SITE DRAINAGE ANALYSIS AND DESIGN REPORT

ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT
MONTROSE COUNTY, COLORADO
KLEINFELDER PROJECT NO. 89241
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1.0 INTRODUCTION

This report summarizes the hydrology analysis and hydraulic design performed by Kleinfelder West, Inc. (Kleinfelder) for the Energy Fuels Resources Corp (EFR) Piñon Ridge Project site. The analyses discussed herein provide a basis for sizing key hydraulic facilities on the property that include both diversion facilities to prevent offsite flows from entering the mill, tailings cells, and evaporation pond areas (i.e., the majority of the license boundary area), and flows generated onsite within the mill complex. The term “offsite” refers to both those flows generated outside of the property boundary and those flows generated within the property boundary that would need to be diverted away from the mill area.

The key drainage facilities evaluated include:

1. South diversion channel and berm at mill complex,
2. West stormwater pond,
3. East stormwater pond,
4. Ore pad channel (to the east stormwater pond),
5. Storm sewer network (stormwater ponds, and overflow pipe to evaporation ponds),
6. Evaporation pond diversion channels, and
7. Main access road drainage.

The hydrology and hydraulic calculations were performed in sufficient detail to support EFR’s application for a mill permit to the Colorado Department of Public Health and Environment (CDPHE). The main objectives in performing these hydrology and hydraulic calculations were to provide design flow rates for conveyance and diversion facilities and stormwater runoff volumes and required outlet pipe sizing for stormwater storage facilities. As such, this report should be considered a companion document for the civil design drawing package for site grading, drainage design, and roadway design (design plans). Roadway design elements were presented in a separate report submitted on October 28, 2008. Site grading design was a coordinated effort between Kleinfelder, Golder (ore pad, tailings cells, and evaporation ponds design) and CH2M-Hill (mill designer). Any excess excavated soil will be stored in a stockpile near the western property boundary for closure cover construction.

The hydrology and hydraulic design calculations consider a phased buildout of the mill, tailing cells, and evaporation pond, and thus the maximum contributing areas are used in the hydrology calculations. Hydrology calculations for the mill decommissioning and closure design are included as an attachment to the Tailing Cell Closure Design Report (Kleinfelder, 2009a).
2.0 DESIGN CRITERIA

The mill area diversion berm and channel and the soil stockpile diversion berm were sized to convey the 100-year rainfall event with adequate freeboard and allowable velocities for a given channel lining material, and to convey the 1,000-year rainfall event under bankfull or zero-freeboard conditions. All other drainage features are designed to convey the 100-year storm event. The maximum permissible non-scouring velocities for earth lined channels on the site are estimated at 3 ft/s during the 100-year event. Channel velocities in excess of that should be riprap lined. All roadway culverts were sized with a target headwater to diameter ratio (HW/D) of 1.5 or less, and no greater than 2. The minimum culvert diameter selected was 18 inches.

The 100-year 24 hour design rainfall depth of 3.0 inches for the Piñon Ridge site was obtained from NOAA Atlas 2, Vol. III. The 1,000-year 24 hour design storm rainfall depth was determined to be 4.4 inches using NOAA Atlas 14 data from a location on the Utah/Colorado border approximately 16 miles west of the Piñon Ridge mill site. NOAA Atlas 14 provides rainfall data for Utah but not Colorado. That alternate location was judged to be appropriate because it has similar elevation and orographic characteristics as the Piñon Ridge site, and NOAA Atlas 2, Vol. III does not tabulate 1,000-year frequency rainfall depths.

The east and west stormwater ponds were designed to contain the 100-year storm volume capacity with no outflow, and to route the 1,000-year storm with full containment. Both stormwater ponds are equipped with emergency overflow structures consisting of a concrete drop inlet with an outflow pipe connecting to a storm drain overflow pipe that eventually discharges into the evaporation ponds. The overflow system is designed to route the 1,000-year storm volume assuming the ponds are already at the 100-year storage capacity.

