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MOAB UMTRA UTAH

UMTRA Project

Completion Report and Supplemental Standard Application for Moab Vicinity Property VP019

September 2007

U.S. Department of Energy

Office of Environmental Management

Work Performed Under DOE Contract No. DE-AC01-02GJ79491
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Draft
Completion Report and
Supplemental Standard Application For
Moab Vicinity Property
VP019

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 Property Description

This completion report is for the clean up of residual radioactive material (RRM) at Moab Vicinity Property VP019 which includes all of the accessible land located within the boundaries of Lot 5, Section 34, T25S, R21, Moab Utah, as well as the adjacent property to the east up to the edge of the Colorado River. The adjacent property is within the flood plain of the Colorado River. The property does not have an assigned address, but it is located on Highway 191, Moab, Utah, 84532. The property is owned by Don Policaro. The property is bounded on the north by the Department of Energy (DOE) Moab millsite, on the east by the Colorado River, and on the west and south by Bureau of Land Management (BLM) property. Utah Highway 279 passes through the property. A map showing the location of the property is shown in Figure 1.

The property includes two areas that were inaccessible due to steep terrain. These areas were not remediated and an application for supplemental standards is contained in Appendix A of this report.

This completion report summarizes the results of the remediation and the radiological survey data for VP019.

2.0 Basis for Remedial Action

Radiological contamination on VP019 originated from the Moab Uranium Mill Tailings Remedial Action (UMTRA) Project Site. This is a former uranium ore processing facility located about 3 miles northwest of the city of Moab. In 2001 the Floyd D. Spence National Defense Authorization Act (Act) was passed which required that the millsite 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. In conjunction with the millsite cleanup, RRM on the adjacent properties is also being remediated. Remediation is managed by the DOE Office of Environmental Management.

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), the *Vicinity Properties Management and Implementation Manual* (DOE 1988); and all other applicable environmental regulations with an emphasis on maintaining all health and safety risks as low as reasonably achievable.

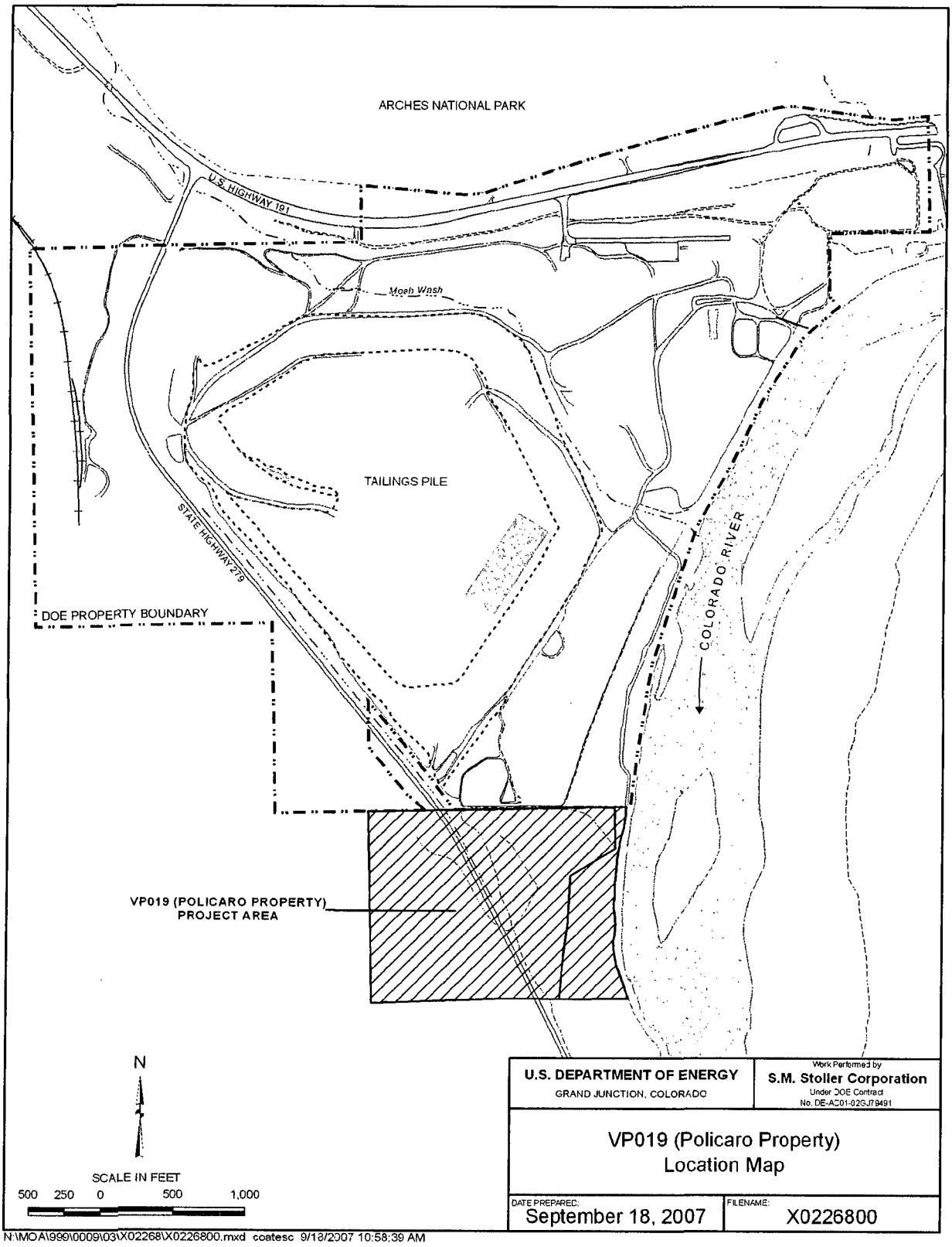

Figure 1. VP019 (Policaro Property) Location Map

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. Therefore, 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.

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
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 Work Performed

4.1 Instrumentation

Gamma scintillometers were used to identify areas where elevated gamma levels indicate possible Ra-226 contamination. The types of scintillometers used included handheld 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 (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.* All instruments had daily operation checks performed in accordance with the *Field Services Procedures Manual.*

4.2 Characterization Survey Prior to Remediation

In order to determine which areas of the property required remediation to meet the cleanup standards, the main property was assessed by S. M. Stoller in October through December, 2005. During this assessment radiological contamination was found to continue onto the eastern property. The eastern property was assessed in March, 2006. The property was assessed using procedures contained in the *Field Services Procedures Manual.* The assessment is contained in Stoller documents X01326, *Radiological Assessment for VP019 Moab, Utah* and X01725, *Addendum to the Radiological Assessment for VP019 Moab, Utah.* Plate 1 shows the areas assessed as requiring remediation. The assessment report was approved by the DOE.

4.3 Remediation

Remediation began in October 2006 and was completed in December 2006. Surveys of the remediated areas were performed in accordance with the *Field Services Procedure Manual.* 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 were removed from VP019 consisted of uranium mill tailings and uranium ore contaminated soils. Depths of removal ranged from 15 cm (6 inches) for surficial contamination to 1.52 m (5 feet) on the west side of the project area in a drainage. The contaminated material was stockpiled at the Moab Millsite. After the disposal cell at Crescent Junction, Utah is excavated, the material will be transported there for final disposal.

4.4 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 cleanup standards were achieved. Areas of VP019 that are designated on Plates 1 and 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.

4.4.1 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-ML). 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-ML-370). Composite verification soil samples were collected from the verification blocks shown in Plates 1 and 2.

4.4.2 Gamma Scan Measurements

The accessible excavated surface was 100 percent scanned for gamma using the handheld scintillometers. To minimize the amount of soil sampling required, field personnel determined a range of gamma reading 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
Collimated Surface 0 to 15 cm Excavation	4 to 8 µR/hr*
Collimated Subsurface >15 cm Excavation	4 to 8 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 Figure 2 and Figure 3. The block locations are shown in Plates 1 and 2.

