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HYDROGEOLOGIC REPORT
PIÑON RIDGE PROJECT
MONTROSE COUNTY, COLORADO

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EXECUTIVE SUMMARY

Energy Fuels Resources Corporation (EFRC) proposes to license, construct, and operate a conventional acid leach uranium and vanadium mill at the Piñon Ridge Mill site (Site) in western Montrose County, Colorado. The Site covers 880 acres on the south side of eastern Paradox Valley, approximately 12 miles west of Naturita near Highway 90. A general location map is presented on Figure ES-1. The purpose of this report is to characterize the hydrogeology of the Site in accordance with the Colorado Department of Public Health and Environment (CDPHE) and the U.S. National Regulatory Commission (NRC) guidance (NRC 2003). To satisfy requirements of the above regulatory norms, this report includes a description of regional hydrogeology, local hydrogeology, groundwater resources, groundwater quality, and the recommended ground water monitoring program.

Paradox Valley lies in the eastern part of the depositional Paradox Basin, a vast basin approximately 200 miles long by 80 miles wide, with a northwest axis that extends across southeastern Utah and southwestern Colorado. The prominent geologic features of the basin are salt domes that are generally northwest-trending, with salt synclines that parallel the salt anticlines. Within Paradox Basin, the major hydrogeologic units consist of an upper Mesozoic sandstone aquifer and a lower Paleozoic carbonate aquifer, which are separated by a thick sequence of confining salt beds of the Hermosa formation (Weir et al. 1983, Whitfield et al. 1983). Within the upper Mesozoic sandstone aquifer, the most important bedrock aquifers are the Navajo Sandstone, Wingate Sandstone, and Entrada Sandstone, which are either absent or not water-bearing in the study area of this report, which is shown on Figure ES-1.

Hydrologically, the site lies in the Dolores River basin. The Dolores River is located approximately seven miles northwest of the Site (Figure ES-1) and receives surface drainage and groundwater discharge. The San Miguel River, located six miles northeast of the Site, is in a separate basin and does not directly receive drainage from the Site.

Because there are no existing detailed studies characterizing the hydrogeology of the eastern Paradox Valley, the site-specific hydrogeologic characterization conducted for the Piñon Ridge project included extensive field investigations of the Site and neighboring properties. Project-specific work included advancement of 35 boreholes: nine completed as monitoring wells (MW-series), three completed as production wells (PW-series), six completed as observation wells near the production wells, and the remaining holes were groundwater exploratory boreholes (EX-series). The locations of these boreholes are shown on Figure ES-2. In addition to borehole advancement, aquifer tests were conducted at 14 locations in the spring and summer of 2008, and water quality samples were obtained from 20 locations over a period of eight quarters.

Based on borehole lithologies, the four formations indentified within the study area that are important from a hydrogeologic perspective are listed below:

1. Alluvium – uppermost sediments, which transmit some fraction of meteoric water to underlying formations;
2. Chinle formation – strata within the study area which contains groundwater in its lower part;
3. Moenkopi formation – strata which underlies the Chinle formation and also may contain groundwater in some locations; and
4. Hermosa formation – formation of primarily salt, which truncates the Chinle and Moenkopi formations near the center line of the valley, thereby terminating the local aquifer; it also acts as a barrier to downward flow of groundwater.

The only known groundwater occurrences within the study area (Figure ES-1) are close to the contact between the Chinle and Moenkopi formations, and close to the contact between the Moenkopi and Hermosa formations. Figure ES-3 shows geologic cross sections and the static groundwater elevations. Groundwater in the Chinle and Moenkopi formations is present from Davis Mesa on the southwest side of the Site, to approximately the alignment of Fault #3, which is shown on Figure ES-2. At locations farther northeast from Fault #3, the Chinle and Moenkopi formations are truncated by the uplift of the salt anticline of the Hermosa formation.

Groundwater flow in the Chinle-Moenkopi aquifer is influenced by the following factors:

- Proximity to Davis Mesa, which acts as a recharge area for the aquifer;
- Northwest-trending faults that parallel Davis Mesa and likely act as conduits to flow; and
- Uplifted sediment and evaporites of the Hermosa formation, which act as a barrier to flow of groundwater.

Based on the factors above, groundwater near the Site generally flows away from the mesa in a northeast direction and is intercepted by faults that parallel the valley axis. These faults appear to act as conduits for flow and recharge and direct groundwater flow to the northwest. Regionally, groundwater flows to the northwest, discharging to the Dolores River (Weir et al. 1983). This groundwater flow direction towards the Dolores River is supported by the data from the study area, indicating groundwater sloping and outflow toward the northwest.

In spring and summer 2008, aquifer testing was conducted to evaluate the water supply potential of the aquifer and to further characterize groundwater at the Site. Testing consisted of nine short term (approximately 4-hour) pumping tests, three long-term (48-hour) pumping tests, and three rising-head/falling-head tests. During the short-term pumping tests, discharge rates ranged from 4.7 to 39.8 gallons per minute (gpm) and during the long-term pumping tests discharge rates ranged from 10.3 to 67.5 gpm, attaining a cumulative pumping rate of 130 gpm from the three completed production wells (PW-1, PW-2, and PW-3; refer to Figure ES-2).

The average conductivity for the tested locations is 3×10^{-3} cm/s, which is high relative to the expected value for intact fine-grained sedimentary rock. The hydraulic testing also indicates a relatively low storativity, averaging 4×10^{-4} (0.04%), based on estimates from observation wells during pumping tests. The distribution of estimated hydraulic conductivity from the testing is narrow. This narrow distribution, combined with relatively high conductivity and low storativity, suggests extensive fracturing, typically associated with faulting having a high degree of fracture networking.

Based on the results of the aquifer testing, predictive analysis of future groundwater availability was conducted by Golder in 2008. For the predictive analysis, the existing production wells were supplemented by two additional proposed wells, and the analysis was extended for a 5-year period of groundwater pumping. Two configurations of aquifer geometry were considered: 1) the aquifer is bounded by the salt dome on one side and extends below Davis Mesa; and 2) the aquifer is bounded on two sides by the salt dome and Davis Mesa. Accounting for groundwater available from storage and recharge, sustainable pumping rates for the first and second scenarios may reach 175 gpm and 100 gpm, respectively.

Water quality within the project area and its immediate vicinity is based on the results of groundwater samples collected from 20 locations over the period of eight quarters from October 2007 to August 2009. The sampling locations included: monitoring wells MW-5, MW-6, MW-7, MW-8B, MW-9;

production wells PW-1, PW-2, PW-3; exploratory holes EX-5, EX-6, EX-7, EX-10, EX-12, EX-15, EX-23; four off-site domestic and/or stock wells, referred to by the owner name (BLM, Boren, Davis, and Hurdle wells); and one off-site spring, Stone Spring, located approximately 4.8 miles northwest of the Site. Two predominant types of groundwater quality are identified at the Site based on the proximity of groundwater to the evaporites of the Hermosa formation: Moenkopi/Chinle water and Hermosa/Chinle water. The Moenkopi/Chinle water is encountered near the contact between the Chinle and Moenkopi formations. The water is characterized by near-neutral pH values generally between 7 and 8, total dissolved solids (TDS) concentrations between 530 and 1,030 mg/L, and alkalinity between 154 and 422 mg/L as $CaCO_3$.

The Hermosa/Chinle water is encountered near the contact between the salts of the Hermosa and Moenkopi formations and is characterized by higher TDS concentrations (1,140 to 4,290 mg/L), primarily due to higher concentrations of sulfate (1,070 to 2,720 mg/L). In addition, the Hermosa contact water is also reducing as demonstrated by the negative oxidation-reduction potential (ORP) values, low dissolved oxygen (DO), and detectable concentrations of sulfide and ammonia.

Figure ES-4 shows a Piper diagram (Piper 1944) of representative water quality samples. The water quality data are consistent through time during the period of record, with no apparent seasonal trends. The majority of the groundwater samples (EX-5, EX-6, EX-7, EX-10, EX-12, MW-5, MW-7, PW-1, PW-2, PW-3, and the off-site wells and spring) were collected from the Chinle/Moenkopi zone. As shown on Figure ES-4, this groundwater ranges from a calcium-bicarbonate to a calcium-sulfate type water. Groundwater samples collected from the Moenkopi/Hermosa zone (MW-6, MW-8B, and EX-23) have similar ion chemistry but exhibit a higher ratio of sulfate ions compared to the Chinle/Moenkopi samples.

Water usage projections (CH2M Hill 2009) indicate that 141 gpm of non-potable water and 3 gpm of potable water will be needed to operate the Piñon Ridge Mill at a processing rate of 500 tons of ore per day (tpd). The potable water will be trucked to the Site from the town of Naturita. The remaining 141 gpm of non-potable water will be obtained by pumping from five or more production wells, three of which have already been installed. Although the on-site aquifer is estimated to be capable of delivering 100 to 175 gpm sustainably, a contingency plan has been developed to provide uninterrupted supply of the water needed for mill operation in the event that the well field cannot provide all the water needed for milling. An agreement has been reached with the town of Naturita to purchase untreated water from town. The water will be sequestered from the San Miguel River, at a rate of up to 150,000 gallons per day, which is equivalent to 104 gpm.

Pumping from the production wells is not anticipated to affect existing water wells located in the vicinity of the Site. The closest operational well is located approximately 3 miles southeast of the nearest production well (see Figure ES-1). During the 48-hour pumping tests in the production wells (PW-series), the largest radius of influence was approximately 1,000 feet (Golder 2008c). Because the closest operational well is located at a distance of over 15 times the radius of influence during testing, interference in terms of dewatering neighboring wells by pumping the production wells is unlikely.

