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U.S. Department of Energy
Office of Legacy Management

Resolution of Seep and Ground Water Monitoring at the Mexican Hat, Utah, UMTRCA Title I Disposal Site

March 2006

Work Performed by the S.M. Stoller Corporation under DOE Contract No. DE–AC01–02GJ79491
for the U.S. Department of Energy Office of Legacy Management.
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1.0 Introduction

The purpose of this report is to present the results and determine the need for continued seep or ground water monitoring at the Mexican Hat, Utah, Uranium Mill Tailings Remedial Action (UMTRA) Title I Disposal Site. In accordance with the U.S. Department of Energy's (DOE) Long-Term Surveillance Plan (LTSP) and Ground Water Compliance Action Plan (GCAP), seep monitoring has been performed at the site as a best management practice (BMP) since 1998. Ground water monitoring of the uppermost aquifer was performed as a BMP, per agreement with the Navajo Nation, from November 2000 through 2002.

Because no unacceptable risks were found associated with the seeps, the previous assessment of seep monitoring reported in April 2002 recommended discontinuing quarterly seep monitoring (DOE 2002). The Navajo Nation responded in a July 3, 2002, letter to DOE by recommending continuing seep monitoring annually with no endpoint specified. Results of ground water monitoring of the uppermost aquifer were last reported in February 2001 (DOE 2001) and DOE committed to continue semiannual monitoring as a BMP through 2002.

This report briefly reviews the site background and monitoring history. A description of the site and the hydrogeology is provided to confirm that the ground water compliance strategy selected for the site remains appropriate. Results of seep and ground water monitoring presented confirm that the hydrogeologic model and risk assessment results for the site remain valid (DOE 2002). The report concludes with recommendations regarding the need and approach for continued monitoring at the site.

2.0 Site Description

2.1 Site Location and History

The Mexican Hat Disposal Site is within the Navajo Reservation in San Juan County, Utah, east of U.S. Highway 163, between the towns of Halchita and Mexican Hat about 10 miles north of the Utah-Arizona border (Figure 1).

Uranium processing was conducted at the on-site mill that operated from 1957 until 1965. A sulfuric acid manufacturing plant also operated at the site from 1957 to 1970. Control of the site reverted to the Navajo Nation after the lease expired in 1970. Residual radioactive material (RRM) from both the Mexican Hat and Monument Valley uranium processing sites were stabilized in a disposal cell at the Mexican Hat Disposal Site by the U.S. Department of Energy (DOE); surface remediation was completed in 1995 (DOE 1993). A total of about 3.6 million cubic yards (4.4 million tons) of RRM were stabilized in the Mexican Hat disposal cell constructed at the location of the former lower tailings pile. The NRC concurred with the remediation and compliance with both Subparts A and B of 40 CFR 192 in their final *Technical Evaluation Report* (NRC 1996).

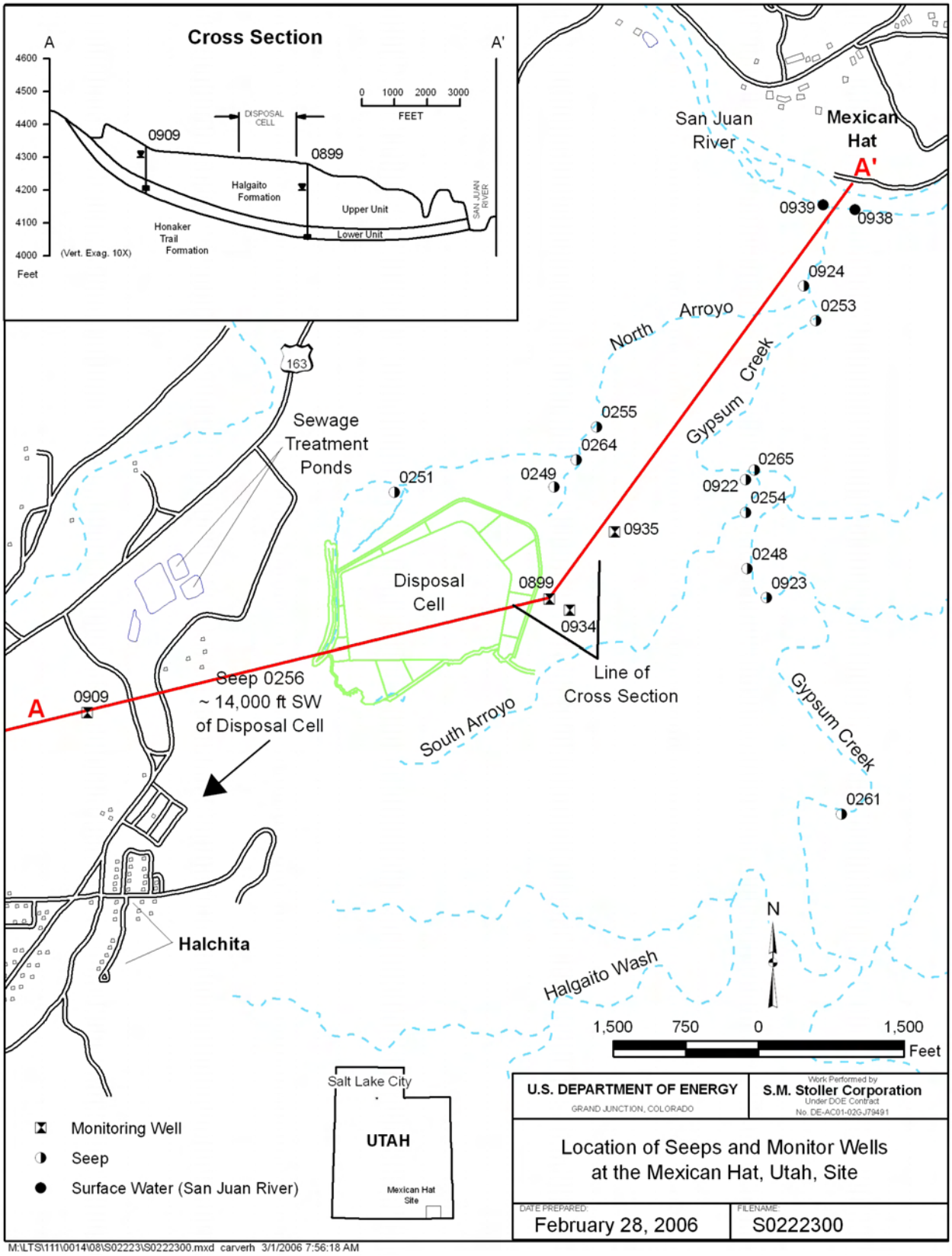

Figure 1. Location of Seeps and Monitor Wells at the Mexican Hat, Utah, Disposal Site

2.2 Site Setting

The site is on a relatively flat mesa within the Colorado Plateau physiographic province at an elevation of about 4,300 feet. The deeply entrenched San Juan River is approximately one mile to the northeast. Surface drainage from the site and surrounding area is into two ephemeral drainages (North and South Arroyos) which discharge to Gypsum Creek and then to the San Juan River. These drainages are narrow and deeply incised. Several low-flowing ground water seeps can be found discharging within these arroyos. The terrain west of the site is similar to that to the north and east. A ridge that extends approximately 100 feet above the site bounds the site on the south.

The climate is arid with widely ranging daily and annual temperatures (<20 to >100 ºF). Significant prevailing winds occur from the southwest. Precipitation averages 6 inches per year and is fairly evenly distributed throughout the year. The native area is sparsely vegetated by desert shrubs and grasses. The surrounding area is used for limited residential purposes and livestock grazing.

2.3 Disposal Cell Design

The disposal cell occupies an area of 68 acres on the 119-acre site. It abuts a rock outcrop on the south and rises 50 feet above the surrounding land on the other sides. A posted barbed-wire perimeter fence surrounds the cell. Residual radioactive materials in the cell were compacted before being covered. The cover of the disposal cell is a multi-component system designed to encapsulate and protect the contaminated materials. The cover comprises (1) a low-permeability radon barrier (first layer placed over compacted tailings), (2) a bedding layer of sand and gravel placed as a capillary break, and (3) a rock (riprap) erosion protection layer (Figure 2). The cell design promotes rapid runoff of precipitation to minimize leachate. The cell cover was constructed with a two-percent grade sloping to the north and east. Runoff water flows down the 20-percent side slopes into the surrounding rock apron and exits the cell via three toe drains to arroyos north and east of the cell.

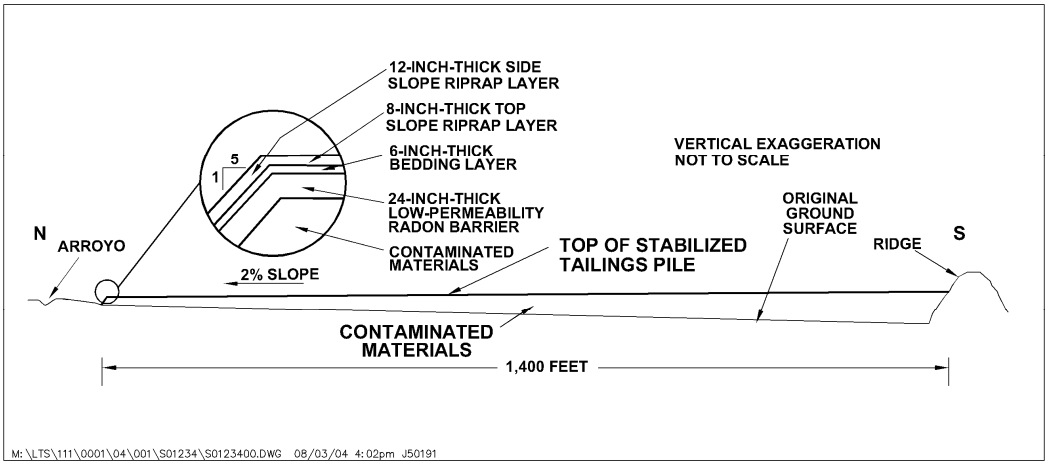

Figure 2. North-South Cross Section of the Mexican Hat Disposal Cell

The site location and design were selected to minimize the potential for erosion from on-site runoff or storm water flow. All surrounding remediated areas were regraded and reseeded with

native species. Existing gullies in the vicinity of the cell were armored with riprap that was keyed into competent rock to control erosion. Riprap-protected diversion ditches were installed to channel surface runoff water away from the cell.

2.4 Hydrogeological Conditions

The geologic unit exposed at ground surface is the Halgaito Formation, which is the basal part of the Permian Cutler Group. The Halgaito consists primarily of interbedded silty sandstone, siltstone, and shale. The unit is approximately 80 to 215 feet thick in the vicinity of the site. The Halgaito is divided into upper and lower units.

The upper unit of the Halgaito Formation is predominantly unsaturated. Ephemeral ground water occurs, at places, in vertical joints and fractures, especially near the surface. Joints and fractures decrease with depth. Perched ground water is also present, and scattered along bedding planes overlying finer-grained zones. Because of the fine-grained nature of the sediments and the presence of intergranular calcium and silica cement, the upper unit exhibits very little primary hydraulic conductivity. Nearly all the ground water presently contained in this upper unit in the vicinity of the site is a result of former uranium processing operations and, to a lesser degree, transient drainage from the cell. However, minor amounts of natural recharge do occur as evidenced by the presence of upgradient seeps.

Ground water in this upper unit is contaminated from former on-site uranium processing operations. Because the upper unit of the Halgaito is unsaturated, it is not considered an aquifer; and due to the minimal amount of ground water present and the low sustained yield it is not suitable for production. Ground water in the upper unit of the Halgaito is not a significant resource because of (1) limited recharge, (2) low hydraulic conductivity, (3) low yields, (4) minimal areal extent, and (5) naturally poor water quality. Because this upper unit is not an aquifer, water in the upper part of the Halgaito Formation is only of concern from a regulatory perspective where it actually surfaces and exposure to site-related contamination by humans and other receptors may occur.

Exposures to contaminated perched ground water in the upper unit of the Halgaito may occur where it discharges along joints, fractures, and bedding planes; and daylights in seeps along North Arroyo (north of the disposal cell) and Gypsum Creek (east of the disposal cell). Most of the seeps have very low flow rates and may be dry at certain times of the year or following periods of dry weather. Historical records, including aerial photographs, indicate that most of the seeps were active or at least intermittently active, before site remediation began.

The lower unit of the Halgaito Formation, classified as the uppermost aquifer beneath the site, is isolated from contaminated ground water in the upper unit of the Halgaito Formation by thin lenticular to continuous limestone beds that act as a confining layer (aquitard) limiting vertical water movement. There also is an upward hydraulic gradient in the uppermost aquifer that prevents contaminated perched ground water in the upper unit of the Halgaito from entering the uncontaminated uppermost aquifer. As a result, ground water in this uppermost aquifer beneath the site was not contaminated from uranium processing operations or from remedial action, and will not be contaminated from the current disposal cell. In addition, recharge to the uppermost aquifer is unaffected by site contamination since it occurs upgradient (southwest) of the site and from upward flow from deeper formations.

The Honaker Trail Formation that lies directly beneath the Halgaito Formation is also effectively hydrologically isolated from the Halgaito Formation by these confining layers and the upward hydraulic gradient.

