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**OTTER CREEK MINE**  
**EXHIBIT 314C**  
**PROBABLE HYDROLOGIC CONSEQUENCES**

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**OTTER CREEK MINE**  
**EXHIBIT 314C**  
**PROBABLE HYDROLOGIC CONSEQUENCES**

**1.0 INTRODUCTION**

Exhibit 314C presents background information, methodology, and results of the evaluation of Probable Hydrologic Consequences for the Otter Creek Mine. Results presented in this exhibit are based on site knowledge and data obtained through baseline investigations. Interpretation and conclusions presented in this exhibit address the requirements of ARM 17.24.314(1)(a) through (c) and (2)(a) through (c).

## 2.0 MINING OPERATIONS

Mining operations are proposed for Tract 2. A complete description of the proposed mine plan is in Exhibit 308A – Operations Plan.

The mine plan is designed to maximize recovery of economically mineable coal in Tract 2, as shown on Map 8-Mine Plan. However, in specific areas, most notably along the downgradient boundaries (west and northern portions) a barrier (buffer) of unmined coal will remain in place. The purpose of this buffer will be to allow management of groundwater flow to the active pits. Hydraulic conductivities of competent Knobloch Coal are multiple orders of magnitude lower than either the alluvium or clinker. Therefore, groundwater flow can be normalized/controlled somewhat during mining operations by leaving a strip of competent coal in place throughout mining. This will also allow recharge to backfilled spoil in the initial cuts to be managed as mining progresses eastward by regulating groundwater flow from the alluvium and clinker through the unmined coal.

### **3.0 PRECIPITATION AND CLIMATE**

Climate data were collected throughout the baseline monitoring period. Results of the first year of site-specific meteorological data collection effort are presented in Exhibit 304I (Climatological Report and On-Site Meteorological Monitoring Summary). Historical climatological data are routinely collected and recorded for Birney, Broadus, Colstrip, and Miles City, Montana. A short summary of the area temperature and climate data are present here to provide a general overview of conditions at the site.

#### **3.1 TEMPERATURE**

Temperatures in the vicinity of the Otter Creek Mine show seasonal extreme fluctuations. Average high temperatures in January are typically about 32 degrees Fahrenheit (°F) to about 88°F in July. Average low temperatures are about 7°F in January to 56°F in July. See Exhibit 304I for additional information.

#### **3.2 PRECIPITATION**

Average monthly precipitation varies from about 0.5 inches in January and February to around 2.5 inches in May and June. Average annual precipitation is approximately 14 inches. Precipitation in the form of snowfall is highest in December and January, when around six inches fall. Total annual snowfall is about 34 inches (Bison, 2012).

#### **3.3 EVAPORATION**

Evaporation monitoring was not conducted within the Study Area during baseline data collection. Average annual evaporation measured approximately 80 miles west and slightly south of the Study Area is 47 inches. This value was reported for the monitoring period from 1948 to 2005 at the Yellowtail Dam (<http://www.wrcc.dri.edu/htmlfiles/westevap.final.html>). In addition, pan evaporation rates for the Absaloka Mine from 1975 to 1989 averaged 37.9 inches (WRI 1992). The Absaloka Mine is located approximately 50 miles northwest of the Study Area.

## **4.0 HYDROLOGIC SYSTEM OVERVIEW**

### **4.1 SURFACE WATER SYSTEM**

Otter Creek flows through strata of the Tongue River Member of the Fort Union Formation. These strata consist of interbedded sandstone, siltstone, shale, and coal deposited from braided drainage systems. This type of depositional environment results in lateral facies changes and strata which show variable levels of resistance to erosion. Erosion of the sedimentary rocks has resulted in a dendritic drainage pattern.

Approximately 350 feet of relief exists in the Study Area. Burning of coal has resulted in the formation of clinker around the perimeter and tops of many hills in the area. Erosion of bedrock formations and associated clinker, and subsequent deposition in valley bottoms, results in relatively broad alluvium filled valleys. Following a period of erosion and deposition, lower periods of precipitation resulted in deposition of finer grained sediments which overlie coarser grained deposits. This has resulted in coarser grained alluvium consisting of sand and gravel above the bedrock contacts and finer grained sediments near the surface. The finer grained sediments at the surface reduce the amount of surface water-groundwater interchange between Otter Creek and underlying unconsolidated sediments.

The Otter Creek coal tracts are approximately eight miles upstream of Ashland, Montana. Surface water quality was monitored at 32 sites in and around Otter Creek Coal Tracts 1, 2, and 3 to collect baseline water resources data. Surface water hydrology of Otter Creek near the Otter Creek Mine area is described in detail in the Baseline Report 304E - Water Resources Data Report.

The United States Geological Survey (USGS) monitors flow and water quality at gaging station 06307740, (Otter Creek at Ashland, MT). Otter Creek drains an area of approximately 711 square miles, of which approximately 709 square miles are above the USGS gaging station. During the period of record (1972 to present), flows ranged from zero to more than 650 cubic feet per second (cfs). During the baseline period, flows at the gaging



station ranged from a few cfs to 650 cfs, suggesting the flows were near maximums for the drainage.

Water in Otter Creek is generally a sodium-sulfate type or a sulfate type with no dominant cation. Sodium adsorption ratios (SAR) in Otter Creek at monitoring sites established for the baseline study were between 4.81 and 8.54; while specific conductance (SC) averaged 3,825  $\mu\text{mhos/cm}$ . Water analyzed by the USGS at the gaging station near Ashland (06307740) had an average SC of 3,507  $\mu\text{mhos/cm}$  and SAR of 6.19 during the period from June 2010 to June 2012, which partially overlaps the period of baseline study. Complete baseline surface water data are in the Baseline Report 304E - Water Resources Data Report.

#### **4.1.1 Surface Water Uses**

Surface water from Otter Creek in the vicinity of the proposed mine is available for livestock and wildlife use. Hay crops in the valley bottom benefit from natural flooding during spring runoff in most years. Livestock and wildlife use Otter Creek, local impoundments, springs, and stock tanks for water sources. Surface water from Otter Creek provides a natural irrigation source during times when stage levels exceed normal bankfull levels. Once out of the channel the water floods the lower terraces and in some areas is distributed across the floodplain with local spreader dikes. Water levels may exceed bank full levels during spring runoff or in response to intense precipitation events. Such flow was observed in 2010, 2011, 2013 and 2014 when ice jams caused the creek to leave its banks. Discharge in excess of bankfull levels was not observed during any other portion of the baseline period. According to local landowners (Ross Denson, personal communication) efforts to irrigate using Otter Creek water were attempted in the past and were unsuccessful. This practice is no longer conducted within the Study Area.

There are no identified uses of surface water for domestic water supply purposes. Farms and ranches in the area rely on groundwater wells for water supply. Further, there are no known industrial uses of surface water in the vicinity of the Study Area.

#### **4.1.2 Surface Water Rights**

The Montana Department of Natural Resources on-line Water Right Query System (<http://nris.mt.gov/dnrc/waterrights/default.aspx>) was used to identify water rights in the vicinity of the Otter Creek Coal Tracts. An advanced search was conducted in October 2014, which includes the area for the entire anticipated life of mine, for water right diversions within the following sections:

- T3S, R44E, Sections 23 – 27, 34 – 36,
- T3S, R45E, Sections 2 – 36,
- T3S, R46E, Sections 18, 19, 30, 31,
- T4S, R44E, Sections 1 – 3, 10 – 14, 24,
- T4S, R45E, Sections 1 – 30, 34 – 36,
- T4S, R46E, Sections 6, 7, 18, 19, 30, 31,
- T5S, R45E, Sections 1 – 3, and
- T5S, R46E, Section 6.