TABLE OF CONTENTS

EXECUTIVE SUMMARY ES-1

1.0 INTRODUCTION 1
- 1.1 Location of Facilities 1
- 1.2 Scope of the Hydrogeological Investigations 2
- 1.3 Previous Hydrogeologic Studies 2
- 1.4 Scope of Site-Specific Hydrogeologic Investigations 3

2.0 REGIONAL HYDROGEOLOGIC SETTING 4
- 2.1 Regional Meteorology 5
- 2.2 Recharge/Discharge Regions and Regional Groundwater Flow 5
- 2.3 Regional Groundwater Quality 6

3.0 SITE HYDROGEOLOGY 7
- 3.1 Study Area 7
- 3.2 Local Hydrostratigraphy 8
  - 3.2.1 Alluvium 9
  - 3.2.2 Chinle and Moenkopi Formations 9
  - 3.3.3 Hermosa Formation 10
- 3.3 Extent of Groundwater Occurrence 10
  - 3.3.1 On-Site Vertical Extent of Groundwater 11
  - 3.3.2 On-Site Horizontal Extent of Groundwater 11
  - 3.3.3 Off-Site Extent of Groundwater 12
- 3.4 Potentiometric Surface 13
  - 3.4.1 Groundwater Flow Direction 13
  - 3.4.2 Temporal Variations of Groundwater Levels 14
- 3.5 Hydraulic Properties of Aquifer 14
  - 3.5.1 Short-term Pumping Tests 15
  - 3.5.2 Long-term Pumping Tests 15
  - 3.5.3 Analysis of Aquifer Testing 16
- 3.6 Aquifer Recharge 17
- 3.7 Direction and Velocity of Groundwater Flow 18

4.0 CONNECTIVITY OF AQUIFERS WITH SURFACE WATER 20

5.0 GROUNDWATER RESOURCES 21
- 5.1 Availability of Groundwater 21
- 5.2 Groundwater Water Quality 22
  - 5.2.1 Available Water Quality Data 22
  - 5.2.2 Quality Assurance/Quality Control (QA/QC) Measures 25
  - 5.2.3 Groundwater Classification 27
  - 5.2.4 Groundwater Characterization 27
  - 5.2.5 Water Quality Relative to CDPHE Standards 30
  - 5.2.6 Spatial and Temporal Variation in Groundwater Quality 31

6.0 CURRENT AND FUTURE USES OF WATER RESOURCES IN THE AREA 33
- 6.1 Identification of Groundwater and Surface Water Resources in the Area 33

6.2 The Proximity and Withdrawal Rates by Groundwater Users 33
6.3 The Potential Impact of Operation on Groundwater Uses 34

7.0 USE OF THIS REPORT 35

8.0 REFERENCES 36

LIST OF TABLES

Table 1 Stratigraphic and Hydrogeologic Units in the Paradox Valley Basin
Table 2 Average Monthly Precipitation and Evaporation
Table 3 Summary of Wells and Exploratory Boreholes
Table 4 Water Levels in Exploratory Boreholes
Table 5 Water Levels in Monitoring Wells, Production Wells, and Observation Wells
Table 6 Off-Site Wells and Springs in the Chinle Formation
Table 7 Summary of Aquifer Properties
Table 8A Estimated 5-Year Sustainable Pumping Rates from Aquifer Storage
Table 8B Estimated 5-Year Sustainable Pumping Rates from Aquifer Storage and Recharge
Table 9 Groundwater Sampling Schedule for Monitoring Wells and Production Wells
Table 10A Analytical Data for Samples from Monitoring Wells MW-5 and MW-6
Table 10B Analytical Data for Samples from Monitoring Wells MW-7, MW-8B, and MW-9
Table 11 Analytical Data for Production Well Samples
Table 12 Analytical Data for Samples from Exploratory Holes, Off-Site Wells, and Off-Site Spring
Table 13 Proposed Groundwater Monitoring Parameters

LIST OF FIGURES

Figure ES-1 Site Location, Study Area, and Drainage Area
Figure ES-2 Location of Boreholes Advanced for Groundwater Exploration and Characterization
Figure ES-3 Hydrogeologic Cross-Sections C-C’ and D-D’
Figure ES-4 Piper Diagram for Groundwater Samples
Figure 1 Site Location, Study Area, and Drainage Area
Figure 2 Geologic Map
Figure 3 Geologic Cross-Sections in the Vicinity of the Site
Figure 4 Location of Boreholes Advanced for Groundwater Exploration and Characterization
Figure 5 Hydrogeologic Cross-Sections C-C’ and D-D’
Figure 6 Potentiometric Surface Map
Figure 7 Water Level Elevations in MW-5
Figure 8 Water Level Elevations in MW-6
Figure 9 Water Level Elevations in MW-7
Figure 10 Water Level Elevations in MW-8B
Figure 11 Water Level Elevations in PW-1
Figure 12 Water Level Elevations in PW-2
Figure 13 Water Level Elevations in PW-3
Figure 14 Relationship between Annual Precipitation and Elevation
Figure 15 Sampled Wells and Boreholes

Figure 16 Piper Diagram for Groundwater Samples
Figure 17 Piper Diagram for Groundwater Samples from Exploratory Boreholes (EX-Series) Off-Site Wells and Spring
Figure 18 Piper Diagram for Groundwater Samples from Monitoring Wells (MW-Series)
Figure 19 Piper Diagram for Groundwater Samples from Production Wells (PW-Series)

LIST OF APPENDICES

Appendix A Off-Site Water Wells and Springs

1.0 INTRODUCTION

Energy Fuels Resources Corporation (EFRC) proposes to license, construct, and operate a conventional acid leach uranium and vanadium mill at the Piñon Ridge Mill site (Site) in western Montrose County, Colorado. Site facilities will include an administration building, a 17-acre mill, tailing cells totaling approximately 90 acres, 40-acres of evaporation ponds (expansion capacity to 80 acres), an approximately 6-acre ore storage pad, and access roads. The mill will process ore produced from mines within a reasonable truck-haul distance. The mill will process up to 500 tons of ore per day, but is designed to accommodate subsequent expanded production capacity of up to 1,000 tons per day. The expected operating life of the mill is 20 to 40 years, depending on the production rate.

The Site covers approximately 880 acres in the southeastern portion of Paradox Valley. Elevations across the Site range from 6,020 feet above mean sea level (amsl) on the lower flank of Davis Mesa to the south, to 5,417 feet amsl near the center of Paradox Valley to the north. The majority of the Site is relatively flat with less than 300 feet of relief from south to north, and is crosscut by minor, ephemeral arroyos or washes.

The Site's primary historic land use has been grazing. Land use adjacent to the Site includes mining, oil and gas exploration, timber harvesting, recreation, and grazing. Current and past mining activities have occurred to the southwest and southeast of the Site.

1.1 Location of Facilities

The proposed Piñon Ridge Mill is located in the Paradox Valley at the address 16910 Highway 90, approximately 12 miles west of Naturita in Montrose County, Colorado. The Site's legal description is the Southwest ¼ of the Southeast ¼ of Section 5, all of Section 8, the North ¼ of Section 17, and the Southeast ¼ of the Northwest ¼ of Section 17, Township 46 North, Range 17 West, of the New Mexico Principal Base and Meridian. The Site is located on both the Davis Mesa Quadrangle (Cater 1955) and Bull Canyon Quadrangle (Cater 1954) 1:24,000 U.S. Geological Survey (USGS) geologic/topographic maps. The general location map is presented on Figure 1.

1.2 Scope of the Hydrogeological Investigations

The purpose of this report is to characterize the hydrogeology of the Site in accordance with the Colorado Department of Public Health and Environment (CDPHE) and the U.S. National Regulatory Commission (NRC) guidance (NRC 2003). The Piñon Ridge Mill is subject to regulation by the State of Colorado and the mill license (Radioactive Source Material License) will be issued and administered by CDPHE. This Hydrogeologic Report is part of the characterization required for the Environmental Report, in accordance with Section 3.8.8, Part 3, 6 CCR 1007-1 (CDPHE 2001) and NUREG 1748 (NRC 2003).

To satisfy requirements of the above regulatory norms, this report includes a description of regional hydrogeology, local hydrogeology, groundwater resources, and groundwater quality.

1.3 Previous Hydrogeologic Studies

Few previous studies have characterized the hydrogeology of the eastern Paradox Valley. Notable regional hydrologic studies include *Regional Hydrology of the Dolores River Basin, Eastern Paradox Basin* (Weir et al. 1983), *Regional Hydrology of the Blanding-Durango Area, Southern Paradox Basin* (Whitfield et al. 1983), and *Geohydrology of Mesozoic Rocks in the Upper Colorado River Basin in Arizona, Colorado, New Mexico, Utah, and Wyoming, Excluding the San Juan Basin* (Freethey and Cordy 1991). Additional studies have focused on the geology in the region, including *Geologic Appraisal of Paradox Basin Salt Deposits for Waste Emplacment* (Hite and Lohman 1973), *Geochemistry and Hydrodynamics of the Paradox Basin Region, Utah, Colorado, and New Mexico* (Hanshaw and Hill 1969), and *Geology of the Pennsylvanian and Permian Cutler Group and Permian Kaibab Limestone in the Paradox Basin, Southeastern Utah and Southwestern Colorado* (Condon 1997).

Although numerous reports are published to address the regional hydrogeology, no published research has focused on the hydrogeology of the eastern Paradox Valley. Many of the regional studies name the Navajo Sandstone, Wingate Sandstone, and the Entrada Sandstone as important bedrock aquifers. However, these formations are either absent or not known to be water-bearing within the project study area, resulting in almost no relevant published information on groundwater within the study area shown on Figure 1.

1.4 Scope of Site-Specific Hydrogeologic Investigations

The site-specific hydrogeologic study included hydrogeologic reconnaissance over the eastern section of Paradox Valley, in the study area shown on Figure 1. To provide site-specific groundwater data, 35 boreholes were advanced within the study area. Nine of the boreholes were completed as monitoring wells, three were completed as production wells, and six as observation wells near the production wells. The remaining boreholes were geological and groundwater exploratory drillings, not completed as permanent wells.

Water quality samples were obtained from 20 locations over a period of eight quarters. Sampled locations included exploratory boreholes, monitoring wells, and production wells. Additionally, existing wells and a spring within 5 miles of the site were sampled with the owners' permission. To quantify aquifer properties, short-term (approximately 4- to 6-hour) aquifer tests were conducted at nine boreholes and wells, and long-term (48-hour) aquifer tests were conducted at three production wells. Results and interpretations from the borehole advancement, water quality sampling, and aquifer testing are summarized in the following sections of this report.

2.0 REGIONAL HYDROGEOLOGIC SETTING

The Site is located in the eastern portion of the Paradox Valley, in the Dolores River basin. The Site is positioned south of the valley axis, bordering the northeast foothill of Davis Mesa. To the north, the Site extends to approximately the center line of the valley. The drainage from the Site trends northwest toward the Dolores River, which is located seven miles northwest of the Site. The San Miguel River, located six miles northeast of the Site, is in a separate basin and does not directly receive drainage from the Site. The location of the project area with respect to the drainages and other salient geographical features is shown on Figure 1. Administratively, the Site is located within the Colorado Division of Water Resources District 61, within Division 4.

