrence

Disposal Unit	Mean (mSv)	95th Percentile (mSv)	Time of Maximum
SLB	8.6E-3	0.017	800 years
Pit 6 RaDU	7.1E-4	1.9E-3	1,000 years
Pit 13 RaDU	1.3E-3	3.0E-3	1,000 years
GCD	3.3E-7	1.0E-6	1,000 years

Table 16. Area 5 RWMS v4.102 GoldSim Model Intruder-Agriculture TEDE Weighted by the Probability of Occurrence

Disposal Unit	Mean (mSv)	95th Percentile (mSv)	Time of Maximum
SLB	0.063	0.23	1,000 years
Pit 6 RaDU	1.1E-5	3.1E-5	1,000 years
Pit 13 RaDU	2.4E-4	9.3E-4	1,000 years
GCD	1.3E-10	NA	100 years

NA – not available, insufficient realizations to calculate 95th percentile

The Area 5 RWMS GoldSim model, version 4.102, includes acute drilling and construction intruder scenarios. The acute drilling scenario estimates the dose to drillers drilling a water well through a disposal unit. The acute construction scenario estimates the dose to a construction crew building a home with a basement on a disposal unit. The acute drilling scenarios were added to the model in FY 2008 because new NNSA/NSO land use plans were judged to decrease the likelihood of chronic intrusion. The acute intrusion scenarios do not consider the probability of occurrence. The mean and 95th percentile acute intruder doses are less than the 5 mSv dose limit for both scenarios at all virtual disposal units (Tables 17 and 18).

Table 17. Area 5 RWMS v4.102 GoldSim Model Acute Drilling Intruder TEDE

Disposal Unit	Mean (mSv)	95th Percentile (mSv)	Time of Maximum
SLB	3.3E-3	3.3E-3	800 years
Pit 6 RaDU	0.024	0.048	1,000 years
Pit 13 RaDU	0.025	0.032	1,000 years
GCD	0.013	0.038	1,000 years

Table 18. Area 5 RWMS v4.102 GoldSim Model Acute Construction Intruder TEDE

Disposal Unit	Mean (mSv)	95th Percentile (mSv)	Time of Maximum
SLB	3.2E-3	7.3E-3	1,000 years
Pit 6 RaDU	8.4E-3	0.019	1,000 years
Pit 13 RaDU	0.022	0.079	1,000 years
GCD	8.9E-7	NA	100 years

NA – not available, insufficient realizations to calculate 95th percentile

The FY 2008 PA results show changes relative to the FY 2007 results reflecting changes to the inventory estimates and model assumptions. The changes are relatively minor, except for the ^{222}Rn flux density and intruder results for the Pit 6 and Pit 13 RaDUs. These results show significant decreases reflecting a decrease in the Pit 6 upper cell inventory, a decrease in the Pit 13 RaDU inventory, and an increase in the Pit 13 RaDU cover thickness occurring with the use of as-built data. All results indicate that there is still a reasonable assurance of meeting all performance objectives. Therefore, the Area 5 RWMS PA results are still considered valid and no need to revise the PA is identified.

Comparison of the FY 2008 results with the 2006 PA update indicates that results have decreased in every category. Therefore, no update of the Area 5 RWMS PA is required.

2.2 MONITORING AND RESEARCH AND DEVELOPMENT RESULTS

2.2.1 Monitoring

Monitoring activities at the Area 3 and 5 RWMSs and at the NTS provide the data necessary to support PA and CA maintenance. The *Nevada Test Site Routine Radiological Environmental Monitoring Plan* (BN, 2003) is the basis for all NTS-wide environmental surveillance, site-specific effluent monitoring, and operational monitoring conducted by various missions, programs, and projects on the NTS. Closure and Monitoring Plans for the Area 3 RWMS and Area 5 RWMS (NSTec, 2007a; 2008a) describe the specific monitoring programs for the waste disposal facilities at the NTS. The program for the RWMSs includes the following monitoring elements:

- Vadose Zone Monitoring
- Groundwater Detection Monitoring (Area 5 RWMS only)
- Radon Monitoring
- Meteorology Monitoring
- Direct Radiation Monitoring
- Biota Monitoring
- Subsidence Monitoring
- Air Monitoring
- Soil Temperature Monitoring around RTGs

The following four reports, published annually, contain details regarding the monitoring program and results:

- *Nevada Test Site Environmental Report* (NSTec, 2008c)
- *National Emissions Standards for Hazardous Air Pollutants Report* (NSTec, 2008d)
- *Waste Management Monitoring Report* (NSTec, 2008e)
- *Area 5 Groundwater Monitoring Report* (NSTec, 2009*)*

Monitoring activities are summarized in Table 19.

Table 19. Summary of Area 3 and Area 5 RWMS Monitoring Programs

Monitoring Element	Area 3 RWMS	Area 5 RWMS
Vadose Zone Monitoring	• Measurements of soil water content in waste disposal unit cover • 8 drainage lysimeters for water balance since 2001	• Measurements of soil water content and water potential in waste disposal unit covers • Measurements of soil water content in waste disposal unit floor • Two weighing lysimeters (vegetated and bare) for water balance in operation since 1994
Groundwater Monitoring	• None	• Resource Conservation and Recovery Act detection monitoring at three wells
Radon Monitoring	• Radon flux measurements from waste covers (various locations)	• Radon flux measurements from waste covers (various locations)
Meteorology Monitoring	• Air temperature at 3 and 10 m (10 and 33 ft) • Relative humidity at two heights • Wind speed at two heights • Wind direction at two heights • Barometric pressure • Solar radiation • Precipitation	• Air temperature at two heights • Relative humidity at two heights • Wind speed at two heights • Wind direction at two heights • Barometric pressure • Solar radiation • Precipitation
Direct Radiation Monitoring	• Nine thermoluminescent dosimeters (TLDs)	• Ten TLDs
Biota Monitoring	• Sampling vegetation for tritium	• Sampling vegetation for tritium
Subsidence Monitoring	• Routine inspection of operational covers	• Routine inspection of operational covers
Air Monitoring	• Air particulates sampled at four locations; atmospheric moisture sampling for tritium at two locations	• Air particulates sampled at two locations; atmospheric moisture sampling for tritium at two locations
Soil Temperature Monitoring around RTGs	• None	• Vertical and horizontal sensor arrays

2.2.1.1 Vadose Zone Monitoring

Vadose zone monitoring is conducted at the Area 3 and Area 5 RWMSs to confirm the key assumption of no downward pathway, to detect changes in system performance, to assess and update parameters for the PA models, and to establish baseline data for long-term monitoring. Vadose zone monitoring data continue to confirm the conceptual models used in the Areas 3 and 5

PA/CAs. Calendar year 2007 was slightly drier than average with annual precipitation totals for Areas 3 and 5 that were approximately 86 to 95 percent, respectively, of their long-term averages.

Two locations in Area 3 are instrumented with vadose zone monitoring sensors: (1) the closure cover of U-3ax/bl, and (2) a drainage lysimeter facility (Figure 5). U-3ax/bl is instrumented with time-domain reflectometers (TDRs) for volumetric water content measurements. Sensors are located approximately every 0.3 m (1 ft) to a depth of 2.44 m (8 ft) at four locations within the cover. Due to the drier than average conditions, the U-3ax/bl TDR data from calendar year 2007 indicate soil water contents were at baseline values (~10 percent) for the majority of the year with only one wetting front penetrating more than 0.3 m (1 ft).

