LMS/DUD/S07230

Treatment System Removal Excavation Control and Verification Report Durango, Colorado

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Contents

Figures

Tables

Attachment

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1.0 Introduction

1.1 Executive Summary

The U.S. Department of Energy (DOE) removed a permeable reactive barrier (PRB) system that was installed in an uncontaminated area adjacent to the Durango, Colorado, disposal cell. The PRB system was no longer in use, and was located upgradient of a well (0618) where increases of uranium concentrations had been previously observed. Because the below ground location of the PRB precluded an accurate assessment of the condition of the structure, DOE decided to remove the PRB in an effort to eliminate it as a potential source of groundwater contamination, and to ensure that it could not become a source in the future. The verification sampling results demonstrated that the soil beneath the PRB was free from residual contamination, and visual inspection of the liner indicated and the PRB system had not likely been a significant source for groundwater contamination.

1.2 Purpose

The purpose of this document is to (1) describe the standards and procedures used for excavation control and the verification of the PRB system removal, and (2) present the verification data.

1.3 Background

The PRB system was installed below grade in an area adjacent to the holding pond. The system consisted of four PRBs containing various reactive media. The PRBs were constructed inside a prefabricated leak-proof retention basin. The retention basin measured 36 feet by 60 feet by 6 feet and was lined with a 2-foot-thick compacted clay layer on the bottom and a 1-foot-thick clay layer on the side slopes. The clay layers were covered with two 40-millmeter-thick high-density polyethylene (HDPE) liners, and a drainage net and water collection system were placed between the liners to verify their integrity.

An estimated 300,000 gallons of water from the disposal cell toe drain was treated in the PRB system. The *Long-Term Surveillance Plan for the Bodo Canyon Disposal Site, Durango, Colorado* (LTSP) (DOE 1996) identifies three indicator parameters for groundwater; uranium, molybdenum, and selenium. The influent concentrations to the PRBs from 1998 to 2000 ranged from 5.5 to 8.0 milligrams per liter (mg/L) for uranium, from 1.1 to 1.2 mg/L for molybdenum, and from 0.20 to 0.37 mg/L for selenium. Another constituent of possible concern is radium-226, however; it was present in low quantities in the influent water ranging from non-detectable to 5.29 picocuries per liter (pCi/L) (Naftz et al. 2002).

1.4 Regulatory Considerations

Federal regulations in Title 10 *Code of Federal Regulations* Part 40.27 (10 CFR 40.27) provide for the licensing, custody, and long-term care of uranium mill tailings disposal sites remediated under Title I of the Uranium Mill Tailings Radiation Control Act. The U.S. Nuclear Regulatory Commission regulates a general license for the long-term custody and care of these sites. Long-term care includes institutional controls, inspection, monitoring, maintenance, and other measures to ensure that the sites continue to protect public health, safety, and the environment after remediation is completed.

The LTSP indicates that remediation activities, similar to the removal of this PRB system, would be performed based on 40 CFR 192.12. 40 CFR 192.12 standards are for radium-226 concentrations in soil under 40 CFR 192 Subpart B, "Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites." However, 40 CFR 192.12 does not apply to this type of remediation, as these standards apply to processing sites as described in 40 CFR 192.10:

> "This subpart applies to land and buildings that are part of any processing site designated by the Secretary of Energy under section 102 of the Act. Section 101 of the Act, states, in part, that "processing site" means—
> (a) Any site, including the mill, containing residual radioactive materials at which all or substantially all of the uranium was produced for sale to any Federal agency prior to January 1, 1971, under a contract with any Federal agency, except in the case of a site at or near Slick Rock, Colorado, unless—
> (1) Such site was owned or controlled as of January 1, 1978, or is thereafter owned or controlled, by any Federal agency, or
> (2) A license (issued by the (Nuclear Regulatory) Commission or its predecessor agency under the Atomic Energy Act of 1954 or by a State as permitted under section 274 of such Act) for the production at site of any uranium or thorium product derived from ores is in effect on January 1, 1978, or is issued or renewed after such date;"

The definitions in 40 CFR 192.11 further indicated that these standards do not apply to disposal sites: "(b) Land means any surface or subsurface land that is not part of a disposal site and is not covered by an occupiable building."

