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Moab Site Project Completion Report Appendix Package

Highway 191 Phase 1

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 Highway 191 (Hwy191) phase 1. 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 192.12, Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, and 40 CFR 192.22, Supplemental Standards); *United States Code* (42 U.S.C. 4321, National Environmental Policy Act); *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); and all other applicable environmental regulations, with an emphasis on maintaining all health and safety risks as low as reasonably achievable.

3.0 Cleanup Standards

3.1 Regulatory Standards

The cleanup standards, 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. So the cleanup standard is 15.8 pCi/g for subsurface soil layers.

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 20.2 to 44.8 pCi/g. The average ratio of Th-230 to Ra-226 was 1.24. Uranium concentrations found during assessment ranged from 15.5 to 21.6 pCi/g. The average ratio of total uranium to Ra-226 averaged 0.8. This indicates that remediation activities to meet the Ra-226 standards will also reduce the Th-230 and uranium to levels that will ensure the site will not exceed the Ra-226 standards over the 1,000-year performance period specified in the standard.

Table 1. Cleanup Standards

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
Ra-226 Concentration in Soil	0.8 pCi/g
Th-230 Concentration in Soil	0.5 pCi/g
Total Uranium Concentration in Soil	1.2 pCi/g

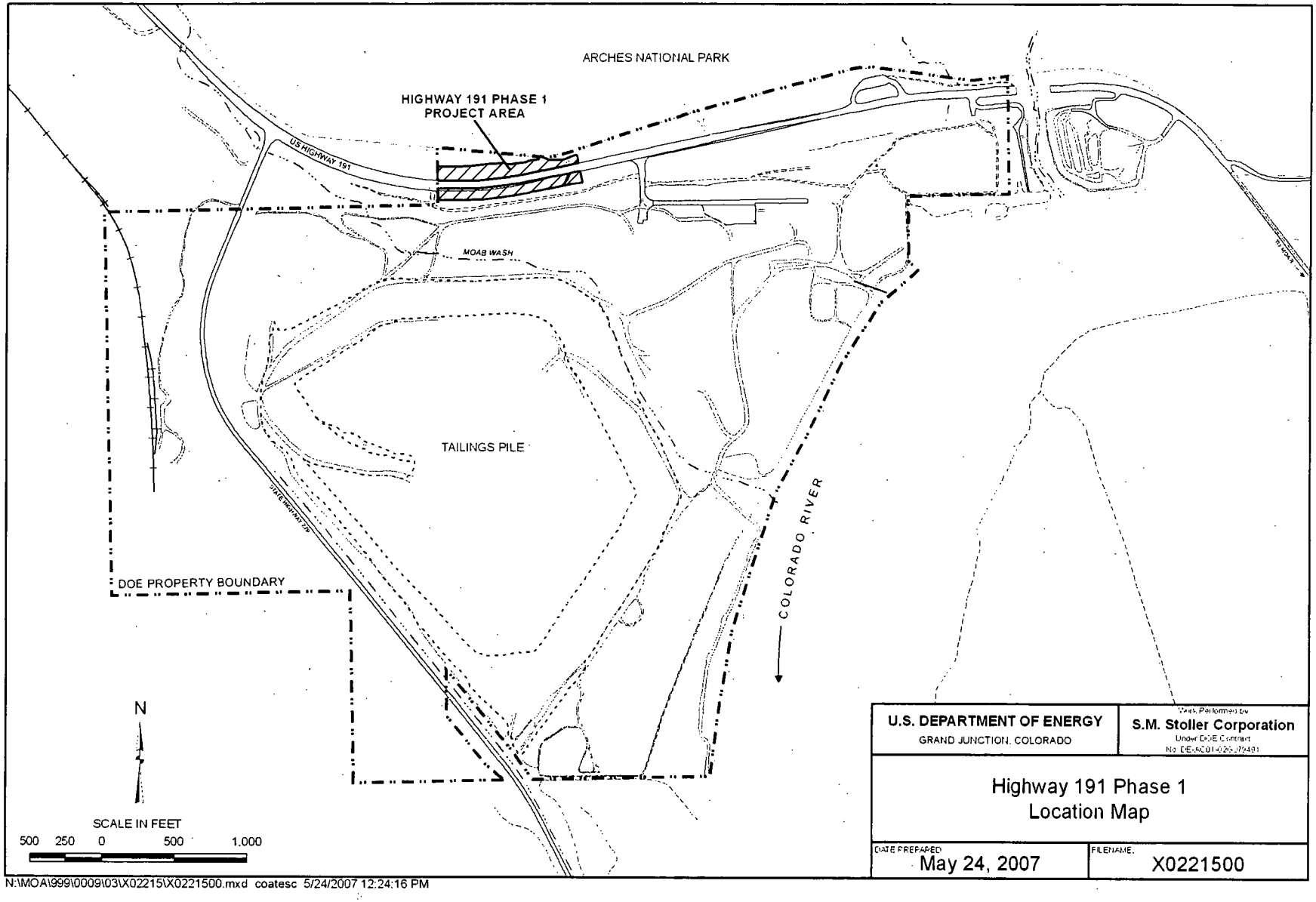

Figure 1. Site Location Map Showing the Highway 191 Phase 1 Project Area

4.0 Description of Area of Remediation

The Hwy191 phase 1 project area includes approximately 15,052 square meters (m^2) (3.7 acres). The project area includes the right-of-way adjacent to Utah State Highway 191 (Hwy 191) and the northern edge of the millsite (Figure 1). Residual radioactive material consists of uranium mill tailings and uranium ore contaminated soils. Crossing Hwy191 phase 1 is a supplemental standards area consisting of a drainage culvert that goes underneath the highway and is surrounded by residual radioactive material (RRM).

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 Hwy191 phase 1 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 were handheld Mount Sopris SC-132s. 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.

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 10 percent of the OCS verification samples were submitted to an independent analytical laboratory.

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

5.2 Characterization Survey Prior to Remediation

In order to determine which areas of the millsite required remediation to meet the cleanup standards, the millsite was characterized by S.M. Stoller between November 2001 and February 2005. The areas and depths of assessed contamination within Hwy191 phase 1 are presented 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 submitted to the Nuclear Regulatory Commission (NRC) for review. Review comments received from NRC were resolved prior to the start of remediation.

