GROUNDWATER AND SURFACE WATER HYDROLOGIC REVIEW
SKYLINE MINE - FLAT CANYON LEASE ADDITION
FEDERAL COAL LEASE TRACT UTU-71144
CARBON AND EMERY COUNTIES, UTAH

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Utah Division of Oil, Gas and Mining
Attention: Steve Christensen
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December 2016

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December 19, 2016
Utah Division of Oil, Gas and Mining
Attn: Steve Christensen
1594 W North Temple, Suite 1210
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Subject: **Final Groundwater and Surface Water Hydrologic Review**
Skyline Mine - Flat Canyon Lease Addition
Federal Coal Lease Tract UTU-71144, Carbon and Emery Counties, Utah
for the Utah Division of Oil, Gas and Mining

Dear Steve:

Please find enclosed our revised Final Report, *Groundwater and Surface Water Hydrologic Review Skyline Mine - Flat Canyon Lease Addition Federal Coal Lease Tract UTU-71144, Carbon and Emery Counties, Utah.* Loughlin Water Associates, LLC prepared this report in accordance with our proposal dated October 18, 2016.

The revised final report incorporates the December 13, 2016 DOGM comments and addresses requested changes to the document. This final report summarizes our opinion as to whether the (1) data and information that have been provided for the Flat Canyon Lease are adequate to evaluate if the Mining and Reclamation Plan (MRP) has been designed to prevent impacts to state appropriated water rights and Electric Lake and (2) proposed water monitoring plan is adequate to detect potential impacts to water rights. We conclude that the mining plan and the monitoring plan are inadequate to assess potential impacts to water rights.

If you have any questions or need more information, please do not hesitate to call us at (435) 649-4005 (office) or JB at (801) 580-4530 (mobile).

Very truly yours,

Loughlin Water Associates, LLC

John S. Brown, P.G.
Senior Hydrogeologist

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Attachment: Report

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File: Doc16-51-DOGM-Final12-19-2016

INTRODUCTION

This report presents our groundwater and surface water hydrologic review of the proposed Skyline Mine, Flat Canyon Lease Addition, Federal Coal Lease Tract UTU-71144 (Flat Canyon Lease). The purpose of our review is to help the Utah Division of Oil, Gas and Mining (DOGM) determine whether the (1) data and information that have been provided are adequate to evaluate if the Mining and Reclamation Plan (MRP) and the amendment to the MRP (the Amendment) have been designed to prevent impacts to state appropriated water rights and Electric Lake and (2) proposed water monitoring plan is adequate to detect potential impacts to water rights.

The Skyline Mine is owned and operated by Canyon Fuel Company, LLC (CFC). The Skyline Mine is located in Carbon and Emery Counties, about five miles by road southwest of Scofield, Utah. Figure 1 shows the location of the Skyline Mine and other features in the region. Figure 2 outlines the area of underground workings of the Skyline Mine, the Flat Canyon Lease boundary, and the Mine No. 4 area. Proposed Mine No. 4 will extend under the Flat Canyon Lease and to the east, as shown on Figure 2.

CFC submitted the original application for the Flat Canyon Lease on October 13, 2015. After one round of deficiencies, DOGM received the revised application from CFC on September 2, 2016. This application would extend the life of the Skyline Mine by approximately 9 to 12 years.

The Skyline Mine began operations in the early 1980's. CFC encountered large, persistent groundwater flows into the mine beginning about 1999. Concerns about impacts to water rights due to pumping from the mine and from dewatering well JC-1 spurred a number of investigations in the early 2000's by CFC and by several parties that believed they were impacted by the CFC dewatering operations. More recently, CFC and its consultants have submitted studies and documents for the permit modification for the Flat Canyon Lease.

PURPOSE AND SCOPE OF SERVICES

The purpose of our review is to help DOGM determine whether the (1) data and information that have been provided are adequate to evaluate if the Amendment has been designed to prevent impacts to state appropriated water rights and Electric Lake and (2) proposed water monitoring plan is adequate to detect potential impacts to water rights. We conducted our review in accordance with our proposal to DOGM dated October 18, 2016.

To achieve our purpose, we met with DOGM staff, visited the Skyline Mine area with DOGM and mine staff, reviewed project documents and data, and prepared this report. Additionally, DOGM invited area water users, including Huntington Cleveland Irrigation Company and PacifiCorp, to meet face-to-face with DOGM staff and representatives of Loughlin Water Associates, LLC (Loughlin Water). The purpose of the meeting was to better understand the concerns of water right users regarding possible impacts from the proposed mining of the Flat Canyon Lease. Although the water users declined to attend,

a meeting was held with Craig Smith of Smith Hartvigsen PLLC who serves as legal counsel to Huntington Cleveland Irrigation Company.

SKYLINE MINE AND FLAT CANYON LEASE

Figure 1 shows the location of the Skyline Mine, which is in Carbon and Emery Counties, about five miles by road southwest of Scofield, Utah. Existing Skyline Mine areas are referred to as Mine No. 1, Mine No. 2, and Mine No. 3. The Flat Canyon Lease will be mined as part of proposed Skyline No. 4 Mine. Figure 2 outlines the area of underground workings of the Skyline Mine, proposed Mine No. 4, and the boundary of the Flat Canyon Lease.

The Skyline Mine employs longwall mining methods. The underground workings in the permit area at the Skyline Mine are accessed through portal facilities located in Eccles Canyon. The main portal is approximately 2.5 miles east of the northern portion of the Flat Canyon Lease at an elevation of about 8600 feet. Water pumped from the mine has been discharged out the mine portal in Eccles Canyon into Mud Creek, which is part of the Price River drainage basin (see Figures 1 and 2). Dewatering well JC-1 is located in James Canyon near the Skyline No. 2 Mine, produces groundwater from a fracture zone in the Star Point Sandstone, and discharges produced water to Electric Lake. James Canyon and Electric Lake are located within the San Rafael River drainage basin.

The mine area includes five Federal coal leases that are incorporated into the current approved permit area for the Skyline Mine. The mining plan for the Flat Canyon Lease area is provided in Chapter 4 of the Amendment. DOGM regulates CFC and the Skyline Mine in accordance with the federal Surface Mining Control and Reclamation Act (SMCRA) of 1977, Permit #C0070005. CFC submitted a modification to their existing Amendment on October 13, 2015 to include the Flat Canyon Lease in the existing permit for the Skyline Mine. The Flat Canyon Coal Lease would extend the life of the mine by approximately 9 to 12 years. The lease contains up to 42 million tons of mineable coal.

Groundwater and surface water data collection at the mine has been on-going since the 1980s. A number of studies of the Skyline Mine area were conducted following large groundwater inflows from fault systems into Skyline No. 2 Mine. These inflows began in March 1999 and discharges up to 9,000 gallons per minute (gpm) have been recorded (Petersen, 2002). The proposed Flat Canyon Lease Amendment modification submitted by CFC indicates that CFC expects to encounter as much, if not more water in Skyline No. 4 Mine than was previously encountered in Mine No. 2. Estimates of inflow to Mine No. 4 range from a possible increase of 7,000 to 12,000 gpm in the Flat Canyon Coal Lease Tract EIS (USDA FS and BLM, 2002) up to 15,000 gpm (Petersen, 2014a).

SUMMARY OF HYDROGEOLOGY OF MINE AREA

GEOLOGIC FORMATIONS

Unless otherwise noted, we obtained most of the information on the geology of the Flat Canyon Lease area presented herein from the Final Environmental Impact Statement

(EIS) for the Flat Canyon Coal Lease Tract that was prepared by the U.S. Department of Agriculture (USDA) Forest Service, dated January 2002. Figure 3 shows the distribution of geologic formations and structural features and the general geology of the Flat Canyon Lease and surrounding areas. Figure 4 presents a generalized stratigraphic section for the geologic formations that are present in the Flat Canyon Lease area.

Bedrock formations in the Flat Canyon Lease area were deposited during the Late Cretaceous and Tertiary periods. Multiple transgressions (expansions) and regressions (retractions) of the Western Cretaceous Interior Seaway resulted in the deposition of a heterogeneous sequence of rock types that are both horizontally and vertically discontinuous. On the terrestrial (landward) side of the shoreline (Wasatch Plateau area) sediment deposition occurred in lacustrine (lake), fluvial (river and stream), floodplain, and swamp environments. Beach sands accumulated along the shoreline. Offshore, sands swept from the beaches and were laid down as bars and blankets of sand in the near-shore shallow marine waters. Muds and clays were deposited in deeper, quieter portions of the sea.

The rock layers exposed in and adjacent to the Flat Canyon Lease area are described below. The geologic units shown on Figure 4 are described below from oldest (generally lowest elevation) to youngest (generally highest elevation).

Star Point Sandstone (Cretaceous)

As indicated on Figure 3, the Star Point Sandstone (Ksp) is exposed (present at or near the ground surface) at the mouth of Eccles Canyon, in areas west of Mud Creek and west of the Pleasant Valley Fault, beneath the lower end of Electric Lake and Electric Lake dam, and downstream from the dam on both sides of Huntington Creek. In the Flat Canyon Lease area, the Star Point Sandstone is found at great depth (more than 800 feet). The Star Point Sandstone will form the floor and is expected to contribute most of the groundwater inflow to the Flat Canyon Mine below the Flat Canyon coal seam.

The Star Point Sandstone is a marine shoreface deposit formed by accumulation of beach sands of the Cretaceous seaway. The Star Point Sandstone is about 1,300 feet thick and consists of two massive units, the Storrs Tongue and the underlying Panther Tongue, which intertongue with the overlying Blackhawk Formation and the underlying Mancos Shale. Both sandstone tongues consist of massive buff-colored sandstone units. The Storrs Tongue pinches out westward within the Flat Canyon Lease.

Blackhawk Formation (Cretaceous)

The Blackhawk Formation (Kbh) is exposed over most of the project area and forms the canyon bottoms beneath Quaternary alluvium and lower and lower-intermediate slopes of Boulger, Flat, Swens and Little Swens Canyons. The Blackhawk Formation is easily eroded and forms slopes.

The Blackhawk Formation is approximately 1,900 feet thick and consists of lenticular sandstone, siltstone, claystone and shale. The lower portion of the Blackhawk Formation is the coal-bearing section of economic interest. None of the coal seams crop

out at the surface within the Flat Canyon Lease area and are found at depths that range from approximately 800 feet along the eastern boundary to more than 2,000 feet along the western boundary.

Castlegate Sandstone (Cretaceous)

The Castlegate Sandstone (Kcg) is about 220 to 320 feet thick and consists primarily of fine- to medium-grained fluvial sandstone. Petersen Hydrologic, Inc. (Petersen, 2014a), reports that thin interbeds of siltstone and claystone are common. The formation was deposited in a braided stream environment, resulting in a series of lenticular deposits. In the Flat Canyon Lease area, exposures of the unit form steep slopes.

Price River Formation (Cretaceous)

The Price River Formation (Kpr) is about 220 to 280 feet thick in the Flat Canyon Lease area and consists of interbedded fluvial sandstone and low-permeability mudstone and conglomerate units. The lenticular, discontinuous nature of the fluvial sandstones combined with the fact that the sandstones are encased in low permeability fine-grained material, prevents the transmission of groundwater significant distances through the unit (Petersen, 2014a). The Price River Formation forms the gently-sloping, vegetation and soil covered upper slopes of the canyons and is difficult to discern from the overlying North Horn Formation.

North Horn Formation (Cretaceous-Tertiary)

The North Horn Formation (KTnr) consists of interbedded lacustrine limestone, sandstone, and mudstone or shale units and caps the upland ridge tops at the west edge of the Flat Canyon Lease area.

Alluvium and Colluvium (Quaternary)

Alluvium (Qal) consists of stream-deposited gravels and is found in canyon bottoms. Soil and colluvium are relatively thick and drape most of the slopes.

Glacial Deposits (Quaternary)

Glacial deposits in the project area consist of terminal, recessional, and ground moraines. Morainal deposits are most notable in Boulger Canyon but are found in the other drainages. Boulger Dam was constructed on a very prominent terminal moraine.

GEOLOGIC STRUCTURE

Figure 3 shows geologic structures that are present in the area. Bedrock in the Flat Canyon Lease generally dips (tilts) to the west at approximately 4 to 10 degrees (Petersen 2014a). More than a dozen normal faults were encountered in the Skyline Mine, most of which, as indicated on Figure 3, have an east-west to northwesterly orientation. Mica-rich igneous dikes, known as lamprophyres, trend nearly east-west and occur within the Skyline Mine at the same approximate orientation as the east-west trending faults.

Figure 3 shows that bedrock in the Flat Canyon Lease area is cut by northeast-trending normal faults. These faults are related to extensional tectonic events, have about 5 to 20 feet of offset, and have mapped lengths that range from 3 to more than 5 miles. The faults cut both the Star Point Sandstone and the Blackhawk Formation and extend to the north-trending Diagonal Mains Fault which produced significant inflow of groundwater to the No. 2 Mine. According to CFC (verbal communication on November 1, 2016), faults encountered in the Skyline Mine generally contain sandy material rather than clayey fault gouge.

The Flat Canyon Lease area and the current permit area of the Skyline Mine lie between two major north-trending normal faults. These include the Pleasant Valley Fault, located to the east and the East Gooseberry Fault, located to the west. The Pleasant Valley Fault roughly parallels the Mud Creek drainage and passes through the town of Scofield. The Pleasant Valley Fault system is down to the east and places the Star Point Sandstone on the west side of the fault against the younger Blackhawk Formation on the east side of the fault.

Note that the location of the East Gooseberry Fault shown by CFC (2010) on Figure 3, is significantly different than the location of the fault shown by Oberhansley (1980) shown on Figure 5. Also on Figure 5 is a west-to-east geologic cross section by Oberhansley (1980) that shows about 1,000 feet of displacement, down to the west, across the East Gooseberry Fault. Oberhansley (1980) is a 1:24,000-scale geologic map that was published by the Utah Geological Survey (UGS). Oberhansley (1980) indicates that the Skyline No. 4 Mine will cross the East Gooseberry Fault in the southwest half of section 5, Township 14 South, Range 7 East, Salt Lake Base and Meridian (SLB&M). A geologic map of the area by Witkind and Weiss (1991) that was published by the U.S. Geological Survey (USGS), shows the East Gooseberry Fault in the same area as Oberhansley (1980). CFC (2010), however, places the East Gooseberry Fault at more than a mile to the west of section 5 and indicates that the mine will not cross the fault.