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 Collimated Gamma (µR/hr)
V-CG-019	PAA 051	11/09/06	0-15	2.00					5.73
V-CG-061	PAA 374	08/28/07	0-15	2.20					5.46
V-CG-082	PAA 029	10/31/06	0-15	2.01					5.50
V-CG-104	PAA 375	08/28/07	0-15	3.20					5.75
V-CG-126	PAA 030	10/31/06	0-15	2.59					5.20
V-CH-005	PAA 060	11/09/06	0-15	1.34					5.48
V-CH-012	PAA 056	11/09/06	>15	1.10					5.36
V-CH-025	PAA 050	11/09/06	0-15	2.33					5.77
V-CH-038	PAA 107	12/04/06	>15	2.97					5.14
V-CH-052	PAA 038	11/07/06	>15	3.05					6.07
V-CH-056	PAA 040	11/07/06	>15	2.70					5.54
V-CH-065	PAA 023	10/31/06	0-15	0.65					5.53
V-CH-068	PAA 028	10/31/06	0-15	1.56					5.55
V-CH-091	PAA 031	10/31/06	0-15	3.49					5.64
V-CH-096	PAA 041	11/07/06	>15	4.51					5.15
V-CH-100	PAA 108	12/04/06	>15	3.27					4.71
V-CH-129	PAA 024	10/31/06	0-15	2.91					4.95
V-CH-139	PAA 042	11/07/06	>15	1.95					5.05
V-CH-150	PAA 376	08/28/07	0-15	4.50					4.81
V-CH-151	PAA 377	08/28/07	0-15	2.80					4.81
V-CH-155	PAA 025	10/31/06	0-15	2.55					5.24
V-CH-171	PAA 378	08/28/07	0-15	3.40					5.02
V-CH-172	PAA 379	08/28/07	0-15	3.70					5.27
V-CH-178	PAA 026	10/31/06	0-15	1.13					5.25
V-CH-182	PAA 043	11/07/06	>15	2.33					6.16
V-CH-185	PAA 109	12/04/06	>15	3.58					4.88
V-CH-193	PAA 380	08/28/07	0-15	3.10					4.57
V-CH-195	PAA 027	10/31/06	0-15	3.03					5.59
V-DG-038	PAA 064	11/14/06	>15	0.31					5.14
V-DG-082	PAA 062	11/14/06	>15	3.46					5.63
V-DG-100	PAA 071	11/07/06	>15	11.65					
V-DG-122	PAA 068	11/14/06	0-15	3.25					5.05
V-DG-165	PAA 067	11/14/06	0-15	0.92					5.00
V-DG-229	PAA 066	11/14/06	0-15	2.84					5.91
V-DG-269	PAA 053	11/09/06	0-15	1.08					5.24
V-DG-334	PAA 059	11/09/06	0-15	0.86					5.77
V-DH-016	PAA 078	11/15/06	>15	2.21					5.65
V-DH-019	PAA 079	11/15/06	>15	3.12	11.38	2.21	5.56	1.2	5.49
V-DH-022	PAA 100	11/28/06	>15	2.47					5.03
V-DH-031	PAA 110	12/04/06	>15	3.56					5.20
V-DH-048	PAA 101	11/28/06	>15	1.02					5.50
V-DH-049	PAA 015	10/04/06	>15	4.11					6.36
V-DH-055	PAA 111	12/04/06	>15	3.54					4.92
V-DH-060	PAA 039	11/07/06	>15	2.45					5.85
V-DH-067	PAA 102	11/28/06	>15	2.82					4.51

Table 4 (continued). 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 Collimated Gamma (µR/hr)
V-DH-073	PAA 112	12/04/06	>15	3.74					4.67
V-DH-079	PAA 120	12/04/06	>15	4.18					4.92
V-DH-092	PAA 016	10/04/06	>15	1.23					5.80
V-DH-124	PAA 044	11/07/06	>15	2.32					5.80
V-DH-130	PAA 095	11/28/06	>15	3.58					5.47
V-DH-136	PAA 094	11/28/06	>15	3.12					4.89
V-DH-138	PAA 121	12/04/06	>15	2.88					5.36
V-DH-143	PAA 045	11/07/06	>15	1.31	7.89	2.1	2.67	1.0	5.40
V-DH-172	PAA 096	11/28/06	>15	4.93					5.18
V-DH-190	PAA 063	11/14/06	0-15	4.17					7.17
V-DH-195	PAA 103	11/28/06	>15	4.32					5.40
V-DH-199	PAA 097	11/28/06	>15	0.48					4.63
V-DH-204	PAA 113	12/04/06	>15	3.28					5.72
V-DH-208	PAA 046	11/07/06	>15	2.92					6.05
V-DH-215	PAA 098	11/28/06	>15	2.33					5.34
V-DH-238	PAA 093	11/28/06	>15	4.15					5.02
V-DH-243	PAA 099	11/28/06	>15	1.91					4.74
V-DH-249	PAA 047	11/07/06	>15	3.40					5.71
V-DH-274	PAA 065	11/14/06	0-15	2.57					5.72
V-DH-285	PAA 058	11/09/06	>15	0.65					5.86
V-DH-303	PAA 055	11/09/06	>15	1.04					5.63
V-DH-308	PAA 114	12/04/06	>15	1.83					4.98
V-DH-312	PAA 048	11/07/06	>15	0.43					5.20
V-DH-319	PAA 061	11/14/06	0-15	0.66					5.51
V-DH-346	PAA 052	11/09/06	>15	1.28					5.41
V-DH-360	PAA 057	11/09/06	0-15	1.70					5.80
V-EG-137	PAA 161	11/01/06	>15	8.61					8.44
V-EG-142	PAA 132	12/18/06	>15	1.85					7.21
V-EG-145	PAA 133	12/18/06	>15	0.89					6.39
V-EG-181	PAA 381	08/28/07	>15	8.30					8.31
V-EG-206	PAA 134	12/18/06	>15	3.38					6.59
V-EG-209	PAA 135	12/18/06	>15	0.26					5.95
V-EG-245	PAA 069	11/14/06	>15	2.10	6.12	1.1	0.74	0.9	7.34
V-EG-250	PAA 136	12/18/06	>15	3.25					7.40
V-EG-293	PAA 145	12/18/06	>15	5.09					7.55
V-EG-309	PAA 382	08/28/07	>15	1.80					6.83
V-EG-330	PAA 383	08/28/07	>15	1.00					
V-EG-331	PAA 384	08/28/07	>15	0.10					
V-EG-352	PAA 070	11/14/06	>15	1.92					5.38
V-EH-108	PAA 131	12/14/06	>15	2.25	5.55	0.76	1.77	1.2	6.87
V-EH-110	PAA 122	12/13/06	>15	3.23	8.05	1.47	4.45	1.7	6.62
V-EH-116	PAA 123	12/13/06	>15	2.53	8.72	1.75	1.39	2.2	6.63
V-EH-119	PAA 129	12/13/06	>15	2.60	5.65	0.79	1	1.0	5.66
V-EH-121	PAA 130	12/13/06	>15	3.88	11.56	2.9	5.31	1.9	6.75
V-EH-124	PAA 072	11/15/06	>15	3.17					6.50
V-EH-130	PAA 124	12/13/06	>15	2.51	4.56	0.57	4.62	1.4	5.88
V-EH-133	PAA 127	12/13/06	>15	2.12	7.34	1.25	1.81	1.4	5.96