Paradox Valley lies in the eastern part of the depositional Paradox Basin, a vast basin approximately 200 miles long by 80 miles wide, with a northwest axis that extends across southeastern Utah and southwestern Colorado. The prominent geologic features of Paradox Basin are salt domes that are generally northwest-trending, with salt synclines that parallel the salt anticlines. The salt anticline in the Paradox Valley resulted from both regional compression and plastic flowage of the Paradox Member of the Hermosa formation (Hite and Lohman 1973). The uplift of the anticline resulted in extensive northwest-trending faults paralleling the axis of the valley (Cater 1954, 1955). Most of the blocks formed by faulting are downthrown toward the valley. Some of the blocks form small horst and graben structures. A geologic map showing regional faults is presented on Figure 2. Figure 3 shows geologic cross-sections for the area (Cater 1954, 1955).

On a large scale, the major hydrogeologic units within the basin consist of an upper Mesozoic sandstone aquifer and a lower Paleozoic carbonate aquifer, which are separated by a thick sequence of confining salt beds (Weir et al. 1983, Whitfield et al. 1983). Within the upper Mesozoic sandstone aquifer, the most important bedrock aquifers are the Navajo Sandstone and the Wingate Sandstone of the Glen Canyon Group, and the Entrada Sandstone of the San Rafael Group. As discussed in Section 3.0, these regional aquifers are absent within the Paradox Valley.

The Dolores, Chinle, and Moenkopi formations act as confining units that limit vertical flow of groundwater within the upper Mesozoic sandstone aquifer. Below this confinement and within the lower Paleozoic carbonate rocks, the Leadville Limestone is the most important aquifer (Weir et al. 1983). Salt beds of the Paradox Member of the Hermosa formation separate the upper and lower aquifers in the region. Within the Paradox Valley, the salt thickness is greater than 1,000 meters

(3,281 feet) (Weir et al. 1983). Table 1 presents the stratigraphic and hydrogeologic units within the Paradox Valley Basin (Topper et al. 2003).

2.1 Regional Meteorology

Within the Dolores River Basin and vicinity, precipitation varies with elevation. According to studies by Weir et al. (1983), average precipitation systematically increases from approximately 310 millimeters/year (12.2 inches/year) or less at an elevation of 1,390 meters (4,560 feet), to more than 600 millimeters/year (23.6 inches/year) at an elevation of 2,865 meters (9,400 feet). According to Pyke (1972), the basin lies in a precipitation transition zone, with areas to the south, west, and east receiving the majority of precipitation in August, followed by secondary precipitation in February, May, and December.

Golder conducted a review of meteorological data obtained from the Western Regional Climate Center for the Uravan, Nucla, Grand Junction (two stations; Airport and 6ESE), and Montrose weather stations. An evaluation of the data for these nearby weather stations indicates that the Uravan weather station is likely to provide reasonable precipitation estimates for the Site (Appendix A-1 of *Evaporation Pond Design Report*, Golder 2008e). The Uravan station is located approximately 8.5 miles north of the Site, at an elevation of approximately 470 feet lower than the Site. Climatic data available for the Uravan weather station include precipitation, air temperature, and snow cover for the period of record from 1961 through 2007. Annual precipitation for the Uravan station averages 12.7 inches, with calculated lake evaporation averaging 38 inches per year. On average, the wettest months of the year are August, September, and October. The Hargreaves et al. (1985) method was used to estimate monthly potential evapotranspiration at the Piñon Ridge site, using the available climate data from the Uravan station. The average monthly climatic data used for design of the Piñon Ridge facilities is summarized in Table 2.

2.2 Recharge/Discharge Regions and Regional Groundwater Flow

Recharge to the upper aquifer occurs as infiltration of runoff and direct precipitation. Runoff in the Dolores River basin occurs primarily from spring snowmelt at higher elevations. In the summer and fall, additional runoff occurs from rainstorms that are sometimes intense and usually limited in extent (Weir et al. 1983). Recharge to the lower aquifer occurs through outcrops outside the study area. The Leadville Limestone of the lower aquifer crops out a short distance north of Durango. Minimal additional recharge may occur through fractures and faults in the salt beds above (Whitfield et al. 1983, Weir et al. 1983).

Groundwater flow in the upper Mesozoic sandstone aquifer is towards the Dolores River where the groundwater discharges. Therefore, within Paradox Valley, the groundwater flow is to the northwest. Studies by Weir et al. (1983) show that between the gauging stations in Dolores, Colorado and Cisco, Utah, the groundwater discharge to the Dolores River averages 3 liters per second per kilometer of the river (i.e., 76 gpm per mile of the river).

2.3 Regional Groundwater Quality

According to USGS data (Weir et al. 1983) and data from Feltis (1966), water from the upper Mesozoic aquifer is typically calcium-bicarbonate water containing varying concentrations of sulfate. The concentration of dissolved solids generally depends on the distance of the sampling location from the recharge zone, with groundwater close to a recharge area having a lower concentration of dissolved solids compared to groundwater that is close to a discharge area.

3.0 SITE HYDROGEOLOGY

3.1 Study Area

The study area for this hydrogeologic report is defined in relation to natural features that determine the presence, extent, and utility of the groundwater within the vicinity of the project area. These features include hydraulic and lithologic boundaries in the vicinity of the Site. The study area also corresponds to the local drainage basin discharging flow from the eastern Paradox Valley to the Dolores River. Figure 1 presents a map of the study area.

To the southwest, the aquifer and study area are assumed to be bounded by the crest of Davis Mesa. This assumption is based on the fact that unconfined aquifers tend to form subdued replicas of the surface topography. Hence, the line of the highest groundwater elevation likely coincides with the crest of the mesa and acts as a groundwater divide on the southwest side of the valley.

To the northeast, the study area is bounded by Sawtooth Ridge on the northeast side of the valley. To the northwest, the Dolores River provides a hydrologic boundary to the study area. The Dolores River is downgradient from the Site and may ultimately receive surface water flow and groundwater seepage from the southeastern portion of the Paradox Valley where the Site is located. To the southeast, the study area was extended to include the upper extent of the drainage basin. The San Miguel River, a tributary to the Dolores River, is not included in the study area because it is located in a separate basin from the Site. The San Miguel River is located approximately 2.5 to 3 miles from the southeastern limit of the study area.

Based on the State Engineer’s records and field reconnaissance, eight groundwater wells are documented to have been installed in the Chinle formation within the Study Area (see Figure 1). These wells are used for domestic and/or ranching purposes. Five of the eight wells were determined to be functional, while three were determined to be intermittent or dry. Two springs were also identified as flowing from the Chinle formation. These springs, Stone Spring and Merrill Spring, were both located approximately five miles northwest of the Site. When inspected in June 2009, Stone Spring was flowing at an estimated rate of 10 gpm, but Merrill Spring was not flowing. The locations of the eight wells completed in the Chinle formation and the two springs flowing from the Chinle formation are shown on Figure 1. Additional information regarding the study area wells and springs is presented in Appendix A.

3.2 Local Hydrostratigraphy

On a regional scale, the hydrostratigraphy has been documented in studies by previous researchers (Weir et al. 1983, Whitfield et al. 1983, Hite and Lohman 1973, Hanshaw and Hill 1968). Regional studies are discussed in Section 2.0. The regional studies were supplemented by site-specific investigations undertaken as part of the current project. Site-specific hydrostratigraphy has been characterized by 35 deep (below alluvium) borings dispersed over approximately 2,000 acres. These borings consist of:

- eighteen exploratory boreholes (EX-2 through EX-15 and EX-20 through EX-23);
- nine monitoring wells (MW-1 through MW-9; however, MW-7 was completed at EX-5);
- three pumping wells (PW-1, PW-2, and PW-3); and
- six observations wells, two near each pumping well.

Details regarding these boreholes and wells are summarized in Table 3 and discussed below. The locations of boreholes advanced for groundwater exploration and characterization are shown on Figure 4. In addition to the above referenced 35 deep borings, local alluvium has been investigated in 93 shallow borings advanced for geotechnical purposes (Golder 2008a).

The four formations indentified within the study area that are important from a hydrogeologic perspective are listed below:

1. Alluvium – uppermost sediments, which transmit some fraction of meteoric water to underlying formations;
2. Chinle formation – strata within the study area which contains groundwater in its lower part;
3. Moenkopi formation – strata which underlies the Chinle formation and also may contain groundwater in some locations; and
4. Hermosa formation – formation of primarily salt, which truncates the Chinle and Moenkopi formations near the center line of the valley, thereby terminating the local aquifer.

Additional information on these formations is found in the paragraphs below. The cross-sections shown on Figure 5 illustrate the relative positioning of these formations and the static water levels measured in the on-site wells and boreholes.

3.2.1 Alluvium

As documented by drilling and previous geological studies of the area (Cater 1954, 1955), alluvial soils are present over the majority of the study area and within the Site property. Extensive deposits of alluvial soils were originally wind-deposited, and were locally reworked by water and intermixed with sheet wash. Alluvial deposits in the boreholes and wells within the Site range in thickness from approximately 5 to 140 feet, with the thinnest zones occurring at both the far southwest end of the study area near Davis Mesa (exploratory boreholes EX-7, EX-5, EX-6, and EX-12), and at the far northeast end (monitoring wells MW-1 and MW-2), near the center of the valley where the Hermosa formation outcrops. Groundwater was not encountered in the alluvium, although the surface soil likely transfers some fraction of meteoric water as recharge to the underlying Mesozoic rocks.

3.2.2 Chinle and Moenkopi Formations

The southwestern flank of the valley is underlain by the Chinle formation of Upper Triassic age, which is underlain by the Moenkopi formation of Lower to Middle Triassic age. These formations are the groundwater bearing strata identified from boreholes and wells completed in the study area. As shown on cross-section C-C’ on Figure 5, the thicknesses of the Chinle and Moenkopi formations decrease from south near the mesa, to the north, farther into the valley. As shown on cross-sections C-C’ and D-D’ on Figure 5, the Chinle and Moenkopi formations are not present at borehole and well locations north of exploratory boreholes EX-23 and EX-4, respectively.