GROUNDWATER SYSTEMS

Groundwater in Unconsolidated Deposits

Logs of exploration borings drilled by CFC (USDA Forest Service, January 2002) indicate that unconsolidated glacially-derived lacustrine and terminal moraine sediments are up to 70 to 90 feet thick in Flat Canyon. The sediments consist primarily of sand and gravel with only minor fine-grained materials, and thus are expected to be fairly permeable (USDA Forest Service, January 2002). Because of the thickness, lateral extent, and saturation of these deposits, the Flat Canyon glacio-lacustrine sediments are designated as a distinct groundwater system (USDA Forest Service, January 2002). Discharge from colluvial/shallow bedrock groundwater systems provides the bulk of recharge to the Flat Canyon glacio-lacustrine sediments. A large portion of the discharge from the Flat Canyon alluvial groundwater system occurs directly to Flat Canyon Creek. Flat Canyon Creek does not appear to be fed by perennial creeks in any of the side drainages. Rather, Flat Canyon Creek appears to gradually gain flow throughout the year along its course

due to discharge from springs and groundwater discharge directly to the creek from this aquifer.

Discharge from the Flat Canyon alluvial aquifer may also occur via underflow through the basal moraine deposits or bedrock underlying the moraine deposits (USDA Forest Service, January 2002). Any underflow would recharge the glacial/alluvial sediments below the moraine and would ultimately discharge to either Boulger Creek below the Boulger Creek Reservoir or to Electric Lake via groundwater inflow. A small amount of water may also flow downward and recharge underlying bedrock of the Blackhawk Formation (USDA Forest Service, January 2002).

Groundwater in the Castlegate Sandstone

The Castlegate Sandstone forms the steep intermediate slopes of the canyons in the Flat Canyon Lease. This unit is present over a large area and is covered with thick soil and colluvial deposits. The Castlegate Formation overlies the less permeable Blackhawk Formation and consequently, springs are common at the contact between these two units (Petersen, 2014a).

Groundwater in the Blackhawk Formation

The Blackhawk Formation consists of lenticular, discontinuous layers of sandstone that are interbedded with layers of claystone, mudstone, shale, and coal. The sandstone beds have significantly higher hydraulic conductivities than the fine-grained claystone and mudstone that surround and encase the sandstones. According to the Amendment, coal seams in the Skyline Mine and other mines in the Wasatch Plateau do not bear water and must be wetted to control dust during mining operations. Lines (1985) reports a wide range in horizontal hydraulic conductivities in core samples from the Blackhawk Formation from the Trail Mountain Mine area, of about 5.29×10^{-6} to 3.5×10^{-13} centimeters per second (cm/sec).

Groundwater occurs at depths greater than about 150 feet and is not always encountered in borings drilled through the Blackhawk Formation in the Flat Canyon Lease area (oral communication with CFC, November 2016). Sandstone units within the Blackhawk Formation have produced groundwater inflow to underground mine workings at the Skyline Mine. Inflow rates, however, are relatively small and tend to diminish quickly due to the limited extent of and poor hydraulic communication between individual sandstone units.

Due to its high shale and claystone content, recharge through the Blackhawk Formation is relatively slow. Confined conditions in the underlying Star Point Sandstone attest to the ability of fine-grained units in the Blackhawk Formation to act as substantial barriers to vertical groundwater flow.

Mayo and Associates (1996) report that groundwater in the deep Blackhawk Formation has radiocarbon ages of 2,500 to 18,500 years and contains essentially no tritium (USDA Forest Service, January 2002). This suggests that groundwater in the Blackhawk Formation has a poor connection to surface water surfaces and that groundwater flow is slow. The stable isotope ratios of mine inflow waters are considerably more negative

than shallow subsurface groundwater, suggesting that these waters likely recharged under ancient, cooler paleoclimatic conditions such as glacial periods.

Faults do not appear to be important in the conveyance of water in the deep Blackhawk Formation groundwater system (USDA Forest Service, January 2002). Reportedly, most water-bearing faults encountered in Wasatch Plateau coal mines are associated with sandstone units (USDA Forest Service, January 2002). Thus, the USDA Forest Service (2002) did not expect that large volumes of water would be encountered in faults within in the Blackhawk Formation.

Table 1 summarizes the construction of monitor wells that are screened in the Blackhawk Formation. Figures 6 through 8 show groundwater elevations in the Blackhawk Formation for June 1997, September 2002, and June 2014, respectively. The water level data are from the DOGM database. The selected time periods represent: (1) two years before large mine inflows were intercepted in the Skyline No.2 Mine (Figure 6), (2) immediately following startup of Well JC-1 (Figure 7) and, (3) after approximately 12 years of pumping from Well JC-1 (Figure 8). Groundwater elevations in the Blackhawk (shown in red) are about 60 to 470 feet higher than groundwater elevations in the underlying Star Point Sandstone, which indicates a downward vertical gradient. A downward gradient is expected considering that the mine area is situated at high elevation on the plateau and is within the zone of recharge. Based on these limited data points, it appears that groundwater elevations in the Blackhawk Formation follow topographic expression of Huntington Canyon, with higher groundwater elevations on either side (east and west) of Huntington Canyon and Electric Lake. These gradients indicate that the direction of groundwater flow in the Skyline No. 4 Mine project area is towards Huntington Canyon and not in the direction of the structural dip which is to the west.

Groundwater in the Star Point Sandstone

As previously described, the Star Point Sandstone is comprised of two sandstone members, the upper Storrs Tongue and the lower Panther Tongue. Mining at the Skyline Mine encountered groundwater associated with both the Storrs Tongue and the Panther Tongue. Because of the westward dip of the bedrock in the Skyline No. 4 Mine area, there is a high probability that mining will encounter additional inflows of 7,000 gpm or more from the Star Point Sandstone (USDA Forest Service, January 2002).

Slow groundwater flow in unfractured Star Point Sandstone is substantiated by relatively small hydraulic conductivities reported for this unit in other areas of the Wasatch Plateau. At the Crandall Canyon Mine in the Huntington Canyon area, hydraulic conductivities from slug tests ranged from 1.46×10^{-6} to 2.25×10^{-5} cm/sec (Mayo and Associates, 1997a) in unfractured Star Point Sandstone. Lines (1985) reports horizontal hydraulic conductivities of 1.1×10^{-5} to 5.29×10^{-6} cm/sec and porosity values of 11 to 17 percent in core samples of the Star Point Sandstone obtained from the Trail Mountain Mine area.

The Storrs Tongue of the Star Point Sandstone interfingers with the overlying Blackhawk Formation, dividing the Lower O'Connor "*A*" Seam from the Flat Canyon Seam; see Figure 4. In the western part of the Flat Canyon Lease area, the Storrs Tongue pinches

out and the Lower O'Connor "A" Seam and the Flat Canyon Seam merge into one coal seam. The Panther Tongue underlies the Flat Canyon Seam, which is the lower-most coal seam where mining would occur in the project area. The Flat Canyon Seam is separated from the Panther Sandstone by 15 to 30 feet of shale, mudstone, and thin coals (USDA Forest Service, January 2002).

The tongues of the Star Point Sandstone are laterally far more extensive than the sinuous and discontinuous sandstones lenses in the overlying Blackhawk Formation. It is anticipated that over larger areas, such as the Skyline Mine and the Skyline No. 4 Mine project areas, each tongue operates as a single groundwater system. However, it is not believed that the Star Point Sandstone is a regional aquifer in the sense that there is hydraulic continuity throughout the Wasatch Plateau (USDA Forest Service, January 2002).

The Star Point Sandstone is exposed in Pleasant Valley, west of the Pleasant Valley Fault and east of the Skyline Mine area near the mouth of Eccles Canyon. Spring (S17-2) issues from the Star Point Sandstone in Eccles Canyon along the mine access road. The Star Point Sandstone also is exposed in Huntington Canyon above and below the dam on Electric Lake. Bedrock units within the Skyline No. 4 Mine project area dip to the west. As the result of the westward dip and overall low permeability of the overlying Blackhawk Formation, the Star Point Sandstone aquifer is confined. Confined conditions are observed in the Star Point Sandstone at many other coal mines in the Wasatch Plateau.

Table 1 summarizes the construction of monitor wells that are screened in the Star Point Sandstone. Figures 6 through 8 show groundwater elevations in the Star Point Sandstone for June 1997, September 2002 and June 2014, respectively. The water level data are from the DOGM database. The selected time periods represent: (1) two (2) years before large mine inflows were intercepted in the Skyline No.2 Mine (Figure 6), (2) immediately following startup of well JC-1 (Figure 7) and, (3) after approximately twelve (12) years of pumping from well JC-1 (Figure 8). Groundwater elevations in the Star Point Sandstone are about 60 to 470 feet lower than groundwater elevations in the overlying Blackhawk Formation, indicating a downward gradient. Based on the limited data points, (a number of wells have been abandoned, destroyed, or have not yet been constructed) it appears that the groundwater elevations in the Star Point Sandstone follow topographic expression of Huntington Canyon, with higher elevations on either side (east and west) of the canyon and Electric Lake. In 1997, the hydraulic gradient north and east of Electric Lake was about 0.05 feet per foot (ft/ft) to the southwest. By 2014, this gradient steepened to about 0.07 ft/ft to the southwest. The hydraulic gradient on the west side of Electric Lake was about 0.04 ft/ft to the northwest in June 2014. This suggests that the direction of groundwater flow in the Skyline Mine does not follow the bedrock dip, but is toward areas of groundwater discharge including the mine workings and towards well JC-1.

GROUNDWATER ENCOUNTERED IN SKYLINE MINE

Prior to 1999, CFC encountered relatively low rates of groundwater inflow during underground mining operations in the Skyline Mine. Most commonly, groundwater

inflow was intercepted in sandstone paleochannels in the mine roof indicating the source was the overlying Blackhawk Formation. Groundwater inflows were generally small, of short duration, and diminished with time. Before 1999, the total discharge from the Skyline Mine was usually on the order of a few hundred gpm or less (Petersen, 2014a). CFC encountered larger mine inflows as mining operations progressed into the southwest portion of the Skyline Mine.

The larger mine inflow rates encountered after 1999 originated from the mine floor as warmer water upwelled through faults and fractures in the underling Star Point Sandstone (Petersen, 2014a). Unlike the smaller, cooler groundwater inflows encountered during mining from the overlying sandstone paleochannels, mine inflows from the underlying Star Point Sandstone were of substantially greater magnitude and more persistent. It is believed that the larger inflows originated from the Panther Tongue of the Star Point Sandstone.

Petersen (2002) reports that groundwater inflows to the Skyline Mine from the Star Point Sandstone had radiocarbon ages greater than 13,000 years and contained no tritium. The carbon-14 of the West Mains 16 Left sample collected in March 2015 had a carbon-14 activity indicative of a radiocarbon mean residence time of about 8,000 years. The very old age of this groundwater is consistent with the primary source being storage in the deep Star Point Sandstone aquifer below the mined coal seam (Petersen, 2002). This suggests that groundwater flow through the Star Point Sandstone is slow and that there is limited hydraulic communication with the surface. Carbon-14 dating of recent (2014-2015) samples of groundwater from well JC-1 indicated average groundwater mean residence times of about 2,000 years (Petersen, 2016).

CFC pumped these large inflows to the mine portal in Eccles Canyon where they were discharged down Eccles Creek, which is in the Price River Drainage Basin. Discharge rates are recorded near the mine portal at CFC monitoring location CS-14. Figure 2 shows the location of the mine portal. Figure 9 shows that pumped discharge peaked during February 2003 with rates exceeding 8,000 gpm (Petersen, 2014a). Much of the peak discharge was in response to a large groundwater inflow that occurred while mining in the 10-Left development entries (Petersen, 2014a).

Figure 2 shows the location of well JC-1, a pumping well that was constructed in 2001. Well JC-1 is completed and screened (60 feet) exclusively in fractured Star Point Sandstone near the Diagonal Fault. When well JC-1 was completed, it was pump tested at 350 gpm with 20 feet of drawdown after 10.5 hours. A specific capacity of 17.5 gpm per foot of drawdown (gpm/ft), was estimated from this test.

Well JC-1 appears to be completed in fractures that are connected to the system that supplies the 10-Left inflow to the No. 2 mine workings (Petersen, 2014a). As indicated on Figure 2, well JC-1 is located in James Canyon. Figure 9 is a plot of pumping rate versus time for well JC-1. Note that well JC-1 was pumped at about 4,000 gpm from late 2002 until October 2011, not pumped from about October 2010 to January 2011, pumped at about 2,000 gpm from January 2011 to July 2011, not pumped from July 2011 to July 2012, pumped at about 4,400 gpm from July 2012 until mid-2015, and pumped at rates of about 3,200 to 4,400 gpm since mid-2015. Groundwater pumped from well JC-1 is discharged to Electric Lake.

After CFC completed mining in the southwest portion of Skyline No. 2 Mine during 2002 and 2003, mine openings were blocked with bulkheads and groundwater levels were allowed to rise and flood the mine. The pumping of groundwater from the flooded southwest portion of the mine has continued to the present. After the pumps were shut off in January 2004, the water level rose to an elevation of approximately 8,290 feet by about August, 2004. CFC resumed pumping in August 2004 and continues to pump to maintain the mine pool at an elevation of approximately 8300 feet (Petersen, 2014a).

REVIEW OF FINDINGS OF TECHNICAL DOCUMENTS

This section provides our comments and opinions on reports and data submitted to DOGM by CRC and others. Note that many of the investigations and reports relate to the Skyline Mine but not the proposed Skyline No. 4 Mine in the Flat Canyon Lease area. These reports provide insight into the hydrology of the area and potential impacts of mining in the Flat Canyon Lease area.