Details for each surface water right are listed in Table 4-1 of Baseline Report 304E - Water Resources Data Report, including: water right number, registered owner(s), type of water right, water right status, priority date, water source, purpose of use, location of point(s) of diversion, and appropriated flow rate and/or volume (if given). Water rights with a status of “dismissed” or “withdrawn” were removed from the list. There were no water rights with a pending status at the time of the search.

Probable hydrologic consequences or potential impacts to surface waters rights and uses are discussed below in Sections 5.0 and 6.4.

#### **4.2 IMPOUNDMENTS**

Six impoundments, all constructed using earthen embankments, were monitored in and around Tract 2. Pond P1 contained water throughout most of the baseline period and showed indications that the pond typically contains water. This pond was dry in September and December of 2012. Pond P2 only contained water during one visit, following a period of

ground thaw, snowmelt runoff, and rainfall. Pond P2 is very shallow due to silting in and has a small volume capacity.

Pond P3 is located along the north boundary of Tract 2 in a tributary to Threemile Creek. Pond P3 contained water throughout most of the baseline period, but does not show evidence that the pond perennially contains water. This pond was observed to be dry in both May of 2012 and 2013. There is a lack of cottonwood trees and riparian vegetation around the pond and no evidence of springs. Livestock frequently use the pond as a source of drinking water, resulting in heavily impacted banks, possibly explaining the lack of vegetation.

Pond P4 is located near the northeast corner of Tract 2 and is within the proposed mining area. This pond is a larger impoundment and contained water throughout the baseline period. The pond filled in response to spring snowmelt and rainfall events and water discharged through the spillway resulting in flood irrigation to fields on the north facing flank of Threemile Creek. Water levels in the pond quickly dropped due to seepage through the bottom, uptake by numerous cottonwoods growing in and around the pond, and evaporation.

Pond P5 (Shorty Creek Reservoir) is located east of Tract 3 on Custer National Forest (CNF) property in Shorty Creek. This pond contained water throughout the monitoring period and appears to typically contain water year-round.

Pond P6 is located on Tenmile Creek. This pond contained water throughout the monitoring period and appears to be a year-round source of water.

### **4.3 WETLANDS**

Wetland areas on Tract 2 were mapped during baseline vegetation studies. Results are in Baseline Report 304J - Vegetation.

#### **4.4 DRAINAGE DENSITY**

Drainage density is a function of climatic variables (precipitation and runoff) and a combination of lithologic, vegetational, edaphic, and topographic influences (Knighton, 1998). Basins in semi-arid climates typically have the greatest drainage densities because they receive enough rainfall to generate runoff, but not enough to sustain impeding vegetation.

Drainage densities were calculated for the proposed mine area. Drainage density is defined as the total channel length in a given basin divided by the basin area. This results in a density of drainage channel per unit area. Table 4-1 contains calculated drainage densities based on pre-mine topography. Pre-mine drainage densities for individual drainage basins within the mining area ranged from 0.28 to 66.94 miles per square mile ( $\text{mi}/\text{mi}^2$ ). The average pre-mine drainage density was calculated at  $2.97 \text{ mi}/\text{mi}^2$ .

#### **4.5 GROUNDWATER SYSTEM**

Baseline Report 304E - Water Resources Data Report contains baseline data for the Study Area, including a detailed description of the hydrogeologic system.

Groundwater in the Study Area occurs in alluvium, overburden, Knobloch Coal, clinker, and Knobloch Coal underburden. Water table and potentiometric maps showing current groundwater flow conditions are in the Baseline Report 304E - Water Resources Data Report. These maps show that groundwater in the overburden and Knobloch Coal flows toward Otter Creek, likely providing recharge to clinker and alluvium in the valley bottoms and along its margins. Underburden follows a similar pattern, but the influence on the Otter Creek valley is not as distinct.

Alluvial groundwater is present in the valley bottoms along Otter Creek, Tenmile Creek, Threemile Creek, and Home Creek. Water in these drainages occurs under unconfined to semi-confined conditions. However, water in Otter Creek also exists in areas under

confined/semi-confined conditions. Otter Creek alluvium exhibits evidence of recharge from the creek, although the magnitude is relatively small and response times longer than would be observed if there were direct contact with the creek. Alluvial recharge appears seasonally in response to elevated stream water levels resulting from occasional ice-jams and runoff due to snowmelt and larger precipitation events occurring primarily in early spring and fall. During the remainder of the year, Otter Creek is a gaining stream from alluvial discharge. Fine-grained sediments (silt and clay) that are present over much of the floodplain limit recharge from the creek, and conversely limit flow from the alluvium to the creek.

Alluvium in Tenmile, Threemile, and Home Creek is typically unconfined, although localized semi-confined conditions also occur. Surface water flow in these drainages is intermittent in some reaches; these drainages through the Study Area are mostly ephemeral. Runoff water in these reaches appears to readily infiltrate into the alluvium, providing recharge to the groundwater system. Exceptions to this scenario are in Tenmile Creek and Threemile Creek near the east Tract 2 boundary where groundwater is near the surface. However, surface water quickly infiltrates into downstream alluvium, particularly in ephemeral reaches where the flanks consist of clinker..

Clinker is comprised of thermally altered and collapsed overburden formed by the burning of previously underlying coal. The degree of thermal metamorphosis varies depending on the temperature of the burn, thickness of the overburden, vertical fracture patterns, moisture, and duration of burn. As the coal burned, its volume decreased. As this occurred, or some period of time after burning concluded, the overburden collapsed into the void left by the burned coal. The result is an interval of highly fractured and often highly permeable rock, capable of transmitting large volumes of groundwater. Ash layers and/or layers of unburned coal sometimes remain at the base of the coal interval. These ash and/or coal layers typically have much lower permeabilities than the overlying clinker, and correspondingly cannot transmit as high of volumes of groundwater.

Water columns (saturated thickness) in clinker are dependent on structure, proximity to zones of lower hydraulic conductivity, and discharge points. For example, water columns adjacent to the Knobloch Coal in Tract 2, in the vicinity of well C-4, are relatively high due to the recharge from coal on the east and alluvium on the west, both of which have lower hydraulic conductivity than the clinker, and connection with Otter Creek to the south. These three factors cause groundwater to accumulate in the clinker as storage with a nearly level gradient. To the north near well C-1, the base of the clinker is at a higher elevation due to an upward structural trend, the supply of groundwater is less, and the unit is better drained (not bound by units of lower permeability). Only a foot or so of water is present at this location and permeability of the saturated portion of the unit is very low. Very little groundwater moves through this area.

With the exception of well C-4, water elevations in clinker wells and alluvial wells in the clinker zone are virtually identical at 3025-3026 feet. This includes wells C-1, C-2, C-3, A-1 on Otter Creek at the Stevens crossing, and AVF6 in lower Threemile Creek. Wells at AVF5 in lower Home Creek have slightly lower water elevations at 3022-3025 feet.

The clinker is in contact with the alluvium from approximately AVF3 downstream to AVF2 above the Home Creek confluence. Where the groundwater elevation in the alluvium is above about 3025 feet, the clinker acts as a drain, with water moving to the clinker from the alluvium. Conversely, where the groundwater elevation in the alluvium is lower, the gradient is reversed and alluvium is recharged from the clinker. The equilibrium point is likely near well A1 and the AVF7 piezometer cross-section.

The average thickness of the Knobloch Coal seam is approximately 70 feet in Tract 2. This coal is generally dense, and cleated in multiple directions. Hydraulic conductivity of the coal varies depending on the degree of interconnection and extent of the interconnected cleats. Zones with higher hydraulic conductivity also occur where weathering of the coal has occurred, near outcrops where overburden and lateral containment have been removed by erosion, and where erosion has cut directly into the seams under creeks or drainages.

Faulting has not been identified on Tract 2, but coal in the vicinity of a fault or other structural anomaly tends to be highly fractured and highly transmissive.

