Appendix I

Bull Mountains Mine No. 1

Cumulative Hydrologic Impact Assessment

Amendment 3

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Acronyms used within this document.	
Acronym	**Definition**
ARM	Administrative Rules of Montana
CDFA	Cumulative Departure From Average
CHIA	Cumulative Hydrologic Impact Assessment
CIA	Cumulative Hydrologic Impact Area
DEQ	Department of Environmental Quality
DNRC	Department of Natural Resources and Conservation
EPA	Environmental Protection Agency
GWIC	Groundwater Information Center
LOM	Life of Mine
MBMG	Montana Bureau of Mines and Geology
MCA	Montana Code Annotated
MCL	Maximum Contaminant Levels
MPDES	Montana Pollutant Discharge Elimination System
MSUMRA	Montana Strip and Underground Mine Reclamation Act
NRWQC	National Recommended Water Quality Criteria
NSDWR	National Secondary Drinking Water Regulations
OSMRE	Office of Surface Mining Reclamation and Enforcement
PHC	Probable Hydrologic Consequences
PMT	Post Mine Topography
SMCRA	Surface Mining Reclamation and Control Act
SPE	Signal Peak Energy LLC
SWL	Static Water Elevation
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
USGS	United States Geological Survey

1.0 INTRODUCTION

The Montana Department of Environmental Quality (DEQ) is the regulatory authority for coal mining operations in the state of Montana and implements the Montana Strip and Underground Mine Reclamation Act (MSUMRA) and the administrative rules pursuant to the Act. The Federal Office of Surface Mining Reclamation and Enforcement (OSMRE) implements the Surface Mining Reclamation and Control Act of 1977 (SMCRA), and has granted primacy to DEQ as the regulatory agency for coal mining in Montana. As such, DEQ is responsible for the review and decisions on all permit applications to conduct surface coal mining operations within the state with oversight from OSMRE.

This assessment of cumulative hydrologic impacts is prepared by DEQ as part of the permit review process for Amendment 3, submitted by Signal Peak Energy, LLC (SPE) for the Bull Mountains Mine No. 1 (SMP C1993017). It includes an analysis of anticipated hydrologic impacts associated with mining in and adjacent to the proposed permit area.

2.0 REGULATORY ENVIRONMENT

Administrative Rule of Montana (ARM) 17.24.314(1) requires that DEQ determine that a given proposed mining and reclamation operation has been designed to minimize disturbance to the hydrologic balance on and off the mine plan area, and prevent material damage[1] to the hydrologic balance[2] outside the permit area. In order to evaluate whether the proposed mining and reclamation plan has been designed to prevent material damage, a Cumulative Hydrologic Impact Assessment (CHIA) is prepared by DEQ. Prior to making a permitting decision, DEQ makes an assessment of cumulative hydrologic impacts of all existing and anticipated mining operations. The CHIA analysis must be sufficient to determine whether mining impacts to the hydrologic balance on and off the permit area have been minimized and material damage outside the permit area has been prevented [ARM 17.24.314(5)].

2.1 MATERIAL DAMAGE CRITERIA

Following the definition of material damage in 82-4-203(31), Montana Code Annotated (MCA), material damage criteria are established for the evaluation of both groundwater and surface water quality and quantity, and are used to determine whether water quality standards and beneficial uses of water, including water rights, outside the permit boundary have been or are expected to be impacted by mining activities. The interruption or diminution of a surface water or groundwater supply to the extent that an existing use is precluded is considered to be material damage. When material damage occurs mitigation is required; mitigation would include dependable, long-term replacement of a resource acceptable for the designated use [ARM 17.24.314(1)(c) and 17.24.648] or treatment to return water quality to state standards.

Material damage criteria include applicable numeric and narrative water quality standards, and criteria established to protect existing beneficial uses of water. Baseline water quantity and quality is compared against changes or anticipated changes in quantity and quality associated with mine activity to determine if uses have been impacted or water quality standards exceeded outside the permit boundary. Threshold criteria are used by DEQ to identify potential problems in water quality and quantity before these problems escalate to material damage (**Table 2-1**).

The Montana Water Quality Act (MWQA) is the primary basis for water quality protection in the state of Montana. Rules promulgated under the authority of MWQA establish surface water and groundwater standards [ARM 17.30.subchapter 6 and 17.30.subchapter 7] to protect the designated beneficial uses of state waters. Numeric standards published in Circular DEQ-7, Montana Numeric Water Quality Standards, were developed using guidance from the Environmental Protection Agency (EPA) which includes:

[1] "Material damage" means, with respect to the 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. [82-4-203(31), MCA]

[2] "Hydrologic balance" means the relationship between the quality and quantity of water inflow to, water outflow from, and water storage in a hydrologic unit, such as a drainage basin, aquifer, soil zone, lake, or reservoir, and encompasses the dynamic relationships among precipitation, runoff, evaporation, and changes in ground water and surface water storage. [82-4-203(24), MCA]

- National Recommended Water Quality Criteria (NRWQC) developed under Section 304(a) of the Clean Water Act
- Drinking Water Lifetime Health Advisory (HA) and Maximum Contaminant Levels (MCL) developed under the Safe Drinking Water Act

Montana's surface water and groundwater rules also contain narrative standards [ARM 17.30.620 through 17.30.670 and 17.30.1001 through 17.30.1045]. The narrative standards are designed to address water quality for which sufficient information does not yet exist to develop parameter-specific numeric standards. These narrative standards are established to protect beneficial uses from adverse effects, supplementing the existing numeric standards.

2.1.1 Surface Water Material Damage Criteria

Material damage to surface water occurs when, as a result of mining, any of the following are met:

- Surface water quality standards outside of the permit area are violated
- Land uses or beneficial uses of water outside of the permit area are adversely affected to the extent that an existing use is precluded
- A surface water right is adversely impacted

Material damage criteria for surface waters[3] include the numeric water quality standards established in Circular DEQ-7 (where applicable) and water use criteria established for parameters where specific numeric standards have not been developed. Surface water quality standards contained in ARM 17.30.620 through 17.30.670 vary according to stream classification. Numeric standards for parameters including *Escherichia coli* bacteria, color, turbidity, pH, and temperature, change with stream classification. Surface waters in the Bull Mountains Mine area are classified as C3 surface waters [ARM 17.30.611]. Beneficial uses of surface waters are established according to the streams' water use classification. Specific water quality standards (along with general provisions) protect the established beneficial uses for each classification [ARM 17.30.620].

Beneficial uses of C3 waters are given in ARM 17.30.629:

> *"Waters classified C-3 are to be maintained suitable for bathing, swimming, and recreation, and growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl, and furbearers. The quality of these waters is naturally marginal for drinking, culinary, and food processing purposes, agriculture, and industrial water supply. Degradation which will impact established beneficial uses will not be allowed."*

With the exception of some spring-fed stream reaches and stockwater ponds, surface waters in the vicinity of the Bull Mountains Mine are typically ephemeral[4], flowing only in response to precipitation

[3] "Surface waters" means any waters on the earth's surface including, but not limited to, streams, lakes, ponds, and reservoirs; and irrigation and drainage systems discharging directly into a stream, lake, pond, reservoir, or other surface water. Water bodies used solely for treating, transporting, or impounding pollutants shall not be considered surface water. [ARM 17.30.602(33)]

[4] "Ephemeral stream" means a stream or part of a stream which flows only in direct response to precipitation in the immediate watershed or in response to the melting of a cover of snow and ice and whose channel bottom is always above the local water table. [ARM 17.30.602(12)]

events or for short reaches below the issue point of springs or seeps. As stated in ARM 17.30.637(6), "*Ephemeral streams are subject to ARM 17.30.635 through 17.30.637, 17.30.640, 17.30.641, 17.30.645, and 17.30.646 but not to the specific water quality standards of ARM 17.30.620 through 17.30.629"* (including Circular DEQ-7, Montana Numeric Water Quality Standards).

Applicable water quality standards for ephemeral surface waters are therefore predominantly narrative and primarily include the General Treatment Standards [ARM 17.30.635], General Operational Standards [ARM 17.30.636], General Prohibitions [ARM 17.30.637], and other descriptive portions of the surface water quality standards.

Numeric surface water standards for perennial and intermittent streams are in **Table 2-2**. This list is not exhaustive, and only includes selected parameters known to be potentially associated with coal mining impacts that are monitored by Montana coal mines. These numeric water quality standards apply to perennial/intermittent streams only and not to ephemeral streams.

The predominant beneficial use of surface water in the area is drinking water for livestock and wildlife. Water quality guidelines established for livestock use (**Table 2-3**) are based on limits for livestock consumption found in documents published by the Montana Extension Service (Sigler and Bauder, 2012, Hutcheson, 2001). These are not enforceable standards but are used by DEQ for guidance in evaluating suitability of pre- and postmine water quality for livestock use. It is not uncommon for water quality in the area to naturally exceed these livestock water quality guidelines.

Surface water availability is variable in the Bull Mountains area. Surface water quantity is generally governed by the seasonal runoff from storms and snow melt. Runoff models submitted with as-built pond designs model the water and sediment retention of sediment control ponds. These models are also used to assess water quantity impacts to downstream users and uses from the capture and/or attenuation of storm runoff. Runoff from areas disturbed by mining operations is required to be managed in a manner that prevents surface water pollution (e.g. increased suspended solids, changes in pH, increases in metals of concern, etc.) outside the permit area to the extent possible with the best technology currently available [ARM 17.24.633].

Impacts to surface water supply and water rights are evaluated with respect to regional and local impacts to surface water resources and natural variations in seasonal and yearly runoff. Mitigation for the loss of a beneficial use of surface water or a water right requires provision of a dependable, long-term replacement water resource of acceptable quality for the designated use and adequate quantity to support the existing and/or planned future use [ARM 17.24.314(1)(c) and 17.24.648].

Material damage criteria are therefore a combination of applicable narrative standards, numeric standards, and livestock beneficial use criteria. Impacts to surface water rights are evaluated on a case-by-case basis, and include an analysis of climatic conditions and the natural availability of surface water.

2.1.2 Groundwater Material Damage Criteria

Groundwater material damage occurs when, as a result of mining, any of the following circumstances occur:

- Groundwater quality standards outside of the permit area are violated

- Land uses or beneficial uses of groundwater outside of the permit area are adversely affected to the extent that an existing use is precluded
- A groundwater right is adversely impacted

Protection of groundwater quality for beneficial uses is based on narrative standards established by ARM 17.30.1006 (**Table 2-4**) and numeric standards for individual parameters in Circular DEQ-7 (**Table 2-2**). Water quality guidelines established for livestock use are shown in **Table 2-3**. Groundwater quality in the area may naturally exceed these livestock water quality guidelines. Groundwater released from the mine is not required to be purer than natural, background conditions [75-5-306, MCA and ARM 17.30.629(2)(k)].

Beneficial uses of groundwater outside the permit boundary include livestock and domestic use. Wells completed in the alluvium, overburden, and underburden supply livestock water. Wells for domestic use typically have reported completion depths that suggest utilization of groundwater from the underburden. The location of private wells and water rights are discussed in Section 6.0, Water Resource Uses.

Water levels and water quality are monitored inside and outside the permit boundary to establish baseline conditions and measure subsequent changes so that impacts during and after mining can be anticipated and evaluated. Analytical results of water quality parameters most likely to be affected by mining are compared to standards to determine suitability of the water for current and anticipated uses. The amount of change to water quality or quantity that can be tolerated before material damage results will depend upon the baseline water level and water quality at a given location. Baseline water levels or water quality that is marginally supportive of a given use are more vulnerable to changes that would cause material damage than water levels or water quality more supportive of an established use.

A transient groundwater flow model was developed to predict drawdown impacts to water levels in aquifers affected by operations at the Bull Mountains Mine. Impacts to wells and springs located within the modeled drawdown area can be anticipated and mitigated to avoid material damage. Mitigation for the loss of a beneficial use of groundwater or a water right requires providing a dependable, long-term replacement water resource of acceptable quality for the designated use and adequate quantity to support the existing and/or planned future use [ARM 314.24.314(1)(c) and 17.24.648].

2.2 CUMULATIVE HYDROLOGIC IMPACT ASSESSMENT

The Cumulative Hydrologic Impact Assessment (CHIA) includes an assessment of the Probable Hydrologic Consequences (PHC) of the proposed operation (Nicklin, 2013[1]). The PHC determination is prepared by the applicant [ARM 17.24.314(3)] and approved by the regulatory authority (DEQ). Prior to making a permitting decision, DEQ makes an assessment of all hydrologic impacts of the proposed operation, existing, previous, or anticipated mining that collectively impact surface and groundwater systems in a cumulative impact area. The CHIA analysis must determine whether mining impacts to the hydrologic balance on and off the permit area have been minimized and material damage outside the permit area has been prevented [ARM 17.24.314(5)]. The hydrologic balance is defined as "the relationship between the quality and quantity of water inflow to, outflow from, and storage in a hydrologic unit such as a drainage basin, aquifer, soil zone, lake, or reservoir, and encompasses the dynamic relationships among precipitation, runoff, evaporation, and changes in ground and surface water storage as they relate to uses of land and water within the area affected by mining and the adjacent area" [ARM 17.24.301(54)].