The Chinle formation within the Paradox Valley is composed of red to orange-red siltstone with layers of sandstone, shale, and limestone-pebble and clay-pellet conglomerate. In places, the lower section of the Chinle formation contains quartz conglomerates, which are of hydrological interest due to their ability to store and transmit groundwater (Cater 1954, 1955). The Moenkopi formation consists of three members: an upper member of reddish-brown and chocolate-brown shale and sandstone; a middle member of purplish to reddish-brown arkosic conglomerate and conglomeratic sandstone; and a lower member of brick-red poorly-sorted sandy mudstone with thin beds of gypsum in places (Cater 1954, 1955). In particular, the arkosic conglomerate beds may contain and conduct water. However, beds comprising both the Chinle and Moenkopi formations are discontinuous and neither of these formations is known to contain contiguous sand or sandstone layers.

3.3.3 Hermosa Formation

The Hermosa formation consists of two members: the upper member of primarily gray limestone; and the lower Paradox member, which consists of salt, gypsum, carbonaceous shale, sandstone, and dolomite (Cater 1955). Within the Site borings, only the Paradox member was encountered. Due to the uplift of the salt diapir in the valley with erosion of the Chinle and Moenkopi formations, the Paradox member was encountered at shallower depths near the center of the valley. At locations north of approximately Fault #4 (Figures 4 and 5), the Paradox member was encountered directly beneath the alluvium, at depths ranging from approximately 40 to 70 feet below ground surface (bgs). At monitoring wells MW-6 and MW-8B, and exploratory borehole EX-23, groundwater was encountered near the contact of the Moenkopi and Hermosa formations, suggesting that the Hermosa formation acts as a barrier to downward migration of groundwater.

3.3 Extent of Groundwater Occurrence

For the purposes of this report, the aquifer in the study area is defined as the groundwater-yielding zones near the contact between the Chinle and Moenkopi formations. Regionally and locally, the Moenkopi formation acts as a confining unit or aquitard that limits vertical flow of groundwater, resulting in groundwater occurrence at the Chinle and Moenkopi contact. Below the Moenkopi formation, the Hermosa formation acts as an aquiclude, eliminating the vertical flow of groundwater. As discussed in the sections below, groundwater has been documented at the contact between the Moenkopi and Hermosa contact; however, the groundwater does not constitute the local aquifer because it does not yield a significant amount of water. According to the CDPHE (2001) *Licensing Requirements for Uranium and Thorium Processing* (6 CCR 1007-1), “an aquifer is a geologic formation, group of formations, or part of a formation capable of yielding a significant amount of ground water to wells or springs.” In contrast, the groundwater occurrence at the Chinle-Moenkopi contact does meet this definition of an aquifer because it yields quantities of groundwater that are usable and therefore significant.

3.3.1 On-Site Vertical Extent of Groundwater

Based on the on-site groundwater investigations, the only known groundwater occurrences within the study area are close to the contact between the Chinle and Moenkopi formations, and close to the contact between the Moenkopi and Hermosa formations. Figure 5 shows geologic cross sections and the static groundwater elevations observed in each borehole or well. Groundwater near the Chinle/Moenkopi contact was encountered in exploratory boreholes EX-5 through EX-15, monitoring wells MW-5 and MW-7, the production wells, and observation wells. Groundwater at the Moenkopi/Hermosa contact was documented at three locations (monitoring wells MW-6 and MW-8B, and exploratory borehole EX-23) and is likely the result of groundwater flow through fractures from the Moenkopi and Chinle contact to the top of the Hermosa. At most locations across the Site, groundwater does not occur at depths below the Chinle/Moenkopi contact. The absence of "deeper" groundwater is documented in several exploratory boreholes that were drilled to depths beyond this contact. For example, EX-6 was drilled to a total depth of 1,040 feet bgs, EX-5 was drilled to a total depth of 880 feet bgs, and EX-4 was drilled to a total depth of 800 feet bgs. In these boreholes, no groundwater was encountered below the Chinle/Moenkopi contact.

3.3.2 On-Site Horizontal Extent of Groundwater

The southwestern boundary of the aquifer is assumed to coincide with the alignment of the crest of Davis Mesa. The assumption is supported by the observation that numerous faults paralleling the mesa likely act as conduits for aquifer recharge, thus elevating water levels beneath the mesa. Additionally, aquifers, especially in recharge areas, tend to form subdued replicas of the surface topography. Therefore, the crest of the mesa likely acts as a groundwater divide.

The northeastern boundary of the aquifer is defined by the salt dome that truncates the Chinle/Moenkopi formations. These formations are truncated north of boreholes EX-4 and EX-23, as shown on Figure 5. As shown in Tables 4 and 5 and illustrated on Figure 6, seven boreholes and wells located in the central and northern sections of the Site did not encounter groundwater. During drilling, no groundwater was encountered at exploratory boreholes EX-2 through EX-4, EX-21 through EX-23, and at monitoring wells MW-1 through MW-4. Following drilling, groundwater collected in wells MW-2, MW-3 and EX-21 through EX-23 after several days. However, groundwater in monitoring wells MW-2 and MW-3 is limited (water column heights are less than four feet) and not representative of the aquifer. The Chinle and Moenkopi formations were absent at wells MW-2 and MW-3. Additionally, the groundwater elevations observed at MW-2 during the second quarter of 2008 and at MW-3 during the third and fourth quarters of 2008 are over 200 feet higher than water levels at MW-8, MW-9, and EX-22, suggesting that water encountered at monitoring wells MW-2 and MW-3 reflects local, perched conditions and is not representative of groundwater encountered elsewhere in the study area.

Seepage of interstitial moisture was encountered at monitoring well MW-9, and water also accumulated after drilling at exploratory boreholes EX-21, EX-22, and EX-23. However, these locations have very slow recharge rates. For example, a rising head test at well MW-9 resulted in an estimated hydraulic conductivity of 2×10^{-8} cm/s, lower than any of the other tested locations. Due to this low conductivity, the well could not be properly developed. Additionally, after purging well MW-9 dry on August 8, 2008, the well required 33 days to sufficiently recharge for sample collection on September 10, 2008. Prior to sample collection, approximately 6.5 gallons of water had accumulated in the well over the 33-day period. The well's very slow recharge suggests that it is completed in an aquitard. Therefore, the water present in the well is derived from interstitial moisture and is not representative of groundwater encountered in the other boreholes and wells.

Boreholes EX-21, EX-22, and EX-23 were drilled dry and did not encounter groundwater during drilling. The holes were left open for observation and groundwater gradually accumulated in all three boreholes. At EX-23, groundwater was blown out of the hole on July 7, 2008 to observe recovery of water levels in the well. After 20 hours, the well had recharged approximately 7.5 gallons, and after 42 hours, the well had recharged 14 gallons. Although aquifer recharge at exploratory hole EX-23 was very low compared to the wells located closer to Davis Mesa, this location may be suitable for future downgradient water quality monitoring of the tailings facilities.

3.3.3 Off-Site Extent of Groundwater

The presence of groundwater along the toe of Davis Mesa and Monogram Mesa is confirmed by the presence of pre-existing wells in the study area. Figure 1 shows the location of eight pre-existing wells that based on their depths, are likely completed in the Chinle formation. Of these eight wells, five wells were determined to be operational. Available information on these pre-existing water wells in the Chinle formation is presented in Table 6. Additional wells are located within the study area, but are not relevant to the project because they are not operational, abandoned, or screened in formations other than the Chinle and Moenkopi. A discussion of these additional wells in the study area is presented in Appendix A. The Dolores River to the northwest is believed to effectively terminate any aquifer in the southeast portion of the Paradox Valley.

3.4 Potentiometric Surface

The potentiometric groundwater surface of the local Chinle-Moenkopi aquifer is influenced by the following factors:

- Proximity to Davis Mesa, which acts as a recharge area for the aquifer;
- Northwest-trending faults, which likely act as conduits to flow; and
- Uplifted sediment and evaporites of the Hermosa formation, which act as a barrier to downward flow of groundwater.

Figure 6 presents a potentiometric surface map of the study area. The groundwater contours shown on the map were generated using August 2008 groundwater elevation data from the monitoring and observation wells. Groundwater elevation data from the exploratory boreholes were not measured in August 2008; therefore elevation data on the map are from the preceding date from April to June 2008, depending on the borehole. As discussed in Section 3.4.2 below, temporal changes in groundwater levels are small (typically less than two feet) and the difference in groundwater monitoring dates has negligible influence on the groundwater contours.

3.4.1 Groundwater Flow Direction

As indicated by the contours, groundwater near the Site generally flows away from the mesa in a northeast direction and is intercepted by faults that parallel the valley axis. According to the *Geologic Report in Support of the Application for License for Source Material Milling* (Kleinfelder 2009), the nearest mapped faults to the Site are associated with the Paradox Valley graben, trending roughly parallel to the base of Davis Mesa, along the southern edge of the Site (USGS Quaternary fault database, No. 2286, 2008). These faults appear to act as conduits for flow and recharge, which direct groundwater flow to the northwest.

Regionally, groundwater flows to the northwest, discharging to the Dolores River (Weir et al. 1983). This groundwater flow direction towards the Dolores River is supported by the data from the study area. For example, exploratory borehole EX-15 is located southeast of the Site and has a groundwater elevation of approximately 5,550 feet amsl, while exploratory borehole EX-14 is located northwest of the Site and has a groundwater elevation of approximately 5,143 feet amsl (i.e., 407 feet lower) indicating groundwater sloping toward the northwest. A more detailed discussion of the groundwater flow direction is included in Section 3.7, Direction and Velocity of Groundwater Flow.

3.4.2 Temporal Variations of Groundwater Levels

The groundwater data at the boreholes and wells show no seasonal trends and the fluctuations of groundwater levels within the period of record (eight quarters or fewer) are typically less than two feet. Figures 7 through 13 show water-level elevations over time for monitoring wells MW-5, MW-6, MW-7, and MW-8B, and production wells PW-1, PW-2, and PW-3. Tables 4 and 5 present measured water levels for the exploratory boreholes and wells, respectively. Within the period of record for these wells (8 quarterly events for MW-5 and MW-6 and 5 quarterly events for MW-7, MW-8B, PW-1, PW-2, and PW-3), the groundwater elevations vary by less than approximately two feet for each well, except PW-3 and MW-5. At PW-3, the groundwater elevation was 5,301 feet amsl in August 2008 and had dropped to approximately 5,294 feet by April 2009; a change of approximately 7 feet. The decrease in water level elevation at PW-3 is likely due to the presence of fractures, which receive recharge and make changes in water levels more pronounced. At MW-5, the water level measurement from October 16, 2007 is approximately 10 feet lower than the following seven quarterly measurements, likely due to slow recharge to the well. The well was dry during drilling that was completed on September 25, 2007 and may not have fully recharged by the time of the first water-level reading in October 2007.

