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UMTRA GROUND WATER PROJECT

# Ground Water Study at Two UMTRA Project Vicinity Properties in Grand Junction, Colorado

February 1999

Prepared by the

U.S. Department of Energy

Grand Junction Office

UMTRA Ground Water Project

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# Acronyms and Abbreviations

| | |
|---|---|
| BLRA | baseline risk assessment |
| BOR | U.S. Bureau of Reclamation |
| CDPHE | Colorado Department of Public Health and Environment |
| cm | centimeter(s) |
| COPC | chemical of potential concern |
| DOE | U.S. Department of Energy |
| EPA | U.S. Environmental Protection Agency |
| ft | foot (feet) |
| GJO | Grand Junction Office |
| gpm | gallons per minute |
| HI | hazard index |
| HQ | hazard quotient |
| in. | inch(es) |
| km | kilometer(s) |
| m | meter(s) |
| MCL | maximum concentration limit |
| mg/L | milligrams per liter |
| mi | mile |
| NEPA | National Environmental Policy Act |
| pCi/g | picocuries per gram |
| RBC | risk-based concentration |
| SEE | Site Environmental Evaluation |
| SOWP | Site Observational Work Plan |
| TDS | total dissolved solids |
| UMTRA | Uranium Mill Tailings Remedial Action (Project) |
| UMTRCA | Uranium Mill Tailings Radiation Control Act |
| USGS | U.S. Geological Survey |
| VP | Vicinity Property |

# Executive Summary

The U.S. Department of Energy (DOE) recently completed the removal of uranium mill tailings, which had been used for fill and other construction purposes, from more than 4,000 private and commercial properties in the Grand Junction area. Tailings removal was accomplished as part of the Uranium Mill Tailings Remedial Action (UMTRA) Project. Most of the tailings were removed from these properties, known as vicinity properties, but some were left in place under the category of supplemental standards or area averaging if evaluations indicated that the tailings posed no risk to human health. DOE and the Colorado Department of Public Health and Environment were concerned that mill tailings may have adversely affected ground water quality and that tailings left in place at some UMTRA Project vicinity properties might continue to contaminate ground-water. To address this concern, one large complex commercial property, the Regional Center, and a group of residential properties, collectively called West Main Street, were studied. Large volumes of tailings had been removed from the Regional Center property, and substantial volumes of tailings were left in place at both properties through the application of supplemental standards or area averaging. These properties were considered to represent worst case scenarios for potential ground water contamination.

Three monitoring wells were installed in the alluvial aquifer at the Regional Center and one monitoring well was installed in the alluvial aquifer at West Main Street. All wells were installed downgradient from major volumes of tailings left in place. Water samples were collected from the wells twice in 1998 and analyzed for the chemicals of potential concern (COPCs) listed in the Baseline Risk Assessment (BLRA) for the Grand Junction millsite (DOE 1995). Ground water samples were collected from eight previously installed alluvial aquifer background monitoring wells during the same period, and analytical results were compared to results of samples from the study areas.

Results showed that mean concentrations of manganese, iron, sulfate, molybdenum, uranium, selenium, chloride, and fluoride in samples from background wells exceeded either UMTRA Project maximum concentration limits or U.S. Environmental Protection Agency secondary drinking water standards. Mean concentrations of manganese, iron, uranium, molybdenum, sulfate, fluoride, and chloride in ground water samples from the Regional Center were slightly higher than mean values from background ground water, but maximum values from the Regional Center were generally within the range of background values. Of particular importance, concentrations of $^{234}U$ and $^{238}U$ averaged 51 picocuries per liter (pCi/L) in ground water samples from the Regional Center compared with 43 pCi/L in background samples, but the maximum concentration in samples from the Regional Center was 55 pCi/L, which is less than the 57 pCi/L maximum in background samples. Ground water samples from the West Main Street property had maximum concentrations of sulfate and manganese that were slightly above maximum background values; the remainder were below the maximum background values. The maximum isotopic uranium concentration was 26 pCi/L, which was also below the background value.

Risks to human health and the environment from background ground water were evaluated in the Grand Junction Site Observational Work Plan (SOWP) (DOE 1999). Concentrations of COPCs identified in the Baseline Risk Assessment in background ground water were above levels considered acceptable for human consumption in a residential setting. Risk calculations for ground water from the Regional Center showed similar risks for most of the same constituents, but the cumulative risk from the Regional Center ground water was less than risk from background ground water. Concentrations of constituents in monitoring wells at the West Main

Street property were lower than those in the Regional Center wells and present no increased risks to human health. Ecological risks were evaluated for the Grand Junction SOWP and determined to be acceptable for background locations and for the Grand Junction millsite. Therefore, ecological risks were not considered an issue at the Regional Center or West Main Street properties.

Background ground water in the alluvial aquifer contains relatively high concentrations of manganese, iron, sulfate, selenium, uranium, chloride, and fluoride and is considered to be of poor quality. Similar concentrations of most of these constituents were detected in samples from the Regional Center, but concentrations were generally lower in samples from the West Main Street wells. Risks to human health and the environment from background ground water are indistinguishable from risks from ground water at the Regional Center. Risks to human health and the environment from background ground water are greater than risks from ground water at West Main Street. From these data it is concluded that mill tailings at vicinity properties do not represent a significant potential for ground water contamination.

# 1.0 Introduction

## 1.1 Background

Uranium mill tailings consist of well-sorted sand that was used as fill material and also as a component of concrete. Mill tailings were available to the public for 15 years from the early 1950s to the mid 1960s when the Climax Uranium Mill was operating and were used extensively in the Grand Junction area. Properties that became contaminated from the use of tailings or from windblown tailings are termed vicinity properties (VPs). More than 4,000 VPs have undergone remedial action in Grand Junction since the Uranium Mill Tailings Remedial Action (UMTRA) Project VP program began in 1983 (Plate 1). Most of the tailings were removed from the VPs, but some tailings were left in place if criteria for supplemental standards or area averaging were met. Criteria for applying supplemental standards include the following (summarized from Title 40 Part 192.21 of the *Code of Federal Regulations* [CFR]):

- Removal would pose a clear and present risk of injury to members of the public.
- Remedial action would produce health and environmental harm that is clearly excessive compared to the benefits.
- The cost of remedial action is unreasonably high relative to the long-term benefits, and the tailings do not pose a clear present or future hazard.
- There is no known remedial action.

Tailings may also be left in place if concentrations of $^{226}$Ra averaged over 100 m$^2$ do not exceed background values by more than 5 pCi/g averaged over the first 15 cm of soil below the surface and 15 pCi/g averaged over 15 cm thick layers of soil more than 15 cm below the surface (40 CFR 192.12).

The U.S. Department of Energy Grand Junction Office (DOE-GJO) and the Colorado Department of Public Health and Environment (CDPHE) were concerned that hazardous constituents might have leached from tailings into ground water over the years or might continue to be leached where tailings were left in place. These constituents might adversely affect ground water quality and endanger human health and the environment at those sites. The strategy for this study was to characterize the ground water at a single, worst case VP site. To select the site, criteria were developed and applied to candidate remediated VPs in the Grand Junction area.

Requirements for ground water compliance at UMTRA Project sites, including the Grand Junction site, were established in the Uranium Mill Tailings Radiation Control Act (42 *United States Code* 7901 *et seq.*) and in the U.S. Environmental Protection Agency's (EPA's) "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings" (40 CFR 192). Detailed assessment and monitoring of ground water at VPs is not required unless DOE, in conjunction with the U.S. Nuclear Regulatory Commission, determines that a significant potential for ground water contamination exists (*Federal Register*, Vol. 60, No. 7, page 2856, January 11, 1995).

## 1.2 Previous Studies

A study by Cahn and others (1988) screened 27 UMTRA Project VPs in the Grand Junction area to determine the potential for ground water contamination. The authors studied reports of vicinity properties at which tailings excavations had intersected the water table. They then sampled ground water at several of those properties and analyzed the samples for essentially the same constituents that are considered in this study. Samples collected at one large vicinity property (Lincoln Park Pool) before and after remedial action indicated that before remediation, ground water was locally contaminated. After the tailings were removed, analysis of a sample collected from a shallow piezometer 35 ft (11 m) downgradient from the site showed no concentrations above UMTRA Project maximum concentration limits (MCLs). This was true even though the piezometer was located in an area where the water table was high and density of vicinity properties was also high. The report concluded that ground water contamination from VPs should be investigated further on a site-specific basis.

# 2.0 Criteria for Selecting a Vicinity Property for Characterization

Criteria for selecting a single worst case site for study were developed after discussions with a number of individuals associated with surface and ground water remedial actions and after investigations of numerous VP completion reports. The criteria are presented in order of decreasing importance.

### Selection Criteria

- Large site where a large volume of tailings was removed (only complex commercial UMTRA properties were considered)
- Site where tailings were known to contact ground water
- Site where some or all tailings were left in place by application of either supplemental standards or area averaging
- Isolated site in which ground water is probably not influenced by other VPs
- Site that has a cooperative landowner who would allow access for this study
- Site that is well characterized for surface contaminants and possibly for ground water contaminants
- Background information on upgradient soil and water constituents is known

After discussions with UMTRA Project managers and field assessment personnel, and by use of these criteria, five of the more than 4,000 VPs were selected for further evaluation.
Plate 1 shows the locations of the five candidate properties; Table 2–1 presents a comparison of the properties.