3.0 HYDROLOGY METHODOLOGY

The Soil Conservation Service (SCS) curve number method (SCS, 1986) was used to compute the runoff discharge and volume for each subbasin. The SCS Type II dimensionless rainfall distribution was used to model rainfall intensity. A 24-hour storm duration was judged to be appropriate and conservative for use with the SCS method to estimate the upper threshold of runoff volume for the stormwater ponds. A local county soils report (NRCS, 2008) was downloaded from the Natural Resources Conservation Service (NRCS) website, and vegetation types were determined based on visual inspection (Kleinfelder, 2009b).

Off-site drainage features include those that divert, channel or collect water that will eventually re-enter the natural and soil stockpile area, ore pad area and evaporation pond diversion channels, access road ditches, administration building ditches, the water
quality swale near State Highway (SH) 90, and several access road culverts. The Rocky Mountain unit hydrograph method (Cudworth, 1989) was used to determine runoff volumes and peak flows for all off-site drainage structures. The Rocky Mountain method was used because it reflects a high intensity, short duration storm that produces high runoff rates.

4.0 HYDROLOGIC AND HYDRAULIC DESIGN

The following sections discuss specific design elements for the drainage facilities above.

**South Diversion Channel and Berm At Mill Complex** – The south diversion channel and berm have been designed to prevent offsite flows south of the mill from entering that area. The 100-year design flow is estimated to be 100 cfs for both the east-flowing channel and the west-flowing berm. The east channel has the following design parameters:

- Bottom Width: 10 ft.
- Side Slope: 3H:1V
- Avg. Slope: 1.9%

The maximum velocity for the 100-year design flow is about 5.7 ft/s, and thus, the channel will be lined with a 1.5 foot thick layer of 9-inch D50 riprap over its length from roadway station 67+00 down station to 55+00. The face of the west diversion berm experiences slightly lower 100-year flow velocities of approximately 4.6 ft/s, and thus will be lined with the same riprap size and thickness. All riprap should have a 4-inch thick layer each of Colorado Department of Transportation (CDOT) Type I and Type II bedding, or a properly sized geotextile placed under the riprap as a filter.

The south diversion channel and berm calculations are presented in Appendix A and details are provided on Drawings C3, C4 and C16 in the design plans.

**West Stormwater Pond** – The west stormwater pond was sized to collect the entire 100-year runoff volume generated by the mill area (generally west of the ore pad) and store that water in a lined pond for disposal by evaporation. Additional volume is provided for storing and routing the 1,000-year runoff volume above the 100-year pond elevation through an outlet pipe that conveys the 1,000-year volume into the evaporation pond through a buried pipe. As such, none of the runoff under a 1,000-year event and generated on the mill area would flow offsite.
The required total pond volume is 4.5 ac-ft, of which 2.9 ac-ft would be occupied by the 100-year runoff volume fully contained, with the remainder for the routed 1,000-year volume. The west pond will be fed by two rundowns off the mill pad that funnel water diverted around the perimeter of the pad by a curb system. An 18-inch diameter outlet pipe was sized to route the 1,000-year runoff event.

Key dimensions and features of the west stormwater pond are presented below.

- Pond Length: 160 ft.
- Pond Width: 160 ft.
- Approx. Pond Depth: 15 ft.
- 100-Year Pond Vol.: 2.9 ac-ft
- 100-Year Pond Elev.: 5522.5
- 1,000-Year Pond Vol.: 4.5 ac-ft
- 1,000-Year Pond Elev.: 5526
- Outlet Pipe Size: 18 inch

The west stormwater pond calculations, including the mill subbasin layout, are presented in Appendix B. The location of the pond is shown on Drawing C6 in the design plans. Pond liner and outlet details are provided in the Golder Associates drawing package “Piñon Ridge Project – Ore Stockpile Pad Design”.

**East Stormwater Pond** – The east stormwater pond is similar in concept to the west pond. It was sized to collect the 100-year runoff volume generated by entire ore pad and dump area and the small eastern portion of the mill area and store that water in a lined pond for disposal by evaporation. Additional volume is provided for storing and routing the 1,000-year runoff volume above the 100-year pond elevation through an outlet pipe that conveys the 1,000-year volume into the evaporation pond through the same buried pipe used by the west stormwater pond. As such, none of the runoff under a 1,000-year event and generated on the ore pad area and inside the access road would flow offsite.