Underburden water at in the study area is present in the Tongue River Member of the Fort Union Formation. Groundwater was found in the porous grained sedimentary rocks as well as coal interpreted to be the Flowers-Goodale seam, approximately 100 feet below the Knobloch Coal. Deeper waters are present in the Tullock Creek Member, but were not studied during the baseline investigation.

#### **4.5.1 Groundwater Flow**

Groundwater flow in unconsolidated and bedrock units have been well documented for the Study Area and proposed mine area (Baseline Report 304E - Water Resources Data Report). Groundwater flow in the alluvial system is restricted to the valley bottoms along Otter Creek, Tenmile Creek, Threemile Creek and Home Creek. There is likely also flow in alluvium of Shorty Creek, east of Tract 2, but this system was not evaluated during the baseline investigation. Groundwater flow in these deposits typically follows the downstream direction of surface water features, under gradients similar to surface topography. Depth to water in these drainages ranges from a few feet to more than 20 feet below ground surface. Along Otter Creek, slight gains and losses are observed due to inflow from alluvial and clinker hydrostratigraphic units. Tributary drainages on the west side of Otter Creek on Tract 3 typically are ephemeral and do not have developed alluvial flood plains.

Gradients in clinker are nearly flat in contrast to the surrounding bedrock and alluvial systems due to very high hydraulic conductivity. Water entering the clinker flows parallel to Otter Creek in a general north-northwesterly direction. It is likely the interchange of waters between the creek and the clinker is limited, although where in direct contact, water from the creek recharges the clinker. The amount of flow between the creek and the clinker is limited by the presence of very fine-grained deposits which underlie the creek and extend across the valley and/or by fine grained sediment that has filled interstitial pore spaces where the creek

flows across the clinker. In the lower portion of the drainage, where the clinker gets structurally pinched out, water flows either into the adjacent alluvium or into the creek.

Groundwater occurrences in the overburden are inconsistent, with lateral continuity only existing locally. Channel sandstones, which have been described in portions of the Fort Union Formation (Lopez and Heath, 2007), were not positively identified in overburden wells installed during the baseline investigation. Water is present in the overburden in the northeast part of Tract 2, but absent through the middle and southeastern (e.g. at well B7) portions of the tract. Groundwater is present in overburden sandstone strata that are in contact with the coal at well K-2, but this sandstone was absent at well K-3. Overburden in Tract 2 had limited groundwater at B4-O and was not observed at the B3 battery. Water was absent in the overburden north of Tract 3 at B2-O and within Tract 3 at the B9 battery. Water was present in the overburden in Tract 3 at well battery B8.

Groundwater flow in the Knobloch Coal is towards Otter Creek on all three coal tracts, suggesting a connection between the coal and the unconsolidated sediments that occupy the valley, and the creek. Groundwater flow patterns do not indicate discharge to Tenmile Creek or Threemile Creek alluvium, although there likely are limited zones of communication in both drainages. The Home Creek alluvium is isolated from the Knobloch Coal by clinker along its entire length through Tract 1. The Knobloch Coal is under hydrostatic pressure. Coal on the east side of Tract 2 is under a substantial pressure head (greater than 100 feet at wells B7 through KL), while the amount of artesian head decreases towards Otter Creek and is absent where in contact with alluvium or clinker.

Groundwater flow in the Knobloch underburden is generally northward. Potentiometric contours bend around the creek suggesting a possible discharge area in the valley bottom. Such discharge could be from flow into deeper alluvium or the result of depressurization by flowing water supply wells constructed in the deeper Tullock Creek Member. Hydrostatic pressure in the Tullock Creek Member has created a potentiometric surface that is higher than the ground surface elevation at several wells in the Otter Creek valley.



#### **4.5.2 Private Wells**

Private wells were inventoried by searching the Montana Bureau of Mines and Geology (MBMG) Groundwater Information Center (GWIC), and Montana Department of Natural Resources and Conservation (DNRC) databases. Wells identified in that search are shown on Plate 2 and Table 2-13 of the Baseline Report 304E – Water Resources Data Report. The initial inventory conducted in 2011 and 2012 and presented in Baseline Report 304E was expanded in 2014 as discussed in the Section 6.0 below. Some wells were also identified in the field that could not be correlated to GWIC information and are listed as unknown or unused. Wells identified in the inventory had the following uses listed.

- Exploration boreholes
- Domestic Wells
- Domestic/Stockwater
- Dry holes (boreholes)
- Industrial
- Irrigation
- Monitoring/Research
- Petroleum well
- Public Water Supply
- Stockwater
- Stockwater/irrigation
- Test holes
- Unknown
- Unused

Note that wells installed during this investigation are not included in the list. It is assumed that the wells will remain in place under the current use as monitoring wells for the foreseeable future.

#### **4.6 SPRINGS**

Baseline Report 304E - Water Resources Data Report (Section 2.6.2 and Appendix G) describes the seeps and springs inventory process conducted for this permit application. That report contains maps and a listing of springs and seeps inventoried in the fall of 2010 and

2011 (Plate 3). Full access was available for the spring and seep inventory in the proposed mine area. However, access was not available for some portions of Tract 1 and Tract 3 or for some lands within the primary hydrologic study area north and west of the tracts. Aerial photos, topographic maps, and electronic databases were examined to identify potential springs and seeps in areas with no available ground access. Electronic databases consulted for identification of seeps and springs included those maintained by the Montana DNRC for water rights and GWIC. Published reports that were consulted for information to identify and locate seeps and springs by the MBMG included: Wheaton, et.al (2008 and 2013), Donato and Wheaton (2004a and b) and Miller, et.al. (1980).

## 5.0 SURFACE WATER – PROBABLE HYDROLOGIC CONSEQUENCES

### 5.1 SURFACE WATER QUANTITY - PROBABLE HYDROLOGIC CONSEQUENCES

#### 5.1.1 Runoff From Precipitation - Probable Hydrologic Consequences

During mine operations, runoff from precipitation and snowmelt will be contained and directed to mining pits or to designed containment structures such as excavated ponds, traps and depressions. Water from designed containment structures will be managed to optimize benefits to the hydrologic system. It is anticipated that contained runoff water will be utilized for haul and access road dust control; will infiltrate to recharge unconsolidated sediments and bedrock below the structures; or will be allowed to evaporate. Discharge to surface waters is not planned during normal operations, but may occur on rare occasions in response to runoff events exceeding the design capacity of the drainage control system.

Detention of runoff water and will reduce peak flows from the mine area to Otter Creek. Surface water runoff and sediment modeling predicted minor flows to Otter Creek to occur during a 100 year/6 hour storm during mining operations. No discharge was predicted during the 2-year, 24 hour storm or the 10-year, 24-hour storms during mining operations (Table 1 – Appendix A). Management of runoff water through stormwater containment structures will regulate the timing and magnitude of releases to Otter Creek. Note however, that the mine area is small compared to the Otter Creek Drainage basin as a whole, as shown below. Therefore, changes in flow observed in Otter creek resulting from water containment and regulated discharge will be imperceptible. Results of surface water runoff and sediment transport modeling is included in Appendix A.

<b>Drainage</b>	<b>Area (acres)</b>	<b>Controlled Acres</b>	<b>% of Drainage Controlled</b>
Otter Creek Total	455,040	4,617	1.0%
Otter Creek Upstream of Otter Creek Mine	377,924	4,617	1.2%
Tenmile Creek	27,520	0	0%
Threemile Creek	32,908	1,143	3.5%
Home Creek	37,760	0	0%

## **5.2 SURFACE WATER QUALITY – PROBABLE HYDROLOGIC CONSEQUENCES**

### **5.2.1 Contained Surface Water**

Runoff from precipitation and snowmelt will be contained and directed to ponds, traps, depressions and/or mining pits. Baseline data has shown that surface water runoff during and following intense storm events may transport high amounts of sediment. These sediments may contain elevated amounts of total recoverable iron, manganese, and aluminum, as indicated by data collected in the baseline monitoring period (See Baseline Report 304E - Water Resources Data Report – Appendix E). Under current conditions, this sediment potentially reaches active waterways, including Otter Creek. The sediment load may cause temporary increases in turbidity and/or deposition in the stream channel. During mining operations, an overall reduction of sediments to Otter Creek and associated tributaries will occur due to runoff containment measures. The result will be a net reduction in sediment load to Otter Creek resulting in a very small net improvement of downstream surface water quality. The reduced contributions of sediment to Otter Creek from the mine area during mining will be difficult to measure downstream of the mine area, and are expected to be within current sediment load variability. As discussed in the previous section, the mine area contributes runoff from approximately 1.0 percent of the entire Otter Creek watershed.