PACIFICORP (2003)

The purpose of the report "*Investigation of Technical Issues Related to the Electric Lake and Huntington Creek Drainage Controversy,"* by PacifiCorp (2003), was to identify and detail principal issues related to the (1) large groundwater inflows into the Skyline Mine that started in about year 1999, (2) pumping of Well JC-1 that started in 2002, and (3) effects that PacifiCorp believed the mine had on Electric Lake and the Huntington Creek drainage. The report documents investigations by PacifiCorp and its consultants, including the history of the lake, groundwater elevations, Electric Lake water balance, surface geophysical surveys, an underwater investigation of lake bottom conditions, and preliminary results of tracer studies. Note that the report does not specifically address potential groundwater flow into the Flat Canyon Lease area.

The report states that the inflows to the Skyline Mine are unlike any experienced at other mines in the region. However, large groundwater inflows were encountered at the Crandall Canyon Mine (about 1,000 gpm for at least four years) and the Deer Creek Mine (more than 1,000 gpm for many years and up to 5,000 gpm from the Roan Canyon fault zone until sealed off (CHIA: DOGM, 2013)).

The history of Electric Lake and other reservoirs demonstrates that lake levels vary seasonally and from year-to-year in response to variations in climatic conditions. However, conclusions are difficult to draw because of sparse or absent data and the number of factors that influence lake level, including reservoir operations. The water balance presentation suffers from lack of data. The report does not appear to us to present a definitive conclusion. The study ended during a period of drought in 2003. Figure 10, herein, extends Electric Lake elevations and discharges presented by PacifiCorp (2003) through 2016 and indicates that the reservoir returned to its maximum capacity by 2008.

Consultants for PacifiCorp performed several surface geophysical surveys: electrical resistivity, induced polarization (IP), and an AquaTrack electrical-magnetic survey. The methods induce electrical currents into the subsurface and measure the earth's electrical or magnetic response at surface points. The responses are affected by the electrical-magnetic properties of earth materials (soil, rock, mineralization, water, water salinity, and the like) and man-made features (power lines, fences, pipelines, and the like). The geophysicist is tasked with interpreting the data and this is seldom straightforward because of the heterogeneity of the earth materials and other features. The report claims that the surveys identified fault locations and the presence and depth of groundwater in addition to saline water at depth. It is difficult to detect groundwater flow with such surveys. The report interprets a "*preferential flow path*" that starts in Electric Lake near the Connelville Fault (as mapped by the mine) and then curves to near well JC-1 and the mine-mapped Diagonal Fault (PacifiCorp, 2003, Appendix E). We are not convinced that this study detected a new pathway between the Connelville and Diagonal faults that was not identified in previous studies.

PacifiCorp commissioned an underwater investigation (ROV and diving personnel) during February 2003 that videoed taped bottom conditions in Electric Lake. Observations included numerous venturi-shaped holes in the lake bottom, the venting of methane from some holes, sediment suspended in lake water being drawn into some holes, and fractures in the bottom sediment in some areas. Personnel observed some holes in overlying ice cover that they attributed to methane release through the lake below; the holes aligned with the fault traces. Maps in Appendix B of the report show locations of methane release, negative water flow (flow into the lake bottom material), and the mine-mapped trace of the Connelville, Diagonal and un-named fault. Groups of holes seemed to lie along the lines (lineaments) that generally trended N45°E. The groups of holes lie in zones of about 300 feet in width along the three mapped faults (the Connelville and Diagonal faults trend N5°E to N10°E).

PacifiCorp (2003) reports that the unconsolidated alluvial deposits are 30 to 60 feet thick under the lake. Downward flowing groundwater and upward flowing methane would have to create pathways to flow through alluvium that is likely variable in character (interbeds of silt, clay, sand and gravel). It appears from the descriptions that the features formed on the lake bottom were in sediment rather than bedrock. The possibility of methane generation by decaying organic matter in lake bottom sediments is not discussed but could also be a possible explanation. Methane was also noted at other locations in the lake. It is possible that the methane releases could be more be more widespread beneath Electric Lake than shown on the video.

Note that a review by Dr. Alan Mayo of Mayo & Associates (CFC, 2003) stated that the video provided evidence that: (1) the fractures were not related to underlying bedrock fractures; (2) lake water does not leak from the lake via the fractures; (3) the fractures are in very soft, lake-bottom mud and appear to be large sub-aqueous desiccation fractures (such as mud cracks); (4) particulate material suspended in the lake floats across and past the fractures and cylindrical holes; (5) when disturbed, the mud creates a density cloud that lingers above the lake bottom before merely settling back to the lake bottom, and (6) bubbles may be from gas released from decomposing organic matter that are directly below the lake. The video was not available for our review.

The report provides some data and preliminary findings of a dye tracer study. We comment upon the dye tracer study in our review of the Ozark Underground Laboratory (2005) report.

The report provides some data and preliminary findings of a study of environmental tracers (tritium and dissolved gases). We comment upon this study in our review of the Solomon (2005) report.

PACIFICORP (2004)

PacifiCorp (2004) presents data and preliminary findings regarding tritium and dye testing. Solomon (2005) and Ozark Underground Laboratories (2005) summarize and evaluate the data. Therefore, we discuss the information as presented in those reports in a later section herein.

SOLOMON (2005)

The report "*Preliminary Draft - Analysis of Groundwater Flow from Electric Lake Towards the Skyline Mine,"* by Solomon (2005) summarizes analyses of tritium, noble gases (especially helium-3), and chlorofluorocarbons (collectively referred to as environmental tracers). Analyses were conducted on waters collected from: (1) Electric Lake and Huntington Creek (between August 2001 to August 2002), (2) Well JC-1 (between September 2001 and April 2004), (3) Well JC-3 (between August 2003 to April 2004) and (4) within the Skyline Mine (10L sumps and 9L boreholes during April–September 2002).

Water that has not been in contact with atmospheric tritium for more than about 50 years ("*old water*") would be expected to have tritium concentrations less than 0.2 tritium units (TU). Tritium concentrations from Electric Lake and Huntington Creek ranged from 7.7 to 12.6 TU with an average of about 9.2 TU. Most of the tritium analyses were from well JC-1, which showed increasing concentrations of tritium from 0.24 TU in September 2001 to 2.99 TU in April 2004. Tritium in samples from the high-discharge areas of the mine (10L sumps and 9L boreholes) had concentrations between 0.24 and 1.6 TU during April-September 2002. However, tritium is not unique to the mine inflows. Figure 11 shows that other springs issuing from the Star Point Sandstone in the mine area also contain small amounts of modern water as indicated by the presence of tritium. Spring S17-2 in Eccles Canyon had tritium concentrations of 1.61 to 1.73 TU in 1996, similar to those concentrations measured in the No. 2 Mine inflows. Sulfur Spring in Huntington Canyon located below the Electric Lake dam also has a component of modern water with increasing concentrations of up to 1.9 TU.

Solomon (2005) calculated apparent ages of groundwater using tritium/helium-3 data. The apparent ages are not actual ages because the water is a mixture of older water (deeper formation water) and younger (surface) water. Solomon also calculates an apparent age of well JC-1 and well JC-3 waters based on chlorofluorocarbon data but states that the calculated recharge dates are not actual dates because, again, the analyses are likely of a mixture of older and younger waters.

Solomon (2005) concludes that "*substantial*" quantities (33%, perhaps more) of surface water mixed with older water in Well JC-1 in 2005. A smaller number of samples collected from the southwest part of Skyline Mine #2 in 2005 had similar (10L Sump) or lower (9L borehole) tritium concentrations, and presumably smaller fractions of young water.

Solomon (2005) postulated that transport of tritium in water was retarded due to molecular diffusion. He used a mathematical model of flow and transport along fracture pathways (CRAFLUSH) to explain the increasing concentration in samples from JC-1 and to predict that tritium in the water will continue to evolve (increase) for more than 10 years (through 2015). The model uses a number of assumed parameter values for which there are no site measurements. He concludes that the modeling "…*demonstrates that it is physically possible to rapidly transport measured losses from Electric Lake towards subsurface discharge points while having the chemical signal of the discharge gradually approach that of the surface water*." However, subsequent measurements of tritium did not show the predicted continuing increase in tritium levels. Figure 11 plots tritium for well JC-1 and shows that tritium concentrations increased from 2.36 TU in August 2003 to 3.14 TU in June 2008, then declined back to 2.3 TU by October 2015.

Solomon (2005) also presents calculations of possible fluid flow rates between Electric Lake and Well JC-1 based on assumed parameter values to indicate that it is physically possible to transport large quantities of water along a relatively small number of fractures. Solomon (2005) used the cubic law, which correlates the total fluid flow from the lake to the mine to the cube of the fracture aperture. This is a calculation that assumes that the presumed lake bottom fractures (which are covered by 30 to 60 feet of alluvium) are open, uninterrupted and continuous for distances of more than one-half mile and to a depth of approximately 700 feet below the lake. The analysis by Solomon (2005) does not account for the sediment on the lake bottom that overlies bedrock.

OZARK UNDERGROUND LABORATORY (2005)

The report "*Preliminary Draft, Summary of Results from Groundwater Tracing Investigations at Electric Lake, Utah,"* by Ozark Underground Laboratory (2005) summarizes placement of dye into Electric Lake, sampling at stations in the Skyline Mine, Well JC-1, Electric Lake and Huntington Creek, and analyses of the samples. The report also presents results of bench tests conducted to assess the magnitude of dye losses to samples of local bedrock. We understand that this preliminary draft report was never finalized. The author stated final analytical data verification and quality assurance had not been completed for this draft and that data should be viewed as preliminary and subject to revision.

During the February 2003 underwater investigation, the dive team buried fluorescein canisters 6 inches deep in sediments: two canisters along the trace of the Connelville Fault (February 17, 2003) and two along the Diagonal Fault (February 19, 2003). Each canister contained one pound of fluorescein dye powder. However, after the dye was placed, PacifiCorp contacted Mr. Tom Aley of Ozark Underground Laboratories who stated that he believed the amount of dye placed was insufficient for the purpose.

In April 2003, Ozark Underground Laboratory placed 50 pounds of eosine dye into the lake along the Diagonal Fault and 35 pounds of fluorescein dye along the Connelville Fault. For placement, the dye was mixed with lake water and pumped via a PVC pipe to about 6 inches above the lake bottom.

Ozark Underground Laboratory sampled for the dyes using carbon packets placed in the water for a period of time. The lab extracted the dye from the packets and analyzed the extract solution using its own laboratory protocols.

The Ozark Underground Laboratory (2005) states that they detected fluorescein dye in samples from Electric Lake and Huntington Creek. The report says that it may have detected fluorescein in samples from Eccles Creek downstream from the Skyline Mine discharge but that the detection was probably antifreeze. The lab sampled water from Well JC-1 between February 27 and July 14, 2003. The report says that fluorescein and eosine were detected in three of five samples from Well JC-1 between May 29 and July 7, 2003.

On February 24, 2004, Ozark Underground Laboratory placed 75 pounds of fluorescein at the location on the Diagonal Fault where eosine dye had been placed the previous April; and 125 pounds of fluorescein at the location on the Connelville Fault where fluorescein dye had been place the previous April. Dye was placed by PVC pipe about two feet above the lake bottom.

Ozark Underground Laboratory (2005) states that they detected fluorescein dye in samples from Well JC-1 December 2004 through May 2005 (from fluorescein placed in Electric Lake in February 2004).

However, we note that the stated range of acceptable wavelengths for identification of fluorescein in the report text does not match that shown in the Appendix A (Ozark Underground Laboratory Procedures and Criteria) for the instrument used to detect the fluorescein in the elutant. Many of the reported detection were outside of the standard range. False positives are not uncommon for fluorescein dye, and the document does not describe any QA/QC procedures followed, such as prior background sampling and analysis, calibration, analysis of blanks, blind duplicate analyses.

CFC (2005)

The letter "*Review of Recently Submitted PacifiCorp Draft Reports, Canyon Fuel Company, Skyline Mine,"* from CFC (2005) is a critique of the reports by Solomon (2005) and Ozark Underground Laboratories (2005).

According to CFC (2005), the two draft reports contain numerous inaccurate assumptions and conclusions. CFC (2005) identifies a few of these inaccuracies and points to invalid conclusions in both reports based on what CFC determined to be faulty conclusions. CFC (2005) requested that PacifiCorp produce final reports to these documents such that CFC could have the opportunity to make formal submittals. Apparently, PacifiCorp has not provided final versions of these reports (Galecki, 2016).

CFC (2005) notes that many detections reported by Ozark Underground Laboratory were not within the laboratory's acceptable wavelength range. CFC notes that on page 12 of the *Groundwater Tracing Handbook* provided to clients of Ozark Underground Laboratory (2002), the handbook indicates that *"In some coal mine settings (particularly those with high sulfur coals) there is sometimes appreciable natural fluorescence in or near the acceptable emission wavelength range of fluorescein dye*."

We believe that CFC (2005) concerns about projecting the bench test to field scale are valid. The Ozark Lab asserts that the scale between the bench testing and field conditions was valid for time of travel and removal of the dye by adsorption without presenting any calculations or evidence to show the relationship between the two. Factors including the long travel distance for the dye, the amounts of dye used, environmental factors within the groundwater flow regime and adsorption/desorption effects for the rocks are not discussed or evaluated in the documents.

According to CFC (2005), neither Solomon (2005) nor Ozark Underground Lab (2005) present definitive evidence that the water presumably lost from Electric Lake between 2001 and 2003 was the result of a direct conduit via faults or fractures existing between Electric Lake and the mine. Groundwater inflows to the mine do contain small amounts of modern water, based on small tritium concentrations. Modern water could be sourced from Electric Lake through seepage losses into the Blackhawk and Star Point Sandstone formations or from recharge directly to the Star Point Sandstone where it crops out. Dye concentrations in the JC wells were several parts per billion (ppb) or less and the results were not convincing. The predicted rise in tritium concentration hypothesized by Solomon (2005) did not occur.