The required total pond volume is 5.2 ac-ft, of which 3.9 ac-ft would be occupied by the 100-year runoff volume fully contained, with the remainder for the routed 1,000-year volume. The east pond is fed by a rundown and channel off the mill pad area and from the settling tank just north of the ore pad. A 30-inch diameter outlet pipe was sized to route the 1,000-year runoff event.

Key dimensions and features of the east stormwater pond are presented below.
• Pond Length: 280 ft.
• Pond Width: 120 ft.
• Approx. Pond Depth: 12 ft.
• 100-Year Pond Vol.: 3.9 ac-ft
• 100-Year Pond Elev.: 5523
• 1,000-Year Pond Vol.: 5.2 ac-ft
• 1,000-Year Pond Elev.: 5525
• Outlet Pipe Size: 30 inch

The east stormwater pond calculations, including the ore pad, access road, and eastern mill subbasin layout, are presented in Appendix C. Pond liner and outlet details are provided in the Golder Associates drawing package “Piñon Ridge Project – Ore Stockpile Pad Design”.

**Ore Pad Channel** – A small channel was sized from the ore pad to the east pond to convey the 1,000-year peak flow of 12 cfs at less than 1.5 feet deep. The computed channel bottom width was 3 feet, with 3H:1V sideslopes and a 10 percent slope. The channel exits the ore pad and flows directly into the concrete settling basin between the truck decontamination station and the east pond. That settling basin then connects directly to the east pond. Because of the channel steepness and the need to handle relatively small, short duration flows, a lining material similar to that used for the east and west stormwater ponds installed on the channel should be sufficient to prevent erosion and scour.

The ore pad channel calculations are presented in Appendix D and details are shown on Drawings C3 and C16 in the design plans.

**Storm Sewer Network** – The storm sewer network consists of the 30-inch diameter high density polyethylene (HDPE) outlet pipe from the east stormwater pond, the 18-inch diameter HDPE outlet pipe from the west stormwater pond, a junction manhole (MH-7 on drawings) located at the southwest corner of Tailing Cell A connecting those two pipes, a single 30-inch diameter HDPE pipe running on the west side of the tailing cells from the junction manhole to MH-3, and a 36-inch diameter HDPE pipe running from MH-3 to the evaporation pond. The pipe was sized to accommodate the 1,000-year storm overflows from the east and west stormwater ponds. The storm sewer network would operate in a pressure mode over much of its length under design flow conditions, but in no case would the hydraulic grade line exceed existing ground or finished grade level. Manhole spacing is 500 feet maximum, in accordance with Water Pollution Control Federation (WPCF) Manual of Practice No. 9. In addition, an impact basin has been recommended for the pipe outlet to provide energy dissipation over the range of expected flows.
The storm sewer network hydraulic calculations are presented in Appendix E. The storm sewer alignment and profile details are shown on Drawings C9, C10, and C11 in the design plans.

**Evaporation Pond Diversion Channels** – The evaporation pond diversion channel is located on the south side of the pond footprint, and diverts surface runoff both westward and eastward from a ridge point near the middle of the footprint. The surface runoff is generated from the area to the south, and was calculated assuming only Tailing Cell A has been constructed. That assumption provides the largest possible tributary areas draining to the diversion channels, with 74 acres draining to the west-flowing channel and 13 acres draining to the east-flowing channel.

The evaporation pond diversion channel has the following design parameters:

- Bottom Width: 5 ft.
- Side Slope: 3H:1V
- Avg. Slope: 0.8%

The maximum velocity for the 100-year design flow of 23 cfs is about 3.0 ft/s, which is less than the allowable velocity, and thus, the channel will be earth lined. The 100-year discharge would flow with a minimum of 0.5 foot of freeboard, and it is expected that portions of the channel would flow at bankfull during a 1,000-year event discharge of approximately 57 cfs. There is a short segment of the west-flowing channel near the divide at the ridge point that has a steeper slope of 5 percent. However, that section has a very small tributary drainage area, and is not expected to need any special erosion protection.