5.3 Remediation

Remediation began in March 2003 and was completed in April 2003. 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 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 Hwy191 phase 1 area consisted of uranium mill tailings and uranium ore contaminated soils. Depths of removal were all greater than 15 cm (6 inches) and were as deep as 1 m (3 ft) around a storm drain culvert that continues under Hwy 191. The contaminated material was stockpiled on-site in the tailing pile area. After completion of the disposal cell at Crescent Junction, Utah, the material will be transported there for disposal.

5.4 Verification

Verification was based on meeting the 40 CFR 192 standards for Ra-226 concentrations in soil. Soil sampling verified that the cleanup standards were achieved. All areas of Hwy191 phase 1 were cleaned to the more stringent surface soil standard of 5.8 pCi/g. Cleaning to the surface standard was done to accommodate grading of the highway right-of-way where some remediated areas might be exposed later. After remediation, the highway was widened, and the area shown as "backfilled" on Plate 1 was built up with clean fill.

5.4.1 Reference Grids

After excavation was complete, a predetermined grid measuring 183 m × 229 m (600 ft × 750 ft) was overlain on the verification area. The same grid was used for both assessment and verification. The verification grid areas are identified by a "V" for verification plus two letters (e.g., grid V-KK). Each grid area was subdivided into 180 smaller verification blocks measuring 9.1 m × 9.1 m (83.6 m^2) (30 ft × 30 ft [900 ft^2]). Blocks are uniquely identified by the alphabetic identifier and location number within the larger grid (e.g., V-KK-070). Composite verification soil samples were collected from the verification blocks shown in Plate 1.

5.4.2 Gamma Scan Measurements

The accessible excavated surface was 100 percent scanned for gamma using the handheld scintillometers. Areas with elevated gamma levels were investigated further to ensure all contamination above the surface soil standard was removed.

5.4.3 Soil Measurements

After remediation the level of Ra-226 in soil was verified by collecting composite soil samples from the 83.6-m^2 verification blocks overlain onto the excavated area. 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 results of the analyses for Ra-226 are provided in Table 3. There were 230 OCS soil samples collected, and 20 were submitted to an independent laboratory for confirmatory analysis. This is three samples less than required by the quality control guidance in the *Field Services Procedures Manual* (STO 203) which requires submittal of 10 percent of the soil samples to an independent laboratory for Ra-226 analysis.

The independent laboratory that performed the analyses was the Grand Junction Office Analytical Laboratory. Ra-226 was analyzed using method GS-1 R06, Th-230 by AS-16 R03, and uranium by method AS-6 R08. All methods are approved by DOE.