In our opinion, if Electric Lake was losing up to 5,000 directly into the mine, then the evidence from these studies should have been more conclusive or convincing. Additionally, large mine inflows began in March 1999, approximately two years prior to observed drops in lake levels, as shown on Figure 10. It is likely that depleted reservoir levels were triggered by drought conditions that persisted between 1999 and 2003. Figure 10 also shows that Electric Lake returned to normal levels around 2006 and approached maximum reservoir height and capacity each year between 2008 and 2011, while the mine was discharging between about 3,000 to 4,000 gpm. Figure 10 also shows that during the time when well JC-1 was not pumping or pumping at a lower rate, the reservoir height remained within the normal range that was noted before 1999.

PETERSEN HYDROLOGIC (2014b)

The report "*Groundwater Conditions in the Star Point Sandstone in the Vicinity of the Skyline Mine,"* by Petersen (2014b) summarizes the geology and history of groundwater mine inflows into the workings of the Skyline Mine with an emphasis on the No. 2 Mine. The report provides graphs of groundwater levels, mine discharge rate, JC-1 pumping rates, and Palmer Drought Index over time.

Petersen (2014b) correlates high pumping rates (from mine and JC-1 during the period from about 2000 to 2003) and changes in groundwater elevations in the Star Point

Sandstone aquifer. However, many of the wells stated in the report as being in the Star Point Sandstone are actually completed in the Blackhawk Formation. Table 1 presents the well construction and the screened interval elevations. The Blackhawk wells are associated with the Lower O'Connor "B" seam, while the Star Point Sandstone wells are associated with the deeper Flat Canyon, Lower O'Connor "A" seam, or the Panther or Storrs tongue of the Star Point Sandstone. Only one well (W79-35-1B) was screened in the upper part of the Blackhawk Formation. Petersen (2014b) compares two monitoring wells that were near the mine showing a clear response in a Star Point Well (W79-35-1A screened in the Storrs Tongue) and a minimal response in Blackhawk Well (W79-35-1B, screened about 450 feet higher in elevation) to high pumping rates from the mine and well JC-1. However, a number of the wells in the Blackhawk Formation (W2-1, W79-26-1, W98-2-1, W99-4-1, W20-28-1) showed clear responses to the pumping, as indicated on Figure 12. This figure presents hydrographs for wells screened in the Blackhawk Formation. Two of the wells in the Blackhawk Formation (W91-26-1 and W91-35-1) did not show a response to the pumping but these wells are located far (5 miles or more) to the north of the pumping. We conclude that wells in the Blackhawk Formation responded to the high pumping rates.

PETERSEN HYDROLOGIC (AUGUST 2016)

The report "*Investigation of Fault-related Groundwater Inflows at the Skyline Mine,"* by Petersen (2016) updates the original report by Petersen (2002). Petersen (2016) does not address conditions in the Flat Canyon Lease. The purpose of the investigation was to characterize the nature and likely origins of the fault-related groundwater systems and to determine the likely impacts of the fault inflows on the hydrologic balance. Petersen (2016) includes (1) updated climate data from the National Climatic Data Center; (2) additional discharge data from selected stream and spring monitoring stations and updated potentiometric data from wells; (3) additional groundwater and surface-water solute chemical and temperature data from streams, springs, and in-mine waters; (4) additional stable isotopic deuterium and oxygen 18 and unstable tritium and carbon 14 data from springs, surface waters, JC-1, CS-14, and in-mine locations; and, (5) microscopic particulate analysis (MPA) performed on groundwater pumped from well JC-1.

The document is comprehensive in its approach to updating the information from 2002. We agree that groundwater flow likely occurs along preferential pathways corresponding with the orientations of faults and fractures rather than locally from diffuse flow through the intergranular spaces in the sandstone. Well JC-1 is completed in a known fault system. It is probable that pumping-induced groundwater flow toward well JC-1 could originate from a considerable distance, particularly after years of pumping at rates exceeding 4,000 gpm based on the effects shown on the monitoring well hydrographs. The analysis by Petersen (2016) and conclusions that tritium concentrations in the Skyline No. 2 Mine were influenced after the startup of pumping from well JC-1 is quite likely. The discussions regarding the groundwater temperature differences in the mine and well JC-1 over time is also relevant as is the discussion of microscopic particulate analyses (MPA) that demonstrate the lack of bio-indicators from well JC-1.

We observed from the monitoring well information provided by CFC that wells W2-1 and 20-28-1 are screened through the Lower O'Connor "B" Seam in the Blackhawk Formation rather than the deeper Star Point Sandstone, as stated by Petersen (2016). Contrary to the Petersen (2016) findings, these two Blackhawk wells show a response to pumping from the Star Point Sandstone aquifer, indicating a hydraulic connection between the lower Blackhawk Formation and the Star Point Sandstone. Petersen (2016) discusses the in-mine concentrations of tritium and the tritium in well JC-1, but does not discuss the fact that tritium is also found in spring S17-2 in Eccles Canyon, and spring S24-1 (Sulfur Spring) in Huntington Canyon that have similar tritium concentrations as the mine inflows.

PETERSEN HYDROLOGIC (AUGUST 2014a)

The report "*Investigation of Groundwater and Surface-Water Systems in the Flat Canyon Tract and Adjacent Area; Probable Hydrologic Consequences of Coal Mining in the Flat Canyon Tract, Sanpete County, Utah,"* by Petersen (2014a) presents the findings of an investigation of groundwater and surface-water systems in the Flat Canyon Lease area. The findings of this investigation construct a framework for a determination of the potential for mining related impacts to the hydrologic regime. Specifically, Petersen (2014a) addresses the requirements of Utah Coal Mining Rule R645-301-728, which requires that a determination of the probable hydrologic consequences (PHC) of coal mining be completed before a coal mining permit is issued by DOGM.

Petersen (2014a) identifies similarities seen at the Skyline Mine and the Flat Canyon Lease, both with respect to geology, hydrogeology water, geochemistry and depths to mining from the ground surface. The behaviors of springs and surface waters and groundwater regimes in the Flat Canyon Lease are also purported to be generally similar to conditions in Skyline Mine permit area. The similarities of the groundwater regimes and groundwater – surface water interactions in the Flat Canyon and existing Skyline Mine permit areas suggests the likelihood that the experience of undermining surface water drainages in the Flat Canyon area should not affect flows in the streams or springs that have been monitored since the late 1990s.

Petersen (2014a) asserts that there is a disconnect between the Blackhawk Formation and the Star Point Sandstone aquifers, and points to the nested wells in Burnout Canyon. However, enlarging the vertical scale on the Blackhawk Formation well 79-35-1B shows that there is measurable drawdown.

We do not consider that the flow reductions noted for mine discharge point CS-14 are the result of a partitioned groundwater system in the Star Point Sandstone based on the wide-distribution of drawdowns in this formation. Figure 13 shows that drawdown in the Star Point Sandstone aquifer is widespread across the mine area with recovery in the wells occurring after June 2003. It is most probable that the flows at CS-14 are dropping off with time because the hydraulic gradient has become flatter and groundwater is traveling farther distances throughout the mine area to the points of discharge, well JC-1 and the pumping from the Skyline No.2 Mine. The effect of widespread drawdowns is further evidenced by the reduced flows at spring S17-2 in Eccles Canyon, Figure 14. This is the only spring that we have noted to demonstrate a

reduction in flow and is the only spring monitored in the Star Point Sandstone north of Huntington Canyon. Springs issuing from the Blackhawk in this area do not indicate a reduction in flow over time.

Petersen (2014a) presents an analysis of water quality using Stiff Diagrams. Due to the very small changes that occur over time as the result of mixing of water types, Piper diagrams would be far more useful for detecting small changes in the ionic composition of groundwater over time. These changes cannot be demonstrated with a Stiff diagram, particularly in light of the fact that anticipated changes from mixing will be small.

Petersen (2014a) states that that there will be no adverse impacts to the hydrologic balance from mining the Flat Canyon Lease, even though it is anticipated that discharge rates during mining in the Flat Canyon Lease will likely be of similar or perhaps somewhat greater magnitude than that currently discharging from the mine. Petersen (2014a) does not discuss that the Flat Canyon Lease is wholly contained in the Huntington Drainage of the San Rafael River Drainage Basin. Large quantities of water removed from Huntington Canyon area will impact flows to the Star Point Sandstone, potentially affecting springs down-canyon. While it is not possible at this point to predict how much of an impact this will cause to flows in down-canyon springs, the SRK Consulting (2016) groundwater model predicted that depressurizing the mine caused 75 to 100 feet of drawdown in the Star Point Sandstone aquifer at the south end of Electric Lake by 2015. It is also likely that some of the water removed from the Skyline Mine at CS-14 is surface water that has infiltrated within Huntington Canyon.

SRK CONSULTING (2016)

The report "*Update of Groundwater Flow Model, Skyline Mine Project, Utah,"* by SRK (2016) updates the groundwater model created by HCI (2003). SRK (2016) modified various features of the 2003 model and recalibrated the model utilizing additional information gathered since the 2003 model was developed. Although SRK (2016) presents a re-calibrated model, it does not model or address impacts of mining the Flat Canyon Lease. The report presents a "*calibrated*" model but the model is not robust, that is, different combinations of assumptions and parameters could be devised to obtain a calibrated model. In fact, SRK (2016, p. 8) presents two different scenarios *"…among the numerous possible conceptual models…"* that show much different impacts to hydrologic features.

An advantage of a numerical model is that it requires accounting for all hydrologic factors and provides a comprehensive water budget for the domain. With a reasonable base of information, modeling can be a useful tool for understanding the groundwater environment, assessing groundwater flows on a large-scale, and comparing relative impacts of alternatives, despite some data deficiencies and model limitations.

The SRK (2016) modeling demonstrated that mine inflow and recovery cannot be modeled from changes in groundwater storage only in the Star Point Sandstone.

A principal limitation of the modeling effort is our limited knowledge of the hydrogeologic properties and conditions, in space and in time, for the vast model area. In this case,

flow is highly influenced by faults, which are extremely heterogeneous and unpredictable in their hydraulic properties. Additional issues include:

- Hydraulic properties of faults in the Flat Canyon Lease area are highly uncertain and subject to great variability.
- Some of the basic data used for construction and calibration of the model appear erroneous; for example, some monitoring wells (also referred to as piezometers) are not in the formations that SRK (2016) assumes for calibration comparisons.
- SRK (2016) presents a "*calibrated*" model but the model is not robust, that is, different combinations of assumptions and parameters could be devised to obtain a calibrated model.

Although there are many details and complications, in very simplified terms the model represents the hydrologic environment as:

- No flow boundaries surround the perimeter and base of the model. The model domain is conceptualized as a 140-square mile groundwater compartment.
- Horizontal layers that might generally be described in descending order as:
  - A surficial layer of relatively high permeability (Overburden upper part);
  - A relatively low permeability layer (Overburden lower part), representing the Blackhawk Formation;
  - Several thin, alternating high and low permeability layers representing coal, interburden and sandstone tongues; and
  - Two thick horizontal layers of high permeability representing the Star Point Sandstone.
- The model contains narrow, vertical fault zones with assigned vertical permeabilities varying from moderate to very high.
- Inflow into the model comes (1) primarily from recharge to the top of the surficial layer (a constant specified amount), (2) from surface source(s) into the South Gooseberry Fault and (3) from Electric Lake (represented as constant head; a very small amount during pre-mining conditions which can increase greatly if induced by water level drawdown).
- SRK (2016) does not explain what the source(s) of water in (2) above are supposed to represent, leading the reader to believe that possible sources of water could include either the Cleveland Reservoir, Fairview Lakes or Gooseberry Creek. These sources were not included in the 2003 model. In the model, water from the source(s) recharges into the South Gooseberry Fault.
- The Skyline Mine geologic map (CFC, 2016, Drawing No. 2.2.1-1) does not show the existence of the "*South Gooseberry Fault*" (Oberhansley, 1980, shows such a fault, shown on Figure 5, herein).
- Outflow from the model is simulated as (1) groundwater discharge to surface streams and springs (drain nodes which in this model allow flow out of model but not back into the aquifer), (2) pumping from Well JC-1 (specified amounts), and (3) water pumped from the mine (drain nodes).

- The model calculates discharge to streams and springs based on surrounding model-generated groundwater levels, assigned permeability of the aquifer, and an assigned leakance factor. The leakance factor helps control (reduce) modeled discharge (versus the use of constant head nodes) and is an artificial factor developed through calibration. Model calibration in steady-state to outflows (streams) is very weak. Model outflows are essentially a function of local recharge in the model.

The model calculates inflow into the mine based on surrounding model-generated groundwater levels, assigned permeability of the aquifer (especially fault permeability), and an assigned leakance factor. Flow into the mine in the model is highly controlled by fault properties and leakance factors. For the mine, different permeabilities and leakance factors were assigned to different faults to calibrate to observed inflows. Some leakance factors were varied with time and with magnitude of change in surrounding groundwater levels in order to calibrate to observed inflows. Developing these parameters for a specific fault may seem to calibrate to past conditions; however, the parameters cannot be reasonably applied to other faults for predictive purposes.

REVIEW OF THE MRP AMENDMENT

We reviewed several documents including CFC (2016), CFC (2015), CFC (2005), and consultant reports attached to the MRP and the amendment to the MRP (the Amendment).

MINING PLAN

The Flat Canyon Lease will be mined as part of proposed Skyline No. 4 Mine. The mine will be located within Huntington Canyon in Emery County, and within the Huntington Creek-San Rafael River Drainage Basin. Mine No. 4 will be directly west of Electric Lake and Huntington Creek, and will lie beneath parts of Little Swens Canyon, Swens Canyon, Flat Canyon and Boulger Canyon, as shown on Figures 2 and 3.