Table 4 (continued). 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 Collimated Gamma (µR/hr)
V-EH-136	PAA 128	12/13/06	>15	2.00	7.74	1.46	2.61	2.6	6.18
V-EH-139	PAA 125	12/13/06	>15	2.04	4.07	1.54	2.51	1.7	5.68
V-EH-152	PAA 126	12/13/06	>15	0.88	4.85	0.71	2.14	1.7	5.58
V-EH-180	PAA 147	12/18/06	>15	2.69					6.29
V-EH-184	PAA 146	12/18/06	>15	2.80					
V-EH-193	PAA 137	12/18/06	>15	3.76					6.47
V-EH-196	PAA 138	12/18/06	>15	1.64	11.02		18.2		5.50
V-EH-199	PAA 139	12/18/06	>15	2.84					6.74
V-EH-208	PAA 073	11/15/06	>15	2.49					5.92
V-EH-244	PAA 140	12/18/06	>15	5.76					6.96
V-EH-247	PAA 141	12/18/06	>15	3.51					6.67
V-EH-256	PAA 142	12/18/06	>15	4.05					5.40
V-EH-259	PAA 143	12/18/06	>15	0.53					4.67
V-EH-262	PAA 144	12/18/06	>15	1.70					4.97
V-EH-271	PAA 074	11/15/06	>15	2.54					5.51
V-EH-295	PAA 104	11/28/06	>15	7.05	16.87		5.44		5.82
V-EH-301	PAA 115	12/04/06	>15	5.27	12.32	4.25	1.85	1.2	5.78
V-EH-306	PAA 116	12/04/06	>15	1.25	5.55	1.44	0.88	1.0	4.98
V-EH-311	PAA 117	12/04/06	>15	4.90					6.18
V-EH-314	PAA 075	11/15/06	>15	4.17					5.68
V-EH-319	PAA 105	11/28/06	>15	0.11	3.28		0.484		4.11
V-EH-331	PAA 118	12/04/06	>15	2.53					5.70
V-EH-349	PAA 119	12/04/06	>15	2.00					4.73
V-EH-355	PAA 080	11/15/06	>15	1.43					5.38
V-EH-361	PAA 106	11/28/06	>15	5.23					5.21
V-EI-130	PAA 081	11/15/06	>15	1.76					5.08
V-EI-148	PAA 087	11/15/06	>15	2.47					5.78
V-EI-176	PAA 088	11/15/06	>15	2.94					4.73
V-EI-193	PAA 082	11/15/06	>15	2.57					5.38
V-EI-211	PAA 083	11/15/06	>15	3.23					5.63
V-EI-238	PAA 084	11/15/06	>15	1.99					4.71
V-EI-256	PAA 076	11/15/06	>15	3.99					4.95
V-EI-280	PAA 085	11/15/06	>15	2.87					4.91
V-EI-319	PAA 077	11/15/06	>15	3.63					4.98
V-EI-358	PAA 086	11/15/06	>15	3.64					5.64

