ALTON/SINK VALLEY
CUMULATIVE HYDROLOGIC IMPACT ASSESSMENT
(CHIA)

For

PROPOSED COAL HOLLOW MINE
C/25/0005

In

KANE COUNTY, UTAH

June 7, 2017
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I. INTRODUCTION

The Coal Hollow Mine operated by Alton Coal Development, LLC (ACD) is within the Alton/Sink Valley Cumulative Impact Area (CIA) in Kane County, Utah. The South Private Lease of the Coal Hollow Mine is in Township 39 South, Range 5 West, Sections 19, 20, 29, and 30, approximately 2.5 miles southeast of the town of Alton, Utah (Figure 1). The permitted area of the South Private Lease is 721 acres leased from private landholders. The North Private Lease (NPL) is an additional 295 acres added to the permit area in 2016 and expanded in 2017. The NPL sits 1.5 miles to the north of the original permit area in Sec. 12 & 13, T39S, R6W and within Sec. 7 & 18, T39S, R5W and is bisected by Kanab Creek. Areas 1, 2, and 3 break up the NPL with Area 1 and 2 west of Kanab creek and Area 3 east of the creek. No prior coal mines have been permitted in the area. In 1982 and 1987, the area was the subject of a large-scale mine permit application by Utah International Inc. Presently, there are Federal leases surrounding the Coal Hollow Mine permit area to the southwest, west, and northwest that are managed by the Bureau of Land Management (BLM). ACD’s objective is to secure some of these leases for future mining activities. Highway 136, which is an unimproved road that is maintained by Kane County, bisects the permit area in Sections 19 and 30. Coal truck traffic runs through the towns of Alton, Panguitch and eventually to Delta, Utah where the coal is sold to Intermountain Power Agency.

The Division has the responsibility to assess the potential for mining impacts both inside and outside permit areas. The CHIA is a findings document prepared by the Division that assesses whether existing, proposed, and anticipated coal mining and reclamation operations have been designed to prevent material damage to the hydrologic balance outside the permit areas. The Division cannot issue a permit to a proposed coal mining operation if the probable, anticipated hydrologic impacts will cause material damage to the hydrologic balance outside the permit area. The CHIA is not only a determination if coal mining operations are designed to prevent material damage beyond their respective permit boundaries when considered individually, but also if there will be material damage resulting from effects that may be acceptable when each operation is considered individually but are unacceptable when the cumulative impact is assessed.
The objective of a CHIA document is to:

1. Identify the Cumulative Impact Area (CIA)  
   (Part II)

2. Describe baseline conditions in the CIA; identify hydrologic systems, resources and uses; and document baseline conditions of surface and ground water quality and quantity  
   (Part III)

3. Identify hydrologic concerns  
   (Part IV)

4. Identify relevant standards against which predicted impacts can be compared  
   (Part V)

5. Estimate probable future impacts of mining activity with respect to the parameters identified in 4  
   (Part VI)

6. Assess probable material damage  
   (Part VII)

7. Make a statement of findings  
   (Part VIII)

This CHIA complies with the federal Surface Mining Control and Reclamation Act of 1977 (SMCRA) and subsequent federal regulatory programs under 30 CFR 784.14(f), and with Utah regulatory programs established under Utah Code Annotated 40-10-et seq. and the attendant State Program rules under R645-301-729.
II. CUMULATIVE IMPACT AREA (CIA)

Reviewing Permit Application Packages (PAP) and Mining and Reclamation Plans (MRP) alone is not sufficient to assess impacts to the geologic and hydrologic regimes. Specific knowledge of the geology and hydrology is crucial in assessing the dynamics and interactions of chemistry, surface and ground-water movement, and surface disturbance and subsidence impact associated with the mine sites. The Division uses pertinent information from many sources, including federal and state agencies; geological and hydrological reports; textbooks and other publications; site visits; and a knowledge base built on experience and training. The purpose of delineating the CIA is to prepare a Cumulative Hydrologic Impact Assessment (CHIA) for the entire region that evaluates the hydrologic systems that may be affected by the proposed operation and the magnitude of those effects.

Plate 1 located in Appendix A delineates the CIA for ACD's Coal Hollow Mine permit area in the Alton/Sink Valley region. Two principle drainage basins exist within the region, the Sink Valley Wash watershed and the Upper Kanab Creek watershed. A sub-drainage watershed known as Lower Robinson Creek encompasses the majority of the permit area in Sections 19, 20 and 30. In Kanab Creek, water flows south from the headwaters in Reservoir Canyon, east of the town of Alton. Sink Valley Wash is an ephemeral tributary of Kanab Creek whose headwaters originate from the canyons of the Paunsaugunt Plateau located to the east of the valley. Sink Valley Wash Drainage and the Upper Kanab Creek drainage basins are separated by upland cliffs. The two drainages intersect in T40S R6W Section 35. This is the boundary of both the Upper Kanab Creek and Sink Valley Wash Drainage Basins. This area is approximately 6.5 miles downstream of the Coal Hollow Permit area. According the Office of Surface Mining regulations (30 CFR 701.5), the physical extent of possible hydrologic impacts and type of operations located within the applicable river basin must be considered when developing the boundary of the CHIA. The confluence of these drainages represents the most downstream point where any hydrological impacts can be measured. The upgradient portion of the CHIA area is defined by Water Canyon and Swapp Hollow canyons, which are the primary sources of groundwater and surface water to the Sink Valley area and therefore are important factors in evaluating upgradient groundwater and surface water recharge areas to the permit and adjacent areas. The northern section of the CHIA is delineated by the Lower Robinson Creek Subdrainage, which is the watershed that feeds Lower Robinson Creek (in addition to Water Canyon). In addition, all Federal coal leases that surround the Coal Hollow permit area to the north, west, and southwest extend up to the southern boundary of the town of Alton are also evaluated in this CHIA for the purposes of future mining activities that may require procurement of these leases (or a portion thereof).
SCOPE OF MINING

Small-scale coal mining has occurred in the Alton Coal field region from the late 1920s to 1969 where five small mines and two prospects have been worked. Production totals from these mines ranged from 35,000 to 50,000 tons. The last operating coal mine was the Smirl Mine, which was located 1.5 miles south of the town of Alton. The Smirl portal was sealed by the Utah Division of Oil, Gas and Mining in 1992.

The coal seams of economic importance in the region are the Smirl seam with a reported thickness of 14-18 feet and the Bald Knoll coal zone located approximately 200 feet below the Smirl coal seam containing several coal seams separated by thin splits with the thickest seam being 4.8 feet thick. Studies of coal cores performed by Doelling in the 1970s, indicated that the quality of the coal in the Alton Coal field is ranked as sub-bituminous B, with average heating values of about 9,560 Btu’s and an average sulfur content of 1.0 percent (Doelling 1972).

The Coal Hollow operation surface mines the Smirl coal seam. Alton Coal Development, LLC (ACD) operates the mine 24 hours per day, six days a week. The annual projected output over the next six years is in the range of ~200,000 to 800,000 tons. In 2014, an additional mining method was added to the approved MRP for highwall mining. Highwall mining uses a trench system and mines by auger method up to 1,000 ft out under the overburden.
III. BASELINE CONDITIONS OF SURFACE AND GROUND-WATER QUALITY AND QUANTITY; HYDROLOGIC SYSTEMS AND USES

BASELINE CONDITIONS

ACD's Coal Hollow Mine permit area within Alton/Sink Valley is located in Kane County, Utah, approximately 2.5 miles southeast of the town of Alton. The bedrock in the area is Cretaceous-age sedimentary rock. The Alton Coal Field is roughly a horseshoe-shaped region that is situated between the Kaiparowits Coal Field to the east, and the Kolob Coal Field to the west. Topographic relief in the area is approximately 2,800 feet. Elevations range from approximately 9,300 feet on top of the Paunsaugunt Plateau, to about 6,500 feet in the valley bottoms. The coal seams of economic viability are situated on the western and southern flanks of the Paunsaugunt Plateau.

An assessment of baseline conditions is needed to determine the land productivity, vegetation and hydrologic conditions that exist prior to mining operations.

Soils

This information was based on data obtained in the Coal Hollow Permit Application, Chapter 2, Volume 1. An Order 2 Soil Survey was prepared for this project by Long Resource Consultants of Morgan Utah January 2008. No published data was available from the National Resource Conservation Service (NRCS). A soil survey map showing the location of the principal soil units is included as Drawing 2-1 in the Coal Hollow MRP.

Field studies for an Order 2 soil survey were completed in 2007 for the Coal Hollow Project. The survey was conducted on private lands leased by by ACD and adjacent lands. The soil survey’s objective was to 1) identify suitable sources of subsoil and topsoil; 2) determine topsoil and subsoil salvage depths and quantities; and 3) develop a post mining reclamation plan using salvaged soil materials. The soil survey encompasses approximately 630 acres. It should also be noted that the Natural Resources Conservation Service (NRCS) is presently actively involved in collecting soil data from the Alton/Sink Valley area for the purposes of publishing a soil survey. Currently, there is limited NRCS data available for the area, in draft format.

A Family - Wapiti Family Complex 3 to 8 percent slopes

Clayey soils dominate the north central portions of the Coal Hollow Mine permit area just west of the Tropic Shale ridge. This unit is characterized with very slow hydraulic conductivity rates of less than 0.04 inches per hour. Sagebrush and grasses dominate on this soil
unit. This unit will underlie the first phase of surface facilities and establish topsoil and subsoil stockpiles built on the site.

**M Family - Calendar Family D Family complex 3 to 8 percent slopes**

This unit occurs at the north end of the permit area where surface facilities are to be built. Soils from this unit contain Tropic Shale parent material at 20-72 inches below the surface. This unit is also dominated by clayey soils with very slow hydraulic conductivity rates of less than 0.04 inches per hour. Vegetation on this unit is dominated by sagebrush and grasses with some pinion pine and Utah juniper.

**Cibeque Family - Wapiti Family complex, 3 to 8 percent slopes**

This unit is comprised of deposits of very deep soils from both the alluvial fan deposition and organic matter from Robinson Creek. The soil is a sandy loam found along the banks of Lower Robinson Creek on the western portion of the permit area.

**Jonale Family – Graystone Cobbly Substratum Family – Wapiti Family complex, 3 to 8 percent slopes**

This unit is characterized by very deep fine-loamy and course-loamy soils with mollic epipedons and calcic horizons. Lime accumulations below 12-22 inches are common. PH is strongly alkaline below 22 inches. Vegetation in this unit supports big sagebrush and grasses. This soil is primarily situated on the west side of Highway 136 with some areas located on the central and the east side of the permit area directly on the alluvial fan complex.

**Calendar Family – M Family – Drififty Family complex, 8 to 25 percent slopes**

This unit is characterized by moderately deep (20 to 40) inches to shallow Tropic shale. The moderately deep soils have clayey texture while the shallow soils are loamy. Vegetation in this unit supports Pinyon pine, Utah juniper, black sage and grasses. This unit is represented in the most northern and western extremes of the permit area.

**Graystone - Cookcan – Jonale Family complex – 1 to 5 percent slopes**

Soils within this unit have medium to course textures and are very deep. This unit is not considered good subsoil. This unit is found on the western side of the permit area. Vegetation in this unit supports grasses, sedges, and forbs.

**Happyhollow Family – Alamosa complex, 1 to 5 percent slopes**

This unit is located on the Tropic shale ridge on the east side of the Sink Valley fault.
Soils are characterized by clay and high water table that is perched on the heavy clay soils. Groundwater is within a foot of the surface during wet periods. This unit supports vegetation comprised of sedges and forbs.

**Brumley – Graystone Cobbly - Sniloc complex, 3 to 8 percent slopes**

These soils are medium to coarse textured developed in very deep alluvium on the east side of the permit area. Evidence of a fluctuating water table was noted at depths between 48 to 60 inches.