As indicated in Table 3, the laboratory analytical results validated the use of OCS for soil verification. The 20 verification samples measured by both the OCS and the independent laboratory averaged 2.5 pCi/g according to the OCS method and 1.3 pCi/g in the laboratory. Therefore, OCS results collected in the field can be considered conservative and are a valid verification measurement.

Table 3. Summary of Soil Data and Gamma Data After Remedial Excavation

Verification Block ID	Sample Ticket No.	Date Sampled	Sample Depth (cm)	OCS Ra-226 (pCi/g)	Lab Ra-226 (pCi/g)	Lab Th-230 (pCi/g)	Lab Uranium (pCi/g)	Average Uncollimated Gamma (µR/hr)
V-SI-012	NEL 552	3/24/03	0–6	0.7				21.0
V-SI-013	NEL 553	3/24/03	0–6	2.3	0.75	0.89	2.00	18.7
V-SI-014	NEL 554	3/24/03	0–6	2.2				19.5
V-SI-015	NEL 555	3/24/03	0–6	1.3				18.7
V-SI-027	NEL 564	3/24/03	0–6	1.4				18.0
V-SI-028	NEL 565	3/24/03	0–6	3.3				19.5
V-SI-029	NEL 566	3/24/03	0–6	3.3				18.0
V-SI-030	NEL 567	3/24/03	0–6	3.9				19.5
V-SI-042	NEL 597	3/31/03	0–6	1.5				18.0
V-SI-043	NEL 598	3/31/03	0–6	1.8				18.7
V-SI-044	NEL 599	3/31/03	0–6	3.3				19.5
V-SI-045	NEL 600	3/31/03	0–6	2.6				19.5
V-SJ-001	NEL 556	3/24/03	0–6	2.2				19.5
V-SJ-002	NEL 557	3/24/03	0–6	0.9				19.5
V-SJ-003	NEL 558	3/24/03	0–6	1.9				19.5
V-SJ-004	NEL 559	3/24/03	0–6	0.4				18.7
V-SJ-005	NEL 560	3/24/03	0–6	2.4				20.2
V-SJ-006	NEL 561	3/24/03	0–6	0.8				18.7
V-SJ-007	NEL 562	3/24/03	0–6	2				18.7
V-SJ-008	NEL 563	3/24/03	0–6	2				19.5
V-SJ-009	NEL 568	3/24/03	0–6	1.5				18.7
V-SJ-010	NEL 574	3/24/03	0–6	1.5				19.5
V-SJ-011	NEL 575	3/31/03	0–6	3.3	1.87	2.2	2.69	18.7
V-SJ-012	NEL 576	3/31/03	0–6	4.5				19.5
V-SJ-013	NEL 626	3/31/03	0–6	3.5				19.5
V-SJ-014	NEL 627	3/31/03	0–6	4.5				18.7
V-SJ-015	NEL 628	3/31/03	0–6	4.6				19.5
V-SJ-016	NEL 596	3/31/03	0–6	3.4				19.5
V-SJ-017	NEL 602	3/31/03	0–6	0.9				19.5
V-SJ-018	NEL 603	3/31/03	0–6	1.9				18.7
V-SJ-019	NEL 611	3/31/03	0–6	4.4				18.7
V-SJ-020	NEL 606	3/31/03	0–6	1.7	2.49	2.7	2.48	19.5
V-SJ-021	NEL 607	3/31/03	0–6	3.5				18.7
V-SJ-022	NEL 608	3/31/03	0–6	3.4				19.5
V-SJ-023	NEL 609	3/31/03	0–6	1.6				18.7
V-SJ-024	NEL 610	3/31/03	0–6	2.2				18.0
V-SJ-025	NEL 618	3/31/03	0–6	3.3	1.9	1.8	2.14	18.7
V-SJ-026	NEL 619	3/31/03	0–6	2				19.5
V-SJ-027	NEL 620	3/31/03	0–6	1.9				19.5

Table 3. Summary of Soil Data and Gamma Data After Remedial Excavation (continued)