2.5 Ground Water Quality

Ground water quality in the upper unit of the Halgaito Formation is unsuitable for human consumption. Poor water quality within this upper unit owes to both natural characteristics and contamination from former on-site uranium processing operations. Analysis of both upgradient and downgradient seeps discharging from fractures within the upper unit of the Halgaito Formation provide evidence of this poor water quality. Results of seep monitoring are presented in Section 4.1.

Although ground water in the lower unit of the Halgaito has not been contaminated by past milling operations, the natural water quality near the site is likely unsuitable for human consumption. Monitor wells installed in the lower unit of the Halgaito showed the presence of hydrogen sulfide gas and naturally occurring petroleum. A small amount of oil is produced from the Halgaito and the underlying Honaker Trail Formation in an oil field near the town of Mexican Hat.

Background water quality of the Halgaito and the Honaker Trail Formations is generally similar. Ground waters from both units contain relatively high concentrations of sulfate and nearly equal concentrations of sodium, calcium, and magnesium. Total dissolved solids concentration is relatively high in the ground waters, ranging from 3,200 to 5,300 milligrams per liter. Several constituents commonly found in solutions produced by uranium-ore processing at the Mexican Hat Disposal Site are also present naturally in ground water seeps upgradient of the site, although at lower concentrations. These constituents include ammonium, boron, magnesium, manganese, molybdenum, nitrate, silica, sulfate, and uranium.

3.0 Monitoring History

3.1 Monitoring Requirements

The Long-Term Surveillance Plan (LTSP) (DOE 1997) for the Mexican Hat Disposal Site acknowledges that: (1) scattered shallow ephemeral perched ground water that lies directly beneath the site is derived primarily from uranium processing operations and is contaminated; (2) the uppermost aquifer beneath the site is hydrogeologically isolated from this overlying site-related contamination by effective confining layers that significantly limit the downward vertical movement of contaminated perched ground water and an upward hydraulic gradient within the uppermost aquifer; (3) monitoring of this contaminated perched ground water is not required under the current protection strategy for the site since it is not considered a current or potential source of drinking water; and (4) the design of the disposal cell, which sheds and diverts surface water to natural drainages, will minimize any additional potential for the downward migration of contaminants from the site.

While ground water and surface water monitoring is not explicitly required by regulation, DOE has been conducting sampling and analysis of ground water and seeps as a best management practice (BMP) due to concerns raised by the Navajo Nation. Locations of ground water

monitoring wells and seep samples are shown on Figure 1. A discussion of monitoring activities is provided in this section. Results are presented in Section 4.0.

There are no known risks to human health and the environment by applying the no site-specific ground water remediation compliance strategy. Ground water in the vicinity of the Mexican Hat Disposal Site is not currently used as a drinking water source, nor is it anticipated to become one. The water supply for the community of Halchita is from a treatment plant that obtains water from the San Juan River. The community of Mexican Hat derives its water supply from the San Juan River and two water supply wells northwest of the San Juan River (DOE 1998). Analytical results of water samples show that the Mexican Hat Disposal Site does not significantly affect the quality of water in the San Juan River (DOE 1993) (see Section 4.1, Table 3).

3.2 Seep Monitoring

Scattered shallow ephemeral perched ground water beneath the Mexican Hat Disposal Site is contaminated as a result of uranium processing and remediation activities that occurred on-site. This contaminated perched ground water intermittently seeps out at several locations along North Arroyo and Gypsum Creek downgradient from the site. Due to concerns raised by the Navajo Nation, NRC concurred with annual monitoring of six seeps to assess disposal cell performance (Subpart A of 40 CFR 192) under the disposal site licensing agreement set forth in the LTSP (DOE 1997), and quarterly monitoring of eleven seeps for 3 years as a best management practice to demonstrate ground water compliance (Subpart B of 40 CFR 192) as set forth in the GCAP (DOE 1999).

In accordance with the LTSP, monitoring of six seeps has been performed since 1998. The six seeps specified in the LTSP to be monitored annually are: 0249 and 0251 in North Arroyo (downgradient); 0248, 0254, and 0922 in Gypsum Creek (downgradient); and 0261 in Gypsum Creek (upgradient – background) (Figure 1). Seep 0249, often found dry, was replaced with seep 0264 that is located approximately 300 feet downstream in North Arroyo. The LTSP acknowledges that insufficient flow from some of the seeps may preclude sampling.

In accordance with the GCAP, DOE agreed to monitor all identified seeps adjacent to the site quarterly beginning in 1999. Eleven seeps were identified: 0249, 0251, and 0255 in North Arroyo (downgradient); 0248, 0253, 0254, 0922, 0923, and 0924 in Gypsum Creek (downgradient); and 0256 and 0261 in Gypsum Creek (upgradient – background) (Figure 1).

Monitoring of several of these seeps occurred prior to LTSP and GCAP requirements. Seeps 0248, 0249, 0251, 0254, 0256, and 0261 were monitored as early as 1990 and seep 0922 as early as 1985.

Annual monitoring of the six seeps specified in the LTSP continues to be conducted as a BMP and was last performed in April 2005.

3.3 Ground Water Monitoring

The DOE monitored ground water in the confined uppermost aquifer at two locations adjacent to the Mexican Hat disposal cell from November 2000 to August 2002 as a BMP, per agreement with the Navajo Nation (DOE 2001). Objectives of the ground water monitoring in the confined uppermost aquifer included analytically demonstrating that there is no site-related contamination

of ground water in the uppermost aquifer and that the upward hydraulic gradient from the uppermost aquifer persists. The two ground water monitoring locations were a newly installed monitor well, MW−0899, located approximately 150 feet downgradient of the disposal cell on the east side, and an existing background monitor well, MW−0909, installed in March 1985 and located approximately 3,000 feet upgradient from the disposal cell on the west side (Figure 1). Indicator parameters of site-related contamination include uranium, sulfate, and nitrate. DOE agreed to perform this monitoring on a semiannual basis through 2002 and then evaluate the need for continued monitoring (DOE 2001).

Two other existing monitor wells are also present downgradient of the disposal cell on the east side. Monitor well MW−0934, located approximately 250 feet southeast of MW−0899, was monitored periodically from 1985 through 2001. Monitor well MW−0935, located approximately 1,000 feet northeast of MW−0899, was monitored once in 1985 and again in 1999 (Figure 1). These two existing downgradient wells were not included in the BMP monitoring due to concern over problems with construction and installation, zone of completion, proximity to the area of interest, and historically fluctuating monitoring results. Therefore, at the request of the Navajos, DOE agreed to install monitor well MW−0899 in November 2000 directly downgradient of the current disposal cell and former processing site.

Well completion logs detailing the lithology of the boreholes and construction of the monitor wells is provided in Attachment A. Concentration versus time plots comparing historical monitoring of MW−0934 and MW−0935 to BMP monitoring of MW−0899 and MW−0909 are provided in Attachment B.

3.4 Monitoring Reports

Following 3 years of quarterly seep monitoring to ensure that contaminant concentrations were decreasing over time, the GCAP called for site conditions to be reevaluated in order to determine the need for continued monitoring. The LTSP calls for periodic evaluations of seep monitoring; no frequency is specified. The *Assessment of Seeps at the Mexican Hat, Utah, UMTRCA Project Site* report (DOE 2002), was submitted in accordance with the GCAP and LTSP to the Navajo Nation in April 2002.

Based on the results of 3 years of quarterly seep monitoring and an updated risk assessment presented in the seep assessment report, DOE determined there was no unacceptable risk to human health and the environment, and recommended discontinuing all seep monitoring. The Navajo Nation responded in a July 3, 2002, letter to DOE with a request to perform annual seep monitoring.

Following the installation of monitor well MW−0899 and the subsequent initial BMP ground water monitoring of the uppermost aquifer agreed to and conducted by DOE at the request of the Navajo Nation, a report was prepared presenting the results. This report entitled *Results of Drilling Activities and Resolution of Ground Water Issues at the Mexican Hat, Utah, UMTRCA Project Site* (DOE 2001) provided information on drilling and monitor well installation, initial ground water monitoring results, and recommendations for continued ground water monitoring.

The report determined that site-related contamination is not present in ground water in the confined uppermost aquifer in the vicinity of the Mexican Hat Disposal Site. Concentrations of uranium, sulfate, and nitrate are similar to ranges observed in the background monitor well MW−0909 in the uppermost aquifer and the background seep 0256 in the underlying formation

upgradient from the site. Downward migration of contaminants related to uranium processing activities into the uppermost aquifer had not been observed and was not expected because of the confining properties of thin limestone beds overlying the uppermost aquifer and the observed upward hydraulic gradient of the uppermost aquifer.

The report recommended conducting semiannual BMP ground water monitoring of the uppermost aquifer for an additional two years (through 2002).

4.0 Monitoring Results

4.1 Seep Monitoring Results

The results of BMP monitoring of seeps adjacent to the Mexican Hat Disposal Site is presented below. A summary of the three indicator parameters (uranium, sulfate, and nitrate) specified in the LTSP is included in Table 1. The concentration range and average for each analyte is provided for each seep location monitored.

Concentrations of uranium, sulfate, and nitrate versus time have been plotted on Figures 3 through 8. Because of the number of seeps (12 total), they were grouped by location; the North Arroyo seeps (4) and the Halgaito background seep (1) were presented in one set of plots and the Gypsum Creek seeps (7) were presented in the second set of plots.

Table 2 provides estimated flow rates available for the seeps. Due to low flows, measurements were not always possible to record. Photographs of the six seeps, monitored in April 2005 in accordance with the LTSP, are provided in Attachment C. These photographs were taken just after a rain event, which accounts for much of the water present at the time and makes them appear wetter than normal.

Table 3 provides the results of monitoring conducted on the San Juan River, both upstream and downstream of the confluence with Gypsum Creek; North Arroyo drains into Gypsum Creek approximately 1,000 feet upstream of the confluence.

Table 1. Summary of Indicator Parameters in Seeps at the Mexican Hat, Utah, Disposal Site

Seep *(Number and Location)*	**Uranium** *MCL = 0.044 mg/L*		**Sulfate** *MCL = none*		**Nitrate** *MCL = 44 mg/L*	
	Range	Average	Range	Average	Range	Average
North Arroyo						
0249 (downgradient)	0.483-1.18	0.789	2850-3813	2847	114-800	347
0251 (downgradient)	0.013-2.10	0.647	614-5650	2438	30-2260	637
0255 (downgradient)	0.568-1.71	0.866	2620-7000	3421	97-1190	437
0264 (downgradient)	0.120-2.16	0.941	1100-6310	3482	110-1110	508
Gypsum Creek						
0248 (downgradient)	0.380-0.779	0.563	1900-4010	3157	4.7-393	163
0253 (downgradient)	0.017-0.488	0.311	2170-4290	3210	16-161	95
0254 (downgradient)	0.612-0.838	0.742	2300-3880	3061	381-994	597
0261 (upgradient)	0.007-0.094	0.027	2690-3950	3232	0.016-8.9	0.829
0922 (downgradient)	0.212-0.503	0.354	2870-3907	3140	1.8-338	132
0923 (crossgradient)	0.012-0.039	0.023	1460-6000	3339	0.049-13.7	2.92
0924 (downgradient)	0.190-0.403	0.296	2570-3770	3017	5.5-116	77.4
Halgaito Wash						
0256 (background)	0.010-0.046	0.028	2030-3260	2310	0.017-3.8	0.662

Concentrations reported in mg/L.
Nitrate reported as NO_3.

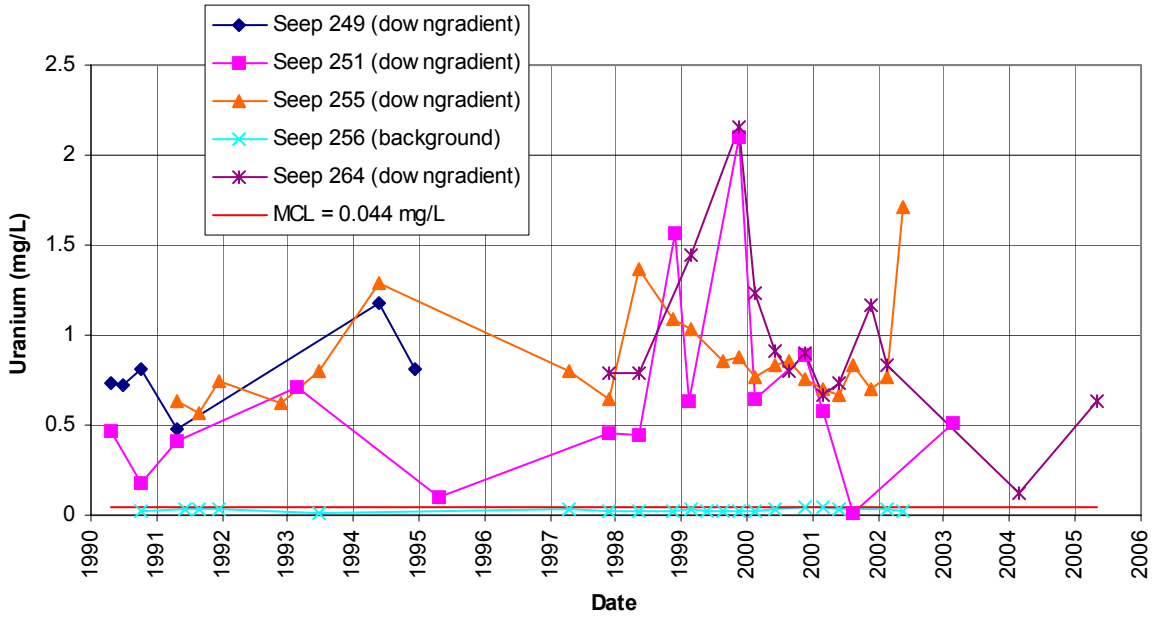

Figure 3. Uranium in North Arroyo Seeps and Halgaito Wash Background Seep at the Mexican Hat, Utah, Disposal Site

