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Moab Site Project Completion Report Appendix Package

Pond, Landfill, Decontamination Pad, and Staging Area

Work Performed by S.M. Stoller Corporation under DOE Contract No. DE–AC01–02GJ79491
for the U.S. Department of Energy Office of Environmental Management,
Grand Junction, Colorado

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1.0 Introduction and Background

The Moab Uranium Mill Tailings Remedial Action (UMTRA) Project Site (site) is a former uranium-ore processing facility located about 3 miles northwest of the city of Moab in Grand County, Utah. It is located on the west bank of the Colorado River at the confluence with Moab Wash. The site encompasses approximately 400 acres, of which approximately 130 acres are covered by a mill tailings pile.

In 2001 the Floyd D. Spence National Defense Authorization Act (Act) was passed which required that the property title and the responsibility for cleanup be transferred from the Moab Mill Reclamation Trust to the U.S. Department of Energy (DOE). The Act mandated remediation of the site in accordance with Title I of the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978. The site is managed by the DOE Office of Environmental Management.

After all areas of the site have been remediated, a final Moab Millsite completion report will be prepared to summarize all remedial action land verification activities at the site.

This Appendix to the final completion report summarizes the results of the remediation and radiological survey data of a portion of the site known as Pond, Landfill, Decontamination Pad, and Staging Area (PLDPSA). The location is shown in Figure 1.

2.0 Basis for Remedial Action

Remedial action for the site has been conducted in accordance with UMTRCA; applicable provisions of the *Code of Federal Regulations* (40 CFR Part 192.12, Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings; and 40 CFR 192.22, Supplemental Standards); *Radiation Protection of the Public and the Environment* (DOE Order 5400.5); *Environment, Safety, and Health Program for Department of Energy Operations* (DOE Order 5480.1B); the National Environmental Policy Act (42 *United States Code* 4321); and all other applicable environmental regulations with an emphasis on maintaining all health and safety risks as low as reasonably achievable.

3.0 Authorized Limits

3.1 Regulatory Standards

The Authorized Limits, based on compliance with 40 CFR 192.12, are summarized in Table 1. This standard requires that the concentration of radium-226 (Ra-226) for the 0- to 15-centimeter (cm) soil layer must be 5 picocuries per gram (pCi/g) above background or less. Since the Ra-226 background for the site is 0.8 pCi/g (see section 3.2), the cleanup standard is 5.8 pCi/g for surface soil. For soil layers deeper than 15 cm, the requirement is that Ra-226 must be 15 pCi/g above background or less. Therefore, the cleanup standard is 15.8 pCi/g for subsurface soil layers.