Water discharged as a result of high snow melt and/or rainfall runoff will be of short duration and consist of melt or rain water, and will be low in dissolved solids, but may carry suspended sediment, although most sediment will be captured by ponds. Any water discharged during frozen ground conditions will not infiltrate, but will flow downstream and presumably enter Otter Creek. Water contained during frozen ground conditions will likely be of high quality because of the lack of effective ground contact. Discharge of this water will have no negative affect on the quality of area surface water bodies.

Water discharged from containment ponds will be of similar or better quality to that of Otter Creek. For example, water quality samples for the baseline period collected Fortune Coulee, an ephemeral tributary to Otter Creek in the proposed mine area during the baseline period

showed average SC and SAR values of 349  $\mu\text{mhos/cm}$  and 0.71, respectively, with corresponding ranges of 173 to 536  $\mu\text{mhos/cm}$ , and 0.29 to 0.65. These values are considered representative of snow melt and stormwater runoff water in the area. Based on these values, there will be an overall improvement in water quality by controlled releases of stormwater runoff. .

Once mining is completed, the site will be reclaimed. As shown on the channel profiles included in Exhibit 313D – Reclamation of Drainage Basins, post mining channels are designed with a shallower gradient than those that currently exist, due to the removal of 60 to 70 feet of coal. Since these channels are to be constructed with similar cross sections and will drain close to the same drainage area, the stream velocity in the post mine drainage channels would be similar or slightly less than they were prior to mining.

Salvaged soils will be redistributed and the site will be revegetated with adapted plant species. Once vegetation is established, restriction to overland flow is expected to be near that currently observed. However, gradients will be flatter. The flatter surface gradients are expected to result in lower runoff velocities. Lower velocity surface water flow is less erosive. Therefore, it is expected that sediment transport from the site, following establishment of vegetation, will be lower than currently observed levels. Sediment loads, shown in tons (Table 1 of Appendix A) for various storm events, are predicted to be similar or slightly lower during post mining runoff in all of the watersheds that do not contain permanent ponds. In watersheds 1, 5, 7, 12, and 15, permanent ponds significantly reduce the sediment yield post mining since they act as a sediment trap for the drainage area above the pond.

Any potential changes in water quality or quantity in Otter Creek due to mining will be imperceptible and within the natural variability of sediment load and flow observed in Otter Creek. .Subsequently no impacts to water quality in the Tongue River will occur as a result of operations at the Otter Creek Mine.

Because there will be no perceptible impact to Otter Creek flows and water quality, no impacts to aquatic life found in Otter Creek are expected. This includes species identified during baseline aquatic surveys including the brassy minnow and plains minnow, potential species of concern, and the mayfly, *caenis youngi*, a species of concern, as listed by the Montana Heritage Program.

### **5.2.2 Managed Groundwater Storage– Probable Hydrologic Consequences**

Dewatering of the Knobloch Coal will be necessary during mining. Mine dewatering rates are expected to be greatest during the first two to five years of pit development. During the initial box cut, and as necessary throughout the life of the mine, water from the pit will be routed to storage facilities within the mine area, inside the coal buffer. This water will be utilized for dust suppression on mine roads, some water will be taken up by evapotranspiration and some will infiltrate into mine spoils.

Because the coal buffer has a constant hydraulic conductivity, groundwater flow through the buffer from mine spoils will be less than baseline flow from the Knobloch Coal, until groundwater recovers to or above premine levels. Reduced flow from the spoils will result in a minimal reduction in groundwater that is delivered to Otter Creek Alluvium and ultimately to Otter Creek. Water levels are projected to fully recover in the mine spoil between 15 and 50 years after mining (see Chapter 6.0 and Appendix B).

### **5.3 IMPOUNDMENTS - PROBABLE HYDROLOGIC CONSEQUENCES**

Four ponds (P1, P2, P3 and P4 – see locations shown on Map 10 - Environmental Monitoring Stations) are within the proposed mining area. All four ponds will be removed by mining. There exist owners of record for water rights on three of these four ponds as listed on Table 5-1. It is anticipated that these impoundments will contain water through the early years of mining and their use will be not be impacted. However, as mining progresses, the ponds will need to be modified to contain sediment and runoff. These ponds will be replaced with permanent ponds as shown on Map 14 – Post Mine Drainage Plan. The replacement ponds are designed to fill with the runoff from a 2-year, 24-hour storm in the fully reclaimed

condition. Each pond's storage capacity also includes the average annual sediment yield in the final grading condition, and 10 times the average annual sediment yield in the fully reclaimed condition. Design information for permanent ponds is presented in Appendix A of Exhibit 315A – Ponds and Embankments. The reclaimed permanent ponds will serve as a livestock, and wildlife water source.

Pond P5 (Shorty Creek Reservoir) will be not be impacted by mining. The source of water for Pond P5 is from runoff and local springs issuing from overburden units that will be unaffected by mining. Runoff to the pond is primarily from drainages that are outside of the Otter Creek Mine area. One tributary to the pond originates in Tract 2. However, mine plans restrict mining to areas opposite the surface water divide, so runoff to the pond from mine disturbances will not occur. USDA Forest Service is the owner of record for water rights from this reservoir (Table 5-1).

Pond P6 will not be affected by mining in Tract 2. This pond receives recharge from upstream areas of Tenmile Creek, either as runoff from precipitation and snowmelt, or as water issuing from the alluvium under the pond. The Denson's are the current owners of record for water rights from this reservoir (Table 5-1).

#### **5.4 WETLANDS - PROBABLE HYDROLOGIC CONSEQUENCES**

Wetlands identified in the proposed mine area during vegetation baseline studies (Baseline Report 304J - Vegetation Inventory) were limited to stock pond margins, pond seepage areas and riparian zones along the banks of Otter Creek. Disturbed wetland features will be addressed in mine reclamation plans in the form of wildlife habitat enhancement features and/or eventual conversion of sediment ponds to permanent ponds. Information on wildlife habitat enhancement features is included in Exhibit 313G – Revegetation Plan.

#### **5.5 DRAINAGE DENSITY - PROBABLE HYDROLOGIC CONSEQUENCES**

Post-mine drainage densities were calculated based on post-mine topography. Similar methodologies were used in that measured drainage lengths shown on Map 12 – Post-Mine

Topography were divided by area in associated drainage basins. Calculated pre-mine drainage densities were 2.97 mile per square mile. Calculated post-mine drainage densities were 3.18 mi/mi<sup>2</sup>. This equates to a pre-mining to post mining drainage density change of about seven percent. Table 4-1 compares calculated drainage densities for pre-mine and post-mine topography. Design of reclaimed drainages is addressed in detail in Exhibit 313D – Reclamation of Drainage Basins.

## **5.6 SURFACE WATER USES - PROBABLE HYDROLOGIC CONSEQUENCES**

Although some short-term, localized uses of surface water may experience abbreviated interruption, the current uses of surface water will not be impacted by the proposed mine. Active irrigation is not practiced in the vicinity of the proposed mine, or in Tract 1 and Tract 3. Irrigation structures are limited to spreader dikes in the Otter Creek drainage and in some tributaries. These structures provide passive flood irrigation by good quality water during runoff events. According to local landowners, past attempts to dam Otter Creek and divert flow for flood irrigation were not successful, presumably due to elevated TDS and SAR.