The PRB system was expected to have some radiological contamination because it was used to remove metals and radionuclides from the toe drain water; however, the standards for the remediation of radium-226 in soil under 40 CFR 192 do not apply to the removal of the PRB system.

In addition to the regulatory considerations, the radium-226 concentrations entering the PRB system were very low. The influent concentration of radium-226 was non-detectable in November 1998 and April 2000, and was 2.57 pCi/L and 5.29 pCi/L in May 1999 (Naftz et al. 2002).

As stated earlier, the LTSP identifies molybdenum, selenium, and uranium as indicator parameters for groundwater contamination. Uranium is the best choice for use in the verification process because it is the most mobile in groundwater, is the only contaminate of concern that is elevated in well 0618, and is the highest in concentration in the influent water treated in the PRB system.

The U.S. Environmental Protection Agency (EPA) establishes regional screening levels for chemical contaminants at Superfund sites, one of which is a risked-based level in soil for migration to groundwater. Although the Durango Site in not a Superfund site, DOE recommended that the soil verification be based on this EPA screening level. The current screening level, from the EPA website accessed on September 20, 2010, is 49.3 milligrams per kilogram (mg/kg) for uranium soluble salts (Attachment 1).

There is also a maximum concentration limit (MCL)–based screening level for migration to groundwater established by EPA (Attachment 1). However this MCL-based screening level would not be relevant to this site. Due to the inherent uncertainties concerning the geographic and statistical distribution of naturally occurring constituents in the groundwater, the LTSP established the concentration limit for uranium at the observed maximum background and not at the MCL. Additionally, groundwater at the site is not available for use, DOE owns and controls the site, and the extent of alluvial groundwater is limited to a relatively small area. Using the risk-based level rather than the MCL-based level is protective and consistent with the current groundwater standards for the site.

2.0 Excavation Verification Process

This section describes the excavation control process, verification process, and soil sampling protocol that the Colorado Department of Public Health and Environment (CDPHE) concurred with and that DOE followed during the removal of the PRB system.

2.1 Excavation Control Process

The excavation of the PRB system was conducted to ensure that the bottom HDPE liner was not damaged before all of the contaminated materials above the liner were removed and before the condition of the liner was documented. Once the top liner was exposed, the following steps were taken:

[1] Carefully cut the top liner and peel it back, exposing the drainage net and water collection system.

[2] Dismantle and remove the drainage net and water collection system.

[3] Carefully remove any water or solid material remaining on the surface of the second liner.

[4] Visually inspect the second liner for integrity.

- [a] If a visual inspection of the liner indicates that the liner is intact, and if there is no sign that it has been breached, proceed to step 5.
- [b] If a visual inspection indicates that the liner has been breached, photograph and document the breach locations, and proceed to step 5.

[5] Carefully cut the liner and peel it back, exposing the underlying clay layer.

[6] Inspect the clay beneath the liner for indications of wetness, discoloration, or salt deposits.

- [a] If no wetness, discoloration, or salt deposits are present, photograph and document this condition, and proceed to step 8.
- [b] If wetness, discoloration, or salt deposits are present, photograph and document this condition, and proceed to step 7.

[7] Over-excavate areas of wetness, discoloration, or salt deposits based on visual observation.

[8] Proceed to the verification process.

2.2 Verification Process

There are not any applicable soil standards for the removal of this PRB system. Nevertheless, the materials below the PRB were sampled as a best management practice.