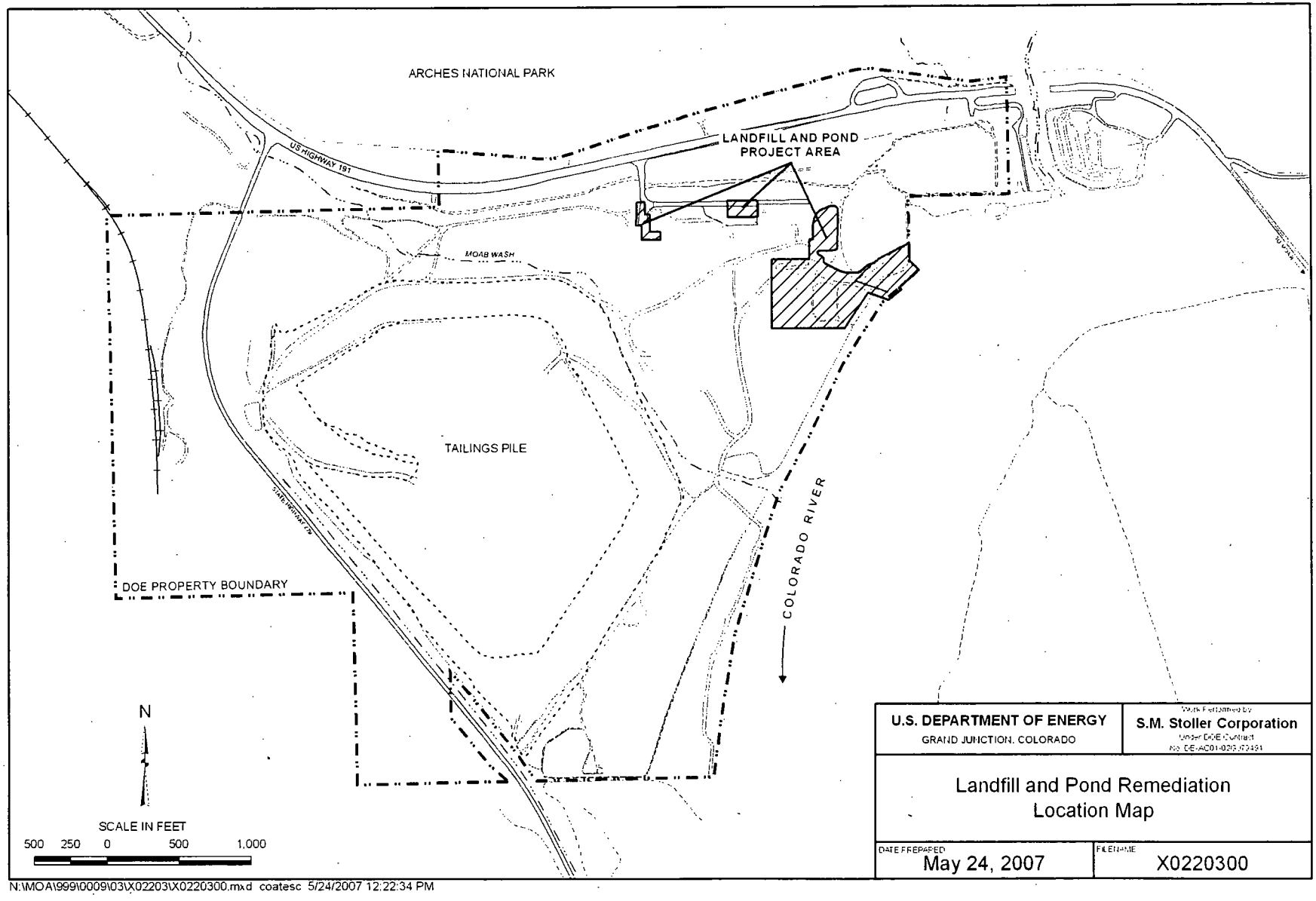

Figure 1. Site Location Map Showing the Pond, Landfill, Decontamination Pad, and Staging Area Remediation Area

Because thorium-230 (Th-230) decays to Ra-226, the Th-230 goals are based on a level of Th-230 that will ensure the site meets the Ra-226 standard over a 1,000-year performance period. The amount of Th-230 that can be left in place is dependent upon the amount of Ra-226 that is also left, as shown in Table 1. The Th-230 concentrations measured during assessment of this area ranged from 2.1 to 68.1 pCi/g. The average ratio of Th-230 to Ra-226 was 1.41. Uranium concentrations found during assessment ranged from 2.48 to 64.21 pCi/g. The average ratio of total uranium to Ra-226 was 1.13. This indicates that remediation activities to meet the Ra-226 standard will also reduce the Th-230 and uranium to levels that will ensure the site will not exceed the Ra-226 standard over the 1,000-year performance period specified in the standard.

Table 1. Authorized Limits

Remediation Goals				
	Surface (including background)		**Subsurface (including background)**	
Ra-226	5.8 pCi/g		15.8 pCi/g	
Th-230	Ra-226 (pCi/g)	Th-230 (pCi/g)	Ra-226 (pCi/g)	Th-230 (pCi/g)
	1.0	14.6	1.0	43.2
	2.0	12.7	2.0	41.2
	3.0	10.9	3.0	39.5
	4.0	9.0	4.0	37.6
	5.0	7.2	5.0	35.7
	5.8	5.8	6.0	33.9
			7.0	32.0
			8.0	30.2
			9.0	28.3
			10.0	26.5
			11.0	24.6
			12.0	22.8
			13.0	20.9
			14.0	19.1
			15.0	17.2
			15.8	15.8
Total Uranium (pCi/g)	Not applicable in this remediation area		Not applicable in this remediation area	

3.2 Background Soil Radionuclide Concentrations

Soil radionuclide-concentration background values are summarized in Table 2. Background soil values for the site were determined from laboratory analysis of eight samples collected from four offsite background locations in November 2001.

Table 2. Background Soil Radionuclide Concentrations

Criterion	Background Value
Radium-226 Concentration in Soil	0.8 pCi/g
Thorium-230 Concentration in Soil	0.5 pCi/g
Total Uranium Concentration in Soil	1.2 pCi/g

4.0 Description of Area of Remediation

The PLDPSA project area includes approximately 43,696 square meters (m^2) (10.6 acres). The project area includes three areas located in the northeast quadrant of the millsite. The Pond and Landfill are one large contiguous area. The Decontamination Pad is a smaller area remediated to allow construction of the site decontamination facilities for trucks. The Staging Area was remediated under what is now the paved parking lot for an office trailer complex. Residual radioactive material (RRM) that was removed consisted of uranium mill tailings and uranium ore contaminated soils.

The original property characterization is reported in the *Radiological Assessment for the Non-Pile Areas of the Moab Project Site* (DOE 2005). The areas and depths of contamination that were assessed for PLDPSA are shown in Plate 1.

5.0 Work Performed

5.1 Instrumentation

Gamma scintillometers were used to identify areas where elevated gamma levels indicate possible Ra-226 contamination. The types of scintillometers used included handheld crutch Mount Sopris SC-132s, and Ludlum 44-10 sodium-iodide detectors mounted on an All-Terrain Vehicle (ATV) or in a backpack unit. Both types of scintillometers can be shielded (collimated) with lead around the sides of the detector. Collimated instruments were used to minimize elevated gamma (shine) caused by adjacent areas that were not yet remediated. Uncollimated instruments were used to maximize sensitivity for locating gamma anomalies. The ATV and backpack scintillometers were linked with a global positioning system (GPS) for mapping the location of the gamma measurements. These systems are referred to as gamma-scanning GPS (GS/GPS). The accuracy of the GPS for the ATV-mounted units is approximately plus or minus 4.6 m (15 ft.). The accuracy of the backpack-mounted units is approximately plus or minus 1 m (3 ft.)

Soil samples were analyzed on-site using a sodium iodide-based Opposed Crystal System (OCS) for Ra-226. Verification to the 40 CRF 192 soil standards was based upon the OCS data. In accordance with quality control procedures a minimum of 5 percent of the OCS verification samples were submitted to an independent analytical laboratory.