CHIA development involves the analysis of critical aspects of the hydrologic system within a defined cumulative impact area to predict the type and magnitude of impacts to the hydrologic system from proposed and existing mining. The CHIA process includes the following: 1) define the area to the studied, 2) describe the hydrologic system, the baseline values, and subsequent changes, 3) identify hydrologic resources likely to be affected, 4) develop criteria for evaluating the impacts, 5) estimate the impacts of mining on hydrologic resources, and 6) make a material damage determination and prepare a statement of findings.

3.0 PROPOSED PERMITTING ACTION

Signal Peak Energy, LLC (SPE) submitted Permit Amendment Application No. 3 that would increase the mine permit area of their underground coal mine (Bull Mountain Mine No. 1) by adding 7,161 acres and expanding the mine from five longwall panels (approved under Amendment 00187) to fourteen longwall panels (**Figure 3-1**). This area is included in 18 sections within Township 6 North, Range 27 East.

SPE is the operator of Montana's only active underground coal mine. The proposed plan includes room and pillar mining to develop nine additional panels for longwall mining. If approved, Amendment No. 3 would extend the permit boundary toward the northeast and increase the permit area by 7,161 acres for a total area of 14,896 acres. Total acreage of the underground mine plan would be 10,569 acres. Approval of this amendment would increase the potential of the ground surface (directly above the panels and within the angle of draw) to be adversely affected by subsidence caused by mining.

Approximately 20 acres of additional surface disturbance is expected as a result of this amendment. This amount of additional disturbance is necessary to construct temporary surface facilities that support underground mining. Temporary surface support facilities include boreholes, associated pads, power lines, and roads. No significant changes to the reclamation plan are proposed since Amendment No. 3 only addresses expansion of the permit area to allow continuation of underground mining. Plans for the mitigation of impacts to springs, seeps and drainages are included in SMP C1993017. Site-specific plans for the repair or mitigation of impacts related to subsidence or other mining impacts will be developed as they are identified, in consultation with DEQ and affected landowners.

If approved, Amendment No. 3 would add approximately 176 million tons of in-place coal reserves or 110 million tons of mineable coal. Of this, approximately 83 percent would be recoverable (91 million tons of coal.

3.1 BACKGROUND & MINING HISTORY

Bull Mountain Mine No. 1 (**Figure 4-1**) is approximately 15 miles southeast of Roundup, MT in Musselshell and Yellowstone counties. Mining Permit C1993017 was originally issued to Meridian Minerals on October 15, 1993, transferred to Glacier Park Company on September 25, 1995, transferred to Mountain Inc., on November 20, 1995, and to BMP Investments, Inc. (BMPII) on July 2, 2002. BMPII was renamed Bull Mountain Coal Mining (BMCM), Inc. on December 13, 2006 and the permit was transferred to SPE on September 15, 2008.

Coal fields in the area extend from the Bull Mountains to just north of Roundup and the Musselshell River (Perry, 1962). Mining in the greater region began in the early 1880's, and commercial mining was underway by about 1906. Coal was shipped to smelters and used as a source of fuel for the railroads (Slagle and others, 1986). All of the mines near the town of Roundup were abandoned by 1956. By the mid-1980's, the last few mines operating in the coal field were located south of Roundup in the Bull Mountains and included the P.M. Mine, the Divide mine, and the Storm King Mine (Slagle and others, 1986) (**Figure 3-2**). These mines mined the Mammoth Coal seam underlying the Bull Mountains that is approximately 10 feet to 15 feet in thickness.

The largest mines were the Divide (or Carlson) mine and the adjacent Gildroy mine, each with about 70 to 80 acres of underground room and pillar mining. These mines are approximately 1.5 miles south of

the Bull Mountains Mine No.1 portals area and extracted Mammoth Coal. Two mines, the P.M. Mine and Meridian Test Pit (**Figure 3-2**), are the predecessors of Bull Mountains Mine No.1. The P.M. Mine included 51 acres of room and pillar mining. The Meridian test pit included 90 acres of strip mining that were reclaimed upon completion of mining. The P.M. Mine was operated as an underground coal mine in the 1930's that was converted to a surface mine in 1972 by the Maged Family. In 1989 Meridian Minerals Company (Meridian) opened the Meridian Test Pit surface mine to the southeast. P.M. Coal Company then reopened the underground mine in 1991. The Meridian Test Pit surface mine and the underground mine combined were termed the Bull Mountains Mine. The remaining mines in the area were all much smaller underground operations that used room and pillar or other simple mining techniques and have been abandoned. The majority of mines are located where the Mammoth Coal crops out at the surface, and it is the coal seam that was most likely mined.

3.2 CURRENT MINING OPERATIONS

Coal at Bull Mountains Mine No. 1 is recovered using continuous mining and longwall mining methods. Continuous mining includes cutting parallel entries (main entries) approximately 8 to 10 feet high by about 20 feet wide intersected by regularly spaced tunnels or crosscuts. Pillars or unmined areas between the entries and crosscuts are the primary supports of the mine. This method of mining is known as "room-and-pillar mining" and is used primarily for developing entries necessary for transportation, ventilation, utilities, and providing access to longwall panels.

Longwall mining requires a significant amount of up-front preparation, or "development" using continuous mining methods. In order to supply power, water, air, and safe transportation corridors to the longwall panels, a set of parallel entries must be established. These main entries, or "mains," are designed to remain intact for the life of mine, and allow access to the longwall panels via "gate roads". Gate roads are driven roughly perpendicular to the mains, and consist of three parallel entries. Besides providing worker access to the longwall panels, gate roads are vital for the installation of longwall equipment, ventilation of the working area, and transportation. Once gate roads have been developed around a panel, the longwall equipment can be installed.

Longwall mining is a method that removes all coal from each longwall panel, effectively achieving 100 percent coal extraction, and causes surface subsidence. Longwall mining uses a series of hydraulic supports, or shields, set up along the longwall face that function as temporary supports to protect workers and equipment. A cutting machine or shearer moves back and forth along the coal face and line of shields, cutting the coal in a series of passes. After the shearer completes a pass the entire system (shields, shearer, and face conveyor) advances (perpendicular to the shearer) and unsupported overburden is allowed to collapse into the void formally occupied by coal.

At full production SPE is capable of mining longwall panels at a rate of 11,000,000 tons of raw coal per year. This is equivalent to the longwall face advancing approximately 55 feet per day. However, actual production rates are expected to be less. Each gate road is designed to stay open for the first panel, but yield as the adjacent panel is mined-out, mining out of sequence would limit access to some panels and limit coal conservation. Panels must be mined in sequential order to achieve maximum coal recovery.

4.0 REGIONAL OVERVIEW

The permit and proposed amendment area of Bull Mountains Mine No.1 is located in the Bull Mountains in central Montana, within the Northern Great Plains physiographic province (**Figure 4-1**). The Bull Mountains lie within the drainage basins of the Yellowstone River and the Musselshell River. The lands to the north of the Bull Mountains drain to the Musselshell River while the lands to the south drain to the Yellowstone River. The majority of the proposed permit amendment area is located within the Rehder Creek and Fattig Creek drainages, which are tributaries of the Musselshell River.

Differential erosion of rocks of varying hardness and resistance is the main process active in forming the present landscape. The underlying rocks are composed of interbedded shales, claystones, siltstones, coals, and sandstones; however, the high mesas and ridges are capped by "clinker". Clinker is a term used to describe the baked sedimentary rocks resulting from burning of underlying coal beds. The shales and claystones tend to be easily eroded, while the sandstone and clinker are more resistant to erosion. Sheet and rill erosion are active geomorphic processes in the upper drainage basins, and mass wasting occurs locally along the steep-walled ridges. Ephemeral streams occur throughout the area; intermittent flow, which may occur on lower reaches of Rehder and Fattig creeks during wet years, has been observed along portions of the streams supported by springs or seeps associated with groundwater base flow.

Vegetation in the Bull Mountains Mine No. 1 study area includes silver sagebrush-mixed grasslands, mixed grasslands, ponderosa pine-mixed grassland, burned ponderosa pine-mixed grassland, and relatively small areas of improved pasture and wetlands. In 1984 an intense fire burned much of the forest leaving many scattered charred logs and dead trees. Currently the burned area is dominated by grasses.

4.1 CLIMATE

The climate of south central Montana is classified as semiarid continental. Precipitation and temperature measurements have been collected at the mine and also at the nearby climate stations at Roundup, MT (National Weather Service Cooperative Observer ID 247214) and Billings, MT (National Weather Service Cooperative Observer ID 240807). Climate data are available from the Western Regional Climate Center (WRCC, 2013) with temperature and precipitation records for Roundup and Billings going back to 1914 and 1948, respectively.

Figure 4-2 shows average precipitation data from the past 30 years at Roundup and Billings, MT. The average annual precipitation (1983-2012) at Roundup (elevation 3,230 ft) is 13.58 inches and Billings (elevation 3,570 ft) is 13.36 inches. The average peak precipitation month is June at Roundup (2.53 inches) and May at Billings (2.21 inches), while the average minimum monthly precipitation occurs in January at Roundup (0.37 inches) and December at Billings (0.46 inches).

4.2 TOPOGRAPHY

The topography in the mine area consists of gently sloping valleys bounded by moderately steep to very steep ridges capped by isolated sandstone and clinker mesas. Elevations range from approximately 3,700 to 4,700 feet above mean sea level. Surface slopes vary from zero to 15 percent in the vicinity of

the proposed surface facilities and up to 50 percent or more in the higher elevations of the Bull Mountains.

4.3 GEOLOGY

Alluvial deposits (gravel, sand, and silt) are generally unconsolidated and typically occur in ephemeral drainages or areas of lower elevation in the stream and valley bottom areas. Alluvial deposits are generally less than 40 feet in thickness.

The Bull Mountain coal region and vicinity is underlain by a sequence of sedimentary rocks that comprise the Bull Mountain Basin. This sequence of rocks is comprised of an alternating sequence of sandstones, siltstones, shales, carbonates, clinker, and coal approximately 12,000 feet in thickness that range from early Paleozoic to Tertiary in age. The basin is underlain by Precambrian metamorphic basement rocks (Wheaton, 1992). The sedimentary sequence was deposited or formed in a single depositional center of the Powder River Basin but is now isolated or separated from the main basin due to post-depositional tectonics and erosion.

Tertiary age continental rocks of the Tongue River Member of the Fort Union Formation are the principal rock units disturbed by longwall mining at the Bull Mountains Mine No. 1. Rocks of the Tongue River Member consist of interbedded siltstones, sandstones, shales and coals and form the bedrock under the mine area where they extend to depths in the range of about 1100 feet below the base of the Mammoth Coal. **Figure 4-3** illustrates the general geologic relationships in the region. **Figure 4-4** shows a detailed lithologic column for the Bull Mountains (Meridian, 1990). It represents about 1250 feet of the uppermost portion of the Tongue River Member occurring at Bull Mountains. Rocks of the Tongue River Member are situated in a broad (approximately 10 miles) and relatively long (axial trace of approximately 15 miles) north-northwest plunging syncline (less than one degree) that includes the Mammoth Coal. This area includes approximately 150 square miles.

A general description of the shallow stratigraphy of the Tongue River Member includes:

- Overburden rocks include interbedded siltstones, sandstones, shales, clinker, and coal above the Mammoth Coal. These rocks thicken toward the north-northwest or along the plunge of the syncline and range from approximately 200 feet to over 800 feet in thickness. Clinker, a reddish-brown, commonly brecciated pyro-metamorphic rock formed by prehistoric coal fires, occurs throughout the study area and commonly caps ridges or areas of higher elevation.
- Rocks of the Mammoth Coal occur immediately below overburden rocks. This coal seam is the principal economic seam in the area and varies in thickness from eight to ten feet within the permit boundary.
- Underburden rocks are similar to rocks of the overburden and are divided into the upper (immediately below the base of the Mammoth Coal) and deeper overburden.

5.0 CUMULATIVE IMPACT AREA

A cumulative hydrologic impact area (CIA) is defined by ARM 17.24.301(31): '"Cumulative hydrologic impact area" means the area, including, but not limited to, the permit and mine plan area within which impacts to the hydrologic balance resulting from the proposed operation may interact with the impacts of all previous, existing and anticipated mining on surface and ground water systems'. "Anticipated mining" includes the entire projected life through bond release of all permitted operations and all operations required to meet diligent development requirements for leased federal coal for which there is actual mine-development information available. The size and location of a given CIA will depend on the surface water and groundwater system characteristics, the hydrologic resources of concern, and projected impacts from the operations included in the assessment. For this CHIA, a surface water CIA and a groundwater CIA are delineated to assess impacts associated within these distinct hydrologic resource areas.