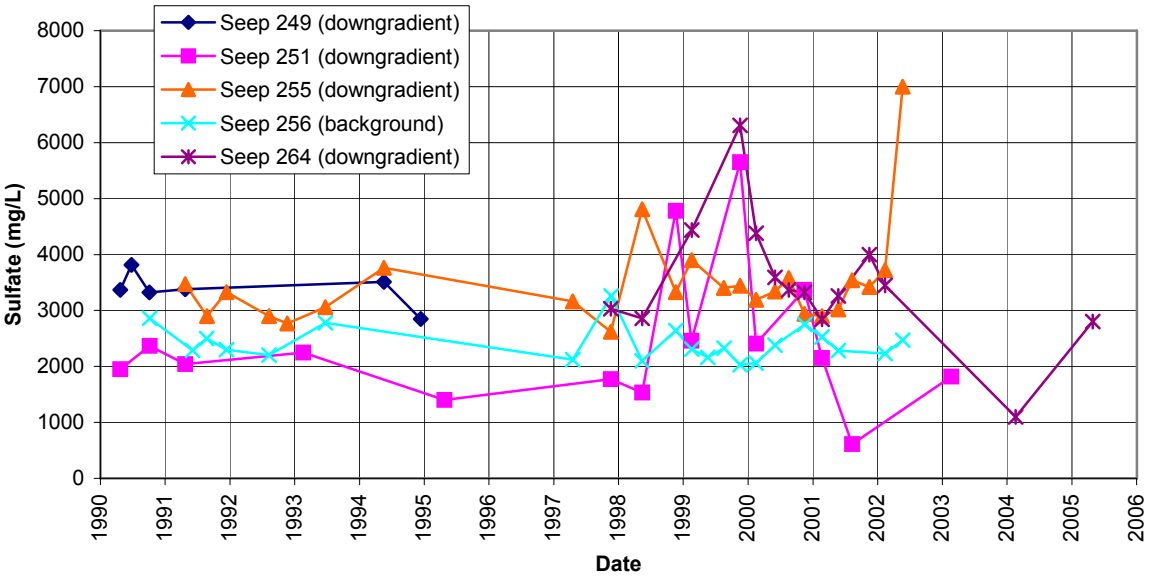

Figure 4. Sulfate in North Arroyo Seeps and Halgaito Wash Background Seep at the Mexican Hat, Utah, Disposal Site

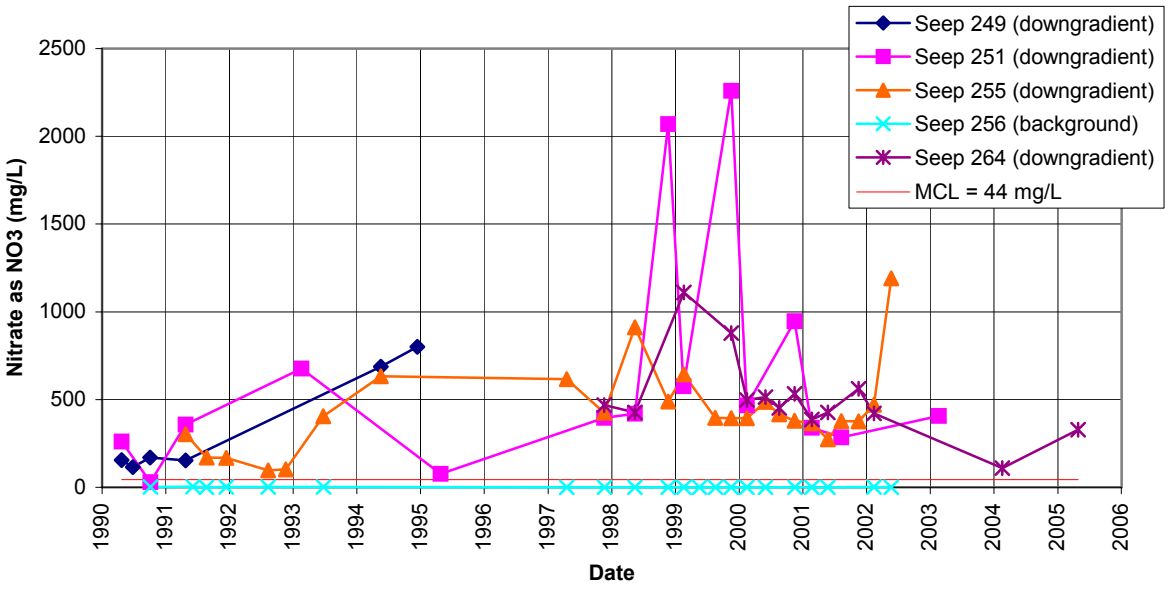

Figure 5.Nitrate in North Arroyo Seeps and Halgaito Wash Background Seep at the Mexican Hat, Utah, Disposal Site