**D Family – Deacon complex, 5 to 30 percent slopes**

This unit is characterized by clayey soils very deep with dark surfaces. Lime content increases between 6 to 12 inches below the surface. Soils appear to have derived from the large alluvial fan deposits. This unit runs parallel to the majority of Lower Robinson Creek. This unit supports big sagebrush, rabbitbrush and grasses with Pinyon pine and Utah juniper.

**Zigzag Clay – 8 to 25 percent slopes**

This unit is comprised of clayey soils derived from the shallow Tropic Shale ridge area that formed along the Sink Valley escarpment. The vegetation supported by this unit includes: Pinyon pine, Utah juniper, black sage and Indian ricegrass.

**A Family Clay– 8 to 25 percent slopes**

These soils are situated on the footslope and backslope of the Sink Valley fault escarpment. These deep clays support grasses, rabbitbrush, and big sagebrush.

**Manzanst Taxadjunct Family clay – 3 to 12 percent slopes**

This unit consists of clayey soils deep to very deep to Tropic Shale formed on gentle to moderately steep slopes along the southwest side of the permit area. This unit supports vegetation consisting of Pinyon pine, Utah juniper, black sage, and Indian ricegrass.

**A Family – Happyhollow Family complex – 1 to 5 percent slopes**

This unit consists of clayey soils very deep to Tropic Shale and formed on nearly level to gently sloping slopes in the south central portion of Sink Valley. Vegetation is grasses.
Vegetation

Vegetation within the Coal Hollow Mine permit area consists of pinyon and juniper in
the most extreme northern, western and southern sections. Sagebrush, rabbitbrush and grasses
are observed on the flatter valley areas within the permit area. Most of the permit area that
follows the county road on the eastern side is considered pastureland with punctuated localized
areas of sagebrush and pinyon/juniper trees. Vegetation in the adjacent areas is fairly
representative of what is found in the permit area. Pinyon and Juniper trees dominate the higher
elevations on the Paunsaugunt Plateau and within some upland areas to the west of the permit
area. The permit and adjacent area is mapped as habitat for the Greater Sage Grouse species
(*Centrocercus urophasianus*). The Greater Sage Grouse utilizes open sagegrass/grassland areas
as breeding grounds during their mating season (also known as “leks”). One lek exits in the
Alton area and is approx. 100 yards west from the Swapp Ranch House (within an enclosed in a
barb-wire fenced pasture). A roosting area is also present 0.25 miles northeast of the lek.
Chapter 3 within the MRP addresses a habitat management plan for the Greater Sage Grouse.

Generalized Geology

Stratigraphic units present in the Alton Coal Field and relevant to the Coal Hollow permit
area are comprised of Cretaceous-age units in the southern and south-central portion of Utah.
Economic coal reserves exist within the Dakota Formation. All the stratigraphic units exposed
in the Alton Coal Fields are listed in ascending order below:

*Navajo Sandstone (Lower Jurassic)*

The Navajo Sandstone is a light gray to tan, massive eolian sandstone deposit that
underlies the entire region. Very prominent features of cross-bedding characterize this rock unit,
making it a very recognizable formation. Thickness of the Navajo Sandstone in the Paunsaugunt
Plateau regions exceeds 1,000 feet. The Navajo Sandstone is the principal deep aquifer in this
region and provides high-quality groundwater to agriculture, municipal and domestic wells in the
area. The Navajo Sandstone is located beneath 1,000 feet of overlying bedrock and is not
impacted by mining activities.

*Carmel Formation (Upper Jurassic)*

The Carmel Formation unconformably overlies the Navajo Sandstone in the region. The
Carmel Formation is heterogeneous and consists of several member units comprised of
limestone, siltstone, sandstone and gypsum beds. The thickness of the Carmel formation ranges
from 650 to 800 feet in the Alton Coal Field area. The Windsor member of the Carmel
Formation outcrops about one mile south of the Coal Hollow permit area.
**Entrada Sandstone (Upper Jurassic)**

The Entrada is a massive, fine-grained, cross-bedded sandstone in the region. The formation does not outcrop in the area of the proposed Coal Hollow permit site.

**Dakota Formation (Cretaceous)**

The Dakota Formation is a fine to medium-grained sandstone interbedded with shale and coal. The economically viable coal seams in the Alton Coal Field are within this rock unit. In the permit area, the Dakota Formation directly overlies the Carmel Formation.

**Tropic Shale (Cretaceous)**

The Tropic Shale consists of gray and carbonaceous silty shale and claystone with few marine sandstone beds located mostly in the upper part. The formation typically erodes to a clayey soil that forms gentle, vegetated slopes. The Tropic Shale is found within the Coal Hollow mine permit area. The regional thickness in this area is approximately 700 feet. In the areas planned for mining, approximately 200-250 feet are present.

**Straight Cliffs Formation (Cretaceous)**

The Straight Cliffs formation is predominately calcite-cemented sandstone and mudstone. The sandstones of the Straight Cliffs Formation make up the lower two-thirds of the ledges radiating out from the southern Paunsaugunt Plateau. The Straight Cliffs Formation outcrops on the hillsides east and north of the Coal Hollow Mine permit area.

**Quaternary Alluvium**

The alluvium deposits in the area consist of poorly sorted alluvial and colluvial silt, clay, sand, and gravel. These deposits consist of stream and fan alluvium and terrace deposits. In downstream areas, the alluvial material consists primarily of mud derived from Tropic Shale. In Sink Valley and Lower Robinson Creek drainages near the Coal Hollow permit area, drill cores indicate that alluvial thicknesses in some locations range from a thin veneer overlying bedrock to at least 140 feet in thickness along eastern margins of sink valley. Much of the land surface in the Coal Hollow Mine permit area consists of fan alluvium deposited from sheet floods, debris flows and mud flows.
<table>
<thead>
<tr>
<th>System</th>
<th>Series</th>
<th>Stratigraphic Unit</th>
<th>Thickness (Feet)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tertiary</td>
<td>Eocene</td>
<td>Claron Formation</td>
<td>1000-1300</td>
<td>Pink, white, and varicolored limestone, cliff forming eroding into picturesque slopes and forms, basal conglomerate of exotic quartzite and limestone cobbles and pebbles.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Unconformity</td>
</tr>
<tr>
<td></td>
<td>Campasian</td>
<td>Kaiparowits Formation</td>
<td>265-700</td>
<td>Dark gray to gray-green arkosic sandstone, friable with weak calcareous cementation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wahweap Formation</td>
<td>500-1300</td>
<td>Alternating sandy shale and thin- to thick-bedded resistant sandstone, ledge and slope topography.</td>
</tr>
<tr>
<td></td>
<td>Santonian</td>
<td>Straight Cliffs Formation</td>
<td>80-500</td>
<td>Yellow-gray to brown, thick-bedded to massive cliff-forming sandstone with subordinate intervening gray shale, shaley sandstone, coal, and carbonaceous shale.</td>
</tr>
<tr>
<td></td>
<td>Coniacian</td>
<td>Minor Coal</td>
<td></td>
<td>Unconformity</td>
</tr>
<tr>
<td></td>
<td>Turonian</td>
<td>Tropic Shale</td>
<td>700-1000</td>
<td>Drab gray shale with subordinate thin brown fine-grained sandstone, slope forming.</td>
</tr>
<tr>
<td>Cretaceous</td>
<td>Cenomanian</td>
<td>Dakota Formation</td>
<td>150-450</td>
<td>Yellow-gray to brown fine- to medium-grained sandstone alternating with gray shale, sandy shale, carbonaceous shale and coal, ledge and slope former creating Gray Cliffs; best coal near bottom and top of unit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Major Coal Seams</td>
<td></td>
<td>Angular Unconformity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cannonville Member</td>
<td>0-300</td>
<td>White and reddish banded fine-grained sandstone and siltstone, friable and earthy weathering, massive.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Garfield Butte Member</td>
<td>0-300</td>
<td>Red-brown and light green siltstone; also red cross-bedded sandstone of the “slickrock” type.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wiggler Wash Member</td>
<td>0-60</td>
<td>Limestone, red siltstone, white and greenish gypsum.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Winsor Member</td>
<td>180-250</td>
<td>White, pink, brown sandstone alternating with thin red siltstone and mudstone.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Paria River Member</td>
<td>55-200</td>
<td>Interbedded light gray and red sandstone, limestone, siltstone, shale, and gypsum.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thousand Pockets Tongue of Navajo Sandstone</td>
<td>0-60</td>
<td>Yellowish cross-bedded friable but resistant sandstone.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crystal Peak Member</td>
<td>120-190</td>
<td>Dark reddish brown and white to light gray fine-grained sandstone, medium-bedded with minor thin gypsiferous or calcareous shales and conglomerate.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Red Hill Tongue of Navajo Sandstone</td>
<td></td>
<td>Unconformity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kolob Limestone</td>
<td>122-350</td>
<td>Gray and tan dense limestone with some thin sand red shale near the base and thin gypsum near top.</td>
</tr>
<tr>
<td></td>
<td>Lower</td>
<td>Navajo Sandstone</td>
<td>1000+</td>
<td>Light gray to tan, locally red fine-grained sandstone, massive, exhibiting large-scale aeolian cross-bedding, calcareous and cliff-forming.</td>
</tr>
</tbody>
</table>

Figure 1. Generalized Geologic Section of Rock Formations in the Alton Coal Field (from Doelling, 1972).
Coal Seam Geology

The principal coal-bearing seam within the permit area is contained within the Dakota Formation. Coal seams are also located in the Smoky Hollow Member of the Straight Cliffs Formation but this seam is only a few inches in thickness and not of economic importance. Two regionally important coal zones are present within the Dakota Formation: the Smirl coal zone, which is planned for mining by Alton Coal Development and the Bald Knoll coal zone, located about 200 feet below the Smirl zone at the base of the Dakota Formation. The Smirl coal zone is reported to be 14 to 18 feet thick while the Bald Knoll coal zone contains several coal seams with the thickest being 4.8 feet thick.

Structure

High plateaus characterize topography in the Alton/Sink Valley CIA. The Alton Coal Field is within a horseshoe-shaped structure with the Kaiparowits Plateau comprising the eastern flank and the Kolob Coal Field comprising the western flank. Rocks within the region have undergone little structural deformation; however, rocks in the western portion of this region have been subjected to several faulting episodes that have produced north/northwest trending faults. The Alton Coal field is bounded by the Paunsaugunt Fault to the east and the Sevier Fault to the west. The displacements of these faults are about 1,000-2,000 feet and 100 to 800 feet, respectively. The Sink Valley Fault bisecting the South Private Lease permit area is only slightly offset a few feet. Bedrock formations in the permit area dip gently to the east/northeast while the surface topography slopes gently opposite to the west/southwest.

The North Private Lease permit area contains both shale outcrops and valley-fill alluvial sediments. The alluvial sediments were laid down by quaternary erosional and depositional processes of Kanab Creek. They mostly rest directly on Tropic Shale, but do contact the underlying Smirl coal seam and the Dakota Sandstone where the shale has been scoured. The deposit is most extensive laterally and vertically along the northern permit boundary. Progressing southward the alluvial sediments bottleneck between Tropic Shale ridges to the east and west and vertically thin along the updip of the Smil Coal seam and the Dakota sandstone. At the southern permit boundary the alluvial sediments are only 160 feet wide and 50 feet deep.

Climate

Climate in the Alton/Sink Valley area ranges from arid in the lowest elevations to sub humid atop the highest plateaus. Normal annual precipitation ranges from 6 inches in the lower elevations to 40 inches in the upper elevations. Winter snow accumulations can occur up to 10 feet in the high altitudes. Summer precipitation exists mainly as localized thunderstorms that can produce up to one inch of rain in less than an hour. Evaporation in the region is a dominant factor with annual rates of evaporation exceeding the annual rates of precipitation. Average annual pan-evaporation rates range from about 75-85 inches (UDNR, 1981). Large evaporation
rates significantly decrease the quantity of water that would otherwise runoff in streams or would recharge the groundwater system. Temperature and precipitation data have been routinely measured and recorded at the Alton, Utah weather station since 1928. Data from the weather station indicates that average annual precipitation is 16.38 inches per year.