Verification Block ID	Sample Ticket No.	Date Sampled	Sample Depth (cm)	OCS Ra-226 (pCi/g)	Lab Ra-226 (pCi/g)	Lab Th-230 (pCi/g)	Lab Uranium (pCi/g)	Average Uncollimated Gamma (µR/hr)
V-SJ-028	NEL 623	3/31/03	0–6	0.9				18.7
V-SJ-029	NEL 624	3/31/03	0–6	4.5				18.7
V-SJ-030	NEL 625	3/31/03	0–6	3.6				18.7
V-SJ-031	NEL 601	3/31/03	0–6	1.4				19.5
V-SJ-032	NEL 604	3/31/03	0–6	1				18.0
V-SJ-033	NEL 605	3/31/03	0–6	3.3				18.0
V-SJ-034	NEL 612	3/31/03	0–6	2	1.61	2.2	1.79	18.0
V-SJ-035	NEL 613	3/31/03	0–6	3.2				18.7
V-SJ-036	NEL 614	3/31/03	0–6	1.8				18.7
V-SJ-037	NEL 615	3/31/03	0–6	1.8				18.0
V-SJ-038	NEL 616	3/31/03	0–6	1.8				18.7
V-SJ-039	NEL 617	3/31/03	0–6	4				19.5
V-SJ-040	NEL 621	3/31/03	0–6	2.3				18.7
V-SJ-041	NEL 622	3/31/03	0–6	2.9				18.7
V-SK-001	NEL 649	4/07/03	0–6	2.9	2.23	2.3	2.96	19.5
V-SK-002	NEL 650	4/07/03	0–6	0.2				18.7
V-SK-003	NEL 651	4/07/03	0–6	1.1				18.7
V-SK-004	NEL 652	4/07/03	0–6	0.8				18.7
V-SK-005	NEL 680	4/07/03	0–6	2.6				19.5
V-SK-006	NEL 681	4/07/03	0–6	1.6				19.5
V-SK-016	NEL 653	4/07/03	0–6	0.8				19.5
V-TI-117	NEL 640	3/31/03	0–6	1.5	1.44	1.3	1.79	18.0
V-TI-118	NEL 715	4/07/03	0–6	0.1				18.0
V-TI-119	NEL 716	4/07/03	0–6	0.1				17.3
V-TI-120	NEL 717	4/07/03	0–6	0.1				18.0
V-TI-132	NEL 641	3/31/03	0–6	1.4				16.5
V-TI-133	NEL 709	4/07/03	0–6	0.9				17.3
V-TI-134	NEL 710	4/07/03	0–6	0.3				18.0
V-TI-135	NEL 711	4/07/03	0–6	0.4				18.0
V-TI-147	NEL 642	3/31/03	0–6	0.7				17.3
V-TI-148	NEL 703	4/07/03	0–6	0.7				18.0
V-TI-149	NEL 704	4/07/03	0–6	0.6				17.3
V-TI-150	NEL 705	4/07/03	0–6	0.2				17.3
V-TI-162	NEL 643	3/31/03	0–6	1				18.0
V-TI-163	NEL 644	3/31/03	0–6	1.9				18.0
V-TI-164	NEL 645	3/31/03	0–6	1.8				18.0
V-TI-165	NEL 646	3/31/03	0–6	0.6				18.0
V-TJ-094	NEL 741	4/14/03	0–6	1.5				18.7
V-TJ-095	NEL 742	4/14/03	0–6	0.9				17.3
V-TJ-096	NEL 743	4/14/03	0–6	2.4				17.3
V-TJ-097	NEL 744	4/14/03	0–6	1				17.3
V-TJ-098	NEL 745	4/14/03	0–6	3.1				17.3
V-TJ-099	NEL 746	4/14/03	0–6	3.6	2.08	2.3	2.07	17.3
V-TJ-100	NEL 747	4/14/03	0–6	3.2				17.3
V-TJ-101	NEL 748	4/14/03	0–6	1.3				17.3
V-TJ-102	NEL 749	4/14/03	0–6	0.8				17.3
V-TJ-103	NEL 750	4/14/03	0–6	1.5				17.3
V-TJ-104	NEL 751	4/14/03	0–6	2.3	0.94	1.3	2.76	18.0
V-TJ-105	NEL 752	4/14/03	0–6	3.1				17.3
V-TJ-106	NEL 712	4/07/03	0–6	0.2				18.0
V-TJ-107	NEL 713	4/07/03	0–6	0.7				18.0

Table 3. Summary of Soil Data and Gamma Data After Remedial Excavation (continued)

