Energy Fuels Resources

Calculation Brief

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Date: May 8, 2010

Re: Precipitation Water Balance for the Piñon Ridge Mill

The purpose of this calculation brief is to provide a general water balance for retained precipitation in the zero-discharge areas at the Piñon Ridge Mill. This water balance does not include inflows of raw process water from production wells or other off-site sources.

General Information

The topographical areas used in the calculations were limited to the zero discharge areas associated with the Mill Facility, Tailings Cell A and the Phase I Evaporation Ponds (see Figure 1). Tailings Cells B and C and the Phase II Evaporation Ponds were not included because, except for relatively short transition periods, only one tailings cell and ten 4-acre evaporation ponds will be in use at any one time. For example, Tailings Cell B will be built as Tailings Cell A nears capacity. Closure and reclamation of Tailings Cell A will start shortly after Tailings Cell B is commissioned.

Precipitation was the only inflow to the system considered and was based on the total area considered and an average annual precipitation of 12.6 inches based on precipitation data from the Uravan Weather Station between 1971 and 2007 (see Attachment 1). Three outflows were considered:

Infiltration: Includes any water not resulting in evaporation or run-off. Values are based on weighted run-off coefficients and average annual precipitation of 12.6 inches. It is worth noting that in this semi-arid climate, the overwhelming majority of water infiltration ultimately is released back to the atmosphere through evapotranspiration processes.

Evaporation: Values based on areas (or range of areas) open to evaporation and average annual lake evaporation rate of 38 inches calculated based on Uravan Weather Station data and the Hargreaves Method (see Attachment 1, Golder 2009).

Usage: This represents the balance of precipitation not going to infiltration or evaporation. Retained water will be used primarily for mineral processing, dust suppression, and in the truck wash.

Run-off Coefficients

Run-off coefficients for the different areas were based on equations listed in the Urban Drainage and Flood Control District (UDFCD) Urban Storm Drainage Criteria Manual Volume I (UDFCD 2001). The run-off coefficients are calculated based on percent imperviousness. The percent imperviousness was based on the best comparable surface characteristic (e.g. roofs) listed in the Criteria Manual. Land Use Characteristics (e.g. light industrial area) were not used as they may be influenced by the urban nature of areas considered by the Criteria Manual and likely would not be representative of the Mill areas. UDFCD's "UD-Rational" worksheets provides run-off coefficients for different percent imperviousness and storm return frequencies of 2, 5, 10, 25, 50, and 100 years for Natural Resources Conservation Service (NRCS) Hydrologic Soil Groups Type A and Type C/D. Soils on the mill site are predominantly Type B. As instructed in the UDFCD Criteria Manual, the Type B run-off coefficients were calculated for each storm frequency as an average of the Type A and Type C/D values. An overall run-off coefficient combining each storm frequency was calculated and those used are presented in Table 1.

Methods and Calculations

Table 1 provides a list of the areas considered, acreages, run-off coefficients used, total precipitation, run-off and infiltration (total precipitation minus run-off). Table 2 provides values or a range of values of evaporation for each area where water is impounded. A range is provided for areas covered by water that will vary over time. Each area is discussed in more detail below.

<u>Mill Facility</u>

The Mill Facility was broken into three categories as follows:

1) Building Roofs,
2) Secondary Containment, and
3) Ground.

Run-off from the building roofs is to be collected in gutters and transferred to the process water tank resulting in maximum use and minimal evaporation of this water. The roof water is collected to reduce infiltration of water around the building foundations.

The larger storage tanks at the facility are located outside on concrete pads equipped with secondary containment. The precipitation collected in these secondary containment areas will be pumped to the process water tank after major precipitation or snow melt events to maintain adequate containment capacity in the event of a tank failure. The precipitation collected during smaller precipitation events will be allowed to evaporate. It was assumed that 50 percent of precipitation collected in secondary containment sumps and lined trenches would be recovered by pumping to the process water tank with the remaining 50 percent being allowed to evaporate.

The area around the buildings and storage tank areas makes up the balance of the mill facility and for the purposes of this calculation brief is defined as "Ground." The ground category is further divided in four subcategories to represent different types of ground cover as follows:

- Stormwater Ponds,
- Bare ground,
- Concrete Pads, and
- Compacted Gravel

All runoff from the mill facility area is directed to two lined Stormwater Ponds (the East Stormwater Pond and West Stormwater Pond). These ponds are designed to contain the precipitation and runoff generated by the plus 100-year storm event. The Stormwater Ponds were assumed to have zero infiltration (i.e. run-off coefficient of 1.0) as shown in Table 1. Runoff coefficients for bare ground, concrete pads, and compacted gravel are also shown in Table 1 along with the calculated precipitation, runoff, and infiltration.