3.5 Hydraulic Properties of Aquifer

Hydraulic properties of the aquifer have been characterized by nine short-term pumping tests, three long-term pumping tests, and three rising-head/falling head tests conducted in the spring and summer of 2008 (Golder 2008b, 2008c, 2008d, 2008f). The work was conducted to evaluate the water supply potential of the aquifer and characterize the hydrogeologic conditions at the Site. A summary of the results is included in this report. Detailed information can be found in the reports: *Phase 3 Long Term Pumping Test Data Report, Piñon Ridge Project* (Golder 2008d), and *Water Supply Evaluation, Piñon Ridge Project* (Golder 2008f), which were previously submitted to CDPHE.

3.5.1 Short-term Pumping Tests

The field hydrogeologic program was conducted in a three-phase program. Phase 1 consisted of drilling six exploratory holes (EX-2 through EX-7) during April 2008 (Golder 2008b). Of these holes, only three encountered groundwater (EX-5, EX-6, and EX-7). Hydrogeologic testing was performed in the three exploratory boreholes and in previously installed groundwater monitoring well MW-6. Aquifer properties and potential productivity were estimated by analysis of the short-term (approximately 4 to 6 hour), variable rate (step-down) pumping tests. During the short-term tests, the pumping rates varied from 4.7 to 27.8 gpm.

Following the Phase 1 study, eight additional exploratory holes were drilled (EX-8 through EX-15) in May 2008 as a Phase 2 investigation. Each of the holes encountered water at or near the contact between the Chinle and Moenkopi formations. During drilling, water production potential estimated by air-lifting in exploratory boreholes EX-9, EX-13, and EX-14 was below 5 gallons per minute (gpm) and therefore was considered too low for further testing. Short-term (approximately 4 to 6 hour) constant-rate pumping tests were conducted in exploratory boreholes EX-8, EX-10, EX-11, EX-12, and EX-15. During the testing, pumping rates varied from 8.8 gpm to 39.8 gpm.

Additional boreholes (EX-20, EX-21, EX-22, and EX-23) were drilled during the Phase 2 program to delineate the northern extent of the aquifer at the Site. EX-21, EX-22, and EX-23 were drilled dry and did not encounter groundwater during drilling. After the holes were completed, seepage began to accumulate in the holes at a slow rate. Therefore, the boreholes did not merit aquifer testing. Additional details regarding recharge at EX-23 are presented in Section 3.3.

3.5.2 Long-term Pumping Tests

Of the eight exploratory boreholes tested during Phase 1 and Phase 2, locations near exploratory holes EX-6, EX-8, and EX-12 were selected as having the most favorable groundwater production potential and were considered for long-term pumping tests, hereafter referred to as Phase 3. In May and June of 2008, two observation wells were installed near each of the three selected pumping test locations to observe aquifer response to pumping and aid in quantification of aquifer properties. In July 2008, production wells were drilled near selected exploratory boreholes (PW-1 near EX-6, PW-2 near EX-8, and PW-3 near EX-12).

Long-term (48-hour) pumping tests, followed by recovery observations, were conducted in the three PW-series wells to estimate aquifer parameters, estimate long term water production potential, and characterize the hydrogeologic system within and near the Site. During the long-term testing, pumping rates ranged from 10.3 gpm at production well PW-2 to 67.5 gpm at production well PW-3. To characterize the aquifer properties north of the pumping wells and outside of the influence of the pumping tests, Phase 3 testing also included a rising-head test at monitoring well MW-9 and rising-head and falling-head tests at monitoring well MW-8B.

3.5.3 Analysis of Aquifer Testing

For analysis of the three phases of the groundwater investigation program, AQTESOLV software (Duffield 2007) was used to analyze the test data. To estimate saturated hydraulic conductivity, results from the pumping tests were analyzed using the Theis equation (Theis 1935) and the Cooper-Jacob method (Cooper and Jacob 1946). Results of the three-phase testing program are included in Table 7.

During the short-term pump testing of Phase 1 and Phase 2, estimated hydraulic conductivities ranged from 2×10^{-4} cm/s at exploratory borehole EX-5 to 2×10^{-2} cm/s at exploratory borehole EX-12. During the long-term pump testing of Phase 3, estimated hydraulic conductivities were similar among the three tested locations, with estimated conductivities for the observation and pumping wells ranging from 1×10^{-3} cm/s at production well PW-3 to 8×10^{-3} cm/s at observation well PW-1 OB-B. The Phase 3 rising-head and falling-head tests resulted in lower conductivities: 2×10^{-4} cm/s at monitoring well MW-8B and 2×10^{-8} cm/s at monitoring well MW-9.

The average conductivity for the tested locations, including monitoring well MW-9 and borehole EX-12, is 3×10^{-3} cm/s, which is high relative to the expected value for intact fine-grained sedimentary rock. The hydraulic testing also indicates a relatively low storativity, averaging 4×10^{-4} (0.04%), based on estimates from observation wells during pumping tests. Most unfractured fine-grained sedimentary rocks are expected to exhibit low hydraulic conductivity, but high porosity, ranging from 0.05 to greater than 0.3 (5% to 30%) (Davis and DeWiest 1966). Together with the relatively high hydraulic conductivity, low storativity is indicative of both a confined aquifer and an aquifer comprised of fracture systems. The distribution of estimated hydraulic conductivity from testing is narrow, with a standard deviation of 0.59 log units, discounting the test result from MW-9 with a hydraulic conductivity of 2×10^{-8} cm/s, which likely represents local unfractured conditions.

The remaining uniformity of the results suggests extensive fracturing, typically associated with faulting having a high degree of fracture networking.

3.6 Aquifer Recharge

Recharge to the Chinle/Moenkopi aquifer locally occurs through two means: as diffuse infiltration of rain and snowmelt over the valley area overlying the aquifer; and as localized infiltration from runoff on the slopes of Davis Mesa. On one hand, studies have shown that diffuse recharge to basin aquifers in arid areas like Paradox Valley is limited or absent due to low precipitation rates, large vadose zones, and the water-scavenging vegetation found in dry areas (Wilson and Guan 2004; Foster and Smith-Carrington 1980). On the other hand, a study of 20 selected catchments worldwide shows that the area-weighted mountain contribution to the annual river basin discharge is about four times that of the basin floor (Viviroli et al. 2003). In arid and semi-arid regions, the mountain contribution can be even greater.

In the Dolores River basin, the greatest recharge reportedly occurs along ephemeral channels, where deep infiltration is most likely (Weir et al. 1983) and, on a local scale, Davis Mesa is considered the main contributor of recharge to the Chinle/Moenkopi aquifer. The mesa is steeply sloping and incised by arroyos. Additionally, northwest-trending faults parallel the mesa and likely facilitate recharge to the aquifer.

In the study area, no groundwater was encountered in the alluvium. In the northern part of the Site, the alluvium overlies the Hermosa formation, which acts as a barrier to downward flow of groundwater. If recharge were occurring through diffuse infiltration of rain and snowmelt over the valley area, then groundwater would likely be present at the contact of the alluvium and Hermosa formation. The absence of this groundwater suggests that diffuse recharge to the valley area is minimal.

Recharge from Davis Mesa is supported by hydrostatic pressures encountered in boreholes. During drilling, saturated conditions were often encountered near the contact between the Chinle and Moenkopi formations, but water levels rose up to 50 feet above the saturated level, as evidenced at boreholes EX-5, EX-6, and EX-7, and production wells PW-1 and PW-2. The hydrostatic pressures indicate recharge to areas at higher elevations (i.e., Davis Mesa). Recharge is expected to be greater along the mesa than on the valley floor due to higher amounts of precipitation at higher elevations and concentration of runoff. The relationship between elevation and precipitation is illustrated on Figure 14 (Weir et al. 1983). In the Dolores River basin, the relationship between elevation and annual precipitation indicates precipitation at an elevation of about 6,500 feet amsl (i.e., corresponding to the top of the mesa) may reach 14.7 inches (360 mm) per year. This is about 17 percent higher than the 12.6 inches of precipitation estimated for the project area at an elevation of 5,480 feet amsl.

3.7 Direction and Velocity of Groundwater Flow

As discussed in Section 3.4, groundwater flow in the Chinle/Moenkopi aquifer is to the northeast, away from Davis Mesa. As groundwater flows to the northeast, it encounters northwest-trending faults, which tend to direct groundwater flow to the northwest. Groundwater flow therefore occurs through a combination of porous-type flow and fracture-type flow related to fault systems.

Groundwater flow toward the Dolores River can also be inferred from observation of groundwater levels in wells installed in the southeastern and northwestern portions of the study area. The elevation of groundwater in exploratory borehole EX-15 installed 3.6 miles southeast of the project Site is at an elevation of 5,500 feet amsl, whereas the elevation of groundwater in boring EX-14 installed 2.3 miles northwest of the Site (toward the Dolores River) is at approximately 5,143 feet amsl (see Figure 4 for boring locations). The difference in these groundwater elevations (i.e., about 350 feet over a distance of 5.9 miles) translates to approximately a one percent (1%) groundwater gradient toward the northwest.

Based on the aquifer testing results described in Section 3.5, a range of groundwater flow velocities were calculated for groundwater flow toward the Dolores River. The lower end of the range (100 feet per year) represents flow through the porous sandstone and the upper end of the range (3,000 feet per year) represents flow velocity through the fractured rock.

For calculations of velocity through porous sandstone, a hydraulic gradient of 0.01 feet/feet was estimated based on the water level elevations at exploratory boreholes EX-14 and EX-15. A hydraulic conductivity of 3×10^{-3} cm/s (the average estimated value from pumping tests) and an assumed porosity of 30% (a representative value for poorly consolidated sandstone [Driscoll, 1986]) were used. Using these values, the estimated average linear velocity for porous-type flow is approximately 100 feet per year.