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

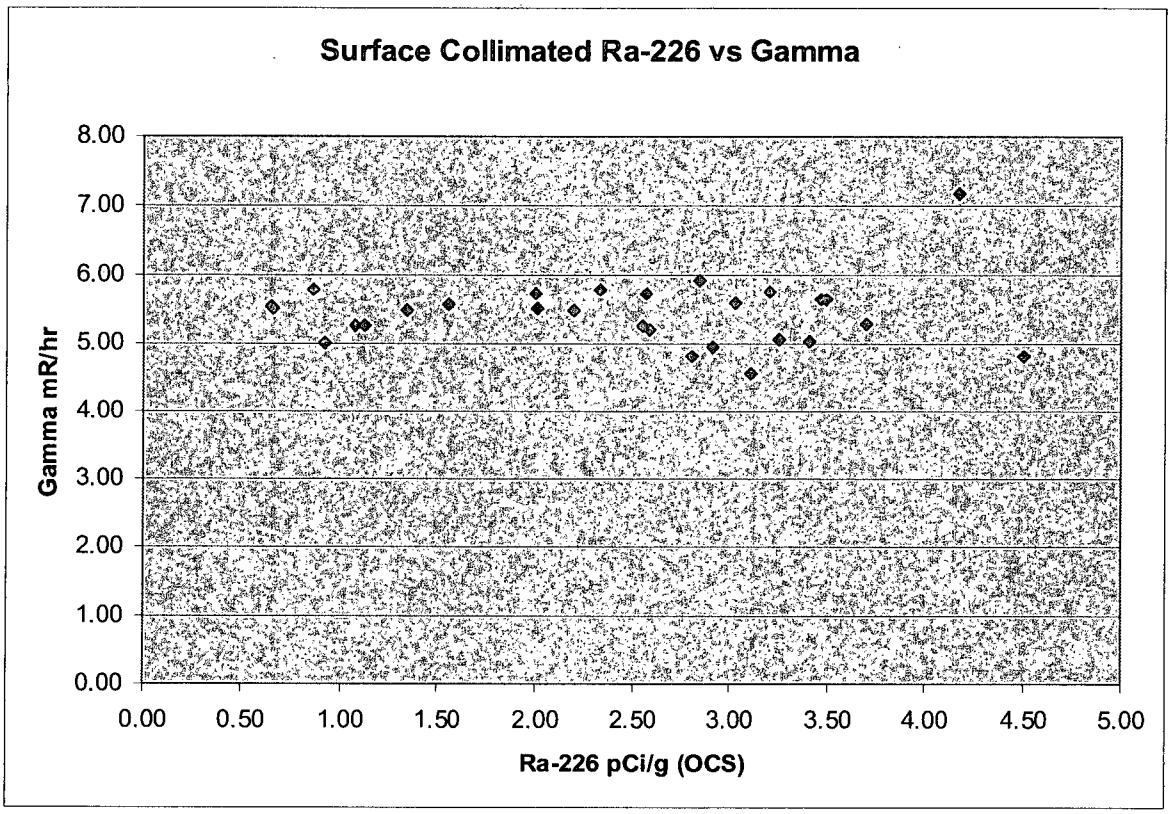

Figure 2. Collimated Data for Areas Verified to the Surface Standard

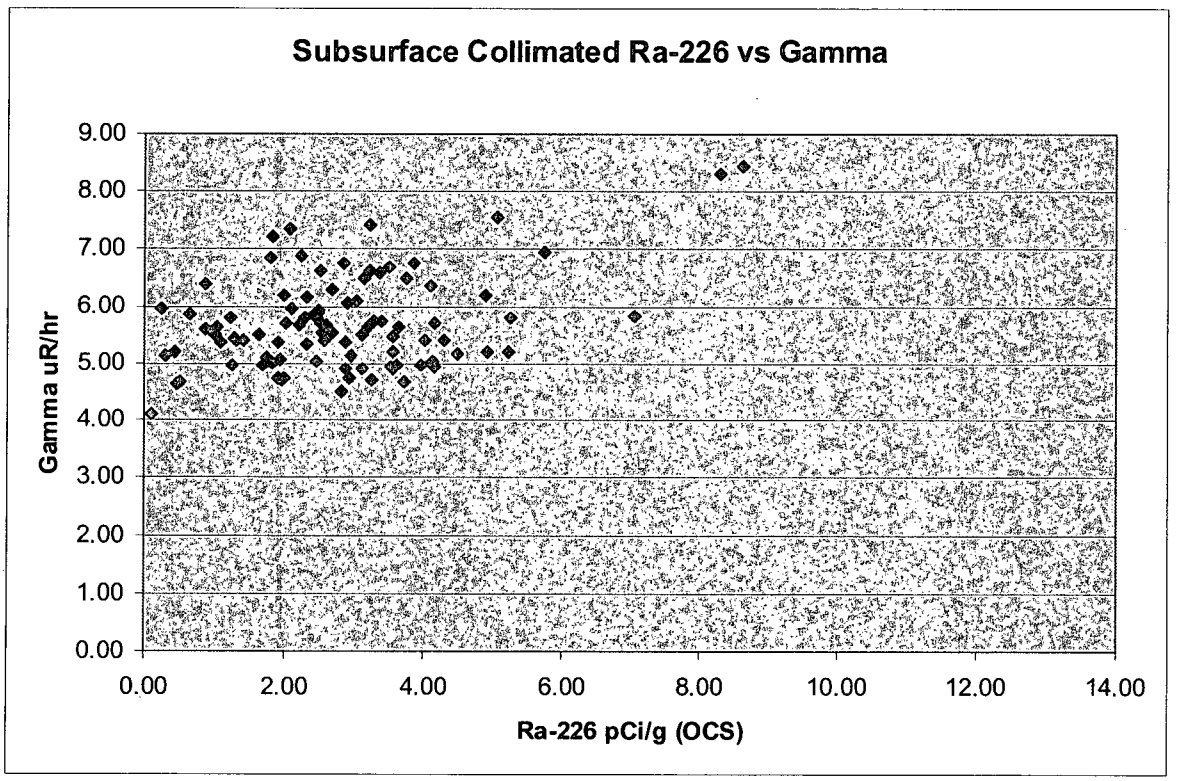

Figure 3. Collimated Data for Areas Verified to the Subsurface Standard

The results of the GS/GPS scans prior to backfilling and final grading are shown in Plate 2. Blocks V-CH-150, -151, -171, -172, -193, V-CG-061, V-EG-309, -330, -331, and -352 did not have GS/GPS data because during scanning they were used as stock pile areas for large rocks. These areas were later verified by soil sampling. The area marked as "Drainage" in the central part of the property was not GS/GPS scanned because it was too muddy to access using the ATV mounted scanner. Scanning using handheld scintillometers showed gamma levels that were comparable to adjacent areas of the site. The other areas on Plate 2 which do not show gamma measurements are due to imprecision in the GPS locations.

4.4.3 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 4.4.2) was being developed; or 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 127 OCS soil samples collected, and 15 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. An additional three samples were submitted to an outside laboratory for Th-230 analysis.

The independent laboratories that performed the quality control analyses were Severn Trent Laboratories St. Louis (STL) and Paragon Analytics Laboratories. 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. Paragon Analytics Laboratories analyzed the three additional Th-230 samples by SOP714R10. All methods are approved by DOE.

As indicated in Table 4, the laboratory analytical results validated the use of OCS for soil verification. The 15 verification samples measured by both the OCS and the independent laboratory averaged 3.26 pCi/g according to the OCS method and 2.46 pCi/g in the laboratory. Therefore, OCS results collected in the field can be considered conservative and are a valid verification measurement. The uranium results by the semi-quantitative HPGe method averaged 7.90 pCi/g and 2.31 pCi/g by the laboratory.

4.4.4 Radon Decay-Product Concentration (RDC) Measurements

There are no habitable structures on the property so RDC measurements were not required.

5.0 Final Condition

A summary of radiological results after remediation is provided in Table 5. Because of the 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.

Table 5. Summary of Radiological Release Survey Results

Certification Criteria	Number of Observations	Cleanup Standard	Cleanup Standard Including Background	Results pCi/g
Ra-226 (pCi/g) Surface	29	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 = 2.40 Maximum = 4.50 Std. dev = 1.05 $z_{95\%}$ = 1.65 $\mu_{95\%}$ = 2.74
Th-230 (pCi/g) Surface	0	Shall not exceed 5 pCi/g above background in the surface to 15-cm layer based averaged over 100 m^2	5.8	NA
Ra-226 (pCi/g) Subsurface	98	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 = 2.87 Maximum = 11.65 Std. dev = 1.79 $z_{95\%}$ = 1.65 $\mu_{95\%}$ = 3.17
Th-230 (pCi/g) Subsurface	18	Shall not exceed 43.2* pCi/g above background in any 15-cm-thick soil layer more than 15 cm below the surface, averaged over 100 m^2 over 1,000 year performance period*	43.2	Laboratory Analysis Sample mean = 3.52 Maximum = 18.20
Uranium Surface	0	Not determined	Not determined	NA
Uranium Subsurface	15	Not determined	Not determined	Laboratory Analysis Sample mean = 1.47 Maximum = 2.62
Interior RDC	0	<0.02 WL	<0.02 wl	NA

*See Table 1

NA = not applicable

n = number of measurements

$z_{95\%}$ = z distribution statistic at 95% confidence (n = 98 for > 15 cm, n = 29 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:

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

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

The 40 CFR 192 standard for subsurface areas is 15.8 pCi/g Ra-226. For subsurface areas the maximum concentration was 11.65 pCi/g, which is below the cleanup standard (Table 5). The mean Ra-226 concentration was 2.87 pCi/g. The projected upper limit of the mean concentration, calculated at the 95 percent confidence level, was 3.17 pCi/g.

The maximum Th-230 value was 18.20 pCi/g. The Ra-226 at this location (V-EH-196) was 11.02 pCi/g. Based on the clean-up standard shown in Table 1, the Th-230 value could be up to 24.6 pCi/g and still meet the Ra-226 standard at the end of the 1,000-year performance period. The actual value of 18.20 pCi/g was below this maximum level. The average value for Th-230 was 3.52 pCi/g.

The average uranium was 1.47 pCi/g, the maximum value was 2.62 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 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 0.75 pCi/g. Backfill soil sample results are shown in Table 6.

Table 6. Backfill Data

Sample Identification	OCS Ra-226 (pCi/g)
Kyes Construction #1	0.6
Kyes Construction #2	0.9

5.2 Areas Verified to the Surface Standard

For areas verified to the surface standard, the maximum concentration of Ra-226 was 4.50 pCi/g, which is below the cleanup standard of 5.8 pCi/g (Table 5). The mean concentration was 2.40 pCi/g. The projected upper limit of the mean concentration, calculated at the 95 percent confidence level, was 2.74 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.

5.3 Areas That Did Not Require Remediation

The millsite characterization (Section 4.2) demonstrated that some areas of VP019 were below the 40 CFR 192 cleanup standards 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 7. Radium-226, and Uranium Data in Areas that Were Not Remediated