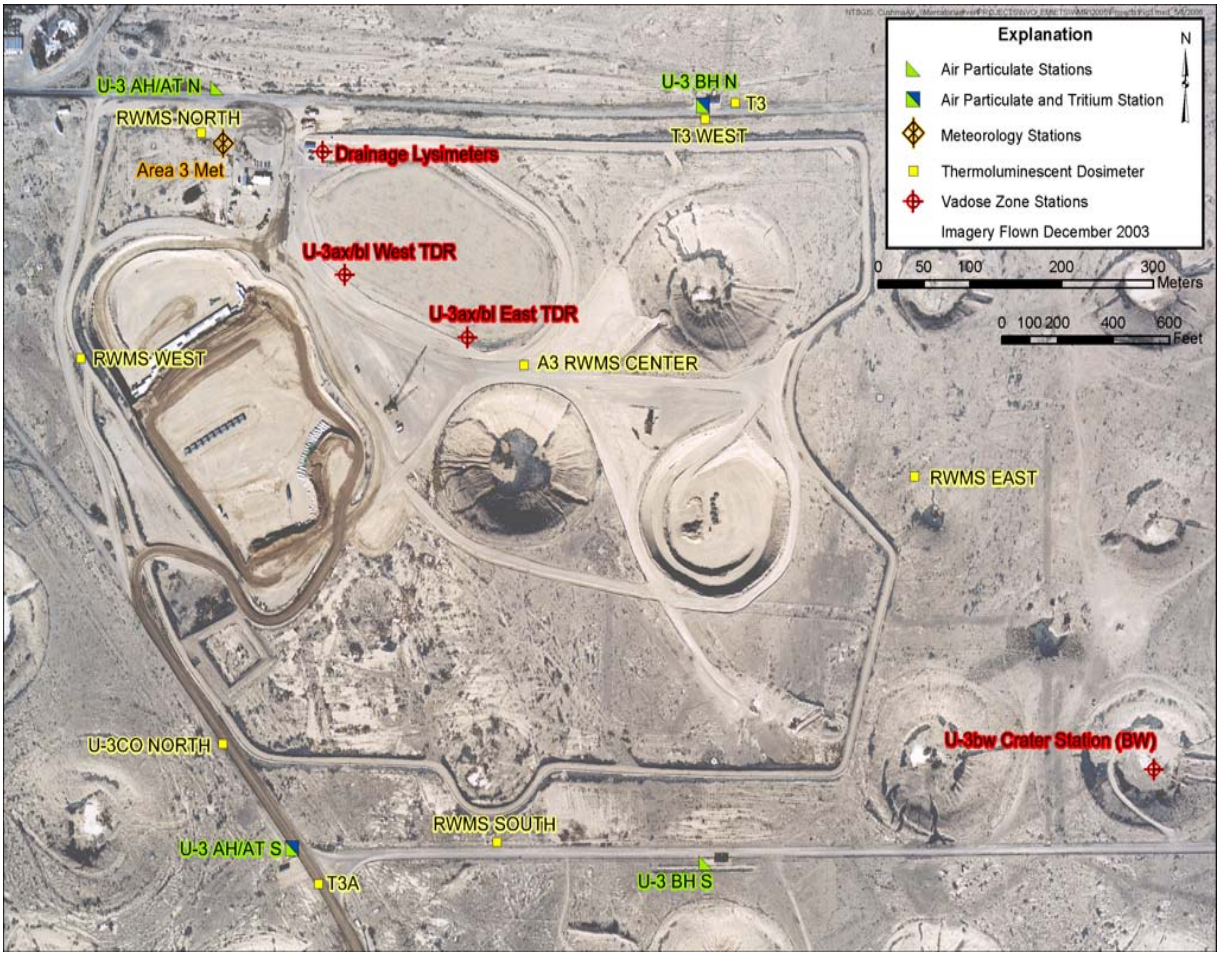

Figure 5. Monitoring Stations at the Area 3 Radioactive Waste Management Site

The Area 3 drainage lysimeters are instrumented with TDRs and heat dissipation sensors to measure matric potential. The Area 3 drainage lysimeter is used to conduct ET cover research. Currently, research is being conducted to assess the performance of ET covers under enhanced precipitation by applying irrigation to one-half of the paired lysimeters to achieve a three-times natural precipitation treatment.

Three operational covers, one pit floor, and two weighing lysimeters are instrumented in Area 5 (Figures 6 and 7). The ten-year vegetated lysimeter data set was used to calibrate a vadose zone flow model. Model simulations are consistent with the conceptual model that there is no downward pathway under vegetated conditions (Desotell et al., 2006). Pit cover TDRs continue to indicate dry conditions with volumetric water contents of approximately 12 percent throughout calendar year 2007. The volumetric water content of the floor of Pit 5 was approximately 10 percent throughout the year with no indication of infiltration. Calendar year 2007 weighing lysimeter data show shallow wetting fronts under vegetated conditions, similar to those observed in the U-3ax/bl cover.

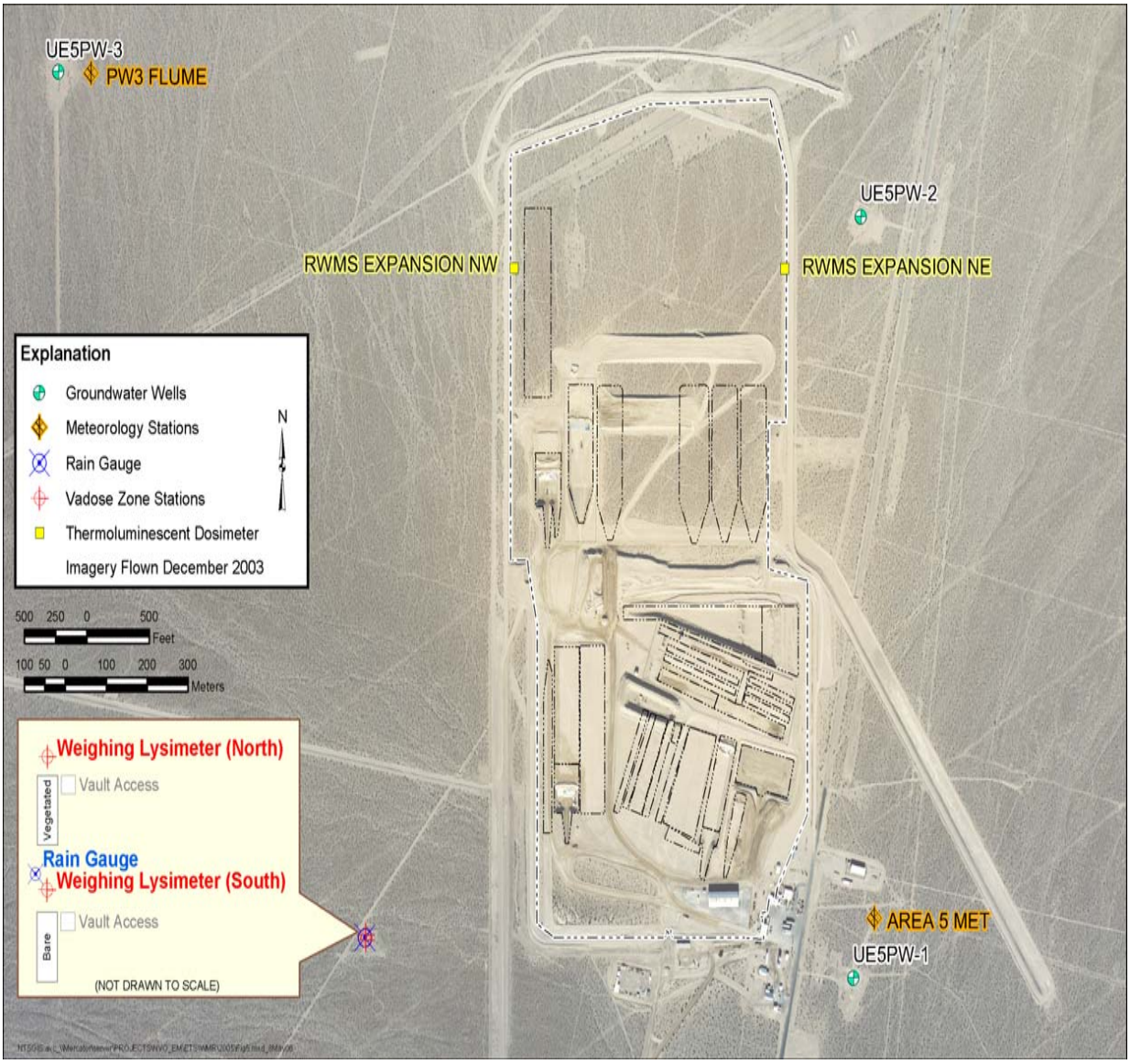

Figure 6. Location of the Area 5 RWMS Pilot Wells and Weighing Lysimeter Facility