*Table 2–1. Characteristics of the UMTRA Project Vicinity Properties Considered for Further Study*

| Property Name (UMTRA Number) | Approximate Area (acres) | Volume of Tailings Removed ($yd^3$) | Commingled Wastes Present | Property Owner | Isolated from other UMTRA VPs | Depth to Ground Water (ft) |
|---|---|---|---|---|---|---|
| Regional Center (GJ-90000-CC) | 250 | 65,000 | Asbestos | State | Yes | 7–9 |
| Sherwood Park (GJ-19571-VL) | 3 | 24,000 | None | City | No | 10–12 |
| Lincoln Park (GJ-90001-CC) | 80 | 25,000 | None | City | No | 3 |
| American Auto Salvage (GJ-90049-CC) | 18 | 128,000 | None | City | No | 6–8 |
| Teller Arms (GJ-90053-CC) | 4 | 16,000 | Organics | Private | No | 2 |

## 2.1 Evaluation of Candidate Vicinity Properties

### Regional Center for Developmental Disabilities (formerly the State Home and Training School)

The Regional Center for Developmental Disabilities (Regional Center) is the second largest site in volume of tailings removed and is essentially isolated from the influence of other UMTRA Project properties. Tailings were in contact with ground water at a number of locations on the

site, and some tailings were left in place along steam pipe corridors through the application of area averaging. The State owns the land and has agreed to permit access.

**Sherwood Park**

Tailings were present at the water table in an old gully that had been filled (with tailings) to level the park. The site is located in a residential area with many other VPs located nearby and upgradient. Some tailings were left in place by area averaging. The City of Grand Junction owns the land and would permit access.

**Lincoln Park**

Tailings were found at the swimming pool area and at a number of locations in the golf course. This site was studied previously by Cahn and others (1988) and access from the City is not a problem. Large volumes of tailings were left in place on the golf course when supplemental standards were applied. This area is irrigated and ground water flushing is probably greater than the average for the Grand Valley. An artificial hydrologic regime has developed due to nearby pumping to remove mounded ground water that results from irrigation of the golf course.

**American Auto Salvage**

This site had the largest volume of tailings removed and has good recent documentation. However, ground water contaminant levels may be influenced by inflow of ground water from other nearby complex commercial vicinity properties. The Site Observational Work Plan (SOWP), Revision 0 (DOE 1996) for the Grand Junction site showed the uranium plume from the millsite migrating onto the American Auto Salvage property. Distinguishing the effects of ground water constituents possibly migrating from the millsite from similar constituents that may have originated from tailings deposits at the VP would be difficult. Access is not a problem.

**Teller Arms**

This area was previously investigated by Cahn and others (1988). The property is surrounded by numerous other VPs and also had hazardous waste associated with it. The owner may not allow access to the property for studies.

## 2.2 Selection of the Regional Center and West Main Street Study Areas

The Regional Center was selected for ground water characterization on the basis of observations summarized in Section 2.1. The West Main Street property was added at the request of CDPHE to study an area where a large volume of tailings was left in place.

**Regional Center**

The Regional Center is located just north of D Road between 28 and 29 Roads (Plate 2). The property is about a mile northeast (upgradient) of the Grand Junction millsite and has the largest surface area of the five candidate vicinity properties. Also, the volume of tailings removed from it was among the largest. This site is also considered desirable for study because it is somewhat isolated from other vicinity properties so that ground water flowing into the site from the north

would probably not be influenced by ground water from other VPs. Three monitoring wells, 1026, 1027, and 1028, were installed at this location.

### West Main Street

This property (Figure 2–1) was added to the study at the request of CDPHE. The property is an area along West Main Street where a series of residential properties underwent remedial action and where 3,459 $yd^3$ (2,645 $m^3$) of tailings were left in place around a 48-inch (1.2-m) storm sewer when supplemental standards were applied (DOE 1989). The tailings were located at a maximum depth of about 60 inches (1.5 m) along the corridor of the storm sewer line.

## 2.3 Location and Installation of Monitoring Wells

### Regional Center

Plate 2 shows the locations at the Regional Center where tailings were removed, where the depth of removal was at least 72 inches (1.8 m), and where tailings were left in place. The depth to ground water in this area is as shallow as 1 ft (0.3 m), and the tailings were (and are) in contact with ground water at the site in many places. No wells existed on the property, so monitoring wells 1026, 1027, and 1028 were installed. The wells were placed in a triangular configuration downgradient from an area where a large quantity of deep tailings were removed or had been left in place through the application of supplemental standards (Plate 2). The well locations were also chosen with the guidance of the facility engineer to avoid disrupting business at the Regional Center. All wells were drilled by hollow stem auger and fitted with 4-inch i.d. schedule 40 PVC casing and a 20-ft section of 0.20 mm slotted screen. The wells were drilled into 20 ft of saturated alluvium. All wells were screened in the alluvial aquifer and developed by surging and pumping until the ground water cleared. Well lithologic and completion logs are shown in Appendix A.

### West Main Street

Monitoring well 1030 at the West Main Street site was placed in a location considered to be downgradient from a large volume of tailings left in place through supplemental standards (Figure 2–1). The well was installed and completed like those at the Regional Center, except that it was flush-mounted. The well terminated in Dakota Sandstone shales at a depth of 30 ft (9 m) below ground surface (see Appendix A).

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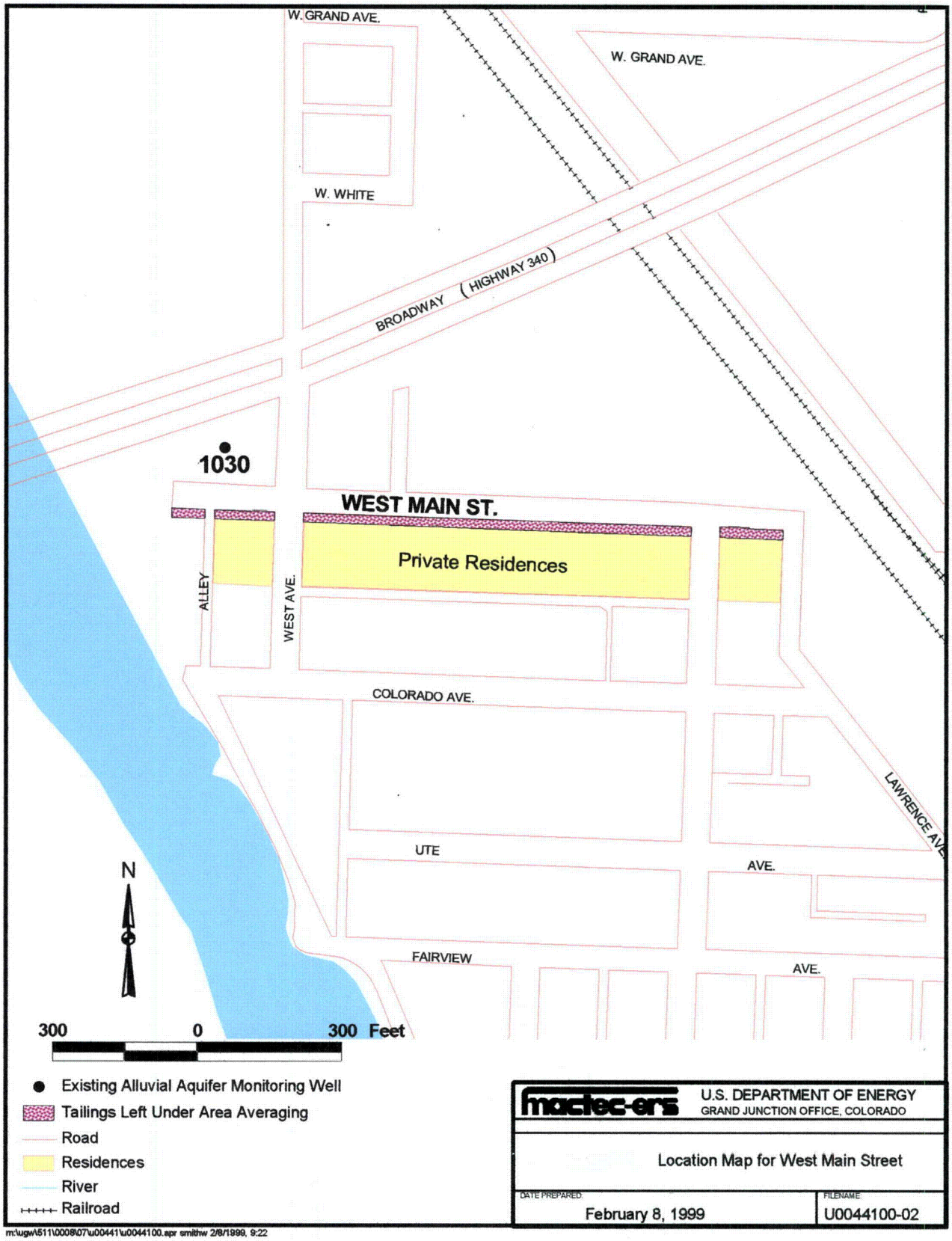


*Figure 2–1. Location Map for West Main Street*

# 3.0 Geology

Discussions of the regional geology and hydrogeology are presented in the *Final Site Observational Work Plan for the Grand Junction, Colorado UMTRA Ground Water Project Site* (DOE 1999), the *Baseline Risk Assessment of Ground Water Contamination at the Uranium Mill Tailings Site at Grand Junction, Colorado* (DOE 1995), and in *Geology and Artesian Water Supply, Grand Junction Area, Colorado* (Lohman 1965).