Since the 1980s, the region has experienced cyclical periods of wetness and drought conditions. The Palmer Hydrologic Drought Index depicts long-term climate trends by illustrating monthly values of drought or wetness by assigning a value to indicate severity. For example, to show a scale of mild to extreme drought negative values ranging from −1 to −5 are assigned −5 being extreme drought. Conversely, wet conditions are shown on a positive scale from 1 – 5 with 5 being an extreme wet spell. Since September of 2008, the region has been in a normal period (with values between −2 and 2) meaning neither wet nor drought. As a result, baseline hydrologic monitoring of the permit and adjacent area since September 2008 has occurred under normal climate conditions.

**Figure 2 - PHDI, Utah Region 4**

The Alton/Sink Valley CIA is located within Palmer Hydrologic Drought Index (PHDI) Regions 4 (Figure 2) and shows the PHDI for 2000 through 2009. Over the past decade, the area has seen cycles of both extreme droughts to extreme wet spells.

Ground-water regimes in the CIA are dependent upon climatic and geologic parameters that establish systems of recharge, movement, and discharge. In the Alton/Sink Valley CIA, precipitation and snowmelt at higher elevations provides most of the water for ground-water recharge (USGS, Plantz, 1985). Recharge has been estimated to be 4 percent (Price and Arnow, 1974) of the average annual precipitation for areas in the Kolob, Alton and Kaiparowits coal fields. Well-developed soils and permeable or fractured lithologies exposed at the surface
Probable Alluvial Valley Floor Areas

The Office of Surface Mining (OSM) has published study guidelines on what criteria to look for when making a determination for an Alluvial Valley Floor (AVF). The definition is presented in Section 701 of the Surface Mine Control and Reclamation Act and the Utah Coal Rules R645-100-200, and the State rules regarding AVFs are in R645.302.321 through 323. The provisions in the rules state that (1) certain types of stream valleys in the Western United States are prohibited from disturbance by coal mining activities and (2) some other types of stream valleys in the West may be allowed to be mined but must meet higher reclamation standards than other types of mined lands. Both of these descriptions of stream valleys fall into the category of alluvial valley floors.

The Division evaluated areas within and adjacent to the North and South Private Leases of the Coal Hollow mine for the presence of alluvial valley floors. The Sink Valley and lower Kanab Creek were evaluated for the South Private Lease and the Alton Amphitheater was evaluated for the North Private Lease.

The Office of Surface Mining requires the following criteria to be evaluated in order to determine the presence or absence of alluvial valley floors in the western United States:

1. located in topographic valleys having an associated stream channel,
2. underlain by unconsolidated deposits whose surface usually has the landform appearance of flood plains or terraces, and
3. have an agricultural importance derived from the availability of surface or groundwater.

The ultimate goal is to prevent surface disturbance to areas that have agricultural importance or to determine that regional water availability is not affected.

The Division published a Technical Analysis document in March 2009 concluding that Upper Sink Valley, consists of high terrain alluvial fan deposits, with no flood plain or terrace complexes. The Division acknowledged that although some of the criteria for an AVF are present within Sink Valley, not all the characteristics listed in the definition were clearly present (i.e. stream-laid deposits holding streams with water availability sufficient for irrigation or subirrigation activities”.

The investigation then focused on a reconnaissance for alluvial valley floors in the adjacent areas of the Coal Hollow Permit area in order to determine possible hydrologic consequences to these adjacent areas from mining. Based on an investigation by Petersen, two locations were identified as probable alluvial valley floors: a valley in the Kanab Creek drainage located in Sections 25 and 35 of T. 39 S., R. 6 W., and the lower portion of Sink Valley located
in Section 6 of T. 40 S., R.5 W.

The Division conducted field reconnaissance in September 2009 to evaluate these areas, the valley within the Kanab Creek drainage was observed to have a continuous stream channel, geomorphic terraces, and improved rangeland where cattle was grazing. The area appeared to be subirrigated. Subirrigation is defined by the alluvial valley floor regulations as “the supply of water to plants from underneath or from a semi-saturated or saturated zone where water is available for use by vegetation” (30 CFR 701.5). This area was determined to have characteristics of an alluvial valley floor. According to the Petersen report, crop production in this area is limited to hay.

The second area evaluated was the Lower Sink Valley Wash. The stream channel in this area was deeply incised and other characteristics such as improved rangeland and geomorphic terraces were present. This area did not appear to be able to support irrigation or show any indications of subirrigation based on the vegetation observed. Vegetation consisted of sagebrush and some grass areas. There is no residential development or active water rights in this area. Based on these observances, the Division concluded that this area does not have the characteristics of an AVF. Plates 1 through 3 in Appendix A show the boundary of the probable AVF area in Sections 25 and 35, T. 40 S., R. 6 W.

The area of the Alton Amphitheater was studied extensively to determine the presence, location and extent of an AVF. The methods, results, and findings are provided in the report, “Alluvial Valley Floor Field Investigation in the North Private Lease” (Petersen, 2014). This report was prepared by professionals within their respective fields who investigated all relevant aspects of hydrology, geology, biology, and soil types to classify and delineate the AVF in the area. The Division thoroughly reviewed the report and field verified the report’s findings. In November 2014 the Division agreed with the assessment that an AVF is exists north of the farm road, but is absent south of the road.

The historic practice of flood irrigation was the primary factor in determining the location and extent of the Alton Amphitheater AVF. The AVF is not subirrigated. Rooting depths on the flood plain terrace range from 0.7’ to 5.7’, while the water table sits 13’ or more below the ground surface. Therefore, any reduction in the water table due to mining operations will not impact the AVF and subsequent farming resource.

Properties of Water-bearing Stratigraphic Units in the Permit Area

Regional aquifer

The aquifer of regional significance is the Navajo Sandstone formation. The Navajo Sandstone is a resource for domestic, municipal and agricultural groundwater. The Navajo Sandstone is isolated by approximately 1,000 feet of overlying strata in the permit area and
consequently, will not be impacted by proposed mining activities. As a result, the Navajo Sandstone will not be considered a factor in evaluating aquifers that are pertinent to this CHIA. In preparing this CHIA, the Division has adhered to the definition of *aquifer* as found in the Coal Mining Rules (R645-100-200), and the term regional aquifer has been deliberately used or avoided, as appropriate, throughout this CHIA. Although there are local alluvial, perched, and fracture-related aquifers at Alton/Sink Valley, the quality, quantity, use, storage, flow and transport, and discharge of ground water do not indicate the presence of a regional aquifer or aquifer system.

Three principal stratigraphic units are found in the permit and surrounding areas that are considered part of this CHIA evaluation are the Dakota Formation, the Tropic Shale and Quaternary-age alluvium. The characteristics of each unit are described below:

**Dakota Formation**

The Dakota Formation is a shaley strata interbedded with fine to medium-grained sandstone and coal. The Smirl coal seam is contained within the Dakota Formation. In a report prepared by Petersen Hydrologic, LLC investigating the groundwater and surface water systems in the permit and adjacent area, Peterson suggests that recharge to the Dakota Formation by the overlying Tropic Shale is negligible due to the poor groundwater transmitting properties of the Tropic Shale. Petersen goes on to suggest that since the unit contains several vertically and horizontally discontinuous sandstone horizons, this impedes the flow of groundwater considerably. Only minor seeps with negligible discharge rates were found to originate in the Dakota Formation in and adjacent to the Coal Hollow Mine permit area.

**Tropic Shale**

The Tropic Shale outcrops as an observable ridge in the east-central portion of the permit area, which is likely a feature formed by the presence of the Sink Valley Fault. Other outcroppings of Tropic Shale are located in the most extreme southwest corner and also as two small knobs on the western side of the permit area. The lithologic characteristics of this unit are primarily uniform shale to silty shale with high clay content. No significant springs or seeps were identified as originating from this unit with the exception of one seep that discharges at a rate of less than 0.5 gallons per minute. The Tropic Shale is a poor transmitter of water and forms a basal confining layer for the overlying alluvial groundwater system. No appreciable amounts of groundwater flow from the Tropic Shale were observed during drilling activities for the baseline monitoring program.

The surficial outcrop of the Tropic Shale ridge along the Sink Valley fault in the South Private Lease is a hydrologic barrier to the up-gradient alluvial aquifer. This impermeable ridge directs groundwater flow to the south.
Alluvial Groundwater

The principal water-bearing stratum in the permit and adjacent area is the alluvial sediments. The groundwater recharge source of the alluvial aquifers is the upland areas of the Paunsaugunt Plateau. Alluvial groundwater discharges to the surface through springs, seeps, and along gaining sections of Kanab Creek.

In the South Private Lease the greatest concentration of alluvial groundwater discharge is found in the central Sink Valley area. This area was found to have the thickest section of alluvial sediments in Sink Valley where groundwater exists under artesian conditions. In January 2007, Petersen Hydrologic conducted a 28-hour pump and recovery test on monitoring well Y-61, which is located in the course alluvium at the base of Swapp Hollow Canyon, adjacent to the eastern boundary of the permit area. The objective of the pump test was to 1) evaluate hydraulic communication between the coarse alluvium of the pumping well Y-61 and the silty, clayey, and sandy alluvial sediments overlying areas planned for mining at the Coal Hollow Mine, and 2) to evaluate the aquifer characteristics of the coarse-grained, artesian portion of the Sink Valley Wash alluvial groundwater system. During the pump test, discharge was measured at four nearby springs and water levels measured in 20 observation wells. Information is in Section 9.3 of Appendix 7-1 of the Coal Hollow Mine MRP. Drawdown in the wells nearest Y-61 within the test period was up to 25 feet; the response to the pump test in other monitoring wells was negligible, with drawdowns of less than one foot. Drawing 7-14 in Chapter 7 illustrates the drawdown at C2-40, Y-102, and Y-59, three observation wells within 1,000 feet of Y-61; Figure 18 of Appendix 7-1 shows the smaller drawdown response at C2, C3, C4, and SS, observation wells along the eastern margin of the proposed mine; and contour lines on Figure 17 of Appendix 7-7 show the extent of the measurable drawdown in the observation wells. The results of the test indicated good groundwater communication between the pumping well and wells and springs within 1,400 feet of the pumping well. Observations at the springs and wells indicated that recovery continued after the 28 hour test. Petersen concluded that either the weak response from the monitoring wells indicates a low degree of hydraulic communication between the groundwater monitoring wells or the distance from these wells to the pumping well was too great for a potentiometric response to be measured. Overall, hydraulic conductivity rates for the coarse grained alluvial groundwater system were calculated to be relatively high at $6 \times 10^{-2}$ cm/sec or 170 feet/day.

The alluvial aquifer in the vicinity of the Alton Amphitheater has been characterized with pumping tests and baseline monitoring of the well network. The hydraulic characteristics were determined using a constant-rate pumping test in the spring of 2016. The pumping test ran for a 56 hour period, while simultaneously measuring the cone of depression in 22 surrounding observation wells. The results were analyzed in Aqtesolv to determine the aquifer type and its properties. The best fit model characterized the aquifer as leaky or semi-confined. The hydraulic conductivity was determined to be 16.7 ft/day or 5.88 x $10^{-3}$ cm/sec. Drawdown during the pumping test was observed in a well up to 1150 ft away (Appendix 7-18, Figure 2). This is typical of leaky confined aquifers where drawdown can affect a large area. The aquifer is stratified with low permeability clays, silts,
and sands that overlay coarser gravels held in a silty matrix. The upper low permeability deposits likely responded to the pumping test as a saturated aquitard.

**Groundwater Flow Characteristics**

Once recharge enters the ground, the rate and direction of ground-water flow is governed mainly by gravity and geology. Since the source of the groundwater originates in the Paunsaugunt Plateau to the east, groundwater migrates toward the permit area from the massive alluvial fan sediments that are considered the primary transport mechanism of supplying groundwater to the springs, seeps and valleys in and around the permit area.