Location	Sample Ticket	Date	Sample Depth (cm)	OCS Ra-226 (pCi/g)	HPGe Uranium (pCi/g)
R0179	NEM 924	3/6/06	0 to 15	3.20	
R0180	NEM 925	3/6/06	0 to 15	2.00	
R0181	NEM 926	3/6/06	0 to 15	3.60	9.5
R0182	NEM 927	3/6/06	0 to 15	2.40	
R0183	NEM 928	3/6/06	0 to 15	3.00	
R0184	NEM 929	3/6/06	0 to 15	1.17	
R0185	NEM 930	3/6/06	0 to 15	3.53	
R0186	NEM 931	3/6/06	0 to 15	3.07	5.4
R0187	NEM 932	3/6/06	0 to 15	4.29	
R0188	NEM 933	3/6/06	0 to 15	4.27	
R0189	NEM 934	3/6/06	0 to 15	3.10	
R0190	NEM 935	3/6/06	0 to 15	2.84	
R0191	NEM 936	3/6/06	0 to 15	3.53	
R0192	NEM 937	3/6/06	0 to 15	3.31	
R0193	NEM 938	3/6/06	0 to 15	1.64	
R0194	NEM 939	3/6/06	0 to 15	1.61	
R0195	NEM 940	3/6/06	0 to 15	1.40	
R0196	NEM 941	3/6/06	0 to 15	3.30	
R0197	NEM 942	3/6/06	0 to 15	3.10	
R0200	NEM 945	3/6/06	0 to 15	2.20	
R0201	NEM 946	3/6/06	0 to 15	3.50	
R0202	NEM 947	3/6/06	0 to 15	2.10	
R0203	NEM 948	3/6/06	0 to 15	1.60	
R0204	NEM 952	3/6/06	0 to 15	2.20	
R0205	NEM 953	3/6/06	0 to 15	2.00	
R0206	NEM 954	3/6/06	0 to 15	1.80	
R0207	NEM 955	3/6/06	0 to 15	3.80	
R0208	NEM 956	3/6/06	0 to 15	1.00	
R0209	NEM 957	3/6/06	0 to 15	2.20	
R0210	NEM 958	3/6/06	0 to 15	4.40	
R0211	NEM 959	3/6/06	0 to 15	2.50	
R0212	NEM 960	3/6/06	0 to 15	1.30	
R0213	NEM 961	3/6/06	0 to 15	3.10	
R0214	NEM 962	3/6/06	0 to 15	4.50	10.5
R0215	NEM 963	3/6/06	0 to 15	2.60	
R0216	NEM 964	3/6/06	0 to 15	3.63	
R0217	NEM 965	3/6/06	0 to 15	2.42	
R0218	NEM 966	3/6/06	0 to 15	0.98	
R0219	NEM 967	3/6/06	0 to 15	2.84	
R0221	NEM 969	3/6/06	0 to 15	3.98	6.3
R0222	NEM 970	3/6/06	0 to 15	1.73	
R0223	NEM 971	3/6/06	0 to 15	1.05	
R0224	NEM 972	3/6/06	0 to 15	1.80	
R0225	NEM 973	3/6/06	0 to 15	2.84	
R0226	NEM 949	3/6/06	0 to 15	1.20	
R0227	NEM 950	3/6/06	0 to 15	3.00	4.6
R0228	NEM 951	3/6/06	0 to 15	4.87	

Note: Blank cells indicate no measurement for that analyte or by that method were taken.

6.0 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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STO 4. *Training Manual*, continuously updated, prepared by S.M. Stoller Corporation for the U.S. Department of Energy, Grand Junction, Colorado.

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STO 17. *Information Technology Policy and Procedures Manual*, continuously updated, prepared by S.M. Stoller Corporation for the U.S. Department of Energy, Grand Junction, Colorado.

STO 18. *Procurement 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.

STO 207. *Finance and Accounting Procedures*, continuously updated, prepared by S.M. Stoller Corporation for the U.S. Department of Energy, Grand Junction, Colorado.

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Appendix A

Supplemental Standard Application for

Moab Vicinity Property

VP019

Contents

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1.0 Applicable EPA Criteria

This Supplemental Standards Application is in accordance with the regulations set by Environmental Protection Agency (EPA) in 40 CFR 192. The potential and applicable criteria as stated in CFR 192.21 are as follows:

__X__ (a) Remedial actions required to satisfy subpart A or B would pose a clear and present risk of injury to workers or to members of the public, notwithstanding reasonable measures to avoid or reduce risk.

__X__(b) Remedial actions to satisfy the cleanup standards for land, §192.12(a), and groundwater, §192.12(c), or the acquisition of minimum materials required for control to satisfy §§192.02(b) and (c), would, notwithstanding reasonable measures to limit damage, directly produce health and environmental harm that is clearly excessive compared to the health and environmental benefits, now or in the future. A clear excess of health and environmental harm is harm that is long-term, manifest, and grossly disproportionate to health and environmental benefits that may reasonably be anticipated.

__X__(c) The estimated cost of remedial action to satisfy §192.12(a) at a "vicinity" site (described under section 101(6)(B) of the Act) is unreasonably high relative to the long-term benefits, and the residual radioactive materials do not pose a clear present or future hazard. The likelihood that buildings will be erected or that people will spend long periods of time at such a vicinity site should be considered in evaluating this hazard. Remedial action will generally not be necessary where residual radioactive materials have been placed semi-permanently in a location where site-specific factors limit their hazard and from which they are costly or difficult to remove, or where only minor quantities of residual radioactive materials are involved. Examples are residual radioactive materials under hard surface public roads and sidewalks, around public sewer lines, or in fence post foundations. Supplemental standards should not be applied at such sites, however, if individuals are likely to be exposed for long periods of time to radiation from such materials at levels above those that would prevail under §192.12(a).

_____ (d) The cost of a remedial action for cleanup of a building under §192.12(b) is clearly unreasonably high relative to the benefits. Factors that should be included in this judgment are the anticipated period of occupancy, the incremental radiation level that would be affected by the remedial action, the residual useful lifetime of the building, the potential for future construction at the site, and the applicability of less costly remedial methods than removal of residual radioactive materials.

_____ (e) There is no known remedial action.

_____ (f) The restoration of groundwater quality at any designated processing site under §192.12(c) is technically impracticable from an engineering perspective.

_____ (g) The groundwater meets the criteria of §192.11(e).

_____ (h) Radionuclides other than radium-226 and its decay products are present in sufficient quantity and concentration to constitute a significant radiation hazard from residual radioactive materials.

2.0 Introduction

This Supplemental Standards Application is for Moab Vicinity Property VP019. Figure A–1 shows the location of the property and Plate 1 shows the two areas for which supplemental standards are proposed.

2.1 Location and Legal Description

This application is for Moab Vicinity Property VP019 which includes all of the accessible land located within the boundaries of Lot 5, Section 34, T25S, R21, Moab, Utah. The property does not have an assigned address but it is located on Highway 191, Moab, Utah, 84532. The property is owned by Don Policaro. The property is bounded on the north by the Department of Energy (DOE) Moab millsite, on the east by the Colorado River, and on the west and south by Bureau of Land Management property. A map showing the location of the property is shown in Figure A–1.

2.2 Major Physical Features

VP019 consists of vacant land that has rocky hills and cliffs on the west, sloping down to relatively flat areas adjacent to the Colorado River. Vegetation is sparse in the steep areas. The site is crossed by Utah Highway 279 and a major power transmission line.

There are two areas being considered for supplemental standards. The larger of these two areas is 24,119 m^2 (5.96 acres) located west of the Utah Highway 279. This area consists of a steep slope which rises to approximately 400 feet above the road grade. This area is shown in Figure A–2. The smaller parcel is long and narrow and borders the eastern side of the Highway 279 right-of-way for approximately 700 feet near the northern boundary of the property. This strip is the steep embankment built for the road and is too rocky and steep to walk up easily. It is shown in Figure A–3. Both areas have very sparse vegetation. The total area of the two is approximately 24, 281 m^2 (6 acres).

2.3 Land Use

The property is currently vacant land and no land use change is anticipated that would disturb or affect the supplemental standard areas. The only utility is the high energy transmission line that crosses the property. No potable water or sewer line service the region west of the Colorado River. Consequently it would be very difficult to change the use of the property to a higher density. In addition, the large eastern area of the remediated portion of the property is in the 100-year flood plain of the Colorado River.

Although the property is privately held, the only impediment to access is a new barbed wire fence and signage constructed by the Department of Energy. There is very little attraction to the site. Mountain biking is popular in the area, but public lands nearby provide more attractive venues. Nevertheless, bikers passing by the land on the paved highway might receive potential dose from the RRM. It is possible that a hiker might traverse the site also, but there are no trails, a narrow shoulder on the road, and no nearby features. Therefore, potential doses calculated for hikers and bikers are considered very conservative.