Skyline Mine No. 1, No. 2 and No. 3 produced coal from three different seams, the Upper O'Connor Seam (Mine No. 1), the Lower O'Connor B Seam (Mine No. 2), and the Lower O'Connor "A" Seam (Mine No. 3). Construction of the Skyline Mine Facilities began in 1980. No. 3 Mine and No. 1 Mines began production in October 1981, and June 1982, respectively (DOGM, 2013). The Skyline No. 2 mine was mining coal from the Lower O'Connor B Seam at an approximate elevation of 8050 feet when the large mine inflows were encountered in 1999. At that location, the Lower O'Connor B Seam was about 100 feet above the Star Point Sandstone with intervening shale and siltstone (SRK, 2016). Inflows to No. 2 Mine were noted at faults and water rose up through the mine floor.

The layout for the Skyline No. 4 Mining plan is presented on CFC Drawing 3.1.8-3. Mine No. 4 will extract coal from multiple seams at lower elevations than in the Mine No. 2. Overburden will be thicker and in places closer in depth to the Star Point Sandstone in Mine No. 4 than in Mine No. 2. Varying seams will be worked in Mine No. 4, but only one seam at a given location. In 2015, CFC excavated a drift that sloped down to the

combined Lower O'Connor A/Flat Canyon Seam near the Flat Canyon lease. The mining plan proposes to complete the first three (3) longwall panels on the north end of the Skyline No. 4 Mine beneath Little Swens Canyon, then progress to the south into the Lower O'Connor "B" seams. The mining panels will be oriented west-southwest to east-northeast beneath portions of sections 27, 28, 33, 34 and into portions of sections 3 and 4 (Township 14 South, Range 6 East). The remaining mining in the Skyline No. 4 Mine will be into the Lower O'Connor "A"/Flat Canyon coal seam with longwall panels oriented north-northwest to south-southeast in sections 4 and 5. The total period of coal production is estimated at approximately 12 years.

Mining elevations within the Skyline No. 4 Mine will range from about 7920 feet on the east side to about 7820 feet on the west side of the lease. Overburden thickness in the Skyline No. 4 Mine will range from about 900 to 2200 feet because of the considerable relief of the land surface.

Figure 3 shows the mine areas and mapped faults. The No. 4 Mine will cross five northeast-trending normal faults while mining the Lower O'Connor "B" seam and two northeast-trending faults while mining the combined Lower O'Connor "A"/Flat Canyon seam. Displacements along these normal faults are relatively small, in the range of 5 to 15 feet. Two faults extend from the No. 4 Mine to the No. 2 Mine and form a graben structure. Inflows to the No. 2 mine from these two faults initially contributed 2,800 gpm before falling to about 600 gpm by 2002. Inflows to the No. 4 Mine are anticipated to be larger than the inflows measured in the Skyline No.2 Mine. Estimates of inflow to Mine No. 4 range from a possible increase of 7,000 to 12,000 gpm in the Flat Canyon Coal Lease Tract EIS (USDA FS and BLM, 2002) to 15,000 gpm (Petersen, 2014a). Inflow estimates are highly uncertain. CFC plans to discharge all water from the mine to Eccles Creek at the portal of the Skyline Mine.

It appears that most of the faults in the No. 4 Mine area are not directly connected to the Diagonal Fault. The Diagonal Fault accounted for most of the measured flow into the No. 2 Mine. Although it is not possible to predict the rate of inflow that will be encountered in the No. 4 Mine, it is probable that similar conditions to the Skyline No. 2 Mine will be encountered based on known faults, proximity to recharge, similar geology and similar head conditions.

Based on well data, groundwater levels within the lease boundaries appears to be rising with time. Groundwater elevations appear to rise westward, while the mine will slope westward in the direction of dip of the coal seams. Hydrograph trends for wells 99-21-1, 20-28-1, 99-4-1, 20-4-1, and (non-functioning) wells 20-4-2 and 99-29-1 indicate groundwater elevations in both the Blackhawk Formation and the Star Point Sandstone have been rising since about June 2004, despite the continued 4,100 gpm discharge from well JC-1. It appears that well JC-1 will not have much influence over inflows into Mine No. 4. Groundwater elevations in 2014 (Figure 8) ranged from about 8284 feet in the northern part of the No. 4 Mine to about 8502 feet in the southern part of the mine. Pressure heads in Mine No. 4 will generally be similar or greater than those experienced in Mine No. 2.

The mining plan shows that coal extraction in the southern half of the No. 4 Mine will be from the Lower O'Connor "A" seam/Flat Canyon Seam. The seam is closer in depth to the Star Point Sandstone than the Lower O'Connor "B" seam.

Electric Lake is directly east of the Skyline No. 4 Mine. Maximum surface elevation of Electric Lake is 8,575 feet with a bottom elevation of about 8400 feet near the dam.

Mine No. 4 Mine is in closer to Electric Lake than the Mine No. 2 Mine, which is about ½ mile from the lake. Mine No. 2 experienced large inflows beginning in 1999.

CFC Drawing 3.1.8-3 shows that the mine will extend beneath the high-water level of the lake near the confluence of Boulger Canyon and Electric Lake. Overburden above the coal seam at this location is shown to be less than 700 feet. At a mine depth of 700 feet, a 22-degree angle of draw plus 25 feet indicates a buffer distance of about 310 feet. At a mine depth of 900 feet, the buffer depth would be about 390 feet.

Although the Amendment predicts large inflows into Mine No. 4, the Amendment does not address water management, control or discharge. The Amendment does not address designs or measures to prevent impacts to water rights. The Amendment does not discuss possible alternative measures to mitigate potential impacts to local water rights. The Amendment does not provide contingency plans to address impacts if impacts occur.

HYDROLOGY AND ASSESSMENT OF POTENTIAL IMPACTS

The hydrology and assessments of impacts of the Skyline Mine and Flat Canyon Lease are presented in Section 2 of the Amendment and attached reports, such as those by Petersen (2014a, 2014b, and 2016). The Amendment conceptualizes the hydrology of the Skyline Mine in general and the Flat Canyon Lease area in particular as having: (1) a surface and near-surface "*active*" hydrologic zone and (2) a deep "*inactive*", completely isolated groundwater system in Star Point Sandstone and mining zone. CFC postulates that the deep zone (mining zone in lower Blackhawk Formation and the Star Point Sandstone) is isolated from surface and near-surface water (1) by shales and other lower permeability strata in the Blackhawk Formation, (2) and by low-permeability, vertical faults that prevent groundwater from crossing the faults. CFC therefore dismisses impacts to surface and near-surface water due to mine dewatering.

Subsidence will disturb and fracture formations above the long wall panels, enhancing permeability to some degree. Groundwater removed from the mine will be replaced in time by water recharged from the surface. We grant that impacts at the surface may not always be obvious.

We believe:

- Under natural conditions, the groundwater flow rate vertically downward from surface water or shallow groundwater to the Star Point Sandstone is small because of the large thickness of low permeability units (shales in the Blackhawk Formation and overlying formations) and the relatively small head differential.

- Under natural conditions, groundwater in the Star Point Sandstone flows laterally to discharge points such as outcrop areas west of Mud Creek and Huntington Creek around Electric Lake Dam. Under natural conditions, groundwater inflow and outflow are in near equilibrium in the Star Point Sandstone.
- Mine dewatering greatly increases the head differential and groundwater will flow into the mining zone downward from the surface, upward from the Star Point Sandstone and laterally from inter-tonguing sandstone units. Faults and fractures may provide enhanced pathways to varying degrees.
- Groundwater flow vertically downward into the mine from the surface through the overburden is expected to be small relative to inflow from the Star Point Sandstone because of low permeability shale units.
    - Vertical faults through the overburden may provide more permeable pathways to the surface. However, we expect that the abundant shale units will not be conducive to the formation of open fractures and therefore faults and fractures will generally not conduct large flows through the overburden. However, the character of the overlying formations is variable and the character of faults more so. Therefore, high inflow rates may occur along fault features but this is difficult to predict.
    - Subsidence due to mining and associated fracturing of the overburden may increase groundwater flow from the surface downward into the mine. Because of the presence of low permeability units and the buffer zone between Electric Lake and the subsidence zones, we expect that subsidence will not greatly increase mine inflows. Again however, this is uncertain.
    - We expect that there will be very small impact to surface water directly above the mine. However, this is uncertain and reliable monitoring is called for.
- Groundwater flow vertically upward into Mine No. 4 through low-permeability inter-burden from the deeper Star Point Sandstone is expected to be greater than from above because the thickness of the underlying low-permeability units is less than above.
    - The presence and thickness of the low-permeability units below the seam to be mined is different in different parts of the proposed mine.
    - Faults and fractures will likely be more permeable below the mine because of thinner shale layers and more sandstone but their effect on increasing groundwater inflow will vary and will be difficult to predict.
- Groundwater will flow laterally into the mining zone through sandstone tongues (such as the Storrs Tongue) and other interbedded permeable sandstone layers.
- Groundwater flow into the mine will cause drawdown in the Star Point Sandstone that will extend for miles away from the mine.
- Faults in the Star Point Sandstone will affect groundwater flow and drawdown. Faults can affect groundwater conditions in several ways:

  - Fracturing of rock in the fault zone adjacent to the fault plane can enhance permeability and groundwater flow parallel to the fault zone.
  - Crushed fine-grained material in the fault plane can form a low permeability layer (fault gouge) that inhibits flow across the fault plane. CFC noted that faults in the Star Point Sandstone tend to have sand gouge.
  - Offset of low-permeability units against high-permeability units can sever the continuity of an aquifer and reduce groundwater flow across the fault.
  - The character of faults is variable and difficult to predict.

- Drawdown will reduce discharge from the Star Point Sandstone and will induce greater infiltration (recharge) in other areas. We note that the Star Point Sandstone crops out over a large area west of Mud Creek and around (and under) the south end of Electric Lake.
- Groundwater flow into the mine will remove groundwater from aquifer storage in the Star Point Sandstone.
  - Following reduction or cessation of mine dewatering, induced recharge from the surface will eventually replace the groundwater removed from aquifer storage. Groundwater levels will recover.
  - Some of the groundwater that that flows into the mine and replenishes storage in the Star Point Sandstone will come from the Mud Creek-Price River drainage basin but more likely will come from the Huntington Creek-San Rafael River drainage basin because Mine No. 4 west of the drainage divide and the Star Point Sandstone is exposed around and under Electric Lake near the dam.
  - The amount of time for water levels to recover to pre-mining conditions and full replacement of groundwater storage in the Star Point Sandstone is uncertain but probably on the order of tens to hundreds of years.

Reliable prediction of mine inflow and impacts are very difficult given the size of the area and many hydrogeologic variables. A groundwater model is one means of evaluating complex conditions; however, the aquifer must be reasonably characterized in order to develop the model.

Based on our review of the available data, we believe:

- Water levels in the Blackhawk Formation were affected by withdrawals of water from the mine and to a lesser degree by the pumping from well JC-1. The effect is evidenced by water level elevations in the Blackhawk Formation, as shown in red on Figures 6 through 8 and on the hydrographs shown on Figure 12, herein.
- Groundwater elevations in the wells designated by CFC as screened in the Blackhawk Formation are higher in elevation than in the underlying Star Point Sandstone (Figures 6 through 8), indicating that there is a downward vertical hydraulic gradient between the two formations at the Skyline Mine and in the Flat Canyon Lease area.

- Groundwater elevations measured between 1997 and 2014 indicate that the groundwater flow gradient is not to the north as stated in the Amendment. Water levels in wells designated as screened in the Star Point Sandstone appear to correspond to the surface topographic expression in Huntington Canyon. Groundwater elevations are higher on both the east and west sides of the Huntington drainage, as shown on Figures 6 through 8 that show the Star Point Sandstone groundwater gradients for the years 1997, 2002 and 2014.
- Groundwater elevations in the Star Point Sandstone were affected by mine pumping and falling water levels were noted over a wide area in the Skyline Mine and the Flat Canyon Lease. One spring (S17-2) issuing from the Star Point Sandstone appears to show a decrease in discharge over the duration of mining activity, as shown on Figure 14.
- Drawdowns in most Star Point Sandstone wells occurred through June 2003. Following June 2003 (mine pumping greatly decreased after this point – see Figure 9), many of these wells began to recover (rise). A similar response is noted in the wells screened in the coal seams in the Blackhawk Formation.
- The Amendment states that faults and related fractures result in the development of secondary permeability that facilitates flow of groundwater, mainly in the Star Point Sandstone, and that groundwater flows from distant locations along these paths. We agree that fault zones often provide a system of high secondary permeability. Primary permeability and groundwater storage in the aquifer provide water to the fault and fracture system. Drawdown in the system induces recharge from the surface.
- The Amendment suggests that radiocarbon (carbon-14) dates show that the groundwater in the Star Point Sandstone is thousands of years old. We do not believe radiocarbon dating to establish the age of water from the formation is very reliable because (1) the carbon analyzed is that which is dissolved in the water, mainly in the form of carbonates and (2) the aquifer contains large amounts of coal and carbonate minerals that were deposited thousand to millions of years ago.
- In our opinion, the results from early investigations, including the dye studies, geophysical surveys, tritium studies and water balance studies of Electric Lake do not conclusively show that inflows into the Skyline Mine and water pumped from Well JC-1 were directly from a high-permeability conduit between the mine and Electric Lake. Small concentrations of tritium (tritium bound into the water molecule) do indicate a small component of mixing with modern waters.
- Note that, groundwater pressure (levels) changes occur rapidly, while the water (molecules) and dissolved constituents move much more slowly.
- The small concentrations of tritium in groundwater issuing from the Star Point Sandstone within the mine at the 10L Sump and from well JC-1 are not unique. Other springs in the area originating from the Star Point Sandstone also contain small concentrations of tritium, including Sulfur Spring in Huntington Canyon and spring S17-2 in Eccles Canyon, as shown on Figure 11.
- The Amendment states that the general decreasing trend in discharge to Skyline Mine workings indicates a lack of communication with the shallow water system.