Livestock and wildlife will still have access to Otter Creek, springs and seeps, as well as water containment structures associated with the mine and permanent ponds planned for the mined area after mining. Recreational uses involving surface water will also continue as available during pre-mine conditions outside of the mine permit boundary.

Following reclamation, surface water uses will be the same as pre-mine uses. Water sources will exist in Otter Creek, Fortune Spring, Coal Creek Spring, and seasonally in topographical low spots or impoundments



## **6.0 GROUNDWATER – PROBABLE HYDROLOGIC CONSEQUENCES**

### **6.1 GROUNDWATER FLOW – PROBABLE HYDROLOGIC CONSEQUENCES**

A groundwater model was developed to aid evaluation of potential hydrologic impacts associated with groundwater flow, groundwater quality, re-establishment of groundwater levels, including influences of surface water flow, and surface water quality. The model is a three-dimensional model consisting of nine different layers representing different hydrostratigraphic units that include: Knobloch Coal, Otter Creek alluvium, clinker, ephemeral tributaries, interburden and underburden. The model domain extends approximately six miles to the north and south of the mine, ten miles to the east, and west to the Tongue River. Appendix B contains a detailed description of the groundwater model, input parameters, and associated results. Results discussed in this section are largely the result of predicted changes from simulations produced by the model.

Water levels declined by less than two feet in the alluvial observation wells during simulated mine dewatering. The maximum water level decline was observed at well A6, less than one mile west of the mine area. Approximately 1.6 feet of drawdown were predicted at A6 during the simulation. Water levels at this well were about five to seven feet below ground surface during the baseline monitoring period. Average seasonal fluctuation of about two feet was observed. Assuming drawdown induced by mining is additive, water levels would be expected to be seven to nine feet below ground surface, within limits of sub-irrigation, and would have no effect on current groundwater uses. Water levels in the alluvium at A8, near the permit boundary are predicted to decline approximately one foot during mining.

Gradual but discernible changes in clinker water levels are predicted by the model. The maximum decline in water level predicted at C-3 was 2.2 feet. This is likely a conservative projection based on the relatively low K assigned to clinker in the model.

Groundwater present in the overburden in the mine area will be removed during mining. Overburden will be converted to unconsolidated spoil as mining progresses. The area will be

graded and reseeded once topsoil is redistributed. Recharge will begin immediately upon spoil placement as a combination of precipitation recharge and lateral flow from coal buffer areas. Spoil will also receive recharge from mine water storage impoundments located within the mine workings.

Removal of the Knobloch Coal will remove this hydrostratigraphic interval from within the mine area. As mentioned in the previous paragraph, overburden removed during the stripping process, will be backfilled as spoil. This will result in spoil being laterally in contact with coal in the reclaimed mine area. A buffer layer of unmined coal around the perimeter of the former pits, which is intended to limit flow into the pit from clinker and alluvium during mining, will be left in place.

As the coal is removed and dewatered, a hydrologic low will result in the mine. Since the Knobloch Coal is generally under hydrostatic pressure, the area in the active pit, and in dewatering areas upgradient of active pits, will experience depressurization. When potentiometric levels are drawn below the top of the coal, unconfined flow conditions will exist. Potentiometric heads in the coal upgradient of the mine will be reduced. Hydrographs in **Figure 5-6 of Appendix B** illustrate reductions in potential based on groundwater model simulations.

Drawdown predicted by the transient model was greatest for the Knobloch Coal east of the Otter Creek Mine; hydrographs for two wells completed in the Knobloch east of the mine area are included in Appendix B, Figure 5-6. The magnitude of drawdown from dewatering will be greatest east of the mine because there are no proximate hydrologic boundaries included in the model. Drawdown extends to approximately 9 miles east of the mine to the extent of the five foot drawdown. Note, however, that predicted drawdown east of the mine assumes homogeneous, isotropic conditions exist throughout the entire area. This condition is unlikely to exist. Heterogeneities and anisotropic conditions are likely to result in a reduction in the actual amount of drawdown that will actually occur.

Modeled drawdown was greatest within one mile of the dewatering simulation; and projected drawdown resulted in water levels below the top of coal (i.e. unconfined conditions) at the CNF boundary. Groundwater model simulations predict 70 to 80 feet of drawdown at the CNF boundary. Drawdown diminishes with distance from the mine, with the extent of drawdown projected at approximately nine miles east of the mine. Note the hydrographs (Figure 5-6, Appendix B) that modeled water levels nearly recovered within 15 to 50 years after mining ceases.

Two underburden hydrostratigraphic units were included in the model: the first sandstone aquifer/Flowers-Goodale coal. The first water-bearing bedrock interval occurs between 20 and 100 feet beneath the Knobloch Coal and is coincident with a thin coal seam thought to be the Flowers-Goodale coal and/or a sandstone bedrock interval. The thickness of this water-bearing interval ranges from eight to 53 feet as observed in the baseline well monitoring network. For the sake of the conceptual model, this unit is assumed to be laterally continuous across the model domain; however, lateral continuity of a horizon this thin is rarely observed in the Fort Union Formation over such a vast area. Modeling predicted drawdown in this unit was slightly greater than two feet during mining.

The second underburden interval is a thicker contiguous sandstone which has been encountered in the Otter Creek monitoring well network at depths between 159 feet and 224 feet beneath the Knobloch Coal. The thickness of this sandstone observed in the Otter Creek monitoring network ranges from 38 to 90 feet. Drawdown resulting from mine dewatering was imperceptible in the model layer used to represent this deep underburden sandstone.

Otter Creek Coal will rely on a local source of groundwater for domestic use (i.e. potable water, showers, etc.) during mine operation. Based on observations at other mines, it is estimated that the Otter Creek mine will use two million gallons annually (3.8 gpm) for domestic purposes. The source of this water will likely be the deeper productive sandstone aquifer encountered at some of the monitoring well batteries during the baseline study. This sandstone is used by local residents as a stock and/or domestic water source; and the required

pumping rate for the domestic well is consistent with pumping rates of wells already completed in this aquifer. Potential influences of the domestic well on the sandstone aquifer were evaluated in two forward analytical solutions. Specifically, forward projections were made using analytical results from pumping tests previously completed at wells B5-U and B10-U. These wells were chosen because, although they are completed in the same aquifer, hydraulic properties at the wells are variable. Transmissivity estimated at well B5-U was 32 ft<sup>2</sup>/day; and transmissivity estimated at well B10-U was 56 ft<sup>2</sup>/day. Both previous analyses were made using the Theis method. This method was further applied to the forward projections. Drawdown for both wells was projected for a period of 20 years at a pumping rate of five gpm, followed by a period of groundwater recovery. Drawdown estimated by the forward projection of B10-U aquifer test results at the end of the 20 year projection was 34 feet at the pumping well, ten feet at one half mile, and two feet at a distance of ten miles. Drawdown projected after 20 years of pumping based on results at B5-U was 59 feet at the pumping well, 16 feet at one half mile, and two feet at a distance of ten miles. Forward projection results are presented in Figure 6-1.

### **6.1.1 Re-Establishment of Groundwater Levels**

Estimation of groundwater level recovery was accomplished using a groundwater flow model to simulate pre and post-mine water levels. Transient model runs were conducted to simulate mine dewatering and recharge to the mine area and surrounding aquifers following mining. Groundwater contours and hydrographs illustrate results of the simulations (Appendix B).

Predicted water levels in alluvium were fully recovered approximately 20 to 30 years after the end of mine dewatering. Perceptible changes in alluvial water levels will likely subside in much less time due to inflow of ground and surface water from upstream.