Higher flow velocities occur within the presence of localized faults and fractures. As before, to estimate fracture-type flow, an average hydraulic conductivity estimated from the pumping tests was used (3×10^{-3} cm/s) and a gradient of 0.01 feet/feet. Additionally, a typical porosity for fractured rocks (approximately 0.01%) (Freeze and Cherry 1979) was used in place of the sandstone porosity of 30%. The fractured-rock porosity of 0.01% equals the average storativity determined from the pumping tests under unconfined conditions (Golder 2008d, 2008f). Using these values, the estimated average linear velocity for fracture-type flow is high and may approach 3,000 feet per year.

4.0 CONNECTIVITY OF AQUIFERS WITH SURFACE WATER

No surface water bodies, including ponds, lakes and annual flow streams are present at the Site. Therefore, no connectivity of groundwater with surficial flows are of relevance. Springs and groundwater discharge to the Dolores River are discussed below for the study area and region.

Within the study area, three springs were identified: Stone Spring, Merrill Spring, and Oublier Spring. Two of these springs (Stone Spring and Merrill Spring) are located approximately 5 miles northwest from the site and flow from the Chinle formation, as shown on Figure 1. When checked in June 2009, Stone Spring was flowing at a rate of approximately 10 gallons per minute and Merrill Spring was not flowing. The third spring (Oublier Spring) is located on the mesa, approximately 4 miles southeast of the site. This spring flows from near the base of the Salt Wash Member of the Morrison formation, which is stratigraphically higher than the Chinle formation. Additional information on these springs is presented in Appendix A.

On a larger scale, the Dolores River, which marks the northwest boundary to the study area, likely receives groundwater seepage from the southeastern portion of Paradox Valley. Regional studies by Weir et al. (1983) show that between gauging stations in Dolores, Colorado and Cisco, Utah, groundwater discharge to the Dolores River averages 3 liters per second per kilometer of the river (76 gpm per mile). Within the study area, flow toward the river can be inferred from observation of the groundwater levels in wells installed in the southeastern and northwestern portions of the study area. As discussed in Section 3.7, there is a 350-foot decrease in groundwater elevations between borehole ES-15 (southeast of the Site) and borehole EX-14 (northwest of the Site), suggesting flow towards the northwest. Additionally, northwest-trending faults in the valley likely act as conduits to flow toward the Dolores River. However, the Dolores River is likely a losing stream in Paradox Valley due to extraction wells that are located near the river. The Paradox Valley Unit, operated by the U.S. Bureau of Reclamation, consists of 13 shallow brine extraction wells which keep brine from discharging into the Dolores River. According to Andy Nicholas of the U.S. Bureau of Reclamation (personal communication, June 25, 2009), the combined extraction rate from the wells in June 2009 was approximately 230 gallons per minute. The extracted solution is filtered and injected into the Leadville Limestone at depths from 14,068 to 15,857 feet bgs (Chafin 2003).

5.0 GROUNDWATER RESOURCES

5.1 Availability of Groundwater

As presented above, groundwater occurs near Davis Mesa in the southwestern part of the project Site, primarily at the Chinle/Moenkopi contact. The water production potential of the Chinle/Moenkopi aquifer was evaluated by aquifer testing in the spring and summer of 2008. The details of the testing are presented in Section 3.5, Hydraulic Properties of the Aquifer, and can also be found in *Phase 3 Long Term Pumping Test Data Report, Piñon Ridge Project* (Golder 2008d), and *Water Supply Evaluation, Piñon Ridge Project* (Golder 2008f), which were previously submitted to CDPHE.

Based on the results of the aquifer testing, a predictive analysis of future groundwater availability was conducted by Golder in 2008. The aquifer testing entailed short-term (4 to 6 hour) pumping tests in eight exploratory boreholes (EX-series) and one monitoring well (MW-6) and culminated in three long-term (48-hour) constant-discharge pumping tests in the three production wells (PW-series). During the long-term pumping tests, the discharge rate was 52.1 gpm at PW-1, 10.3 gpm at PW-2, and 67.5 gpm at PW-3. Thus, the total rate from the three pumping wells was approximately 130 gpm. However, to predict the long-term, sustainable productivity of the aquifer, a series of aquifer simulations was conducted. For the predictive analysis, the following considerations were made:

- Analysis extended for a 5-year period;
- The existing set of production wells (PW-1, PW-2, and PW-3) will be supplemented by two additional proposed wells (PW-4 and PW-5), to be installed at a later date; and
- The complexity of the aquifer, due to faulting, lithologic composition, and diverse hydraulic properties, has been accounted for in the predictive analysis of the aquifer properties.

Considering the complexity of the geology and the lack of historic hydrogeological data over the Site, the predictive analysis accounted for the following two aquifer configurations:

- Scenario 1. Aquifer is bounded on one side to the northeast by the salt dome and extends below Davis Mesa to the southwest; and

- Scenario 2. Aquifer is bounded on two sides: to the northeast by the salt dome uplift; and to the southwest immediately south of the faults represented as a no-flow boundary along the edge of the mesa. Under this conservative scenario, the aquifer is assumed to be a strip 4,500 feet wide.

For scenarios 1 and 2, the flow rates predicted for five pumping wells over a 5-year period are presented in Table 8A. The pumping rates presented in Table 8A are conservative because they consider water available from aquifer storage only. However, the aquifer receives recharge from direct infiltration (although limited in the area underlying the project area), and from runoff and focused recharge from Davis Mesa which may amount to an additional 40 gpm (Golder 2008f). Table 8B summarizes pumping rates from aquifer storage and recharge. As seen, higher pumping rates than those attainable from storage only may be possible. If recharge is accounted for, and if the aquifer is bounded on one side only *(Scenario 1)*, the water supply may reach 135 gpm from aquifer storage and up to 40 gpm from aquifer recharge for a 5-year period. Hence, the rate of groundwater supply for the project may reach a rate on the order of 175 gpm. The scenario of an aquifer bounded on two sides (*Scenario 2)* is a conservative representation of the Site hydrogeology. Under this scenario, sustainable water production from aquifer storage is estimated to be 64 gpm. However, if aquifer recharge is considered, the sustainable pumping rates may be higher, on the order of 100 gpm.

Because the aquifer productivity is sensitive to the presence/absence of features such as faults, lithology and placement of wells, the long-term sustainable pumping rates will need to be confirmed following observation of aquifer response to production pumping.

5.2 Groundwater Water Quality

5.2.1 Available Water Quality Data

Characterization of groundwater quality within the project area and its immediate vicinity is based on results of groundwater samples collected from 20 locations over the period of eight quarters from October 2007 to August 2009.

The sampling locations include:

- Five groundwater monitoring wells, including MW-5, MW-6, MW-7, MW-8B, and MW-9;

- Three groundwater production wells (PW-1, PW-2, and PW-3);

- Seven exploratory holes (EX-5, EX-6, EX-7, EX-10, EX-12, EX-15, and EX-23);
- Four off-site wells, referred to by the name of the well owners listed on Table 6: BLM (permit number 258704), Boren (permit number 253522), Davis (permit number 269575) and Hurdle (permit number 226684); and
- One off-site spring, Stone Spring.

Figure 15 shows the locations of the monitoring wells, production wells, exploratory boreholes, off-site wells, and off-site spring that have been sampled. The sampling schedule and procedures are summarized in the sections below. Additional information regarding sampling procedures can be found in the quarterly groundwater monitoring reports, which were previously submitted to CDPHE (Kleinfelder 2008a, 2008b, 2008c, 2008d; EFRC 2009a, 2009b, 2009c, 2009d) and the *Groundwater Monitoring Summary Report, Piñon Ridge Project* (Golder 2009).

5.2.1.1 Sampling of Permanent Monitoring Wells (MW Series)

Water quality sampling of the monitoring wells commenced in October 2007 and continued for seven additional quarterly sampling events through July 2009. During the first and second sampling events (fourth quarter 2007 and first quarter 2008), only monitoring wells MW-5 and MW-6 had been installed. By the second quarter 2008, monitoring well MW-7 had been installed, and by the third quarter 2008, monitoring wells MW-8B and MW-9 had been installed. As discussed in Section 3.3, water encountered at well MW-9 is interstitial moisture that is not representative of the contiguous aquifer; therefore, the well was not sampled in subsequent sampling events. Table 9 provides a summary of the groundwater sampling schedule for the monitoring wells.

During each sampling event, a static water level was taken from the wells prior to purging. Samples from the monitoring wells have been collected using bailers, stainless-steel submersible pumps, and bladder pumps, depending on the location and the sampling event. Since the fourth quarter of 2008, quarterly sampling methods have been consistent, with samples from wells MW-7, MW-8B, PW-1, PW-2, and PW-3 collected with low-flow bladder pumps, samples from MW-5 collected with a dedicated bailer, and samples from MW-6 collected with a dedicated stainless-steel pump. Throughout purging and prior to sample collection, field parameters of temperature, pH, specific conductivity, dissolved oxygen (DO), and oxidation/reduction potential (ORP) were measured.

5.2.1.2 Sampling of Production Wells (PW Series)

The production wells were not designed and installed for groundwater monitoring; however, they have been monitored to provide additional groundwater elevation and quality data for characterization of the Site. The initial two water quality samples from the production wells were collected during the August 2008 pumping tests. One sample was collected toward the beginning of the pumping test after purging had occurred (i.e., generally after an hour of pumping), and a second sample was collected towards the end of the 48-hour tests. During the subsequent quarterly events, additional samples were collected from production wells PW-1, PW-2, and PW-3 using a bladder pump and low-flow techniques in which the purge rates were less than 0.5 gpm. Field parameters of pH, temperature, specific conductivity, ORP, and DO were measured during purging and prior to collection of the samples.

5.2.1.3 Sampling of Temporary Exploratory Boreholes (EX Series)

The purpose of the exploratory boreholes was to further delineate geologic lithologies, detect groundwater, and assess potential pumping rates. In boreholes where the potential for groundwater production was observed, sampling was conducted during the short-term (approximately 4-hour) pumping tests, after a minimum of one hour of purging. These pumping tests are described in Section 3.5 and occurred between April and August of 2008 (Golder 2008a, 2008b). Not all exploratory boreholes were sampled during the short-term pumping tests. Exploratory boreholes were selected for sampling based on their location and the potential to enhance the spatial coverage of groundwater characterization. The exploratory boreholes from which samples were collected are EX-5, EX-6, EX-7, EX-10, EX-12, EX-15, and EX-23. Field parameters of pH, temperature, specific conductivity, ORP, and DO were measured prior to collection of the samples from exploratory boreholes. At the time of pumping and sampling, the exploratory holes were equipped with temporary casing.