Ground water tends to flow more readily through shallower systems where weathering and fracturing produce hydraulic conductivities that are generally larger than in deeper systems. Much of the ground-water flow continues both laterally and downward through these shallower, local systems until it intercepts the surface and is discharged at a spring or seep, enters a stream as baseflow, is transpired by vegetation, or simply evaporates to the atmosphere. Because of the lithic characteristics of the Tropic Shale and Dakota Formation’s groundwater is primarily confined to the alluvium and not expected in infiltrate into deeper underlying strata (i.e. Navajo Sandstone).

Tritium and radiogenic carbon values are typically used to date the groundwater residence time within an aquifer system. This information is useful in determining the age of groundwater and how often a groundwater system recharges. Tritium in the atmosphere is the result of atomic weapons testing that has occurred over the past 100 years. Tritium present in groundwater indicates that groundwater has made contact with the atmosphere and suggests its is of relatively recent age. Radiocarbon measurements of groundwater indicate how long groundwater has become isolated from soil-zone gasses and near-surface groundwater.

Tritium testing of groundwater and surface water from springs, wells, and streams in the Coal Hollow Mine permit/adjacent area was found to primarily be of modern ages. The Petersen report concluded that travel time of groundwater in Sink Valley was less than 50 years. All alluvial groundwater in Sink Valley indicates that recharge rates have occurred in modern times. The only exception to this was groundwater found in the Dakota Formation, which was determined to be isolated from the surface for at least the past 50 years and a groundwater residence time of approximately 1,000 years. The results of this testing indicate that the shallow groundwater system is relatively dynamic from the Paunsaugunt Plateau recharge area to discharge points located in Sink Valley.

There are numerous seeps and springs within the CIA. Discharge volumes are summarized in Table 1 below. Petersen Hydrologic LLC identified 38 seeps and springs in and adjacent to the permit area in their 2008 baseline survey. Most of the springs and seeps in and adjacent to the permit area have been identified within the alluvial groundwater systems in Sink
Valley. Springs SP-3 and SP-5 are located in upland areas southeast of the permit area. These springs are considered to be part of the groundwater recharge source area within the Paunsaugunt Plateau and will not be affected by mining activities. Two springs that discharge in the lower Sink Valley Wash area, SP-4 and SP-34. The discharge from these springs is thought to be from either alluvium or faulting in the valley. The discharge from these springs is negligible with less than 1 gallon per minute being reported. Neither of these springs have any water rights associated with them. Spring SP-37 is utilized for stock water and wildlife and is located at the eastern edge of Sink Valley. This spring discharges at less than 1 gallon per minute. Three springs are used for seasonal domestic water supply for the three residential properties in the adjacent area. SP-8 (Swapp Ranch House), SP-33 (Johnson cabin) and SP-35 (Sorensen Ranch House) each have variable discharge rates. The highest yielding spring is the spring located at the Swapp Ranch House with an average gpm of 14.31. Multiple springs to the west of and along the northeast/southwest trending boundary of the permit area are used for stockwater and support wildlife. Many of these springs may be dislocated when mining development commences.

Bank seepage occurs along Lower Robinson Creek in Section 19, T. 39 S., R. 5 W. The Petersen report concluded that is from the alluvial groundwater where the potentiometric surface of the groundwater intersects the stream channel. Based on data from the springs that have been monitored, spring discharge is distributed roughly as follows:

<table>
<thead>
<tr>
<th>Lithologic Unit</th>
<th>Number of Springs Included in Survey</th>
<th>Number of Springs Monitored</th>
<th>Total Average Monitored Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alluvium</td>
<td>35</td>
<td>27</td>
<td>1.54 gpm</td>
</tr>
<tr>
<td>Sorensen Spring (Alluv.)</td>
<td>-</td>
<td>-</td>
<td>0.02 gpm</td>
</tr>
<tr>
<td>Johnson Spring (Alluv.)</td>
<td>-</td>
<td>-</td>
<td>6.20 gpm</td>
</tr>
<tr>
<td>Dames Spring (Alluv.)</td>
<td>-</td>
<td>-</td>
<td>14.31 gpm</td>
</tr>
<tr>
<td>Tropic Shale Formation</td>
<td>0</td>
<td>0</td>
<td>n/a</td>
</tr>
<tr>
<td>Dakota Formation</td>
<td>3</td>
<td>3</td>
<td>0.36 gpm</td>
</tr>
</tbody>
</table>

Groundwater in the Alton Amphitheater is held in the alluvial valley fill sediments. The direction of groundwater flow is from north to south and generally parallels Kanab Creek. The alluvial sediments are heterogenous layers of clays, silts, and gravels within the permit area. Low permeability clays and silts make up much of alluvial deposit and are readily prevalent along the perimeter of the deposit near the Tropic Shale contact and the upper 20 to 30 feet of the deposit. Coarse gravels within a silty matrix are mostly in the center of the alluvial valley and extend vertically from the base of the contact to within 20 to 30 feet of the surface.
Groundwater exits the southern permit boundary primarily contained in a narrow and shallow gravel alluvial deposit resting on top of the Dakota sandstone.

The groundwater outflow through the alluvial sediments is calculated near the southern area of the Alton Amphitheater or southern permit boundary. The monitoring well network just south of the county road crossing of Kanab Creek was utilized for this study. A pumping test on well CLEM-4 determined the hydraulic conductivity at this location to be $8.515 \times 10^{-4}$ cm/sec. The gradient is the average change in head between the two up-gradient wells and the two down-gradient wells. The cross-sectional area is the width and depth of the geologic bottle neck of the alluvial sediments at the location of the well network. Using these data it is determined the total groundwater discharge at the southern end of the permit area is 4.6 gpm. In early May 2017 when this study was conducted, Kanab Creek was flowing at a rate of about 330 gpm. Therefore, the total calculated outflow at the southern boundary of the NPL permit area was 335 gpm.

Faults and fractures

Faults and fractures can act as effective conduits for ground water flow but can also be barriers to flow, especially to flow across the fault plane. The location of the Tropic Shale ridge that is located in the central portion of the permit area and is likely associated with the Sink Valley Fault provides a hydrologic barrier to groundwater flow originating from the eastern upland area. A readily observable pattern is shown on infrared aerial photography maps that concentrations of water represented in the varying forms of vegetation. These patterns show up as pink areas on the infrared maps. The Tropic Shale ridge clearly is showing that the alluvial groundwater is intercepted by the shale ridge and deflected toward the south. Infrared aerial and aerial photography maps of the Coal Hollow permit and adjacent area are included as Plates 2 and 3 in Appendix A. Only one spring originating in the Dakota Formation fault/fracture system about 1 mile south of the permit area is known to exist and this spring discharges negligible amounts of groundwater.

Hydraulic Conductivity and Permeability

In sedimentary rocks, there is a wide range of textures or fabrics that determine the hydraulic characteristics of the unfractured medium. These textures or fabrics are related to the mineralogy or composition of the sediments, the range of sizes of the sedimentary particles (sorting), the spatial distribution of different sediment-sizes (grading), the shape and spatial orientation or arrangement of the sediment particles after compaction (packing), cementation, and properties acquired or altered as and after the sediments were lithified. Lateral and vertical variations in these characteristics can create internal low-permeability zones or barriers, so that a unit that to the eye appears to be uniform and to have aquifer characteristics can actually be incapable of storing or transporting water in any significant amount.
The initial field investigation conducted in and adjacent to the permit area was designed to:

1) Better define the vertical and lateral extent of permeable, course-grained sediments in the alluvial groundwater system;
2) Characterize the water bearing and water transmitting properties of alluvial sediments and;
3) to evaluated the degree of hydraulic communication between the course-grained portion of the alluvial system in Sink Valley and the clayey alluvial sediments in the proposed mining areas.

The tasks performed as part of the initial field investigation included: A total of 30 monitoring wells were drilled in and adjacent to the permit area. A 28-hour pump test was conducted at well Y-61 located within the course alluvial sediments east of the permit area in the northwest portion of Section 29, T. 39 S., R. 5 W. Finally, slug testing was performed on 20 monitoring wells to determine approximate hydraulic conductivity values within the various formations.

Groundwater inflow values were determined based on the results of slug tests and calculated using Darcy’s Law:

\[ Q = KIA \]

Where

- \( Q \) = groundwater discharge rate
- \( K \) = hydraulic conductivity
- \( I \) = hydraulic gradient
- \( A \) = cross-sectional area

These data from the slug tests indicate that hydraulic conductivity in monitoring wells in the Lower Robinson Creek area and in the Dakota Formation above the coal seam was negligible, with transmissivity of groundwater being less than one gallon per minute. Significant transmissivity rates in the tests performed in wells in the Sink Valley area are summarized in the table below.

<table>
<thead>
<tr>
<th>Well ID</th>
<th>Formation</th>
<th>Conductivity Value (Maximum) cm/second</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y-61</td>
<td>Coarse alluvium (artesian system)</td>
<td>( 6.0 \times 10^{-2} )</td>
</tr>
<tr>
<td>C7-20'</td>
<td>Shallow Sink Valley clayey alluvium</td>
<td>( 8.3 \times 10^{-4} )</td>
</tr>
<tr>
<td>C2-28'</td>
<td>Mid to Lower Sink Valley sandy, silty, clayey alluvium</td>
<td>( 5.3 \times 10^{-3} )</td>
</tr>
<tr>
<td>SS-75'</td>
<td>Lower Sink Valley coal burned area</td>
<td>( &gt;10^{2} )</td>
</tr>
<tr>
<td>Y-98</td>
<td>Upper Robinson Ck drainage</td>
<td>( 3.2 \times 10^{-2} )</td>
</tr>
<tr>
<td>Y-38</td>
<td>Smirl Coal Seam</td>
<td>( 6.3 \times 10^{-5} )</td>
</tr>
</tbody>
</table>
Groundwater inflow rates into mine openings were estimated based on these data. The report concludes that groundwater inflow rates into the northwest corner of Section 29, 39 S., R. 5 W., which is considered the artesian alluvial groundwater system (C2 area), inflow rates are estimated at less than 10 gallons per minute. The report emphasized that these numbers were general estimates and if mine openings were to intersect a substantial thickness of coarse-grained material, that inflow rates could be much greater. The greatest hydraulic conductivity value was found in the burned out coal zone at the southern end of the permit area and encountered at a depth of 75 feet in borehole SS. The conductivity value presented was \( >10^{-2} \) and listed as high with data indicating mine inflow rates of 220 gpm over 100 linear feet. Rates of alluvial groundwater flow intercepted by the Coal Hollow project are expected to be variable due to the heterogeneity of the deposits. ACD estimates that groundwater on the order of a few tens of gallons per minute to several hundred gpm could be expected to be encountered.

Section 728.333 and Appendix 7-9 address specific protocols that the mine plans to implement in order to manage large, unexpected inflows of groundwater into the mine pits. Large cross-sectional areas of water-bearing strata will not be exposed to the mine pits because allowing the pits to flood would be prohibitive to coal extraction activities. Data show hydraulic conductivity values are highest in the area of a section of burned out coal located in the southern corner of the permit area. This area was documented at a depth of 75 feet in borehole SS. This area could experience high levels of groundwater inflow if it is encountered. According to page 7-28 of the MRP, the mine intends to avoid this highly permeable area by delineating the competent coal seam from the burned out section in order to design mining opening that will avoid exposing the burned (highly permeable) coal section.

**Water Quality**

The alluvial sediments in the Coal Hollow Mine permit area primarily consist of low permeable clays, silts, and sands derived mainly derived from the Tropic Shale that do not appear to readily transmit water. Deeper, coarser alluvia, especially on the east side of Sink Valley Wash are derived from Cretaceous and Tertiary strata exposed along the canyons of the Paunsaugunt Plateau east of Sink Valley Wash. Because appreciable amounts of groundwater originating from the Tropic Shale are not anticipated to flow out of the mine pit areas, minimal to no impacts to important water quality parameters in receiving surface and groundwater resources are expected to occur. Similar to the Tropic Shale, the coal-bearing Dakota Formation is not anticipated to have any adverse affects to water quality parameters. The Dakota was found to contain low-permeable shales and interbedded sandstone lenses which data has shown to be a poor transmitter of groundwater.