Verification Block ID	Sample Ticket No.	Date Sampled	Sample Depth (cm)	OCS Ra-226 (pCi/g)	Lab Ra-226 (pCi/g)	Lab Th-230 (pCi/g)	Lab Uranium (pCi/g)	Average Uncollimated Gamma (µR/hr)
V-TJ-108	NEL 714	4/07/03	0–6	1.8				18.0
V-TJ-109	NEL 727	4/14/03	0–6	1.6				17.3
V-TJ-110	NEL 728	4/14/03	0–6	0.3				18.0
V-TJ-111	NEL 729	4/14/03	0–6	1.4				17.3
V-TJ-112	NEL 730	4/14/03	0–6	2.1				17.3
V-TJ-113	NEL 731	4/14/03	0–6	2.1				17.3
V-TJ-114	NEL 732	4/14/03	0–6	1.8	1.03	1.2	2.69	17.3
V-TJ-115	NEL 753	4/14/03	0–6	1.2				16.5
V-TJ-116	NEL 754	4/14/03	0–6	1.4				17.3
V-TJ-117	NEL 755	4/14/03	0–6	2.2				18.0
V-TJ-118	NEL 756	4/14/03	0–6	2.5				19.5
V-TJ-119	NEL 757	4/14/03	0–6	1.1				17.3
V-TJ-120	NEL 758	4/14/03	0–6	0.8				17.3
V-TJ-121	NEL 706	4/07/03	0–6	0.7				18.7
V-TJ-122	NEL 707	4/07/03	0–6	1.1				18.0
V-TJ-123	NEL 708	4/07/03	0–6	2.1				18.0
V-TJ-124	NEL 718	4/14/03	0–6	1.9				17.3
V-TJ-125	NEL 719	4/14/03	0–6	0.5				18.0
V-TJ-126	NEL 720	4/14/03	0–6	1.9	0.59	1	2.14	16.5
V-TJ-127	NEL 721	4/14/03	0–6	1.4				18.0
V-TJ-128	NEL 722	4/14/03	0–6	0.3				17.3
V-TJ-129	NEL 723	4/14/03	0–6	1.4				17.3
V-TJ-130	NEL 733	4/14/03	0–6	1.5				17.3
V-TJ-131	NEL 734	4/14/03	0–6	1.6				17.3
V-TJ-132	NEL 735	4/14/03	0–6	0.7				19.5
V-TJ-133	NEL 666	4/07/03	0–6	3.3				19.5
V-TJ-134	NEL 667	4/07/03	0–6	2.9				19.5
V-TJ-135	NEL 668	4/07/03	0–6	2.6				19.5
V-TJ-136	NEL 700	4/07/03	0–6	0.6				18.0
V-TJ-137	NEL 701	4/07/03	0–6	1.4				18.0
V-TJ-138	NEL 702	4/07/03	0–6	1.4				18.0
V-TJ-139	NEL 724	4/14/03	0–6	0.2				17.3
V-TJ-140	NEL 725	4/14/03	0–6	1.3				18.0
V-TJ-141	NEL 726	4/14/03	0–6	0.6				18.7
V-TJ-142	NEL 660	4/07/03	0–6	2.1				19.5
V-TJ-143	NEL 661	4/07/03	0–6	0.9				18.7
V-TJ-144	NEL 662	4/07/03	0–6	2.2				19.5
V-TJ-145	NEL 663	4/07/03	0–6	2.2	0.49	2.1	1.52	19.5
V-TJ-146	NEL 664	4/07/03	0–6	1.1				19.5
V-TJ-147	NEL 665	4/07/03	0–6	3.1				19.5
V-TJ-148	NEL 669	4/07/03	0–6	1.8				18.7
V-TJ-149	NEL 670	4/07/03	0–6	1.3				19.5
V-TJ-151	NEL 647	3/31/03	0–6	1.9				18.0
V-TJ-152	NEL 648	3/31/03	0–6	0.7				18.7
V-TJ-153	NEL 656	4/07/03	0–6	1.1				18.7
V-TJ-154	NEL 657	4/07/03	0–6	1.1				18.7
V-TJ-155	NEL 658	4/07/03	0–6	1.4				18.7
V-TJ-156	NEL 659	4/07/03	0–6	1.7				19.5
V-TJ-174	NEL 569	3/24/03	0–6	0.7				18.0
V-TJ-175	NEL 570	3/24/03	0–6	0.2				18.0
V-TJ-176	NEL 571	3/24/03	0–6	0.6				19.5

Table 3. Summary of Soil Data and Gamma Data After Remedial Excavation (continued)