5.1 SURFACE WATER CUMULATIVE IMPACT AREA

The surface water CIA includes all areas that may see a measurable change in water quantity or water quality due to mining activities at the Bull Mountains Mine. The surface water CIA is presented in **Figure 5-1**.The CIA extends beyond the proposed Amendment No. 3 boundary and includes Rehder Creek to its confluence with Halfbreed Creek, and Fattig Creek to stream monitoring station 52996, both of which flow north to the Musselshell River. The CIA extends southward to include a number of named and unnamed ephemeral watercourses that flow south from the Bull Mountains to the Yellowstone River. CIA boundaries were established to allow evaluation of any potential impacts to streams, springs, and ponds that could reasonably be affected by present and future mining operations on and off the permit area. The CIA boundaries are established downgradient from potentially affected streams and springs, and include all surface water monitoring stations to allow assessment of impacts to stream water quality and quantity. Likewise, the CIA extends southward to include springs and ephemeral stream channels that could potentially be affected by subsidence-related changes in hydrology as Dunn Mountain and the southern portions of the permit area are undermined.

5.2 GROUNDWATER CUMULATIVE IMPACT AREA

The groundwater CIA boundary is based on the anticipated or potential extent of impacts to groundwater affected by mining based on the hydrology of the mine area. Potential impacts to groundwater include changes to water level or water quality such that the resource is no longer available or suitable for established uses.

The groundwater CIA is presented in **Figure 5-2**. This area is drawn to include mining-induced groundwater impacts from drawdown of the Mammoth Coal and underburden aquifers, as well as impacts upon shallow aquifers (alluvium and shallow fractured bedrock) from operations (ponds, conveyors, storage areas including fueling and laydown areas) within the facilities area, and impacts from the Waste Disposal Area (WDA). Water storage areas or ponds, pipelines, conveyors, fuel and other storage areas including the WDA have the potential to affect the shallow groundwater system of Rehder Creek and its tributaries such as PM Draw. Also, any mining-induced water quality impacts are expected to be contained within the CIA.

Results of the new transient flow model (Nicklin, 2013[2]) indicate that drawdown in the upper underburden and Mammoth Coal aquifers immediately after the cessation of mining would extend approximately three miles down gradient of the permit boundary to the northwest and generally extend to the outcrop of the Mammoth Coal in the cross and up gradient directions (**Figure 5-2**).

The groundwater CIA includes a buffer area around the modeled upper underburden five-foot drawdown contour and is also extended around the facilities area. The modeled drawdown for the upper underburden is used to define the CIA instead of the drawdown for the Mammoth Coal because drawdown in the upper underburden has a greater areal extent.

6.0 WATER RESOURCE USES

Historic and current surface and groundwater uses in and adjacent to the mine area include domestic, livestock, wildlife, and industrial uses. Wells located within and immediately adjacent to the CIA were identified from the Montana Bureau of Mines and Geology, Groundwater Information Center (GWIC). Registered surface water and groundwater rights were identified from records at the Montana Department of Natural Resources and Conservation (DNRC). Groundwater users (wells and groundwater rights) are shown in **Table 6-1** and **Figure 6-1**, and surface water users (surface water rights) are shown in **Table 6-2** and **Figure 6-2.**

6.1 DOMESTIC

Domestic use is indicated in GWIC or DNRC records for 33 wells within the groundwater cumulative impact area. Domestic or private wells in the area generally produce water under confined conditions from relatively deep underburden sandstones that are hydrologically separated from the upper underburden aquifer and Mammoth Coal, although a few domestic wells are completed in the upper underburden. Office Supply Well No. 1 (OSW), which supplies water to the mine office facilities, also produces from the deep (355 to 405 feet) and relatively thick (50 feet) underburden sandstones.

6.2 INDUSTRIAL

Three industrial supply wells, currently used for mining operations are completed in carbonate rocks of the Madison Group, at depths greater than 8,700 feet. These wells produce hot (approximately 165°F) and highly mineralized water that is isolated from the shallow aquifers of the Fort Union Formation by thousands of feet of confining rock units. The water contains concentrations of fluoride and radionuclides in excess of drinking water standards for groundwater that make the deep Madison well water unsuitable as potable water. Shallow aquifers disturbed by mining (i.e., overburden, Mammoth Coal and upper underburden) are not expected to have an effect on aquifers of the Madison Group.

Groundwater extraction from the Madison aquifer is expected to be approximately 600 acre-feet per year and will not have a significant drawdown effect on the aquifer. The nearest Madison well off site is approximately 20 miles from the mine and calculations indicate that the radius of influence of the Madison Group wells in use at the mine is limited to several miles (DNRC, 2012).

Industrial water from the Madison wells is stored in Madison Pond No. 1, a lined pond used by the mine for coal processing in the preparation plant, and to control road dust and dust generated during mining. Wastewater generated from the preparation plant and underground dust control is filtered and re-used in a closed-loop system.

6.3 AGRICULTURE

Livestock watering is the dominant water use in the CIA, and surface water, springs, and groundwater wells in the CIA area are used for livestock watering. Water quality in surface water, springs, and shallow wells is variable and may change seasonally with the availability and use of the water source. Deeper wells provide a more consistent and reliable water source.

60 wells that lie within the groundwater CIA are identified for stockwater use in the GWIC and DNRC databases. The completion depths listed for stockwater wells indicate that groundwater resources used for supply include alluvium, overburden, coal, and upper and deep underburden aquifers. There are also 46 groundwater rights listed for stockwater use at springs in the groundwater CIA. These springs are primarily sourced from overburden aquifers with a few sourced by the Mammoth Coal.

Livestock are listed as the use at 30 of the 34 surface water rights within the surface water CIA in the DNRC database. Livestock use of surface water is typically directly from the source or at a stock pond. The remaining four surface water rights are listed for irrigation use. Nearly half of the surface water rights in the surface water CIA are owned by SPE.

6.4 AQUATIC AND WILDLIFE HABITAT

Aquatic plants, macroinvertebrates, and vertebrates are associated with springs and ponds in the permit area. Fish have not been found in any of the ponds or stream reaches, and no threatened or endangered aquatic species or habitat has been identified in the area. Aquatic species are associated predominantly with stock ponds and rely on spring-water inputs for the maintenance of habitats.

7.0 MONITORING PROGRAM

Surface water and groundwater monitoring programs have been implemented at the Bull Mountains Mine No. 1 and are the basis for assessment of mining impacts on water resources. Monitoring has been designed to collect water quantity and quality information pertinent to the evaluation of impacts. The monitoring plan identifies parameters, sampling frequency, geologic units monitored, and site locations. All current monitoring sites are shown on **Figure 7-1** and **Figure 7-2**. A list of currently required analytical parameters is shown in **Table 2-2**. Quality assurance is an essential part of analytical requirements.

In addition to monitoring requirements issued under Mine Permit C1993017, the Bull Mountains Mine No. 1 also monitors MPDES-regulated discharges from the facilities and waste disposal areas, as directed under MPDES Permit No. MT0028983. The Bull Mountains Mine has eight outfalls under the MPDES Permit, of which six discharge to PM Draw and two discharge to Rehder Creek.

As mining proceeds or potential impacts are anticipated, the monitoring plan is revised to accommodate changes, including replacement of monitoring sites or development of new sites. Monitoring is required to continue through the final phase of bond release.

7.1 SURFACE WATER

Surface water monitoring began in 1989 with the original permit applicant, Meridian. Baseline surface water quality and quantity data were collected by Meridian from 1989-1991 as required by ARM 17.24.304. Monitoring resumed in 2003 when BMPII, assumed the surface mining permit from Meridian. Currently Signal Peak Energy operates the mine and collects surface water monitoring data associated with streams, springs, and ponds in accordance with ARM Section 17.24.314 (Permit C1993017, Vol. 3, Section 314, Protection of the Hydrologic Balance).

Streamflow is typically ephemeral in nature, with local spring inputs forming wet areas or short reaches of streamflow before infiltration into the alluvium. Flow from most springs is dependent upon precipitation and recharge of shallow perched aquifers that feed area springs and seeps. Continuous flow is therefore infrequent to rare.

Stream monitoring consists of the collection of water quality parameters and flow measurements at 12 established surface water monitoring stations within and outside of the permit area. Streams are sampled for a variety of field parameters, analytical constituents, peak flows, and instantaneous flows (**Table 7-1**). The stream monitoring network is shown in **Figure 7-1**.

Spring (spring and seep) monitoring consists of collection of water quality parameters and flow measurements at 81 established monitoring stations on and off the permit area. Springs are sampled for a variety of field parameters, analytical constituents, peak flows, and instantaneous flows (**Table 7-1**). The spring monitoring network is shown in **Figure 7-1**.

Pond monitoring consists of collection of field parameters at 16 established stock pond monitoring stations. Measurements are scheduled monthly at 13 ponds and semi-annually at 3 ponds. Parameters associated with pond sampling are field parameters only, as included in **Table 7-1**. The pond monitoring network is shown in **Figure 7-1**.

7.2 GROUNDWATER

Meridian installed the majority of the wells in the original monitoring network at Bull Mountains Mine No. 1 between 1989 through 1991. A number of wells installed by the Montana Bureau of Mines and Geology (MBMG) as early as 1981 were incorporated into the monitoring network that included 110 monitoring wells by 1995. With the exception of MBMG wells and a few wells that were transferred to landowners, the Meridian monitoring wells were abandoned and reclaimed after the Bull Mountains Mine No. 1 closed in 1998.

In 2002 and 2003, BMPII constructed a new monitoring network for the Bull Mountains Mine No. 1. The new monitoring wells were designed and completed to monitor the same stratigraphic interval in the same general location as the former monitoring wells. In some cases, new well construction differed from construction of the former well due to different drilling conditions and other limitations or purposes. BMCM reinstated the frequency and type of groundwater monitoring specified in the Meridian permit document including water level measurements, water chemistry field parameters, and groundwater quality sampling and laboratory analyses. While data from the original set of wells can generally be compared with data from the new wells, differences in well construction or monitoring methods and techniques create problems that prevent comparison of water level and water quality data between the old and new monitoring networks.

The monitoring plan was revised and updated in 2012. Currently, there are 105 groundwater wells which are monitored: 42 alluvial, 28 overburden, 15 Mammoth Coal, and 20 underburden (**Figure 7-2**). The existing groundwater monitoring wells and schedule are shown in **Table 7-2**. As overburden collapses into the void where Mammoth Coal has been removed, future groundwater monitoring wells will be installed in the gob to monitor the quality and quantity of water as the depleted aquifer is recharged.

8.0 BASELINE HYDROLOGIC CONDITIONS

The goals in establishment of baseline hydrologic conditions are to characterize the local hydrology, understand the regional hydrologic balance, and identify any water resource or water use that could be affected by the mining operation.

The hydrologic and geologic data required to evaluate baseline hydrologic conditions, probable hydrologic consequences, and cumulative hydrologic impacts of mining was collected by the original permit applicant, Meridian, from 1989-1991 and submitted with the initial permit application, and are discussed in detail in Sections 17.24.304(1)(e) and (f), respectively, of Mine Permit C1993017.

Baseline hydrologic and geologic data of the permit area and adjacent area of potential hydrologic impact were collected from a number of sources including literature review, hydrogeologic field reconnaissance, static water level measurements, aquifer tests, groundwater and surface water sampling and well and spring inventories. Monitoring data were collected by Meridian, the Louisiana Land and Exploration Company (LL&E), Yellowstone Coal Company, the P.M. Mine, Consolidation Coal Company, the United States Geological Survey (USGS), MBMG, and the Mine Safety and Health Administration (MSHA).

Baseline monitoring in the area was begun by LL&E as early as 1980. MBMG began monitoring the area in 1981 with the installation of eight monitoring wells. During baseline monitoring between 1989 and 1991 by Meridian and MBMG, a total of 3509 flow and water level measurements were taken, 614 water quality samples were collected, 59 aquifer tests were performed, and continuous flow data from three surface water sites and one spring were collected. In addition, narrative descriptions of surface drainage and channel characteristics were included in baseline water quality and quantity assessments.

Although the mining permit was originally issued to Meridian in the fall of 1993, substantial mining and disturbance at the mine site did not occur until mining by SPE began in 2008. Data collected by BMPII. and SPE from 2003 to 2008 may be considered baseline data for the purposes of impact assessment, and in some cases data collected from 2008 to present may also be considered baseline data where it was collected outside the area of mining influence (i.e. Fattig Creek drainage).

8.1 SURFACE WATER BASELINE

Surface water baseline conditions were derived from a network of surface water monitoring stations (springs/seeps, streams, ponds) established during initial permit development and include data predominantly from 1989 through 1991. Data collection resumed in 2003 with the onset of mining activities and continues presently.