Since the alluvial sediments have been demonstrated to be the primary unit of importance in the permit and adjacent area for the transport of groundwater, water quality parameters could be adversely affected when mine workings intercept flow. One of the most important water
quality parameters is Total Dissolved Solids (TDS), which is a measure of the amount of dissolved sediment in the ground and surface water systems.

Under the Standards of Quality for Waters of the State of Utah (UAC R-317-2.13), waters in Kanab Creek and its tributaries - from irrigation diversion at the confluence with Reservoir Canyon to headwaters - are classified as, 2B, 3A and 4.

- **2B** - Protected for infrequent primary contact recreation. Also protected for secondary contact recreation where there is a low likelihood of ingestion of water or a low degree of bodily contact with the water. Examples include, but are not limited to, wading, hunting, and fishing;
- **3A** - Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain;
- **4** - Protected for agricultural uses including irrigation of crops and stock watering

Water originating from Water Canyon and Swapp Hollow is good quality from the Paunsaugunt Plateau on the eastern flank of Sink Valley. As surface water travels down the canyons and makes contact with the silty, clayey, sandy sediments from the alluvium and Tropic Shale formation, surface water quality generally degrades and higher levels of TDS are detected. Depending on the duration of contact, water quality degrades downstream to where TDS levels reaching 3,000 mg/L are not uncommon.

**Total Dissolved Solids (TDS) in Surface Water Systems**

In the Paunsaugunt Plateau, water quality is good in headwater areas and produces some of the freshest water in the region, where rocks contain only small amounts of readily soluble material. TDS concentrations are typically less than 300 mg/L and dominant ions are calcium, magnesium and bicarbonate. TDS concentrations increase at lower elevations, where stream waters flow along more saline sediments such as the alluvium and the Tropic Shale. Overall, surface water quality in the Kolob-Alton coal field region is considered fresh to moderately saline with TDS values ranging from 250 – up to 10,000 mg/L (Price, 1980). Surface water TDS values in Sink Valley typically range from 250 – 1,000 based on heavy flow to low flow conditions that vary by the season. TDS levels are naturally highest in Kanab Creek and Sink Valley drainages, mainly due to the general degradation of water quality as it travels and continues to make contact with sediment. TDS concentrations in the surface water drainages range from 500 – 3,000 mg/L.

**TDS in Groundwater Systems**

Overall, groundwater quality in the Kolob-Alton coal field region is considered fresh to slightly saline with TDS values ranging typically from <1,000 to 3,000 mg/L (Price, 1981). The freshest groundwater originates in the high plateau areas as well as at the headwaters of Kanab
Creek. In these areas, TDS values are typically less than 500 mg/L. More saline water is found in the Tropic Shale with TDS concentrations in groundwater typically ranging anywhere from 500 to 10,000 mg/L. TDS groundwater values within Sink Valley have been reported to range from 500-3,000 mg/L.

Aquatic Species

Streams in and adjacent to the Coal Hollow Mine flow in response to rainfall and snowmelt. Although there are episodes with high flow volumes, the channels are typically dry for several months out of each year and flow is too inconsistent to provide any aquatic habitats for fish. Amphibians and macroinvertebrates may survive in reaches of Kanab Creek west of the Coal Hollow Mine, but Lower Robinson Creek and Sink Hollow Wash do not support aquatic habitats.

Limited aquatic resources are found within the Kanab Creek drainage. Aquatic species, reptiles and mollusks, have been documented in the Kanab Creek drainage to include both native and nonnative fish species.

<table>
<thead>
<tr>
<th>Fish Species</th>
<th>Native (Y) or Non-Native (N)</th>
<th>General Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speckled dace</td>
<td>Y</td>
<td>Wide variety of water conditions and habitats, marshy wetlands to large streams</td>
</tr>
<tr>
<td>Mountain Sucker</td>
<td>Y</td>
<td>Riffles in clear, cold creeks and rivers in mountains</td>
</tr>
<tr>
<td>Rainbow Trout</td>
<td>N</td>
<td>Wide range of habitat including large, deep lakes, rivers and small streams.</td>
</tr>
</tbody>
</table>

Relatively few wetlands have been documented in the Kanab Creek/Virgin River Drainage Basin. Small seep or pothole-type wetlands act as water reserves and provide baseflows that can support aquatic communities during low-water periods. Potholes, small ponds and marshy areas provide subsurface flow that supplements direct water sources like springs and run-off. These wet areas also provide important habitat for invertebrate and amphibian populations. Waterfowl habitat areas are limited to a few “potholes and marshes” created by seepage from farm ponds.

The Kanab Creek drainage does not support significant habitat for sport fisheries. Flows are considered too small to provide adequate habitat for fish. Limited aquatic habitat is possible in the upper stream reaches, which would include the Alton/Sink Valley area.
Surface Water Baseline Conditions

Surface runoff from the permit and adjacent area are directed to three principal drainage basins in the region. In the lower half of the South Private Lease permit area surface runoff is directed to the Sink Valley Wash Drainage. The remainder of runoff in the South Private lease flows to the Lower Robinson Creek subdrainage. The North Private lease falls within the Upper Kanab Creek Drainage basin. The Sink Valley Wash is a tributary to Kanab Creek where the confluence of the two water bodies is located approximately 6 miles south of the permit area. Runoff in the Alton-Kolob region is generated from precipitation that falls directly on the area and snowmelt. The contributing area of Dry and Water Canyons and Swapp Hollow is approximately 5,080 acres. The area of Sink Valley is about 730 acres. Price (1982) gave mean averages in the Sink Valley area from 1 to 8 inches per year (Price 1982), but data from the Alton, Utah weather station indicate average annual precipitation of 16.38 inches per year (Appendix 7-6). ACD has maintained a weather station at the Coal Hollow permit area since 2006, and data from this station are in Appendix 7-6 of the Coal Hollow Mine MRP.

Dry Canyon

This drainage delineates the north and northeastern-most boundary of the CIA and represents the headwaters of Lower Robinson Creek. The surface and groundwater that originates in Dry Canyon follows a southwesterly gradient. Any runoff from heavy precipitation events from this canyon is directed west toward Lower Robinson Creek. The alluvial sediments originating from this canyon and Water Canyon form the geomorphic features of the alluvial fan structure found along the eastern flank of Sink Valley. Because this canyon is upgradient of proposed mining operations, surface and groundwater originating from this canyon will not be affected by any mine operations. For surface water baseline sampling purposes, the sampling point from this canyon is referred to as RID-1 – Robinson Creek.

Water Canyon

The surface and groundwater that originates in Water Canyon follows a southwesterly gradient. Surface runoff from Water Canyon is shown on topographic maps as intermittent. However, surface water monitoring has not detected flow since the baseline water monitoring program began in 2005. Runoff from Water Canyon is directed toward Robinson Creek. Because this canyon is upgradient of proposed mining operations, surface and groundwater originating from this canyon will not be affected by any mine operations. For surface water baseline sampling purposes, the sampling point from this canyon is referred to as SW-7 – Swapp Hollow (Adjacent).

Swapp Hollow

This drainage delineates the eastern-most boundary of the CIA. Surface water originating from Swapp Hollow Canyon may have at one time drained into a channel that existed in Sink
Valley, which is now buried beneath the alluvial fan. Currently, there is no continuous stream channel in Sink Valley. However, landform features of dried up channels can be seen in 2009 aerial photographs.

The surface water monitoring point midway up the canyon consistently reports flow. The data from the baseline monitoring period beginning in 2005 have reported flows ranging from 2.0 gpm through 290 gpm. Because this canyon is upgradient of proposed mining operations, surface and groundwater originating from this canyon will not be affected by any mine operations. For surface water baseline sampling purposes, the sampling point from this canyon is referred to as SW-8 – Swapp Hollow.

Sink Valley

Remnants of an old stream channel appear in Sink Valley. The Division has observed that this channel, shown on the USGS Alton Topographic Quad and evident on the ground, is a feature superimposed on the alluvial fan: it has not created a floodplain; it originates near the head of the fan in Section 21 Canyon, where sheetwash collects into rills and channels, and is augmented by flow from Swapp Hollow and several smaller drainages.

The channel appears discontinuous when viewing current aerial photographs. The only surface water monitoring point in Sink Valley (SW-6) is located adjacent to the southeast corner of the permit boundary near a spring. Surface flow from this point has only been detected twice since the beginning of the baseline monitoring period in 2005 during the spring season. Although appreciable amounts of groundwater are found in zones of coarse alluvium within Sink Valley, surface water expression is infrequent. Surface water runoff near monitoring point SW-6 (adjacent to the southeast boundary of the permit area) does have potential to increase upon the inception of mining activities due to the diversion of water being directed southward (i.e. downgradient) from the mine pits.

Lower Sink Valley Wash

Lower Sink Valley begins in the northeast corner of Section 6, T. 40 S., R. 5 W where the county road crosses the drainage and the channel looking south becomes significantly incised. There are only two surface water monitoring points in Lower Sink Valley Wash: SW-9 and SW-10. Similar to surface water conditions in Sink Valley, surface water has only been measured twice - in March 2006 and March 2008 - since the beginning of the baseline monitoring period in 2005, although data from the 1980s in the Division’s database show episodic flow as great as 763 gpm. No development and no active water rights exist in this area. These surface water monitoring points do have potential to be impacted by upgradient mining activities in the form of increased runoff. However, the closest monitoring point in Lower Sink Valley Wash is 1.5 miles downstream of the permit area boundary. The effects of mining, if any, this far downstream are not yet known, but will require close monitoring.
Kanab Creek

Kanab Creek is a tributary of the Colorado River that originates at the base of the Paunsaugunt Plateau at Reservoir Canyon east of Alton, Utah and flows 29.7 miles south through the town of Kanab, Utah to the Utah-Arizona state line. Perennial headwaters reach a maximum of 8,300 feet elevation, while Kanab Creek exits the state at 4,700 feet. There are no lakes or reservoirs in the drainage catalogued by the Utah Division of Wildlife Resources (Hadley, 2007).

On a regional scale, Kanab Creek flows to the south and is a part of the Colorado River Basin and ultimately discharges to the Colorado River. The Colorado River Basin drains approximately 246,000 square miles, including parts of seven western U.S. states (Wyoming, Colorado, Utah, New Mexico, Nevada, Arizona, California) and Mexico. Three-fourths of the Colorado basin is federal land comprised of national forests, national parks, and Indian reservations (Water Encyclopedia). Surface water in Kanab Creek is primarily used for stock watering and crop irrigation in irrigable areas.

Robinson Creek

In the Robinson Creek drainage, water in the form of precipitation or snow melt originates in the upper reaches of the stream from Water Canyon and other canyons east of the permit area on the Paunsaugunt Plateau. Robinson Creek exhibits geomorphic features of a highly incised natural channel that is often dry but likely receives water from torrential rainstorms.

The data show that stream flow significantly drops off as it continues downstream to where Lower Robinson Creek drains to Kanab Creek. The Kanab Creek drainage shows consistent spring and fall seasonal flow along all the sampling points on the creek. During spring runoff season, stream flow does steadily decrease as it travels downstream.

Water Canyon and Swapp Hollow Canyon are represented by surface water sampling points SW-7 and SW-8, respectively. Interestingly, no stream flow data has been detected in Water Canyon during the baseline monitoring period. Conversely, data from Swapp Hollow Canyon do show consistent stream flow data throughout the year. Surface water points SW-6, SW-9, and SW-10 represent sampling locations along Sink Valley and Sink Valley Wash. Baseline stream flow data show that flow is detected only during spring runoff season. These three points will be the surface water points that have potential to see effects to surface water runoff from mining activities, especially if groundwater flow is to be redirected away from the mining pits.