Verification Block ID	Sample Ticket No.	Date Sampled	Sample Depth (cm)	OCS Ra-226 (pCi/g)	Lab Ra-226 (pCi/g)	Lab Th-230 (pCi/g)	Lab Uranium (pCi/g)	Average Uncollimated Gamma (µR/hr)
V-TJ-177	NEL 572	3/24/03	0–6	2				19.5
V-TJ-178	NEL 573	3/24/03	0–6	1.2				19.5
V-TJ-179	NEL 580	3/31/03	0–6	3.2	1.29	2.6	1.79	18.7
V-TJ-180	NEL 581	3/31/03	0–6	2.3				19.5
V-TK-065	NEL 759	4/14/03	0–6	3.5	1.74	1.6	3.79	18.0
V-TK-066	NEL 760	4/14/03	0–6	0.9				18.0
V-TK-072	NEL 769	4/14/03	0–6	2.4				18.7
V-TK-073	NEL 770	4/14/03	0–6	0.9				18.7
V-TK-074	NEL 771	4/14/03	0–6	3.4				19.5
V-TK-078	NEL 763	4/14/03	0–6	1.5				18.0
V-TK-079	NEL 764	4/14/03	0–6	2.1				17.3
V-TK-080	NEL 761	4/14/03	0–6	1.7				18.0
V-TK-081	NEL 762	4/14/03	0–6	3				18.0
V-TK-082	NEL 772	4/14/03	0–6	2.5				17.3
V-TK-083	NEL 773	4/14/03	0–6	4.6				17.3
V-TK-084	NEL 774	4/14/03	0–6	4.8				18.0
V-TK-085	NEL 775	4/14/03	0–6	3.3	2.53	2.7	5.79	18.7
V-TK-086	NEL 776	4/14/03	0–6	4.7				18.7
V-TK-087	NEL 777	4/14/03	0–6	2				18.7
V-TK-088	NEL 778	4/14/03	0–6	2.3				18.7
V-TK-089	NEL 779	4/14/03	0–6	0.1				18.7
V-TK-091	NEL 765	4/14/03	0–6	0.1				18.0
V-TK-092	NEL 766	4/14/03	0–6	0.5				17.3
V-TK-093	NEL 767	4/14/03	0–6	0.6				17.3
V-TK-094	NEL 768	4/14/03	0–6	0.6				18.0
V-TK-095	NEL 738	4/14/03	0–6	1.3				18.0
V-TK-096	NEL 739	4/14/03	0–6	1.4				18.7
V-TK-097	NEL 780	4/14/03	0–6	1.7	0.89	1.3	3.51	17.3
V-TK-098	NEL 781	4/14/03	0–6	0.7				18.0
V-TK-099	NEL 693	4/07/03	0–6	2				18.7
V-TK-100	NEL 695	4/07/03	0–6	1.8				19.5
V-TK-101	NEL 696	4/07/03	0–6	1.8				18.7
V-TK-102	NEL 697	4/07/03	0–6	1.1				19.5
V-TK-103	NEL 698	4/07/03	0–6	3.5				24.7
V-TK-104	NEL 699	4/07/03	0–6	1.9	1.26	2.7	6.34	24.7
V-TK-106	NEL 740	4/14/03	0–6	2.6				19.5
V-TK-107	NEL 736	4/14/03	0–6	1.7				17.3
V-TK-108	NEL 737	4/14/03	0–6	2.2				18.0
V-TK-109	NEL 688	4/07/03	0–6	2.4				18.0
V-TK-110	NEL 689	4/07/03	0–6	0.7				19.5
V-TK-111	NEL 690	4/07/03	0–6	1.3				17.3
V-TK-112	NEL 691	4/07/03	0–6	0.7				19.5
V-TK-113	NEL 692	4/07/03	0–6	1.4				19.5
V-TK-114	NEL 694	4/07/03	0–6	3.1				18.7
V-TK-121	NEL 671	4/07/03	0–6	2.5				19.5
V-TK-122	NEL 685	4/07/03	0–6	1.3				18.7
V-TK-123	NEL 686	4/07/03	0–6	1.6				18.7
V-TK-124	NEL 687	4/07/03	0–6	2				18.0
V-TK-131	NEL 590	3/31/03	0–6	2				18.0
V-TK-132	NEL 591	3/31/03	0–6	0.2				18.0
V-TK-133	NEL 592	3/31/03	0–6	0.3				18.7

Table 3. Summary of Soil Data and Gamma Data After Remedial Excavation (continued)