**Regional Center**

The two shallowest geologic units beneath the Regional Center consist of unconsolidated Quaternary sediments that contain an unconfined alluvial aquifer underlain by shales of the Mancos Shale that form an aquitard. Surface components of the hydrologic system include irrigation canals and ditches north, east, and south of the study area, irrigated fields east of the area, and irrigated lawns in the area.

**West Main Street**

The two shallowest geologic units beneath the West Main Street location are unconsolidated Quaternary sediments and underlying shales of the Dakota Sandstone. Surface components of the hydrologic system include the Colorado River, which is about 300 ft (91 m) to the west, and irrigated lawns in the residential neighborhood.

## 3.1 Quaternary Sediments and Fill

Quaternary sediments north of the Colorado River are generally divided into two types of deposits: (1) bedload cobbles and gravel and (2) overlying floodplain deposits of sand, silt, and clay. These two sediment types constitute a hydrologic unit called the alluvial aquifer, which is the uppermost hydrogeologic unit at both locations and is the only unit that is considered in this report. The bedload cobbly zone of the alluvial aquifer has been called the "cobble aquifer" by some investigators (Schneider 1975; BOR 1986), who proposed that the Colorado River was formerly about 3 miles (5 km) north of its present channel and the cobble zone was deposited as bedload during lateral migration of the river to its present position. As part of the Colorado River Basin salinity control project in the late 1970s and 1980s, the Bureau of Reclamation investigated the cobble aquifer and produced a map of its extent (BOR 1986). The cobble aquifer is as much as 40 ft (12 m) thick in the Clifton area, at least 20 ft (7 m) thick at the Regional Center, and 15 ft (5 m) thick at West Main Street. Fine-grained floodplain deposits generally 5 to 10 ft (1.5 to 3 m) thick and composed of sandy clay, clayey sand, sandy silt, and silty sand overlie the cobbly zone at both VP locations. Cahn and others (1988) noted that in places the base of the floodplain deposits consisted of clay lenses. Where continuous, this clay could confine the underlying cobble aquifer. At the Regional Center this clay was only found separating the floodplain deposits from the cobbly zone at well 1028. This does not suggest a sufficiently large area of clays to perch a significant volume of water. Clays were not found at the base of floodplain deposits at West Main Street. Materials composing the lower cobbly zone at both locations include silty gravel and silty gravel with sand. For this study, the lower cobbly zone and overlaying floodplain deposits are considered together as the alluvial aquifer.

## 3.2 Mancos Shale

Approximately 4,000 ft (1,219 m) of Late Cretaceous Mancos Shale deposited in the interior epicontinental seaway are present in the Grand Valley in the Grand Junction area. Only the lowermost part of the Mancos Shale, the nonresistant Tununk Member (about 200 ft [61 m] thick), is present at the Regional Center. The lower part of the Tununk Member consists of calcareous, medium- to dark-gray shale and silty shale that weathers to yellowish brown or olive gray. Although no bedrock was noted during drilling of monitoring wells at the Regional Center, mapping studies performed during field work for the final SOWP (DOE 1999) have shown that the underlying bedrock is Mancos Shale. The trace of the subcrop (below alluvium) separating the Mancos on the east from the Dakota Sandstone on the west extends along a line heading northwest, which is located about 4,200 ft (1,280 m) west of the Regional Center.

## 3.3 Dakota Sandstone

Late Cretaceous Dakota Sandstone was deposited in marginal marine environments as the Mancos sea began to encroach. The Dakota consists of sandstones, siltstones, shales, and carbonaceous layers that in places form low-grade coal deposits. This formation contains a lower sandstone and upper shale layer that underlies parts of Grand Junction and the area of West Main Street. Its shales are the uppermost bedrock unit beneath the Grand Junction millsite and form an effective aquitard much like the Mancos Shale. Dakota Sandstone shales have been confused with Mancos Shale, but the Dakota shales commonly contain carbonaceous flecks, and the Mancos is calcareous and reacts to hydrochloric acid. Drilling of monitoring well 1030 at the West Main Street site extended into the bedrock shales of the Dakota.

# 4.0 Hydrology

## 4.1 Alluvial Aquifer

Ground water is present under unconfined conditions in the alluvial aquifer beneath the Regional Center and West Main Street properties. Depth to ground water ranges from 1 ft (0.3 m) to 5 ft (1.5 m) at the Regional Center and was measured at 15 ft (5 m) at the West Main Street well. The saturated thickness of the aquifer ranges from 15 ft (5 m) to more than 30 ft (9 m). Ground water flows west to southwest toward the Colorado River at a hydraulic gradient of approximately 15 ft/mile (2.8 m/km) as shown in Figure 4–1.

The alluvial aquifer is recharged by infiltration of precipitation, leakage from upgradient irrigation canals and ditches in the area, and infiltration of river water (well 1030) during spring runoff in the Colorado River. During periods of high water in the Colorado River, recharge enters the alluvial aquifer from the river, flattens hydraulic gradients, and creates a more northerly ground water flow orientation. Ground water levels were measured with water level indicators twice a year during sampling events. Seasonal fluctuations in water levels beneath the study areas range from less than 1 ft (0.3 m) at the Regional Center to about 2 ft (0.6 m) at West Main Street. Ground water discharges primarily into a major irrigation ditch south of the Regional Center and into the river during low-flow stages at West Main Street. Some discharge also occurs as evapotranspiration from vegetation growing in areas of shallow ground water.

Hydraulic conductivity at the Regional Center was estimated by slug tests performed in monitor wells 1026, 1027, and 1028 and averaged 4 ft/day (1.2 m/day). No slug tests were performed in monitor well 1030 at the West Main Street area. Estimates of hydraulic conductivity from slug tests are generally low and provide information for a very limited area, so information from aquifer pumping tests in alluvial aquifer wells in the west (0590), central (1034/1035), and east (1018) portions of the Grand Junction site were used as an approximation of the hydraulic parameters in the two VP areas. Results of these aquifer pumping tests indicate transmissivity ranging from 161 to 2,434 $ft^2$/day (15 to 226 $m^2$/day) (DOE 1999). Hydraulic conductivity ranges from 18 to 304 ft/day (5.5 to 93 m/day) based on saturated thickness in the alluvial aquifer ranging from 6 to 9 ft (1.8 to 2.2 m) in the different wells. These millsite wells are located about 1 mi (1.6 km) southwest of the Regional Center and about 3 mi (5 km) east of West Main Street. As expected, the values of hydraulic conductivity are variable across the site, even in the relative proximity of wells 1034 and 1035. Variation in these values is a result of several factors: (1) lateral and vertical lithology changes typically found in an alluvial depositional environment, including possible effects of old channels in the alluvium, (2) Colorado River as a boundary condition, particularly in the vicinity of well 0590 (about 60 ft [18 m] from the river), and (3) well construction and screen type may cause variable well efficiency and response to pumping stress. The average linear ground water velocity beneath the millsite is about 2.0 ft/day (0.6 m/day) based on an average estimated hydraulic conductivity of 100 ft/day (30 m/day), a hydraulic gradient of 0.004, and an effective porosity of 20 percent. Because many variables affect hydraulic parameter values in an aquifer system, the results are an approximation that provides a general idea of the characteristics of the alluvial aquifer.

## 4.2 Aquitards

The Mancos Shale and shales in the Dakota Sandstone are highly impermeable, and earlier tests indicate extremely low hydraulic conductivities (slug test data from Jacobs Engineering Group Inc. 1985). These shales are considered to be effective aquitards that prevent any downward migration of surface water or ground water from the alluvial aquifer. Ground water in wells screened in the Dakota Sandstone shows different chemistry than ground water in overlying alluvial aquifer wells. The Dakota wells located downgradient of the millsite do not show contamination associated with milling operations.