Baseline surface water monitoring at the Coal Hollow mine site began in June 2005 and has been collected on a quarterly basis ever since. Surface water collection points are shown on
Drawing 7-2 of the Coal Hollow Mine MRP. The principal drainage systems in the permit and adjacent area are: Lower Robinson Creek, Kanab Creek, Water Canyon, Swapp Hollow, and Sink Valley. Table 3 below indicates the minimum and maximum flows recorded since 2005 along with mean flow data where available. As can be seen on Table 3, the principal drainages are grouped together with the upstream to downstream locations grouped left to right.

### TABLE 3
#### SEASONAL SURFACE WATER FLOW DATA

<table>
<thead>
<tr>
<th>RID-1 Robinson Creek</th>
<th>SW-4 Robinson Creek</th>
<th>SW-101 Robinson Creek</th>
<th>SW-5 Robinson Creek</th>
</tr>
</thead>
<tbody>
<tr>
<td>Month</td>
<td>Min</td>
<td>Max</td>
<td>Avg.</td>
</tr>
<tr>
<td>March April</td>
<td>-</td>
<td>13</td>
<td>-</td>
</tr>
<tr>
<td>May April</td>
<td>3.5</td>
<td>48.6</td>
<td>24</td>
</tr>
<tr>
<td>July August</td>
<td>-</td>
<td>2.8</td>
<td>1.4</td>
</tr>
<tr>
<td>September October</td>
<td>7</td>
<td>0</td>
<td>33</td>
</tr>
<tr>
<td>November December</td>
<td>0</td>
<td>64.7</td>
<td>24</td>
</tr>
</tbody>
</table>

Baseline TDS data in Surface Water

Another water quality parameter that has significant effects to the quality of surface water is TDS concentration. TDS is an indicator of how much sediment load a water body is carrying: the lower the TDS concentration in surface water, the fresher the water. As previously mentioned, data published by the U.S. Geological Survey (Price 1980) indicated that TDS data
in the drainage basins of Kanab Creek and Sink Valley typically range from 500 – 3,000 mg/L. Table 4 shows concentrations of TDS in each of the drainages relevant to the permit and adjacent area. The drainages are grouped together in rows with the upgradient to downgradient sampling locations shown from left to right. TDS levels originating from the upland areas of the Robinson Creek drainage show TDS levels under 300 mg/L, as what was reported by USGS data back in the 1980s.

<table>
<thead>
<tr>
<th>TABLE 4</th>
<th>Total Dissolved Solids in Surface Water</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>TDS in mg/L</th>
<th>TDS in mg/L</th>
<th>TDS in mg/L</th>
<th>TDS in mg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>Max</td>
<td>Avg</td>
<td>Min</td>
</tr>
<tr>
<td>March</td>
<td>April</td>
<td>-</td>
<td>254</td>
</tr>
<tr>
<td>May</td>
<td>June</td>
<td>186</td>
<td>265</td>
</tr>
<tr>
<td>July</td>
<td>August</td>
<td>-</td>
<td>203</td>
</tr>
<tr>
<td>September</td>
<td>October</td>
<td>-</td>
<td>245</td>
</tr>
<tr>
<td>November</td>
<td>December</td>
<td>250</td>
<td>273</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TDS in mg/L</th>
<th>TDS in mg/L</th>
<th>TDS in mg/L</th>
<th>TDS in mg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>Max</td>
<td>Avg</td>
<td>Min</td>
</tr>
<tr>
<td>March</td>
<td>April</td>
<td>530</td>
<td>1236</td>
</tr>
<tr>
<td>May</td>
<td>June</td>
<td>578</td>
<td>813</td>
</tr>
<tr>
<td>July</td>
<td>August</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>September</td>
<td>October</td>
<td>1095</td>
<td>1259</td>
</tr>
<tr>
<td>November</td>
<td>December</td>
<td>442</td>
<td>1085</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TDS in mg/L</th>
<th>TDS in mg/L</th>
<th>TDS in mg/L</th>
<th>TDS in mg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>Max</td>
<td>Avg</td>
<td>Min</td>
</tr>
<tr>
<td>March</td>
<td>April</td>
<td>305</td>
<td>366</td>
</tr>
<tr>
<td>May</td>
<td>June</td>
<td>238</td>
<td>274</td>
</tr>
<tr>
<td>July</td>
<td>August</td>
<td>298</td>
<td>353</td>
</tr>
<tr>
<td>September</td>
<td>October</td>
<td>321</td>
<td>397</td>
</tr>
<tr>
<td>November</td>
<td>December</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Downstream data from Lower Robinson Creek do show increased levels of TDS in the drainage within the permit boundary and at the confluence of Lower Robinson Creek and Kanab...
Creek. Limited data show concentrations of TDS reaching slightly above 3,000 mg/L in Robinson Creek. It is anticipated that with the construction of Coal Hollow Mine surface facilities near Lower Robinson Creek, there would be a potential for increased contributions of sediment to Lower Robinson Creek and therefore sediment control practices in accordance with the Utah Coal Rules would need to be closely monitored in this area.

TDS concentrations in Kanab Creek from monitoring points SW-1 and SW-3 averaged approximately 1,200 mg/L. Concentrations of TDS increased slightly in downstream sample SW-2, with limited data showing a maximum concentration of 1,771 mg/L. SW-2 is downgradient of the confluence of Lower Robinson Creek and has the potential to see increases to sediment loads from mining activities.

TDS concentrations in the Swapp Hollow drainage show concentrations consistent with a fresh water classification.

Perched Water-Bearing Zones

There appears to be a perched aquifer adjacent to the Coal Hollow Mine. Petersen Hydrologic reported that perched groundwater conditions exist locally in the alluvial groundwater system in the Lower Robinson Creek subdrainage (Section 11.1, Appendix 7-1). As spring and stream flow moves down the canyons it infiltrates into the matrix at the head of the alluvial fan. In its downward movement it comes in contact with finer lentils materials then moves horizontal until it comes to the surface. This feature is seen in the wet areas (A and B) and spring discharges described by the Coal Hollow Mine MRP.

Anderson (1991) indicated two aquifers on his cross section. The pump test at Y-61 produced drawdown in wells screened in the same deeper, coarser materials that Y-61 was pumping from, but flows in springs at the surface were also reduced. The alluvial groundwater system is probably not homogeneous and anisotropic, but rather is a series of more permeable and less permeable materials with varying degrees of interconnectivity.

These systems may not always be perched in the strict sense, because they may be underlain or even enveloped by saturated low-permeability rock, but large contrasts in hydraulic conductivity effectively isolate them.
IV. IDENTIFY HYDROLOGIC CONCERNS

GROUND WATER

Groundwater systems in the permit and adjacent area have been identified within four formations: Navajo Sandstone, Dakota Formation, Tropic Shale and the Quaternary Alluvial Sediments. The Navajo Sandstone has been ruled out as having any impacts to the hydrologic balance of the permit and adjacent area since it does not outcrop in the area, is separated from the Smirl Coal Seam by several hundred feet of low permeability strata, and will not be encountered during surface mining activities. The Dakota and Tropic formations are considered poor transmitters of groundwater in the permit/adjacent area and are not considered a significant source of groundwater that could affect the hydrologic balance. The alluvial groundwater system supports springs, seeps and provides the groundwater source for several wells within the permit/adjacent area and is considered the formation of primary importance to the hydrologic balance.

Page 7-25 of the Coal Hollow MRP identifies three potential mechanisms of producing hydrologic consequences of surface mining activities in the Coal Hollow Permit Area. They are:

1. Where water-bearing strata in the proposed mining areas are mined through, groundwater systems within these strata will obviously be directly intercepted,
2. Where groundwater flow paths through mine openings are interrupted, groundwater flow in down-gradient areas could be diminished, and
3. Where mine openings intercept permeable strata, groundwater resources in up-gradient areas could potentially be diminished if appreciable quantities of groundwater were to be drained from up-gradient areas.

Seventeen springs and seeps are being monitored within and adjacent to the Coal Hollow permit and adjacent area. Average flows from baseline monitoring of springs within and adjacent to the permit area are presented in the table below.

<table>
<thead>
<tr>
<th>SPRING ID</th>
<th>LOCATION</th>
<th>FLOW (in gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLM-1</td>
<td>Kanab Creek</td>
<td>3.4</td>
</tr>
<tr>
<td>SP-4</td>
<td>Lower Sink Valley Wash – Dakota Fm Fracture</td>
<td>0.7</td>
</tr>
<tr>
<td>SP-6</td>
<td>Alluvium - seep in Sink Valley</td>
<td>0</td>
</tr>
<tr>
<td>SP-8</td>
<td>Alluvial spring at Dames Ranch</td>
<td>16</td>
</tr>
<tr>
<td>SP-14</td>
<td>Alluvium - Sink Valley</td>
<td>3.9</td>
</tr>
<tr>
<td>SP-16</td>
<td>(Teal Spring) - Alluvium -</td>
<td>0.9</td>
</tr>
</tbody>
</table>
Springs on the east side of the South Private Lease in Sink Valley such as the Sorensen Spring (SP-40) and Sorensen Pond (SP-19) along with several others on the east side of the permit boundary in Section 29 are upgradient of the mine and will not likely be affected by mining activities. Springs that will be affected by mining activities when the mine pits are constructed will be the springs within the permit area along the northeast to southwest permit boundary: these include SP-14, SP-22, and SP-23. Currently, these springs are used for stockwatering. The mine plan in the MRP states that groundwater flow that feeds these springs will be intercepted by an engineered barrier to be installed further to the west of these springs. The photo below show one of these springs within the permit boundary. The view is to the south with the fence line noted in the background.

Most of the springs show an average annual flow of less than one gallon per minute. Springs with significant flow include the springs located near the residential properties that are used for domestic purposes. These springs include SP-8 near the Dames property and SP-33 near the Johnson property. Neither of these springs is likely to show any effects from mining activities since their groundwater recharge source is to the east and consequently upgradient of mining activities.

**Ground Water Intercepted by Mining**

Groundwater resources in the relatively impermeable Tropic Shale are considered meager and therefore unlikely that appreciable amounts of groundwater would be intercepted within this formation. Similarly, groundwater resources within the Dakota Formation are also considered meager. The coal seam within the Dakota Formation will be extracted but the underlying strata will not be disturbed. Consequently, adverse impacts to direct interception of groundwater with these two formations are not considered to be significant.

Alluvial groundwater systems in the permit area will be directly intercepted by mining activities. The areas of permeable strata that are to be excavated for mining activities have the potential to drain groundwater resources in the upgradient areas. Hydraulic conductivity data available from the artesian alluvial groundwater system found in the coarsest alluvium (well C2 area) indicate a “worst case” scenario discharge rate from mine inflows is estimated to be less
than 10 gallons per minute. The permeability of backfill materials that will be placed into the mine pits during operations also needs to be considered in a groundwater permeability analysis. The potential for the migration of appreciable quantities of groundwater through fill material is considered low because the material will be clay rich in nature and the material has low permeability characteristics (Coal Hollow Mine MRP Appendix 7-10 and Appendix 7-20). In the event that appreciable amounts of groundwater inflows into the mine pits do occur, ACD has proposed to install a low-permeability barrier adjacent to the undisturbed alluvial sediments along highwalls with high inflow rates. The objective of this barrier is to prevent significant inflows of groundwater into the mine pits and minimize long term impacts to subirrigation, soil moisture, and adjacent water tables and potentially affect the hydrologic balance.

If mining operations do encounter groundwater in the mine workings, the water will be discharged to surface drainages through UPDES outfalls. Mine water will ultimately be discharged to the Sink Valley Wash drainage and Kanab Creek drainage.

**Diminution of Down-Gradient Ground Water Resources**

When areas to be mined intercept groundwater flow paths, there is the potential that diminution of down-gradient groundwater resources could occur. As previously mentioned, groundwater resources in the Tropic Shale and Dakota Formation formations transmit meager amounts of groundwater and do not provide measureable baseflow to streams down-gradient of mining areas.