Exploratory borehole EX-23 is an exception to the above, in that it was not sampled during a pumping test and that temporary casing was not installed at the time of sampling. At the time of drilling, no groundwater was observed at this borehole; however, groundwater accumulated in the borehole following drilling. A grab sample (no purging) was collected on July 21, 2008, after the well had been blown dry on July 7, 2008. Additional details of recharge rates for EX-23 are presented in Section 3.3.

5.2.1.4 Sampling of Off-Site Domestic and Stock Wells

Of the five operational off-site wells completed in the Chinle formation in the vicinity of the project, four wells were sampled for water quality analysis: BLM, Boren, Davis, and Hurdle wells, which correspond to permit numbers 258704, 253522, 269575, and 226684, respectively (Table 6). Access to the fifth well, Herron (permit number 234136), could not be obtained during the third quarter 2009 sampling event. The BLM, Davis, and Hurdle wells are located approximately 3 to 4 miles southeast of the Site boundary, and the Boren well is located approximately 5 miles northwest of the Site boundary. The sample from the Hurdle well was collected in April 2008, and samples from the BLM, Boren, and Davis wells were collected in July 2009.

Prior to sample collection, the wells were purged using pumps that were already installed in the wells. The BLM well was purged of 682 gallons at a rate of 7.5 gpm, the Boren well was purged of 3,051 gallons at a rate of 12 gpm, the Davis well was purged of 512 gallons at a rate of 6.5 gpm, and the Hurdle well was purged of 80 gallons at a rate of 8 gpm. Samples from the BLM, Boren, and Davis wells were collected directly from the well spigots using an adapter. The sample from the Hurdle well was collected directly from an outdoor faucet via a garden hose.

5.2.1.5 Sampling of an Off-Site Spring

One sample has been collected from an off-site spring, Stone Spring, located approximately 4.8 miles northwest of the Site. Stone Spring was found to be the only flowing spring in the vicinity of the project that originates from the Chinle formation (Appendix A). The spring provides water to two households on the Boren property through a 1.25-inch diameter PVC pipe. Prior to sample collection, approximately 1,149 gallons were allowed to pass through the gravity-fed PVC pipe, which extends approximately 1,000 feet from the spring to the well house, where the sample was collected.

5.2.2 Quality Assurance/Quality Control (QA/QC) Measures

Golder considers the overall data set suitable and representative for the purposes of this characterization. Laboratory analyses were conducted within hold times, except for the following analyses:

- Sulfide and mercury analyses for the MW-5 sample collected on January 31, 2008;

- Sulfate and sulfide analyses for the MW-6 sample collected on January 29, 2008;
- Total suspended solids (TSS) analysis for the EX-7 sample collected on April 24, 2008;
- Total dissolved solids (TDS) analysis for the Hurdle Well sample collected on April 22, 2008;
- TDS analysis for the EX-5 sample collected on April 22, 2008;
- Sulfide analysis for the PW-1 sample collected on August 13, 2008; and
- Total suspended solids analysis for MW-5 and PW-1 samples collected on April, 30, 2009.

Sample anion-cation charge balances were within acceptable ranges, except for the MW-6 sample from April 2008 (charge balance of 7.8%), PW-1 sample from August 2008 (charge balance of 10.2%), Hurdle Well sample from April 2008 (charge balance of 11.2%), and Davis Well sample from July 2009 (charge balance of 7.9%). Laboratory quality assurance and quality control (QA/QC) results were generally within acceptable ranges. Where control limits were exceeded, the laboratory provided narratives in the laboratory reports to indicate or resolve discrepancies. Laboratory reports are included in the quarterly monitoring reports, which have been previously submitted to CDPHE (Kleinfelder 2008a, 2008b, 2008c, 2008d; EFRC 2009a, 2009b, 2009c, 2009d) and in the *Groundwater Monitoring Summary Report, Piñon Ridge Project* (Golder 2009).

Duplicate samples and equipment blanks were collected as part of the field activities. The duplicate and equipment blank results are presented in the quarterly monitoring reports, which have been previously submitted to CDPHE (Kleinfelder 2008a, 2008b, 2008c, 2008d; EFRC 2009a, 2009b, 2009c, 2009d) and in the *Groundwater Monitoring Summary Report, Piñon Ridge Project* (Golder 2009). Samples were handled and shipped following chain-of-custody procedures. Sampling and purging procedures vary; details regarding sampling procedures are provided in the quarterly reports and in preceding sections. Low yields or slow recharge affected the purging and sampling methods for individual wells or samples; however, as described in the monitoring reports, effort was taken to obtain samples representative of the aquifer.

5.2.3 Groundwater Classification

The pre-existing, operational groundwater wells within the study area that are completed in the Chinle formation are classified as domestic use and agricultural use. According to CDPHE classifications contained in *The Basic Standards for Groundwater* (5 CCR 1002-41, CDPHE 2008), domestic uses are defined as the existing or potential future uses of groundwater for household or family use, including, but not limited to: drinking, gardening, municipal, and/or farmstead uses. Agricultural uses are defined as the existing or potential future uses of groundwater for the cultivation of soil, the production of crops, and/or the raising of livestock. Based on these classifications, three wells in the study area are used solely as domestic wells (permit numbers 226684, 253522, and 234136), one well is used for both domestic and agricultural uses (permit number 269575), and one well is designated solely for agricultural use (permit number 258704). Table 6 summarizes the known information about the pre-existing, operational wells in the study area that are completed in the Chinle formation.

As discussed in Section 5.2.5 below, the water quality in the study area does not meet all of the state water quality standards for domestic and agricultural use; however, the water quality is adequate for use in the mill. The production wells (PW-series) installed in July 2008 are classified as industrial use wells.

5.2.4 Groundwater Characterization

Results of water quality analyses are shown in Table 10 for the monitoring (MW) wells, Table 11 for the production (PW) wells, and Table 12 for the exploratory holes (EX holes), off-site wells and spring. Specific water quality parameters or constituents analyzed are shown in the tables and include dissolved metals, major anions, total organic carbon (TOC), total suspended solids (TSS), total dissolved solids (TDS), dissolved radionuclides, and field parameters.

In terms of major ion chemistry, most of the groundwater at the Site is similar, with no dominant cation and sulfate-bicarbonate anions. Figure 16 presents a Piper diagram for groundwater at each sampled location. For locations with multiple sample dates, a representative date was selected for Figure 16. Figures 17 through 19 present Piper diagrams for groundwater samples at the exploratory boreholes, off-site wells and spring (Figure 17), monitoring wells (Figure 18), and production wells (Figure 19). Piper diagrams show relative concentrations of major ions (bicarbonate, chloride, sulfate, magnesium, sodium, potassium, and calcium) and are widely used to illustrate variations in water chemistry.

As shown in the Piper diagrams, the majority of samples, which includes samples from exploratory boreholes EX-5, EX-6, EX-7, EX-10, EX-12, production wells PW-1, PW-2, PW-3, monitoring wells MW-5, MW-7, and the off-site Hurdle and BLM wells, have similar major-ion chemistries, with no dominant cation and dominant sulfate anions. Sulfate concentrations from these samples ranges from 360 to 520 mg/L, and bicarbonate concentrations range from 154 to 262 mg/L as $CaCO_3$. These samples were collected from wells that were screened at or near the contact of the Chinle and Moenkopi formations and boreholes that were drilled through the contact of these formations.

Besides the above boreholes and wells, the majority of which are located within the Site or in close proximity to the Site, samples from the Boren and Davis wells, Stone Spring, and borehole EX-15 were also collected from the Chinle/Moenkopi aquifer. These samples are similar to the majority of the samples in terms of major cation ratios, but differ in terms of anion ratios. These samples have a lower ratio of sulfate ions and a higher ratio of bicarbonate ions, relative to the majority of samples described above. Sulfate concentrations at the Boren and Davis wells, Stone Spring, and EX-15 range from 90 to 220 mg/L, and bicarbonate concentrations range from 239 to 422 mg/L as $CaCO_3$. In comparison, the majority of samples from the Chinle/Moekopi aquifer, as described in the preceding paragraph, have higher sulfate concentrations (ranging from 360 to 520 mg/L) and lower bicarbonate concentrations (ranging from 154 to 262 mg/L). The off-site Boren and Davis wells, Stone Spring, and borehole EX-15 are located over three miles from the Site boundary, which may result in differences in geology, recharge sources, and therefore water quality as well.

Different water quality was observed in wells completed close to the salt-rich Hermosa formation. Due to proximity to the Hermosa formation, major-ion chemistries for samples from monitoring well MW-8B and borehole EX-23 differ from the other groundwater samples collected, with higher ratios of calcium and sulfate ions compared to the other samples. Well MW-6 is also influenced by the Hermosa formation, as discussed below, but is transitional in that it has major ion concentrations that resemble the majority of sampled locations, yet negative ORP values, low DO, and detectable concentrations of sulfide and ammonia, which resemble well MW-8B and borehole EX-23.

The sample from well MW-9 has an anomalous, sodium-bicarbonate type water. As discussed in section 3.3, well MW-9 is screened in an aquitard and water sampled from the well is interstitial moisture. The water is therefore not representative of the Chinle/Moenkopi aquifer.

Water quality encountered at the Site and vicinity can be grouped into two types based on the proximity of the groundwater to the evaporites of the Hermosa formation. These two types include:

1. Moenkopi/Chinle Water: this water is found close to Davis Mesa and at the contact of the Moenkopi and Chinle formations; and
2. Hermosa Contact Water: found in the proximity of evaporites of the Hermosa formation which underlies the Moenkopi formation.

5.2.4.1 Moenkopi/Chinle Water

Water from the Moenkopi and Chinle formations is characterized by near neutral pH values generally between 7 and 8, TDS concentrations between 530 and 1,030 mg/L, and alkalinity between 154 and 422 mg/L as $CaCO_3$. Reduction/oxidation (redox) conditions for this water range from slightly reducing to oxidizing, with ORP values ranging from -210 to 203 mV. This type of water quality is found in exploratory boreholes EX-5, EX-6, EX-7, EX-12, and EX-15, the three production wells, monitoring wells MW-5 and MW-7, Stone Spring, and off-site BLM, Boren, Davis, and Hurdle wells (permit numbers 258704, 253522, 269575, and 226684, respectively; shown in Table 6 and on Figure 1).