2.3 Soil Sampling Protocol

Verification sample locations were based on a 10-foot-by-10-foot grid system overlain onto the excavation. One sample was collected from the center of each area. The sample location was recorded by GPS, and the samples were analyzed for uranium soluble salts. Background samples were taken from the soils and clay layer on the side slope, as clay can contain naturally elevated uranium. The background samples were taken from areas of the side slope that the PRB system could not have contaminated. If the background samples were found to be high in uranium, DOE would consult with CDPHE to adjust the screening level to account for the background levels. If a verification sample were to exceed the screening level of 49.3 mg/kg uranium (soluble salts), then a composite sample of that area would be taken. If the composite sample also exceeded the screening level, the areas with elevated levels would be excavated and re-sampled until the levels were below the screening level. Twenty percent of the samples were also analyzed for molybdenum, selenium, and vanadium to ensure that the soil left under the PRB could not be a future source of these constituents, which were also present in the water treated by the PRB.

3.0 Results

3.1 Field Observations

DOE contractor personnel thoroughly examined the bottom liner, and its condition was documented by photo and video. Two cuts were evident in the liner. One was on the side slope in the southeast corner about a foot below the top of the retention basin. This cut occurred during the removal of the PRB system materials above both liners. The excavator tore the top liner and snagged the bottom liner. The cut was immediately patched with cargo tape. The second cut was on the floor of the retention basin. This cut was caused by a reciprocating saw during the removal of the drainage net system. This cut was also immediately sealed using cargo tape. No other cuts were found in the bottom liner, indicating that the liner was likely intact and had not leaked. The bottom of the retention basin was surveyed as a safety precaution before the liner was cut. Readings on a crutch SC-132 scintillometer ranged from 140 to 160 counts per second (cps), which are equivalent to background values for the area.

The clay layer beneath the liner was inspected for evidence of leaks, such as wetness or discoloration. The condition of the clay layer was documented by photo and video. Some water was discovered in the northeast corner; however, it was only wet to about 4 inches and was not saturated, indicating that it was recently wet and that the wetness was most likely the result of rainwater that had accumulated on the liner prior to removal. Although the water was pumped off to an adjacent retention pond, and although squeegees were used to push water to the sumps, some water still remained as the liner was being removed. The clay looked moist in several other areas; however, it was evident that the moisture was new and not a permanent feature. A second gamma scan was made of the entire retention basin as a safety precaution. Gamma surveys

ranged from 140 to 160 cps. The northeast corner gave a slightly elevated reading, at 180 cps. The radiological control technician did not consider the slightly elevated readings to indicate contamination.

3.2 Sampling

Soil samples were taken according to the soil sampling protocol. The survey grid on the floor of the retention basin was approximately 40 feet east-west and 60 feet north-south. Twenty-four 10-foot-by-10-foot square areas were delineated, although the measurement of the eastern line of squares was closer to 10-feet-by-6-feet because the basin was not symmetrical. One soil sample plug was collected from the center of each square, and four background samples were also collected from each of the walls about 3 to 4 feet above the floor of the basin denoted by north, south, east, and west in Figure 1. All of the samples were analyzed for uranium to verify that the system was removed without leaving contamination in the underlying clay or soil. All of the samples were also analyzed for radium-226, and seven samples were analyzed for vanadium, selenium, and molybdenum (Table 1).

Table 1. Soil Analysis Performed

Sample	Verification Analysis	Additional Analysis	Sample	Verification Analysis	Additional Analysis
Loc 1	Uranium	Radium	Loc 15	Uranium	Radium, Vanadium, Selenium, Molybdenum
Loc 2	Uranium	Radium	Loc 16	Uranium	
Loc 3	Uranium	Radium	Loc 17	Uranium	Radium, Vanadium, Selenium, Molybdenum
Loc 4	Uranium	Radium, Vanadium, Selenium, Molybdenum	Loc 18	Uranium	Radium
Loc 5	Uranium	Radium, Vanadium, Selenium, Molybdenum	Loc 19	Uranium	Radium
Loc 6	Uranium	Radium	Loc 20	Uranium	Radium
Loc 7	Uranium	Radium	Loc 21	Uranium	Radium
Loc 8	Uranium	Radium	Loc 22	Uranium	Radium
Loc 9	Uranium	Radium	Loc 23	Uranium	Radium
Loc 10	Uranium	Radium	Loc 24	Uranium	Radium, Vanadium, Selenium, Molybdenum
Loc 11	Uranium	Radium	North Background	Uranium	Radium
Loc 12	Uranium	Radium	South Background	Uranium	Radium
Loc 13	Uranium	Radium	East Background	Uranium	Radium, Vanadium, Selenium, Molybdenum
Loc 14	Uranium	Radium	West Background	Uranium	Radium, Vanadium, Selenium, Molybdenum