There will be two culverts installed in the diversion channels. In the west channel, a 30-inch diameter corrugated metal pipe (CMP) will be necessary where the diversion channel crosses under the 36-inch diameter HDPE storm sewer line from the stormwater ponds. The HDPE line needs to enter the evaporation pond closer to the crest than the bottom, and thus would need to be elevated in fill material where it intersects the evaporation pond west diversion channel. At the evaporation pond southeast corner, access to the pond crest will be necessary, and thus an 18-inch diameter CMP would be required at that location where the crest access road crosses the diversion channel.

The evaporation pond diversion channels design calculations are presented in Appendix F. Details for the evaporation pond diversion channel can be found on Drawings C12, C13, and C16 in the design package.

**Main Access Road Drainage** – The main access road drainage components are sized to convey the maximum expected 100-year peak discharge, based on the phased
construction of facilities that would result in the maximum contributing drainage area at specific locations. These locations include:

- Access road flows in a west side ditch,
- The SH 90 culvert and access road culvert just south of SH 90,
- Other access road culverts (e.g., ore pad area, administrative office area)

The access road west side ditch drains a maximum area of about 98 acres and would generate a 100-year peak discharge of about 24 cfs. The access road west side ditch has the following design parameters:

- Bottom Width: 2 ft.
- Side Slope 3H:1V
- Avg. Slope Varies: 2% to 3.5%

The maximum velocity ranges from about 4.2 ft/s up to 5 ft/s, and thus the main access road west ditch would need minimum riprap dimensions as follows:

<table>
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<th>Ditch Slope (ft/ft)</th>
<th>Riprap D$_{50}$ (ft)</th>
<th>Riprap Thickness (ft)</th>
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<tbody>
<tr>
<td>S ≤ 0.02</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>0.02 &lt; S ≤ 0.035</td>
<td>0.75</td>
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All riprap should have a 4-inch thick layer each of CDOT Type I and Type II bedding, or a properly sized geotextile placed under the riprap as a filter. Site access road typical sections are shown on Drawing C15 of the design plans. Site access road plan and profile details are shown on Drawings C19 through C28. Ore pad roadway plan and profile details are shown on Drawings C3 and C17, respectively. Administration Building roadway plan and profile details are shown on Drawings C5 and C18, respectively.

The SH 90 and other culverts along the main access road were sized to pass the 100-year discharge. All culverts were assumed to operate under inlet control. Culvert details and locations are shown on Drawings C3, C5, C7, C12 and C13 of the design plans, and culvert design parameters are presented below.
A water quality swale (WQS) is proposed for the segment of channel between the access road and SH 90 for the purpose for retarding flow before crossing Hwy. 90 and leaving the property. The WQS location and details are shown on Drawings C7 and C8, respectively. The WQS is to serve as a final sediment catchment for site runoff before leaving the property boundary. The decision to provide a WQS at the proposed location was made during internal progress meetings during the preparation of these designs. Standard design practice and standard details were used to size the swale (flat gradient and side slopes, maximize length) within the topographic constraints available as opposed to a detailed engineering or water quality analysis. As such, no detailed calculations were completed. The main access road drainage design calculations are presented in Appendix G.

### 5.0 LIMITATIONS

Kleinfelder prepared this report in accordance with generally accepted standards of care in the project area at this time. This report may contain specifications, designs and drawings, (designs). Unless otherwise stated these designs are for conceptual planning and regulatory approval. They are not 100% design specifications and they shall not be used for final costing, design or construction. This report may be used only by Golder Associates and Energy Fuels Resources Corporation and only for the purposes stated. All information gathered by Kleinfelder is considered confidential and will be released only upon written authorization by Energy Fuels Resources Corporation or as required by law. Non-compliance with these requirements by Golder Associates, Energy Fuels Resources Corporation or anyone else, unless specifically agreed to in advance by Kleinfelder in writing, will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party and Golder Associates and Energy Fuels Resources Corporation agree to defend, indemnify, and hold harmless Kleinfelder from any claim or liability associated with such unauthorized use or non-compliance.
6.0 REFERENCES