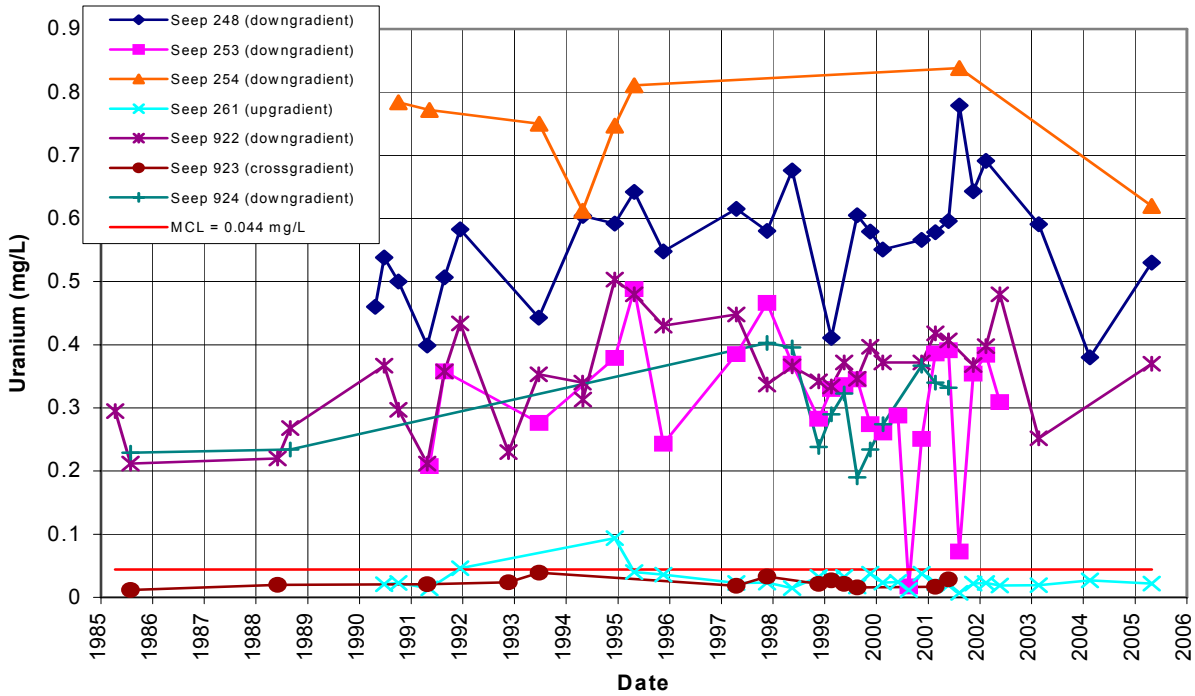

Figure 6. Uranium in Gypsum Creek Seeps at the Mexican Hat, Utah, Disposal Site

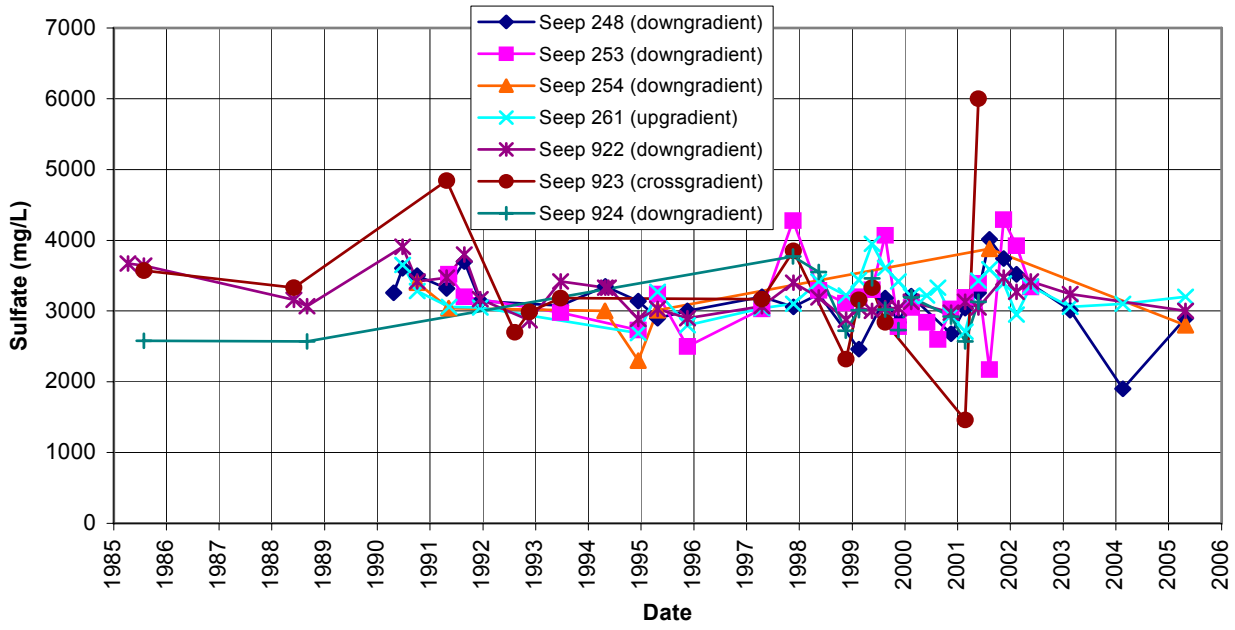

Figure 7. Sulfate in Gypsum Creek Seeps at the Mexican Hat, Utah, Disposal Site

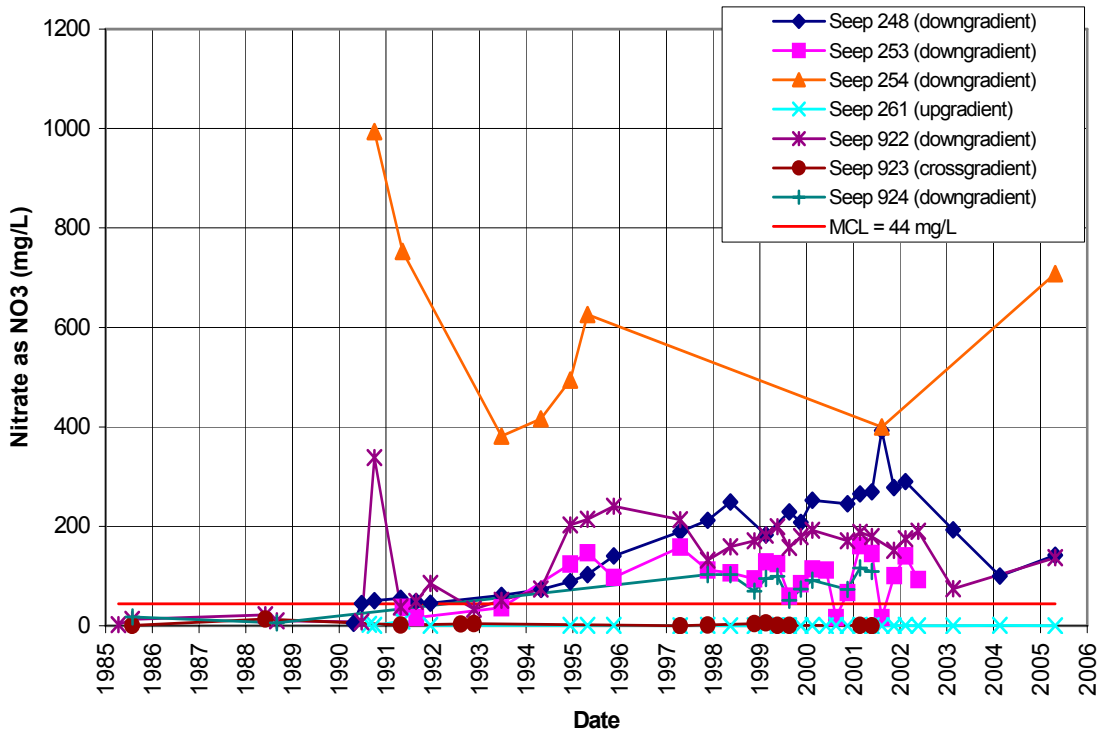

Figure 8. Nitrate in Gypsum Creek Seeps at the Mexican Hat, Utah, Disposal Site

Table 2. Estimated Flow of Seeps at the Mexican Hat, Utah, Disposal Site

Date	Seep Number											
	0248	0249	0251	0253	0254	0255	0256	0261	0264	0922	0923	0924
Nov 1998	Dry	ND	Damp	NF	Dry	NF	NF	NF	ND	NF	NF	NF
Feb 1999	NF	ND	NF	NF	Dry	NF	NF	NF	NF	NF	NF	NF
May 1999	Dry	ND	Dry	NF	Dry	Dry	NF	NF	ND	NF	NF	NF
Aug 1999	NF	ND	ND	NF	ND	NF	NF	NF	ND	NF	NF	NF
Nov 1999	0.25	ND	NF	0.25	Dry	0.5	0.75	0.25	NF	0.25	Dry	0.13
Feb 2000	NF	ND	NF	NF	ND	NF	NF	NF	NF	NF	ND	NF
May 2000	NF	ND	NF	NF	ND	0.13	NF	NF	NF	NF	NF	NF
Aug 2000	Damp	ND	Dry	NF	Dry	0.25	Dry	NF	NF	Dry	Dry	Dry
Nov 2000	NF	ND	NF	NF	ND	2.0	NF	NF	NF	NF	ND	NF
Feb 2001	NF	ND	<0.5	~1.0	Dry	~0.5	~1.0	NF	~0.5	~2.0	NF	~1.5
May 2001	NF	ND	NF	0.13	NF	<0.13	NF	<0.13	<0.13	NF	NF	<0.13
Aug 2001	NF	ND	NF	NF	Damp	NF	Damp	NF	NF	Damp	Damp	Damp
Nov 2001	0.25	ND	Dry	3.0	Dry	0.13	Damp	0.13	0.13	NF	Dry	Dry
Feb 2002	0.1	ND	Dry	1.5	Dry	1.0	1.5	1.0	NF	0.1	NF	NF
May 2002	Dry	ND	Dry	NF	Dry	NF	NF	0.25	Dry	NF	Dry	Dry
Feb 2003	0.25	ND	NF	NS	Dry	NS	NS	1.0	1.5	0.25	NS	NS
Feb 2004	0.5	ND	Dry	NS	Dry	NS	NS	2.0	NF	Dry	NS	NS
Apr 2005	<0.1	ND	Dry	NS	<0.05	NS	NS	<0.1	NF	NF	NS	NS

Flows estimated in gallons per minute (gpm).
Dry – no flow.
Damp – minimal water, no flow measured.
NF – no flow measured.
NS – no longer sampled
ND – no data available.

Table 3. Summary of Indicator Parameters in Surface Waters of the San Juan River Upstream and Downstream of the Mexican Hat, Utah, Disposal Site

Location *(Number & Orientation)*	Uranium	Sulfate	Nitrate
	All Samples Collected in November 1985		
SW-0938 (upstream)	0.0009 J	129	1
SW-0939 (downstream) – sample #1	0.005	150	1 U
SW-0939 (downstream) – sample #2	0.0022 J	151	1 U
SW-0939 (downstream) – sample #3	0.0025 J	156	1 U
SW-0939 (downstream) – sample #4	0.0051	158	1 U
SW-0939 (downstream) – sample #5	0.0024 J	138	1 U

Concentrations reported in milligrams per liter (mg/L).
Nitrate reported as NO_3.
Method detection limits: uranium = 0.003 mg/L, sulfate = 0.1 mg/L, nitrate = 1.0 mg/L.
J = estimated value; reported below the method detection limit.
U = analytical result below detection limit.

When comparing to upgradient and background seeps, results appear to indicate that site-related contamination, primarily uranium and nitrate, is present within seeps downgradient of the Mexican Hat Disposal Site, with the highest concentrations occurring in the North Arroyo seeps. Sulfate concentrations in the background and upgradient seeps are generally equivalent to concentrations in the downgradient seeps, indicating the naturally elevated occurrence of this parameter in the area.

Results demonstrate that no significant site-related impact to the surface waters of the San Juan River is occurring.

4.2 Ground Water Monitoring Results

Analytical results of ground water monitoring of the uppermost aquifer both downgradient and upgradient (background) of the Mexican Hat Disposal Site from November 2000 through August 2002 (and prior results where applicable) are included in this report. The two monitor wells completed in the uppermost aquifer and sampled were: MW−0899 located approximately 150 feet downgradient of the disposal cell on the east side and MW−0909 located approximately 3,000 feet upgradient from the disposal cell on the west side (Figure 1). Results from the upgradient seep (MW−0256) located approximately 14,000 feet southwest of the disposal cell and which discharges from the underlying formation that provides recharge to the uppermost aquifer are also included for comparison (Figure 1). Concentrations of uranium, sulfate, and nitrate versus time have been plotted on Figures 9, 10, and 11, and are provided in Table 4.

Table 4. Summary of Indicator Parameters in Ground Water within the Uppermost Aquifer at the Mexican Hat, Utah, Disposal Site

Monitor Well *(Number and Location)*	**Uranium** *MCL = 0.044 mg/L*		**Sulfate** *MCL = none*		**Nitrate** *MCL = 44 mg/L*	
	Range	Average	Range	Average	Range	Average
Downgradient						
MW–0899	0.008−0.014	0.010	4,220−4,600	4,390	0.02-0.09	0.04
Upgradient (Background)						
MW–0909	0.039−0.064	0.046	1,750−2,800	2,103	0.8−12.4	7.6
Halgaito Wash Seep (background)						
0256	0.010-0.046	0.028	2030-3260	2310	0.017-3.8	0.662

Concentrations reported in mg/L.
Nitrate reported as NO_3.

Concentrations of uranium in ground water have remained relatively constant in background monitor well (MW−0909) with an average just above the maximum concentration limit (MCL) at 0.046 milligrams per liter (mg/L). Concentrations in the upgradient seep (MW−0256) are variable, as expected; with an average of 0.028 mg/L. Concentrations of uranium in ground water in the downgradient monitor well (MW−0899) in the uppermost aquifer remain low with an average of 0.010 mg/L. These results confirm that there is no site-related contamination from the former uranium-processing site or disposal cell migrating into ground water in the confined uppermost aquifer.

Concentrations of sulfate in ground water have remained relatively stable in the background monitor well (MW−0909) and the background seep (MW−0256) at an average of approximately 2,200 mg/L. Concentrations of sulfate have been more elevated in ground water in the downgradient monitor well (MW−0899), which is not unexpected as sulfate values are variable and naturally elevated in some parts of the lithologic units.

Concentrations of nitrate in ground water have been substantially below the MCL and less than 1.0 mg/L in the downgradient monitor well (MW−0899). This indicates no impact from site-related contamination on ground water in the uppermost aquifer.

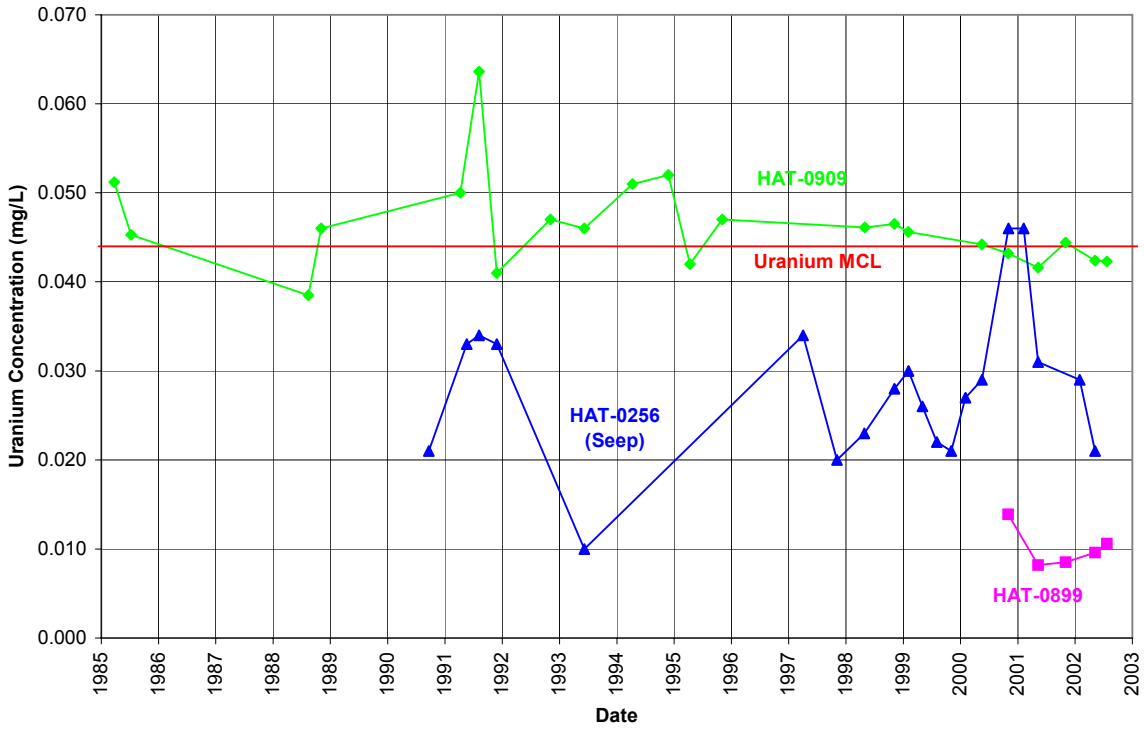

Figure 9. Uranium in Ground Water of the Uppermost Aquifer at the Mexican Hat, Utah, Disposal Site

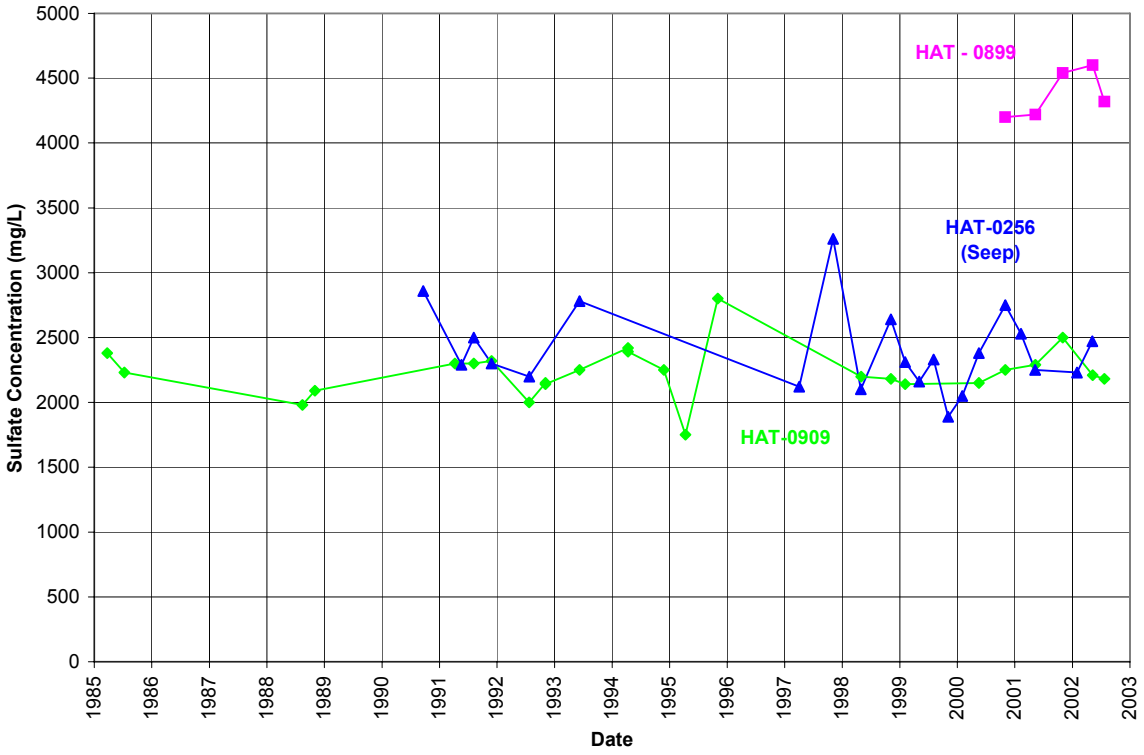

Figure 10. Sulfate in Ground Water of the Uppermost Aquifer at the Mexican Hat, Utah, Disposal Site