Discharges from the Skyline Mine portal which have tapered from about 4,400 gpm in November 2011 to less than 2,000 gpm in June 2016. However, we note that groundwater levels in the Star Point Sandstone have been rising; this indicates that the reduction in mine inflow is related to a cause other than depletion of groundwater storage. There must be some other cause such as a change in mining operations, locations flooded or pumped, placement of bulkheads, or the like.

- Other evidence indicates that the Star Point Sandstone is not isolated from the effects of surface recharge to the aquifer. Water levels in well W79-14-2A in Eccles Canyon varies seasonally after August 2010, as shown on Figure 13. This observed effect demonstrates that the Star Point is not isolated from recharge, but rather that groundwater in the Star Point is in communication with infiltration from the ground surface in some areas.
- The presence of tritium and noted seasonal effects in the Star Point Sandstone where the aquifer is shallow indicates that the Star Point Sandstone is not isolated from the effects of modern surface water, but rather that the Star Point Sandstone receives recharge where there is little or no overlying low permeability formations.
- The Star Point Sandstone is also likely recharged where it lies in direct contact with overlying surface water. Seepage from Electric Lake into the Star Point Sandstone may occur in Section 14 (Township 14 South, Range 6 East) near the Electric Lake dam or beneath the lake where the Star Point Sandstone is exposed, as shown on Figure 3.
- The Amendment apparently dismisses potential impacts to the east of the Skyline Mine based on observations in the mine that the Connelville Fault appears to be a barrier to groundwater flow. However, fault displacements along the Connelville, O'Connor and Valentine Faults are insufficient to completely offset the continuity of the Star Point Sandstone. Reduced flow from Spring S17-2 also suggests impacts from mining west of the faults. The SRK (2016) groundwater model treats the Connelville Fault as relatively permeable. However, there is no information in the Amendment that demonstrates the permeability characteristics of these fault zones.
- The Amendment anticipates subsidence at the land surface overlying longwall panels but dismisses potential hydrologic impacts based on studies in Burnout Canyon. However, this is not certain and monitoring is called for.
- Water in the Flat Canyon Lease area is of very good quality. Average total dissolved solids (TDS) concentrations of spring waters sampled during baseline monitoring range from approximately 72 to 272 milligrams per liter (mg/L). Stream waters sampled during baseline monitoring have average TDS concentrations ranging from 157 to 198 mg/L. Average pH values for springs and streams in the Flat Canyon Tract area range from about 7.1 to 8.5 (Petersen, 2014a).

The Amendment states that mining activities in the Skyline No. 4 Mine will encounter large groundwater inflows (potentially 7,000 to 15,000 gpm). The Amendment says little about how these flows will be controlled or managed. The Amendment has no contingency plan for mitigating impacts to surface and near-surface waters or to water rights, even if obvious impacts are experienced. The Amendment does not address water

right issues related to removing water from the Huntington Creek / San Rafael basin to the Mud Creek / Price River basin.

WATER RIGHTS

The Flat Canyon Lease area and proposed Mine No. 4 lie wholly within the San Rafael drainage basin. Skyline Mine No. 1, No. 2 and No. 3 lie along or straddle the divide between the San Rafael drainage basin and Price River drainage basins. The policies of the Utah Division of Water Rights (DWRi), also known as the Utah State Engineer, for these basins (Area 91-Price River and Area 93-San Rafael River) are available on line at:

http://nrwrt1.nr.state.ut.us/wrinfo/policy/wrareas/default.asp

The policies for both areas state that (1) surface waters are considered to be fully appropriated and (2) some limited groundwater resources are available within the basins but the upper reaches of Price River, Huntington Creek and some other upper watershed areas are closed to new appropriations.

The Amendment identifies a total of twenty water rights including nine "*groundwater*" rights and eleven "*surface*" water rights in the Flat Canyon Lease area. The text appears to be dated as it refers to the water rights for 2002. The Amendment discusses surface water rights in section 2.3.5.1 of the Amendment. Groundwater water rights are discussed in section 2.3.5.2 in the Amendment. Potentially affected ground and surface water rights are discussed in section 2.5.1. The groundwater rights section does not appear to address the Flat Canyon Lease. CFC presents water rights and their locations in the Flat Canyon Lease on Drawing 2.3.5.1-1 of the Amendment.

We reviewed Amendment Drawing 2.3.5.1-1, *Surface Water Rights on and Adjacent to the Skyline Property*. Specifically, we reviewed existing water rights within the Flat Canyon Lease area. Table 2 presents a listing of these water rights that we downloaded from the DWRi website; the DWRi website can also generate maps of water right point of diversion (POD) locations. We noted a number of discrepancies between the Amendment water rights map and the DWRi water rights map and listing. Some of the water rights shown on the Amendment map have been withdrawn. A number of other existing water rights are not shown on the Amendment drawing. Review of the DWRi database for sections within the Flat Canyon Lease boundaries indicates 47 water rights, including surface, point-to-point and underground water rights. There is a domestic well (with an underground water right) located in section 33 (Township 13 South, Range 6 East). Water rights within the Flat Canyon Lease are listed in Table 2.

Uses of the water rights within the boundaries of the Flat Canyon Lease include domestic, stock watering, irrigation, and other uses. Of the 47 water rights listed within the lease boundary, CFC proposes monitoring four (4) of these rights including site SW32-277 (WR number 93-846), SW4-429 (WR number 93-95), SW33-268 (WR number 93-60), and SW4-173 (WR number 93-1534). The Amendment does not discuss the rationale for selecting these four water rights or why other locations were not selected for monitoring. Although these baseline data are not contained in the DOGM database, baseline histories for these locations are presented in Petersen (2014a). We recommend considering the monitoring of some of these springs. We note inconsistencies between

sample site nomenclature in Amendment Table 2.3.7-1, and Drawing 2.3.6-1 and locations described in the text of the Amendment. Additionally, not all of the proposed monitoring sites are shown on the sampling map, Drawing 2.3.6-1, including sample site S32-277.

In recent years, well JC-1 has been pumping about 4,100 into Electric Lake (San Rafael drainage basin) from the Star Point Sandstone, while the Skyline Mine pumps several thousand gpm (falling more recently to less than 2,000 gpm) to the Price River drainage basin. To some degree, the water pumped to Electric Lake is a mitigating measure for the groundwater being removed by mining.

The Amendment does not address potential impacts to water rights where groundwater issues from Star Point Sandstone springs to the east of the mine. Exposures of the Star Point Sandstone are notable east of the mine and west of Mud Creek, as shown on Figure 3. The spring at the mouth of Eccles Canyon (S17-2) shows that flow from the Star Point Sandstone has diminished over time. The DWRi database shows existing water rights in Sheep, Slaughter House, Boardinghouse, and Long Canyons, all within the Mud Creek drainage with surface exposures of Star Point Sandstone. Only one point is proposed for monitoring in Mud Creek drainage, located in Finn Canyon just above the town of Clear Creek. Future monitoring along Mud Creek is shown to be "*inactive*". Therefore, a monitoring program that does not include spring and surface water issuing from the Star Point Sandstone, we believe, is not protective of water rights existing in these areas.

MONITORING PLAN

The groundwater monitoring plan is presented in Sections 2.3.7 and 2.4.4 of the Amendment. Given the anticipated large mine inflows, number of mapped faults and the projected subsidence within the lease area, a robust monitoring plan will be critical to identifying and assessing impacts.

In our opinion, the monitoring plan for the Flat Canyon Lease and Skyline Mine should focus on where monitoring should occur, what is being monitored, and when monitoring should be completed. Although monitoring criteria are not specifically stated in the CFC Amendment, we assume that CFC is performing sampling and analysis as required by UAC 645-301-723 and that CFC's collection methods, sample measurement methods, sample handling, holding times and chain of custody methods, quality assurance and quality control procedures, data analysis and validation methods and contingencies for addressing problems identified during data collection consistently follow their internal protocols for monitoring and standard accepted procedures.

Locations of the proposed monitoring sites are shown on Figure 15 herein.

Surface Water (Stream) Monitoring

The Amendment states that "*Undermining of portions of Boulger, Swens, and Little Swens Creeks is planned, but only minor subsidence is anticipated...*" (Amendment, p. 3-6a). Because subsidence is anticipated by CFC in these areas (0.3 to 0.5 feet), it is important

to monitor the streams overlying the longwall mined areas prior to, during and after mining to ensure that water rights for those streams are protected and not impaired by subsurface losses.

The sampling plan does not identify stream flow measurement methods or whether different methods of flow measurements will be applied for each sampling location or if multiple methods will be used for each site. Stream flow measurements obtained for the baseline data collection are briefly described (Petersen, 2014a) as using methods described by the USGS and from the US Bureau of Reclamation (USBR), or by using a calibrated container and a stopwatch. It is uncertain which methods of measurement are being employed and where. Based on limited discussion in Petersen (2014a) of background data collection, it is uncertain which methods will be used in the future or where specific methods will be employed such that the stream data are collected to give accurate, consistent, and interpretable results. We recommend that this specific information be added to the monitoring plan. The plan and Table 2.3.7-1 from the Amendment do not state the frequency at which the surface streams will be monitored. Monitoring frequency should be added to the table.

The Amendment indicates that a significant surface water sampling program was conducted in Flat Canyon Creek and Boulger Creek. These data are presented in Petersen (2014a) that is contained as an appendix to the Amendment. Although Petersen (2014a) shows Universal Transverse Mercator (UTM) coordinates in their report for the surface water sites for a number of background monitor locations in the Huntington drainage, it is difficult to determine which stream is monitored based on a lack of site descriptions in the text, tables, or from looking at Drawing 2.3.6-1 in the Amendment.

Due to the anticipated subsidence from mining, we believe that surface water stream monitoring locations should be placed both upstream and downstream of the anticipated longwall mining plan, as well as from contributing side canyons to allow evaluation of potential water losses to the subsurface. This is not always the case in the Amendment, although we note that upstream and downstream monitoring points are in place in Little Swens Canyon.

In Swens Canyon, surface water monitoring point CS-28 is shown on Drawing 2.3.6-1. below the confluence with North Fork of Swens Canyon. No background or baseline data are available for this proposed monitoring point. An additional monitoring point should be added in the creek downstream from the confluences of the side canyon from the north and south drainages in Swens Canyon in order to calculate the contributions from these side streams at monitoring point CS-16. Without assessing contributing stream measurements between CS-28 and CS-16, losses between the most upstream and downstream locations within the canyon could go undetected. A water balance calculation should be made at CS-16 to show that the side canyon contributions are accounted for and that losses are not occurring beneath the main canyon.

Surface water flows should be evaluated across the entire Boulger Creek drainage to ensure that no losses are occurring within the Boulger Creek drainage in order to protect water rights in the area. Currently, there are an insufficient number of monitoring points on the creek because the current monitoring plan does not account for all of the stream contributions. Monitoring site CS-18 is adequate to monitor the Boulger Creek at the

most downstream point. Site CS-29 is located to the west of the planned longwall mining activity and determines the flow contributions from Flat Canyon. Site CS-30 is above Boulger Reservoir and monitors the total flows coming in from both the left and right forks of Boulger Creek. Site CS-31 will monitor Boulger Creek at the most upstream location west of section 5. However, the mining plan indicates that sections 4 and 5 are planned for longwall mining. Therefore, potential losses can go undetected over a stretch of about two miles on Boulger Creek. We recommend addition of a stream monitoring location in the left fork of Boulger Creek just upstream of the confluence near well 20-4-1. We also recommend adding a monitoring point on the right fork of Boulger Creek just above the confluence on the creek at the section line between sections 4 and 5.

The mining plan does not show longwall undermining of Huntington Creek although some mine workings cross beneath the creek and mining will occur within several hundred feet of the creek. We recommend that CFC obtain monitoring data generated by PacifiCorp from Boulger or Huntington Creek to aid understanding of inflows to Electric Lake.

Monitoring streams once a quarter during three quarters per year will likely not characterize streamflow response to climatic variations through the year. We recommend that consideration be given to monitoring several streams "*continuously*" with automated devices. Also, continuous or daily flow monitoring of significant stream flows into Electric Lake would aid evaluation of potential water losses from the lake.

Groundwater (Spring) Monitoring

The mining plan overburden isopach (thickness) map (Drawing 2.2.7-4) indicates that 700 to more than 2200 feet of overburden lies above the coal seams in the No. 4 Mine area. We agree with CFC that the thick overburden sequence of the combined Blackhawk and Castlegate Formations makes subsidence and impacts to springs or surface water rights improbable. However, sufficient monitoring should be performed to show that mining activities do not impair water rights at the surface.

Some of the narrative contained in the groundwater monitoring plan is dated, in that some of the details refer to old monitoring schedules and historic sampling results that do not reflect on-going data collection, or the plan cites the findings of past studies that have concluded (such as studies on Mud Creek, in Eccles Canyon and in Burnout Canyon). We believe that this information is central to the understanding of what lessons were derived from past monitoring events for the Skyline Mine Nos. 1, 2 and 3. However, we recommend that CFC frame the historic monitoring plan discussion to provide a much more clear and concise presentation of the relevance of these past monitoring events to the development and monitoring of the Skyline No. 4 Mine. Another instance is that the Mine No. 2 water is no longer discharged from well JC-3 and well JC-3 has not been monitored since 2004 so CFC should determine whether this sample site should be included for on-going sampling as indicated in the text and in the tables.

The monitoring plan presented in the Amendment is not concise, in that the narrative of the text in the monitoring plan does not always match the tables. For example, the plan states that springs 8-253 (Flat Canyon area), 2-413 (James Canyon), S24-1 (Sulfur Spring in Huntington Canyon), and S15-3 (Upper Huntington Creek) will be sampled

during the 2nd Quarter (April - June) and 4th Quarter (October - December) monitoring period and analyzed for tritium content. Table 2.3.7-1 indicates that these samples will be collected for the 2nd, 3rd and 4th quarters. If monitoring cannot be completed due to safe access to the sites, then the plan should state the circumstances that would preclude monitoring of sites on this prescribed schedule. Review of the database indicates some samples were collected either once, twice, or three times per year.