As indicated by model results (Appendix B), water level recovery in mine spoils is highly spatiotemporally variable. Mine spoils nearest the western mine boundary, bordered by clinker and alluvium, are projected to recover first. In model simulations, the direction of

groundwater flow returns to the pre-mine orientation between 25 and 30 years after dewatering efforts end.

Water levels in Knobloch Coal adjacent to the mine area are projected to recover at rates similar to mine spoils discussed above. Recovery rates will vary based on proximity to hydrologic boundaries, such as alluvium, clinker, or surface water features. For example, water levels in Knobloch Coal outside the mine area but adjacent to Threemile Creek or Tenmile Creek are expected to recover faster than water levels in coal east of the mine area. Note the hydrographs and potentiometric contours generated by the model (Appendix B) that predict water levels nearly recovered in off-site coal within 50 years of the dewatering simulation.

## **6.2 GROUNDWATER QUALITY – PROBABLE HYDROLOGIC CONSEQUENCES**

Overburden in the mine will be stripped to allow removal of the Knobloch Coal. Overburden will then be placed as spoil material to fill the interval previously occupied by the coal. Groundwater from the un-mined Knobloch Coal east of the mine will flow into the spoil. In lower elevations along the western part of the mine, water from clinker and alluvium will flow into the spoil through a coal barrier providing recharge until water levels in the spoil rise to a level where groundwater flow directions will approximate current patterns. Precipitation recharge will also occur. Initial post-mine recharge rates from precipitation will likely be higher than current recharge rates, due to higher vertical permeabilities created by mining disturbance. Once the area is reclaimed and vegetation is established, recharge rates from precipitation to the spoil should approximate current conditions.

Water quality within the spoil is expected to be more similar to that observed in overburden, than the coal aquifers that it replaces (Van Voast, Hedges, McDermott, 1977). Variability in quality can also be expected between areas. An initial increase in total dissolved solids (TDS) can be expected since stratified overburden deposits will be excavated and replaced in an unstratified condition with considerable mixing. This will result in more chemical constituents becoming available for dissolution and transport in groundwater (Van Voast and

Hedges, 1975). Van Voast et al. (1988) noted that average TDS concentrations in mine spoil of southeastern Montana mines are 50 to 200 percent higher than average concentrations in undisturbed aquifers. Given an approximate average TDS of 1750 mg/L for the Knobloch Coal, TDS in spoils groundwater could range from 2,650 to 5,250 mg/L. Groundwater from overburden monitoring wells in the study area ranged from 1,030 to 7,020 mg/L TDS.

Overburden samples were collected from 55 boreholes during the 2011 Ark Land exploration drilling program. Samples were submitted for chemical analysis of saturated paste extract. Saturated paste extracts provide a conservative estimate of initial spoils groundwater quality. Concentrations of major ions in saturated paste extracts have been found to compare favorably to those occurring in the first pore volume of column leachate (Van Voast et al., 1978). Weighted averages of saturated paste extract results were calculated for pH, specific conductance (SC), and sodium adsorption ratio (SAR). Resulting values were: pH = 8.0; SC = 3,820  $\mu$ mhos/cm; and SAR = 19.1. For comparison purposes, average values of the same parameters for baseline water quality samples from the Knobloch Coal were; pH = 8.4, SC = 2,499  $\mu$ mhos/cm, and SAR = 35.3 (Baseline Report 304E - Water Resources Data Report).

Initial concentrations of TDS in spoil water will be highest following initial wetting. As groundwater flows through the spoil, availability of soluble salts will diminish and concentrations are expected to decrease. Column testing was also conducted on overburden samples from four of the 55 exploration boreholes. (Refer to Appendix C for details on methodology and results of the column testing.) Overall, column leach test results for Otter Creek overburden exhibit similar characteristics as observed and described by Van Voast et al (1978). Salt concentrations are initially high (TDS of 3,000 to 15,000 mg/L; SC of 4,000 to 14,000  $\mu$ mhos/cm) during the time that overburden is partially saturated (less than one pore volume) and decrease rapidly after full saturation is achieved. Salt concentrations continued to decline with additional leaching and by the fourth pore volume were very similar to well water. Results of these analyses were used to refine recharge water quality predictions that may be expected in the re-saturated spoil as described below.

Groundwater flows from the Knobloch Coal in the proposed mine area to clinker and alluvium downgradient of the proposed mine. As mine dewatering commences, the direction of groundwater flow will trend toward the active dewatering area. Based on transient groundwater flow modeling results (Appendix B), the direction of groundwater flow will be re-established 25 to 30 years after the conclusion of mine dewatering; and spoils are expected to be recharged to near baseline groundwater levels between 25 and 50 years after the end of dewatering. A “coal buffer”, left in place to restrict flow from alluvium and clinker during dewatering, will also regulate flow from spoils to clinker and alluvium to near background levels. Assuming gradients are similar or flatter than the current gradients, groundwater flow from the mined area will be equal to or less than current estimated flow.

A groundwater quality mixing analysis was performed by coupling the results of saturated paste extracts and column leach testing, with flow budgets from mine spoils to downgradient receptors. An estimated SC of 7,000  $\mu\text{mhos/cm}$  was assigned to the spoil water for the mixing analysis (Appendix C).

Flow budgets were extracted from the transient groundwater flow model (Appendix B). The model derived flow paths for spoil water moving from mine are through the coal buffer, into the clinker downgradient is shown on Figure 6-2. Based on the mixing analysis, de-minimus changes in SC within the range of natural variability are projected for the downgradient clinker and the Threemile Creek alluvium. Model predicted post mine SC values are compared to pre-mine baseline conditions in the table below:

UNIT	Premine SC ( $\mu\text{mhos/cm}$ )		Predicted Post Mine SC ( $\mu\text{mhos/cm}$ )
	Max	Ave	
Clinker	4240	3144	3446
Threemile Alluvium	3940	3243	3417
Otter Creek Alluvium	6650	3607	
Otter Creek Surface Water	4990	3825	

The overall lack of spoil water influence on downgradient water quality is attributable to the minimal amount of disturbance relative to the overall size of the groundwater flow system.

Furthermore, the modeling used to predict impacts to water quality downgradient of the mine used a simple mixing analysis and did not consider other chemical or physical transformations that may occur as the spoil water flows through the coal buffer as it moves downgradient. Clark's (1995) study of spoils water at two mines in Montana indicated that, under certain conditions, concentrations of some dissolved ions in spoil water will decrease as the water flows into an unmined coal seam. The geochemical processes most likely to result in these decreases include: a population of sulfate reducing bacteria, organic carbon suitable as an energy source for the bacteria, a source of iron to facilitate the precipitation of iron-sulfide minerals, and the capacity of the coal to exchange sodium ions for calcium or magnesium ions. Clark's study focused on spoils water at the Big Sky Mine and the West Decker Mine in Montana.

Spoil water quality from other mines in southeast Montana provide further insight into groundwater quality that might be expected in the Otter Creek Spoil. Van Voast 1988 reported that water in undisturbed units contained substantially lower concentrations of dissolved constituents than spoil water. Samples from wells completed in coal seams averaged about 1750 mg/L; whereas average spoil water quality ranged from 2,880 to 3,660, about double the concentrations observed in the undisturbed units. Sodium, calcium, magnesium, and sulfate comprised the majority of additional dissolved solids in the spoil.