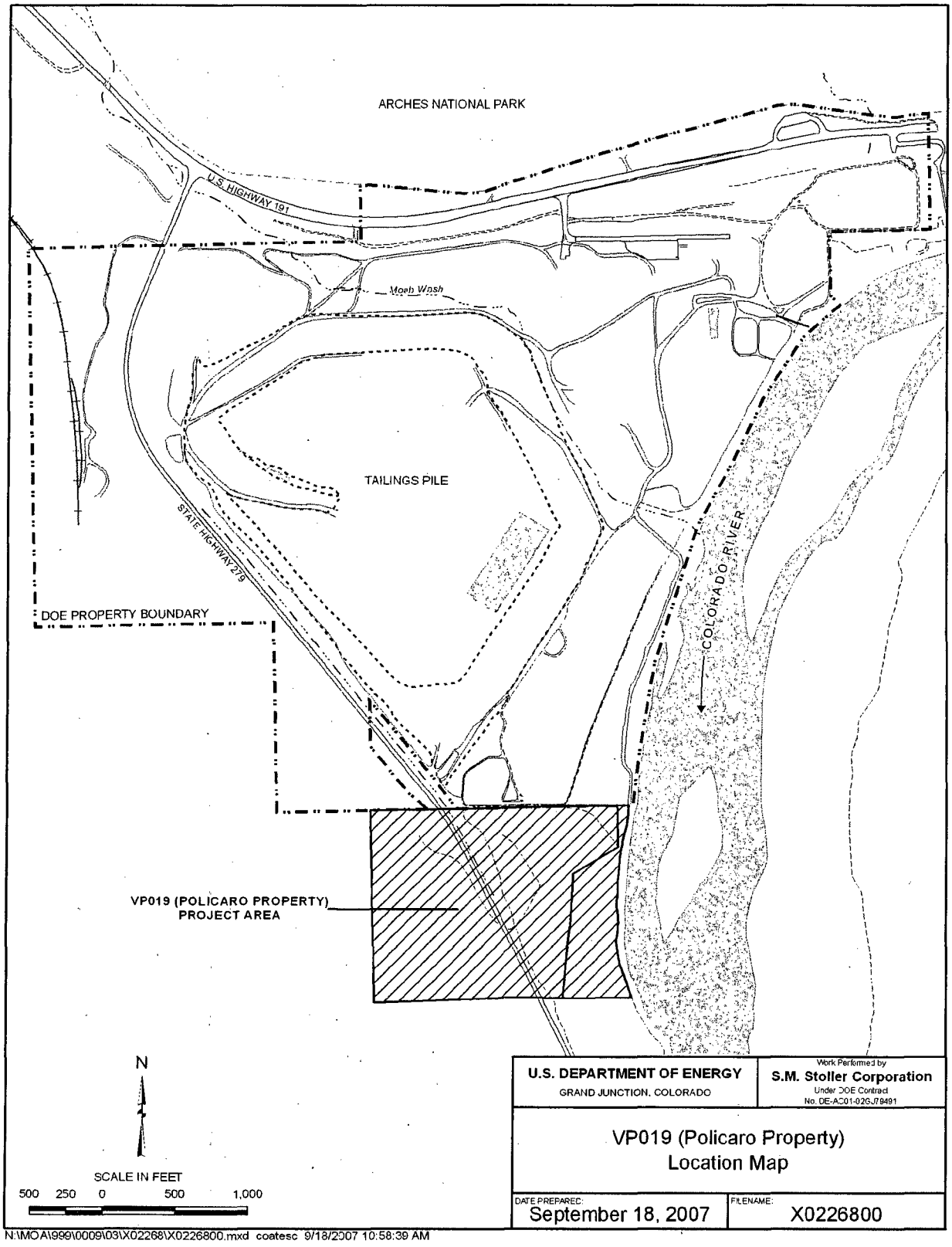

Figure A–1. VP019 (Policaro Property) Location Map

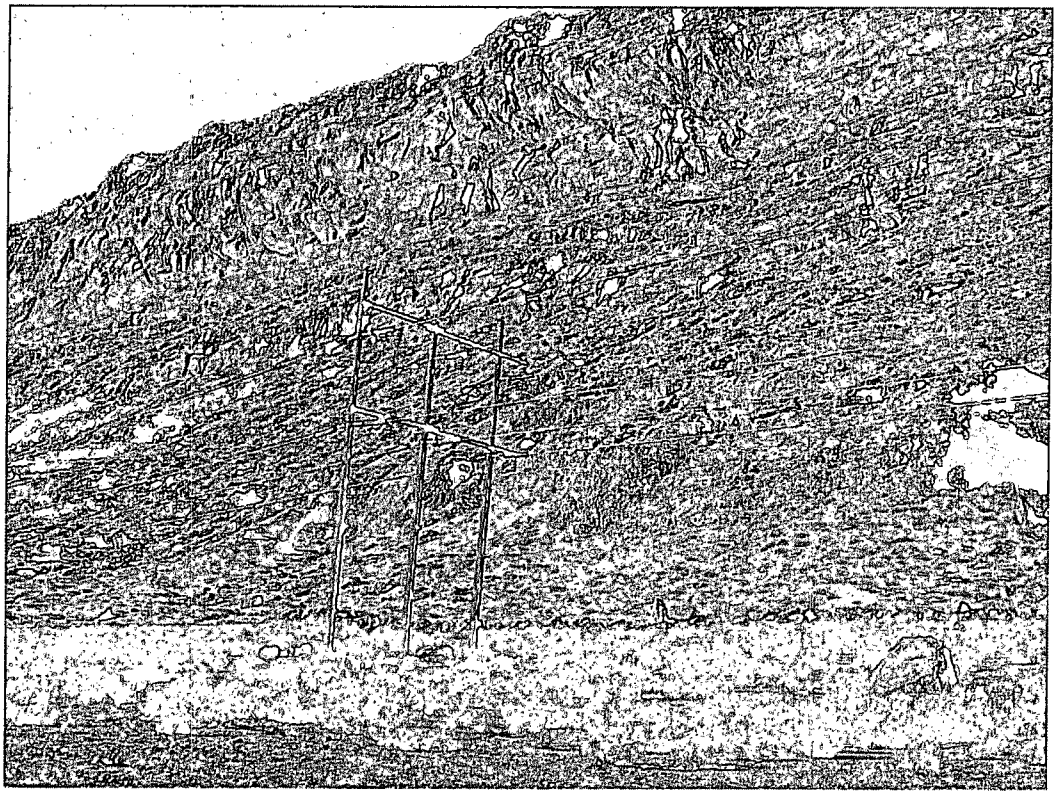

Figure A–2. Supplemental Standards Area One, Boulders Mark Edge of Remediated Area