Soil samples were also analyzed on-site for uranium using an Ortec Gamma Gauge© high-purity germanium (HPGe) detector. The HPGe is used for screening and is considered a semi-quantitative method.

Instrument procedures are included in *Field Services Procedures Manual* (STO 203). All instruments had daily operation checks performed in accordance with the *Field Services Procedures Manual* (STO 203).

5.2 Characterization Survey Prior to Remediation

In order to determine which areas of the millsite required remediation to meet the Authorized Limits, the millsite was characterized by S.M. Stoller between November 2001 and February 2005. A map of the areas and depths of assessed contamination within the PLDPSA are shown in Plate 1 and discussed in the *Radiological Assessment for Non-Pile Areas of the Moab Project Site* (DOE 2005). That report also provides a description of the methods used to characterize the site. It was approved by DOE and was submitted to the Nuclear Regulatory Commission (NRC) for review. Review comments received from the NRC were resolved prior to the start of remediation.

5.3 Remediation

Remediation began in July 2006 and was completed in November 2006. Surveys of the remediated areas were performed in accordance with the *Field Services Procedure Manual* (STO 203). After excavation to the assessed depth of contamination, the excavations were 100 percent gamma scanned with handheld crutch gamma scintillometers to locate any areas above the background gamma range that required further removal. Where required, excavation control soil samples were collected to further delineate areas for removal.

RRM that was removed from the PLDPSA consisted of uranium mill tailings and uranium ore contaminated soils. The PLDPSA contained a number of features, many of which are visible in the aerial photo which underlies Plate 2:

- The Pond: This area was used for freshwater storage. The pond was elevated with bermed sides that were approximately 3 m (10 ft) above ground level. This entire elevated area was removed to somewhat below ground level. After remediation, a new freshwater supply pond was built somewhat to the east of the original pond.
- The Fresh Water Supply Line: Heading west from the pond to the river was a berm. This was the location of the water line that supplied the pond. Approximately 15 to 30 cm (6 to12 inches) of material were removed from the top of the berm. The remaining portion of the berm was not contaminated. Historical data indicated it was one of the first things built at the site and so was built on uncontaminated land. This was further confirmed after remediation was complete. The berm material was removed for use as fill on other areas on the millsite. As it was taken off in 30-cm (12-inch) lifts, it was gamma-scanned to verify that it was uncontaminated.
- The Cottonwood Trees: This is the circular area surrounding verification block V-KJ-311. In order to save the trees, contaminated material was hand-excavated from around their roots.
- The Tamarisk Area: The eastern edge of the area, along the Colorado River, was covered with tamarisk. During assessment access to this area was limited because of the difficulties of moving through the brush. No contamination was found during assessment. During verification the tamarisk was removed, and the area was rescanned with handheld crutch scintillometers to verify that it was clean.
- The Landfill: This was a stockpile of contaminated soil removed from around the high pressure gas lines. It was verified using 100 percent soil sampling because it was remediated during the winter, and muddy and icy conditions made use of the ATV scanner impractical.

- The Decontamination Pad: This area is shown in the NW corner of Plates 1 and 2. After it was remediated, a truck decontamination pad and retention pond were built.
- The Staging Area: This was an asphalt-paved parking lot during the period the millsite was active. During the early part of remediation activities it was used as a staging area for administrative and field laboratory trailers. During remediation the asphalt and up to 61 cm (2 ft) of contaminated soil were removed. After remediation it was backfilled and paved for use as the parking lot.

The contaminated material was stockpiled on-site in the tailings pile area. After completion of the disposal cell at Crescent Junction, Utah, the material will be transported there for disposal.

Plates 1 and 2 show which areas were backfilled. The backfilled area includes some uncontaminated land west of the Colorado River that was backfilled because of road construction.

5.4 Verification

Verification was based on meeting the 40 CFR 192 standards for Ra-226 concentrations in soil. Gamma scanning and soil sampling were used to verify that the Authorized Limits were achieved. Areas of PLDPSA that are designated on Plate 1 and Plate 2 as "backfilled" were verified to the subsurface radium-in-soil standard of 15.8 pCi/g. All other areas were verified to meet the surface standard of 5.8 pCi/g.

5.4.1 Reference Grids

After excavation was complete, a predetermined grid measuring 210 m × 180 m was overlain on the verification area. The verification grid areas are identified by a "V" for verification, plus two letters (e.g., grid V-KL). Each grid area was subdivided into 378 smaller verification blocks measuring 10 m × 10 m (100 m^2). Blocks are uniquely identified by the alphabetic identifier and location number within the larger grid (e.g., V-KL-370). Composite verification soil samples were collected from the verification blocks shown in Plates 1 and 2.

5.4.2 Gamma Scan Measurements

The accessible excavated surface was 100 percent scanned for gamma using the handheld crutch scintillometers. To minimize the amount of soil sampling required, field personnel determined a range of gamma readings that were representative of the background in the excavated area. The background ranges are shown in Table 3.

Table 3. Verification Background Gamma Levels

Type of Measurement	Background Value
Uncollimated Surface >15 cm Excavation	4 to 7 µR/hr
Uncollimated Subsurface 0–15 cm Excavation	4 to 9 µR/hr

*µR/hr microroentgens per hour

To determine the background ranges, the GS/GPS data were used to calculate the average gamma for verification blocks where soil sampling showed the block met the cleanup standard.