Preliminary spoil (backfill) water quality data collected in the Middle Powder River Basin (PRB) in Wyoming from spoil monitoring wells at active coal mines indicates post-mine groundwater quality in spoil aquifers approximates pre-mine water quality (WDEQ CHIA 27, 2011). A median of 3,080 mg/l for TDS was observed from 1709 samples reported by the PBR mines between 1977 and 2011. The spoil water in the study area is a Ca-SO<sub>4</sub> type which is the same type as was observed in the overburden. The median concentration of



TDS in the overburden (Wasatch Formation) was reported to be 2,568 mg/l. Ogle (2004) reports a median of 3,514 TDS from over 2000 spoil water samples collected between 1986 and 2002 from coal mines on the eastern edge of the PRB in Wyoming. Ogle also found that higher TDS concentrations in the spoils aquifer were associated with distance to drainage channels and clinker outcrops. Hoy et al (2003) also evaluated spoil water quality data from mines along the eastern PBR and found that spoil water is usually similar to baseline water quality in the coal (Wyodak-Anderson) and the overburden (Wasatch).

### **6.3 ALLUVIAL VALLEY FLOORS - PROBABLE HYDROLOGIC CONSEQUENCES**

At the time of this writing, an alluvial valley floor (AVF) determination has not been completed. However, disturbances, if any, to potential AVF's will only occur in association with construction of access roads, conveyors, and other associated mine support facilities, and will have no effect on surface water in Otter Creek or alluvial ground water. Coal removal will not occur under any potential AVF's.

Observations, production data and shallow groundwater quality data indicate that existing shallow ground water conditions do not significantly facilitate or enhance agricultural production, due to elevated EC in soils and groundwater. The majority of production enhancement in the vicinity of the coal tracts occurs in response to infiltration of higher quality runoff water from snow melt and major rainfall events. Essential hydrologic functions are addressed in detail in Baseline Report 325A – Alluvial Valley Floors, Section 5.

Groundwater modeling of the proposed mine indicates water levels in the alluvium along Otter Creek may be temporarily lowered less than 2 feet. Because there appears to be minimal sub-irrigation under existing conditions, impacts from lowering groundwater levels in potential AVF's will not be discernible, and may be beneficial due to reduced concentration of salts in the root zone. As noted above, a groundwater quality mixing analysis was performed by coupling saturated paste extract results and column leach test of overburden and projected flow budgets from mine spoils to downgradient receptors. Based

on the mixing analysis, nearly immeasurable changes in SC are predicted for alluvium in Otter Creek and Threemile Creek.

#### **6.4 SPRINGS- PROBABLE HYDROLOGIC CONSEQUENCES**

Following reclamation, surface water uses and accessibility will be essentially the same as available during pre-mine uses, except as described below and in Section 5.0, above. Water sources will continue to exist in Otter Creek, Fortune Spring, Coal Creek Spring, and seasonally in topographical low spots and the remaining or new impoundments.

##### **6.4.1 Spring Water Quantity- Probable Hydrologic Consequences**

Fifteen springs or seeps were identified within the Tract 2 mine permit boundary area. Six of those that lie within the extent of the area to be mined in Tract 2 will be removed by mining and will not be replaced. The seeps and springs within the mine area and permit boundary are listed on Table 5-1 and Plate 3, Baseline Report 304E - Water Resources Data Report. All seeps identified in the proposed mining area were either standing water with no discernible flow (possibly localized topographic lows and/or with residual water from recent precipitation events), or seeps that derived their source water as release from storage in nearby sediments. Each of these sites was visited in June 2012, and all were dry. This indicates that the seeps were fed by water held in local storage from heavy precipitation in 2011 and not by baseflow.

Pond P1 likely has a spring associated with it due to its perennial nature. This pond and the associated spring will be removed during mining. The owner of record for water rights from this pond is Ark Land Company.

Eight minor seeps or springs are located within the proposed permit boundary, but outside of the area to be mined. All are very low yield seeps likely receiving recharge from the release of water from local unconsolidated sediments. None are perennial seeps and each has been observed to be dry during past years of monitoring. At springs SSI-11-14 and SSI-11-19 mine activities could affect the recharge areas due to infrastructure construction located

upgradient of the site. However, given the lack of yield and ephemeral nature of all the seep and spring sites, no impact to the hydrologic balance of the undisturbed sites will occur. Potential consequences for each seep and spring are described in Table 5-1.

Site SSI-11-20 appears to be a moist spot in a small oxbow near Otter Creek. The presence of water at this location is dependent on water levels in the alluvium near the creek and would be temporarily impacted if mine dewatering lowers water in the alluvium.

#### **6.4.2 Spring Water Quality - Probable Hydrologic Consequences**

Two named springs are located outside of the proposed mine boundary; Fortune Spring and Coal Creek Spring. Both springs receive recharge water from overburden units that are stratigraphically above and higher in elevation than the coal to be mined. There will not be any disturbance in recharge areas for these springs. Based on these relationships, changes in water quality are not reasonably expected at these springs. The USFS is the current owner of record of water rights at these two springs (Table 5-1).

As mentioned in the previous section, Site SSI-11-20 appears to be a moist spot in a small oxbow near Otter Creek. The presence of water at this location is dependent on water levels in the alluvium near the creek. Water derived at this site would be from the Otter Creek alluvium. Flow to the area is from the south and will not be affected by mining at the Otter Creek Mine. Therefore, water quality impacts at this site are not reasonably expected.

#### **6.5 PRIVATE WELLS - PROBABLE HYDROLOGIC CONSEQUENCES**

Wells within the groundwater model predicted limit of five foot drawdown in the Knobloch Coal are listed in Table 6-1. Also included in the table is an estimate of potential impacts to the wells and overall usability of the wells for their intended purposes. The locations of the wells are shown on Figure 6-3.

One hundred and eight private wells were identified within the projected extent of the five foot drawdown. Estimates of impacts were based on the location of the wells, stratigraphic

position of the wells, completion intervals, water management plans, groundwater modeling results, and understanding of local hydrogeology. Monitoring wells installed for the Otter Creek Mine baseline study are not included in this discussion or shown on Table 6-1. Based on this review, it was concluded that 15 wells will potentially show some level of impact.

Projected impacts include complete removal of the well, or temporary decreases in water levels. Projected impacts to private wells are as follows:

- Four wells will be removed by mining; and
- Eleven wells may experience very slight to moderate drawdown.

Wells within the proposed mine area will be removed during mining. Replacement wells will be installed if the post-mine use requires wells in these areas, or for monitoring purposes. Potential water supply targets are described in Baseline Report 304E – Water Resources Data Report.

A limited number of wells exist within Tract 2, and around its perimeter. Generally, wells completed in the overburden in the proposed mine area will be removed. Wells in the overburden near the mine area are not likely to experience significant impacts due to mining since recharge to these wells occurs locally.

Wells completed in the Knobloch Coal will have varying amounts of water level changes. Changes in groundwater levels do not necessarily equate to impacts to use. For example, if a well is completed in a 60 foot coal seam and exhibits a potentiometric head that is 50 feet above the top of the coal, a reduction in head of 20 feet will not necessarily affect the usefulness of that well. Groundwater monitoring wells at batteries B6 and B7 have been installed to detect and quantify changes in water levels in the coal near the permit boundary. Additional monitoring wells will be installed on CNF property to the east of the mine area to provide additional information regarding water levels and quality for evaluation of potential impacts.

Impacts from potential future mining in Tract 1 and Tract 3 are not included in this evaluation. However, any wells in these areas will be thoroughly evaluated prior to mining in those areas. It is anticipated that impacts to wells in these areas would be similar to those in the Tract 2 area, and that replacement water could be provided from deeper units if necessary.

## **7.0 WATER RESOURCES MONITORING PLAN**

Water resources at the Otter Creek Mine will be monitored for quality and quantity through a network of monitoring sites that include wells, surface water, springs, and ponds. A monitoring plan has been developed for the mine and is included in Exhibit 314B – Hydrologic Monitoring and Quality Assurance Plan.

## **8.0 MATERIAL DAMAGES**

Material damage is defined in 82-4-203(31), MCA, as “with respect to protection of the hydrologic balance, degradation or reduction by coal mining and reclamation operations of the quality or quantity of water outside of the permit area in a manner or to an extent that land uses or beneficial uses of water are adversely affected, water quality standards are violated, or water rights are impacted. Violation of a water quality standard, whether or not an existing water use is affected is material damage.”