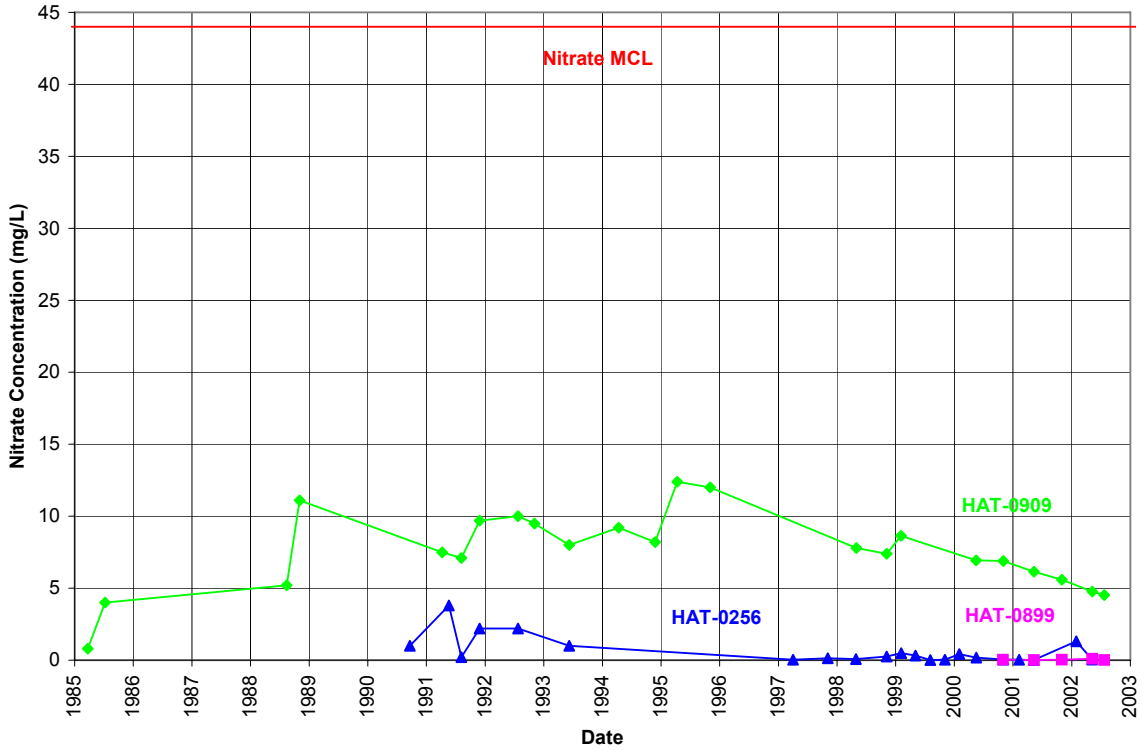

Figure 11. Nitrate in Ground Water of the Uppermost Aquifer at the Mexican Hat, Utah, Disposal Site

4.3 Ground Water Level Monitoring Results

Measurement of ground water levels in the two monitor wells has confirmed that there continues to be an upward vertical hydraulic gradient within the uppermost aquifer (Figure 12). The top of the confined uppermost aquifer in the lower unit of the Halgaito Formation was encountered in the downgradient well (MW-0899) at approximately 190 feet below land surface, and the top of the 10-foot screened interval is set at approximately 207 feet below land surface (Attachment A). The static ground water level at approximately 35 feet below top of casing (top of casing is approximately one foot above land surface) demonstrates a substantial upward hydraulic gradient from the confined uppermost aquifer (Figure 12 and cross section in Figure 1).

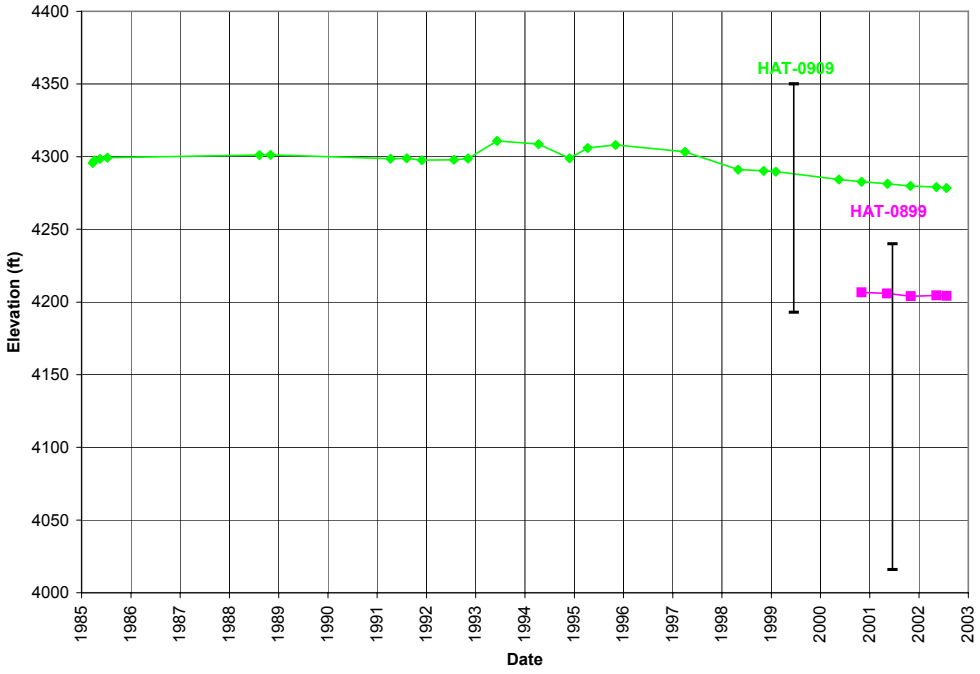

Figure 12. Ground Water Elevations of the Uppermost Aquifer at the Mexican Hat, Utah, Disposal Site

5.0 Risk Assessment

Because the surrounding site conditions and land use have not changed significantly, the conclusions reached in the updated risk assessment for exposure to seep water downgradient of the site previously presented (DOE 2002) are still applicable and continue to serve as the basis for recommendations made regarding the need for continued seep monitoring (Section 6.0).

Risk calculations for human health associated with the seeps at the Mexican Hat Disposal Site were provided in the Site Observational Work Plan (SOWP) (DOE 1998). The Navajo Nation concurred in a July 3, 2002, letter to DOE that the errors observed in the human and ecological risk assessment in the SOWP were addressed in the updated risk assessment for exposure to seep water presented in the *Assessment of Seeps at the Mexican Hat, Utah, UMTRCA Project Site* report (DOE 2002), and that no changes to the SOWP were necessary. Results of the updated risk assessment for exposure to seep water are presented below.

Although the scenario used in the SOWP risk assessment remains unlikely based on the limited quantity of available water, calculations for ingestion of meat and milk from sheep and cattle watered with seep water were made and the results indicated that no unacceptable risks were associated with these pathways. Ingestion of seep water as a primary drinking water source was not considered to be a complete pathway in the SOWP risk assessment because the nearest residence was over a mile from the site in the town of Halchita and the town was served by a municipal system; these conditions still apply and continue to be relevant regarding site related risk. Potential risks associated with incidental exposure to seep water also continue to be negligible. Therefore, the SOWP risk assessment conclusion that the seeps at the Mexican Hat Disposal Site posed no unacceptable human health risks remains applicable.

Because surrounding site conditions and land use have not changed significantly, the conclusions reached by previously performed ecological risk assessments also still apply. A conservative, screening level ecological risk assessment was first performed for ground water seeps present at the Mexican Hat Disposal Site (Duncan, et al. 1994). That assessment resulted in the identification of several constituents—boron, nitrate, selenium, silica, and uranium—as having the potential for posing unacceptable risks to ecological receptors. Those constituents were reevaluated using more recent monitoring data, updated toxicological data, and a more reasonable exposure scenario (DOE 2002). In this reevaluation, water was considered to be the only medium of concern. Livestock were the receptors evaluated, and it was assumed that potential risks to any other wildlife receptors would be similar to those for livestock. Maximum surface water concentrations from any seep used in the previous calculations were used in this reevaluation to be conservative. The exposure assumptions made in the SOWP (DOE 1998) were used in the calculations. Specifically, the assumption was made that receptors would only be exposed to the seeps for one day per week, based on the fact that water in the seeps is limited and that the home range for livestock and wildlife of concern is fairly large. Toxicity benchmarks used for calculations in the reevaluation were commonly accepted for performing DOE ecological risk assessments (Sample, et al. 1996). Results of the reevaluation indicate that potential risks to livestock and wildlife through ingestion of seep water are negligible. Hazard quotients for livestock receptors for the three contaminants evaluated are all more than an order of magnitude below the maximum acceptable level. It is probable that potential risks to any other wildlife receptors (e.g., coyotes) would be equally low.

Ground water monitoring results confirm that site-related contamination is not present in the uppermost aquifer beneath the site (Section 4.2). This is because the uppermost aquifer is hydrogeologically isolated and protected from contamination within the overlying perched ground water by effective confining layers and an upward hydraulic gradient. Therefore, no risk assessment regarding exposure to ground water in the uppermost aquifer is necessary.

6.0 Conclusions and Recommendations

6.1 Seep Monitoring

Site-related contamination is present within scattered perched ephemeral ground water in the upper unit of the Halgaito Formation that is the source of seep water discharge. However, because of the low flows observed from these seeps, they do not constitute a water resource and do not provide sufficient volume to present a significant risk to human health and the environment. In addition, the remote location of these seeps and minimal grazing in the area also greatly reduces the likelihood of any significant human health risks associated with the seep water. The potential ecological risks to wildlife through ingestion of contaminated seep water are negligible.

Therefore, discontinuing seep water quality sampling and analysis is recommended because the risk assessment demonstrates there is no significant human or ecological risk associated with the seeps. Concentrations of contaminants in the seeps appear to have leveled off and remain within the range of historic concentrations. Continued water quality sampling and analysis will provide little further benefit in assessing protectiveness of the site.

It is recommended that visual observations of seeps continue to be made during regular inspections of the disposal cell. Because of the low flows observed historically, an attempt to

directly measure seep flow is not practical or necessary, and therefore, is not recommended. A more qualitative description of the seeps should be adequate (e.g., dry, moist, dripping, flowing), along with photographic documentation for yearly comparisons. If significant increases in water flow from seeps is noted, this may be an indicator that the cell is no longer performing as anticipated. Additional sampling and analysis or evaluation may then be justified at that time. This approach should be incorporated into the next scheduled revision of the LTSP for the site.

6.2 Ground Water Monitoring

Ground water monitoring of the uppermost aquifer beneath the site is not required, nor warranted, because it is hydrogeologically isolated by confining layers which limit vertical ground water movement and an upward hydraulic gradient within the uppermost aquifer, both of which prevent any downward migration of contaminants from the overlying perched water. The BMP monitoring performed at the request of the Navajo Nation demonstrates that the uppermost aquifer is not contaminated by on-site uranium processing activities and that an upward hydraulic gradient persists. The design of the disposal cell, which sheds and diverts surface water to natural drainages, will minimize any additional potential for the downward migration of contaminants from the site.

Additionally, ground water in the upper most aquifer contains naturally elevated concentrations of sulfate and hydrogen sulfide, and therefore, is not a current or potential source of drinking water in the vicinity of the site. Recharge to the uppermost aquifer is unaffected by site-related contamination since it occurs upgradient of the site and from upward flow from deeper formations. The nearby San Juan River and two water supply wells are dependable sources that provide sufficient water for current and anticipated future needs of the local residents. Analytical results of water samples show that the Mexican Hat Disposal Site does not significantly affect the quality of water in the San Juan River.

In conclusion, based on an assessment of the data, DOE has met the objectives of the BMP ground water monitoring program conducted in accordance with concerns raised by the Navajo Nation, and has demonstrated that there is no evidence of, or potential for, site-related contamination to impact ground water in the uppermost aquifer. Consequently, DOE recommends that no additional ground water monitoring of the uppermost aquifer is needed and to decommission all remaining monitor wells at the site.

7.0 References

Duncan, J.R., A. Redfearn, and F.L. Guty, 1994. *Mexican Hat, Utah, Preliminary Ecological Risk Assessment for Groundwater Seeps*, ORNL/TM-12736, March.

Sample, B.E., D.M. Opresko, and G.W. Suter II, 1996. *Toxicological Benchmarks for Wildlife*, 1996 Revision, ES/ER/TM-86/R3, June.

U.S. Department of Energy (DOE), 1993. *Remedial Action Plan* (RAP) *for the Codisposal and Stabilization of the Monument Valley and Mexican Hat Uranium Mill Tailings at Mexican Hat, Utah*, UMTRA-DOE/AL-050509.0000, February.

———, 1997. *Long-Term Surveillance Plan for the Mexican Hat Disposal Site, Mexican Hat, Utah*, DOE/AL/62350-207, Rev. 2, June.

———, 1998. *Final Site Observational Work Plan* (SOWP) *for the UMTRA Project Site at Mexican Hat, Utah*, U0026800, Rev. 1, July.

———, 1999. *Draft Ground Water Compliance Action Plan* (GCAP) *for the Mexican Hat, Utah, UMTRA Project Site*, U00455AA, March.

———, 2001. *Results of Drilling Activities and Resolution of Ground Water Issues at the Mexican Hat, Utah, UMTRA Project Site*, U0123000, February.

———, 2002. *Assessment of Seeps at the Mexican Hat, Utah, UMTRA Project Site*, GJO-2002-300-TAR, April.

U.S. Nuclear Regulatory Commission (NRC), 1996. *Final Technical Evaluation Report* (FTER) *for the Proposed Remedial Action Plan for the Co-disposal of the Monument Valley and Mexican Hat Contaminated Materials at the Mexican Hat Tailings Site, Utah*, transmitted from NRC to DOE with letter of February 27, 1996.