Any water collected in the Stormwater Ponds as run-off from the ground areas and not lost to evaporation in the ponds would be used at the truck wash or for dust suppression. As shown in Table 2, evaporation was calculated as a range of values dependent on the minimum and maximum anticipated water surface areas in the Stormwater Ponds and an annual evaporation rate of 38 inches.

<u>Tailings Cell A</u>

Tailings Cell A is approximately 30 acres in size and has multiple liners with leak collection and recovery systems. The tailings, consisting of fine sand particles and barren process water, are pumped into the cell where the sand particles settle out and the clarified water is pumped back to the mill via a barge-mounted pump for reuse. The water pool in the tailings cell is covered with plastic "bird balls" to deter migratory birds from landing on the tailings water. The exposed sand beaches are routinely sprayed with tailings water to minimize dust emissions. Tailings Cell A was broken up into two categories based on type of cover as follows:

1) Lined Cell (liner covered by tailings sands and tailings water), and
2) Bare ground run-on area (located south of Tailings Cell A)

The Lined Cell area was assumed to have zero infiltration as any precipitation over the liner area is ultimately collected or evaporated. As shown in Table 1, all the infiltration calculated for Tailings Cell A occurs within the bare ground run-on area. Run-off from this area was calculated similarly to the Mill facility bare ground subcategory.

As shown in Table 2, evaporation was calculated based on the minimum and maximum anticipated exposed tailings surface in the tailings cell. It was assumed that at any point in time, one half of the

surface area exposed in the tailings cell would be tailings beaches and the remaining half would be the tailings water pool. Since the water pool is covered with bird balls, evaporation will be limited to the saturated beach sands. It is important to note that the direct precipitation and runoff collected in the tailings cell that evaporates is being used for dust suppression purposes. Any water not used for dust suppression is pumped back to the mill for reuse. The pump-back system is expected to supply 187.5 gpm or 290 acre-feet of water over a 350-day-operating year to the mill's counter-current decantation (CCD) circuit.

Evaporation Pond

The Phase 1 Evaporation Pond area consists of ten 4-acre lined ponds covered with bird netting to exclude birds. The mill is expected to generate 192 gpm of raffinate (barren waste water) from the vanadium extraction circuit. Approximately 72% or 214 acre-feet per year will be recycled to the mill for reuse in the tailings disposal circuit. The remaining 28% or 83 acre-feet of raffinate is disposed of in the evaporation ponds. This water, which has a pH of 4.4 and total dissolved solid (TDS) concentrations of up to 100,000 parts per million, cannot be recycled for use in other portions of the mill without extensive treatment. Required treatment would include pH adjustment and precipitation with lime or a similar material and removal of the remaining dissolved solids using a reverse osmosis (RO) unit. Water treatment using these methods would be very expensive and would produce several additional waste streams. Accordingly, a system of evaporation ponds was included in the mill design to evaporate the excess water that cannot be re-used economically in the mill. As the water evaporates, the dissolved solids precipitate out of solution and, over a period of years, gradually fill the pond. The raffinate in the evaporation ponds is circulated within the evaporation pond area for dust suppression purposes (i.e., to keep precipitants covered with water or saturated). When a pond is filled with precipitated salts, it is decommissioned by placing the salts and pond liner in one of the tailings cells.

Any precipitation falling in the evaporation pond area would ultimately evaporate. As such, the precipitation inflow and the evaporation outflow are equal with zero outflows for infiltration and usage.

Water Balance Results

Table 3 summarizes the water balance results. Figure 2 shows the overall precipitation inflows and outflows for each area and Figure 3 shows the overall precipitation inflows and outflows for the mill areas considered as a whole.

As shown in Table 3, the Mill Facility area is expected to receive an average of 36.8 acre-feet per year in precipitation of which 23.4 acre-feet or about two-thirds infiltrates into the ground. Between 1.8 and 4.6 acre-feet are lost to evaporation and between 8.8 and 11.6 acre-feet are used by the mill for processing, dust suppression, and truck washing.