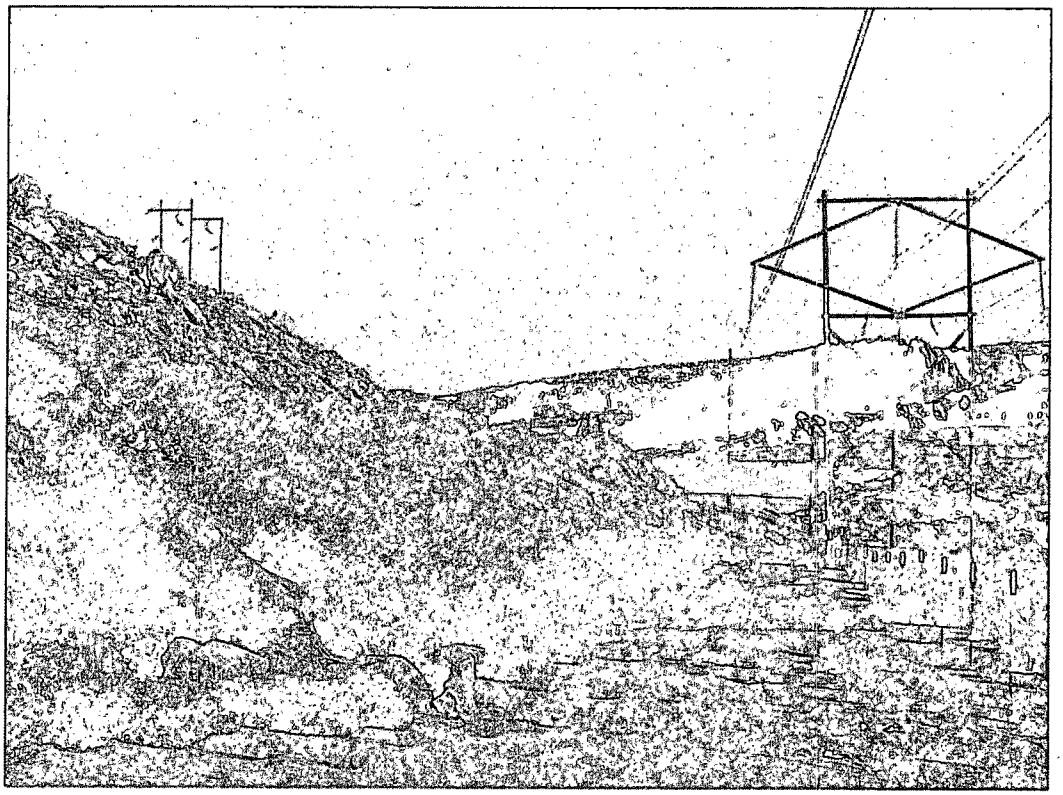

Figure A–3. Supplemental Standards Area Two, Highway is at Top of Hill

2.4 Owner and Local Agency Input

Note: text for this section will be added later

2.5 General Assumptions and Parameters

The parameters of the supplemental standards areas are shown on Plate 1 and are labeled as Area One and Area Two.

Remaining RRM is likely windblown mill tailings from the former Moab Atlas mill. Ra-226 concentrations in surface soils range from 17.8 to 50.1 pCi/g in the top 6". Ambient gamma at 1 m above ground level ranges from 21 to 58 μR/hr. Radiological data is based on direct gamma exposure rate measurements and laboratory analysis of soils collected from the property. Because of the steepness and ruggedness of the both slopes, very little radiological data could be obtained.

3.0 Radiological Data

3.1 Health Risk Analysis

Radiation doses to members of the public from residual radioactive materials were calculated using data generated during the remedial action site surveys. Attachment 1 details the equations and calculations.

3.1.1 Potential Exposure Pathways

The potential exposure pathways for both hikers and bikers on the site are as follows:

- Direct gamma exposure
- Inhalation of dust from radionuclides while traversing or passing by the site and
- Ingestion of windblown radionuclides in soil while traversing and passing by the site.

Exposure pathways explicitly not considered in the analysis include inhalation of radon decay products, consumption of vegetation grown on the site, and ingestion of water from sources on the site. Radon gas from the site would diffuse off-site before a significant concentration of radon decay products could build up. There is no edible vegetation in the area and it is highly unlikely that the supplemental standards area would be used to grow edible plants. There are no water sources on the site.

For the purpose of calculating the direct gamma radiation dose it was assumed that a hiker spent up to two hours traversing the site once per month for a year, a highly conservative scenario. The biker was assumed to ride by the site once weekly in both directions at a speed of 5 mph. The lower exposure rate of 21 μR/hr was used for the biker because it was assumed that his or her center of body mass would be slightly higher than for the hiker. Annual dose equivalents were calculated. Table 2 summarizes the assumptions used.

Table A–1. Parameter Values Used in the Estimate of Dose

Parameter	Assumed or Measured Value	
	Hiker	Biker
Exposure time per event	2 hr	0.4 hr
Events per year	12	52
Soil Ingestion	0.1 g/day	0.1 g/day
Airborne dust concentration	1.5E-4 g/m^3	1.5E-4 g/m^3
Ra-226 concentration	50 pCi/g	50 pCi/g
Net gamma exposure rate	21–58 uR/hr	21–58 uR/hr

3.1.2 Results

Using the parameters shown above, the estimated doses are as shown below for the hiker and the biker. Low and high values of direct exposure came from using the range of exposures shown above. Estimates of dust inhalation and soil ingestion were calculated for single values only.

Table A–2. Summary of Exposures to Hikers and Bikers

Pathway	Hiker	Biker
	mrem/yr	
Direct exposure - low value	3.5E-01	3.1E-01
Direct exposure – high value	9.7E-01	8.4E-01
Dust inhalation	5.4E-02	4.7E-02
Soil ingestion	1.2E-01	1.1E-01
Total	0.53–1.2	0.46–1.0

Total dose equivalents for the hiker, under the conservative assumptions made range from 0.5 to 1.2 mrem per year. Values for the biker are very similar ranging from 0.46 to 1 mrem per year. In actuality, doses to hikers or bikers accessing the area are likely to be far smaller. These are well below both the 100 mrem/yr standard used by the NRC for acceptable doses to the public, or the 25 mrem/yr standard used by the NRC for decommissioning.

4.0 Remediation Alternatives

4.1 Alternative 1–No Remediation (Supplemental Standards)

No additional work is required under this alternative. The health risks associated with this alternative are summarized in Table A–2. Using conservative estimates the total exposure to users is 0.5 - 1.2 mrem/yr. This alternative would minimize disturbance of the fragile and scenic desert terrain present on this property. No additional costs would be incurred if this alternative is chosen.

Although no other action is required, the DOE installed a barbed wire fence to help the owner deter campers from using the property.

4.2 Alternative 2–Full Remediation

Implementing this alternative would require removal of all soil contaminated in excess of the EPA standard. The area is approximately 24,280 m^2 (6 acres) and the estimated volume of material to be removed (based on a 15-cm (6- inch) soil layer) for windblown contamination would be 3,700 cubic meters of material. Because of the steep slopes, unstable soils, and large rocks present, conventional equipment could not be used. The cliff portions of the site cannot be remediated by any known technology that would not permanently damage the natural terrain and stability of the hillside. Hand excavation or large scale washing would be required to remove the contamination from the less steep areas. This would exposure workers to potential risks such as falling rocks, landslides, and falls. The estimated cost to remediate this area is approximately $208K.

In addition, the highway embankment in Area 2 is already at it's maximum slope of approximately 1:1. Any work to remediate it would require rerouting the highway temporarily as remediation would affect the stability of the slope. The estimated cost to remediate the highway is approximately $163K.

Under this alternative the health risks to the public due to radiological exposure would be reduced. However the work would cause ecological damage to the fragile and scenic desert terrain. Because of the steepness of the slope, revegetation would be difficult or impossible. This property is close to, and visible from, Arches National Monument and large scale disturbance may be visually unacceptable.

5.0 Summary and Recommendations

The accessible portions of the site have been remediated to EPA standards contained in 40 CFR 192. Two areas totaling approximately 24,280 m^2 (6 acres) have not been remediated because they consist of steep rocky hillsides and sandstone cliffs. These areas are vacant land and will probably remain vacant lands due to their steepness. The contamination remaining on the site would not pose a significant present or future health risk due to the low levels of radioactivity and limited use by members of the public. Remediation of the site would pose an unacceptable risk to workers performing the remediation due to the steepness of the site. Any remediation will result in ecological damage to the fragile desert terrain and restoration may be difficult or impossible.

Based on this S. M. Stoller recommends that *Alternative 1 – No Remediation* be approved. The estimated gamma exposure rate for a member of the public under this alternative is 0.5–1.2 mrem/yr. This exposure is a small fraction of the NRC's 25 mrem per year decommissioning standard, even when very conservative assumptions are used.

End of current text

Attachment 1

Assessment of Potential Public Dose from Residual Radioactive Materials

Policaro Property (VP019)

Supplemental standards are sought for the 12.4 acre Policaro property (Lot 5, Section 34, T25S, R21, Moab). Radiation doses to members of the public from residual radioactive materials were calculated using data generated during the remedial action site surveys. These surveys included direct gamma exposure rate measurements and laboratory analysis of soils collected from the property.