Table 2. Soil Analysis Results

Sample	Uranium (mg/kg)	Radium-226 (pCi/g)	Vanadium (mg/kg)	Selenium (mg/kg)	Molybdenum (mg/kg)
Loc 1	1.25	1.26			
Loc 2	1.11	1.41			
Loc 3	1.48	1.18			
Loc 4	1.35	1.46	45.3	0.763	0.737
Loc 5	1.15	1.03	43.8	0.68	0.67
Loc 6	1.15	1.41			
Loc 7	1.26	1.52			
Loc 8	1.27	1.41			
Loc 9	1.08	1.63			
Loc 10	1.08	1.27			
Loc 11	1.17	1.03			
Loc 12	1.16	1.11			
Loc 13	1.09	1.1			
Loc 14	1.1	1.36			
Loc 15	1.06	1.05	39.3	0.637	0.59
Loc 16	1.16	1.25			
Loc 17	1.21	1.66	42.2	0.664	0.626
Loc 18	1.03	1.32			
Loc 19	0.916	1.38			
Loc 20	1.08	1.19			
Loc 21	4.1	1.24			
Loc 22	1.08	1.3			
Loc 23	1.25	1.29			
Loc 24	0.641	1.16	15.6	0.509	0.515
North Background	1.31	1.25			
South Background	1.07	1.16			
East Background	1.57	1.39	44.3	1.08	0.833
West Background	1.3	1.21	37.4	0.838	0.756

pCi/g = picocuries per gram

3.3 Data

GEL Laboratories, LLC, analyzed the samples. The results are summarized in Table 2 and discussed in the following sections.

3.3.1 Uranium

The soil samples were analyzed for uranium soluble salts and compared to the EPA soil-to-groundwater screening level of 49.3 mg/kg. Figure 2 presents the results. All of the samples were equivalent to the background samples (except for location 21, which was higher, at 4.1 mg/kg). All of the samples were well below the screening level.