Tailings Cell A is expected to receive an average of 41 acre-feet per year in precipitation, all of which will be used in mill processing and dust suppression. Initially, when the tailings area is relatively small, 75% (i.e., 30 acre-feet) of the collected precipitation will be pumped back to the mill. As the tailings area expands within the cell, the collected water will be increasingly used for dust suppression on the exposed tailings beaches. The water used for dust suppression is shown in Table 1 as being evaporated, as this is its ultimate fate.

The Evaporation Pond is expected to receive 48.7 acre-feet per year in precipitation, all of which will eventually evaporate.

Combining the totals from all zero-discharge areas, total precipitation in an average year is estimated to be 126.5 acre-feet. This is approximately half of the 252 acre-feet of average precipitation estimated for the 240 acre zero-discharge area. As discussed previously, retained precipitation will only approach the higher value when transitioning between tailings cells when multiple cells are in use at the same time, or when additional evaporation ponds are brought on line.

Twenty-four percent (29.9 acre-feet) of the precipitation is expected to infiltrate and the remaining 76% (96.6 acre-feet) used on site or evaporated. If we take an average use value of 10.2 acre-feet per year for the Mill Facility area and combine that with the 34.5 acre-feet per year used in Tailings Cell A, total usage of retained precipitation can be estimated at 44.7 acre-feet per year or approximately 35% of the total precipitation. Similarly, if the average evaporation rate for the stormwater ponds in the Mill Facility area of 3.2 acre-feet per year is added to the 48.7 acre-feet per year evaporated from the Evaporation Ponds, total evaporation with no prior use can be estimated to be 51.9 acre-feet per year or approximately 41% of the total precipitation.

References

Golder Associates Inc. (Golder), 2009. Hydrogeologic Report, Piñon Ridge Project, Montrose County, Colorado. October.

Urban Drainage Flood Control District, 2001. Drainage Criteria Manual (Volume 1), revised April 2008. June.

Tables

Table 1 Annual Precipitation and Infiltration
Table 2 Annual Evaporation
Table 3 Total Annual Precipitation Inflows and Outflows

Table 1
Annual Precipitation and Infiltration

Category		Area (ac)	Run-Off Coefficient	Total Precipitation (ac-ft)		Run-off (ac-ft)		Infiltration [1] (ac-ft)	
Mill Facility		**35.1**	**0.35**	**36.8**		**12.9**		**23.9**	
Ground	Stormwater Ponds	1.5	1.0	1.6	31.7	1.6	8.3	0.0	23.4
	Bare Ground	10.1	0.05	10.6		0.5		10.0	
	Concrete Pads	1.0	0.90	1.1		1.0		0.1	
	Compacted Gravel	17.5	0.28	18.4		5.2		13.3	
Building Roofs		3.4	0.90	3.6		3.2		0.4	
Secondary Containment		1.5	0.90	1.6		1.4		0.2	
Tailings Cell A		**39.1**	**0.84**	**41.0**		**34.5**		**6.5**	
Lined Cell		32.5	1.0	34.2		34.2		0.0	
Bare Ground Run-on Area		6.5	0.05	6.9		0.3		6.5	
Evaporation Pond		**46.4**	**1.0**	**48.7**		**48.7**		**0.0**	

(1) Infiltration on this table represents any precipitation that does not run-off from the surface which included minor amounts of evaporation.

Table 2
Annual Evaporation

	elevation (ft)	area (SF)	area (ac)	Evaporation (ac-ft)
Mill Facility				
East Stormwater Pond				
min	5513	7693	0.18	0.6
max	5523	25740	0.59	1.9
West Stormwater Pond				
min	5510	0	0.00	0.0
max	5525	20641	0.47	1.5
Mill Facility Total			min	0.6
			max	3.4
Tailings Cell A				
min	5445	61919.5	1.42	4.5
max	5520	632539	14.52	46.0

Table 3
Total Annual Precipitation Inflows and Outflows

Area		Total Precipitation (ac-ft)	Infiltration [1] (ac-ft)	Evaporation (ac-ft)	Used (ac-ft)
Mill Facility	**min**	**36.8**	**23.4**	**1.8**	**8.8**
	max			**4.6**	**11.6**
Ground	min	31.7	23.4	0.6	4.9
	max			3.4	7.7
Building Roofs [2]		3.6	0.0	0.4	3.2
Secondary Containment [2]		1.6	0.0	0.9	0.7
Tailings Cell A [3]	**min**	**41.0**	**6.5 [4]**	**4.5**	**0.0 [5]**
	max			**46.0**	**30.0**
Evaporation Pond		**48.7**	**0.0**	**48.7**	**0.0**
Grand Total	**min**	**126.5**	**29.9**	**55.0**	**0.0 [5]**
	max			**99.3**	**41.6**

(1) Infiltration on this table represents any precipitation that does not run-off from the surface which included minor amounts of evaporation except those areas indicated by Note 2.