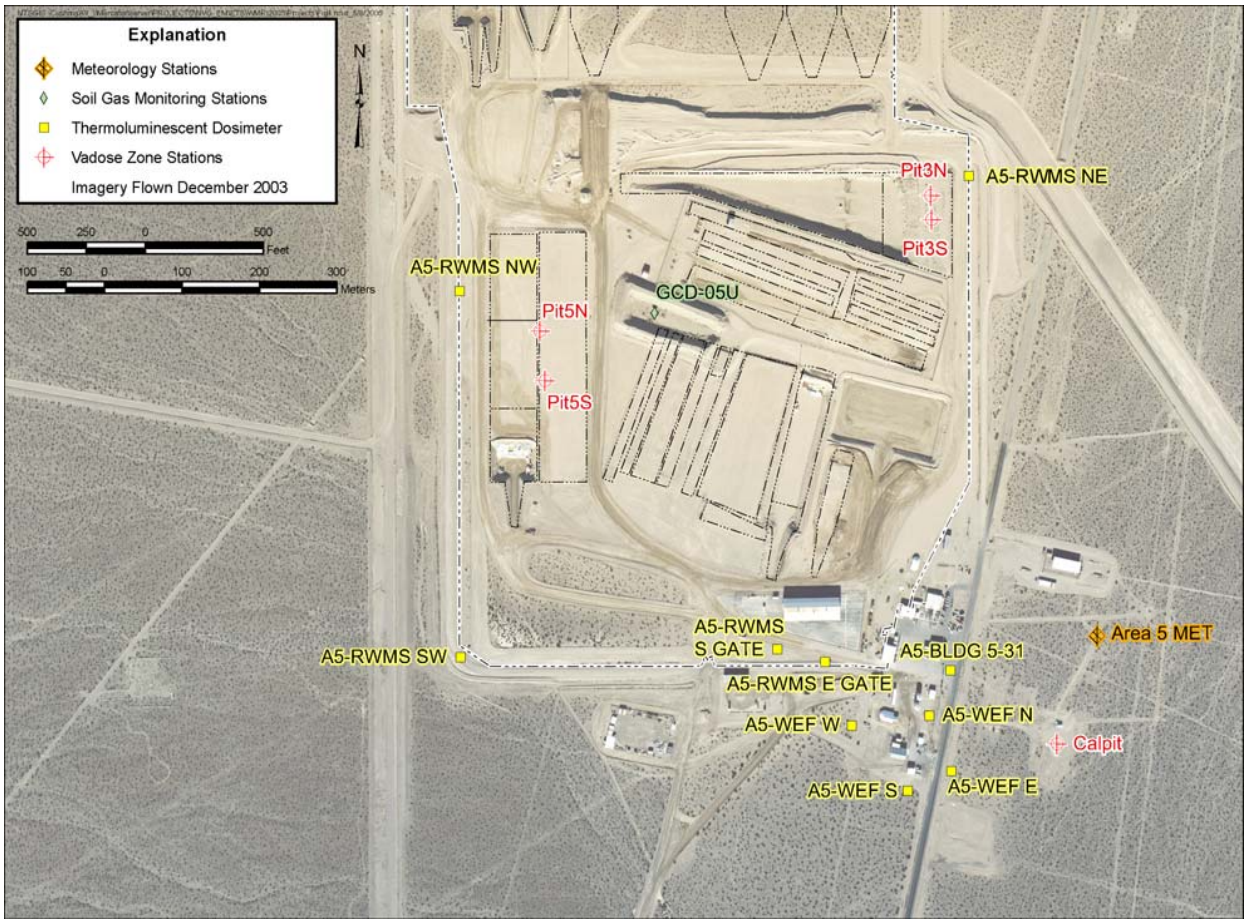

Figure 7. Monitoring Stations at the Area 5 Radioactive Waste Management Site

2.2.1.2 Groundwater Monitoring

Groundwater monitoring has been conducted for a suite of radiological and chemical constituents at the three wells surrounding the Area 5 RWMS since 1993 (Figure 6). In calendar year 2008 all wells were sampled two times for indicators of contamination (i.e., pH, specific conductance, total organic carbon, total organic halides, and tritium) and general water chemistry parameters. All analytical data continue to indicate that there is no measureable impact of Area 5 RWMS operations on the uppermost aquifer. Additionally, elevation measurements taken at the three wells surrounding the RWMS, as well as nearby locations, indicate the uppermost aquifer is approximately 235 m (771 ft) below ground surface and the water table is essentially flat, with very low groundwater velocities.

Groundwater is not monitored at the Area 3 RWMS. Because of the great depth to the water table (~490 m [1,607 ft] below ground surface) and negligible chance of recharge, a groundwater monitoring waiver was granted by the State of Nevada for the mixed waste disposal unit U-3ax/bl, located within the Area 3 RWMS.

2.2.1.3 Radon Monitoring

Radon flux monitoring has been conducted at various locations within the Area 3 and Area 5 RWMSs since 2000. In calendar year 2007, ^{222}Rn flux density was monitored at the Area 3 RWMS U3-ax/bl cover, the Area 5 RWMS Pit 1 (P01U) cover, and at background control sites. U-3ax/bl and Pit 1 are the disposal units at each RWMS with the expected highest present-day ^{222}Rn flux. All results were a small fraction of the 0.74 Bq m^{-2} s^{-1} flux density limit. The Area 5 RWMS Pit 1 flux density was less than measured at the control site. The 2007 U-3axbl flux measurements were lower than observed in 2006, but still greater than the control site. All results are generally consistent with PA results that project negligible ^{222}Rn flux at closure.

2.2.1.4 Meteorology Monitoring

Detailed meteorological data are collected at both the Area 3 and Area 5 RWMSs (Figures 5 and 7). Measurements include precipitation, air temperature, relative humidity, wind speed and direction, barometric pressure, and incoming solar radiation. These are the basic meteorological parameters required to quantify the exchange of water and heat between the soil and atmosphere. Meteorological measurements are taken to (1) confirm that the RWMSs are sited in arid environments, (2) be used as input in process level models, and (3) refine PA/CA parameter distributions. Onsite meteorological data were recently used in process level water balance modeling for the Area 5 RWMS (Desotell et al., 2006). Long-term data are being compiled to refine the wind speed distributions used in the PA/CA models. In calendar year 2007, precipitation totals were below average, totaling 13.7 centimeters (cm) (5.4 inches [in.]) and 12.4 cm (4.9 in.) in Areas 3 and 5, respectively. Potential ET to precipitation ratios for 2007 are 11.8 and 12.9 for Areas 3 and 5, respectively.

2.2.1.5 Direct Radiation Monitoring

Exposure rates measured by thermoluminescent dosimeters (TLDs) indicate that annual exposures at the Area 5 RWMS are within the range of exposures measured at NTS background locations. The Area 3 RWMS is located within 400 m (1,300 ft) of 14 historic atmospheric nuclear weapons tests. These tests left radioactive surface soil contamination and therefore elevated radiation exposures across the area. During disposal operations, waste is covered with clean soil. The use of clean cover material has resulted in lowering TLD readings within the Area 3 RWMS to background levels.

2.2.1.6 Biota Monitoring

Biota sampling was conducted at the Area 3 RWMS, Area 5 RWMS, and control sites in August 2007. Plant, small mammal, and soil spoils from ant and mammal burrows were collected.

Plants, animals, and soils at the Area 3 RWMS had elevated levels of all analytes relative to the control site. Tritium was significantly elevated relative to other analytes, which were slightly elevated above control levels. The elevated ^{3}H levels are consistent with PA conceptual models and results, which expect ^{3}H to be rapidly released from the site. The slightly elevated levels of activation product, fission product, and transuranic radionuclides are thought to be due to the widespread presence of soil contamination from above- and below-ground nuclear testing conducted in Area 3.

Elevated levels of ^{3}H were detected in Area 5 RWMS plant and animal samples. All other analytes were indistinguishable from control levels. Soils excavated by animal burrowing were at control levels indicating that the animals had not intruded into buried waste.

A survey of animal burrowing was conducted in calendar year 2007 at U-3ax/bl and the Area 5 RWMS. Small mammal burrows were found uniformly distributed over the U-3ax/bl cover at a density of approximately 59 ha^{-1} (146 ac^{-1}), or an order of magnitude less than assumed in the Area 3 RWMS PA GoldSim model. Small mammals have been trapped and removed from the U-3ax/bl cover since 2005 at the request of the Nevada Division of Environmental Protection. Animal burrowing at the Area 5 RWMS is less frequent and less uniformly distributed. The lower animal burrow density at the Area 5 RWMS is thought to be due to the lack of vegetation on covers. Burrowing is concentrated on the side slopes of operational covers and much more frequent on older disposal units.