8.1.1 Surface Water Regime

The region is drained by tributaries of the Musselshell and Yellowstone Rivers north and south of the permit area, respectively. Tributaries within and in the vicinity of the permit area that drain north to the Musselshell River include Fattig Creek, Rehder Creek, East Parrot Creek and Halfbreed Creek. Tributaries that drain south to the Yellowstone River include Pompey's Pillar Creek, Railroad Creek, and Razor Creek. There are no perennial streams within the surface water cumulative impact area. The nearest perennial stream of consequence is lower Halfbreed Creek which flows into the Musselshell River approximately 18 miles to the north. Tributary streams in the area are generally ephemeral and have

deeply cut valleys that often flood after heavy rains (Woolsey and others, 1917). Some drainages within the project study area contain intermittent reaches, which vary from year to year depending upon precipitation received in the contributing drainages and the amount of spring output contributing to baseflow.

8.1.2 Surface Water Quantity

Baseline water quantity data consists primarily of data collected from 1989 through 1991, and includes flow and/or water level data for streams, springs/seeps, and ponds. Streamflow in the study area are typically ephemeral, with short reaches supporting intermittent streamflow during wet years or periods of prolonged or above average precipitation. Typically streams flow only in response to seasonal snowmelt, precipitation events, or directly below spring inputs from local perched aquifers. The shallow alluvium or colluvium and bedrock outcrops in the study area are generally conducive to natural spring discharges. These springs are an expression of groundwater as geologic units crop out. At these outcrops, surface flow is initiated. The length of the surface expression is dependent on a number of variables, including amount of flow, width, and depth of alluvium/colluvium, and landowner manipulation of the drainage for livestock use.

Landowner manipulation of spring inputs has a dominant effect on surface flow as indicated at the major springs in the permit area including numbers 14325 (Busse Water), 17415 (Litsky), and 16655 (Cold Water). At these locations, embankments have been constructed across the drainages to form ponds which impound water for livestock. These ponds control downstream drainage and in some cases the ponds are large enough to eliminate downstream flow. Ponds are typically located directly below spring issuances or directly atop the spring input and are a reflection of spring water inputs from shallow groundwater movement.

In the absence of immediate precipitation events or spring snowmelt, stream and pond water quantity is generally governed by spring inputs from shallow perched aquifers that respond to seasonal precipitation. In most years, streambeds are dry, except below spring issue points. Sustained streamflows were observed, however, in 1991 when 19.1 inches of precipitation was recorded in Roundup, an amount nearly six inches above the 30-year (1982-2011) annual average of 13.4 inches. Sustained streamflows on Rehder Creek and Fattig Creek were again observed from 2011 through 2013 as a result of well-above average precipitation during the spring of 2011 and 2013. Conditions observed during the baseline periods should therefore be viewed within the context of regional precipitation trends, and at times, represent conditions during a period of above-normal precipitation.

As mining progresses and coal is removed through the longwall mining process, subsidence of overburden has the potential to affect spring flows and, consequently, associated stream flows. Due to ephemeral conditions in potentially affected drainages, the limited streamflow data set precludes detailed analysis and establishment of typical numeric baseline streamflow conditions. Rather, potential impacts from mining activity are more readily evaluated through changes in groundwater discharge from springs and the location of issue points that feed established ponds and stream reaches.

Flowing or ponded baseline conditions were reported for 36 individual springs from 1989 through 1991. **Table 8-1** presents an estimated average flow rate for 30 springs with flows greater than 1.0 gpm during the baseline monitoring period, and represents baseline flow conditions for springs for the climatic conditions observed during the 1989-1991 baseline monitoring timeframe.

8.1.3 Surface Water Quality

Baseline surface water quality data consists primarily of data collected from 1989-1991, and includes field parameters and analytical water quality samples from streams, springs/seeps, and ponds. Precipitation at Roundup, MT during this period was 15.2, 11.6, and 19.1 inches, respectively. The 30-year average annual rainfall at Roundup is 13.4 in.

Baseline (1989-1991) stream water quality data consists of water quality samples (n=10) from eight stream-sampling locations. All samples were collected during runoff events and represent water quality associated with ephemeral stormwater flows; seven of the 10 samples were collected during a single major storm event in June 1991. **Table 8-2** presents summary water quality statistics for analytical water quality samples collected during this time frame. A low number of observations (n=10) and high variability among data results reflects the ephemeral event-driven nature of surface flows in the area. Ephemeral flows are typically high in suspended solids as they occur in response to storm-driven events, resulting in detects of several metals (iron, manganese, aluminum, zinc) associated with suspended sediment. Other, less common metals (cadmium, chromium, mercury, nickel, silver) were detected at very low levels, or were not detected at all in baseline samples. As sampling events were from stormwater events on ephemeral streams, numeric standards in Circular DEQ-7 do not apply (see Section 2.2.1).

Baseline pond water quality data (1991) consists of water quality samples (n=20) from 16 pond-sampling locations. **Table 8-3** presents summary water quality statistics for analytical water quality samples collected during the sampling time frame (05/91-08/91). Baseline pond water quality data was collected from May through July of 1991 during a period of unusually high precipitation and may not reflect typical conditions in the region, which typically are much dryer.

Baseline spring water quality data (1989-1991) consists of water quality samples (n=231) from 16 spring-sampling locations. Spring water quality data is comparable to overburden water quality; sulfate and total dissolved solids (TDS) ranged from 11 mg/L to 3,020 mg/L and 226 mg/L to 6,030 mg/L and averaged 466 mg/L and 1,118 mg/L, respectively. **Table 8-4** presents summary water quality statistics for analytical water quality samples collected during this time frame.

In addition to baseline spring water quality data collected by Bull Mountains Mine No 1, Wheaton and Donato (1991) reported concentrations of sulfate and TDS collected in 1978 from six seepage sites along Halfbreed Creek just west of the permit area. Respective sulfate and TDS concentrations ranged from 370 mg/L to 640 mg/L and 947 mg/L to 1,460 mg/L and averaged 508 mg/L and 1,182 mg/L. Similarly, Wheaton and Donato (1991) reported concentrations of sulfate and TDS from eleven springs in the vicinity of the permit area. Respective sulfate and TDS concentrations ranged from 11 mg/L to 2,400 mg/L and 420 mg/L to 4,170 mg/L and averaged 615 mg/L and 1,592 mg/L.

8.2 GROUNDWATER

Baseline water level and water quality were measured in the alluvium, overburden, Mammoth Coal, and underburden during the baseline period 1989 - 1991. Monitoring continued during ownership by subsequent operators, but most of the monitoring wells used to determine baseline conditions were abandoned when the mine closed in 1998. A new network of 121 monitoring wells was completed in 2002 and 2003 by BMPII and continued to monitor baseline conditions as substantial mining disturbance had not yet occurred.

8.2.1 Groundwater Regime

Groundwater in the mine area occurs in the alluvial, overburden, Mammoth Coal, and underburden aquifers. Groundwater flow is generally toward the north-northwest except in the often dry alluvial aquifer system. Contiguous rock units including the sandstone above the Rock Mesa Coal (lower overburden aquifer), the Mammoth Coal, and the underburden are saturated across much of the study area.

Aquifer tests were performed by the MBMG and Meridian from 1982 through 1991. Aquifer tests results are summarized in **Table 8-5**. These results show a wide range of hydraulic conductivity (geometric mean between 28 and 0.013 feet per day) that decreases with depth. For example, unconsolidated alluvium has a hydraulic conductivity that is four orders of magnitude greater than that of the underburden. Storage coefficients were determined by 11 aquifer pumping tests in bedrock aquifers. These results indicate a wide range of storage coefficients in the overburden and the Mammoth Coal ranging from 1×10^{-3} to 6×10^{-6}. The underburden values were even wider in range, from 1×10^{-1} to 4×10^{-6}. In general, this indicates that groundwater typically occurs under confined conditions in bedrock aquifers.

8.2.2 Alluvial Baseline

Alluvial sediments locally are up to 20 feet in saturated thickness but are generally dry in the permit area except following periods of significant precipitation. Alluvial baseline water quantity was determined by a network of 25 relatively shallow monitoring wells completed in alluvium that occurs in the valley bottoms of the larger ephemeral stream channels. Alluvial material is not a major aquifer in the region due to its limited saturation and areal distribution.

Measurements from baseline alluvial wells indicated that the alluvial aquifer is generally dry in the permit area and becomes partly saturated in Rehder Creek near the northern border of the permit boundary. Alluvial groundwater flow in Rehder Creek is toward the west-northwest (downstream). The alluvium of ephemeral tributaries from the permit area into Rehder Creek is generally dry and becomes partly saturated along short reaches due to spring discharge and during significant seasonal precipitation events.

Alluvial baseline water quality was determined by monitoring 11 wells (**Table 8-6**). Data from these wells indicate that alluvial groundwater in the permit area and vicinity is generally of a magnesium-sulfate or magnesium-bicarbonate composition. Specific Conductance (SC) ranged between 759 μS/cm and 2,360 μS/cm with a mean of 1,625 μS/cm, and sulfate concentrations ranged from 143 mg/L to 1,000 mg/L with a mean of 535 mg/L. Alluvial groundwater ranged between Class I and Class II water (**Table 2-4**). However, most alluvial groundwater quality falls into Class II. Water quality of most alluvial groundwater is suitable for livestock.

8.2.3 Overburden Baseline

Overburden rocks are commonly over 200 feet in thickness and range to over 800 feet in thickness within the permit boundary. Shallow overburden groundwater is typically unconfined, perched, and often moves laterally along sedimentary layers before discharging as springs, seeps, or into alluvium (**Figure 4-3**). Water levels in the perched aquifers and spring flow issuing from them are strongly influenced by seasonal and periodic fluctuations in precipitation. Deeper overburden groundwater occurs in sandstones stratigraphically above the Rock Mesa and the Mammoth Coal seams (**Figure 4-4**).

These sandstones are up to 80 feet in thickness. Flow in these sandstones is generally toward the north-northwest, nearly coincident with the synclinal structural axis.

Overburden baseline groundwater quantity was determined by a network of 26 groundwater wells. Where saturated, overburden groundwater occurs under both confined and unconfined conditions depending upon the proximity to the outcrop. Baseline data indicate that overburden groundwater is associated with alternating perched aquifers and rock units of low permeability and unsaturated rocks that extend to approximately 100 feet in depth. However, deeper overburden rocks are saturated and in hydrologic connection with the underlying strata. 12 of the 26 baseline overburden monitoring wells were completed in sandstones within the lower overburden above the Rock Mesa and the Mammoth Coal seams.

16 wells were used to determine the baseline water quality of the overburden aquifer (**Table 8-7**). Water in the overburden wells is generally of sodium-bicarbonate or sodium-sulfate composition, and is relatively poor in quality due to high sulfate and SC. Overburden baseline SC ranged from 464 μS/cm to 3,330 μS/cm, with an average of 1,644 μS/cm, and sulfate concentrations ranged between 12 mg/L and 1,410 mg/L, with an average of 1,143 mg/L and 457 mg/L. Water sampled from overburden wells ranged from Class I through Class III groundwater, but most wells produce Class II water. Only wells 30-2 and 62721-10W, located east and upgradient of mining, had water classified as Class I groundwater. Locally, baseline water quality within the deeper overburden wells is suitable for livestock.

8.2.4 Mammoth Coal Baseline

The west margin of the Mammoth Coal crops out at the mine portal. Near the western margin, the coal is dry but becomes saturated and eventually becomes confined toward the synclinal axis. Groundwater flow in this unit is toward the north-northwest, following the direction of synclinal plunge. Recharge reaches the Mammoth Coal via exposed outcrops, subcrops, and from infiltration through the overburden.

The geometric mean hydraulic conductivity of the Mammoth Coal is 0.16 ft/day (**Table 8-5**). Although the hydraulic conductivities for the Mammoth Coal are relatively higher than the overburden, they are typically inadequate to provide a reliable source of well water and few production wells are completed in the coal. **Figure 8-1** illustrates the potentiometric surfaces in the Mammoth Coal and in overburden sandstones above the Rock Mesa Coal. Water levels indicate that the Mammoth Coal aquifer is isolated from overlying overburden aquifers.

Mammoth Coal baseline groundwater quantity was determined by a network of 14 groundwater wells. Water levels in most Mammoth Coal wells showed little natural fluctuation and did not vary more than two feet over the period of baseline monitoring, except in one well near the Mammoth coal outcrop which showed larger fluctuations apparently in response to precipitation.

Baseline water quality of the Mammoth Coal aquifer was determined from samples from 10 wells (**Table 8-8**). Generally, sodium and sulfate are the dominant ions in groundwater collected from most Mammoth Coal monitoring wells. SC and sulfate baseline concentrations in the Mammoth Coal tend to be greater than in the overburden. SC ranged from 1,400 μS/cm to 3730 μS/cm with an average of 2,272 μS/cm. Sulfate concentrations ranged from 251 mg/L to 1,690 mg/L, with an average of 798 mg/L.

Mammoth baseline groundwater samples fall into Class I through Class III groundwater. However, water from most Mammoth Coal wells is Class II groundwater. Mammoth Coal groundwater is generally suitable for watering livestock.

8.2.5 Underburden Baseline

In the context of the mine permit, the term underburden refers to rocks below the base of the Mammoth Coal. Generally, the underburden aquifer can be divided into two distinct aquifers: 1) the upper underburden aquifer immediately below the base of the Mammoth Coal that is hydraulically connected to the Mammoth Coal, and 2) the deep underburden sandstones hydraulically isolated from the upper underburden aquifer that typically occur hundreds of feet below the base of the Mammoth Coal.