(2) Infiltration values for the building roofs and secondary containment were classified on this table as evaporation because these surfaces are impervious and any precipitation not resulting in run-off is actually evaporation.

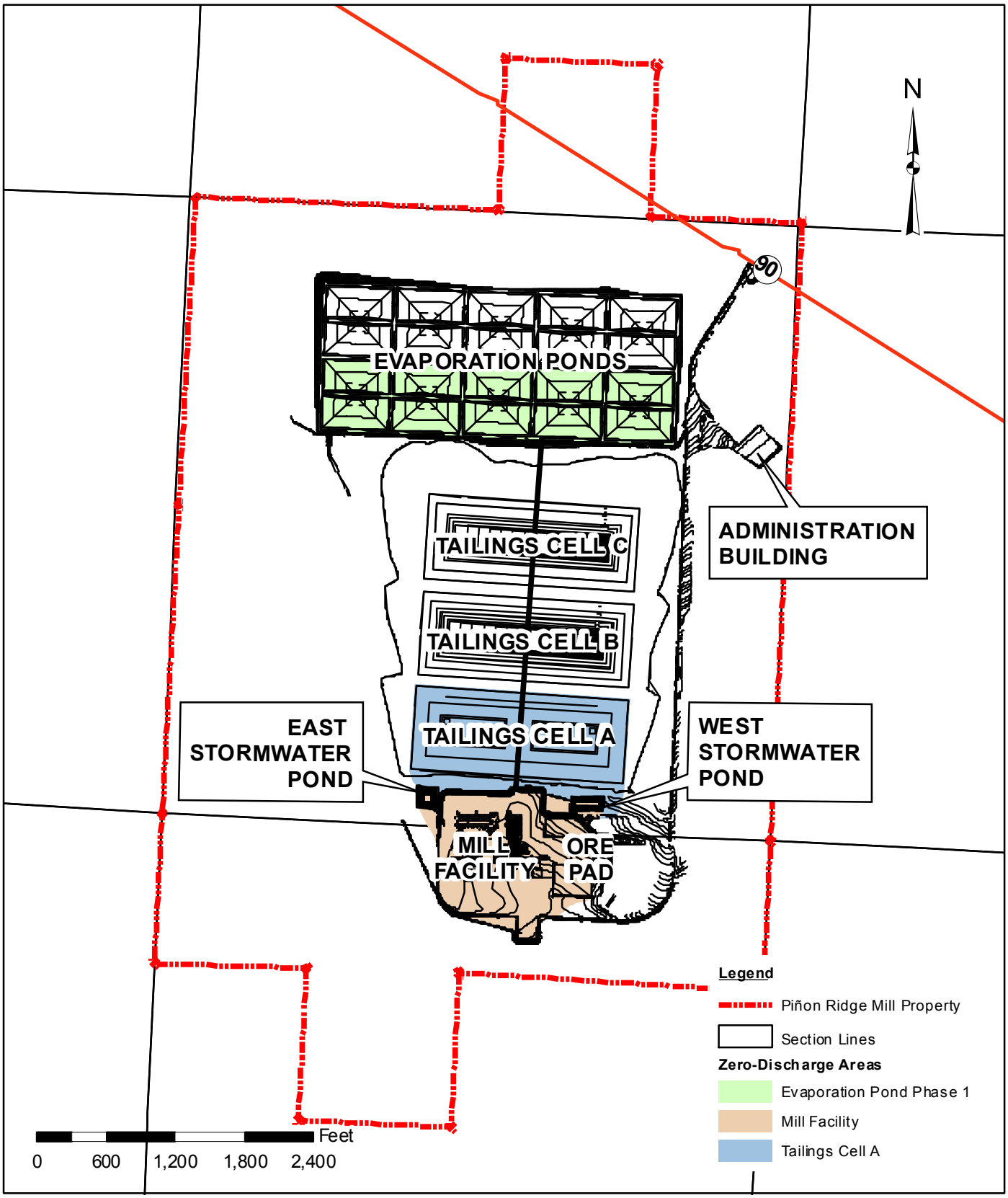
(3) Tailings Cell A water shown as lost to evaporation is actually used for dust suppression on the tailings sands.