2.2.1.7 Subsidence Monitoring

Subsidence has been formally monitored since 2000. Subsidence occurs most commonly in recently filled disposal units, especially along the edges where soil backfill may not be completely compacted. Subsided areas are repaired and documented. Prediction of the timing and magnitude of subsidence because of container collapse continues to be an area of high uncertainty where more research is needed. No large subsidence events occurred in calendar year 2007.

2.2.1.8 Air Monitoring

Air particulate samples are collected at the Area 3 and Area 5 RWMSs. Results indicate that elevated levels of plutonium-239 plus plutonium-240 ($^{239+240}Pu$) are present at the Area 3 RWMS. The source of plutonium is likely the nearby soil contamination areas created by atmospheric nuclear weapons tests. The mean concentration for $^{239+240}Pu$ in calendar year 2007 ($\sim 3.7 \times 10^{-7}$ Becquerels per cubic meter [Bq m^{-3}]) is less than any level of public concern. Measured concentrations of airborne plutonium at the Area 3 RWMS are consistent with CA model calculations of resuspension from contaminated soils sites in Yucca Flat.

Air particulate data collected at the Area 5 RWMS are consistent with the screening analyses conducted for the Area 5 CA, which concluded that the contaminated soil sites in Frenchman Flat and the Area 5 RWMS are not interacting sources. The Frenchman Flat soil sites are therefore not included in the CA.

Tritium in air data are collected at the Area 3 and Area 5 RWMSs. The mean airborne ^{3}H activity concentration in calendar year 2007, 0.04 Bq m^{-3}, is a small fraction of the derived concentration guide. The concentration shows slight variation during the year, increasing slightly from May through November when ET is at its highest. These data could be used in conjunction with modified PA models to evaluate the accuracy of tritium migration predictions.

2.2.1.9 Soil Temperature Monitoring Around RTGs

Four ^{90}Sr RTGs were disposed in P05U on September 27, 2007, with conditions on the spacing between adjacent RTGs, the distance to low-level waste, and the depth of burial. The disposal conditions were set to control temperatures on the surface of the RTGs, in adjacent low-level waste, and in the plant root zone. Vertical and horizontal arrays of temperature sensors were installed every 0.3 m (1 ft) to a distance of 4 m (13 ft) adjacent to the largest curie inventory RTG package. Hourly average temperature measurements were collected.

Data collected in FY 2008 indicate that temperatures continue to slowly increase with a maximum temperature in contact with the RTG of 99.8 degrees Celsius (211 degrees Fahrenheit). Near-surface (i.e., < 2 m [6.6 ft]) soil temperature and temperature in adjacent low-level waste has not been significantly impacted by RTG heat production. Although the disposal conditions appear sufficient to control heat effects, measured temperatures differ systematically from modeled temperatures. Temperature monitoring data will be used in FY 2009 to revise the estimate of the thermal conductivity of alluvium.

2.2.2 Research and Development

The PA/CA Maintenance Plan calls for annual reviews of R&D activities relevant to the PA. Results of both onsite and offsite R&D activities (e.g., those performed at other DOE sites, the national laboratories, the Desert Research Institute, and academic institutions) provide the data necessary to manage uncertainty in conceptual models, mathematical models, model parameters, and evaluation scenarios of the PA and to assure continuing adequacy of the PA.

The DASs require NNSA/NSO to address all secondary issues (e.g., consistency of models and parameters between the Area 3 and 5 RWMSs) noted during the PA/CA reviews as part of the maintenance program. R&D is the mechanism for NNSA/NSO to address these issues and manage uncertainty.

2.2.2.1 Fiscal Year 2008 Research and Development Activities

The major R&D efforts undertaken in FY 2008 were the continuation of the development of the Area 5 RWMS PA and Area 5 RWMS inventory GoldSim models. These are summarized below.

Area 5 RWMS PA GoldSim Model Development

The FY 2008 PA update was performed with the Area 5 RWMS v4.102 PA model. Version 4.102 was approved by NNSA/NSO for all model applications, including waste stream evaluations and compliance determinations (NNSA/NSO, 2009). Major developments since version 4.004 of the model include the following:

- All inventories are updated to FY 2008 estimates.
- The P06UA/P06U and P13U RaDU disposal unit dimensions are revised to reflect as-built conditions.
- A residential exposure scenario without agriculture is included in the model.
- The residential exposure scenario is the compliance scenario for the CA.

- Drilling and construction acute intruder scenarios are included in the model.
- Replaced fixed beef, milk, poultry, and egg transfer factors with probability density functions.
- Added an ALARA optimization module to the model.
- The selenium distribution coefficient (Se K_d) value was corrected based on an error reported in the original published data source (Fuhrmann and Schwartzman, 2008).

Area 3 RWMS GoldSim Model Development

Version 2.0 is the current version of the model approved by NNSA/NSO for all model applications, including waste stream evaluations and compliance determinations, with the condition that the model should be run with subsidence for U-3ah/at disabled (NNSA/NSO, 2006b). The Se K_d value was corrected based on an error reported in the original published data source (Fuhrmann and Schwartzman, 2008). No new versions of the Area 3 RWMS model were approved in FY 2008.

Area 5 RWMS Inventory GoldSim Model Development

The Area 5 RWMS FY 2008 inventory estimate was prepared with the A5 Inventory v2.104 model. The changes to this model from the previous version include the following:

- Disposed waste records are updated with FY 2008 disposal data.
- The P13U inventory is partitioned into a SLB and RaDU portion.
- Pre-1988 waste inventory uncertainty distributions were changed from loguniform to lognormal.
- The future waste inventory uncertainty is increased to include characterization uncertainty. Previously, uncertainty in future waste concentration was limited to observed variability in the annual concentration of waste disposed in the past. The model now assumes that the annual concentration of waste disposed in the past has a characterization uncertainty equal to the lognormal uncertainty assumed for past waste disposals.

2.2.2.2 Fiscal Year 2009 R&D Activities

The current R&D activities include the following:

- Performing cover thickness optimization studies in support of design of the closure cover for the original Area 5 RWMS 92-acre disposal area
- Continuing development of the Area 3 RWMS GoldSim model
  - Subsidence will be further evaluated and the consequences of subsidence will be incorporated into the model with the addition of new values for transport and media parameters under subsided conditions when no cover maintenance takes place. The member of public compliance scenario developed for the Area 5 RWMS model will replace the current scenarios implemented in version 2.0 of the model. Acute intruder

scenarios will be added to the model to ensure consistency with the new institutional control policies (NNSA/NSO, 2007).

- Performing sensitivity analyses for the Area 3 RWMS GoldSim model

2.2.2.3 Fiscal Year 2010 R&D Activities

Activities beyond FY 2009 will focus on the following:

- Updating the models as more data or information become available
- Using the model to support future disposal, closure, monitoring, and research decisions
- Using sensitivity analysis to simplify the Area 5 RWMS GoldSim model
- Evaluating new and revised waste streams as they are proposed

The GoldSim models will continue to be used to evaluate PA results using revised closure inventories that include current disposals. Based on the results of the sensitivity analyses undertaken in FY 2009, new studies may be undertaken in future years to reduce the uncertainty of sensitive model parameters, if it is feasible to do so.

2.2.2.4 R&D Activities Beyond Fiscal Year 2010

The long-term goal of the maintenance program is to reduce uncertainty in exposure scenarios (member of public and inadvertent human intrusion), conceptual models, mathematical models, and model parameters. Reduction of uncertainty and associated improvement of the PA model will be accomplished through special studies. In addition, future R&D activities include the development of new waste concentration limits, evaluation of waste forms and containers (both engineering and geochemical properties) for disposal, the refinement of closure cover designs, and evaluation of institutional control and land-use options for optimizing disposal operations.

2.3 SUMMARY OF CHANGES

Waste operations, monitoring results, and R&D results for the Area 3 and Area 5 RWMSs have been reviewed to identify changes potentially impacting the PA and the DAS. Waste operations changes required to ensure continuing compliance with the DAS have also been identified.