End of current text

Attachment A

Monitoring Well Completion Logs for MW−0899, MW−0909, MW−0934, and MW−0935

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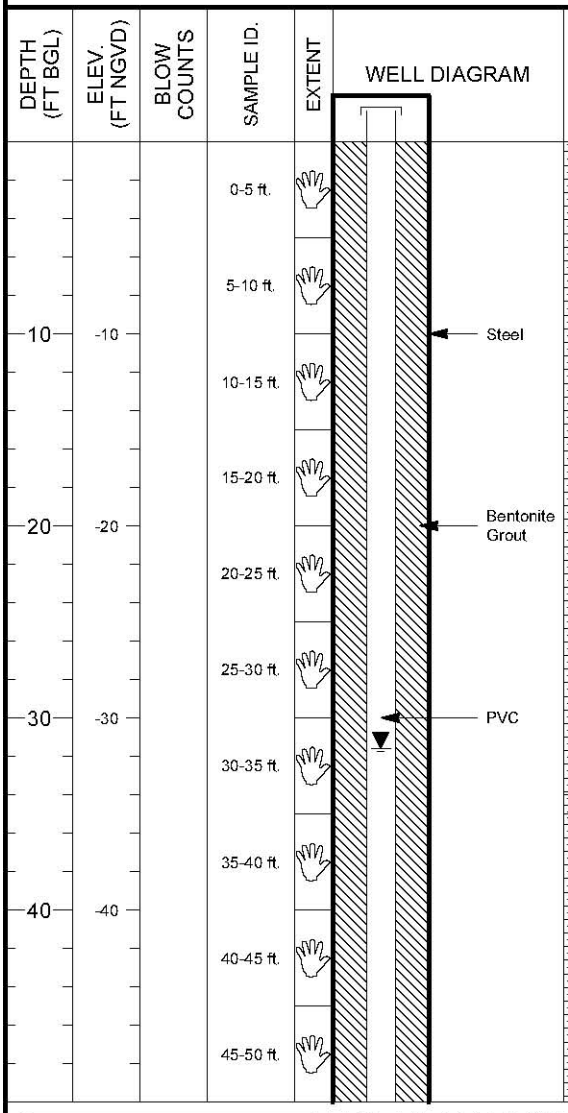
MONITORING WELL COMPLETION LOG HAT01-0899

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	174121.38	**DATE DRILLED**	11/04/2000
LOCATION	MEXICAN HAT, UT	**EAST COORD. (FT)**	2475312.56	**SURFACE ELEV. (FT NGVD)**	
SITE	MEXICAN HAT	**HOLE DEPTH (FT)**	224.00	**TOP OF CASING (FT)**	
WELL NUMBER	0899	**WELL DEPTH (FT)**	217.90	**MEAS. PT. ELEV. (FT)**	
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:	6.875 in. Steel	-1.0	to	163.62
BLANK CASING:	2 in. PVC	-3.2	to	207.43
WELL SCREEN:	2 in. Machine Slotted PVC	207.43	to	217.57
SUMP/END CAP:	2 in. PVC	217.57	to	217.9
SURFACE SEAL:				
GROUT:	Bentonite	-1.0	to	189.0
SEAL:	Bentonite Pellets	189.0	to	194.0
UPPER PACK:	30-70 Silica Sand	194.0	to	196.0
LOWER PACK:	10-20 Silica Sand	196.0	to	224.0

DRILLING METHOD REVERSE CIRCULATION
SAMPLING METHOD CYCLONE/GRAB
DATE DEVELOPED
WATER LEVEL (FT BTOC) 34.8 on 11/04/2000
LOGGED BY Spencer, L.
REMARKS BIT sizes used: 11" to 64 ft., 9" to 164 ft., 6 5/8" to 224 ft. Steel casing with 1 ft. of stickup above ground surface.



0-29 ft. SILTSTONE; Halgaito Formation, yellowish red (5 YR 5/6), some interbedded sandstone lenses, very fine grained, a few pebbles, subangular of grayish green limestone, hard and softer lenses, some well cemented fine grained sand, some crumbly dry, calcareous, somewhat weathered and soft, cuttings are powder-like (fine).

29-34 ft. SILTSTONE; dark reddish brown (2.5 YR 3/4) harder drilling than 0-29 ft., calcareous, dry, some chert.

34-35 ft. SILTSTONE/SHALE; red (2.5 YR 4/8) softer drilling, calcareous, dry, cuttings are up to 1/2 inch long, (coarse).

35-58 ft. SILTSTONE; dark reddish brown (2.5 YR 3/4) harder drilling, chips up to 3/4 inch long.

MONITORING WELL COMPLETION LOG HAT01-0899

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0899
SITE MEXICAN HAT **DATES DRILLED** 11/04/2000

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
60	-60		50-55 ft.				
			55-60 ft.				58-61 ft. SILTSTONE; red (2.5 YR 4/6) fairly soft drilling, some very tiny micaceous siltstone pebble chips up to 1/8 inch long.
			60-65 ft.				61-65 ft. SILTSTONE; dark reddish brown (2.5 YR 3/4) a few greenish gray chips of limestone up to 1/4 inch long (small limestone lense) pale olive (5 Y 6/3).
			65-70 ft.				65-70 ft. SANDSTONE; reddish brown (5 YR 5/4) very fine grained.
70	-70						70 ft. Water zone, less than 1 GPM. Note: Drilling with water to keep from sticking the drill tools
			70-80 ft.				70-75 ft. SILTSTONE; yellowish red (5 YR 5/6).
							75-90 ft. No sample.
80	-80						
			No Sample				
							89 ft. Water has pretty much dried up.
90	-90						90-97 ft. SILTSTONE; dark reddish brown (2.5 YR 3/4) with a few greenish gray chips, most fines are gone.
			90-95 ft.				95 ft. Water 2.5 GPM (?) interbedded silt and sandstone lenses.
			95-100 ft.				97-110 ft. SILTSTONE; very little, if any, water.
100	-100		100-105 ft.				
			105-110 ft.				
110	-110		110-115 ft.				110-125 ft. SILTSTONE; fairly soft, same color as above.
							112 ft. SANDSTONE; A thin lense of very fine grained sandstone,

MONITORING WELL COMPLETION LOG HAT01-0899

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0899
SITE MEXICAN HAT **DATES DRILLED** 11/04/2000

Continued from Previous Page

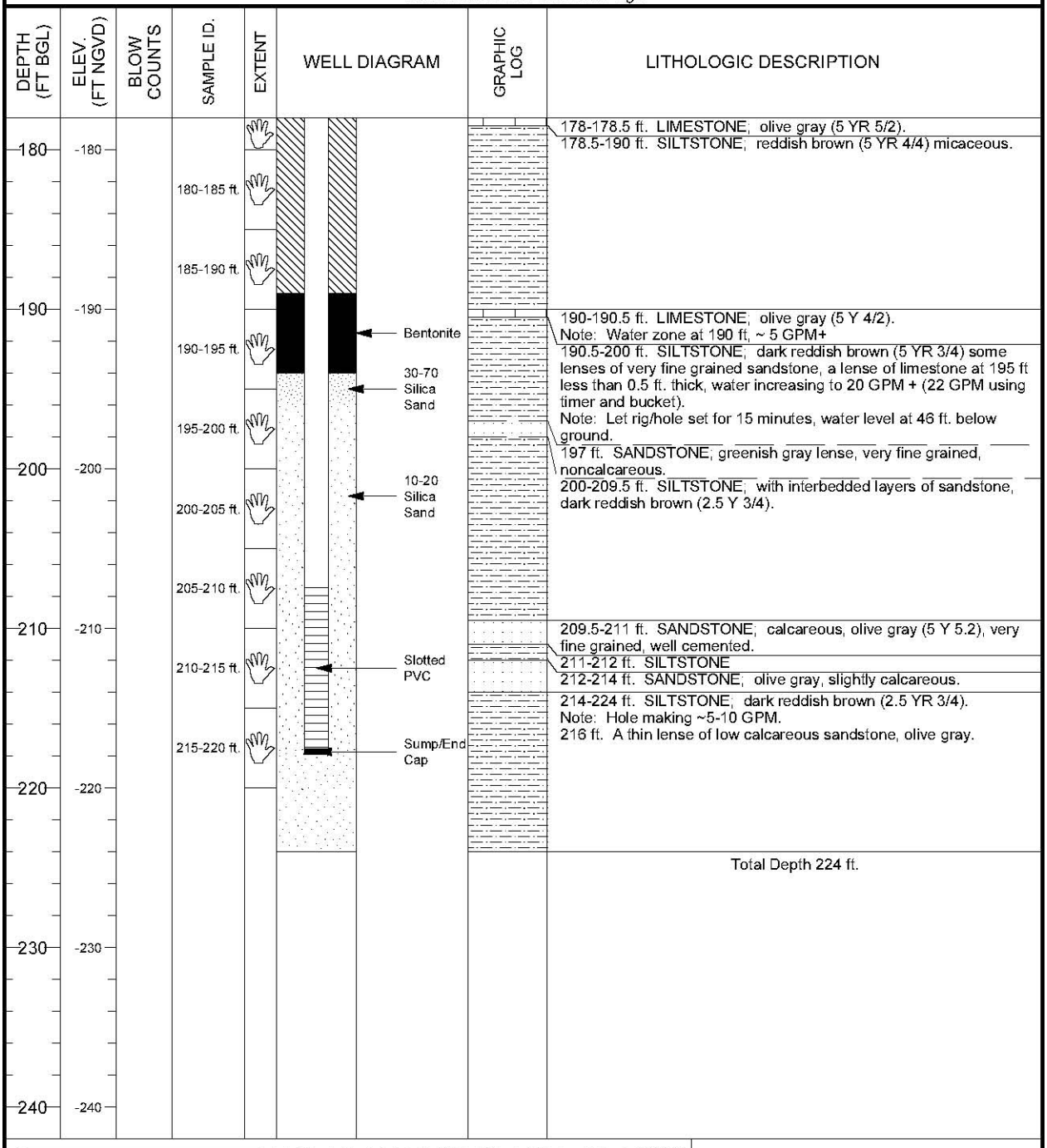
DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
			115-120 ft.				light gray (2.5 Y 7/2) noncalcareous, making a very small smount of water - less than 1/2 GPM.
120	-120		120-125 ft.				124 ft. No water. 125-141 ft. SILTSTONE; micaceous, dark reddish brown (2.5 YR 3/4) very little, if any water.
			125-130 ft.				
130	-130		130-135 ft.				
			135-140 ft.				
140	-140		140-145 ft.				141-143 ft. MUDSTONE; Drilled faster, softer zone. 143-144 ft. SILTSTONE; Drilled harder. Note: Total hole making 2.5-3.0 GPM circulated - quit for 11-2-2000 at 144 ft. in depth. On 11-3-2000 unloaded hole ~ 100 gallons. 144-158 ft. SILTSTONE; with mudstone lenses, reddish brown (5 YR 5/3).
			145-150 ft.				
150	-150		150-155 ft.				
			155-160 ft.				158 ft. Slightly making water. 158-159 ft. CLAYSTONE; Soft, yellowish red (5 YR 5/6) water on top of it.
160	-160		160-165 ft.				159-164 ft. SILTSTONE; Dry, calcaceous, mudstone highly calcareous, no mica in either. 164-170 ft. SILTSTONE; dark red (2.5 YR 3/6) a few thin lenses of very fine grained sandstone, dry. Note: Blowing dust.
			165-170 ft.				
170	-170		170-175 ft.				170-178 ft. SILTSTONE; with mudstone lenses, reddish brown (5 YR 4/4).
			175-180 ft.				

MONITORING WELL COMPLETION LOG HAT01-0899

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0899

SITE MEXICAN HAT **DATES DRILLED** 11/04/2000

Continued from Previous Page



PROJECT *MEXICAN HAT SITE, UTAH*

LOG OF WELL BORING NO. 909

JOB NO. *HAT01* DATE *03/29/85*

SURFACE ELEVATION 4349.77

TOP OF FILTER PACK 120.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

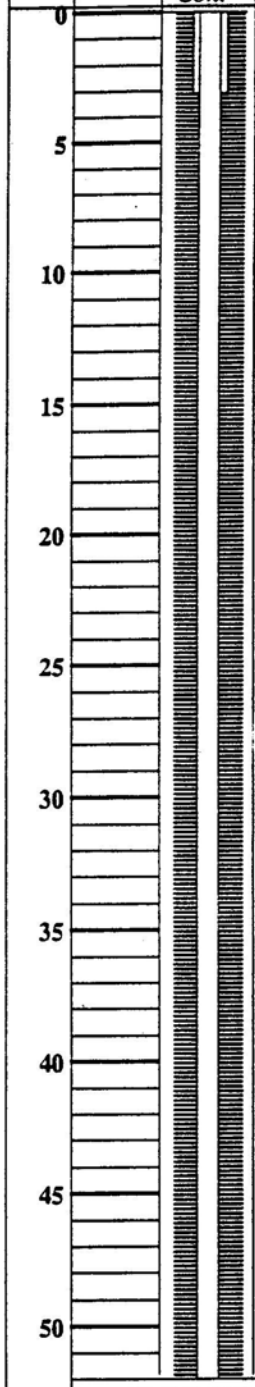
TOTAL DEPTH 215.0 feet

RIG TYPE MOBILE B-80

BORING TYPE HSA WITH NO CORE

LOCATION N 7925.50 E 7134.40

DATUM MSL, @ GROUND SURFACE



Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2.0-in PVC well to 150 feet.		SM	**SOIL:** SILTY SAND, lt. reddish brown.
		Protective steel casing placed to 3 feet (?).		SP	**HALGAITO SHALE MEM.**
				SM	SANDSTONE, with interbedded
5				ML	siltstone, greyish red.
					SILTSTONE, with limestone nodules, locally closely spaced fractures, grey.
		Installed Bentonite/ grout seal to 117 feet.		CH	CLAYSTONE, highly weathered, greyish red.
10				ML	Note: Limestone seam at 10 to 10.5 feet.
					SILTSTONE, greyish red.
15					Note: Massive bedded, no apparent bedding planes.
				CL	CLAYSTONE, with grey nodules, mod. weathered, greyish red.
20					Note: Limestone inclusions.
				LS	LIMESTONE, grey.
25				ML	SILTSTONE, very hard, with blue-grey limestone nodules, greyish red.
30					
35					
40					
45					
50					Note: Reddish brown color.