The upper underburden has very low conductivities with a geometric mean of 0.013 ft/day and does not supply substantive amounts of groundwater to wells. The deep underburden is characterized by a 50-foot thick massive fluvial sandstone at a depth of approximately 350 feet below the Mammoth Coal. The deep underburden provides much of the domestic and livestock well water in the vicinity of the mine, including the office supply well used by the mine. A pump test of the office well completed in these deep sandstones indicated a hydraulic conductivity of 3.8 feet per day, which is two orders of magnitude higher than the conductivities of the upper underburden and the Mammoth Coal (**Table 8-5**).

Underburden baseline quantity was determined from a network of 19 wells. Groundwater in the upper underburden generally occurs under confined conditions and flows north-northwest like the overlying aquifers.

Baseline water quality of the upper underburden was determined by 12 monitoring wells (**Table 8-9**). The baseline water quality of the upper underburden is similar to that of the Mammoth Coal. Sulfate was the dominant anion and sodium tended to be the dominant cation. Underburden groundwater generally fell into Class II and III. Respective SC and sulfate concentrations of the upper underburden aquifer ranged from 1,440 μS/cm to 4,280 μS/cm and 216 mg/L to 2,680 mg/L. Average SC and sulfate concentrations were 2,721 μS/cm and 1,121 mg/L. Upper underburden wells are typically suitable for livestock use, and some are marginally suitable for domestic use. Water quality analysis of a sample from the office well completed in the deeper underburden indicated Class I groundwater, and is suitable for the mine public water supply. Most deeper underburden wells are suitable for domestic and livestock use.

9.0 HYDROLOGIC IMPACT ASSESSMENT

As required by ARM 17.24.314(5), DEQ must provide an assessment of the cumulative hydrologic impacts of the proposed operation and all anticipated mining upon surface and groundwater systems in the cumulative impact area. The assessment must be sufficient to determine if the Bull Mountains Mine No. 1 operation has been designed to prevent material damage to the hydrologic balance outside the permit area. This process takes into account the measures to be taken during and after mining to minimize impacts to the hydrologic balance, and evaluates hydrologic monitoring data with respect to these measures to determine whether impacts to the hydrologic balance have been minimized and material damage prevented. Material damage criteria include Montana water quality standards and water quality criteria to support the approved post-mine land use.

To prevent material damage outside the permit area, action thresholds have also been established for surface water and groundwater inside the permit area in order that potential water quantity or quality impacts are anticipated and mitigated prior to reaching levels that exceed standards or impinge on designated uses (**Table 2-1**).

9.1 MINIMIZATION OF IMPACTS

Montana's Strip and Underground Mine Reclamation Act requires permit holders to employ measures to minimize disturbance to the hydrologic balance. Per ARM 17.24.314(1), the proposed measures must minimize disturbance of the hydrologic balance sufficiently to sustain the approved postmining land use and the performance standards of subchapters 5 through 12 and must provide protection of:

a) the quality of surface and ground water systems, within both the proposed mine plan and adjacent areas, from the adverse effects of the proposed strip or underground mine operations;
b) the rights of present users of surface and ground water; and
c) the quantity of surface and ground water within both the proposed mine plan area and adjacent areas from adverse effects of the proposed mining activities, or to provide alternative sources of water in accordance with ARM 17.24.304(1)(e) and (f) and 17.24.648, where the protection of quantity cannot be ensured.

Among these measures are requirements and performance standards given for a variety of processes and activities. These include requirements and standards for drainage control, pond design and maintenance, sediment control, road design and maintenance, reclamation, permitted discharges to surface waters, and protection of undisturbed drainages. In addition, adherence to Best Technology Currently Available (BTCA) and Best Management Practices (BMPs) in the design and implementation of equipment, devices, systems, methods, and techniques is required for the minimization of hydrologic disturbance. These requirements and performance standards established in ARM 17.24 subchapter 5 through subchapter 12 are incorporated into operation and reclamation plans included throughout the Bull Mountains Mine No. 1 surface mining permit (SMP C1993017), and have been reviewed and approved by DEQ.

9.2 HISTORIC, PRE-LAW MINING

Past coal mining in the area include the P.M. Mine and some historic, small-scale operations along the Mammoth Coal outcrop that utilized room and pillar methods, which resulted in some limited residual

subsidence (USDI, 2011). Existing residual impacts from historic coal mining in the area near the Bull Mountains Mine No.1 are unknown, as water quality data for these historic mining areas is unavailable.

Water quality data from underground coal mines to the north of the CIA (near Roundup, MT), however, is available. Water quality data reported by Reiten and Wheaton (1988) indicate that the average groundwater concentrations of TDS and sulfate at underground coal mines in the Roundup area, sampled between 1910 and 1986, were 1,324 mg/L and 659 mg/L, respectively. Later, Wheaton (1992) again reported concentrations of TDS and sulfate in the groundwater of coal mined areas near Roundup collected between 1986 and 1991. Average TDS and sulfate concentrations were 2,647 mg/L and 1,445 mg/L, respectively.

These data do not represent water quality at the Bull Mountains Mine No. 1, but are presented to illustrate that residual water quality from abandoned mines in the area near Bull Mountains have the potential to influence water quality where historic workings are in close proximity to existing monitoring wells. At this time, it is unknown whether historic workings have influenced water quality in the Bull Mountains area, however no residual impacts from historic mining have been identified.

9.3 ALLUVIAL VALLEY FLOORS

As defined in 82-4-203(3)(a) and (b), MCA, "'Alluvial valley floor' means the unconsolidated stream-laid deposits holding streams where water availability is sufficient for subirrigation or flood irrigation agricultural activities. The term does not include upland areas that are generally overlain by a thin veneer of colluvial deposits composed chiefly of debris from sheet erosion and deposits by unconcentrated runoff or slope wash, together with talus, other mass movement accumulation, and windblown deposits".

The presence of an alluvial valley floor is determined by the presence of geologic, hydrologic, and biologic properties necessary to support agriculture. Alluvial deposits are found in both the Rehder and Fattig Creek valleys, however the alluvial deposits are generally dry and do not provide a source of subirrigation. Historic and current farming also does not depend on surface irrigation. Therefore, no alluvial valley floor has been identified in the area.

9.4 SURFACE FACILITIES AND WASTE DISPOSAL AREA IMPACTS

The facilities and waste disposal area (WDA) of the Bull Mountains Mine No. 1 are located to the northwest of the longwall panels (**Figure 9-1**). The main facilities area lies within PM Draw and an unnamed ephemeral tributary to Rehder Creek, and includes coal processing, storage and loading facilities, the WDA, unpaved roads, the rail loop, equipment fueling and storage areas, shops, the mine portal, and the mine offices. Additional peripheral facilities such as unpaved roads, crib pads, boreholes, power lines, and other improvements are located throughout the permit area and serve to support mine operations.

Within the disturbed area, Bull Mountains Mine No. 1 uses a network of ditches and detention ponds to convey and treat mine water and stormwater runoff. Mine water and stormwater from disturbed areas are detained within ponds, allowing suspended solids to settle out before discharge to ephemeral drainages, Rehder Creek and PM Draw, in accordance with MPDES Permit MT0028983. Solids retained in the ponds are removed to maintain sediment volume in the pond below 60% of the as-built storage volume. Sediments removed from settling ponds are disposed of in the WDA along with coal processing

wastes and mine development wastes. Coal processing wastes are comprised of shales, sandstones, mudstones, and unrecovered coal fines that are removed from mined coal to make it marketable. Coal processing wastes make up more than 90% of the material disposed of in the WDA. Mine development wastes consist of shales, sandstones, mudstones, and poor quality coal that are removed to access economic-quality, or to maintain safety and access to underground workings. Mine development wastes are hauled directly to the WDA from underground without further processing. Mine development wastes makes up less than 10% of the materials in the WDA. Both coal processing waste and underground mine wastes use water from the deep underburden Madison wells (see Section 6.2) for cleaning and processing.

Each MPDES-permitted outfall at the facility is associated with a sediment pond designed to contain the runoff from a 10-year, 24-hour rainfall event. **Table 9-1** provides a description of the discharge point for each outfall. Influent flow to sediment ponds consists mainly of stormwater runoff from the disturbed zones within the facilities area. Sediment ponds are discharged periodically by pumping to retain pond storage capacity once adequate time for settling has occurred so that the discharge will comply with applicable MPDES requirements. Precipitation events in excess of the design capacity of a pond may cause discharges from ponds as flows overtop low lying spillways. Outfalls 001 and 008 are the primary outfalls controlling release of mine-produced water to Rehder Creek and PM Draw.

In addition to stormwater runoff, Outfall 006 is associated with a sediment pond (Pond F) that also receives groundwater discharged from underground mine workings (**Figure 9-1**). Water in this pond is either used for dust control or pumped into a second, lined storage pond for re-use underground. Ponds at outfalls 001, 002, 004, 005, and 008 may occasionally receive underground mine discharge water if water must be pumped from Pond F to other sediment ponds.

9.4.1 Impacts to Surface Water: Surface Facilities and WDA

No permanent effects to the quantity and quality of surface water are anticipated from the facilities and WDA. Flow through disturbed areas is ephemeral, occurring only in response to precipitation, and is managed through sedimentation ponds and regulated under DEQ's MPDES permitting section.

Due to the low precipitation in the area, pond discharges are infrequent. Recent discharges in 2011 and 2013 were the first since 1991. Extended wet spring conditions were widespread across much of Montana in the spring and early summer of 2011 and 2013, and wet-weather discharges were reported at the Bull Mountain Mine No. 1 in both circumstances. During discharges which occurred in 2011 (**Table 9-2**), total recoverable iron, pH, total suspended solids (TSS), and oil and grease were within allowable limits. Settleable solids and pH effluent limitations were exceeded during a July 2011 discharge at Outfall 008, however violations were not issued due to widespread flooding throughout the region, and a 'state of emergency' issued by Montana Governor Schweitzer, in response to the extreme hydrologic conditions.

Discharges at several outfalls occurred again in 2013 (**Table 9-3**). Discharges were the result of a precipitation event in excess of the 10-yr/24-hour event flow, and effluent limitations for iron and TSS are therefore not applicable per ARM 17.24.633(5). SPE did receive a violation, however, due to settleable solids results being in excess of permit effluent limitations at Outfall 008, which controls discharge from the WDA. DEQ conducted a follow-up assessment in response to this discharge by sampling channel sediments at three locations downstream from Outfall 008. At each location, sediments were sampled for a variety of constituents including arsenic, barium, cadmium, chromium,

lead, mercury, selenium, and silver. Toxicity characteristic leaching procedure (TCLP) analyses were conducted, and results compared against EPA solid waste criteria established under the Resource Conservation and Recovery Act (RCRA). Results showed non-detects for all TCLP parameters in all samples at levels well below criteria established by RCRA, indicating that's settleable solids released during these events posed no toxic threat to the environment.

In addition to analytical parameters for which limits are established (**Table 9-3**), several additional water quality parameters (nutrients, metals) are collected, in accordance with MPDES permit requirements, to assist in characterizing effluent quality from disturbed lands within the facilities area. This additional information collected on effluent water quality is used to inform analysis for future MPDES permitting actions.

Due to the use of deep Madison well water for coal processing, the potential for the accumulation of Madison water constituents in coal processing waste emplaced in the WDA exists, however they are not anticipated to approach levels of concern for groundwater or surface waters. Groundwater flow through the WDA is controlled to prevent groundwater flow from the WDA to underlying aquifers, thereby limiting their potential for contamination due to WDA materials. Likewise, surface water runoff is controlled through MPDES-permitted outfalls. As stated earlier, runoff from the WDA is rare and only occurs during significant precipitation events, which would provide significant dilution of any constituent concentrations that may be present in WDA runoff water. Therefore, it is not anticipated that constituents in coal processing wastes will contribute significantly to groundwater or surface water quality conditions.

During the life of the mining operation, ditches and culverts are employed to handle surface runoff within and around the mine facilities area. All ditches and culverts are routinely inspected to ensure that accelerated erosion is not occurring at the outfalls. No long term or permanent water quality impacts are anticipated due to the emplacement of these structures. Ponds are used to retain stormwater runoff from events equivalent to or less than the 10-year 24-hour precipitation event. Ponds are anticipated to alter the duration, volume, timing, and frequency of stormwater runoff through PM Draw downstream of the mine area. This attenuation of runoff has limited potential to affect downstream surface water quantity and, as no surface water rights are held on PM Draw or Rehder Creek downstream of the facilities area (**Figure 6-2**), diminution or withholding of streamflows from ephemeral flow events is not expected to significantly impact downstream surface water users. The nearest downstream water rights are located on perennial reaches of Halfbreed Creek.