The paired average gamma and Ra-226 soil results for the gamma data are shown in Table 4 and graphically presented in Figures 2 and 3. The block locations are shown in Plates 1 and 2.

The results of the GS/GPS scans prior to backfilling and final grading are shown in Plate 2. No GS/GPS data were collected for the Landfill Area and for blocks V-KJ-67, -68, -70, -89, and -90 because they were verified by 100 percent soil sampling. There is no gamma data for the freshwater supply line berm because it was too steep for the ATV-mounted scanner, and a backpack gamma scanning unit was not available until later in the project. The other areas on Plate 2 which do not show gamma measurements are due to imprecision in the GPS locations.

The elevated gamma readings south of V-KJ-354 were determined to be due to shine from adjacent unremediated material. After remediation, that area was covered by a flood-control dike.

5.4.3 Soil Measurements

After remediation, the level of Ra-226 in soil was verified by collecting composite soil samples from selected 100-m^2 verification blocks. Composite samples were taken by dividing a block into approximately nine equal sub-blocks and then collecting an aliquot at the center of each sub-block. Soil samples were analyzed for Ra-226 using the OCS method. The blocks were randomly selected by verification personnel to give a representative coverage of the remediated area. Some areas were sampled at a greater frequency while the background gamma range (Section 5.4.2) was being developed, to verify that elevated gamma levels along the edges of excavations were due to shine from adjacent, unremediated areas.

The results of the OCS analyses for Ra-226 are provided in Table 4. There were 156 OCS soil samples collected, and 35 were submitted to an independent laboratory for confirmatory analysis. This exceeds the quality control guidance in the Field Services Procedures Manual that requires 5 percent of the samples be submitted to an outside laboratory.

The independent laboratory that performed the quality control analyses was Severn Trent Laboratories St. Louis (STL). STL analyzed Ra-226 by method EML GA-01-R MOD, Th-230 by method EML A-01-R MOD, and uranium by method EPA 6020. All methods are approved by DOE.

As indicated in Table 4, the laboratory analytical results validated the use of OCS for soil verification. The 35 verification samples measured by both the OCS and the independent laboratory averaged 1.06 pCi/g according to the OCS method, and 1.82 pCi/g in the laboratory. The average uranium using the on-site HPGe system was 8.34 pCi/g, and the average for the same samples analyzed by the laboratory was 2.22 pCi/g.

Table 4. Summary of Soil Data and Gamma Data After Remedial Excavation

Verification Block ID	Sample Ticket No.	Sample Date	Sample Depth (cm)	OCS Ra-226 (pCi/g)	HPGe U (pCi/g)	Lab Ra-226 (pCi/g)	Lab Th-230 (pCi/g)	Lab U (pCi/g)	Average Uncollimated Gamma (µR/hr)
V-LH-227A	NEM 422	06/05/06	>15	4.50					
V-KJ-068	NEM 443	06/12/06	>15	1.30		0.51	0.67	0.6	
V-KJ-089	NEM 444	06/12/06	>15	2.30		2.48	2.79	3.8	
V-KJ-090	NEM 445	06/12/06	>15	1.87	10.50				
V-KH-018	NEM 446	06/12/06	>15	1.69					
V-KH-019	NEM 447	06/12/06	>15	0.65					
V-KH-020	NEM 448	06/12/06	>15	2.87					
V-LH-269B	NEM 449	06/12/06	>15	1.50	4.25	0.71	1.07	2.0	
V-LH-290	NEM 450	06/12/06	>15	4.10					
V-LH-291	NEM 451	06/12/06	>15	1.60					
V-LH-311	NEM 452	06/12/06	>15	2.80					
V-LH-312	NEM 453	06/12/06	>15	1.90					
V-LH-332	NEM 454	06/12/06	>15	2.70					
V-LH-333	NEM 455	06/12/06	>15	1.16					
V-LH-353	NEM 456	06/12/06	>15	2.22	17.64	2.59	2.28	3.3	
V-LH-354	NEM 457	06/12/06	>15	1.11					
V-LH-355	NEM 458	06/12/06	>15	7.40					
V-LH-356	NEM 459	06/12/06	>15	1.30		1.10	2.29	2.5	
V-LH-374	NEM 460	06/12/06	>15	2.70					
V-LH-375	NEM 461	06/12/06	>15	2.37	7.63	0.91	1.22	2.1	
V-LH-376	NEM 462	06/12/06	>15	0.79					
V-KJ-268	NEM 785	01/17/06	>15	1.80		0.58	0.69	2.5	4.4
V-KJ-291	NEM 786	01/17/06	0 to15	2.70		0.38	0.48	2.4	5.4
V-KJ-330	NEM 795	01/17/06	>15	2.00		0.39	0.48	2.3	4.8
V-KJ-354	NEM 796	01/17/06	>15	1.73		0.32	0.56	2.4	5.6
V-KJ-371	NEM 797	01/17/06	>15	0.72		0.39	0.38	2.4	6.0
V-KK-051	NEM 798	01/23/06	>15	0.63	5.81				
V-KK-114	NEM 799	01/23/06	>15	10.20	18.46				8.1
V-KK-154	NEM 800	01/23/06	>15	11.00	18.36				5.0
V-KK-152	NEM 801	01/23/06	>15	10.32	17.47				5.8
V-KK-113	NEM 802	01/23/06	>15	3.48	11.36				5.5
V-KK-132	NEM 803	01/23/06	>15	4.29	10.08				4.9
V-KK-049	NEM 804	01/23/06	>15	2.32					
V-KK-068	NEM 805	01/23/06	>15	0.57	6.23				
V-KK-069	NEM 806	01/23/06	>15	0.34					
V-KK-070	NEM 807	01/23/06	>15	3.13	7.08				
V-KK-087	NEM 808	01/23/06	>15	1.63					
V-KK-088	NEM 809	01/23/06	>15	0.93					
V-KK-089	NEM 810	01/23/06	>15	1.84		0.62	0.61	0.7	
V-KK-050	NEM 811	01/23/06	>15	1.38	7.06				
V-KK-106	NEM 812	01/23/06	>15	2.40					
V-KK-107	NEM 813	01/23/06	>15	0.60					
V-KK-108	NEM 814	01/23/06	>15	1.30					
V-KK-127	NEM 815	01/23/06	>15	1.60					
V-KK-128	NEM 816	01/23/06	>15	3.24	5.26	0.84	0.97	1.2	