2.3.1 Proposed Changes

In FY 2008, NNSA/NSO formalized an institutional control policy to maintain land-use restrictions based in UGTA groundwater impacts. The Area 5 RWMS PA GoldSim model was revised to include acute intrusion scenarios in response to the new institutional control policy.

The Area 3 RWMS has been inactive since FY 2006. Therefore, no significant operational changes occurred for the Area 3 RWMS in FY 2008. Operational changes for the Area 5 RWMS include inventory changes and a decrease in the planned closure cover thickness. All of the noted changes are implemented in the Area 5 RWMS PA model, except for the new closure cover thickness.

The monitoring and R&D programs are largely unchanged from previous years. Results from monitoring and R&D are consistent with previous results and continue to support PA conceptual models.

Conditions on the disposal of four RTG waste streams were stipulated based on the results of special analyses. The conditions, which specified the disposal geometry, were set to control heat generation. The four RTG waste streams were disposed and the conditions implemented in FY 2008.

2.3.2 Discovered Changes

The only discovered change in FY 2008 was a change in the reported value of the Se K_d based on an error reported in the literature. The Area 3 RWMS and Area 5 RWMS PA GoldSim models were revised with the correct value. Model sensitivity analyses have never shown this parameter to be important and the change is expected to have a negligible effect on PA results.

2.4 RECOMMENDED CHANGES

Changes requested by waste operations or waste generators are tested with the PA models before they are implemented. If the changes are acceptable, inventory and PA models are revised to reflect the new conditions. Similarly, PA models are revised as new results from environmental monitoring or R&D programs are identified and confirmed. Occasionally, PA results may set conditions for waste operations or require changes to the monitoring plan.

Operational changes occurring in FY 2008 remain to be implemented in PA models. The Area 3 RWMS PA GoldSim model should be revised to include acute intrusion scenarios to reflect the new institutional control policies. The Area 5 RWMS PA GoldSim model should be revised to use the proposed thinner cover thickness pending review and acceptance of the cover optimization study in FY 2009.

None of the noted changes affect the PA maintenance plan, closure plans, or the monitoring plans. No changes are recommended for these planning documents.

There are no recommended changes to operations or monitoring based on PA results.

2.5 CONCLUSIONS

The most significant change at the Area 3 RWMS is the increased inventory since the approved PA in 1996 and its placement in inactive status. The site's conceptual model, important features, events, process, and site characteristics remain unchanged. The FY 2006 A3 RWMS v2.0 GoldSim model results indicate that there is still reasonable assurance of compliance with the performance objectives. Overall, the Area 3 RWMS PA's conclusions regarding compliance and important parameters and processes remain valid. A revision of the Area 3 RWMS PA is recommended to update the PA with GoldSim model results as well as with the latest estimate of the closure inventory.

Analysis of the current Area 5 RWMS inventory data with the Area 5 RWMS v4.102 GoldSim model indicates that there is reasonable assurance of compliance with all performance objectives. No significant changes have occurred since the preparation of the 2006 Area 5 RWMS PA update. The PA's conclusions continue to remain valid. Therefore, no new revision to the Area 5 RWMS PA is necessary.

3.0 COMPOSITE ANALYSIS

3.1 SOURCE TERMS

The assumptions and conceptual models of the CAs are compared with current conditions to assess three key questions:

1. Are changes to the CAs required?
2. Are the conclusions of the CAs still valid?
3. Are the disposal facilities in compliance with the CA dose constraint and all DAS conditions?

The CA includes the waste source terms evaluated in the PAs for the Area 3 and Area 5 RWMSs. The results and conclusions of the PA review described above are applicable to the review of the CAs. The following sections emphasize changes and results relevant to issues unique to the CA. Issues unique to the CA mostly concern the pre-1988 inventory of the RWMSs and sources of residual radioactive materials from Environmental Restoration (ER) sites that interact with the RWMSs. Review results for the RWMSs and ER sources are summarized below.

3.1.1 Radioactive Waste Management Sites

3.1.1.1 Waste Characteristics and Facility Design

There were no proposed or discovered changes for pre-1988 waste forms and containers or for facility design and operations at the Area 3 and Area 5 RWMSs in FY 2008. No special analyses relevant to pre-1988 wastes were performed.

There were no significant changes to the pre-1988 waste inventories for the Area 3 RWMS. The Area 3 RWMS CA inventory was estimated with the A3 Inventory v 2.010 model in FY 2006. The Area 5 RWMS CA inventory was estimated with the A5 Inventory v 2.104 model (see Section 2.0). The version 2.104 model was revised to replace the loguniform distribution describing uncertainty in activity of pre-1988 waste with a lognormal distribution. The new probability density function causes slight changes in the mean and standard deviation of the pre-1988 inventory.

3.1.1.2 Closure

The Area 3 RWMS PA/CA assumes that the site will be closed with a vegetated ET monolayer cover of native alluvium (Shott et al., 2001). The cover is assumed to be 3 m (10 ft) thick after subsidence. The U-3ax/bl disposal unit was closed in FY 2001 with the installation of a monolayer alluvium cover. The existing 2.7-m (8.9-ft) operational cover was supplemented with an additional 0.3 m (1 ft) of soil and sloped to promote drainage off the cover. The installed cover is generally consistent with the CA assumption of a 3-m (10-ft) monolayer cover.

The Area 5 RWMS CA makes similar but slightly less conservative assumptions (BN, 2001b). The CA assumes that the cover is maintained for 100 years and public access is restricted for 250 years. The cover is assumed to be a monolayer ET cover, measuring 2 to 6 m (6 to 20 ft) thick.

The Area 3 and Area 5 closure plans (NSTec, 2007a; 2008a) remain consistent with the PA/CA assumptions. The current plans are to construct 3-m (10 ft) monolayer-ET closure covers at both sites. This remains consistent with existing CA assumptions.

3.1.2 Underground Testing Areas

The CAs for the Area 3 and Area 5 RWMSs assumed that land-use restrictions can control exposure of the public to groundwater contamination from UGTAs on the NTS. In FY 2008, the NNSA/NSO implemented a formal policy to implement and maintain the UGTA land-use restrictions.

The results of the flow and transport model that will simulate alternative forecasts of the 1,000-year groundwater contaminant boundaries for Yucca Flat are not expected until FY 2020. The Area 3 RWMS CA assumptions are still consistent with current plans for the Yucca Flat CAU. Site characterization studies are continuing to estimate the current and expected extent of groundwater contamination from the underground testing in Frenchman Flat. The Frenchman Flat CAU flow and transport model will be submitted in late FY 2009 for review and approval by the Nevada Department of Environmental Protection prior to public release. The Frenchman Flat Corrective Action Decision Document is not expected until FY 2011. Therefore, the Area 5 RWMS CA is still consistent with the existing plan to manage the Frenchman Flat UGTA.

3.1.3 Soil Sites

The CAs assume that the NTS Soil Sites will not be remediated. No Soil Sites considered in the CAs have been characterized or remediated since completion of the CAs. The closure of Soil Sites is currently awaiting a regulatory determination of appropriate cleanup levels. Therefore, the results of the CAs remain valid and provide bounding estimates of site performance.

3.1.4 Industrial Sites

The CAs assume that the impact of the Industrial Sites is insignificant compared with the Soil Sites. No Industrial Sites have been characterized or remediated that impact interacting sources in Frenchman Flat or Yucca Flat since preparation of the CAs. Therefore, the CA assumptions remain unchanged.

3.2 UPDATED CA RESULTS

The Area 5 RWMS CA results were updated with the A5 RWMS v4.102 GoldSim model. The model was run as described for the PA, except that the model was placed in CA mode. A slight decrease is observed for the dose at the Area 5 RWMS boundary (Table 20). The mean and 95th percentile doses are significantly less than the 0.3 mSv dose constraint. Therefore, the Area 5 RWMS CA results are still considered valid.

Table 20. Area 5 RWMS v4.102 GoldSim Model CA All Pathways Result for a Resident at the Area 5 RWMS.