According to the Amendment (pages 2-33), spring locations in the mine area were selected according to the following criteria: *"An original baseline survey or Hydrologic Inventory was compiled in 1979, utilizing data collected from 1974 through 1979, where all possible springs, seeps and streams were monitored. Additional water monitoring data was collected for the North Lease from 1991 through 1993. Following the completion of the inventory and consultation with both DOGM and the U.S. Forest Service (USFS), representative monitoring sites were selected. Important parameters included geologic unit, critical area where damage may occur, quantity of flow, reasonable year-round access, and representative distribution.*"

The groundwater monitoring plan states that monitoring is being conducted quarterly at each of the groundwater stations identified on Table 2.3.7-3 of the Amendment and depicted on Drawing 2.3.6-1. Review of the DOGM database indicates that only two of the 13 sites on the Flat Canyon Lease shown on the drawing and listed in the table have monitoring data. DOGM typically does not include baseline data in their database files. Petersen (2014a) presents background monitoring for a number of these spring sites. However, data results do not indicate quarterly monitoring, rather that sites were monitored one to three times per year since 1997 (for some sites) with no samples collected between 2001 to 2006. Therefore, baseline data do exist for a number of locations, but not quarterly data.

Mayo and Associates (1997) identified about 94 springs in the Flat Canyon Lease area. According to the Amendment, "…*the near-surface groundwater system in the Blackhawk Formation will be monitored by a series of springs located in the Little Swens, Swens and Boulger canyons.*" Review of Drawing 2.3.6-1 does not indicate any spring monitoring in Swens or in Little Swens Canyon. All of the springs recommended for monitoring are south of Boulger Canyon. Mayo and Associates (1997) indicates the presence of 34 springs within the lease boundaries in sections 21 and 28 north of Boulger Canyon.

There is conflicting information presented for the proposed spring monitoring. Six (6) springs are shown on Amendment Figure 2.3.6-1. It is not explained in the Amendment, nor is any rationale presented for monitoring only six springs in the Flat Canyon Lease area. The monitoring plan states that "…*groundwater monitoring will include the addition of springs SW32-277, SW33-268, SW4-429, SW4-173 and SW5-590 which represent water from the Price River Formation, Castlegate Sandstone, and Blackhawk Formation, respectively.*" Our review of Drawing 2.3.6-1 (Location of Hydrologic Monitoring Stations) and Drawing 2.2.1-1 (General Geologic Map of Permit Area) indicates that SW4-173 is in the Blackhawk Formation and the remainder of the sites appear to issue from the Castlegate Sandstone.

Based on our review of the Geologic Map, Drawing 2.2.1-1, two of the monitored springs issue from the Blackhawk Formation whereas the remainder of the springs proposed for

monitoring issue from the overlying Castlegate Formation. This agrees with descriptions in Petersen (2014a) of the spring formations. However, monitoring of only two springs issuing from the Blackhawk Formation over the approximate 2,700-acre lease area may not be adequate to detect impacts if they occur, regardless of the overburden thicknesses.

Monitor Wells

The Amendment does not have a clear concise listing of monitor well construction data. We summarize monitor well information in Table 1 herein. Wells are shown as monitoring either the Blackhawk Formation or Star Point Sandstone. However, it should be noted that the screened intervals between the two well groups are somewhat close in elevation such that both groups are screened down within the coal seam areas. Blackhawk Formation wells extend to the Lower O'Connor "B" seams and the Star Point wells extend to the Lower O'Connor A seam and the Flat Canyon Seam. A review of Table 2.3.7-1 (Comprehensive Water Quality Analytical Schedule) in the Amendment indicates that monitoring of the wells will include quarterly water levels that will be measured in each of the wells. However, review of the water level data obtained from DOGM (2016) indicates that water levels were only measured three times a year, as would be expected given the heavy winter snowpack in the area making the wells inaccessible. Table 2.3.7-1 also indicates monitoring of wells W99-21-1, 91-35-1, W20-4-1, W79-35-1A, JC-3, W79-35-1B, and 91-26-1. Drawing 2.3.6-1 shows that these are all active monitoring sites.

Our review of the DOGM database indicates the following:

- Well JC-3 is completed into the Star Point Sandstone and has not been monitored since 2004 (there has not been discharge from JC-3 since 2004);
- W99-21-1 is completed into the Star Point Sandstone and has not been monitored since 2014 and is marked as "*dry well*";
- 91-35-1 is completed into the Blackhawk and has not been monitored since 2014;
- W20-4-1 is completed into the Star Point Sandstone, is shown as "*blocked*" in the database and has not been monitored since 2014;
- W79-35-1A is completed into the Star Point Sandstone and has not been monitored since 2012;
- W79-35-1B is completed into the Blackhawk and has not been monitored since 2014; and
- 91-26-1 is completed into the Blackhawk and has not been monitored since 2014 and is marked "*blocked*".

All of these wells should be field checked and verified that they are functioning for accurate water level measurements. If the wells are no longer in service or non-functional, Drawing 2.3.6-1 and the tables should reflect that the wells are discontinued or abandoned. Wells should be sealed and abandoned in accordance with DWRi regulations. Tables 2.3.7-1 and 2.3.7-3 should be modified in the monitoring plan to reflect the current status of these wells. Additionally, well 15-21-2 location is not shown

on Drawing 2.3.6-1 and should be added. If the above wells are removed from the monitoring plan because they are no longer in service, then only two wells (20-28-1 and 99-4-1) remain in the Flat Canyon Lease area, both of which are screened in the Blackhawk Formation. We believe this is an inadequate monitoring network. The closest functioning well completed within the Star Point Sandstone appears to be well W-14-2, located in Eccles Canyon.

CFC expects to encounter significant inflows from the Star Point Sandstone when mining the Skyline No. 4 Mine. Without any means of monitoring water levels in the Star Point Sandstone and limited data from the Blackhawk Formation, CFC will be unable to assess effects to the aquifer during mining, will be unable to monitor the gradient as mining progresses, and will be unable to monitor potential effects to existing water rights in the area.

We believe that the water monitoring plan for the mine, including the Flat Canyon Lease, should detail the future monitoring program in a precise, coherent standalone monitoring plan document, including a sampling and analysis plan.

Monitoring of Mine Discharge

The monitoring plan calls for monitoring the combined flow from the Skyline Mine including Mine No. 4 at the portal in Eccles Canyon. We believe that the monitoring plan should have a provision for measuring flow and sampling where inflows are encountered. The plan should state what parameters will be measured or analyzed and should provide details of sampling and measurement procedures from Flat Canyon Lease separately from the other mine workings.

CONCLUSIONS AND RECOMMENDATIONS

ADEQUACY OF THE MINING PLAN TO PREVENT IMPACTS TO WATER RIGHTS

We believe that the information in the Amendment is not adequate for evaluating whether the mining plan for the Skyline Mine Flat Canyon Lease has been designed to prevent impacts to state appropriated water rights and Electric Lake because:

- The Amendment predicts large inflows into Mine No. 4 but scarcely addresses water management, control and discharge of mine water.
- The Amendment does not adequately outline monitoring of mine inflows.
- The Amendment predicts subsidence at the ground surface (up to 0.5 feet) but states that potential impacts to surface or near-surface groundwater would be short-lived as streams would fill the ground surface fractures with sediment.
- The Amendment scarcely discusses designs or measures to prevent impacts to water rights, other than to dismiss the likelihood of impacts occurring.
- The Amendment minimally addresses measures to prevent impacts to Electric Lake or Boulger Reservoir other than to not mine within a buffer zone.

- The Amendment does not accurately or completely identify existing water rights.
- The Amendment does not discuss possible alternative measures to mitigate potential impacts to local water rights.
- The Amendment does not address water right issues of trans-basin diversion (pumping mine inflows from groundwater in the San Rafael drainage basin to the Price River drainage basin).
- The Amendment does not provide an adequate monitoring plan in our opinion (discussed further in the next section).
- The Amendment does not set parameters that would trigger actions to address potential impacts to water rights. Trigger parameters could be based on monitoring or observations and might include particular mine inflow rates, observed or suspected spring or stream losses, changes in groundwater levels, and water quality concentrations. Actions that could be triggered might include notifications to regulatory agencies, increased monitoring, increased technical evaluations, and preparation of contingency control and mitigation plans.
- The Amendment does not provide contingency plans to address impacts if impacts occur.

We recommend that CFC address these points.

ADEQUACY OF MONITORING PLAN TO IDENTIFY IMPACTS

We believe that the proposed water-monitoring plan in the Amendment is not adequate for detecting impacts to state appropriated water rights because:

- The monitoring plan should clearly describe the plan for monitoring going forward for the Skyline No. 4 Mine and the tables should reflect the accuracy of what will be monitored and when monitoring should occur. While we believe that past studies are important to the understanding of the hydrology at the Skyline Mine, discussion of past results and evaluations should be framed with the relevancy of monitoring in the Flat Canyon Lease and presented in the Amendment in a separate section.
- The plan should state that quality assurance (QA) or quality control (QC) procedures will be carried out in accordance with requirements under UAC R645-301-723.
- The plan proposes insufficient stream flow measurement locations to detect losses from streams that cross subsidence and disturbed areas with potential for flow losses related to mining. At a minimum, stream flow should be measured upstream and downstream of potential water loss areas. Additional monitoring of intermediate contributing streams may require monitoring.
- The plan proposes to monitor a small number of springs compared to the large permit area. Additional spring monitoring is warranted in our opinion. The monitoring plan should provide rationale for spring selection for monitoring.

- The plan proposes to monitor a number of wells that appear to not be functional. We believe the proposed monitoring well network is inadequate.
- The plan does not clearly describe monitoring of groundwater inflow into the mine.
- Some additional water quality monitoring of common ions for Electric Lake, JC-1 and mine inflows into the No. 4 Mine is warranted to understand which waters are mixing.

Additional discussion of these points follows.

Monitoring Plan Document

The monitoring plan should define measurement or sample collection methods in a clear and concise manner. Monitoring plan should include a statement that sampling will be completed in accordance with UAC R645-301-723. We recommend that the plan include some details in tabular form, including:

- Monitoring site locations
- Consistent site names or designations
- Other site designations used for same location in previous documents
- Site location in accordance with UAC R645-301-722.300
- Location common name (such as lower Boulger Creek)
- Monitoring parameters (such as stream flow rate)
- Field measurement methods or sample collection methods
- Monitoring frequency and schedule
- Staking and labeling monitoring sites to assure consistent measurement locations
- Plan should include summary of monitor well construction information in accordance with UAC R645-301-722.400.

The monitoring text, tables and figures should be updated to eliminate locations that are no longer monitored and to reflect the actual schedules for monitoring.

Surface Water (Streams)

Surface waters in the Skyline No. 4 Mine should be monitored at a minimum of three locations along streams, including (1) the most upstream (west) location from above the areas to be mined, (2) a location midstream, or just below the confluences of side tributaries, and (3) at the most downstream location from the mined areas. A water balance should be made in the field or in the office immediately following monitoring to assess that losses are not occurring.

In Swens Canyon, we recommend an additional monitoring point located in the creek downstream from side canyon contributions from the north and the south drainages in order to calculate the contributions from these side streams at monitoring point CS-16.

We believe that there is an insufficient number of monitoring points on Boulger Creek because the current monitoring plan does not account for all of the stream contributions. Site CS-31 will monitor Boulger Creek at the most upstream location west of section 5. We recommend additional stream monitoring at a location in the left fork of Boulger Creek just upstream of the confluence near well 20-4-1. We also recommend including an additional monitoring point on the right fork of Boulger Creek just above the confluence on the creek at the section line of sections 4 and 5.

One or more points of continuous stream monitoring would provide valuable information on stream hydrology and climatology for the Flat Canyon Lease. We recommend that CFC place an automated continuous recorder in Boulger Creek and/or in Huntington Creek to provide at least daily average flow record. This record could be used in conjunction with climatic data (precipitation, snow melt, evaporation and drought). Such continuous monitoring data would be valuable to assess and compare changes in flows at other locations and adds confidence to the surface water measurements being made within each of the drainage basins contributing to Huntington Creek.

Springs

We recommend that CFC increase the proposed number of springs for monitoring in the Flat Canyon Lease area. Petersen (2014a) shows the location of 17 springs that were monitored for baseline information. Due to potential subsidence impacts, we believe that the number of monitored springs should be increased. The monitoring plan Table 2.3.7-3 only shows five (5) of the baseline springs for sampling. Drawing 2.3.6-1 in the Amendment shows six (6) spring locations, but all of these are located in the southern half of the lease leaving about half of the lease area unmonitored. Springs should be monitored in Swens and in Little Swens canyons. We recommend that CFC consider using a portable cutthroat flume or similar device to (1) gage stream flows and achieve consistent and accurate measurement results, (2) reduce the time required to measure flows, and (3) to reduce the potential for error when calculating flows.

Monitoring of springs to the east of the mine should continue or should be established to protect water rights. Springs issuing from the Star Point Sandstone west of Mud Creek should be monitored, including on-going monitoring of spring S17-2 and monitoring of springs in Green, Slaughterhouse, Sheep, Boardinghouse, Finn, Long, Hughes and Valentine Canyons. All of these canyons have significant exposures of the Star Point Sandstone.

Monitor Wells

Apparently a number of wells designated for monitoring have not been monitored since 2014. CFC should determine why the wells are not being monitored according to their schedule or whether these wells are no longer functional. If the wells are not functional, then there are no wells available to monitor heads in the Star Point Sandstone in the No. 4 Mine and Skyline Mine area other than well W14-2 in Eccles Canyon. Without any wells to the Star Point Sandstone, it will not be possible to evaluate the effects of removal of the large mine inflows that are expected to occur in the No. 4 Mine. We recommend

additional wells to monitor the Star Point Sandstone water levels. Two Blackhawk wells already exist in the vicinity of the Flat Canyon lease.

We recommend that CFC add one or more shallow wells in Boulger and/or Swens Canyon. These wells should be screened in sandstone or potentially permeable units below the water table in the Blackhawk Formation, but considerably above the coal seams. The purposes of these wells would be to evaluate changes to water levels in the Blackhawk Formation near the springs, to assess the effects of dewatering No. 4 Mine and to assess the effects of subsidence in the Blackhawk Formation, if any.