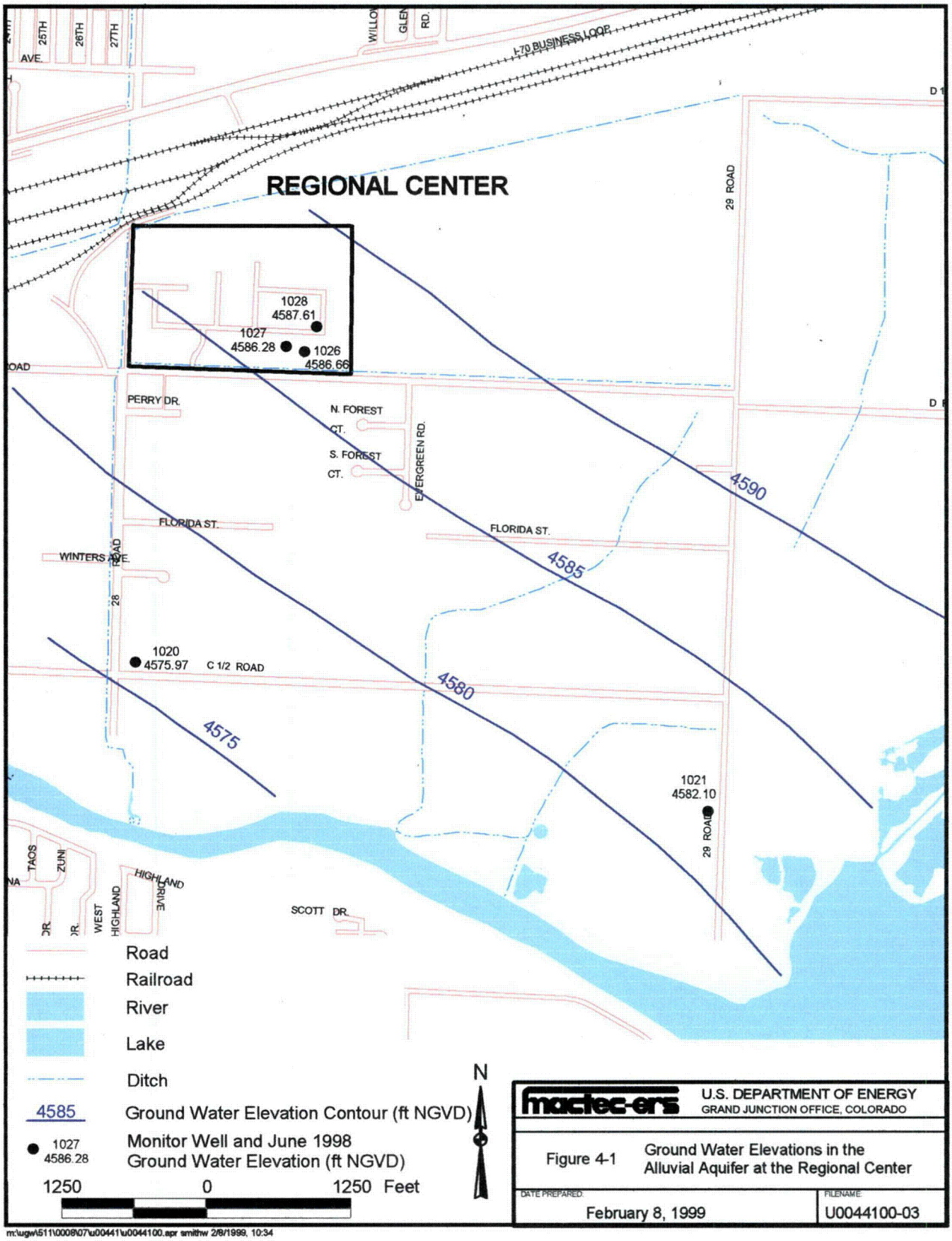


*Figure 4–1. Ground Water Elevations in the Alluvial Aquifer at the Regional Center*

# 5.0 Geochemistry

## 5.1 Background Ground Water

Ground water samples were collected twice during 1998 from 43 UMTRA Project wells in the Grand Valley and analyzed for the chemicals of potential concern (COPCs) listed in the Baseline Risk Assessment for the Grand Junction site (DOE 1995). These wells included wells 1026, 1027, 1028, and 1030 that were installed for the vicinity property study. Background ground water locations established for the final SOWP (DOE 1999) were wells 713, 715, 745, 1020, 1021, 1023, 1025, and CW21 (Plate 1). The minimum, maximum, and mean concentrations of analytes in samples from background wells and VP wells are shown in Table 5–1. The results of all analyses are stored in the Site Environmental Evaluation (SEE) UMTRA database maintained at DOE-GJO.

Concentrations of uranium and selenium were above the UMTRA MCLs in background ground water samples. The UMTRA Project standard for uranium is based on activity concentrations of the uranium isotopes $^{234}U$ and $^{238}U$ having a total concentration of 30 pCi/L. The mean value for uranium isotopic concentration in background ground water is 43 pCi/L, which exceeds the MCL. The average concentration of elemental uranium was 0.047 mg/L, which exceeds the MCL of 0.044 mg/L, assuming secular equilibrium of the uranium isotopes.

Organic-rich dark marine shales are known to carry anomalously high concentrations of uranium. Levinson (1980) described black marine shales that had uranium concentrations ranging from 3 to 1250 mg/kg; a specific example, the marine Chattanooga Shale of Tennessee, has large areas that average 57 mg/kg uranium (Mickle and Mathews 1978). Butler and others (1994) analyzed six samples of Mancos Shale from the Grand Valley in which uranium concentrations ranged from 3.7 to 11.2 mg/kg and averaged 6.2 mg/kg. The crustal abundance of uranium averages 1.8 mg/kg (Mason and Moore 1982) and averages 4 mg/kg in all shales (Levinson 1980). Ground water passing over the interface between saturated Mancos Shale and the alluvial aquifer could leach uranium from this formation.

The statistical population of selenium values from background samples was bimodal. Half the values were well above the UMTRA MCL and half the values were below detection. If the values below detection limits were assumed to be at the detection limits, the mean selenium concentration was 0.03 mg/L, which exceeds the UMTRA MCL of 0.01 mg/L.

Selenium is known to be especially concentrated in Cretaceous marine shales found in many western states. (Larkin and Byers 1941). The U.S. Geological Survey (USGS) studied selenium origins and concentrations because high levels of selenium are present in the Imperial Valley in California and at other downstream locations in the Colorado River drainage. High selenium levels are not indigenous to those locations, and the problem is thought to result from upstream irrigation, where selenium leached from soil by irrigation water eventually drains into the Colorado River. Because 25 percent of surface water samples in the Grand Valley contain selenium levels of at least 0.005 mg/L, the USGS has classified the Grand Valley as having irrigation-induced selenium contamination (USGS 1997). This situation is caused by high evaporation rates and high concentrations of naturally occurring selenium in the Mancos Shale.

Mean concentrations of chloride, manganese, sulfate, and total dissolved solids in background ground water exceed EPA secondary drinking water standards established under the Safe Drinking Water Act. These standards are based largely on taste and odor of the water. The high concentrations of these constituents detected in ground water from background locations provide further indication that the ground water quality in the alluvial aquifer is naturally poor.

## 5.2 Comparison of Background and Vicinity Property Ground Water

Table 5–1 shows the minimum, maximum, and mean values of constituents in background and vicinity property ground water.

### 5.2.1 Regional Center

The mean concentrations of molybdenum, fluoride, and sulfate in ground water samples from Regional Center wells are slightly higher than average background concentrations but are still within the range of background. The mean and maximum concentrations of iron and manganese are higher in Regional Center wells than in background wells, and the mean concentration of uranium (0.063 mg/L) is higher than the mean background concentration (0.047 mg/L). The average isotopic concentration of $^{234}U + ^{238}U$ (51 pCi/L) is also higher at the Regional Center than the average background concentration (42 pCi/L), but the maximum Regional Center concentration of 55 pCi/L is less than the maximum background concentration of 57 pCi/L.

The MCL for elemental uranium of 0.044 mg/L is based on a total activity concentration of the isotopes $^{234}U$, $^{235}U$, and $^{238}U$ of 30 pCi/L, assuming secular equilibrium. Isotopic analyses have indicated that these isotopes are not in equilibrium in background ground water, and the adjusted standard is actually lower, probably around 0.037 or 0.038 mg/L (DOE 1999). When compared to the adjusted MCL, uranium concentrations in background ground water are even higher above the MCL. Also, background ground water has an isotopic maximum uranium concentration greater than the concentration in any sample from the Resource Center. Therefore, it is not possible to identify any contribution of uranium to ground water at the Regional Center as a result of leaching from mill tailings.

### 5.2.2 West Main Street

The mean concentrations of analytes in samples from West Main Street are consistently lower than mean concentrations in background samples. However, the maximum concentration of sulfate (3,930 mg/L) is slightly higher than the maximum background concentration (3,720 mg/L), and the maximum concentration of manganese (5.53 mg/L) is higher than the maximum background value of 2.22 mg/L. These values do not exceed any MCLs or risk criteria.