Disposal Unit	Mean (mSv yr^{-1})	95th Percentile (mSv yr^{-1})	Time of Maximum
All	1.0E-4	3.4E-4	1,000 years

3.3 MONITORING AND R&D RESULTS

3.3.1 Monitoring

The monitoring activities discussed in Section 2.2.1 also pertain to the CAs. As discussed in Section 2.2.1, the results of environmental monitoring across the NTS are reported annually in the Annual Site Environmental Report and National Emissions Standards for Hazardous Air Pollutants reports (NSTec, 2008c; 2008d). Tritium and $^{239+240}$Pu are the only man-made radionuclides routinely detected at the Area 3 RWMS at slightly elevated levels. The source of the $^{239+240}$Pu is believed to be the former atmospheric testing sites throughout Yucca Flat, including ground zeros in the immediate vicinity of the RWMS. The mean result for 2007 was 3.7×10^{-7} Bq m^{-3}. This is consistent with previous results and the CA model estimated $^{239+240}$Pu concentration of 7×10^{-6} Bq m^{-3}. Results of the CA resuspension and dispersion models for plutonium are consistent with environmental monitoring results.

3.3.2 Research and Development

No R&D activities in FY 2008 have had results that might impact the CA results and conclusions. The discussions of the R&D activities in Section 2.2.2 for PAs are also pertinent for CAs.

3.4 SUMMARY OF CHANGES

3.4.1 Proposed Changes

In FY 2008, NNSA/NSO formalized an institutional control policy to maintain land-use restrictions based in UGTA groundwater impacts. The new institutional control policy strengthens CA assumptions, but requires no changes to the CA models.

The Area 3 RWMS has been inactive since FY 2006. Therefore, no significant operational changes occurred for the Area 3 RWMS in FY 2008. Operational changes for the Area 5 RWMS include slight changes in the estimates of the pre-1988 SLB inventory and a decrease in the planned closure cover thickness. All of the noted changes are implemented in the Area 5 RWMS CA model, except for the new closure cover thickness.

The monitoring and R&D programs are largely unchanged from previous years. Results from monitoring and R&D are consistent with previous results and continue to support CA conceptual models.

3.4.2 Discovered Changes

The only discovered change in FY 2008 was a change in the reported value of the Se K_d based on an error reported in the literature. The Area 3 RWMS and Area 5 RWMS CA GoldSim

models were revised with the correct value. Model sensitivity analyses have never shown this parameter to be important, and the change is expected to have a negligible effect on CA results.

3.5 RECOMMENDED CHANGES

Changes requested by waste operations are tested with the CA models before they are implemented. If the changes are acceptable, inventory and CA models are revised to reflect the new conditions. Similarly, CA models are revised as new results from environmental monitoring or R&D programs are identified and confirmed. Progress in ER programs is reviewed for their impacts on CA assumptions and models. Occasionally, CA results may set conditions for waste operations or require changes to the monitoring plan.

Operational changes occurring in FY 2008 remain to be implemented in CA models. The Area 5 RWMS CA GoldSim model should be revised to use the proposed thinner cover thickness pending review and acceptance of the cover optimization study in FY 2009.

None of the noted changes affect the CA maintenance plan, closure plans, or the monitoring plans. No changes are recommended for these planning documents.

There are no recommended changes to operations or monitoring based on CA results through FY 2008.

3.6 SUMMARY

The reviews of the Area 3 and Area 5 RWMS inventories, the results of the monitoring and R&D activities, and land-use planning show that the assumptions in the CAs have not changed. The ER sources considered in the CA models remain unchanged for the Area 3 RWMS. The Area 5 RWMS CA showed that there was negligible interaction between the contaminated soil sites in Frenchman Flat and the RWMS. Therefore, the Area 5 RWMS CA model calculates the dose for a future member of public 100 m (330 ft) from the RWMS boundary and does not explicitly include the minor air pathways doses from ER soil sites. No new sources of contamination have been identified, and there is no new information that would reduce the uncertainty of the current sources. There have been no changes in FY 2008 that affect the conclusions of the CAs, as indicated by reviews of the disposal unit closure inventories, estimated inventories of the ER sources of residual radionuclides, the progress of the ER cleanup projects, land-use planning, and the results of the monitoring and R&D activities.

Current inventories have been analyzed with the new Area 5 RWMS CA model. The results indicate a high probability that the doses from all interacting sources are less than the 0.3 mSv dose constraint.

In conclusion, review of the Area 3 and Area 5 RWMS CAs indicates that the CA conclusions remain valid and that there is no need to revise the CAs at this time. Current CA models indicate there is a high likelihood that the Area 3 and Area 5 RWMS continue to meet the 0.3 mSv dose constraint.

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APPENDIX A

Checklist for Review of Annual Summary

This appendix summarizes the results of a review conducted to confirm that the annual summary contains all the information as required by the Low-Level Waste Disposal Facility Federal Review Group (LFRG) Program Management Plan.

Table A.1. Checklist for Review of Annual Summary

Requirement	Result
1.0 Key Questions *The annual summary for each disposal facility must provide information sufficient to evaluate three key questions about the PA for the facility:* *a. Does the annual summary information indicate that changes to the PA are required?*	Section 2.5 concludes that the Area 3 RWMS PA needs to be updated and that the Area 5 RWMS PA does not require revision.
b. Does the annual summary information indicate that the conclusions of the PA remain valid?	Section 2.5 concludes that the conclusions of the Area 3 and Area 5 RWMS PAs remain valid.
c. Does the annual summary information indicate that facility performance will remain within the PA limits imposed by the DOE Manual 435.1-1 performance objectives and any conditions in the facility DAS?	Section 2.5 concludes that the Area 3 and Area 5 RWMSs continue to meet all performance objectives based on PA model results using PA models updated with FY 2008 data.
2.0 Necessary Information *The information provided in the annual summary for each low-level waste disposal facility should include the following:* *a. Description of any changes affecting the PA. Does the annual summary indicate whether any changes affecting the PA have occurred? If so, are their effects on the PA adequately described?*	Changes occurring are described in Section 2.1 and summarized in Section 2.3. The effects of changes on PA results are described in Section 2.1.7.
b. Description of any PA ramifications of special analyses and reviews performed or proposed for the facility. Does the annual summary indicate whether any special analyses or reviews were performed? If so, are the ramifications for the PA adequately described?	Special analyses and their impacts are described in Section 2.1.3.1.
c. Description of any proposed changes in facility design or operations. Does the annual summary indicate whether any changes are proposed in facility design or operations? If so, are the effects of the proposed change on the PA adequately described?	Changes to facility designs and operations are discussed in Section 2.1.
d. Description of any corresponding changes required in the PA maintenance plan, the closure plan, and the monitoring plan. Does the annual summary indicate whether any corresponding changes are required in the plans? If so, are they adequately described?	Section 2.4 concludes that no changes are required for the maintenance plan, closure plan, or monitoring plan.
e. Description of any proposed changes in the PA. Does the annual summary indicate whether any changes to the PA are required? If so, are they adequately described?	Section 2.3.1 describes proposed changes to the PA model. Section 2.5 concludes that no changes to the PA are required.

Requirement	Result
2.1 Factors to be Addressed *The basic factors to be addressed in the annual summary and evaluated by the LFRG in reviewing the annual summary are operations, facility design, closure design, and research and development. More detailed descriptions of the information relevant to these basic factors are provided below. (For additional detail on the scope and level of detail expected for the topics, see Section 2.2 of the "Maintenance Guide for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments and Composite Analyses," November 10, 1999.)* *2.1.1 Operations Considerations* *Disposal unit consistency with the PA models (e.g., size and configuration of trenches, shafts, and pits; waste placement and configuration; thickness of operational backfill/cover). Does the annual summary adequately describe disposal unit consistency with the PA models?* *a. Waste receipts including description of form and packaging (especially special waste forms) and their consistency with PA analyses and projections. Does the annual summary adequately describe waste receipts and their consistency with PA analyses and projections?*	Waste receipts are described in Section 2.1.3. The impacts of waste receipts on PA results are described in Section 2.1.7.
b. Waste acceptance criteria including radionuclides significant to and evaluated in the PA, radionuclide concentration and quantity limits established, waste form and packaging requirements, and consistency with PA results. Does the annual summary adequately describe the WAC and their consistency with the PA results?	Section 2.1.5 describes the waste acceptance criteria.
c. Procedures and systems (e.g., verification of waste characteristics, inventory limit controls, generator certification) intended to prevent disposal of inappropriate wastes. Does the annual summary adequately describe procedures and systems?	The Radioactive Waste Acceptance Program is described in Section 2.1.5.
2.1.2 Facility Design Considerations *a. Disposal technology and facility configuration consistency with the PA analyses. Is the consistency adequately described?*	Consistency of facility configuration with PA analyses is described in Section 2.1.2.
b. Engineered barrier consistency with the PA. Is the consistency adequately described?	Consistency of the closure cover with PA analyses is described in Section 2.1.6.
c. Monitoring provisions appropriate for evaluation of facility performance. Are monitoring provisions adequately described?	The Monitoring Program is described in Section 2.2.1.
d. Operational controls to promote stability and to compensate for potential subsidence. Are operational controls adequately described?	Controls and monitoring of subsidence is described in Section 2.2.1.7.
2.1.3 Closure Design Considerations *a. Engineered barrier description including consistency of the closure cover design with PA analysis and threats to cover integrity and viability. Are engineered barriers adequately described?*	Consistency of the closure cover with PA analyses is described in Section 2.1.6.