Table 4. Summary of Soil Data and Gamma Data After Remedial Excavation (continued)

Verification Block ID	Sample Ticket No.	Sample Date	Sample Depth (cm)	OCS Ra-226 (pCi/g)	HPGe U (pCi/g)	Lab Ra-226 (pCi/g)	Lab Th-230 (pCi/g)	Lab U (pCi/g)	Average Uncollimated Gamma (µR/hr)
V-KK-129	NEM 817	01/23/06	>15	1.60					
V-LJ-243	NEM 818	01/23/06	>15	0.92					
V-LJ-245	NEM 819	01/23/06	>15	2.39					
V-LJ-246	NEM 820	01/23/06	>15	0.68					
V-LJ-247	NEM 821	01/23/06	>15	1.56		0.45	0.44	1.0	
V-LJ-263	NEM 822	01/23/06	>15	1.06					
V-LJ-264	NEM 823	01/23/06	>15	1.05					
V-LJ-265	NEM 824	01/23/06	>15	7.30		9.01	0.43	1.0	
V-LJ-266	NEM 825	01/23/06	>15	1.50					
V-LJ-267	NEM 826	01/23/06	>15	0.80					
V-LJ-268	NEM 827	01/23/06	>15	0.90					
V-LJ-286	NEM 828	01/23/06	>15	0.90					
V-LJ-285	NEM 829	01/23/06	>15	2.00		0.75	0.58	1.4	
V-LJ-287	NEM 830	01/23/06	>15	1.34					
V-LJ-288	NEM 831	01/23/06	>15	0.26					
V-LJ-289	NEM 832	01/23/06	>15	0.08					
V-LJ-305	NEM 833	01/23/06	>15	1.13					
V-LJ-306	NEM 834	01/23/06	>15	0.10					
V-LJ-307	NEM 835	01/23/06	>15	0.13					
V-LJ-328	NEM 836	01/23/06	>15	0.70					
V-LJ-347	NEM 837	01/23/06	>15	1.20					
V-LJ-348	NEM 838	01/23/06	>15	0.90					
V-LJ-349	NEM 839	01/23/06	>15	1.44	5.85				
V-LJ-350	NEM 840	01/23/06	>15	1.20					
V-LJ-369	NEM 841	01/23/06	>15	1.00					
V-LJ-308	NEM 842	01/23/06	>15	0.37		0.39	0.29	1.7	
V-LJ-309	NEM 843	01/23/06	>15	0.45					
V-LJ-310	NEM 844	01/23/06	>15	1.50					
V-LJ-326	NEM 845	01/23/06	>15	0.16					
V-LJ-327	NEM 846	01/23/06	>15	0.21	7.36				
V-LJ-370	NEM 847	01/23/06	>15	1.20					
V-LJ-371	NEM 848	01/23/06	>15	0.40		0.43	0.57		
V-LJ-329	NEM 849	01/23/06	>15	1.20					
V-LJ-330	NEM 850	01/23/06	>15	0.90		0.59	0.40		
V-LJ-331	NEM 851	01/23/06	>15	0.19	3.70				
V-LJ-351	NEM 852	01/30/06	>15	2.40					
V-LJ-352	NEM 853	01/30/06	>15	1.30					
V-LJ-372	NEM 854	01/30/06	>15	2.30	7.56				
V-LJ-373	NEM 855	01/30/06	>15	0.57					
V-KJ-311	NEM 856	01/09/06	>15	14.38	28.40				8.3
V-KJ-179	NEM 857	02/06/06	>15	2.10		0.86	0.84	0.7	5.3
V-KJ-204	NEM 858	02/06/06	>15	3.40		1.30	0.75	1.7	5.4
V-KJ-227	NEM 875	02/06/06	>15	0.80		0.72	0.66	1.2	4.5
V-KJ-241	NEM 876	02/06/06	>15	1.70		0.89	0.83	0.8	5.9
V-KJ-245	NEM 877	02/06/06	>15	1.73		0.62	0.71	1.7	4.6

Table 4. Summary of Soil Data and Gamma Data After Remedial Excavation (continued)