*Table 5–1. Grand Junction Site – Vicinity Property Data Summary for 1998 Sampling*

| GRAND JUNCTION SITE - VICINITY PROPERTY DATA SUMMARY FOR 1998 SAMPLING | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Contaminant | | No. | Minimum | Maximum | Mean | MCL | RBC | %exceeding benchmark[1] | | |
| | | | mg/L | mg/L | mg/L | mg/L | mg/L | | | |
| Arsenic | | | | | | 0.05 | .011N | | | |
| Background | | 3/15 | 0.001 | 0.0014 | n/a | | .000045C | 0% | | |
| Regional Center | | 0/6 | 0.001 | 0.001 | n/a | | | 0% | | |
| West Main St. | | 0/2 | 0.001 | 0.001 | n/a | | | 0% | | |
| Cadmium | | | | | | 0.01 | | | | |
| Background | | 0/15 | 0.001 | 0.001 | n/a | | | 0% | | |
| Regional Center | | 0/6 | 0.001 | 0.001 | n/a | | | 0% | | |
| West Main St. | | 0/2 | 0.001 | 0.001 | n/a | | | 0% | | |
| Cobalt | | | | | | | 2.2N | | | |
| Background | | 0/15 | 0.006 | 0.008 | n/a | | | 0% | | |
| Regional Center | | 0/6 | 0.006 | 0.008 | n/a | | | 0% | | |
| West Main St. | | 0/2 | 0.006 | 0.008 | n/a | | | 0% | | |
| Fluoride | | | | | | 4 | 2.2N | | | |
| Background | | 15/15 | 0.453 | 1.62 | 0.895 | | | 0% | | |
| Regional Center | | 6/6 | 1.47 | 1.81 | 1.65 | | | 0% | | |
| West Main St. | | 2/2 | 1.6 | 1.67 | n/a | | | 0% | | |
| Iron | | | | | | | 11N | | | |
| Background | | 10/15 | 0.003 | 3.13 | 0.552 | | | 0% | | |
| Regional Center | | 6/6 | 0.0995 | 3.88 | 0.709 | | | 0% | | |
| West Main St. | | 2/2 | 0.283 | 1.13 | n/a | | | 0% | | |
| Manganese | | | | | | | 1.7N | | | |
| Background | | 15/15 | 0.233 | 2.22 | 1.4 | | | 53% | | |
| Regional Center | | 6/6 | 2.19 | 3.08 | 2.49 | | | 100% | | |
| West Main St. | | 2/2 | 1.7 | 2.53 | n/a | | | 100% | | |
| U234&238 (pCi/L) | | | | | | 30 pCi/L | | | | |
| Background | | 7/7 | 25.1 | 57 | 42 | | | 88% | | |
| Regional Center | | 3/3 | 49.2 | 54.7 | 51.1 | | | 100% | | |
| West Main St. | | 1/1 | 25.9 | n/a | n/a | | | 0% | | |
| Molybdenum | | | | | | 0.1 | 0.18 | | | |
| Background | | 15/15 | 0.0158 | 0.124 | 0.0587 | | | 24% | | |
| Regional Center | | 6/6 | 0.1 | 0.118 | 0.109 | | | 100% | | |
| West Main St. | | 2/2 | 0.0734 | 0.096 | n/a | | | 0% | | |
| Nickel | | | | | | | 0.73 | | | |
| Background | | 10/15 | 0.0074 | 0.0281 | 0.15 | | | 0% | | |
| Regional Center | | 4/6 | 0.0096 | 0.02 | 0.015 | | | 0% | | |
| West Main St. | | 1/2 | 0.0076 | 0.016 | n/a | | | 0% | | |
| Nitrate | | | | | | 44 | | | | |
| Background | | 15/15 | 0.0579 | 71.4 | 21.85 | | | 18% | | |
| Regional Center | | 6/6 | 0.0686 | 1.37 | 0.761 | | | 0% | | |
| West Main St. | | 2/2 | 12.8 | 39.4 | n/a | | | 0% | | |
| Radium-226 (pCi/L) | | | | | | 5 pCi/L | | | | |
| Background | | 7/15 | 0.04 | 0.34 | n/a | | | 0% | | |
| Regional Center | | 3/6 | 0.09 | 0.23 | n/a | | | 0% | | |
| West Main St. | | 1/2 | 0.05 | 0.13 | n/a | | | | | |
| Selenium | | | | | | 0.01 | 0.18 | | | |
| Background | | 8/15 | 0.001 | 0.137 | 0.0359 | | | 53% | | |
| Regional Center | | 4/6 | 0.001 | 0.0179 | 0.007 | | | 33% | | |
| West Main St. | | 2/2 | 0.0174 | 0.0244 | n/a | | | 100% | | |
| Sulfate | | | | | | | | | | |
| Background | | 15/15 | 416 | 3720 | 2566 | | | | | |
| Regional Center | | 6/6 | 2910 | 3040 | 2983 | | | | | |
| West Main St. | | 2/2 | 3770 | 3930 | n/a | | | | | |
| Uranium | | | | | | 0.044 | | | | |
| Background | | 15/15 | 0.0228 | 0.0662 | 0.0469 | | | 59% | | |
| Regional Center | | 6/6 | 0.0587 | 0.0682 | 0.063 | | | 100% | | |
| West Main St. | | 2/2 | 0.0318 | 0.0398 | n/a | | | 0% | | |

*Table 5–1 (continued). Grand Junction Site – Vicinity Property Data Summary for 1998 Sampling*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Vanadium | | | | | | | 0.26N | | | |
| Background | | 10/15 | 0.001 | 0.0049 | 0.0019 | | | 0% | | |
| Regional Center | | 0/6 | 0.001 | 0.0033 | n/a | | | 0% | | |
| West Main St. | | 0/2 | 0.001 | 0.0024 | n/a | | | 0% | | |
| Zinc | | | | | | | 11N | | | |
| Background | | 1/15 | 0.004 | 0.0051 | n/a | | | 0% | | |
| Regional Center | | 0/6 | 0.004 | 0.005 | n/a | | | 0% | | |
| West Main St. | | 0/2 | 0.004 | 0.005 | n/a | | | 0% | | |
| | | | | | | | | | | |
| Regional Center wells include 1026, 1027, 1028 | | | | | | | | | | |
| West Main Street well is 1030 | | | | | | | | | | |
| Background wells include 713, 715, 745, 1020, 1021, 1023, 1025, CW21 | | | | | | | | | | |
| | | | | | | | | | | |
| [1]Benchmark = MCL if available; RBC used if no MCL | | | | | | | | | | |

# 6.0 Risk Evaluations

The Final Grand Junction SOWP (DOE 1999) presents discussions about risks to human health and the environment. DOE must ascertain that any compliance strategy for the Grand Junction site is protective of human health and the environment. The results of those risk studies are pertinent to this report.

## 6.1 Human Health Risk

The original SOWP for the Grand Junction site (DOE 1996) provided point-exposure dose calculations for constituents in background ground water and concluded that regional (background) alluvial ground water had the potential to cause adverse health effects if it were used for residential drinking water. The update to the BLRA presented in the Final Grand Junction SOWP (DOE 1999) used EPA's *Risk Assessment Guidance for Superfund Methodology* (EPA 1989) to calculate hazard quotients (HQ) for noncarcinogenic exposures and point estimates for excess cancer risk from current or potential carcinogenic exposures. The risk estimates were made for both background and plume-related ground water and were calculated by assuming that ground water was used in a residential exposure scenario. Table 6–1 shows the background risks calculated for noncarcinogenic constituents based on COPCs from the BLRA, and Table 6–2 shows the risks calculated for the Regional Center. The hazard index (HI) is 4.54 for background constituents and 4.48 for constituents in ground water at the Regional Center indicating a greater hazard for background ground water. The total noncarcinogenic risk for constituents in ground water at the Regional Center is less than the noncarcinogenic risk for constituents in background ground water in the alluvial aquifer. Carcinogenic risks for the background ground water exceeded EPA guidance for arsenic and the uranium isotopes (DOE 1999); risks for Regional Center ground water were not calculated but would be lower than background risks because analyte concentrations are lower. Neither noncarcinogenic nor carcinogenic risks were calculated for exposure to ground water at West Main Street because the concentrations of COPCs were low and risks would be lower than those for background ground water.

## 6.2 Ecological Risk

An ecological risk assessment was conducted for the Final SOWP for the Grand Junction site (DOE 1999). A reference (background) area located about 3 miles (5 km) upstream along the Colorado River was compared to a similar habitat at the millsite and downgradient of the millsite. Biota, sediment, and surface water samples were collected from both areas, analyzed for all analytes listed in the BLRA, and compared. Concentrations of some millsite constituents were elevated in some of the surface water and associated biota samples collected from ponded areas where evaporation may have concentrated the analytes. However, the overall ecological risk assessment concluded that no unacceptable risks were present.

Although no ecological samples were collected from the Regional Center or West Main Street, concentrations of analytes in ground water samples from these study areas are similar to background or reference area concentrations. Any incremental increase in ecological risk due to tailings at the study areas would still result in less risk than at the Grand Junction millsite, which had no unacceptable ecological risks.

*Table 6–1. Intake/Risk Calculations for Ingestion of Background Ground Water*

## Grand Junction Site Background

$$\text{Intake} = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

where:

Intake is in (mg/kg-d)
CW = chemical concentration in water (mg/L); site-specific
IR = ingestion rate (L/d); 2L/day adult
ED = exposure duration (years); 30 yrs for adult
EF = exposure frequency (d/yr); 350 days/yr
BW = body weight (kg); 70 kg adult
AT = averaging time; ED x 365 d/yr non-carc., 70yr x 365 d/y carc.