(4) Infiltration shown for Tailings Cell A occurs on the bare ground run-on area upstream of the tailings cell, not in the lined cell itself.

(5) Zero was substituted for negative values where outflows exceed precipitation inflows in some max evaporation cases.

Figures

Figure 1 Precipitation Water Balance Areas
Figure 2 Piñon Ridge Mill Annual Precipitation Inflows and Outflows
Figure 3 Piñon Ridge Mill Overall Annual Precipitation Inflow and Outflows



Energy Fuels Resources Corporation

PROJECT	Pinon Ridge
DRAWN:	5/7/10
DRAWN BY:	Z Rogers
CHECKED BY:	
FILE NAME:	Figure1.mxd

Precipitation Water Balance Areas

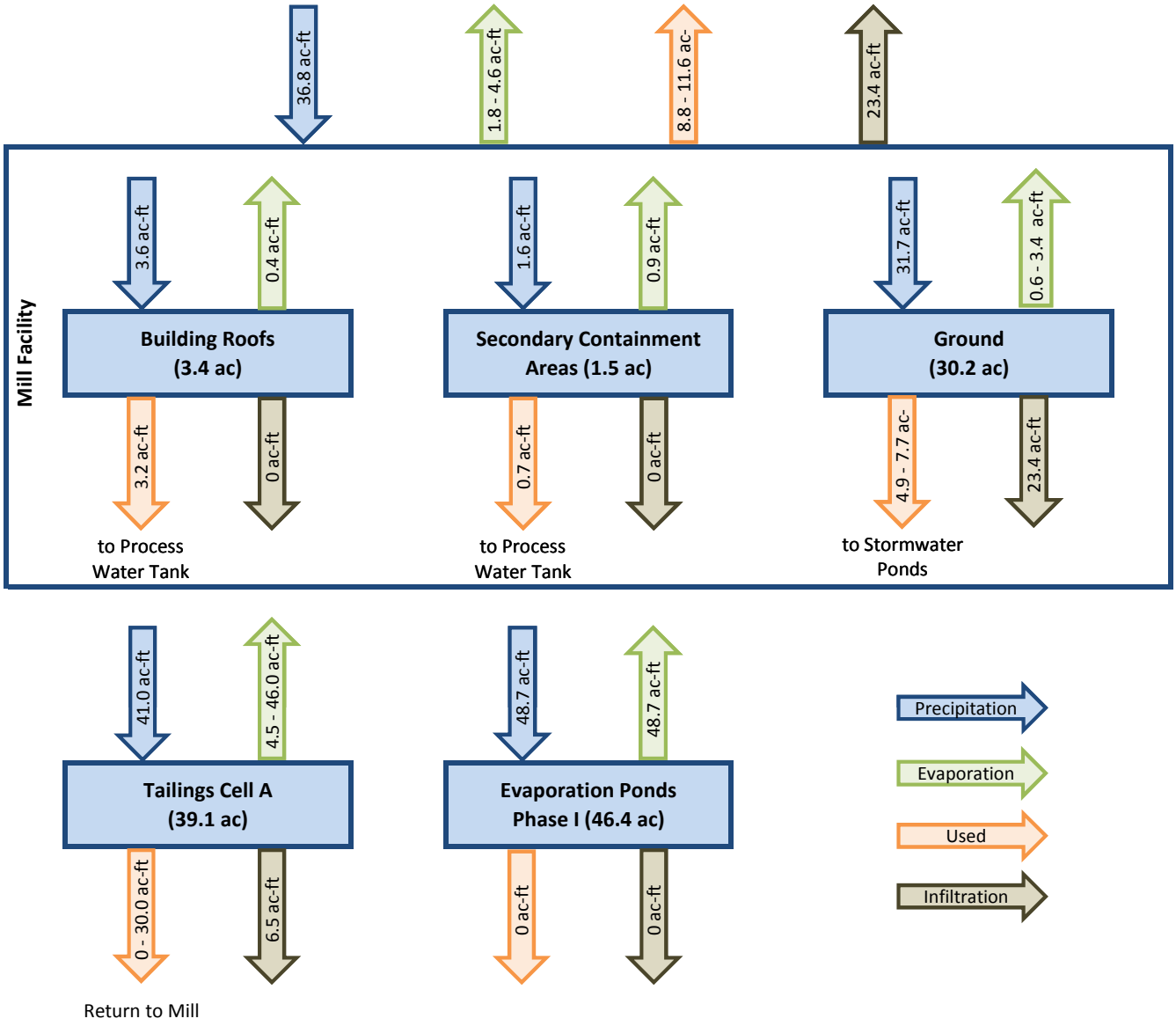
ENERGY FUELS RESOURCES
PIÑON RIDGE MILL SITE
MONTROSE COUNTY, COLORADO

ORIGINATOR: Z Rogers
APPROVED BY:

FIGURE

1

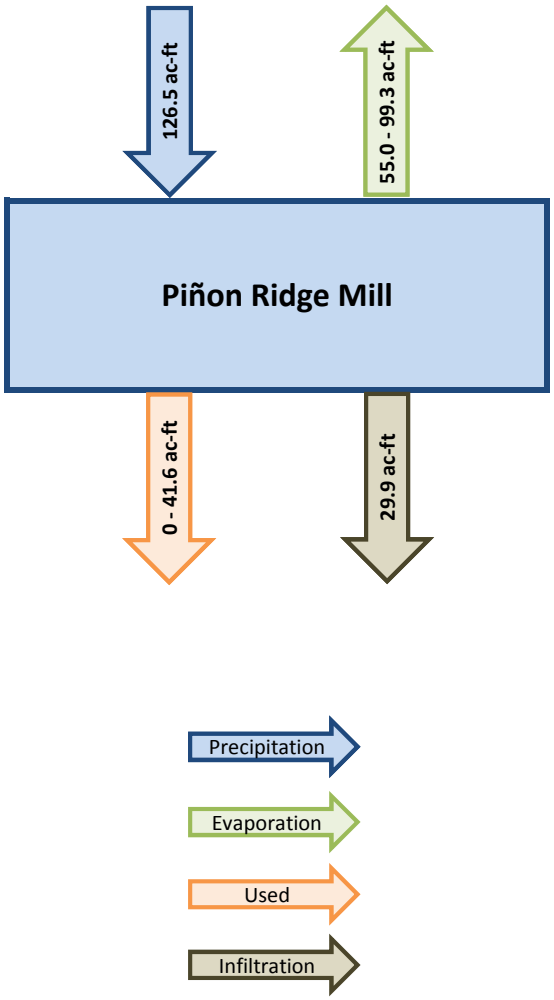
Figure 2
Piñon Ridge Mill Annual Precipitation Inflows and Outflows



Notes

1) Precipitation volume based on an average precipitation of 12.6 inches per year
2) Infiltration values include all precipitation not resulting in runoff except as indicated in Note 3
3) Infiltration values for the building roofs and secondary containment were classified on this figure as evaporation because these surfaces are impervious and any precipitation not resulting in run-off is actually evaporation