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 909

JOB NO. HAT01 DATE 03/29/85

SURFACE ELEVATION 4349.77

TOP OF FILTER PACK 120.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 215.0 feet

RIG TYPE MOBILE B-80

BORING TYPE HSA WITH NO CORE

LOCATION N 7925.50 E 7134.40

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					**HALGAITO SHALE MEM., Continued. (SILTSTONE, greyish red.)**
60					
65					
70					
75					**Note: Thin bands of limestone, and seams with clay clasts.**
80					
85					
90					**Note: Clayey, mudstone seams from 90 to 94 feet.**
95					**Note: With rock salt sized limestone nodules.**
100					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 909

JOB NO. HAT01 DATE 03/29/85

SURFACE ELEVATION 4349.77

TOP OF FILTER PACK 120.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 215.0 feet

RIG TYPE MOBILE B-80

BORING TYPE HSA WITH NQ CORE

LOCATION N 7925.50 E 7134.40

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105				LS	**HALGAITO SHALE MEM., Continued.** LIMESTONE, hard, grey.
				ML	SILTSTONE, with limestone partical clasts, greyish red.
110				SC	MUDSTONE, with siltstone seams, greyish red.
115				ML	SILTSTONE, laminar, well cemented, occ. limestone nodules, greyish red. Note: Thin limestone seam at 117.1 to 117.3 feet.
120		Bentonite pellet seal placed from 117 to 120 feet.			Note: Thin limestone seam at 123 feet.
125		Filter pack sand installed from 120 to 155 feet.			Note: Sandstone layer at 125 to 126 ft.
130		Well screen installed from 130 to 150 feet.			Note: Color change from greyish red to dark red.
135					Note: Alternating interbeds of limestone from 135 to 145 ft.
140					
145					Note: Occasional thin seams of claystone and limestone from 145ft.
150		Five foot blank sump installed from 150 to 155 ft.			
155					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 909

JOB NO. HAT01 DATE 03/29/85

SURFACE ELEVATION 4349.77

TOP OF FILTER PACK 120.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 215.0 feet

RIG TYPE MOBILE B-80

BORING TYPE HSA WITH NQ CORE

LOCATION N 7925.50 E 7134.40

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
					HALGAITO SHALE MEM. Continued.
		Bentonite pellet seal placed from 155 to 157 ft.		LS	LIMESTONE, mod. soft, masssive, grey.
160		Not confirmed if initial core hole was reamed or if off-set hole was drilled for installation of well to 156 feet.			
165					
170					Note: sulphur traces in limestone, strong acid odor.
175					Note: traces of petroleum imbedded in core at 177 to 179 ft.
180					
185					Note: Increasing siltstone interbeds from 184 ft. Note: More oil imbedded in core from 185 to 187 ft.
190					
195				ML	SILTSTONE, massive, with occasional beds of limestone, red.
200					
205					Note: Interbedded thin limestone seams and nodules.

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 909

JOB NO. HAT01 DATE 03/29/85

SURFACE ELEVATION 4349.77

TOP OF FILTER PACK 120.00

WELL CASING TYPE 2.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 215.0 feet

RIG TYPE MOBILE B-80

BORING TYPE HSA WITH NO CORE

LOCATION N 7925.50 E 7134.40

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
210					**HALGAITO SHALE MEM., Continued.**
215					**TD AT 215 FEET.**
220					
225					
230					
235					
240					
245					
250					
255					
260					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 934

JOB NO. HAT01 DATE 10/16/85

SURFACE ELEVATION 4289.27

TOP OF FILTER PACK 177.00

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 200.0 feet

RIG TYPE BEEMAN ROTARY

BORING TYPE ROTARY - AIR

LOCATION N 9221.30 E 11989.90

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Reamed 5 1/8-in hole to 8-in hole. Installed 4-in PVC cased well to 197 feet.		ML	**HALGAITO SHALE MEM., CUTLER FM.:** SILTSTONE, cherty, calcareous, some interbedded mudstone, medium orange- brown. Note: Surface strewn with rock slabs of weathered limestone, and traces of gypsum.
5					
10		Placed steel protective casing to 8 feet.			
15		Installed bentonite-cement grout to 172 feet.			Note: Color change to med. brown.
20					Note: Becomes thin bedded, little or no chert present from 22 ft.
25					
30					Note: Considerable mudstone interbeds from 29 to 36 feet.
35					
40					Note: Occasional mudstone seams from 36 to 44 feet.
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 934

JOB NO. HAT01 DATE 10/16/85

SURFACE ELEVATION 4289.27

TOP OF FILTER PACK 177.00

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 200.0 feet

RIG TYPE BEEMAN ROTARY

BORING TYPE ROTARY - AIR

LOCATION N 9221.30 E 11989.90

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					**HALGAITO SHALE MEM., Continued.** Note: Some mudstone interbeds from 55 to 57 feet.
60					
65					Note: Occasional thin limestone and mudstone interbeds from 66 to 82 ft.
70					
75					
80					
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 934

JOB NO. HAT01 DATE 10/16/85

SURFACE ELEVATION 4289.27

TOP OF FILTER PACK 177.00

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 200.0 feet

RIG TYPE BEEMAN ROTARY

BORING TYPE ROTARY - AIR

LOCATION N 9221.30 E 11989.90

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					**HALGAITO SHALE MEM., Continued.**
110					**Note: Occasional interbeds of thin grey limestone and orange mudstone seams from 100 to 117 feet.**
115					
120					**Note: cherty siltstone from 120 to TD; Occasional thin limestone and mudstone seams.**
125					
130					
135					
140					
145					
150					**Note: Wet below 150 feet.**
155					**Note: Stopped drilling 5 1/8-in**

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF WELL BORING NO. 934

JOB NO. HAT01 DATE 10/16/85

SURFACE ELEVATION 4289.27

TOP OF FILTER PACK 177.00

WELL CASING TYPE 4.0-IN.SCHED.40 PVC

COMPLETION HALGAITO SHALE MEM.

TOTAL DEPTH 200.0 feet

RIG TYPE BEEMAN ROTARY

BORING TYPE ROTARY - AIR

LOCATION N 9221.30 E 11989.90

DATUM MSL, @ GROUND SURFACE

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
					borehole at 155 feet. Reamed with 8.0-in and deepened to 200 feet after water encountered at 150 ft.
160					HALGAITO SHALE MEM., Continued.
165					
170					
		Placed bentonite- slurry seal from 172 to 177 feet.			
175					Note; Some interbeds of sandstone, slightly micaceous. Color change to dark red to red.
		Placed filter pack sand from 177 to 197 feet.			
180					
185					
		Placed .051 slot well screen from 188 to 198 feet.			
190					Note: Color change to orange red, slightly clayey, trace mica, calcareous,
195					
		Cave-in fill from 197 to 200 feet. Two foot sump installed at 198 ft.			
200					TD AT 200 FEET.
205					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT *MEXICAN HAT SITE, UTAH*

LOG OF TEST BORING NO. 935

JOB NO. *HAT01* DATE *10/19/85*

LOCATION *N10023.8 E12468.3*
RIG TYPE *BEEMAN ROTARY*
BORING TYPE *ROTARY - AIR* *5 1/8-IN*
SURFACE ELEV *4230.62*
DATUM *MSL, @ GROUND SURFACE*

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot - 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SP		**HALGAITO SHALE MEM., CUTLER FM.:** SANDSTONE, very fine grained, calcareous, fissle, hard, occasional siltstone seams, reddish brown.
								ML		SILTSTONE, highly calcareous, hard, dark red to lt. orange red.
5										
10										
15										
20										
25								ML SM		SANDSTONE AND SILTSTONE, alternating with variable sand content, reddish brown.
30										
35										
40										
45										
50										

GROUNDWATER

DEPTH	HOUR	DATE

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF TEST BORING NO. 935

JOB NO. HAT01 DATE 10/19/85

LOCATION N10023.8 E12468.3
RIG TYPE BEEMAN ROTARY
BORING TYPE ROTARY - AIR 5 1/8-IN
SURFACE ELEV. 4230.62
DATUM MSL, @ GROUND SURFACE

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
55										**HALGAITO SHALE MEM., Continued.** Note: Some orange clayey siltstone interbeds with sandstone and siltstone layers.
60										
65										
70										
75										
80								SM		SANDSTONE, silty, very fine grained, calcareous, lt. grey.
85								ML SM		SANDSTONE AND SILTSTONE, interbedded, highly calcareous, hard, dark red to reddish brown.
90										
95										
100										

GROUNDWATER

DEPTH	HOUR	DATE

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF TEST BORING NO. 935

JOB NO. HAT01 DATE 10/19/85

LOCATION N10023.8 E12468.3
RIG TYPE BEEMAN ROTARY
BORING TYPE ROTARY - AIR 5 1/8-IN
SURFACE ELEV 4230.62
DATUM MSL, @ GROUND SURFACE

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
105										**HALGAITO SHALE MEM., Continued.**
110										
115										
120										
125										
130										
135										**Note; Continued alternating sandstone and siltstone with change of color of siltstone to maroon, highly calcareous.**
140										
145										
150										
155										

GROUNDWATER

DEPTH	HOUR	DATE

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

PROJECT MEXICAN HAT SITE, UTAH

LOG OF TEST BORING NO. 935

JOB NO. HAT01 DATE 10/19/85

LOCATION N10023.8 E12468.3
RIG TYPE BEEMAN ROTARY
BORING TYPE ROTARY - AIR 5 1/8-IN
SURFACE ELEV. 4230.62
DATUM MSL, @ GROUND SURFACE

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
										HALGAITO SHALE MEM., Continued.
160								ML		SILTSTONE, reddish brown, with 50 % interbedded lt. grey limestone,some thin sandstone seams.
165								ML		SILTSTONE, maroon, with 5 % limestone seams,
170								ML SM		SANDSTONE AND SILTSTONE, interbedded, limestone absent, moist, maroon to reddish brown.
175										Note: Color change to dark red or reddish brown to chocolate brown siltstone/sandstone; fissle, very hard.
180										
185								ML		SILTSTONE , with 50 % lt. grey limestone.
										TD AT 187 FEET.

GROUNDWATER

DEPTH	HOUR	DATE

SAMPLE TYPE

RX - Rock Coring - NX or HX
S - 2" O.D. 1.38" I.D. tube sample.
U - 3" O.D. 2.42" I.D. tube sample.
T - 3" O.D. thin-walled Shelby tube.
G - Grab, cuttings sample

JEG TAC TEAM

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Attachment B

Concentration Versus Time plots Comparing Historical Monitoring of MW−0934 and MW−0935 to BMP Monitoring of MW−0899 and MW−0909