Operations at the Otter Creek Mine will be conducted in a manner to minimize adverse effects on and prevent material damage to the hydrologic balance. Mitigating measures are discussed in Exhibit 314A – Protection of the Hydrologic Balance. Additionally, groundwater and surface monitoring programs have been designed to allow early detection of changes in quality and quantity of water resources within the permit boundary. Review of water quality, water level and flow data will be evaluated to identify potential changes in the hydrologic system. Any changes identified in the hydrologic system will be evaluated and addressed through further investigation, revision or application of best management practices, and/or implementation of specific mitigation measures (if necessary).

Management practices will be employed to reduce the potential for occurrence of changes in the hydrologic balance. These will include management of surface water and groundwater to minimize impacts through surface water runoff containment, groundwater management, mine planning, and water resources monitoring. Management practices will be revised if/when methods to enhance protection of the hydrologic balance are identified.

Based on the evaluation of baseline data and probable hydrologic consequences analysis, no material damages are expected. However, based on the monitoring design for the system, any indicators of potential material damages will allow early detection of potential changes in the hydrologic system, which can be evaluated and addressed, as necessary.

## **9.0 LIFE OF MINE CUMULATIVE HYDROLOGIC IMPACTS**

### **9.1 ANTICIPATED MINING**

The only other anticipated mining in the vicinity of Otter Creek Tract 2 is on Otter Creek Tracts 1 and 3, both of which are leased by Ark Land, are within the mine plan area, and hence will be sequentially mined by OCC as shown on Map 1 – Mining Sequence. There are no other known coal leases in the area except Sections 16 and 36 (T4S, R45E); both are State of Montana leases within the Otter Creek Coal Tracts which are currently held by Consolidation Coal Co. and Great Northern Properties, respectively. There are no known existing or pending Federal coal leases in the area, nor are there any pending permit applications.

### **9.2 CUMULATIVE IMPACT AREA**

The Cumulative Impact Area for purposes of this discussion consists of Otter Creek Coal Tracts 1, 2 and 3, and the adjacent area where surface water and/or ground water resources “could reasonably be expected to be adversely affected by proposed mining operations” (82-4-203 MCA). This definition is distinct from “material damage”, also defined at (82-4-203 MCA), and addressed in Section 8.0 above. Adverse effects can occur without constituting material damage.

### **9.3 CUMULATIVE HYDROLOGIC IMPACTS**

As described in detail above, hydrologic impacts will be localized, largely confined to the permit area, and for the most part temporary. The mine plan has been designed to minimize hydrologic impacts and prevent material damage to hydrologic resources outside the permit area, and the nature of the hydrologic system is such that projected impacts are so slight as to be in all probability not discernible. Mining on Tracts 3 and 1 will follow in sequence; similar mitigating measures will be employed in mine plan design and implementation, and hydrologic impacts are expected to be similar and probably less because on Tract 2 hydraulic gradients in the Knobloch Coal and direct contact with the Otter Creek alluvium are both



greater than on Tracts 3 and 1. Projection of cumulative hydrologic impacts for mining in Tracts 1 and 3 will be aided by observations and analysis performed during the mining of Tract 2. Groundwater dewatering and performance of water management practices will provide additional data in further evaluating the potential cumulative impacts, either direct or indirect, which can be anticipated with expanded coal mining in the area.

Analyses provided in this document suggest that localized impacts to Otter Creek and the groundwater system will occur. Current hydrologic information suggests that Tracts 1 and 3 will generally behave in a similar fashion to Tract 2. However, any project impacts associated with mining are not expected to have the effect of causing water quality standards to be violated or degrading water quality, or reducing the volume of water to a point that the current uses would be impaired or damaged.

#### **9.4 MATERIAL DAMAGE CRITERIA**

Material damage is defined in 82-4-203(31), MCA, as “with respect to protection of the hydrologic balance, degradation or reduction by coal mining and reclamation operations of the quality or quantity of water outside of the permit area in a manner or to an extent that land uses or beneficial uses of water are adversely affected, water quality standards are violated, or water rights are impacted. Violation of a water quality standard, whether or not an existing water use is affected is material damage.”

Otter Creek was originally listed as impaired for agriculture, warm-water fishery, and aquatic life beneficial uses by salinity, TDS, chlorides, metals, suspended solids, and other habitat alterations on the Montana 1996 303(d) list (MDEQ, 1996). The basis of the 1996 determination was unknown; and sufficient credible data were not available to make an impairment determination on the 2006 303(d) list (MDEQ, 2006; USEPA/Tetra Tech, 2007). Otter Creek is listed as impaired by iron, salinity, and suspended solids on the 2012 303(d) list.

A numeric water quality standard for salinity of 500  $\mu\text{mhos/cm}$  was adopted by the Montana Board of Environmental Review in 2006 for all tributaries of the Tongue River to protect these waters for agricultural use. In a review of available data for Otter Creek (USEPA/Tetra Tech, 2007), it was found that the salinity standard (by SC) was exceeded by nearly all individual samples. Only samples taken during the highest 5% of surface water flows had SC less than 500  $\mu\text{mhos/cm}$ . All of the monthly averages included in the comparison were greater than 500  $\mu\text{mhos/cm}$ . A modeling analysis included in the study indicated that exceedances of the salinity standard were due to natural causes (USEPA/Tetra Tech, 2007).

Similarly, seasonal numeric water quality standards were adopted for SAR. During the growing season (March 2 through October 31), a monthly average SAR standard of 3.0 applies. The maximum SAR standard for a single sample during the growing season is 4.5. The monthly average and instantaneous maximum SAR standards during the non-growing season (November 1 to March 1) are 5.0 and 7.5, respectively. Otter Creek exceeds the growing season SAR standard greater than 96% of the time. The source of SAR exceedances is thought to be due to natural causes, rather than human influences (USEPA/Tetra Tech, 2007).

MDEQ initiated Total Maximum Daily Load (TMDL) development for Otter Creek in 2013 by implementing a sampling program (MDEQ 2013a), developing a salinity model and holding a Watershed Advisory Group meeting. Subsequently, DEQ determined Otter Creek is not impaired for sediment and removed the sediment impairment from the 303(d) list (impaired waters list) (MDEQ, 2013b). The salinity model was completed and the simulated results show that EC and SAR under pre-Columbian Era conditions exceed Montana's Tongue River tributary standards over 99% of the time, and that current agricultural practices and other human activity have negligible impacts on EC and SAR in Otter Creek.

AVF studies during the baseline investigation concluded that maximum benefits to agricultural areas along Otter Creek occur during spring snowmelt. During these times, the creek may become bank full, and overflow waters across the valley floor, providing higher

quality soil water for plant utilization and flushing of accumulated salts. Operations at Otter Creek Mine will have no effect on spring runoff arising from the upper reaches of the Otter creek watershed. As evidenced by 2012 field observations, crops along the creek appear to receive negligible benefit from sub irrigation. Changes in water levels will have little, if any, impact on late season production. Further, Otter Creek does not flow continuously, with some years drying up completely (no flow measured at Ashland USGS station). During these times, the contribution of surface flow to the Tongue River is zero. During normal baseflow conditions, the flow is quite small providing only low flows with SAR exceeding established standards. Changes to the volume of flow, and the quality of flow to Otter Creek, are projected to be minimal, if detectable at all, and within the range of natural variation. Furthermore, negative affects to the existing uses are not projected.

Although water level declines in the Knobloch Coal are projected during mine operations, adverse impacts on water and land use are not anticipated because of a lack of wells completed in this unit. Although the groundwater model projects water level declines for up to about 10 miles to the east of the mine, measurable declines would be material only if the decline in a specific well precluded its use, and the water supply could not be replaced.

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