Verification Block ID	Sample Ticket No.	Date Sampled	Sample Depth (cm)	OCS Ra-226 (pCi/g)	Lab Ra-226 (pCi/g)	Lab Th-230 (pCi/g)	Lab Uranium (pCi/g)	Average Uncollimated Gamma (µR/hr)
V-TK-134	NEL 593	3/31/03	0–6	1.3				18.7
V-TK-135	NEL 594	3/31/03	0–6	2.5				18.7
V-TK-141	NEL 584	3/31/03	0–6	0.9				18.0
V-TK-142	NEL 587	3/31/03	0–6	1.2				18.0
V-TK-143	NEL 588	3/31/03	0–6	2				18.0
V-TK-144	NEL 589	3/31/03	0–6	1.8				18.7
V-TK-145	NEL 595	3/31/03	0–6	2				18.7
V-TK-146	NEL 633	3/31/03	0–6	1.8	0.67	0.71	1.79	18.0
V-TK-147	NEL 634	3/31/03	0–6	1.4				19.5
V-TK-148	NEL 635	3/31/03	0–6	1.9				18.7
V-TK-149	NEL 676	4/07/03	0–6	2.4				19.5
V-TK-150	NEL 654	4/07/03	0–6	1.3				19.5
V-TK-151	NEL 577	3/31/03	0–6	1.2				18.7
V-TK-152	NEL 578	3/31/03	0–6	1				18.0
V-TK-153	NEL 583	3/31/03	0–6	2.1				18.0
V-TK-154	NEL 579	3/31/03	0–6	1.2				18.7
V-TK-155	NEL 585	3/31/03	0–6	1				18.0
V-TK-156	NEL 586	3/31/03	0–6	0.7				18.0
V-TK-157	NEL 636	3/31/03	0–6	2				18.7
V-TK-158	NEL 637	3/31/03	0–6	1.2				18.7
V-TK-159	NEL 638	3/31/03	0–6	1.6				18.7
V-TK-160	NEL 639	3/31/03	0–6	0.3				18.7
V-TK-161	NEL 672	4/07/03	0–6	2				19.5
V-TK-162	NEL 673	4/07/03	0–6	0.6				18.7
V-TK-163	NEL 674	4/07/03	0–6	4.2	0.52	0.88	1.65	20.2
V-TK-164	NEL 675	4/07/03	0–6	1.5				19.5
V-TK-165	NEL 655	4/07/03	0–6	1.2				19.5
V-TK-166	NEL 582	3/31/03	0–6	2.8				19.5
V-TK-167	NEL 629	3/31/03	0–6	2.5				19.5
V-TK-168	NEL 630	3/31/03	0–6	1				20.2
V-TK-169	NEL 631	3/31/03	0–6	0.5				19.5
V-TK-170	NEL 632	3/31/03	0–6	1.2				19.5
V-TK-171	NEL 682	4/07/03	0–6	1.9				19.5
V-TK-172	NEL 683	4/07/03	0–6	1.7	0.36	0.63	1.79	18.7
V-TK-173	NEL 684	4/07/03	0–6	1				19.5
V-TK-174	NEL 677	4/07/03	0–6	3.2				19.5
V-TK-175	NEL 678	4/07/03	0–6	4.3				19.5
V-TK-176	NEL 679	4/07/03	0–6	1.8				19.5

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

6.0 Final Condition

A summary of radiological results after remediation is provided in Table 4. 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)

All areas in the Hwy191 phase 1 area were verified to the surface standard to accommodate possible exposure of remediated soils during grading of the highway right-of-way.

6.2 Areas Verified to the Surface Standard

The 40 CFR 192 cleanup standard for surface areas is 5.8 pCi/g Ra-226. The maximum concentration of Radium-226 was 4.80 pCi/g, which is below the cleanup standard (Table 4). The mean Ra-226 concentration was 1.79 pCi/g. The projected upper limit of the mean concentration, calculated at the 95 percent confidence level, was 1.91 pCi/g. These results indicate that the radionuclide concentrations do not exceed the cleanup standards; therefore, all cleanup criteria have been met for the areas verified to the surface standard.

The excavated areas were backfilled with material with an average Ra-226 concentration of 0.6 pCi/g. Backfill soil sample results are shown in Table 5.