Verification Block ID	Sample Ticket No.	Sample Date	Sample Depth (cm)	OCS Ra-226 (pCi/g)	HPGe U (pCi/g)	Lab Ra-226 (pCi/g)	Lab Th-230 (pCi/g)	Lab U (pCi/g)	Average Uncollimated Gamma (µR/hr)
V-KJ-283	NEM 878	02/06/06	>15	1.94		0.83	0.84	0.8	5.8
V-KJ-325	NEM 879	02/06/06	>15	2.01		0.67	0.74	2.3	5.0
V-KJ-368	NEM 880	02/06/06	>15	0.92		0.82	0.78	3.0	4.7
V-KJ-012	NEM 881	02/06/06	>15	2.30					
V-KJ-013	NEM 882	02/06/06	>15	2.70					
V-KJ-014	NEM 883	02/06/06	>15	3.91	10.02				
V-KJ-015	NEM 884	02/06/06	>15	2.42					
V-LJ-368	NEM 886	02/06/06	>15	1.76					
V-KJ-033	NEM 887	02/06/06	>15	1.00					
V-KJ-034	NEM 888	02/06/06	>15	1.39	6.46				
V-KJ-035	NEM 889	02/06/06	>15	1.90		0.69	1.32	2.7	
V-KJ-036	NEM 890	02/06/06	>15	2.40					
V-KJ-054A	NEM 892	02/06/06	>15	1.48					
V-KJ-055	NEM 893	02/06/06	>15	0.97					
V-KJ-056	NEM 894	02/06/06	>15	1.90					
V-KJ-057	NEM 895	02/06/06	>15	1.65	7.23				
V-KJ-010	NEM 900	02/13/06	>15	1.39					
V-KJ-011	NEM 901	02/13/06	>15	1.79					
V-KJ-031	NEM 902	02/13/06	>15	2.07	7.70				
V-KJ-032	NEM 903	02/13/06	>15	1.47					
V-KJ-052	NEM 904	02/13/06	>15	0.52					
V-KJ-053	NEM 905	02/13/06	>15	1.20					
V-KJ-073	NEM 906	02/13/06	>15	1.40					
V-KJ-074	NEM 907	02/13/06	>15	1.78	10.11				
V-KJ-075A	NEM 908	02/13/06	>15	2.50					
V-KK-192	NEM 911	02/27/06	>15	2.30	6.94	1.94	2.22	2.3	5.4
V-KJ-187	NEM 912	02/27/06	>15	0.10		0.37	0.53	0.4	3.8
V-KK-211	NEM 913	02/27/06	>15	1.39	2.02				4.5
V-KK-236	NEM 914	02/27/06	>15	1.30					5.4
V-KJ-115	NEM 915	02/27/06	>15	0.98		1.00	0.83	2.5	4.3
V-KJ-117	NEM 916	02/27/06	>15	3.14		0.55	0.61	11.0	4.2
V-KJ-166	NEM 917	02/27/06	>15	0.70		0.59	0.89	1.2	3.7
V-KK-169	NEM 918	02/27/06	>15	0.57		0.99	1.43	1.0	4.4
V-KJ-361	NEM 919	05/22/06	0 to15	2.10	9.60				6.2
V-KJ-365	NEM 920	05/22/06	0 to15	3.34	11.10				5.2
V-LH-269A	NEM 921	06/05/06	>15	1.70		0.65	1.71		
V-LH-248B	NEM 922	06/05/06	>15	3.33					
V-LH-356A	NEN 380	07/17/06	>15	1.70					
V-LH-377	NEN 418	07/17/06	>15	2.70					
V-KH-039	NEN 419	07/17/06	>15	2.00					
V-KH-020A	NEN 420	07/17/06	>15	1.41					
V-KH-018A	NEN 421	07/17/06	>15	0.34					
V-KJ-129	NEN 422	09/05/06	>15	1.80					5.4
V-KJ-133	NEN 423	09/05/06	0 to 15	2.60					5.4
V-KJ-152	NEN 424	09/05/06	0 to 15	1.80					6.4

Table 4. Summary of Soil Data and Gamma Data After Remedial Excavation (continued)

Verification Block ID	Sample Ticket No.	Sample Date	Sample Depth (cm)	OCS Ra-226 (pCi/g)	HPGe U (pCi/g)	Lab Ra-226 (pCi/g)	Lab Th-230 (pCi/g)	Lab U (pCi/g)	Average Uncollimated Gamma (µR/hr)
V-KJ-174	NEN 425	09/05/06	0 to 15	1.50					6.0
V-KJ-193	NEN 426	09/05/06	0 to 15	1.10					5.2
V-KJ-235	NEN 427	09/05/06	0 to15	1.14					4.8
V-KJ-258	NEN 428	09/05/06	0 to15	2.21					5.3
V-KJ-297	NEN 429	09/05/06	0 to15	1.69					5.6
V-KJ-301	NEN 430	09/05/06	0 to15	3.70					5.7
V-KJ-320	NEN 431	09/05/06	0 to15	1.07					5.2
V-LH-310	PAA 004	10/08/06	>15	5.54					
V-LH-289A	PAA 005	10/09/06	>15	5.93					
V-LI-226	PAA 032	11/02/06	>15	5.32					6.0
V-LI-248	PAA 033	11/02/06	>15	2.63					4.6
V-LI-246	PAA 034	11/02/06	>15	0.86					4.1
V-KJ-087	PAA 167	01/17/07	>15	5.02					
V-KJ-067	PAA 171	02/05/07	>15	3.62					
V-KJ-091	PAA 305	04/25/07	>15	0.71					
V-KJ-092	PAA 306	04/25/07	>15	1.27					
V-KJ-070	PAA 307	04/25/07	>15	2.12					
V-KJ-272	PAA 351	05/30/07	0 to15	0.64					5.5
V-KJ-312	PAA 352	05/30/07	0 to15	1.88					5.6
V-KJ-334	PAA 353	05/30/07	0 to15	0.44					6.4
V-KJ-292	PAA 354	05/30/07	0 to15	1.36					5.6

Note: Blank cells indicate no measurement for that analyte or by that method were taken.
*Average gamma is based on multiple uncollimated GS/GPS readings for the verification block.