Hazard Quotient (HQ) = Intake/Reference Dose (RfD)
Risk = Chronic Daily Intake (averaged over 70 years) x Slope Factor

**Non-Carcinogens - Background Groundwater Ingestion Only (Adults)**

| Contaminant | CW | IR | EF | ED | BW | AT | Intake | RfD | HQ |
|---|---|---|---|---|---|---|---|---|---|
| Arsenic | 0.0014 | 2 | 350 | 30 | 70 | 10950 | 3.84E-05 | 0.0003 | 0.128 |
| Selenium | 0.137 | 2 | 350 | 30 | 70 | 10950 | 0.003753 | 0.005 | 0.751 |
| Fluoride | 1.62 | 2 | 350 | 30 | 70 | 10950 | 0.044384 | 0.06 | 0.740 |
| Iron | 3.13 | 2 | 350 | 30 | 70 | 10950 | 0.085753 | 0.3 | 0.286 |
| Manganese | 2.22 | 2 | 350 | 30 | 70 | 10950 | 0.060822 | 0.047 | 1.294 |
| Molybdenum | 0.124 | 2 | 350 | 30 | 70 | 10950 | 0.003397 | 0.005 | 0.679 |
| Nickel | 0.0281 | 2 | 350 | 30 | 70 | 10950 | 0.00077 | 0.02 | 0.038 |
| Uranium | 0.0662 | 2 | 350 | 30 | 70 | 10950 | 0.001814 | 0.003 | 0.605 |
| Vanadium | 0.0049 | 2 | 350 | 30 | 70 | 10950 | 0.000134 | 0.007 | 0.019 |
| Zinc | 0.0051 | 2 | 350 | 30 | 70 | 10950 | 0.00014 | 0.3 | 0.000 |
| | | | | | | | | **HI =** | **4.540** |

*Table 6–2. Intake/Risk Calculations for Ingestion of Regional Center Ground Water*

## Regional Center

$$\text{Intake} = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

where:

Intake is in (mg/kg-d)
CW = chemical concentration in water (mg/L); site-specific
IR = ingestion rate (L/d); 2L/day adult
ED = exposure duration (years); 30 yrs for adult
EF = exposure frequency (d/yr); 350 days/yr
BW = body weight (kg); 70 kg adult
AT = averaging time; ED x 365 d/yr non-carc., 70yr x 365 d/y carc.

Hazard Quotient (HQ) = Intake/Reference Dose (RfD)
Risk = Chronic Daily Intake (averaged over 70 years) x Slope Factor

**Non-Carcinogens - Regional Center (Max) Groundwater Ingestion Only (Adults)**

| Contaminant | CW | IR | EF | ED | BW | AT | Intake | RfD | HQ |
|---|---|---|---|---|---|---|---|---|---|
| Arsenic | 0.001 | 2 | 350 | 30 | 70 | 10950 | 2.74E-05 | 0.0003 | 0.091 |
| Selenium | 0.0179 | 2 | 350 | 30 | 70 | 10950 | 0.00049 | 0.005 | 0.098 |
| Fluoride | 1.81 | 2 | 350 | 30 | 70 | 10950 | 0.049589 | 0.06 | 0.826 |
| Iron | 3.88 | 2 | 350 | 30 | 70 | 10950 | 0.106301 | 0.3 | 0.354 |
| Manganese | 3.08 | 2 | 350 | 30 | 70 | 10950 | 0.084384 | 0.047 | 1.795 |
| Molybdenum | 0.118 | 2 | 350 | 30 | 70 | 10950 | 0.003233 | 0.005 | 0.647 |
| Nickel | 0.02 | 2 | 350 | 30 | 70 | 10950 | 0.000548 | 0.02 | 0.027 |
| Uranium | 0.0682 | 2 | 350 | 30 | 70 | 10950 | 0.001868 | 0.003 | 0.623 |
| Vanadium | 0.0033 | 2 | 350 | 30 | 70 | 10950 | 9.04E-05 | 0.007 | 0.013 |
| Zinc | 0.005 | 2 | 350 | 30 | 70 | 10950 | 0.000137 | 0.3 | 0.000 |
| | | | | | | | | **HI =** | **4.476** |

End of current text

# 7.0 Conclusions

Mean and maximum concentrations of uranium, iron, and manganese in ground water samples from the Regional Center wells are slightly higher than concentrations in background samples. Mean $^{234}U + ^{238}U$ isotope concentrations are slightly higher than background in samples from the Regional Center ground water, but the maximum concentration of these isotopes is higher in background samples than in samples from Regional Center ground water. Mean concentrations of molybdenum, fluoride, and chloride are slightly higher in ground water at the Regional Center than in background ground water; however, maximum values of these constituents are higher in background samples than in samples from the Regional Center.

At the West Main Street study area, maximum concentrations for sulfate and manganese slightly exceed maximum background values. Neither constituent is a good indicator of leaching of uranium mill tailings in the valley because Mancos Shale produces high sulfate concentrations, and manganese occurs in naturally elevated concentrations in alluvial ground water.

Health risks for background ground water and ecological risks were evaluated for the final SOWP for the Grand Junction site (DOE 1999). Several constituents in background samples had the potential to cause adverse health effects to humans if water were directly ingested on a regular basis. Water in wells at the Regional Center has slightly elevated concentrations of several constituents compared to background concentrations, but total human health risks posed by the constituents were less than total risk posed by background ground water. Ecological risks at the Grand Junction millsite are considered acceptable and ecological risks at the Regional Center and West Main Street properties would also be considered acceptable.

Ground water concentrations of contaminants expected to be derived from uranium mill tailings at vicinity properties do not appear to significantly exceed background concentrations. Therefore, it can be reasonably concluded that constituents leached from mill tailings before remediation or constituents in tailings that were left in place through the application of supplemental standards or area averaging do not appear to constitute "... a significant potential for groundwater contamination" as stated in the UMTRA Project final legislation preamble (*Federal Register*, Vol. 60, No. 7, p 2856, January 11, 1995), that would require detailed assessment and monitoring of ground water at vicinity properties.

End of current text

# 8.0 References

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# Appendix A

# Lithology/Well Completion Logs

# MONITORING WELL COMPLETION LOG GRJ01-1026

| | | | | | |
|---|---|---|---|---|---|
| PROJECT | UMTRA GROUNDWATER | NORTH COORD. (FT) | 462343.4 | DATES DRILLED | 11/12/97 to 11/12/97 |
| LOCATION | GRAND JUNCTION,CO | EAST COORD. (FT) | 1140481.7 | SURFACE ELEV. ( FT NGVD) | 4593.73 |
| SITE | GRAND JUNCTION | HOLE DEPTH (FT) | 27 | TOP OF CASING (FT) | 4593.83 |
| WELL NUMBER | 1026 | WELL DEPTH (FT) | 26.45 | MEAS. PT. ELEV. (FT) | 4593.83 |
| | | | | SLOT SIZE (IN) | 0.02 |
| | | | | BIT/AUGER SIZE (IN) | 12.25 / 12.25 |

| | WELL INSTALLATION | INTERVAL (FT) | | |
|---|---|---|---|---|
| SURFACE CASING: | Steel | | | |
| BLANK CASING: | 4 in. PVC Sch 40 | 0 | to | 9.4 |
| WELL SCREEN: | 4 in. Johnson PVC | 9.4 | to | 26.2 |
| SUMP/END CAP: | 4 in. PVC Sch 40 | 26.2 | to | 26.45 |
| SURFACE SEAL: | Concrete | 0 | to | 4 |
| GROUT: | | | | |
| SEAL: | Bentonite Pellets | 4 | to | 6 |
| UPPER PACK: | 16-40 CO Silica | 6 | to | 7 |
| LOWER PACK: | 10-20 CO Silica | 7 | to | 26.45 |

| | |
|---|---|
| DRILLING METHOD | HOLLOW STEM AUGER |
| SAMPLING METHOD | SPLIT SPOON |
| DATE DEVELOPED | 12/3/97 |
| WATER LEVEL (FT BMP) | 3.61 |
| LOGGED BY | L. Spencer |
| REMARKS | Flush mount well |

| DEPTH (FT BGL) | ELEV. (FT NGVD) | BLOWS COUNTS | SAMPLE ID. | EXTENT | WELL DIAGRAM | GRAPHIC LOG | LITHOLOGIC DESCRIPTION |
|---|---|---|---|---|---|---|---|
| | 4590 | | | | Concrete; PVC Sch 40; Bentonite Pellets; 16-40 CO Silica; 10-20 CO Silica | | Fill, sandy silt, dark brown (10 YR 4/3) 60% silt, 35% sand, 5% clay, poorly graded, subrounded, low plasticity, moist. A few roots and root hairs. |
| 5 | | 3, 4, 6, 8 | UNKNOWN | | | | Slough - No recovery. |
| | | | | | | | Fill, Sandy silt, grayish brown (2.5 Y 5/2) 60% silt, 35% sand, 5% clay, a few small patches of light white colored sand grains, poorly sorted, subrounded medium plasticity, moist. W. L. 10 feet. |
| | 4585 | | | | | | No recovery. |
| 10 | | 2, 1, 1, 1 | UNKNOWN | | | | Alluvium? |
| | | | | | | | Slough - No recovery. |
| | | | | | | | Sand, very fine to fine grained, brown (10 YR 4/3) 90% sand 5% silt, 5% clay, poorly graded, subrounded slight plasticity, saturated. Red, yellow and black mineral grains. |
| | | | | | | | No recovery |