Alluvial groundwater systems in Sink Valley and Alton Amphitheater show the highest rates of hydraulic conductivity where the coarsest alluvial deposits are mapped. In contrast, the total flux of groundwater migration through finer, clayey and silty sediments considerably less.

**Draining of Up-Gradient Groundwater Resources**

Based on information from water monitoring wells, including slug tests and a pumping and recovery test of Y-61, and analysis of the geology and hydrology of the proposed permit and adjacent area, the Coal Hollow Mine is designed to minimize potential diminution of flow from the alluvial springs in the Coal Hollow Mine permit and adjacent area.

The pump at Y-61 was stopped at the end of the 28-hour pumping test, and spring discharge rates and water levels in alluvial monitoring wells recovered to approximate pre-test levels. Figure 18 in Appendix 7-1 of the MRP shows the drawdown and recovery response of four wells (C2-40, C3-40, C4-30, and SS-30) and three springs (SP-20, SP-8, and SP-14). The observation springs were 750 to 1,400 and the wells 1,800 to 4,400 feet from the pumping well. Drawing 7-14 illustrates the drawdown at C2-40 and two other wells, Y-102 and Y-59, which were within 1,000 of Y-61; drawdowns at more distant wells are too small to show at the scale on that drawing.
The relationship of the alluvial ground-water table to wells and springs in and adjacent to the NW1/4 of Section 29 is crucial in understanding the PHC of the mining operation. Figure 18 in Appendix 7-1 indicates that during the pump test on Y-61, water levels actually increased at C2-40 and SS-30 and flow increased at SP-8 after 4 hours of pumping.

If inflows to the mine pits become excessive as mining progresses, ACD commits to use techniques such as bentonite- or clay-filled cutoff walls to minimize inflows (Appendix 7-20, Coal Hollow Mine MRP). Temporary reductions in flow from alluvial aquifers may occur but are likely to be short-lived as the pits will remain open for only 60 to 120 days.

Water replacement is discussed in Section 727. Long-term diminution of flow will be replaced with water from a well. The town of Alton has entered into an agreement to transfer a point of diversion for water rights to 50 acre-feet of water, which ACD plans to use to satisfy the water replacement requirements: a copy of the agreement with the town of Alton is in Appendix 7-8 of the Coal Hollow Mine MRP. The production well is constructed on lands currently leased by Alton Coal Development, LLC.

Based on information from water monitoring wells, including slug tests and a pumping and recovery test of Y-61, and analysis of the geology and hydrology of the Coal Hollow Mine permit and adjacent area, ACD has concluded that the proposed mine plan is designed to minimize potential diminution of flow from the alluvial springs in the permit and adjacent area.

The MRP for ACD’s Coal Hollow Mine notes that after the pump at Y-61 was stopped at the end of the 28-hour pumping test, spring discharge rates and water levels in alluvial monitoring wells recovered to approximate pre-test levels. Figure 18 in Appendix 7-1 shows the drawdown and recovery response of four wells (C2-40, C3-40, C4-30, and SS-30) and three springs (SP-20, SP-8, and SP-14). The observation springs were 750 to 1,400 and the wells 1,800 to 4,400 feet from the pumping well. Drawing 7-14 in Chapter 7 illustrates the drawdown at C2-40, Y-102, and Y-59, three observation wells within 1,000 of Y-61; Figure 18 of Appendix 7-1 shows the smaller drawdown response at C2, C3, C4, and SS, observation wells along the eastern margin of the proposed mine; and contour lines on Figure 17 of Appendix 7-7 show the extent of the measurable drawdown in the observation wells.

The relationship of the alluvial ground-water table to wells and springs in and adjacent to the NW1/4 of Section 29 is crucial in understanding the PHC of the proposed mining operation. Figure 18 in Appendix 7-1 indicates that during the pump test on Y-61, water levels actually increased at C2-40 and SS-30 and flow increased at SP-8 after 4 hours of pumping.

SURFACE WATER
Increased discharge, especially runoff from disturbed areas, could alter flow volumes, water quality, and runoff and flood patterns in creeks. Mining in the Alton area is not expected to increase discharge of surface or ground water beyond current levels. Creeks and drainage areas discussed are shown on Figure 19, Appendix 7-1 of the Coal Hollow Mine MRP.

**AQUATIC HABITAT**

Macroinvertebrates are excellent indicators of stream quality and can be used to evaluate suitability of a stream to support fish and other aquatic life. However, streams in and adjacent to the Coal Hollow Mine flow in response to rainfall and snowmelt. Although there are episodes with high flow volumes, the channels are typically dry for several months out of each year. Amphibians and macroinvertebrates may survive in reaches of Kanab Creek east of the Coal Hollow Mine, but flow in Lower Robinson Creek and Sink Hollow Wash is too inconsistent to support aquatic habitats.

Water withdrawals within the upper Colorado River Basin impact habitats of four endangered fish species in the Colorado River and its tributaries: the Colorado squawfish, razorback sucker, bonytail chub, and humpback chub. Water withdrawals from the Colorado River Basin above Lake Powell are restricted, and water withdrawals in excess of the limit could trigger consultation requirements with the U.S. Fish and Wildlife Service (USFWS). The Coal Hollow Mine and other possible future mines covered by this Alton/Sink Valley CIA do not flow to the Upper Colorado River Basin and are not subject to these restrictions.
V. IDENTIFY RELEVANT STANDARDS AGAINST WHICH PREDICTED IMPACTS CAN BE COMPARED

The UPDES permit for the Coal Hollow mine provides some standards for water quality in the area. Utah water quality standards exist for numerous parameters other than those discussed below, but at this time there is neither evidence to indicate nor reason to believe that those parameters are of concern in the Alton/Sink Valley CIA. However, additional parameters recommended for routine monitoring in UDOGM directive Tech-004 are included in the water-monitoring plans of the Coal Hollow operation.

Flow: There is no standard for flow in the Utah water quality standards. Flow is very sporadic in Lower Sink Valley. The only measured flow in Lower Sink Valley during the pre-mining baseline monitoring period was during the springtime runoff season. Similarly, surface water measurements in Robinson Creek during the baseline period showed only occasional flow.

The UPDES General Permit for Coal Mining contains no limit on flow. Discharge is to be measured monthly, and the duration of intermittent discharge is to be reported along with flow. Characteristics such as stream morphology, vertebrate and invertebrate populations, and water chemistry can be affected by changes in flow and therefore can provide an indirect standard for flow.

R645-301-731.530 and -731.800 require prompt replacement of State-appropriated water that is contaminated, diminished, or interrupted. Baseline hydrologic and geologic information is to be used to determine the impact of mining activities upon ground- and surface-water supplies.

Oil and Grease: There is no State water quality standard for oil and grease, but the limit in the UPDES General Permit for Coal Mining is 10 mg/L. Any observation of visual sheen requires a sample be taken immediately.

A 10 mg/L oil and grease limit does not protect fish and benthic organisms from soluble oils such as those used in longwall hydraulic systems, and UDWR has recommended soluble oils be limited to 1 mg/L (Darrell H. Nish, Acting Director UDWR, letter dated April 17, 1989 to Dianne R. Nielsen, Director UDOGM). Hydraulic longwall systems will not be present in the Coal Hollow Mine.

pH: Allowable pH ranges are 6.5 to 9.0 under State water quality standards for all Classes, and also under the UPDES General Permit for Coal Mining.

Total Dissolved Solids (TDS) concentrations: TDS is commonly used to indicate general water quality with respect to inorganic constituents. Kanab Creek and its
tributaries are categorized as Class 2B, 3A and 4 waterbodies. There is no state water quality standard for TDS for Classes 1, 2, and 3, but 1,200 mg/L is the limit for agricultural use (Class 4).

**Total Suspended Solids (TSS) and Settleable Solids:** There is no State water quality standard for solids in the water, but an increase in turbidity is limited to 10 NTU for Class 2A, 2B, 3A, and 3B waters. The UPDES General Permit for Coal Mining has the following allowable limits on TSS: 30-day average, 25 mg/L; 7-day average, 35 mg/L; daily maximum, 70 mg/L. TSS is to be determined by a monthly grab sample.

Under the current UPDES General Permit for Coal Mining, all samples collected during storm water discharge events are to be analyzed for settleable solids. Samples collected from increased discharge, overflow, or bypass that is the result of precipitation that does not exceed the 10-year, 24-hour precipitation event may comply with a settleable solids standard of 0.5 ml/L daily maximum rather than the TSS standard, although TSS and the other UPDES parameters are still to be determined. If the increased discharge, overflow, or bypass is the result of precipitation that exceeds the 10-year, 24-hour precipitation event, then neither the TSS nor settleable solids standard applies.

**Iron and Manganese:** UPDES General Permit for Coal Mining limit on daily maximum for total iron is 1.0 mg/L as determined by a monthly grab sample. State water quality standards (UDWQ 2009) allow a maximum of 1,000 μg/L (1 mg/L) dissolved iron in Class 3A, 3B, 3C, and 3D waters, with no standard for Class 1, 2, and 4 waters.

Monitoring of total manganese is required by SMCRA and the Utah Coal Mining rules, but there is no UPDES or Utah water quality standard for either total or dissolved manganese.

**Macroinvertebrates:** Macroinvertebrates are excellent indicators of stream quality and can be used to evaluate suitability of a stream to support fish and other aquatic life. However, streams in and adjacent to the Coal Hollow Mine flow in response to rainfall and snowmelt. Although there are episodes with high flow volumes, the channels are typically dry for several months out of each year. Amphibians and macroinvertebrates may survive in reaches of Kanab Creek east of the Coal Hollow Mine, but flow in Lower Robinson Creek and Sink Hollow Wash is too inconsistent to support aquatic habitats.

**MATERIAL DAMAGE**

Material damage to the hydrologic balance would possibly manifest itself as an economic
loss to the current and potential water users, would result in quantifiable reduction of the
capability of an area to support fish and wildlife communities, or would cause other quantifiable
adverse change to the hydrologic balance outside the permit area. The basis for determining
material damage may differ from site-to-site within the CIA according to specific site conditions.
Surface-water and ground-water concerns have been identified for CHIA evaluation.

The direct effect of mining on the hydrology of the area is mainly focused on managing
the limited amount of water that is available for present uses. This means that the quantity,
quality and distribution of the water must be maintained at minimum present levels. The specific
objectives of this CHIA used to evaluate material damage are:

1. Determine any changes in the quality of water that reaches the off-permit stream
   systems
2. Evaluate the sediment load to the stream system during and after mining and
   reclamation

Parameters for surface-water quantity and quality

The potential material-damage concerns this CHIA focuses on are changes of surface
flow rates and chemical composition that would physically affect the off-permit stream channel
systems as they presently function. Based on the data from the area, there is a minimal presence
of aquatic habitat in this area. Wildlife habitat most likely to be affected by the proposed Coal
Hollow Mine has been determined to be sage grouse. There is livestock grazing and an AVF in
Kanab Creek west of the permit area. In accordance with R645.302.323, “the proposed
operations would not materially damage the quantity and quality of water in surface and
underground water systems that supply those alluvial valley floors or portions of alluvial valley
floors which are outside the permit area of an existing or proposed coal mining and reclamation
operation”.

Therefore, water-quality and quantity criteria are intended to identify changes in the
present discharge regime that might be indicators of economic loss to the water users and
grazing-right owners, of significant alteration to the channel size or gradient, or of loss of
capacity to support existing fish and wildlife communities within the CIA. In order to assess the
potential for material-damage to these elements of the hydrologic system, the following indicator
parameters were selected for evaluation at each evaluation site: low-flow discharge rate and
TDS.