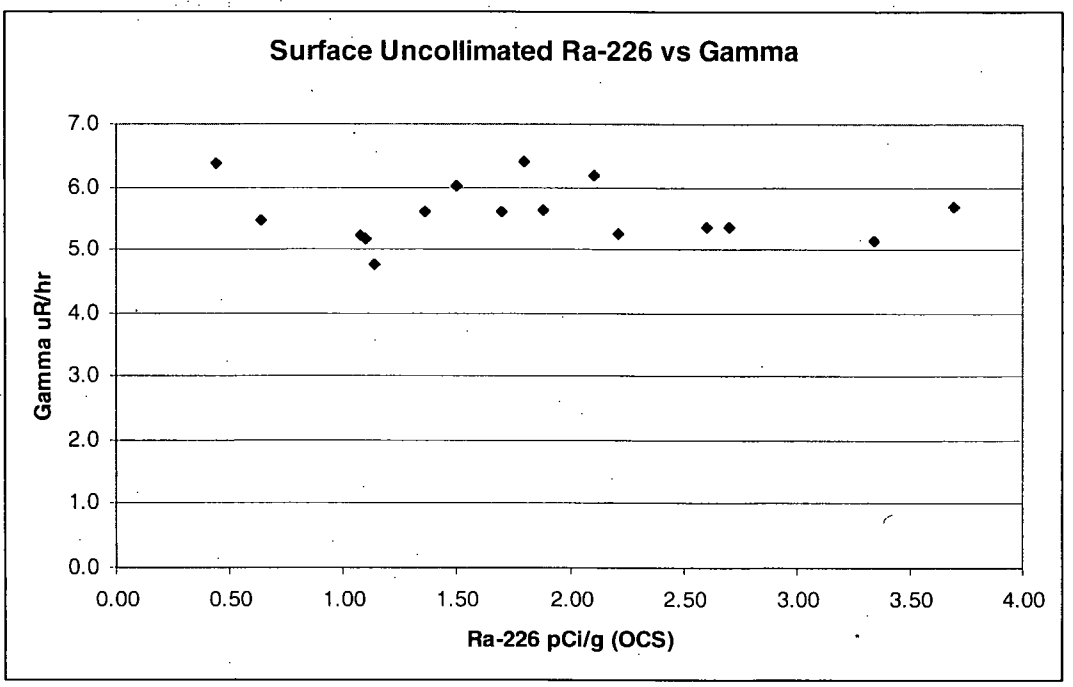

Figure 2. Uncollimated Data for Areas Verified to the Surface Standard

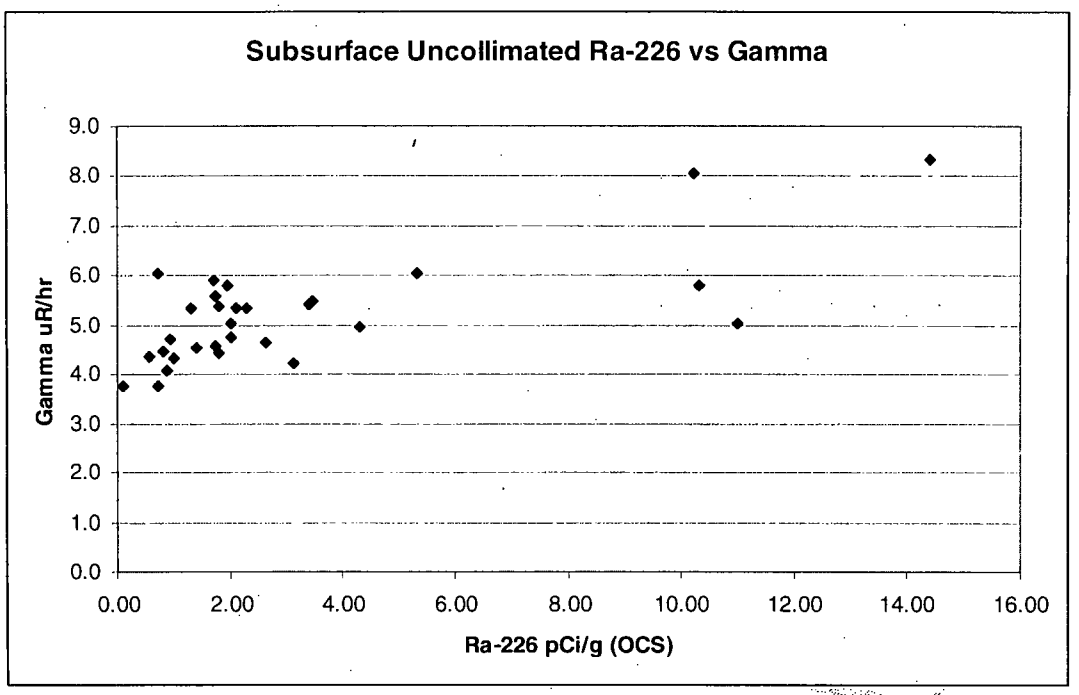

Figure 3. Uncollimated Data for Areas Verified to the Subsurface Standard

6.0 Final Condition

A summary of radiological results after remediation is provided in Table 5. Because of limitations of current technology and procedures for identifying and remediating RRM, unknown deposits of contamination may exist below the levels excavated during this remediation. After remediation, the area was contoured and planted with native vegetation.