Table 4. 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	230	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 = 1.79 Maximum = 4.80 Std. dev = 1.07 $z_{95\%}$ = 1.65 $\mu_{95\%}$ = 1.91
Th-230 (pCi/g) Surface	20	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 = 1.72 Maximum = 2.70
Ra-226 (pCi/g) Subsurface	0	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	NA
Th-230 (pCi/g) Subsurface	0	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	NA
Uranium Surface	20	Not determined	Not determined	Laboratory Analysis Sample mean = 2.67 Maximum = 6.34
Uranium Subsurface	0	Not determined	Not determined	NA

NA = not applicable
n = number of measurements
$z_{95\%}$ = z distribution statistic at 95% confidence (n = 230 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 5. Backfill Data

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

7.0 References

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

40 CFR 192.22, Environmental Protection Agency (EPA), "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.

Order 5480.1B *Environment, Safety, and Health Program for Department of Energy Operations,* September 1986.

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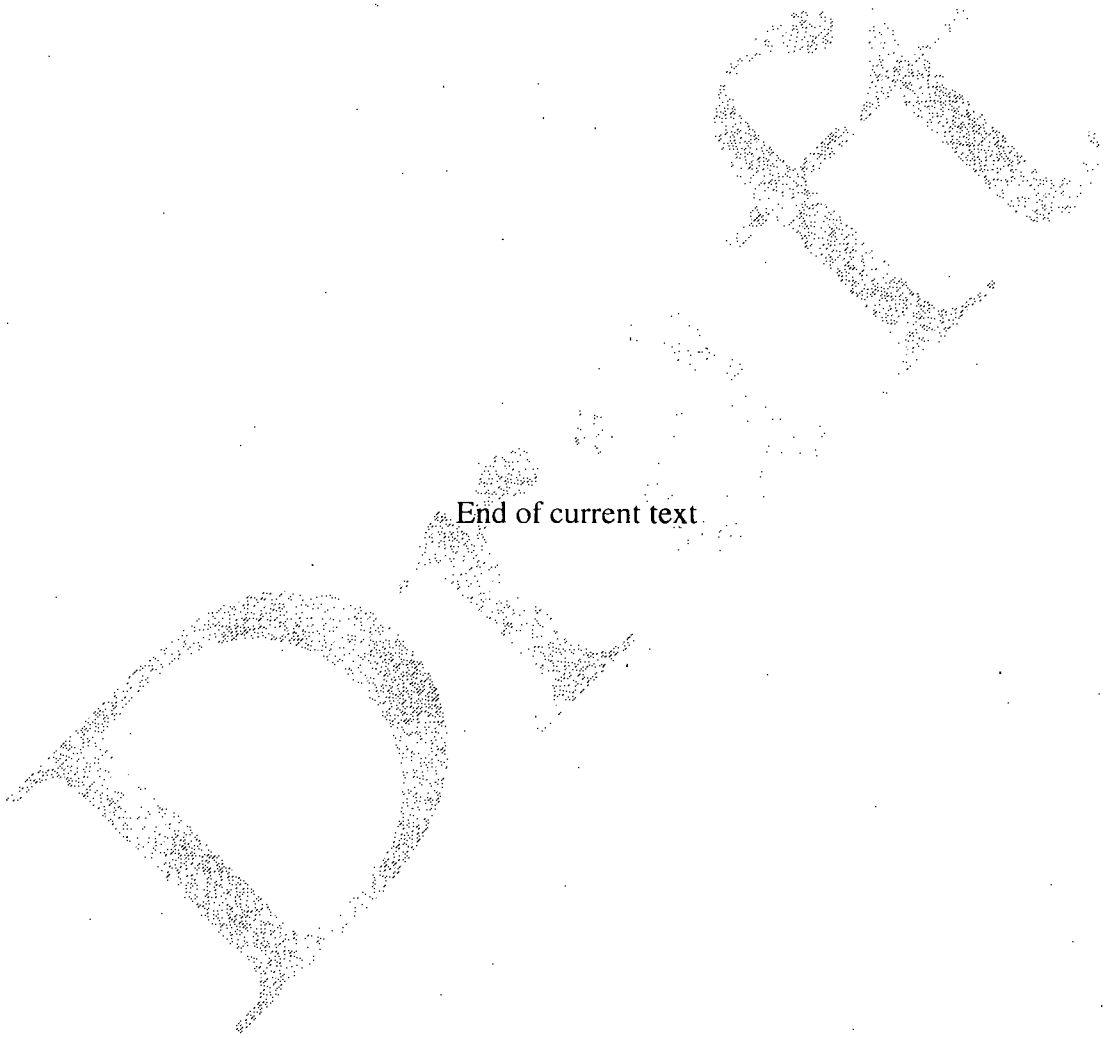

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