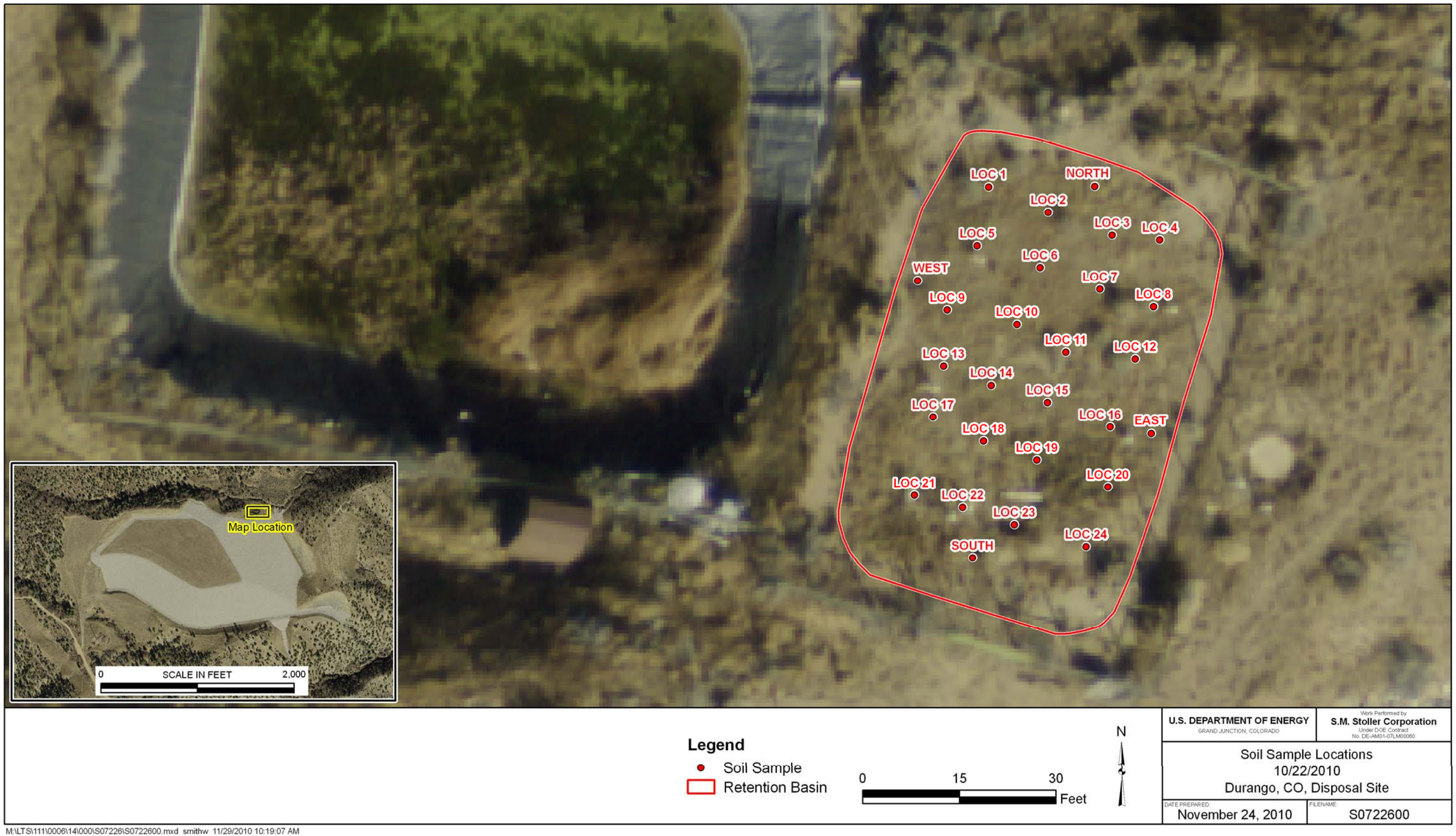

Figure 1. Soil Sample Locations