Requirement	Result
b. Future land use plan consistency with PA assumptions. Is consistency of the land use plan with the PA assumptions adequately described?	Land-use plan consistency with PA assumptions is described in Section 2.1.4.
2.1.4 Research and Development Considerations *a. R&D efforts required by the facility disposal authorization statement. Are these efforts adequately described?*	R&D efforts required by the DAS are summarized in Section 1.1.
b. R&D efforts pursued for improving and refining the performance assessment. Are these efforts adequately described?	R&D efforts are described in Section 2.2.2.
c. Results of any confirmatory testing performed. Was any confirmatory testing performed? If so, are the results adequately described?	Confirmatory monitoring of site performance is described under monitoring in Section 2.2.1.
2.2 Changes *The changes that could cause divergence from the conditions used for the PA analysis should be categorized as discovered changes, proposed changes, or R&D changes and should be listed and described in the annual summary.* *[Note: This section of the review should focus on description of the changes (discovered, proposed, and R&D) and any effects of the changes not described in Section 2.2.]* *2.2.1 Discovered Changes* *The annual summary should report divergences from expected or planned conditions that have been <u>discovered</u> in facility operations, construction, site characteristics, and other conditions significant to facility performance. Specific information should address the baseline from which the divergence was identified, comparison of expected conditions to any available monitoring results, significance of the divergence as indicated by comparison to the four LFRG review thresholds (listed below), and incorporation of the changes in the performance assessment, if appropriate.* *The four LFRG review thresholds that trigger the review by the LFRG are* *a. an increase of 25 percent or more in the forecasted doses reported in the current, approved facility documentation or any violation of the performance objectives imposed by DOE Manual 435.1-1,*	Section 2.1.7 summarizes the FY 2008 PA results for the Area 3 and Area 5 RWMSs. Current PA results for the Area 3 RWMS, which have not been revised since FY 2006, indicate that model and inventory changes have caused increases in projected results and the a PA update is needed. All results continue to meet all performance objectives. Comparison of the FY 2008 Area 5 RWMS PA results with the approved PAs indicates that all results have decreased and continue to meet all performance objectives.
b. any change in the point of compliance as reported in the current approved facility documentation,	Changes to PA models are described in Section 2.2.2.1. No change in the point of compliance occurred in FY 2008.
c. any fundamental change in the analysis methodology or model used for the facility documentation, and	Changes to PA models are described in Section 2.2.2.1.
d. any fundamental change in the hydrologic or geologic parameters used in the facility analysis methodology or model.	Changes to PA models are described in Section 2.2.2.1. There are no major changes in hydrologic or geologic models.

Requirement	Result
2.2.2 Proposed Changes *a. The annual summary should identify divergences from expected or planned conditions that have been or will be voluntarily made by the facility operators to facility operations, facility construction, or other conditions significant to facility performance. Specific information should address the baseline from which the divergence is planned, comparison of current performance to performance expected after the change is made, significance of the divergence as indicated by comparison to the four LFRG review thresholds (listed in Section 2.4.1 above), and incorporation of the changes in the performance assessment, if appropriate. Does the annual summary report any proposed changes? If so, are they adequately described?*	Proposed changes are described in Section 2.3.1.
2.2.3 Research and Development Changes *a. The annual summary should include descriptions of research and development (both generic and site-specific) relevant to the PA analysis models and input data for them that are to be used to improve the conclusions of the PA. The annual summary should include a description of the significance of the improvements, when and how the anticipated improvements will be incorporated in PA modeling and analyses, and whether the improvements are expected to change the conclusions of the PA. Does the annual summary report any R&D changes? If so, are they adequately described?*	Proposed changes are described in Section 2.3.1. Changes to the PA models are described in Section 2.2.2.1.
3.0 Composite Analysis Summary *The annual summary for each disposal facility should provide the information required by the LFRG members and staff to evaluate whether the facility CA continues to satisfy the requirements of DOE M 435.1-1 and any additional conditions specified in the facility disposal authorization statement. The focus of the CA review will be on the interacting source terms relative to the performance goals established in DOE M 435.1-1 because the review of the facility PA is focused on the facility itself.* *a. Does the annual summary state that the conclusions of the CA remain valid? If so, does the annual summary state whether confidence in the conclusions has changed?*	Section 3.6 concludes that the Area 3 and Area 5 RWMS CAs remain valid and that there is a high likelihood of compliance with the 0.3 mSv dose constraint.
3.1 Key Questions *The annual summary for each disposal facility must provide information sufficient to evaluate three key questions about the composite analysis for the facility:* *a. Does the annual summary information indicate that changes to the CA are required?*	Section 3.6 concludes that no changes or revisions to the CAs are required.
b. Does the annual summary information indicate that the conclusions of the CA remain valid?	Section 3.6 concludes that the conclusions of the CAs remain valid.
c. Does the annual summary information indicate that the facility performance will remain within the CA performance goals provided in DOE Manual 435.1-1 performance goals and any conditions in the facility DAS?	Section 3.6 concludes that there is a reasonable expectation that the Area 3 and Area 5 RWMSs meet the 0.3 mSv dose constraint.

Requirement	Result
3.2 Necessary Information *[This section of the review should focus on the effects of the changes on the CA. Section 3.4 should focus on description of the changes and any effects not described in this section.]* *The information provided in the annual summary for each low-level waste disposal facility should include the following:* *a. Description of any changes affecting the CA including changes in the design or operations of facilities with releases potentially interacting with the disposal facility releases. Does the annual summary indicate whether any changes affecting the CA have occurred? If so, are their effects on the CA adequately described?*	Changes affecting the CAs are described in Section 3.2.
b. Description of any CA ramifications of special analyses and reviews performed or proposed for the facility. Does the annual summary indicate whether any special analyses or reviews were performed? If so, are the ramifications for the CA adequately described?	Section 3.1 describes the review performed for the CA in FY 2008. Section 3.2 describes CA results using the results of the FY 2008 review.
c. A description of any proposed changes in the low-level waste disposal facility design or operations. Does the annual summary indicate whether any changes are proposed in facility design or operations? If so, are the effects of the proposed changes on the CA adequately described?	Section 3.1 describes changes occurring in FY 2008. Section 3.2 describes CA results using the results of the FY 2008 review. Section 3.4 summarizes changes.
d. A description of proposed changes (including remediation activities) in design or operations of facilities with releases potentially interacting with the disposal facility releases. Does the annual summary indicate whether any changes are proposed in the design or operations of facilities with releases potentially interacting with the disposal facility? If so, are the effects of the proposed changes on the CA adequately described?	Proposed changes are summarized in Section 3.4.1.
e. A description of any corresponding changes required in the CA maintenance plan, the closure plan, and the monitoring plan. Does the annual summary indicate whether any corresponding changes are required in the plans? If so, are they adequately described?	Section 3.5 summarizes recommended changes.
f. A description of any proposed changes in the CA. Does the annual summary indicate whether any changes to the CA are required? If so, are they adequately described?	Proposed changes are summarized in Section 3.4.1. Section 3.6 concludes that no changes to the CAs are required.
3.3 Factors to be Addressed *The basic factors to be addressed in the annual summary and evaluated by the LFRG in reviewing the annual summary are operations, facility design, closure design, research and development, and interacting source terms. (For additional detail on the scope and level of detail expected for the topics, see Section 2.2 of the "Maintenance Guide for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments and Composite Analyses," November 10, 1999.)*	