Low-Flow Discharge Rate

In the Wasatch Plateau, Waddell and others (1981) found that correlating three years of
low-flow records (September) at stream sites against corresponding records from long-term
monitoring sites would allow the development of a relationship that could be used to estimate
future low-flow volumes at the stream sites within a standard deviation of approximately 20 %.
Ten years of measurements reduced the standard deviation to 16 - 17 % and 15 years of data reduced it to about 15 %. This relationship indicates that a change in low-flow rates of less than 15 to 20 % probably would not be detectable. A 20 % decrease in the low-flow rate will provide a threshold indicator that decreased flows are persisting and that an evaluation for material damage is needed. However, because flow in many streams is intermittent, material damage due to loss of flow is very unlikely, and the intermittent nature of the flow will also make any such loss almost impossible to detect. Any such apparent change in discharge would need to be correlated against precipitation and a drought index such as the PHDI.

Aside from torrential precipitation events, currently Lower Robinson Creek sees minimal surface water flows in its stream channel. With the advent of surface mining, this area may see an increase in surface water via sheet flow along the surface as mining of the disturbed areas may produce some flows following a southwesterly gradient into Lower Robinson Creek. Monitoring of surface water flow levels at Lower Robinson Creek both at the mine site and downstream sample locations will provide a means to evaluate effects of the surface water flows resulting from disturbed areas on the receiving streams. Additionally, water from disturbed areas will be monitored at the discharge from the sedimentation ponds.

Total Dissolved Solids (TDS)

The concentration of dissolved solids is commonly used to indicate general water quality with respect to inorganic constituents. Wildlife and livestock use is the designated post-mining land use for the CIA, so established dissolved solids tolerance levels for wildlife and livestock have been adopted as the thresholds beyond which material damage may occur. The state standard for TDS for irrigation of crops and stockwatering (Class 4) is 1,200 mg/L. However, baseline conditions in the Coal Hollow permit and adjacent area have shown in both scientific literature from the USGS field investigations and in the baseline surface water data collected, that TDS concentrations can exceed levels over 3,000 mg/L in the stream channels - especially when surface water makes contact with silty, clayey or sandy sediments. As a result, material damage criteria for excessive TDS concentrations that persistently exceed 3,000 mg/L in springs, UPDES discharges, or receiving streams, it will be an indication that evaluation for potential material damage is needed.

Parameters for Ground Water Quantity and Quality

The potential material-damage concerns of this CHIA are intended to limit changes in the quantity and chemical composition of water from ground-water sources to magnitudes that:

- Will not cause economic loss to existing or potential agricultural and livestock enterprises;
- Will not degrade domestic supplies;
- Would not cause structural damage to aquifers; and
- Will maintain adequate capacity for wildlife and the limited aquatic communities that
exist in the area.

To assess the potential for material damage to these elements of the ground-water hydrologic system, the following indicator parameters were selected for evaluation: seasonal flow from springs and TDS concentration in spring and mine-discharge water.

Ground-water concerns will be monitored at numerous springs, wells, and UPDES discharge points. Locations are identified on Drawing 7-10 of the Coal Hollow Mine MRP. If inflow to a mine is significant or persistent, UDOGM can require monitoring of mine inflow.

**Seasonal flow from springs**

Maintain potentiometric heads that sustain average spring discharge rates, on a seasonal basis, equal or greater than 80% of the mean seasonal baseline discharge, or in other words baseline minus 20% probable measurement error. The 20% measurement error is based on analogy with the accuracy of measuring low-flow surface discharge rates. A 20% decrease in flows, determined on a seasonal basis, will indicate that decreased flows are probably persisting and that an evaluation for material damage is needed.

**TDS concentration**

The concentration of total dissolved solids is commonly used to indicate general water quality with respect to inorganic constituents. The quality of water from underground sources reflects the chemical composition of the rocks the water passes through. Ground-water quality may be degraded by intrusion of poorer quality water from wells or mines, by leakage from adjoining formations, or by recharge through disturbed materials. Wildlife and livestock use ground water discharging from seeps and springs, and those are the designated postmining users most likely to be impacted. Baseline conditions in the Coal Hollow permit and adjacent area have shown in both scientific literature from USGS field investigations and in the baseline groundwater data collected that TDS concentrations from the upland areas range from 100-500 mg/L while baseline groundwater TDS concentrations in Sink Valley typically range from 500-3,000 mg/L. There are no state-established groundwater quality standards for TDS. If TDS concentrations persistently exceed 3,000 mg/L it will be an indication that evaluation for material damage is needed.
VI. ESTIMATE PROBABLE FUTURE IMPACTS OF MINING ACTIVITY WITH RESPECT TO THE PARAMETERS IDENTIFIED IN V.

GROUND WATER

Dewatering related to mining has the greatest potential for impacting ground-water resources in the CIA.

Dewatering

Large-scale dewatering of the alluvial groundwater system, such that appreciable compaction of the aquifer skeleton could occur, is not anticipated (Section 724.500). Increased rates of dewatering may in the future result in depletion of ground-water storage in some beds above the coal seams. Upon cessation of mining, evaporation and water discharge, if there has been any, will be discontinued. Ground-water conditions similar to those that existed before mining will probably be established.

Estimates of groundwater inflow rates suggest that large, unmanageable amounts of alluvial groundwater will likely not be encountered; however, special mining protocols found in Appendix 7-9 of the MRP will be used when mining east of well C2 (Pits 13, 14, and 15) in order to minimize the potential for interception of large groundwater inflows.

When the pits are backfilled, it is likely that the average hydraulic conductivity of the placed run-of-mine backfill material will be low because of the pervasiveness of low-permeability, clay-rich materials in the overburden and the anisotropic nature of the placed fill material. Consequently, the potential for the migration of appreciable quantities of groundwater through the fill is considered low. In addition, to minimize the potential for long-term impacts to the alluvial groundwater system that could occur from long-term draining of alluvial groundwater into the pit backfill area, a low-permeability barrier may be emplaced adjacent to the undisturbed alluvial sediments.

SURFACE WATER

Changes in flow volume and total dissolved sediments in water quality have the greatest potential for impacting water resources in the CIA. Sites that were used for baseline monitoring of the Coal Hollow Mine are on Drawing 7-2 of the MRP. Sites to be monitored during mine operation are on Drawing 7-10.

Water Quality

Uncontrolled runoff from the disturbed lands and spoil pile could increase sediment
concentrations and alter the distribution and concentration of dissolved solids in the receiving streams. Sediment control measures such as sedimentation ponds are to be used to protect receiving streams from impacts from the mine’s disturbed areas.

Kanab Creek, Lower Robinson Creek, and Sink Valley Wash are monitored above and below the proposed Coal Hollow Mine, and monitoring will continue through mining and reclamation. Discharges from sedimentation ponds will be monitored under the Coal Hollow Mine’s UPDES permit. There is no plan to discharge water directly from the Coal Hollow Mine, but should the need arise, ACD has made a commitment to obtain a UPDES permit (MRP Section 724.200).

Based on analyses for the acid- and toxic-forming potential of the overburden and Smirl Coal Seam at the Coal Hollow Mine permit area (Appendices 6-1 and 6-2)x6-2), it is apparent that acid-forming and toxic-forming materials that could result in the contamination of surface-water or groundwater supplies in the Coal Hollow Mine permit and adjacent area are generally not present. Both groundwaters and earth materials are moderately alkaline.

CIA Sediment Control

Four sedimentation ponds and associated diversion ditches will be the primary sediment control method at the Coal Hollow Mine. Miscellaneous controls such as silt fence, straw bales, and berms are also proposed during construction and for specific areas, such as where impoundments or diversions are not suitable to the surrounding terrain.

Water Quantity

Discharges from sedimentation ponds will be monitored under Coal Hollow Mine’s UPDES permit. There is no plan to discharge water directly from the mine, but should the need arise, ACD has made a commitment to obtain a UPDES permit (MRP Section 724.200).

Estimates of groundwater inflow rates suggest that large, unmanageable amounts of alluvial groundwater will likely not be encountered; however, special mining protocols found in Appendix 7-20 of the MRP will be used when mining adjacent to alluvial sediments in order to minimize the potential for interception of large groundwater inflows.

When the pits are backfilled, it is likely that the average hydraulic conductivity of the placed run-of-mine backfill material will be low because of the pervasiveness of low-permeability, clay-rich materials in the mine overburden and the anisotropic nature of the placed fill material. Consequently, the potential for the migration of appreciable quantities of groundwater through the fill is considered low.

The clays, claystones, silts, siltstones, and shales that dominate the overburden have low hydraulic conductivity and consequently groundwater seepage through backfill in reclaimed mine pits and excess spoils storage areas will not be large.
VII. ASSESS PROBABLE MATERIAL DAMAGE

FIVE-YEAR PERMIT TERM

Coal Hollow Mine

Planned operational monitoring will document any measurable changes in the surface- and ground-water systems. Surface disturbances and UPDES permitted discharges are not expected to degrade surface- or ground-water quality. There is no AVF in the Coal Hollow Mine permit area or adjacent area to be impacted. Sediment control measures should continue to effectively prevent diminution of water quality in the receiving drainages.

The operations plan for the Coal Hollow Mine indicates that the operator should be able to control water inflow.

BLM LBA area

The Division will need to do further evaluation of areas along Kanab Creek for the presence of AVFs and potential impacts from mining before a mining permit can be issued for the future LBA area. The Division will also update the CHIA based on the findings of that determination.

FUTURE MINING

If it is demonstrated that mining has caused or will cause a diminution, contamination, or interruption of an appropriated water right or a material impact either within or outside of the permit area, ACD will be required by the Division to address means of minimizing the impact and replacing any appropriated water rights. Evaluation of Coal Hollow Mine PHC and the preparation of this CHIA do not indicate that there is any evidence that such impacts will result from the proposed mining in the Alton/Sink Valley CIA, and as a consequence, there is no reason to require operators to propose alternatives for disposing of the displaced water or other possible actions as part of the PAP.

Increased rates of dewatering may in the future result in depletion of ground-water storage in some beds above the coal seams. Upon cessation of mining, mine water discharge, if there has been any, will be discontinued. Ground-water conditions similar to those that existed before mining will probably be established as the mine workings flood.

Drainage from surface disturbance due to coal mining and reclamation operations will be managed through appropriate sediment controls. Excess spoil areas will be adequately covered with topsoil and all disturbed areas will be stabilized and revegetated to prevent surface water contamination.
VIII. STATEMENT OF FINDINGS

Based on the information presented in this CHIA, the Utah Division of Oil, Gas and Mining finds that the proposed coal mining and reclamation operations in of the Coal Hollow Mine have been designed to prevent material damage to the hydrologic balance outside the permit area. The Division has found no probability of material damage to the hydrologic balance from all anticipated mining operations in the CIA.
VIII. REFERENCES


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ABBREVIATIONS

AML  Abandoned Mine Lands
AVF  Alluvial Valley Floor
BLM  Bureau of Land Management
CIA  Cumulative Impact Area
CHIA Cumulative Hydrologic Impact Area
CVSSD Castle Valley Special Service District
DWR  Utah Division of Wildlife Resources
EA   Environmental Assessment
NEWUSSD North Kane Water Users Special Service District
MRP  Mining and Reclamation Plan
MSHA Mine Safety and Health Administration
PAP  Permit Application Package
PHC  Probable Hydrologic Consequences
PHDI Palmer Hydrologic Drought Index
SMCRA Surface Mining Control and Reclamation Act of 1977
UDOGM Utah Division of Oil, Gas and Mining
UDWR Utah Division of Water Resources
UDWQ Utah Division of Water Quality
UPDES Utah Pollution Discharge Elimination System
UP&L Utah Power and Light
USFS United States Forest Service
USFWS United States Fish and Wildlife Service
USGS United States Geological Survey
APPENDIX A

PLATES

Plate 1   CIA Boundary and Coal Hollow Permit Area with Federal Leases
Plate 2   Infrared Aerial Photography Map
Plate 3   Aerial Photography Map
Alton Coal Hollow Permit Area

Plate 1 CIA Boundary and Coal Hollow Permit Area with Federal Leases

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