Outside the main facilities area, land disturbance from peripheral support facilities has the potential for hydrologic impacts, and may include geomorphic alteration of channels, increases in sediment loading to drainages, and alteration of stream hydrographs. Surface water impacts to ephemeral streams resulting from surface disturbance are assessed through adherence to established and approved design criteria for the installation and maintenance of roads, culverts, and other surface structures, and through the proper placement and usage of BMPs designed to minimize surface impacts to watercourses. Surface water control and treatment plans have been designed to protect the hydrologic balance within the permit area and adjacent areas in accordance with ARM 17.24.314(2)(a) and (b) and 17.24.631 through 17.24.652. A detailed discussion of practices employed to comply with these requirements is provided in Permit C1993017, Vol. 3, Section 314, 3.0 Surface Water and Groundwater Control and Treatment Plan.

Adherence to the surface water control plan is evaluated through monthly inspections by DEQ staff. Where impacts or the potential for impacts is observed, DEQ conducts an assessment of the issue and directs the operator to comply with permit conditions as stated in the approved control and treatment plan. Currently, there is no compelling evidence that surface disturbance has impacted surface water resources off the permit area.

9.4.2 Impacts to Groundwater: Surface Facilities and WDA

The alluvial aquifer with the greatest potential to be affected by operational impacts is in PM Draw since this drainage goes through the principal areas of operations**. Figure 9-2** presents hydrographs for alluvial monitoring wells BMP-26 and BMP-40 in PM Draw and show that the alluvium has been unsaturated except after the significant precipitation in 2011.

The WDA where coal waste is stored is in the drainage of an unnamed tributary just south of Rehder Creek. Potential impacts to the Rehder Creek alluvial aquifer and shallow bedrock may occur due to precipitation, runoff, and infiltration from the WDA. However, impacts are limited by compaction to engineering standards of materials placed in the WDA. **Figure 9-3** presents hydrographs of static water level (SWL) and selected water quality data for Rehder Creek alluvial monitoring well BMP-33 and overburden monitoring well BMP-52 located near the northern boundary of the WDA. Water levels in both wells show a response to the high precipitation event of 2011. Recent water quality data for both of these wells have shown increases in conductivity and TDS, with an increase in sulfate also evident in alluvial well BMP-33. These increases do not appear to be related to the WDA because similar increases also occurred in up gradient Rehder Creek alluvial well BMP-1 (**Figure 9-8**). The abnormally high water levels in the alluvial aquifer due to the significant precipitation in 2011 may be responsible for mobilizing additional ions in shallow groundwater and producing the observed increases in water quality parameters.

After the WDA fill has reached it final elevation and is graded, it will be covered with a minimum of 4 feet of the best available non-toxic and non-combustible material, including subsoil and topsoil as described in the Reclamation Plan. No subdrainage systems will be installed. Toxic, acid-forming and other deleterious materials will be handled and covered in accordance with the Rules 17.24.505(2) and 17.24.204(2). The WDA will be revegetated in accordance with the Reclamation Plan.

9.5 UNDERGROUND MINE IMPACTS

9.5.1 Impacts Due to Subsidence

Subsidence impacts include those hydrologic impacts introduced as a result of surface subsidence cracks or deformation of overlying strata as the coal is mined. Each longwall panel at the Bull Mountains Mine No. 1 consists of a large block of coal, approximately 1,250 feet in width by 15,000 to 23,300 feet in length. Surface depressions or subsidence troughs are expected to form as the overburden is undermined and coal is extracted. Overburden rocks are allowed to flex downward, fracture (creating a Fractured Zone) and collapse or cave into the void (forming a Caved Zone) causing immediate and progressive surface subsidence as the longwall system advances along the length of the panel. Generally, the amount of surface subsidence is less than the thickness of the coal seam and has been predicted to be about 70 percent of the extraction height in the Bull Mountains (Agapito, 1990).

The Mammoth Coal ranges in thickness from 8 to 12 feet in the permit area, so approximately seven to eight feet of surface subsidence is expected. This was confirmed in August 2011 when Panel 2

undermined the communication tower on Dunn Mountain and seven feet of subsidence was recorded. No damage to the towers was recorded; tension on the guy-wires was constantly adjusted as Panel 2 approached and undermined the tower. Linear surface fractures, minor rockslides, and small sink-like depressions (approximately 5 feet in depth) have occurred in some areas of higher overburden. This amount of subsidence including surface fracturing was anticipated as discussed in the protection/mitigation plan that was submitted and approved prior to initiation of longwall mining.

Continued mining as proposed under Amendment No. 3, would create surface subsidence features similar to those experienced to date. Where subsidence features occur within established ephemeral watercourses, the profiles of these drainages may be modified by small ridges held up over barriers, pillars, mains, and by depressions over the longwall panels. Minor damage to roads and fences is anticipated, and minor cracks have been observed in the fall of 2013 along some roads above Panel 3.

State regulations require mine operators to promptly repair damage to private property, and landowners must be provided with a mining schedule at least six months before their property is undermined. The schedule must contain enough information to enable landowners to move cattle to safe areas, and to avoid hazardous areas while mining is taking place.

The main hydrologic issue regarding subsidence at the Bull Mountains Mine No. 1 is the potential for loss or diminution of the quantity and quality of groundwater and surface water, and impacts to wells, springs, ponds, and stream reaches as a result of subsidence-related fracturing of overburden shales and sandstones. The potential exists for the alteration of surface and shallow groundwater flow paths as a result of subsidence-related fracturing.

Near vertical subsidence fractures are expected to be controlled or buffered by thick and relatively soft shales. Subsidence fractures in areas of shallow overburden cover may cause diversion of the shallow groundwater, and some increased lateral drainage from higher overburden units to lower springs also may occur as a result of flow along subsidence fractures. Settling and compression after mining are expected to heal or close most subsidence fractures, thereby returning the shallow groundwater flow directions, including flow to springs, to approximately the premining orientation. Some spring impacts are expected as not all pre-existing hydrologic flow-paths may be reestablished to pre-mine conditions. If flow to the springs is impacted, the permittee is committed to replacing the water resource following methods discussed in Permit C1993017, Vol. 3, Section 314, 5.0, Mitigation Plans.

Portal discharge is possible after reclamation, and would be controlled initially by seals and a piping system as the rubble zone saturates and water levels rise. However, even without a piping system, the temporary effectiveness of the portal seals would probably not allow water levels to raise much beyond the elevation of the portal. Chemical and physical deterioration of the portal seals is expected to limit the operational life of the seals to a relatively short period. Seepage through the fractured shallow bedrock around the portal seals and deterioration of the seals should prevent filling of the mine pool much above the elevation of the portal. Any water flowing through the portal opening will be discharged into PM Draw at an approved MPDES discharge location, and be subject to MPDES regulatory requirements.

To date, only the first three panels of the proposed total of 14 longwall panels have been mined under the current permit. A network of springs and surface water stations are monitored regularly to evaluate the potential for impacts or material damage during or post mining. As longwall mining approaches monitored springs, the frequency of flow monitoring increases from monthly or quarterly to weekly so

that any discernible impacts may be evaluated and mitigated in a timely manner and in accordance with the approved mitigation plan. Thus far, several springs above panels 2 and 3 have been under mined.

Litsky Spring (Station No. 17415), the first known spring to be affected, was undermined in late-March/early-April of 2012. Recent site visits and monitoring data confirm that the pond at Litsky Spring maintains water for livestock and wildlife use, suggesting that flow from the spring has not been impacted as to affect water supply at the site.

Adjacent monitoring wells BMP-60 and BMP-90 (**Figure 9-4**), however, recorded the drop in overburden water levels as the area under Litsky Spring was mined, followed by recharge of monitoring wells as subsidence fractures healed and water levels rebounded. The drop in water level in well BMP60 was more pronounced as it was located over the middle of panel 2, while BMP 90 is located closer to an underground gate road which limits the short-term subsidence observed at this well location. Presently, the water level in well BMP 60 is about 5 feet below historically low levels, while BMP 90 remains about 3 feet above historically low levels. The drop in water level in BMP 60 reflects both loss of water due to undermining and subsidence (estimated elevation loss due to subsidence is estimated at 3 feet). Recent recharge from abnormally high precipitation in 2011 and 2013 confounds comparison of existing well levels to historical (2003 to present). As subsurface strata continues to deform and heal, it is anticipated that water levels will be reestablished at a stratigraphic level equivalent to pre-undermining. Continued monitoring of water levels will inform understanding of short and long-term response of underlying strata and consequent flow paths to undermining and subsequent recovery.

More recent undermining of springs occurred in 2013 when several springs (17115, 17145, 17165, 17185, & 17315) were undermined as the longwall miner advanced through panel 3 (**Figure 7-1**). Springs 17115, 17165 and 17315 are typically dry, precluding any evaluation of impacts from undermining. Spring 17145 was dry in the months prior to undermining; after undermining in March 2013, flow was reported at @ 0.5 gpm (**Figure 9-5a**). Spring 17185 exhibited a brief interruption of flow immediately after undermining in May of 2013, and flow resumed within two weeks and has shown no discernible interruption in flow since recovery (**Figure 9-5b**). In both cases flows were higher after undermining than before undermining; however undermining occurred in the spring during a period of abnormally high precipitation. As present flows are within the range of historic flows recorded at these sits (**Figure 9-5c**), it is unclear whether the flows observed after undermining are a result of increased precipitation and recharge of overburden aquifers, of increased transmissivity due to deformation and fracturing of overburden strata or a combination of factors. In either case, spring flows were not adversely affected in the short term. Continued monitoring of wells and springs will allow additional evaluation of potential impacts as longwall mining advances and additional springs are undermined.

Mitigation of impacts from subsidence generally involves replacement of water supplies lost or diverted by subsidence-related processes with the purpose of maintaining premine land uses. Mitigation plans in the permit include restoring springs, stream reaches, and ponds by opportunistic development of springs where they appear, guzzler emplacements, horizontal wells, vertical wells, pipeline systems, deepening or rehabilitating existing wells, reclamation of stream reaches and function, water treatment where appropriate or necessary, and restoring premine land uses (MDSL, 1993). Detailed monitoring and mitigation plans are provided in Permit C1993017, Vol. 2, Section 313, Appendix 313-2 Spring/Seep Mitigation Plan.

Likewise, the rights of present and future groundwater and surface water owners or users will be protected in accordance with ARM 17.24.314(1)(b) and 17.24.648. ARM 17.24.648 states that "the

permittee will replace the water supply of any owner of interest in real property who obtains all or part of his supply of water for domestic, agricultural, industrial or other legitimate use from a surface or underground source if such supply has been affected by contamination, diminution, or interruption proximately resulting from strip or underground mining operation by the permittee". To protect uses replacement water must be of a quality and quantity sufficient to satisfy premining consumption requirements.

9.5.2 Impacts Due to Dewatering

Groundwater monitoring data, maps and graphs and the groundwater flow model included in the PHC were the chief tools used to assess groundwater impacts to the hydrologic balance within the CIA. Groundwater levels and quality data reported in annual hydrology reports submitted to DEQ each year by SPE were also used in this analysis. This data was used to evaluate water quantity and water quality in the potentially affected aquifers in the groundwater CIA.

9.5.2.1 Groundwater Model

The Amendment No. 3 application included a transient flow model to evaluate the potential effects of mining on groundwater in the area surrounding the mine (Nicklin, 2013[2]). **Figure 9-6** shows the model domain and layering. The groundwater model simulates flow in all aquifers of concern but is focused on the Mammoth Coal and upper underburden, as these aquifers are expected to experience the greatest effects from mining. The groundwater model is calibrated by comparing model results to measured water levels from monitoring wells and adjusting model parameters to achieve the best simulation of groundwater conditions. After calibration the model was run forward in time to predict water levels at the end of mining. In this predictive simulation, the mine tunnels are added to the model according to the proposed mine plan schedule as drains which simulate the dewatering associated with mine development. As mining progresses the material properties of the Mammoth Coal and overburden layers are also modified to simulate the collapse of material into the void left behind by longwall mining, and the subsidence and fracturing that occurs above the mined out areas. The results of this simulation are shown in **Figure 9-7**, which displays the predicted drawdown in the Mammoth Coal and upper underburden at the end of mining. In the Mammoth Coal, the area of the mine workings is completely dewatered, and an area of drawdown extends primarily to the north of the mine. A drawdown cone of depression is formed in the upper underburden, centered on the northern part of the mine workings and extending throughout the life of mine area and to the north. Drawdown to the south, east, and west in both the Mammoth Coal and the upper underburden is limited by the outcrops of the aquifers in those directions.

9.5.2.2 Alluvium

46 alluvial monitoring wells monitor the alluvial aquifer system in the Bull Mountain area (**Figure 9-8**). Historic monitoring data indicates that the alluvium within and near the permit boundary is often dry. Generally, alluvial water levels have increased over time (since 2003) and are responsive to seasonal precipitation events, especially during events in May of 2011.