# MONITORING WELL COMPLETION LOG GRJ01-1026

**PROJECT** UMTRA GROUNDWATER **WELL NUMBER** 1026
**SITE** GRAND JUNCTION **DATES DRILLED** 11/12/97 to 11/12/97

*Continued from Previous Page*

| DEPTH (FT BGL) | ELEV. (FT NGVD) | BLOWS COUNTS | SAMPLE ID. | EXTENT | WELL DIAGRAM | GRAPHIC LOG | LITHOLOGIC DESCRIPTION |
|---|---|---|---|---|---|---|---|
| | 4580 | | | | | | |
| 15 | | 23<br>43<br>50/4" | UNKNOWN | | | | Slough - No recovery. |
| | | | | | | | Sandy gravel, 70% gravel, 25% sand, 5% silt, brown (10 YR 4/3) from cobbles to 1/4" size, well graded, subrounded to subangular, saturated. |
| | | | | | 0.02" Johnson PVC | | No recovery. |
| | 4575 | | | | | | |
| 20 | | 4<br>5<br>33<br>50/4" | UNKNOWN | | | | Sand, quartzose, brown (10 YR 4/3) fine to medium grained 100% sand, subrounded poorly graded. Red, yellow, black mineral grains; some yellowish white cherts, saturated. |
| | | | | | | | Sandy gravel, 70% gravel, 25% sand, 5% silt, brown (10 YR 4/3) from cobbles to 1/4" size, well graded, subrounded to subangular, saturated. |
| | | | | | | | No recovery |
| | 4570 | | | | | | |
| 25 | | | | | PVC Sch 40<br>Slough | | |
| | | | | | | | Bottom of boring 27.0 ft |

# MONITORING WELL COMPLETION LOG GRJ01-1027

| | | | | | |
|---|---|---|---|---|---|
| PROJECT | UMTRA GROUNDWATER | NORTH COORD. (FT) | 462388.59 | DATES DRILLED | 11/14/97 to 11/14/97 |
| LOCATION | GRAND JUNCTION,CO | EAST COORD. (FT) | 1140321.44 | SURFACE ELEV. ( FT NGVD) | 4593.21 |
| SITE | GRAND JUNCTION | HOLE DEPTH (FT) | 33 | TOP OF CASING (FT) | 4593.34 |
| WELL NUMBER | 1027 | WELL DEPTH (FT) | 29.77 | MEAS. PT. ELEV. (FT) | 4593.34 |
| | | | | SLOT SIZE (IN) | 0.02 |
| | | | | BIT/AUGER SIZE (IN) | 12.25 / 12.25 |

| | WELL INSTALLATION | INTERVAL (FT) | | | | |
|---|---|---|---|---|---|---|
| SURFACE CASING: | Steel | | | | DRILLING METHOD | HOLLOW STEM AUGER |
| BLANK CASING: | 4 in. PVC Sch 40 | 0 | to | 9.4 | SAMPLING METHOD | SPLIT SPOON |
| WELL SCREEN: | 4 in. Johnson PVC | 9.4 | to | 29.4 | DATE DEVELOPED | 12/4/97 |
| SUMP/END CAP: | 4 in. PVC Sch 40 | 29.4 | to | 29.77 | WATER LEVEL (FT BMP) | 1.35 |
| SURFACE SEAL: | Concrete | 0 | to | 1.5 | LOGGED BY | L. Spencer |
| GROUT: | | | | | REMARKS | Flush mount well |
| SEAL: | Bentonite Pellets | 1.5 | to | 7 | | |
| UPPER PACK: | 16-40 CO Silica | 7 | to | 8 | | |
| LOWER PACK: | 10-20 CO Silica | 8 | to | 29.77 | | |

| DEPTH (FT BGL) | ELEV. (FT NGVD) | BLOWS COUNTS | SAMPLE ID. | EXTENT | WELL DIAGRAM | GRAPHIC LOG | LITHOLOGIC DESCRIPTION |
|---|---|---|---|---|---|---|---|
| | 4590 | | | | Concrete; PVC Sch 40; Bentonite Pellets | | Fill, sandy silt, dark brown (10 YR 4/3) 60% silt, 35% sand fine grained, 5% clay, poorly graded, low plasticity, moist. A few white to clear patches of fine grained sand mixed in homogenous silt. |
| 5 | | 1, 2, 5, 7 | UNKNOWN | | | | Alluvium at 7 ft |
| | 4585 | | | | 16-40 CO Silica; 10-20 CO Silica | | No recovery |
| 10 | | 3, 15, 32, 27 | UNKNOWN | | | | Sand, fine to medium grained, dark brown (10 YR 4/3) 90% sand, 5% silt, 5% clay, poorly graded, slight plasticity, subrounded, saturated. Red, yellow and black mineral grains, some tiny yellowish white chert chips. |
| | | | | | | | Sandy gravel, 80% gravel, 20% sand, from cobbles to 1/4". Saturated, subrounded well graded. |
| | 4580 | | | | | | No recovery |
| 15 | | 8, 25, 50, 41 | UNKNOWN | | | | Sand, fine to medium grained, dark brown (10 YR 4/3) 90% sand, 5% silt, 5% clay, poorly graded, slight plasticity, subrounded, saturated. Red, yellow and black mineral grains, some tiny yellowish white chert chips. |
| | | | | | | | Sandy gravel, dark brown (10 YR 4/3) 60% gravel from 1/4" to cobbles, 30% sand, fine to medium grained, and 10% silt, well graded, subrounded, saturated. |
| | 4575 | | | | 0.02" Johnson PVC | | No recovery. |
| 20 | | 10, 47, 50/2" | UNKNOWN | | | | Slough - No recovery. |
| | | | | | | | Sandy gravel, dark brown (10 YR 4/3) 60% gravel from 1/4" to cobbles, 30% sand, fine to medium grained, and 10% silt, well graded, subrounded, saturated. |
| | 4570 | | | | | | No recovery |

# MONITORING WELL COMPLETION LOG GRJ01-1027

| | | | |
|---|---|---|---|
| **PROJECT** | UMTRA GROUNDWATER | **WELL NUMBER** | 1027 |
| **SITE** | GRAND JUNCTION | **DATES DRILLED** | 11/14/97 to 11/14/97 |

*Continued from Previous Page*

| DEPTH (FT BGL) | ELEV. (FT NGVD) | BLOWS COUNTS | SAMPLE ID. | EXTENT | WELL DIAGRAM | GRAPHIC LOG | LITHOLOGIC DESCRIPTION |
|---|---|---|---|---|---|---|---|
| | 4565 | | | | PVC Sch 40 | | NOTE: Driller could feel boulders/ cobbles from approximately 25 to 33 feet. Very hard, jerky drilling. |
| 30 | | | | | Slough | | |
| | 4560 | | | | | | Bottom of boring 33.0 ft |
| 35 | | | | | | | |
| | 4555 | | | | | | |
| 40 | | | | | | | |
| | 4550 | | | | | | |
| 45 | | | | | | | |
| | 4545 | | | | | | |
| 50 | | | | | | | |
| | 4540 | | | | | | |
| 55 | | | | | | | |

# MONITORING WELL COMPLETION LOG GRJ01-1028

| | | | | | |
|---|---|---|---|---|---|
| PROJECT | UMTRA GROUNDWATER | NORTH COORD. (FT) | 462558.95 | DATES DRILLED | 11/15/97 to 11/15/97 |
| LOCATION | GRAND JUNCTION,CO | EAST COORD. (FT) | 1140583.78 | SURFACE ELEV. ( FT NGVD) | 4594.94 |
| SITE | GRAND JUNCTION | HOLE DEPTH (FT) | 34 | TOP OF CASING (FT) | 4594.99 |
| WELL NUMBER | 1028 | WELL DEPTH (FT) | 31.82 | MEAS. PT. ELEV. (FT) | 4594.99 |
| | | | | SLOT SIZE (IN) | 0.02 |
| | | | | BIT/AUGER SIZE (IN) | 12.25 / 12.25 |

| | WELL INSTALLATION | INTERVAL (FT) | | |
|---|---|---|---|---|
| SURFACE CASING: | Steel | | | |
| BLANK CASING: | 4 in. PVC Sch 40 | 0 | to | 11.45 |
| WELL SCREEN: | 4 in. Johnson PVC | 11.45 | to | 31.45 |
| SUMP/END CAP: | 4 in. PVC Sch 40 | 31.45 | to | 31.82 |
| SURFACE SEAL: | Concrete | 0 | to | 1.6 |
| GROUT: | | | | |
| SEAL: | Bentonite Pellets | 1.6 | to | 7 |
| UPPER PACK: | 16-40 CO Silica | 7 | to | 10.4 |
| LOWER PACK: | 10-20 CO Silica | 10.4 | to | 31.82 |