The property is currently vacant land and no land use change is anticipated that would disturb or effect the supplemental standard areas. Remaining residual radioactive material is likely windblown mill tailings from the Moab Atlas mill. Ra-226 concentrations in surface soils range from 17.8 to 50.1 pCi/g in the top 6". Ambient gamma at 1 m above ground level ranges from 21 to 58 μR/hr. The area for which supplemental standards are sought is slightly over 6 acres in two parcels. The larger of these two (5.96 ac) is west of the Utah Highway 279. This parcel consists of a naturally vegetated steep slope which rises to approximately 400 feet above the road grade. The smaller parcel is long and narrow and borders the eastern side of Hwy 279 Right-of-Way for approximately 700 feet near the northern boundary of the property. This strip comprises the steep embankment built for the road and is too rocky and steep to walk up.

Although the property is privately held, the only impediment to access is a barbed wire fence and signage. There is very little attraction to the site. Mountain biking is popular in the area, but public lands nearby provide more attractive venues. Nevertheless, bikers passing by the land on the paved highway might receive potential dose from the residual radioactive material. It is possible that a hiker might traverse the site also, but there are no trails, a narrow shoulder on the road and no nearby features. Therefore, potential doses calculated for hikers and bikers are considered very conservative.

All doses calculated in this assessment are effective doses.

Potential exposure pathways

The potential exposure pathways for both hikers and bikers on the site are as follows:

- Direct gamma exposure
- Inhalation of dust from radionuclides while traversing or passing by the site and
- Ingestion of windblown radionuclides in soil while traversing and passing by the site.

Exposure pathways explicitly not considered in the analysis include inhalation of radon decay products, consumption of vegetation grown on the site, and ingestion of water from sources on the site. Radon gas from the site would diffuse off-site before a significant concentration of radon decay products could build up. There is no edible vegetation in the area and it is highly unlikely that the area would be used to grow edible plants. There are no water sources on the site.

Dose Equations

The total dose to either the hiker or the biker is described by:

$D_T = D_G + D_D + D_S$,

Where:

D_T = total dose
D_G = dose from direct radiation exposure
D_D = dose from inhalation of radionuclides in airborne dust
D_S = dose from soil ingestion.

The basic equations for calculating the dose by each exposure pathway are as follows:

Direct radiation exposure

$D_G = [X][0.7\ \text{mrem/mR}][t][1.0E\text{-}3\ \text{mR}/\mu\text{R}]$

Where:

X = measured exposure rate (μR/hr)
t = time of exposure (hr)

The conversion factor for exposure (mR) to dose (mrem) was derived from the values given by UNSCEAR (2000). The factor of 0.7 for an adult takes into account self-shielding of critical organs by the body.

For the purpose of calculating the direct gamma radiation dose it was assumed that a hiker spent up to two hours traversing the site once per month for a year, a highly conservative scenario. The biker was assumed to ride by the site once weekly in both directions at a speed of 5 mph. The lower exposure rate of 21 μR/hr was used for the biker because it was assumed that his or her center of body mass would be slightly higher than for the hiker. Annual dose equivalents were calculated.

Inhalation of dust

$D_D = [t][I_{inh}][C_d][C_s][DC(inh))][2.5][3.7E\text{-}2\ \text{Bq/pCi}][1E5\ \text{mrem/Sv}]$

Where:

I_{inh} = inhalation rate = 1.7 m3/hr
C_d = total dust concentration in air (g/m3)
C_{si} = concentration of Ra^{226} in soil (pCi/g)
DC(inh) = ICRP72 inhalation dose coefficient for Ra^{226} per Ci/g for an adult (Sv/Bq).

The transit times used for direct radiation exposure, 2 hr for the hiker and 0.4 hr for the biker were applied to the calculation of dust inhalation, as were the number of events annually. An enhancement factor of 2.5 was used in the analysis to account for the fact that the radionuclide concentrations in airborne dust may be greater than the concentrations in soil. This factor is generally accepted and is used in the dose analyses performed by the MILDOS code (ANL 1998).

The ICRP 72 dose coefficients (ICRP 1996) were used for inhalation and ingestion dose calculations. The coefficients are given below. The coefficients for Ra-226 and its decay products, Po-210 and Pb-210, were summed and applied to the Ra-226 intake.

ICRP 72 Dose Coefficients for Ra^{226} and its Decay Products

Nuclide	Inhalation (Sv/Bq)*	Ingestion (Sv/Bq)
Ra-226	9.5E-6	2.8E-7
Pb-210	5.6E-6	6.9E-7
Po-210	4.3E-6	1.2E-6
Sum Ra-226+D	1.9E-5	2.2E-6

* Assumes 1 μm activity median aerodynamic diameter (AMAD)

The mass concentration of airborne dust was assumed to be a 0.15 mg/m^3, which is the value used by the RESRAD dose calculation code (Yu et al. 2001).

The concentrations of Ra-226 in soil were measured. Concentrations of Po-210 and Pb-210 were assumed to be equal to the Ra-226 concentration. The dose coefficients were summed and applied to the Ra-226 intake as shown in the table above.

Ingestion of soil

The hiker and biker were each assumed to ingest a small amount of soil during his/her time transiting the property. The dose due to soil ingestion was calculated as follows:

$D_S = [I_{ing}][C_{si}][(DC(ing)][3.7E\text{-}2\ Bq/pCi][1E5\ mrem/Sv]$

Where:

I_{ing} = soil ingestion rate (g/day)

C_s = concentration of Ra^{226} in soil (pCi/g)

DC(ing) = ICRP 72 ingestion dose coefficient per pCi/g ingested for Ra^{226} for an adult (Sv/Bq)

ICRP 72 ingestion dose coefficients were used in the calculation. The amount of soil ingested while either hiking or biking was assumed to be 0.1 g/day, the daily soil ingestion rate generally assumed for adults, normalized for transit time.

Inputs to Dose Calculation

Estimates for dose to a hiker or biker from direct gamma radiation, inhalation of airborne radionuclides in dust, and ingestion of soil were calculated using the equations above. Material left behind is likely windblown tailings from the Moab Atlas mill. Concentration values shown are taken from measurements on the site.

Parameter Values Wsed in the Estimate of Dose

Parameter	Assumed or measured value	
	Hiker	Biker
Exposure time per event	2 hr	0.4 hr
Events per year	12	52
Soil Ingestion	0.1 g/day	0.1 g/day
Airborne dust concentration	1.5E-4 g/m3	1.5E-4 g/m3
Ra-226 concentration	50 pCi/g	50 pCi/g
Net gamma exposure rate	21 - 58 uR/hr	21 – 58 uR/hr

Results

Using the parameters shown above, the estimated doses are as shown below for the hiker and the biker. Low and high values of direct exposure came from using the range of exposures shown above. Estimates of dust inhalation and soil ingestion were calculated for single values only.

Pathway	Hiker	Biker
	mrem/yr	
Direct exposure - low value	3.5E-01	3.1E-01
Direct exposure – high value	9.7E-01	8.4E-01
Dust inhalation	5.4E-02	4.7E-02
Soil ingestion	1.2E-01	1.1E-01
Total	0.53 - 1.2	0.46 – 1.0

Total dose equivalents for the hiker, under the conservative assumptions made range from 0.53 to 1.2 mrem per year. Values for the biker are very similar ranging from 0.46 to 1 mrem per year. In actuality, doses to hikers or bikers accessing the area are likely to be far smaller.

Conclusion

The most probable future use of the property in question is as vacant land. The above calculations demonstrate that the dose to members of the public who access the property by hiking across it or biking nearby would be a small fraction of the NRC 25 mrem per year decommissioning standard even when very conservative assumptions are used. The dose calculation was based on multiple events annually (monthly for the hiker and weekly for the biker) which are likely very large exaggerations.

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End of current text

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