Rehder Creek drains much of the proposed permit area. **Figure 9-9** shows Rehder Creek alluvial responses in upgradient well BMP-17 and down gradient wells BMP-19 and BMP-1, indicating that all wells responded to increased precipitation in 2007 and 2011. Also notable in **Figure 9-9** is how the degree and duration of saturation increases moving downstream. At upstream well BMP-17 alluvial water is present only after major precipitation events, moving downstream at well BMP-19 a small

amount of water is usually present except during long dry periods, further downstream at well BMP-1 alluvial groundwater is always present.

Portions of the proposed permit area are also drained by Fattig Creek and Railroad Creek, and alluvial wells from these drainages are shown in **Figure 9-10**. Well BMP-77 is completed in the Fattig Creek alluvium and shows a similar increasing trend with response to precipitation events as seen in the Rehder Creek alluvium. Alluvial groundwater quality in Fattig Creek also shows a response to the significant precipitation event of 2011, with increases in SC, TDS, and sulfate. Well BMP-80 is located in the Railroad Creek drainage, and shows the presence of alluvial groundwater only in response to major precipitation events.

Tributaries of Rehder Creek known as the 16 and 17 drainages drain the majority of the current permit area. Water levels and quality in alluvial wells in these drainages are shown in **Figure 9-11**. Alluvial well BMP-62 shows an example of alluvial groundwater influenced by inflow from the shallow overburden aquifer. Alluvial groundwater is present most of the time, with seasonal variations in water level due to snowmelt and increase spring precipitation evident. Water quality at BMP-62 is also much better than at other alluvial wells. The 17 drainage is the only drainage which has been undermined to date. Alluvial monitoring wells BMP-32 in the 16 drainage and BMP-45 in the 17 drainage show that alluvial water quantity and quality are similar in both drainages, indicating that undermining has not affected alluvial water quality or quantity in the 17 drainage.

The alluvial hydrographs discussed above indicate that there is no evidence that mining and associated dewatering of the Mammoth Coal have affected water levels of the alluvial aquifer system. Because the alluvial aquifer is typically a perched aquifer supplied by recent precipitation or snow melt, additional mining is not expected to affect water levels in the alluvial aquifer.

Water quality of the alluvial groundwater generally declined recently, however, based on the alluvial water quality graphs discussed above this appears to be due to significant precipitation in 2011 and the resultant higher alluvial water levels. Currently, there is no evidence that alluvial water quality has been impacted by mining. No exceedances of water quality standards were observed for any of the alluvial monitoring wells. The additional proposed mining is not expected to have any effects on alluvial water quality.

9.5.2.3 Overburden

Overburden water levels are monitored by 33 monitoring wells within the permit boundary and vicinity (**Figure 9-12**). Generally, water levels in shallow overburden (BMP-47, total depth (TD)=40 feet) and relatively deep overburden wells (BMP-4, TD=200 feet) have increased over time (**Figure 9-13**). Shallow well BMP-47 in the Rehder Creek drainage shows an abrupt water level increase of approximately 15 feet due to seasonal precipitation in June 2011. By contrast, deeper well BMP-4 shows a slow but steady increase in water level in the deeper overburden aquifer in an area remote from mining.

Figure 9-13 shows that the water-level response of shallow overburden well BMP-47 is similar to that of nearby Rehder Creek alluvial well BMP-1 (**Figure 9-9**), indicating that both the shallow overburden and alluvium rapidly respond to seasonal precipitation events. Respective well logs show alluvium directly overlying overburden bedrock in Rehder Creek drainage indicating a likely hydraulic connection.

Currently, there is little evidence that longwall mining has had a significant impact upon overburden water levels except in areas affected by subsidence. Water levels in monitoring wells BMP-60 and BMP-

90 in the vicinity of longwall panel 2 have shown declines of approximately nine feet and 18 feet, respectively (**Figure 9-4**). Inspection of the hydrographs for the two wells indicates that water levels in these relatively shallow overburden wells (BMP-60, TD=50 feet; BMP-90, TD=30 feet) were slowly declining from the precipitation of 2011 and then declined abruptly between February 2012 and April 2012 when BMP-60 went dry. **Figure 9-4** indicates that after this period water levels in both wells began to recover and subsequently have had a slow decline, likely due to dry conditions.

The abrupt decline of water levels suggests that the relatively shallow overburden and perched aquifer system in the vicinity of these wells was partially drained via subsidence fractures that healed over the period between February and April 2012 leading to the water level rebound as seen in **Figure 9-4**. Well log data indicates that relatively impermeable gray shale occurs below the respective screened intervals. These rocks may have become fractured, allowing perched groundwater to drain into the mine workings, and then healed due to compression and settling. This data may illustrate that the various perched aquifers within the upper overburden may have become temporarily dewatered by subsidence fractures in the vicinity of BMP-60 and BMP-90 due to mining. Monitoring data will continue to be collected to evaluate the affect upon local overburden dewatered due to subsidence fractures.

Similar temporary overburden dewatering may occur over all longwall mining areas as subsidence occurs, but these effects are expected limited in spatial and temporal extent. No long term effects on overburden water quantity are expected as a result of mining.

Comparison of current and baseline water quality concentrations of TDS, sulfate, bicarbonate, and specific conductance show no significant differences, indicating that mining has not impacted water quality of the overburden aquifer. The water quality of shallow overburden (BMP-43, **Figure 9-13**) and Rehder Creek alluvium (BMP-1, **Figure 9-9**) located just down gradient of mining remains relatively consistent, but shows a decline in water quality during the rise of water levels associated with the 2011 high precipitation event. Deeper overburden water quality at well BMP-4 (**Figure 9-13**) has remained consistent over time.

Elevated arsenic concentrations were reported in 2006 from monitoring well BMP-10, located over longwall panel 4 and up gradient of mining at that time. The initial arsenic concentration (0.051 mg/L) recorded in 2006 was approximately five times the DEQ-7 human health limit of 0.01 mg/L. Arsenic concentrations in this well have rapidly declined (**Figure 9-14**) and are currently below laboratory detection limits. The source of the elevated arsenic concentrations in the overburden aquifer is unknown but its location up gradient indicates that it is not related to mining. A similar pattern of declining concentrations was recorded in this well for iron, which was associated with a less pronounced decline of specific conductance, TDS, sulfate, and bicarbonate (**Figure 9-14**).

Because overburden groundwater does not flow through the mine workings, or come into contact with the mine gob, mining is not expected to affect overburden groundwater quality.

9.5.2.4 Mammoth Coal

17 groundwater monitoring wells monitor water levels of the Mammoth Coal aquifer in and outside of the permit boundary (**Figure 9-15**). Water level data associated with a number of wells, especially those within the permit boundary, indicate that longwall mining and the development of gate roads has lowered water levels and created a cone-of-depression in the Mammoth Coal that radiates outward from panels 3 and 4 as mining continues. **Figure 9-16** indicates that drawdown or the radius of influence

is greater east of mining because of confined conditions within the coal; unconfined conditions prevail west and south of mining where the radius of influence is limited.

Hydrographs show that the respective water levels in BMP-37, BMP-11, and BMP-8 have been lowered approximately 30, 25, and 18 feet respectively (**Figure 9-17**). Mammoth Coal drawdown is not observed three miles east of BMP-8 toward BMP-14 and BMP-21 (**Figure 9-18**), where water levels have remained stable or increased slightly during the same general period (2004-2011). Similarly, drawdown rapidly decreases west of BMP-37 as water levels in BMP-30 have shown a general increasing trend since 2003 as seen in the hydrograph of BMP-30 (**Figure 9-18**). Mammoth Coal wells to the south of BMP-11 are typically dry.

Water levels in the Mammoth Coal north of the permit boundary in wells BMP-3 and BMP-5 generally declined from 2003-2010, which is likely attributable to mining related drawdown (**Figure 9-19**). Water levels in both of these wells increased following the high precipitation of 2011, with BMP-3 water levels rising 15 feet due to the hydraulic connection of the Mammoth Coal and alluvium near this location. Since 2011 water levels in BMP-3 have declined to approximately the same level as 2012 and BMP-5 water levels have declined approximately two feet below 2010 levels. The high precipitation of 2011 may have acted to temporarily interrupt mining related drawdown at BMP-3 and BMP-5, but does not appear to have altered the long term trend of drawdown north of the mine.

The water level observations in Mammoth Coal monitoring wells are generally consistent with the expected pattern of decreasing drawdown radiating outward in all directions from the dewatered mine area. Current Mammoth drawdown illustrated in **Figure 9-16** (calculated drawdown 2004-2011) lies within the predicted drawdown of the groundwater flow model described in the PHC. Hydrologic impacts of longwall mining activity upon the Mammoth Coal are limited by the extent of the coal to the south and west. The amount and extent of drawdown in the Mammoth Coal is expected to increase as mining progresses, particularly to the north of the active mine area. Following the completion of mining, water levels will begin to recover, and are expected to reach a post-mine equilibrium within 50 years.

Currently, there is no evidence that mining has affected the water quality of the Mammoth Coal aquifer. Comparison of SC, TDS, sulfate, and bicarbonate concentrations in Mammoth Coal wells over time indicate that there are no persistent trends associated with mining. **Figure 9-17**, **Figure 9-18, and Figure 9-19** indicate that water quality data have generally been consistent over time regardless of changes in water level. Water quality of BMP-37, BMP-11, and BMP-8 are generally unchanged through time despite being in the immediate vicinity of active longwall mining. The average specific conductivity of water produced by Mammoth Coal wells is higher relative to the alluvial and overburden aquifers due to relatively greater concentrations of sulfate and sodium. Approximately one-half of the Mammoth Coal wells produce Class II water and one-half produce Class III water. This data is consistent with Mammoth Coal baseline water quality (Class II to Class III). No exceedances of DEQ-7 standards were observed in any of the Mammoth Coal wells.

Because mine dewatering produces groundwater flow towards the mine working during mining, no water quality affects are expected during mining. After mining is completed, some of the mine gob will become saturated. Groundwater quality in the mine gob is expected to be degraded relative to natural water quality, however, due to the small quantity of gob influenced water and the slow water movement in the Mammoth Coal this poor quality water is not expected to migrate outside the permit boundaries within 50 years after mining.

9.5.2.5 Underburden

The underburden aquifer in the area is monitored by 25 monitoring wells (**Figure 9-20**). The drawdown map (**Figure 9-21**) of the upper underburden aquifer within the permit area show water level declines similar to and development of a cone-of-depression nearly coincident with the drawdown observed in the overlying Mammoth Coal aquifer. This indicates the upper underburden aquifer has also been affected by mining and that a hydraulic connection exists in some areas between the Mammoth Coal and upper underburden aquifers where the potentiometric heads are similar.

Comparing the hydrographs for upper underburden wells BMP-12, and BMP-9 in **Figure 9-22** to the hydrographs for co-located Mammoth Coal wells BMP-11, and BMP-8 (respectively) in **Figure 9-17** shows that while drawdown has occurred at both locations in both aquifers, the timing and magnitude of drawdown can vary. This is likely due to the variable geology of the underburden, where the water bearing units tend to be discontinuous and separated by lower permeability rocks. Although no underburden well is co-located with Mammoth Coal well BMP-37 (**Figure 9-17)**, underburden well BMP-44 (**Figure 9-22**), located approximately one mile north shows a similar water level response to mining. **Figure 9-23** shows underburden wells located to the east (BMP-83 and BMP-15) and west (BMP-31) of the mine area which have not been affected by mine drawdown. The two wells east of the mine are in similar locations as Mammoth Coal wells BMP-21 and BMP-14 (**Figure 9-18**) and show similar water level trends. Underburden well BMP-31 is co-located with Mammoth Coal well BMP-30, but the underburden well shows water level fluctuations not observed in the Mammoth Coal well indicating a hydraulic separation between the hydrologic units at this location. The water level fluctuations in the underburden well do not appear to be related to mining and recent water levels have been similar to those first observed in 2003.

Underburden wells north of the mine show different water level responses depending on local geologic factors (**Figure 9-24**). Underburden well BMP-38 shows no effects of mining related drawdown, and the well mimics the water level response of the alluvial aquifer observed in co-located well BMP-33 (**Figure 9-3**) indicating that the underburden is hydraulically connected to the alluvium near this location. As illustrated in **Figure 9-24** water levels in underburden well BMP-6 show a general decreasing trend since 2007, but recovered in response to the high precipitation in 2011. The decrease in water level in BMP-6 is similar to the response seen in Mammoth Coal well BMP-5 (**Figure 9-19**) and is likely related to mine drawdown.

Due to the hydraulic connections between the Mammoth Coal and the upper underburden, the effects of mining on upper underburden water quantity are expected to be similar to those described for the Mammoth Coal.

By contrast, the relatively deep sandstones of the lower underburden aquifer are hydraulically isolated from the Mammoth Coal and upper underburden aquifers. Aquifer test data (Hydrometrics, 2009) associated with the Office Supply Well (OSW) confirm that confined conditions exist in these relatively deep sandstones (355-405 feet) and that the nearest domestic well, a distance of approximately 4,200 feet from the OSW, will not be adversely impacted by continuously pumping the OSW at approximately 6 gpm. During a pump test, observation well 62614-100-UB (BMP-121), located 3,346 feet from OSW, recorded 1.4 feet of drawdown. Projected drawdown shows 3.3 feet of drawdown in monitoring well BMP-121 and three feet of drawdown in the nearest private well after 20 years of continuous pumping. These relatively deep sandstones are the source of domestic use and are isolated from the effects of mining.