6.1 Areas Verified to the Subsurface Standard (>15 cm)

The 40 CFR 192 standard for subsurface areas is 15.8 pCi/g. For subsurface areas the maximum concentration was 14.38 pCi/g, which is below the cleanup standard (Table 5). The mean Ra-226 concentration was 2.06 pCi/g. The projected upper limit of the mean concentration, calculated at the 95 percent confidence level, was 2.36 pCi/g. These results indicate that the radionuclide concentrations do not exceed the Authorized Limits; therefore, all cleanup criteria have been met for the areas verified to the subsurface standard.

All areas verified to the subsurface standard were backfilled with a minimum of 15 cm (6 inches) of material with an average Ra-226 concentration of 0.6 pCi/g. Backfill soil sample results are shown in Table 6.

6.2 Areas Verified to the Surface Standard

For areas verified to the surface standard, the maximum concentration of Ra-226 was 3.70 pCi/g, which is below the cleanup standard of 5.8 pCi/g (Table 5). The mean concentration was 1.83 pCi/g. The projected upper limit of the mean concentration, calculated at the 95 percent confidence level, was 2.21 pCi/g. These results indicate that the radionuclide concentrations do not exceed the Authorized Limits; therefore, all cleanup criteria have been met for the areas verified to the surface standard.

6.3 Areas That Did Not Require Remediation

The millsite characterization (Section 5.2) demonstrated that some areas of PLDPSA were below the 40 CFR 192 Authorized Limits and therefore did not require remediation. The data from these areas is shown in Table 7 and the locations are shown on Plates 1 and 2.

Table 5. Summary of Radiological Release Survey Results

Certification Criteria	Number of Observations	Cleanup Standard	Cleanup Standard Including Background[a]	Results[a] pCi/g
Ra-226 (pCi/g) Surface	16	Shall not exceed 5 pCi/g above background in the surface to 15-cm layer, averaged over 100 m^2	5.8	OCS Analysis Sample mean = 1.83 Maximum = 3.70 Std. dev = 0.92 $z_{95\%}$ = 1.65 $\mu_{95\%}$ = 2.21
Th-230 (pCi/g) Surface	1	Shall not exceed 5 pCi/g above background in the surface to 15-cm layer based averaged over 100 m^2	5.8	Laboratory Analysis Sample mean = 0.48 Maximum = 0.48
Ra-226 (pCi/g) Subsurface	140	Shall not exceed 15 pCi/g above background in any 15-cm-thick soil layer more than 15 cm below the surface, averaged over 100 m^2	15.8	OCS Analysis Sample mean = 2.06 Maximum = 14.38 Std. dev = 2.10 $z_{95\%}$ = 1.65 $\mu_{95\%}$ = 2.36
Th-230 (pCi/g) Subsurface	34	Shall not exceed 16 pCi/g above background in any 15-cm-thick soil layer more than 15 cm below the surface, averaged over 100 m^2	15.8	Laboratory Analysis Sample mean = 0.95 Maximum = 2.79
Uranium Surface	1	Not determined	Not determined	Laboratory Analysis Sample mean = 2.41 Maximum = 2.41
Uranium Subsurface	34	Not determined	Not determined	Laboratory Analysis Sample mean = 2.22 Maximum = 10.96

NA = not applicable
n = number of measurements
$z_{95\%}$ = z distribution statistic at 95% confidence (n=140 for > 15 cm, n = 16 for 0 to 15 cm)
$\bar{x}$ = sample mean
S = Std. dev., the sample standard deviation
$\mu_{95\%}$ = upper limit of the true population mean at the 95 percent confidence level, using the following equation:

$$\mu_{95\%} = \bar{x} + z_{95\%} \frac{S}{\sqrt{n}}$$

Table 6. Backfill Data

Sample Identification	OCS Ra-226 (pCi/g)
LeGrande Pit #1	0.3
LeGrande Pit #2	0.4
LeGrande Pit #3	1.2

Table 7. Radium-226 Data in Areas That Were Not Remediated

Location	Sample Depth (cm)	OCS Ra-226 (pCi/g)
R1022	0-15	5.03
R1023	0-15	4.29
R1024	0-15	1.59
R1026	0-15	4.82
R1027	0-15	3.91
R1028	0-15	2.64

7.0 References

40 CFR 192.12. EPA (Environmental Protection Agency), Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, *Code of Federal Regulations*, March 2007.

40 CFR 192.22, EPA (Environmental Protection Agency), Supplemental Standards, *Code of Federal Regulations*, March 2007.

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Order 5400.5	*Radiation Protection of the Public and the Environment*, February 1990.
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STO 1. *Quality Assurance Manual*, continuously updated, prepared by S.M. Stoller Corporation for the U.S. Department of Energy, Grand Junction, Colorado.

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STO 206. *Quality Assurance Desk Instructions*, continuously updated, prepared by S.M. Stoller Corporation for the U.S. Department of Energy, Grand Junction, Colorado.

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