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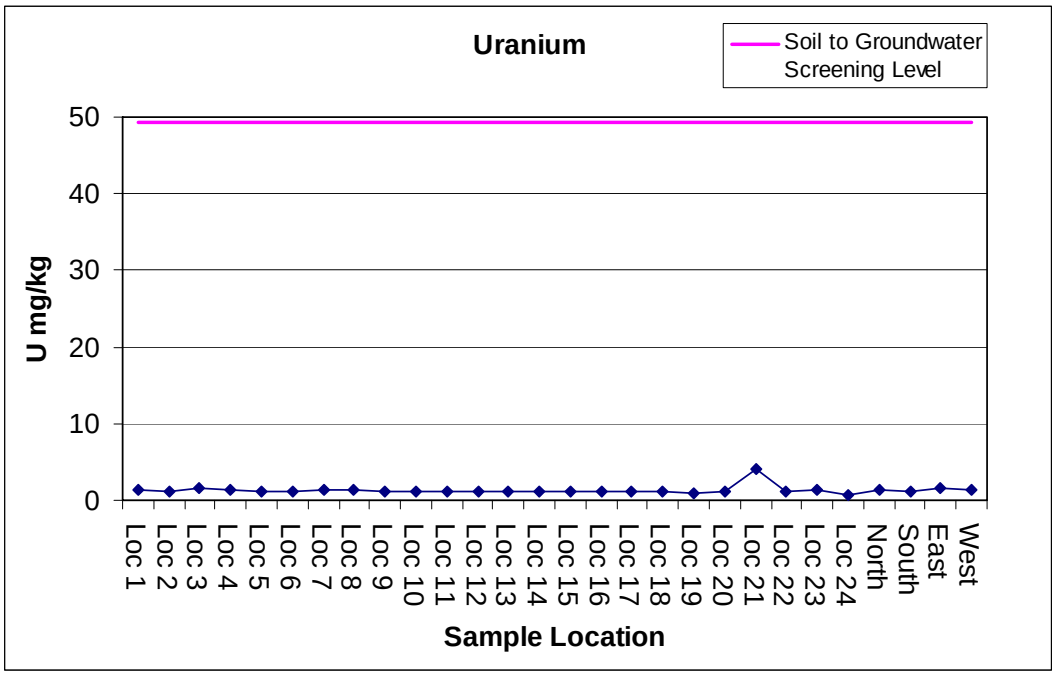