4) Assumed that one half of water collected in secondary containment is used and the remainder is allowed to evaporate
5) Evaporation volumes based on 38 inches per year of lake evaporation
6) Evaporation rates for ground surface vary based on level of water retained in the East and West Stormwater Ponds
7) Evaporation rates for tailings cells vary based on level of tailings raffinate
8) Assumed one half of exposed surface of tailings is covered with raffinate
9) Infiltration shown for Tailings Cell A occurs on the bare ground run-on area upstream of the tailings cell, not in the lined cell itself

Figure 3
Piñon Ridge Mill Overall Annual Precipitation Inflow and Outflows



Attachments

Attachment 1 Monthly Precipitation and Evaporation Values

Monthly Precipitation and Evaporation Values

Month	Average Precipitation (1) (inches)	Evaporation (2) (inches)
January	0.88	0.8
February	0.76	1.2
March	1.03	2.2
April	1.01	3.3
May	0.94	4.8
June	0.48	5.8
July	1.19	6.3
August	1.36	5.4
September	1.5	3.8
October	1.51	2.5
November	1.05	1.2
December	0.88	0.7
Total	12.6	38

(1) Precipitation values obtained for Uravan weather station from 1961 to 2007.

(2) Evaporation values calculated by Hargreaves Method and based on climate data from the Uravan weather station.