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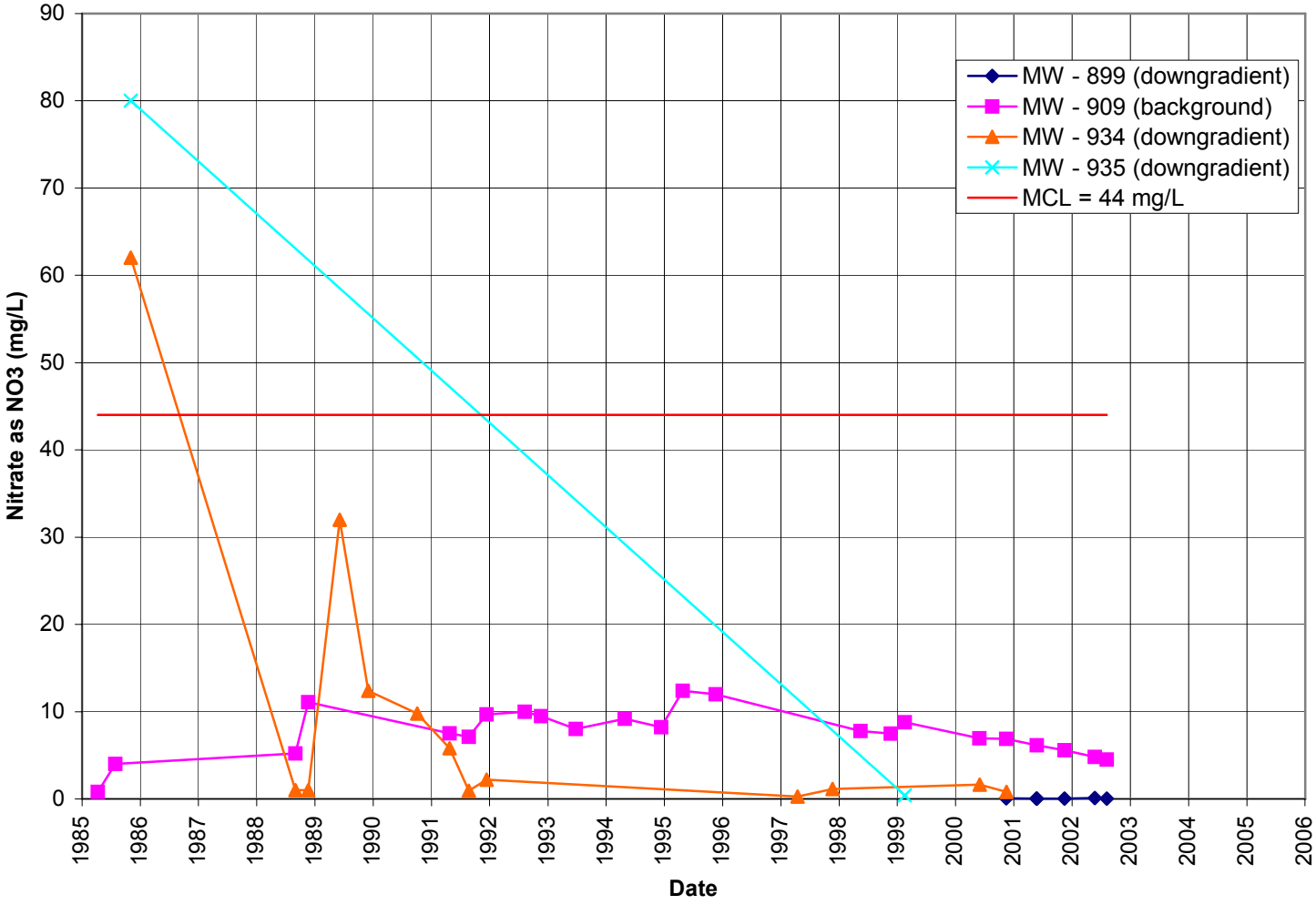
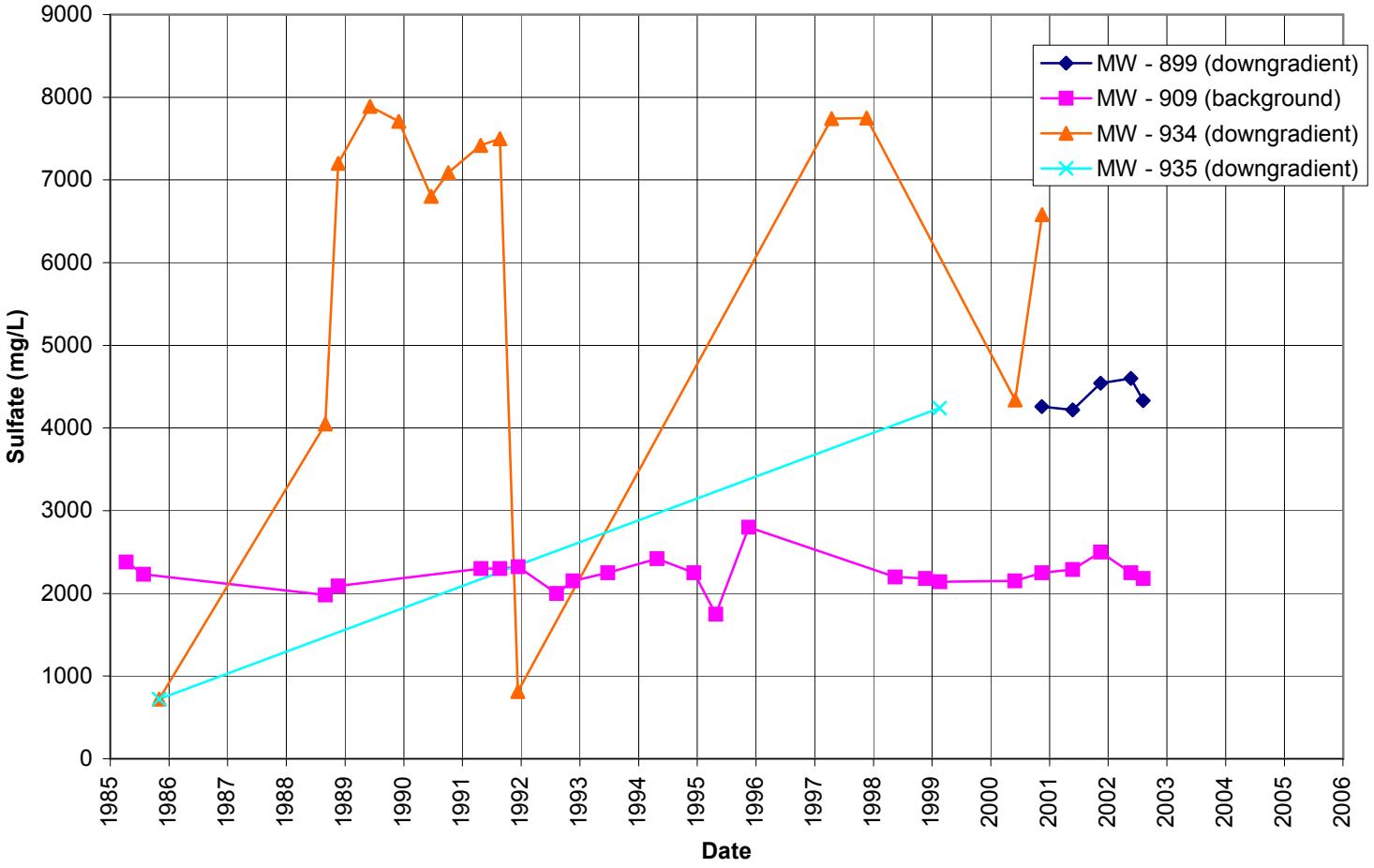
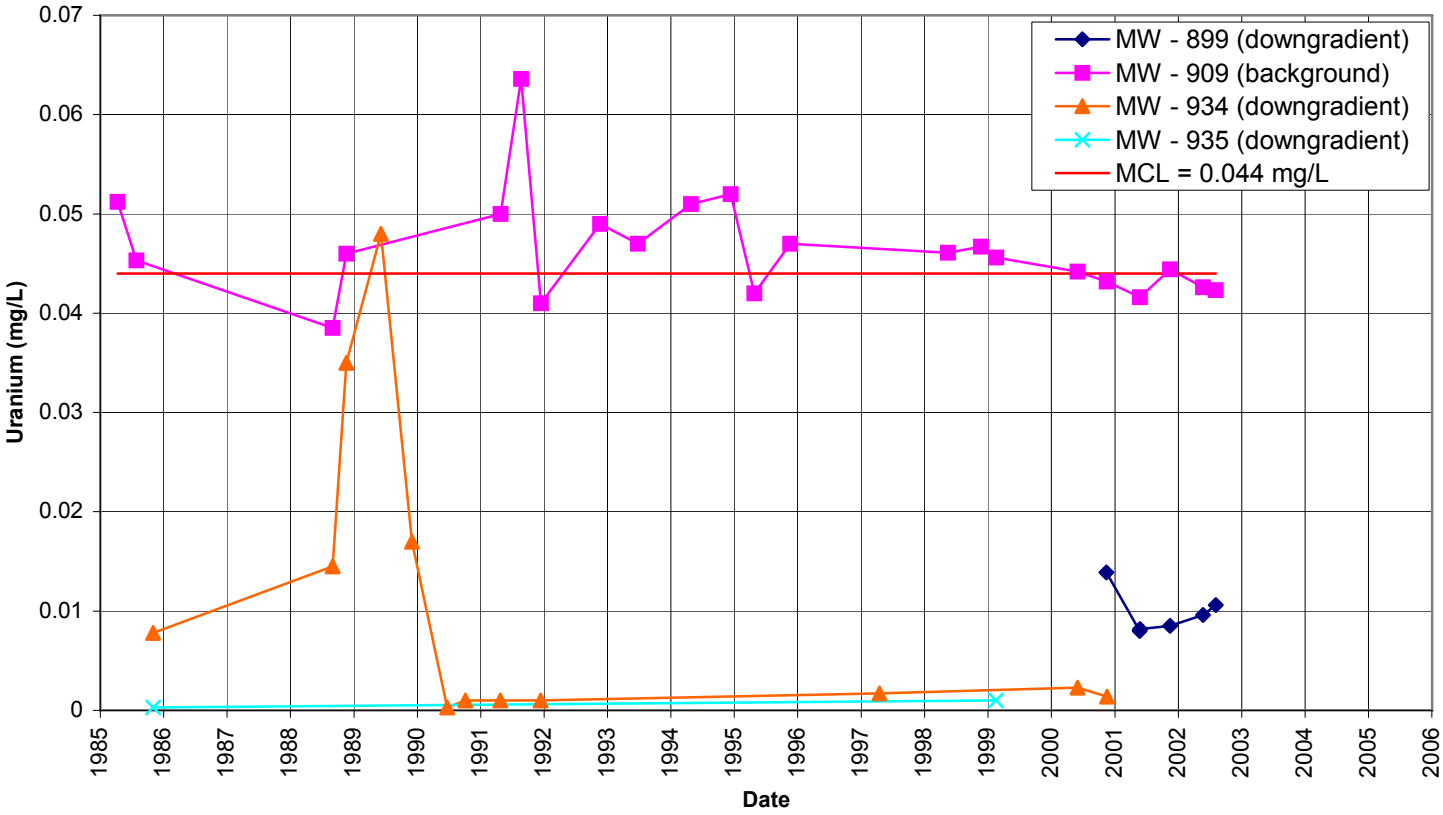
Mexican Hat Disposal Site
Ground Water Monitoring Wells - Uppermost Aquifer



Mexican Hat Disposal Site
Ground Water Monitoring Wells - Uppermost Aquifer



Mexican Hat Disposal Site
Ground Water Monitoring Wells - Uppermost Aquifer



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Attachment C

Photographs of Seeps Monitored in 2005

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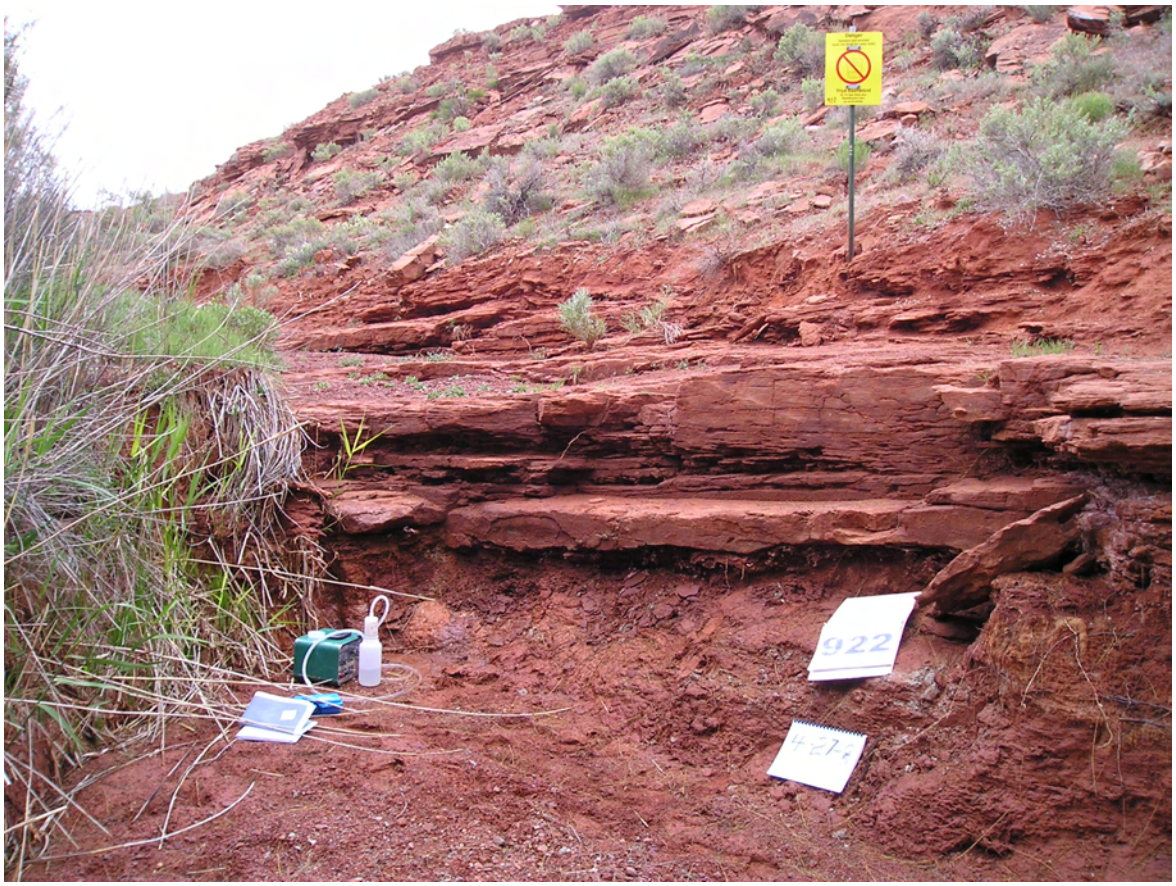
Seep 0248 in Gypsum Creek (April 27, 2005)

Seep 0251 in North Arroyo (April 27, 2005)

Seep 0254 in Gypsum Creek (April 27, 2005)

Seep 0261 in Gypsum Creek (April 27, 2005)

Seep 0264 in North Arroyo (April 27, 2005)



Seep 0922 in Gypsum Creek (April 27, 2005)

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