Baseline water quality of the upper underburden aquifer is similar to water quality observed between 2003 and 2011. Currently there is no evidence that mining has affected the water quality of the upper underburden aquifer. Water quality graphs show no persistent trends or changes in the water quality of the underburden aquifer even in areas where the potentiometric surface of the upper underburden has been affected by mining (**Figure 9-22**). Consistent water quality has been recorded in a number of other underburden wells indicating they have remained unaffected by mining. BMP-15 (**Figure 9-23**), located down gradient just outside the eastern Amendment 3 boundary; BMP-31 (**Figure 9-23**), located down gradient along the western permit boundary; and BMP-6 (**Figure 9-24**), located immediately down gradient just north of the Amendment boundary show consistent water quality from 2003 to the present.

Approximately one-half of the underburden wells exhibit Class II water and the rest have Class III water consistent with baseline SC and water quality. Based upon monitoring well information, there is no evidence of any mining related impacts to upper underburden or to the relatively deep upper underburden water quality in the vicinity of the Bull Mountains Mine No. 1 and no exceedances of DEQ-7 water quality standards have been reported in the wells.

Similar to the Mammoth Coal, water quality in the upper underburden aquifer may be locally affected by poor quality water from the mine gob after mining is completed and water levels in the mine area recover. No water quality effects on the deeper underburden aquifer are expected due to the hydraulic separation between this aquifer and the mine.

10.0 MATERIAL DAMAGE

As defined by Montana statue, "material damage means, 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 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'" (82-4-203, MCA). Observation of changes to the hydrologic balance observed with current mining provides a framework within which continued and future impacts can be anticipated. It is possible to make quantitative and qualitative projections regarding the severity and extent of impacts expected with proposed mining and to evaluate the likelihood that impacts will extend outside the permit area **(Table 2-1**).

10.1 CUMULATIVE IMPACT OF HISTORIC AND CURRENT MINING

Currently there is no evidence that the quantity and quality of surface waters has been impacted by mining activities. Surface streamflow in the area is ephemeral and driven by storm events and extended periods of wet weather that act to recharge perched aquifers. Perched aquifers, in turn, supply spring flow and dry up during extended periods of below normal precipitation. Spring-flow may be impacted through subsidence processes related to undermining of the overburden aquifers, potentially interrupting, and/or altering subsurface flow-paths. Potential impacts to identified surface water users in the surface water CIA are shown in **Table 6-2**.

Springs and seeps are monitored regularly in order to assess impacts from mining. Where flows from springs and seeps are impacted, water quantity and water rights have the potential to be impacted. Impacts to water rights are assessed and evaluated with respect to regional and local impacts to spring systems that feed surface water resources. To date, several springs under panels 2 and 3 have been undermined. While some springs (17145, 17185) have shown a temporary alteration or interruption of flows or adjacent well-water levels as anticipated, weekly monitoring of spring flows prior to and after undermining have shown no adverse long-term effects.

As stated in Section 9.0, surface water runoff is controlled through a series of ponds and diversion structures in the facilities and WDA, and regulated through DEQ's MPDES program. Discharges to surface waters are very infrequent with the first discharges in 20 years occurring during extreme wet periods in 2011 and 2013. Water management controls on peripheral facilities areas (permit lands not including the main facilities and WDA) include structures to control runoff from mine roads, pads, and other land surface disturbances, and are managed through the implementation of BMPs. BMPs typically include a variety of design considerations (culvert sizing, berming, placement of structures, etc.) and are described in detail in Permit C1993017, Vol. 3, Section 314, 3.0, Surface Water and Groundwater Control and Treatment Plan. Evaluation of impacts relating to surface water runoff and management are therefore evaluated with respect to adherence to approved design plans and permit conditions in controlling and managing surface runoff. No significant impacts to surface water resources have been observed to date regarding implementation and management of surface water controls, including MPDES-permitted discharges and surface BMPs.

Current monitoring indicates mining has affected groundwater quantity by producing an area of drawdown around the dewatered mine workings. This area of drawdown is expected to increase and

expand as mining progresses and then recover after mining is completed. Potential impacts to identified groundwater users in the groundwater CIA are shown in **Table 6-1**.

The most significant drawdown and the greatest radius of influence have been recorded in the Mammoth Coal (drawdown of approximately 30 feet in BMP-37) consistent with the predictions made in the PHC. Significant drawdown (approximately 20 feet in BMP-44) has also been recorded in the upper underburden that generally mimics the drawdown pattern or radius of influence of the overlying coal indicating that the upper underburden and coal aquifers are hydraulically connected.

The flow model prediction in the PHC indicates groundwater associated with the Mammoth Coal and upper underburden aquifers will recover to near pre-mining levels approximately 50 years after the cessation of mining. After the conclusion of mining, the gate roads may remain intact or may collapse, thus each of these scenarios was tested using the groundwater model. If the gate roads collapse, groundwater levels in the northern part of the mine area and north of the permit area will return to near pre-mine levels. If the gate roads remain intact, a mine pool will form in the northern part of the mine workings resulting in post-mine water levels higher than pre-mine near the north permit boundary. In either scenario, some residual drawdown will persist in the southern part of the mine area indefinitely due to the change in aquifer properties from coal to gob.

By contrast, very little drawdown has been recorded in the overburden aquifer except directly over panel 2 (BMP-60 and BMP-90) during active mining. Extensive overburden drawdown is expected over the mined area as mining advances consistent with predictions in the PHC as overburden subsidence fractures provide a series of transmissive conduits into the mineralized gob of the Caved Zone. Drawdown in the overburden is not expected outside of the subsidence area due to the generally perched and discontinuous nature of the overburden aquifers. Drawdown of the alluvial aquifer system is not expected as these sediments are often dry and become partially saturated due to significant precipitation events.

Currently, there is no evidence that local and off permit groundwater quality of any of the hydrologic units has been degraded or impacted by mining. Groundwater quality of shallow and deep aquifers (alluvium, overburden, coal, and underburden) is monitored regularly by a network of 105 monitoring wells to alert DEQ about the potential for material damage during or post mining.

A decline of groundwater quality is expected as longwall mining and subsidence continue to produce additional panels of collapsed and mineralized rubble in the Caved Zone (gob). Vertically transmissive and mineralized fractures may intercept and direct shallow groundwater into the Caved Zone affecting local overburden groundwater levels, spring discharge, and surface drainage that may ultimately increase mine discharge. This prediction is consistent with the PHC: “A general increase in total dissolved solids, sodium, and sulfate concentration is anticipated in the groundwater that flows through the gob and potentially in the highly fractured zones immediately above the mined out area” (Page 314-5-47). As described in Section 6.2.3 of the PHC, Madison well water used in the underground mine workings is expected to constitute less than 0.1 percent of the total water in the mine gob voids. Because of this, the use of Madison well water in the underground mine workings is not expected to have any measurable impact on the quality of mine gob water. The eventual groundwater quality within the mined-out area or Caved Zone may become similar to the groundwater quality within abandoned coal mines near Roundup, MT where the average TDS, sulfate, and specific conductance concentrations are 2,042 mg/L, 1,106 mg/L and 3,038 μS/cm, respectively. However, the groundwater quality within the

Caved Zone may exceed these concentrations since the groundwater in the abandoned mines near Roundup does not come into contact with mineralized gob.

10.2 MATERIAL DAMAGE ASSESSMENT

10.2.1 Surface Water

Evaluation of material damage to surface waters includes an assessment of potential impacts to surface waters and the monitored response of surface water systems to potential impacts. Material damage criteria established in Section 2.0 include water quality standards, beneficial use criteria for the support of livestock, and impact to water rights.

Thus far, impacts to surface waters have been minimal; potential impacts include impacts to surface waters from water management and control within the facilities area and WDA, the effects of surface infrastructure (roads, culverts, pads) on surface waters outside the facilities and WD, and the effects of undermining and subsidence on springs and seeps.

Impacts from surface water runoff both within the facilities area and WDA are evaluated through compliance with narrative water quality standards (for ephemeral streams) and MPDES permit requirements. Adherence with general operational provisions of the narrative surface water quality standards (ARM 17.30.635 through 17.30.637) constitutes compliance with water quality standards for ephemeral streams. On-site management of surface water is detailed in the Permit C1993017, Vol. 3, Section 314, 3.0, Surface Water and Groundwater Control and Treatment Plan, and includes a variety of surface water controls that meet the requirements of the narrative surface water quality standards contained in ARM 17.30.645 through 647. Adherence and compliance with the Surface Water and Groundwater Control and Treatment Plan is assessed during monthly mine inspections by department personnel, and through departmental management and oversight of permitted activity. No significant issues regarding compliance with this plan have been noted to date, and no material damage has been observed in regards to surface water runoff from disturbed areas within the permit area. With the exception of a wet-weather exceedance for settleable solids and pH during 2011 and 2013 (see Section 9.4.1), MPDES discharges to date have been very infrequent and have not violated MPDES permit conditions.

As underground mining thus far has progressed only through Panel 3, potential impacts to surface waters have been confined to springs within panels 2 and 3 and to the capture of stormwater runoff within the mine permit area. As described in Section 9.5.1, impacts due to subsidence have been limited, buffered by recent recharge of overburden aquifers, and have had no impact on the quality and quantity of surface water resources (springs) in the permit area. Accordingly, because the current mining methods are proposed to extend throughout the expanded permit area, significant, irremediable impacts to the quality and quantity of surface water resources are not expected from continued underground mining.

Due to the fact that only the first three longwall panels have been undermined, surface water impacts are limited in their potential extent. To date, no material damage to surface waters is evident. Narrative standards for surface waters have not been violated or exceeded, and the quantity of surface waters (springs and ephemeral runoff) has not been impacted due to mining activity, and surface water rights have not been impacted. Accordingly, because current mining activities are proposed throughout the expanded permit area, disturbance of the hydrologic balance on and off the permit area and material

damage to surface waters outside the permit area are not expected from continued underground mining.

10.2.2 Groundwater

Currently, there is no evidence of material damage and no material damage is predicted with mining proposed in Amendment 3. There is no evidence from monitoring data to suggest a change in predictions made in the PHC with regard to potential impacts to water quality and levels. Comparison of baseline and recent groundwater quality data show no significant changes. No water quality standards, numeric or narrative, have been exceeded and beneficial uses (domestic and livestock) have not been impacted.

Mining is not expected to affect the alluvial aquifer beyond the permit boundary. The alluvial section within the boundary is generally dry. Groundwater levels in the overburden, Mammoth Coal and upper underburden near the western permit boundary have been lowered as a result of mining and drawdown in these aquifers will continue as mining advances. Mining proposed in Amendment 3 will result in continued drawdown to the east, south and north of the mine but is expected to remain largely within the mine permit boundary and drawdown will not affect most groundwater users. Mining related drawdown in these aquifers may affect a few domestic wells completed in the upper underburden north of the permit area. Since most domestic and stock wells produce from relatively deep sandstones (deep underburden aquifer) that are hydraulically isolated from mining by a relatively thick section of alternating shales and siltstones, no impact to these deeper wells is expected. SPE is committed to replacing any water supplies affected by mine related drawdown with a comparable permanent supply.

Post mining groundwater quality within the mined-out area (Caved Zone) is expected to degrade after coming into contact with fresh rock surfaces exposed in subsidence fractures and mineralized rubble or gob. Oxidizing conditions are anticipated until after mining is complete and resaturation of the collapsed material has occurred. These conditions may result in increased sulfide oxidation, cation exchange, leaching, and weathering, which together may cause an increase in the concentrations of calcium, magnesium, sulfate and sodium ions. Due to the buffering capacity of the alkaline mineralogy of the overburden and shallow underburden, development of acidic conditions in water present in the gob is extremely unlikely. As explained above at 9.5.2, any degradation of groundwater quality is not expected to render groundwaters unsuitable for current or anticipated use. Accordingly, because current mining methods are proposed throughout the expanded permit area, material damage to the quality or quantity of groundwater resources outside the proposed permit area is not expected from continued underground mining. Although presently there is no evidence of a general increase in any water quality parameters that can be attributed to mining, continued monitoring will provide additional insights of the potential effects on groundwater quality predicted to accrue over time as mining progresses.

10.3 CONCLUSION

SPE's Bull Mountains Mine No. 1 has supplied sufficient information for the completion of this CHIA and finding. Although DEQ analysis identified some surface water users and water rights holders outside the permit area that may experience a temporary impact to their water resources, the Bull Mountains Mine permit commits to replacing water supplies that have been affected by mining with water of similar quality and quantity.

At this time, DEQ finds that the operational and reclamation plans for the Bull Mountains Mine No. 1 have been designed to minimize impacts to the hydrologic balance within the permit area and to prevent material damage outside of the permit area.

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