Figure 2. Uranium Levels in Soil Samples

3.3.2 Additional Constituents

The soil verification for the removal of the PRB system was based on the uranium levels and the EPA soil-to-groundwater screening level. At the request of CDPHE, vanadium, selenium, and molybdenum were analyzed for in seven of the samples. Figures 3 through 5 present the results; no screening levels were established for these constituents. In all cases, the average results were below the average of the background samples.

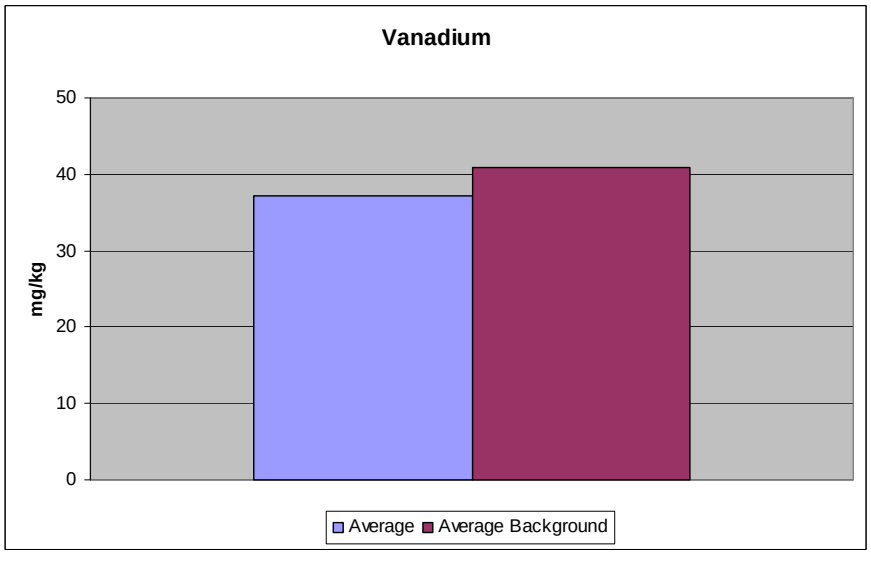

Figure 3. Vanadium Levels in Soil Samples

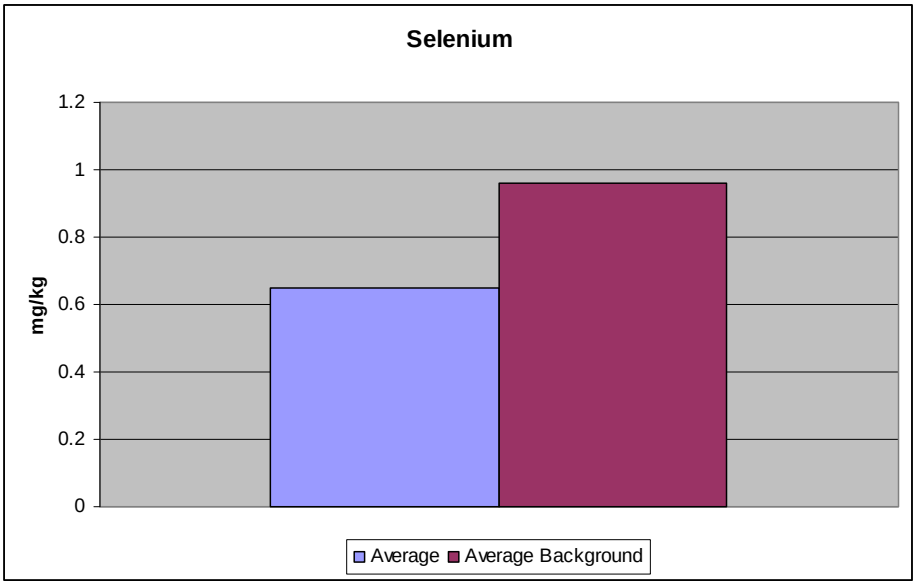

Figure 4. Selenium Levels in Soil Samples

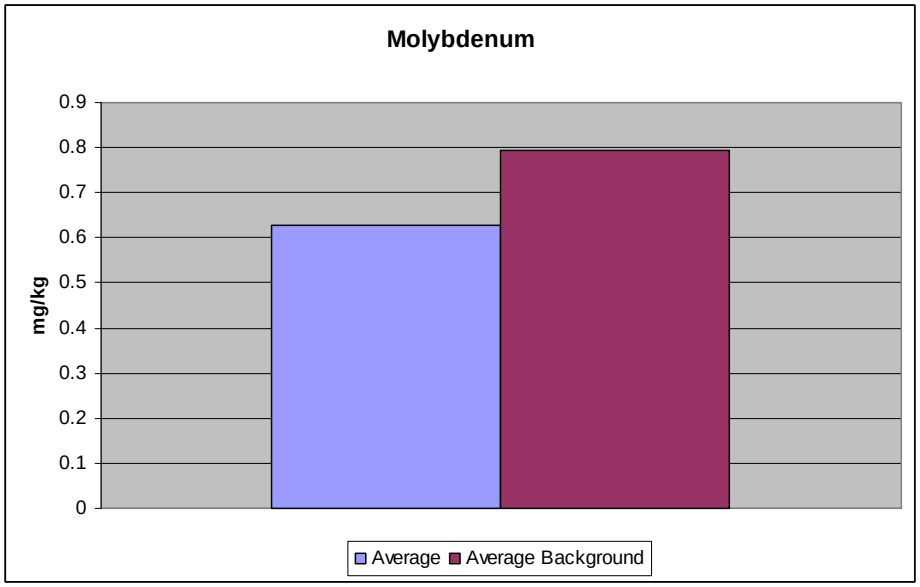

Figure 5. Molybdenum Levels in Soil Samples

Although it was determined that the verification would not be based on radium and that the radium standard was not relevant to this type of project, all of the samples were analyzed for radium as additional proof that the system had not left contamination in the soil. Figure 6 shows the results. All of the results were roughly equivalent to the background results.