5.2.4.2 Hermosa Contact Water

The Hermosa contact water is characterized by higher TDS concentrations (1,140 to 4,290 mg/L), primarily due to higher concentrations of sulfate (1,070 to 2,720 mg/L). In addition, the Hermosa contact water is also reducing as demonstrated by the negative ORP values (ranging from -373 to -123 mV), low DO, and detectable concentrations of sulfide and ammonia, as shown in Table 10. This type of water is found in monitoring wells MW-6 and MW-8B and exploratory borehole EX-23. The quarterly monitoring reports also indicate the presence of a sulfur smell during purging of MW-6 and MW-8B, which is consistent with reducing conditions.

In addition to the water types above, the single sample collected from well MW-9 cannot be categorized as either Hermosa contact water or Chinle/Moenkopi water, based on the descriptions above. As described earlier in sections 3.3 and 5.2.4, the sample from MW-9 is interstitial moisture and is not representative of groundwater at the Site or study area. Therefore, water quality from MW-9, while shown on Table 10, is not discussed further here.

5.2.5 Water Quality Relative to CDPHE Standards

The concentrations of several parameters in the groundwater are consistently above the CDPHE Domestic Water Supply and Agricultural standards. These constituents are discussed below:

- **Arsenic**: Arsenic concentrations are above the domestic water supply standard of 0.01 mg/L in samples from PW-1, PW-3, EX-6, EX-7, EX-12, and the Boren well. The highest concentration was measured in the sample from PW-1 (0.0177 mg/L). The standard was recently reduced from 0.05 mg/L to 0.01 mg/L.

- **Sulfate**: Sulfate concentrations are above the domestic water supply standard of 250 mg/L in all of the groundwater samples, with the exception of the EX-15, Davis well, Boren well, and Stone Spring. Dissolution of natural salts present in the Moenkopi, Chinle and Hermosa formations, such as gypsum, will result in sulfate concentrations above the standard. The concentrations are highest at wells MW-6 and MW-8B, and borehole EX-23, which are screened partially in the Hermosa formation. The highest reported concentration of sulfate in a sample from a monitoring or production well was 1,810 mg/L for a sample from monitoring well MW-8B collected in July 2008. The highest reported sulfate concentration from monitoring and production wells screened in the Moenkopi/Chinle formations was 480 mg/L in MW-7.

- **Selenium**: Selenium concentrations have been measured above the agricultural standard of 0.02 mg/L in several samples from exploration holes, off-site wells, monitoring wells, and production well PW-3. However, only selenium concentrations from EX-15, EX-23, MW-6, MW-8B, and the BLM well are above the domestic water supply standard of 0.05 mg/L. Selenium is common in shale in sedimentary rocks of the western U.S. and the Colorado Plateau area (e.g., Coleman and Delevaux 1957). The highest selenium concentration from a monitoring or production well was 0.24 mg/L from a sample collected at MW-6 in November 2008.

- **Boron**: Boron is elevated above the agricultural standard of 0.75 mg/L in samples from MW-6, MW-9, EX-15, EX-23, and the Davis well. The highest boron concentration from a monitoring or production well was 2.6 mg/L from a sample collected at MW-9 in September 2008; however, this sample may not be representative of groundwater quality at the Site, as discussed in Section 3.3. The next highest boron concentrations were 2.2 to 2.5 mg/L from samples collected from MW-6.

- **Iron**: Iron concentrations are above the domestic water supply standard of 0.3 mg/L in samples from PW-1, PW-2, MW-6 and MW-8B. At PW-1 and

PW-2, elevated iron concentrations are related to the steel casing used for well construction and reducing conditions, in which iron is more mobile at these neutral pH values. The reducing conditions at PW-1 and PW-2 help explain why iron is not elevated at PW-3, which also has steel casing. As discussed in section 3.4.2, PW-3 is likely completed in a fractured recharge zone, which results in higher DO (oxidizing conditions) and lower iron concentrations, while conditions at PW-1 and PW-2 are likely confined, as evidenced by the hydrostatic pressure encountered during well installation (section 3.6). Iron concentrations are also relatively high in groundwater samples from MW-6 and MW-8B, which have low DO content that is characteristic of Hermosa contact water described in section 5.2.4.2. The highest iron concentration from a monitoring or production well was 24 mg/L from a sample collected from PW-2 in July 2009.

- **Manganese**: Manganese concentrations are above the domestic water supply standard of 0.05 mg/l in samples from MW-5, MW-6, MW-8B, PW-1, PW-2, and EX-23. Like iron, manganese precipitates in aerobic conditions; therefore, higher manganese is expected in Hermosa contact water and in groundwater in non-recharge areas. The highest manganese concentration from a monitoring or production well was 1.4 mg/L from a sample collected at MW-8B in November 2008.

- **Uranium and gross alpha**: Uranium concentrations and gross alpha activity levels are above the domestic water supply standards of 0.03 mg/L (uranium) and 15 pCi/L (gross alpha) at the majority of the sampling locations. However, the gross alpha analyses included uranium and radon; therefore, these results cannot be directly compared to the water quality standard, which specifically excludes the alpha contributions from these two elements. It is likely that the majority of the gross alpha in the groundwater is attributable to uranium. Gross alpha and uranium concentrations are generally higher at wells with high DO and positive ORP, such as MW-5, MW-7, and PW-3.

Chromium, molybdenum, and nitrate/nitrite have also been detected at the Site at concentrations above CDPHE standards; however, these detections are not consistently above standards.

5.2.6 Spatial and Temporal Variation in Groundwater Quality

Based on the available data, spatial variation in groundwater quality is related to the proximity to the Hermosa formation. As demonstrated by the water quality of samples from MW-6, MW-8B, and EX-23, contact with the Hermosa formation results in higher sulfate and TDS concentrations due to the dissolution of evaporites, particularly gypsum.

Temporally, the available data suggest that water quality is consistent through time during the period of record. For example, concentrations of chloride, generally considered a conservative constituent, vary in MW-6 from 142 to 170 mg/L over eight quarters of sampling with no apparent trends.

Figures 17 through 19 show Piper diagrams of the groundwater samples collected during the quarterly sampling events. As shown in the figures, relative concentrations of major ions are consistent from quarter to quarter.

Iron and manganese concentrations at wells PW-1 and PW-2 are exceptions to the consistent water quality described above. Concentrations of these metals have increased following the initial sampling events in August 2008. As discussed in section 5.2.5, relatively higher concentrations of iron and manganese at these wells are related to the steel casing used for well construction and reducing conditions. The increases in concentrations are also related to the sampling methods. Concentrations were low during the August 2008 sampling events, which were conducted during pumping tests with flow rates ranging from 10 gpm at PW-2 to 52 gpm at PW-1. After the August 2008 sampling event, sampling was conducted using low-flow techniques, in which purge rates were less than 0.5 gpm. Concentrations of iron and manganese increased once the low-flow sampling methods were implemented.

6.0 CURRENT AND FUTURE USES OF WATER RESOURCES IN THE AREA

Water usage projections (CH2M Hill 2009) indicate that 141 gpm of non-potable water and 3 gpm of potable water will be needed to operate the Piñon Ridge Mill at a processing rate of 500 tons of ore per day. The potable water will be trucked to the Site from the town of Naturita. The remaining 141 gpm of non-potable water may be obtained by pumping from five production wells, three of which have already been installed.

Although the on-site aquifer is estimated to be capable of delivering 100 to 175 gpm sustainably, a contingency plan has been developed to provide uninterrupted supply of the water needed for mill operation. An agreement has been reached with the town of Naturita to purchase untreated water from town. The water will be sequestered from the San Miguel River at a rate of up to 150,000 gallons per day, which is equivalent to 104 gpm. The delivery of water from the San Miguel River may commence in the year 2011 and continue for 40 years, if needed by mill operations.

6.1 Identification of Groundwater and Surface Water Resources in the Area

No surface water resources are located within the Site. The Dolores River forms the northwest boundary of the study area defined in this report; however, due to the distance to the river (approximately 7 miles) and its downgradient location, the river is not considered a surface water resource for the Site.

The Chinle-Moenkopi aquifer constitutes the sole groundwater resource within the Site and its vicinity. The availability of the groundwater and the quality of the groundwater are discussed in detail in Section 5.0.

6.2 The Proximity and Withdrawal Rates by Groundwater Users

Within the study area, five pre-existing, functional wells completed in the Chinle formation have been identified. An additional three Chinle formation wells in the study area are known to be inoperable, dry, or only intermittently used due to poor recharge. The locations of these eight pre-existing wells completed in the Chinle formation are shown on Figure 1. More detailed information, including withdrawal rates and groundwater use is summarized in Table 6 and discussed in Section 3.1.

6.3 The Potential Impact of Operation on Groundwater Uses

The closest off-site operational water well (permit number 258704, owned by the Bureau of Land Management and shown on Figure 1 and in Table 6) is approximately 3 miles from the southern part of the project area, where the production wells are located. During the 48-hour pumping tests in the production wells (PW-series), the largest radius of influence induced by pumping was approximately 1,000 feet (Golder 2008c). The distance to the closest operational well is over 15 times the radius of influence observed during the testing. Considering this long distance between the project well field and the nearest operational well, interference in terms of dewatering by pumping the project wells is unlikely. Although interference is unlikely, the monitoring plan described in The Operational Monitoring Plan (Visus 2009) includes monitoring to assess the potential impact of pumping the production wells on domestic and agricultural water wells and springs located in the vicinity of the project.

7.0 USE OF THIS REPORT

This report has been prepared exclusively for the use of Energy Fuels Resources Corporation (EFRC) for specific application to the Piñon Ridge Project. The analyses reported herein were performed in accordance with accepted practices. No third-party engineer or consultant shall be entitled to rely on any of the information, conclusions, or opinions contained in this report without the written approval of Golder and EFRC.

The site investigation reported herein was performed in general accordance with generally accepted Standard of Care practices for this level of investigation. It should be noted that special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions. Even a comprehensive sampling and testing program implemented in accordance with a professional Standard of Care may fail to detect certain subsurface conditions. As a result, variability in subsurface conditions should be anticipated and it is recommended that a contingency for unanticipated conditions be included in budgets and schedules.

Golder sincerely appreciates the opportunity to support EFRC on the Piñon Ridge Project. Please contact the undersigned with any questions or comments on the information contained in this report.

Respectfully submitted,

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