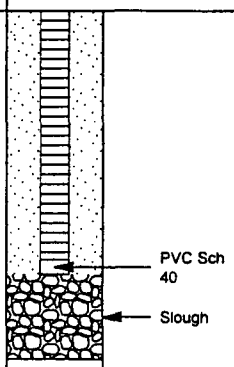
| | |
|---|---|
| DRILLING METHOD | HOLLOW STEM AUGER |
| SAMPLING METHOD | SPLIT SPOON |
| DATE DEVELOPED | 12/5/97 |
| WATER LEVEL (FT BMP) | |
| LOGGED BY | L. Spencer |
| REMARKS | Flush mount well |

| DEPTH (FT BGL) | ELEV. (FT NGVD) | BLOWS COUNTS | SAMPLE ID. | EXTENT | WELL DIAGRAM | GRAPHIC LOG | LITHOLOGIC DESCRIPTION |
|---|---|---|---|---|---|---|---|
| | | | | | Concrete | | Fill, sandy silt, dark grayish brown (10 YR 4/2) 60% silt, 30% sand, 5% gravel, 5% clay, well graded, subrounded, low plasticity, moist. A few roots and root hairs. |
| | | | | | Bentonite Pellets | | |
| 5 | 4590 | 1 1 2 3 | UNKNOWN | | | | Alluvium at 6.2 ft |
| | | | | | PVC Sch 40 | | ALLUVIUM; Clayey silt, grayish brown (10 YR 5/2) 60% silt, 20% clay, 20% fine grained sand, homogenous, medium plasticity, wet. Patches of white to clear fine grained sand throughout sample. |
| | | | | | 16-40 CO Silica | | No recovery |
| 10 | 4585 | 1 3 4 4 | UNKNOWN | | 10-20 CO Silica | | Slough - No recovery. |
| | | | | | | | Silty sand, dark brown, (10 YR 4/3) 75% sand fine grained, 20% silt, 5% clay, homogenous, tiny red, black, and yellow mineral grains, subrounded, low plasticity, saturated. No recovery. |
| 15 | 4580 | 1 1 3 3 | UNKNOWN | | | | Slough - No recovery. |
| | | | | | | | Clayey silt, yellowish brown (10 YR 5/4) mottled with dark yellowish brown (10 YR 4/6) few, fine to medium distinct, moist, 10% sand, medium plasticity. |
| | | | | | | | No recovery |
| | | | | | | | NOTE: Driller could feel gravel at 18 feet in depth. |
| 20 | 4575 | 11 30 23 43 | UNKNOWN | | 0.02" Johnson PVC | | Slough - No recovery. |
| | | | | | | | Sandy gravel, subrounded, well graded from 1/4" to cobbles, 60%, sand fined grained 30%, 10% silt, saturated. |
| | | | | | | | No recovery. |

# MONITORING WELL COMPLETION LOG GRJ01-1028

**PROJECT** UMTRA GROUNDWATER **WELL NUMBER** 1028
**SITE** GRAND JUNCTION **DATES DRILLED** 11/15/97 to 11/15/97

*Continued from Previous Page*

| DEPTH (FT BGL) | ELEV. (FT NGVD) | BLOWS COUNTS | SAMPLE ID. | EXTENT | WELL DIAGRAM | GRAPHIC LOG | LITHOLOGIC DESCRIPTION |
|---|---|---|---|---|---|---|---|
| | | | | |  | | No recovery. |
| 30 | 4565 | | | | | | |
| 35 | 4560 | | | | | | Bottom of boring 34.0 ft |
| 40 | 4555 | | | | | | |
| 45 | 4550 | | | | | | |
| 50 | 4545 | | | | | | |
| 55 | 4540 | | | | | | |

# MONITORING WELL COMPLETION LOG GRJ01-1030

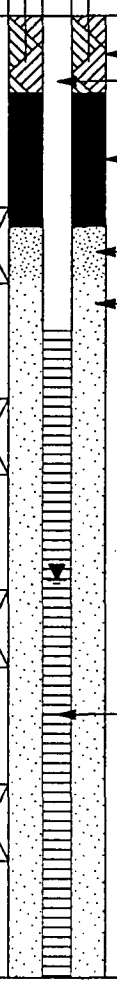
| | | | | | |
|---|---|---|---|---|---|
| PROJECT | UMTRA GROUNDWATER | NORTH COORD. (FT) | 464339.84 | DATES DRILLED | 11/11/97 to 11/11/97 |
| LOCATION | GRAND JUNCTION,CO | EAST COORD. (FT) | 1125984.87 | SURFACE ELEV. ( FT NGVD) | 4555.64 |
| SITE | GRAND JUNCTION | HOLE DEPTH (FT) | 30.5 | TOP OF CASING (FT) | 4555.93 |
| WELL NUMBER | 1030 | WELL DEPTH (FT) | 28.57 | MEAS. PT. ELEV. (FT) | 4555.93 |
| | | | | SLOT SIZE (IN) | 0.02 |
| | | | | BIT/AUGER SIZE (IN) | 12.25 / 12.25 |

| | WELL INSTALLATION | INTERVAL (FT) | | |
|---|---|---|---|---|
| SURFACE CASING: | Steel | | | |
| BLANK CASING: | 4 in. PVC Sch 40 | -1.8 | to | 8.2 |
| WELL SCREEN: | 4 in. Johnson PVC | 8.2 | to | 28.2 |
| SUMP/END CAP: | 4 in. PVC Sch 40 | 28.2 | to | 28.57 |
| SURFACE SEAL: | Concrete | 0 | to | 2 |
| GROUT: | | | | |
| SEAL: | Bentonite Pellets | 2 | to | 5.5 |
| UPPER PACK: | 16-40 CO Silica | 5.5 | to | 6.83 |
| LOWER PACK: | 10-20 CO Silica | 6.83 | to | 28.57 |

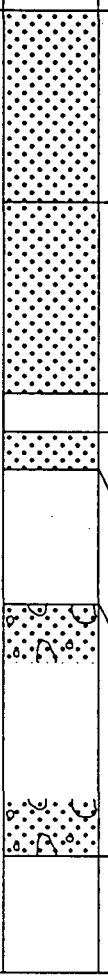
| | |
|---|---|
| DRILLING METHOD | HOLLOW STEM AUGER |
| SAMPLING METHOD | SPLIT SPOON |
| DATE DEVELOPED | 12/9/97 |
| WATER LEVEL (FT BMP) | 14.74 |
| LOGGED BY | L. Spencer |
| REMARKS | |

| DEPTH (FT BGL) | ELEV. (FT NGVD) | BLOWS COUNTS | SAMPLE ID. | EXTENT | LITHOLOGIC DESCRIPTION |
|---|---|---|---|---|---|
| | 4555 | | | | Fill, sand, fine to medium grained, brown (7.5 YR 5/4) 60% sand, 30% gravel, 10% silt, well graded, subrounded, no plasticity, moist. |
| 5 | 4550 | 4 3 3 3 | UNKNOWN | | Fill, sand fine to medium grained, yellowish brown (10 YR 5/4) 70% sand, 15% gravel, 15% silt, subrounded, well graded, slightly plasticity moist. |
| 10 | 4545 | 1 20 30 31 | UNKNOWN | | No Recovery. |
| | | | | | Fill, sand fine to medium grained, yellowish brown (10 YR 5/4) 65% sand, 20% gravel, 15% silt, subrounded, well graded, slightly plasticity moist. |
| | | | | | No sample collected-hard rock drilling. |
| 15 | 4540 | 23 27 50-4" | UNKNOWN | | No recovery. |
| | | | | | Alluvium at 5 ft |
| | | | | | ALLUVIUM; Gravelly sand, grayish brown (10 YR 5/2) 55% sand, 40% gravel, subrounded, 5% silt, well graded, slight plasticity, saturated. No recovery. |
| 20 | 4535 | 5 6 24 50 | UNKNOWN | | |
| | | | | | No recovery |

WELL DIAGRAM




GRAPHIC LOG



# MONITORING WELL COMPLETION LOG GRJ01-1030

**PROJECT** UMTRA GROUNDWATER **WELL NUMBER** 1030
**SITE** GRAND JUNCTION **DATES DRILLED** 11/11/97 to 11/11/97

*Continued from Previous Page*

| DEPTH (FT BGL) | ELEV. (FT NGVD) | BLOWS COUNTS | SAMPLE ID. | EXTENT | WELL DIAGRAM | GRAPHIC LOG | LITHOLOGIC DESCRIPTION |
|---|---|---|---|---|---|---|---|
| | 4530 | | | | | | |
| | | | | | PVC Sch 40 | | |
| | | | | | Slough | | |
| 30 | | | | | | | Bedrock at 30 ft Dakota Ss |
| | 4525 | | UNKNOWN | | | | DAKOTA SANDSTONE; Bedrock, siltstone, weathered, very dark gray (10 YR 3/1) very tiny shiny flakes, soft, moist. Carbonaceous? Noncalcareous. |
| | | | | | | | Bottom of boring 30.5 ft |
| 35 | 4520 | | | | | | |
| 40 | 4515 | | | | | | |
| 45 | 4510 | | | | | | |
| 50 | 4505 | | | | | | |
| 55 | 4500 | | | | | | |

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## THAT CAN BE VIEWED AT THE RECORD TITLED:

## DRAWING NO.: U0044100-01, "PLATE 1: VICINITY PROPERTY MAP AND WELL LOCATIONS"

## WITHIN THIS PACKAGE... OR, BY SEARCHING USING THE DOCUMENT/REPORT DRAWING NO. U0044100-01

**D-01**

# THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

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## DRAWING NO.: U0043500-01, "PLATE 2: REGIONAL CENTER WITH MONITORING WELL LOCATIONS"

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**D-02**