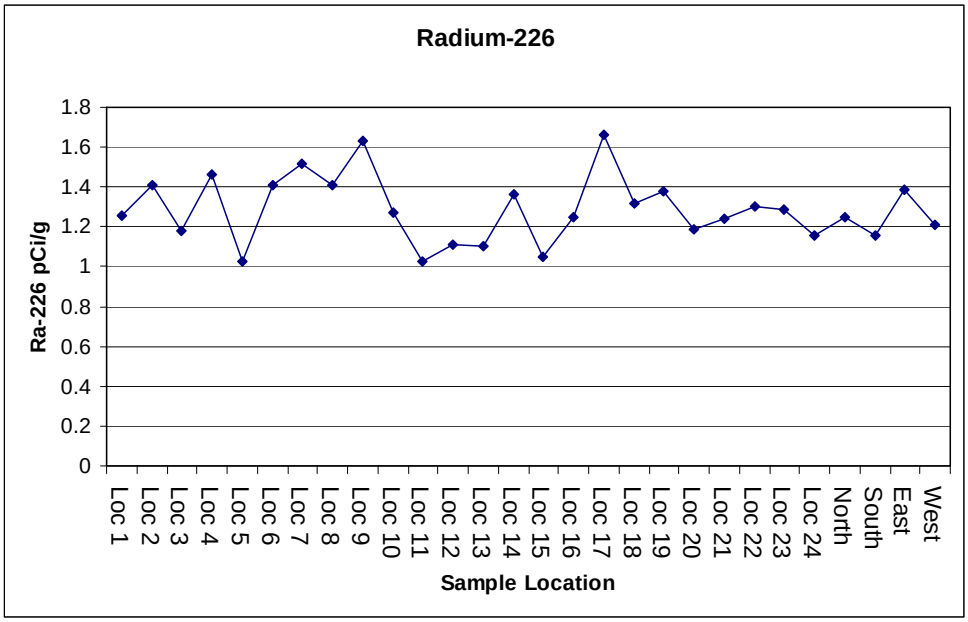

Figure 6. Radium Levels in Soil Samples

4.0 Summary

The PRB system at the Durango Disposal Site was removed and the soil beneath was verified to be free from residual contamination. These results, along with visual inspection of the liner and the soil beneath it, indicate that the PRB system may not have been a significant source term for the increased uranium levels observed in well 0618.

5.0 References

DOE (U.S. Department of Energy), 1996. *Long-Term Surveillance Plan for the Bodo Canyon Disposal Site, Durango, Colorado,* DOE/AL/62350-77, Rev. 2, prepared by the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Naftz, D.L., S.J. Morrison, J.A. Davis, and C.C. Fuller, 2002. *Handbook of Groundwater Remediation Using Permeable Reactive Barriers,* Elsevier Science.

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Attachment 1

Regional Screening Levels for Chemical Contaminants at Superfund Sites

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Equation Inputs for Soil to Groundwater

Variable	Value
Target cancer risk (TR) - unitless	1.0E-6
Target hazard quotient (THQ) - unitless	1
Averaging time (AT) - days	365
Exposure frequency (EF) - days	350
Exposure duration (ED) - years	30
Mutagenic Exposure duration (ED_{0-2}) - years	2
Mutagenic Exposure duration (ED_{2-6}) - years	4
Mutagenic Exposure duration (ED_{6-16}) - years	10
Mutagenic Exposure duration (ED_{16-30}) - years	14
Life Time (LT)	70
Exposure Time (ET) hours/day	24
Body Weight - adult (BW_a) - kg	70
Body Weight - children 1-6 yr (BW_c) - kg	15
Exposure duration - child (ED_c) - years	6
Water Ingestion - adult (IRW_a) - L/day	2
Water Ingestion - child (IRW_c) - L/day	1
Volatilization factor of Andelman (K) - L/m^3	0.5
Ingestion Factor - L-year/kg-day	1.0857142857
Mutagenic Ingestion Factor - L-year/kg-day	3.3904761905
Dilution factor (unitless)	1
Depth of source (d_s) - m	.
Aquifer thickness (d_a) - m	.
L (source length parallel to ground water flow) m	.
I (Infiltration Rate) m/yr	0.18
i (hydraulic gradient) m/m	.
K (aquifer hydraulic conductivity) m/yr	.
Soil particle density (kg/L)	2.65
Dry soil bulk density (kg/L)	1.5
Water-filled soil porosity (L_{water}/L_{soil})	0.3
Fraction organic carbon in soil (unitless)	0.002

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Risk-Based Screening Levels for Soil to Groundwater

ca=Cancer, nc=Noncancer, ca* (Where nc SL < 100 x ca SL),
ca** (Where nc SL < 10 x ca SL),
max=SL exceeds ceiling limit (see User's Guide), sat=SL exceeds csat

Chemical	CAS Number	Ingestion SF (mg/kg-day)$^{-1}$	SFO Ref	Inhalation Unit Risk (mg/m^3)$^{-1}$	IUR Ref	Chronic RfD (mg/kg-day)	RfD Ref	Chronic RfC (mg/m^3)	RfC Ref	K_d	K_{oc}	H`
Uranium (Soluble Salts)	NA	-		-		3.00E-03	I	3.00E-04	A	450	-	0

Chemical	Risk-Based Water Concentration (ug/L)	MCL-Based Water Concentration (ug/L)	MCL-Based Screening Level (mg/kg)	Risk-Based Screening Level (mg/kg)
Uranium (Soluble Salts)	1.10E+02	3.00E+01	1.35E+01	4.93E+01

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