Requirement	Result
3.3.1 Operations Considerations *a. Significant changes in the operations (including remediation activities) and configurations of facilities with releases that could potentially interact with releases from the low-level waste disposal facility. Does the annual summary describe any significant changes in potentially interacting facilities?*	Section 3.1 describes changes affecting the CAs.
b. Disposal unit consistency with the CA models (e.g., size and configuration of trenches, shafts, and pits; waste placement and configuration; thickness of operational backfill/cover). Does the annual summary adequately describe disposal unit consistency with the CA models?	Section 3.1.1 describes RWMSs disposal unit changes affecting the CAs.
c. Waste receipts including description of form and packaging (especially special waste forms) and their consistency with CA analyses and projections. Does the annual summary adequately describe waste receipts and their consistency with CA analyses and projections?	Section 3.1.1.1 describes changes to the pre-1988 waste inventories. Changes to post-1988 inventories are described in Section 2.1.3.
d. Waste acceptance criteria including radionuclides significant to and evaluated in the CA, radionuclide concentration and quantity limits (established in the PA), and waste form and packaging requirements. Does the annual summary adequately describe the WAC and their consistency with the CA results?	The WAC are described in Section 2.1.5.
e. Procedures and systems (e.g., verification of waste characteristics, inventory limit controls, generator certification) intended to prevent disposal of inappropriate wastes. Does the annual summary adequately describe procedures and systems?	The Radioactive Waste Acceptance Program is described in Section 2.1.5.
3.3.2 Facility Design Considerations *a. Consistency with the CA analyses of operations technology and configuration at facilities with releases potentially interacting with releases from the low-level waste disposal facility. Is the consistency adequately described?*	Consistency of facility design with CA analyses is described in Section 3.1.
b. Engineered barrier consistency the CA. Is the consistency adequately described?	Consistency of cover design with CA analyses is described in Section 3.1.1.2.
c. Monitoring provisions appropriate for evaluation of facility performance and interacting source terms. Are monitoring provisions adequately described?	The CA monitoring program is described in Section 3.3.1.
d. Operational controls to promote stability and to compensate for potential subsidence. Are operational controls adequately described?	Controls and monitoring of subsidence is described in Section 2.2.1.7.
3.3.3 Closure Design Considerations *a. Engineered barrier description (including those for facilities with releases that interact with the low-level waste disposal facility) including consistency of the closure cover design with CA analysis and threats to cover integrity and viability. Are engineered barriers adequately described?*	Consistency of cover design with CA analyses is described in Section 3.1.1.2.
b. Future land use plan consistency with CA assumptions. Is consistency of the land use plan with the CA assumptions adequately described?	The consistency of land-use plans with CA assumptions is discussed in Section 3.1.

Requirement	**Result**
3.3.4 Research and Development Considerations *a. R&D efforts required by the DAS. Are these efforts adequately described?*	R&D efforts relevant to the CAs are described in Section 3.3.2. DAS-required R&D efforts to characterize UGTA source terms are described in Section 3.1.2.
b. R&D efforts pursued for improving and refining the composite analysis. Are these efforts adequately described?	R&D efforts relevant to the CAs are described in Section 3.3.2.
c. Results of any confirmatory testing performed. Was any confirmatory testing performed? If so, are the results adequately described?	Confirmatory monitoring is described in Section 3.3.1.
3.3.5 Interacting Source Term Considerations *a. Evaluation of significant interacting source terms. Does the annual summary indicate that there is a need to re-evaluate significant interacting source terms? If so, are they adequately re-evaluated?*	Section 3.1 reviews the status of interacting source terms and concludes that no significant changes have occurred.
b. Alteration of existing source terms. Does the annual summary report any changes in existing source terms including new source terms?	Section 3.1 reviews the status of interacting source terms and concludes that no significant changes have occurred.
c. Alteration of uncertainty in characteristics of existing sources. Does the annual summary report any changes in uncertainty in characteristics of existing source terms?	Section 3.1 reviews the status of interacting source terms and concludes that no significant changes have occurred.
3.4 Changes *The changes that could cause divergence from the conditions used for the CA analysis should be categorized as discovered changes, proposed changes, or R&D changes and should be listed and described in the annual summary.* *[This section of the review should focus on description of the changes (discovered, proposed, and R&D) and any effects of the changes not described in Section 3.2.]* *3.4.1 Discovered Changes* *The annual summary should report divergences from expected or planned conditions that have been <u>discovered</u> in facility operations, construction, site characteristics, and other conditions significant to determination of cumulative doses from the disposal facility and potentially interacting source terms. Specific information should address the baseline from which the divergence was identified, comparison of expected conditions to any available monitoring results, significance of the divergence as indicated by comparison to the four LFRG review thresholds (listed in Section 2.4.1 above), and incorporation of the changes in the performance assessment, if appropriate.* *a. Does the annual summary report any discovered changes? If so, are they adequately described?*	Section 3.4.2 describes discovered changes.

Requirement	Result
3.4.2 Proposed Changes *a. The annual summary should identify divergences (for both the low-level waste disposal facility and for facilities with potentially interacting source terms) from expected or planned conditions that have been or will be voluntarily made by the facility operators to facility operations, facility construction, interacting source terms, or other conditions significant to combined facility and interacting source behavior. Specific information should address the baseline from which the divergence is planned, comparison of current performance to performance expected after the change is made, significance of the divergence as indicated by comparison to the four LFRG review thresholds (listed in Section 2.4.1 above), and incorporation of the changes in the performance assessment, if appropriate. Does the annual summary report any proposed changes? If so, are they adequately described?*	Proposed changes to the CA are described in Section 3.4.1.
3.4.3 Research and Development Changes *a. The annual summary should include descriptions of research and development (both generic and site-specific) relevant to the CA analysis models and input data for them that are to be used to improve the conclusions of the CA. The annual summary should include description of the significance of the improvements, when and how the anticipated improvements will be incorporated in CA modeling and analyses, and whether the improvements are expected to change the conclusions of the CA. Does the annual summary report any R&D changes? If so, are they adequately described?*	The CA R&D efforts are described in Section 3.3.2. Proposed changes are summarized in Section 3.4.1.
4.0 Disposal Authorization Statements *a. The facility annual summary should describe the conditions stated in the current DAS for the facility. For conditions that specify actions to be taken (such as resolution of data uncertainties), the annual summary should describe the required action, any deadlines specified in the DAS, and the current status of efforts to satisfy the requirement. For conditions that place limits on the operations of a facility (such as the maximum allowable inventory of a specified radionuclide), the annual summary should describe the limit, actions taken to ensure compliance with the limit, and either a statement of compliance with the limit or a description and explanation of any divergence. Does the annual summary state whether any DAS conditions are in effect? If so, are they adequately described including satisfaction of any continuing limitations and description of actions to resolve temporary conditions?*	The DAS and closure of DAS conditions are discussed in Section 1.1.

Requirement	Result
5.0 Status of Other Required Documents *The annual summary should describe the status of the facility PA/CA maintenance plan, the monitoring plan, and the closure plan. The description should state whether the documents are currently in draft or final form and should describe any planned revisions. For documents that are in draft form, a description of the key milestones and schedule for completion should be provided. Complete citations should be provided for the current version (or draft) of each document. Is the status of the documents adequately described including milestones and schedules for completion of any that are in draft form, and are full citations provided for the required documents?*	The Maintenance Plan, Closure Plans, and Monitoring Plans are identified in Sections 1.0, 2.1.6, and 2.2.1, respectively. Complete citations are found in Section 4.0.

DAS	Disposal Authorization Statement
DOE	U.S. Department of Energy
CA	Composite Analysis
FY	Fiscal Year
LFRG	Low-Level Waste Disposal Facility Federal Review Group
mSv	millisievert
PA	Performance Assessment
RWMS	Radioactive Waste Management Site
R&D	Research and Development
UGTA	Underground Test Area
WAC	Waste Acceptance Criteria