We also recommend that CFC place a water pressure transducer-recorder in well JC-1. This will allow continuous measurement of the pumping water level and drawdown. Evaluation of the transducer data will allow assessments with respect to the other observed monitoring locations and aid identification of possible effects to water rights impacts.

Water Quality Monitoring

Spring and surface waters in the Flat Canyon Lease area are of good quality. We believe that underground mining is unlikely to impair surface water quality in the Flat Canyon Lease area, although water discharged from mine inflows could cause impairment to water quality. Therefore, our recommendations have been primarily made with respect to water level and flow monitoring. Based on our review of the Amendment, we recommend adding sample collection and analysis for a full suite of common ions from samples of Electric Lake, well JC-1 and mine inflows. These samples should be collected at the same time and schedule as that for tritium. Results should be plotted on a Piper diagram to identify and assess changes in common ion chemistry which could show mixing of waters over time much more clearly than Stiff Diagrams and can be used more effectively for assessing the origins of water types. Periodically, mine inflow samples should be collected and analyzed for constituents compatible with requirements for discharge permitting.

ADEQUACY OF ELECTRIC LAKE MONITORING

As previously stated in this review, we do not believe that prior studies of Electric Lake have conclusively determined that a direct conduit exists or was created by mining activity between Electric Lake and the Skyline No. 2 Mine. However, the Skyline No. 4 Mine will be in closer proximity to Electric Lake than the No. 2 Mine. The mine plan shows that approximately 1.5 miles of mine workings are planned approximately parallel to, and in close proximity to the west shore of the lake. Therefore, we believe that it is essential for CFC to monitor potential impacts from mining to Electric Lake as part of the monitoring plan. While the burden of proof to show impacts to water rights rests with the water rights owners, including PacifiCorp and Huntington Cleveland Irrigation Company, we believe that the proposed monitoring of Electric Lake as presented in the Amendment should be expanded to protect water rights and to show that no impacts to Electric Lake are occurring in the future because:

- There are no provisions in the Amendment for monitoring of Electric Lake by CFC related to water balance evaluations or detection of significant water losses.

PacifiCorp monitors and reports daily reservoir level and discharge which presumably will continue to be available to CFC. CFC monitors discharge from Well JC-1 and JC-3. CFC monitors flow in Huntington Creek upstream of Electric Lake three times per year (once each quarter during three different quarters of the year) at site UPL-10; however, such limited data would not much help in calculating a water balance or identifying significant water loss from the lake.

- The Amendment does not include provisions for evaluating monitoring data by CFC to detect possible significant water losses from the lake. The Amendment does not provide provision for reporting detected or suspected significant losses from the lake by CFC.
- The Amendment does not set parameters that would trigger actions to address potential significant impacts to Electric Lake. Trigger parameters could be based on mine inflow rates, lake monitoring, observations or water balance calculations and might include particular water balance results, mine inflow rates, observed or suspected spring or stream losses, and changes in groundwater levels and water quality concentrations. Actions that could be triggered might include notifications to regulatory agencies, increased monitoring, increased technical evaluations, and preparation of contingency control and mitigation plans.
- The Amendment calls only for monitoring tritium concentrations in Electric Lake at sites EL-1 and EL-2. Other water quality parameters including collecting a suite of common ion chemistry may be pertinent for (1) helping to identify lake water in mine inflows and (2) obtaining permits to discharge into the lake or Huntington Lake basin if found to be necessary.
- The Amendment does not provide contingency plans to address impacts to Electric Lake should impacts be detected or suspected.

We recommend that CFC consider establishing additional monitoring and data evaluation protocols to detect significant water losses from Electric Lake. Additional monitoring could include automated daily monitoring of flow in Huntington Creek above Electric Lake and other significant sources of lake inflow. Data collection and evaluations might include download of pertinent data from PacifiCorp or Emery County Water Conservancy District, publicly-available climatic data (such as precipitation, Snotel, evaporation, and the like), and calculation of water balance for the lake. We recommend that CFC consider additional water quality monitoring of the lake. We recommend that CFC develop a clear, complete, concise monitoring plan that includes monitoring of Electric Lake.

REFERENCES

CFC (Canyon Fuel Company, LLC), 2003, *A Brief Response to PacifiCorp's "Data and Finding Summary for Investigation of Technical Issues Related to the Electric Lake and Huntington Creek Drainage Controversy*, June 25, 2003" C/007/005: Letter to DOGM dated August 5, 2003.

CFC, 2005, *Review of Recently Submitted PacifiCorp Draft Reports, Canyon Fuel Company, Skyline Mine, C/007/005*: Letter to DOGM dated August 25, 2005.

CFC, 2002 to 2015, Previous MRP submittals *Chapter 2-Environmental Resources:* Compilation of pages of MRP Section 2 with various dates of incorporation; Received by Loughlin Water from DOGM on October 7, 2016; 377 p.

CFC, 2015, *Flat Canyon Lease, Federal Lease UTU-77114, Canyon Fuel Company, LLC, Skyline Mine, Task ID #5017, C/007?0005*: Letter dated October 9, 2015, with attachments (application for permit change) to DOGM; 961 p.

CFC, 2016, *Flat Canyon Lease, Federal Lease UTU-77114, Canyon Fuel Company, LLC, Skyline Mine, Task ID #5017, C/007?0005*: Letter dated August 26, 2016, with attachments (application for permit change) to DOGM; 1279 p.

DOGM (Division of Oil, Gas and Mining), 2013, *Mud Creek Basin and Upper Huntington Creek Basin, Cumulative Hydrologic Impact Assessment (CHIA) For Skyline Mine C/007/0005, White Oak Mine C/007/0001, Blazon Mine FOR/007/0021, Kinney #2 Mine C/007/0047, In Carbon, Emery, and Sanpete Counties, Utah*: Report dated October 7, 2013.

HCI (Hydrologic Consultants, Inc. of Colorado), 2003, *Findings of Ground-Water Flow Modeling of Skyline Mine and Surrounding Area, Carbon, Sanpete, and Emery Counties, Utah*: Consultant report dated September 2003.

Mayo and Associates, LC, 1996, *Investigation of surface and groundwater systems in the vicinity of the Skyline Mines, Carbon, Emery, and Sanpete Counties, Utah: Probable hydrologic consequences of coal mining at the Skyline Mines and recommendations for surface and groundwater monitoring*: unpublished consulting report for Utah Fuel Company, Helper, Utah, 1996.

Mayo & Associates, 1997, *West Tract Spring and Seep Inventory*: unpublished consultant's report, Fall 1997.

Oberhansly, G.G., 1980, *Geologic Map of Fairview Lakes Quadrangle, Utah*: Utah Geological Survey Map No. 56.

Ozark Underground Laboratory (Ozark Underground Laboratory, Inc.), 2003, *Preliminary Draft, Summary of Results from Groundwater Tracing Investigations at Electric Lake, Utah*: Consultant report dated June 22, 2005.

PacifiCorp, 2003, *Data and Finding Summary for Investigation of Technical Issues Related to the Electric Lake and Huntington Creek Drainage Controversy*: Industry report dated June 25, 2003.

PacifiCorp, 2004, *Electric Lake Update*: letter to DOGM from PacifiCorp dated July 6, 2004.

Petersen Hydrologic, LLC, 2014a, *Investigation of Groundwater and Surface-Water Systems in the Flat Canyon Tract and Adjacent Area; Probable Hydrologic Consequences of Coal Mining in the Flat Canyon Tract, Sanpete County, Utah*: Consultant report dated August 13, 2014.

Petersen Hydrologic, LLC, 2014b, *Groundwater Conditions in the Star Point Sandstone in the Vicinity of the Skyline Mine, 2014*: Consultant report dated August 18, 2014.

Petersen Hydrologic, LLC, 2016, *Addendum to: Investigation of Fault-related Groundwater Inflows at the Skyline Mine by Petersen Hydrologic, LLC, 27 October 2002*: Consultant report dated August 19, 2016.

Solomon, D. K., 2005, *Preliminary Draft, Analysis of Groundwater Flow from Electric Lake Towards the Skyline Mine*: consultant report dated June 2005.

SRK (SRK Consulting (U.S.), Inc.), 2016, *Update of Groundwater Flow Model, Skyline Mine Project, Utah*: Consultant report dated July 1, 2016.

USDA FS and BLM, 2002, *Flat Canyon Coal Lease Tract Final Environmental Impact Statement*, January 2002.

Witkind, I.J., and Weiss, M.P., 1991, Geologic Map of the Nephi 30' x 60' Quadrangle, Carbon, Emery, Juab, Sanpete, Utah and Wasatch Counties, Utah: Miscellaneous Investigations Map I-1937.

Table 1
Skyline Mine Well Construction and Water Level Information

Well Designation	Other Designation	Top of Screen (ft MSL)	Bottom of Screen (ft MSL)	Vertical Distance Screen to Coal (above of below)	Date of WL Measurement	WL Elevation (ft MSL)	Date Range of WL	Name of Associated Seam	Well Location, Township (T), Range (R), & Section (Sec)	Included in Monitoring Plan?	Monitored Formation
W10-1	W79-10-1A	7393	7373	Through Coal Seam	9/5/2002	9017.3	Blocked	Lower O'Connor A" "	T 13 S, R 6 E, Sec. 10	No	Star Point -Sandstone (Storrs Tongue) (Blocked)
	W79-10-1B						6/96 to 10/15		T 13 S, R Q E, Sec. 10	Yes	
W14-2	W79-14-2A	8342	8322	Through Coal Seam	9/5/2002	8947.5	9/95 to 12/15	Lower O'Connor A" "	T 13 S, R 6 E, Sec. 14	Yes	Star Point -Sandstone (Storrs Tongue)
	W79-14-2B						Blocked		T 13 S, R 6 E, Sec. 14	No	
	W79-22-2-1						Blocked		T 13 S, R 6 E, Sec. 22	No	
W22-2	W79-22-2-2						Blocked		T 13 S, R·6 E, Sec. 22	No	
W26-1	W79-26-1	8411	8391	Through Coal Seam	8/15/2002	8919.2	8/82 to 11/16	Lower O'Connor B" "	T 13 S, R 6 E, Sec. 26	Yes	Blackhawk -Sandy Siltsone
W35-1	W79-35-1A	8092	8072	5' Below Coal Seam	9/10/2002	8381.6	7/82 to 2012	Lower O'Connor A" "	T 13 S, R 6 E, Sec. 35	Yes , Not measured since 2012	Star Point -Sandstone (Storrs Tongue)
	W79-35-1 B	8542.4	8504.4		9/10/2002	8552.7	7/82 to 10/14	Not associated with coal seam	T 13 S, R 6 E, Sec. 35	Yes, not measured since 2014	Blackhawk -Sandy Siltsone
W2-1	98-2-1	8030.4	8000.4	Through Coal Seam	8/2/2002	8364.4	12/99 to 6/16	Lower O'Connor B" "	T 14~, R 6 E, Sec. 2	Yes	Blackhawk -Sandy Siltsone
JC-1		7918		11.5' Below Coal Seam				No Current Data Lower O'Connor B" "	T 13 S, R 6 E, Sec. 35	Yes	Star Point -Sandstone (Storrs Tongue)
JC-2								Lower O'Connor B" "	T 13 S, R 6 E, Sec. 35	No	Star Point -Sandstone (Storrs Tongue)
JC-3		8061.7, 7730.1	8018.0, 7711.1	Though Coal Seam			None	Lower O'Connor B" "	T 13 S. R 6 E, Sec. 35	Yes , not monitored since 2004	Star Point -Sandstone (Storrs Tongue)
99-4-1		7551	7521	Through Coal Seam	9/10/2002	8520.5	9/02 to 6/16	Lower O'Con nor B" "	T 14 S, R 6 E, Sec. 4	Yes	Blackhawk -Sandy Siltsone
99-21-1		7431.3	7401.3	Through Coal Seam	9/24/2002	8322.6	8/01 to 12/14	Flat Canyon (Middle Seam)	T 13 S, R 6 E, Sec. 21	Yes , Not measured since 2014, comment as dry well	Star Point -Sandstone (Panther Tongue)
99-28-1		7477	7457	Through Coal Seam	9/24/2002	8377.3	9/02 to 11/08	Flat Canyon (Middle Seam)	T 13 S, R 6 E, Sec. 28	Yes	Star Point -Sandstone (Panther Tongue)
20-4-1		7491	7464	Lost Core	9/27/2002	8490.7	9/02 to 6/14	Lost Core	T 14 S, R 6 E, Sec. 4	Yes , marked as blocked in June 2014	Star Point -Sandstone (Storrs Tongue)
20-4-2		7574	7544	16' Below Coal Seam	9/10/2002	8420.5	9/02 to 6/10	Lower O'Connor A" "	T 14 S, R 6 E, Sec. 4	Yes	Star Point -Sandstone (Storrs Tongue)
20-28-1		7420	7390	Through Coal Seam	9/24/2002	8393.7	9/02 to 12/15	Lower O'Connor B" "	T 13 S, R 6 E, Sec. 28	Yes	Blackhawk -Sandy Siltsone
91-26-1	North Lease	7698.1	7668.1	Through Coal Seam	9/9/2002	7941	6/02 to 2014	Lower O'Connor B" "	T 12 S, R 6 E, Sec. 26	Yes , not measured since 2014	Blackhawk -Sandy Siltsone
91-35-1	North Lease	7616.9	7586.9	Through Coal Seam	9/5/2002	8011.4	6/02 to 2014	Lower O'connor B" "	T 12 S, R 6 E, Sec. 35	Yes, marked as no access, not measured since 2014	Blackhawk -Sandy Siltsone
92-91-03		NA	NA	NA	NA	NA	9/93 to 6/16	NA	NA	NA	NA

COMPILED BY LOUGHLIN WATER FROM WELL TABLE PROVIDED BY CFC AT THE SKYLINE MINE

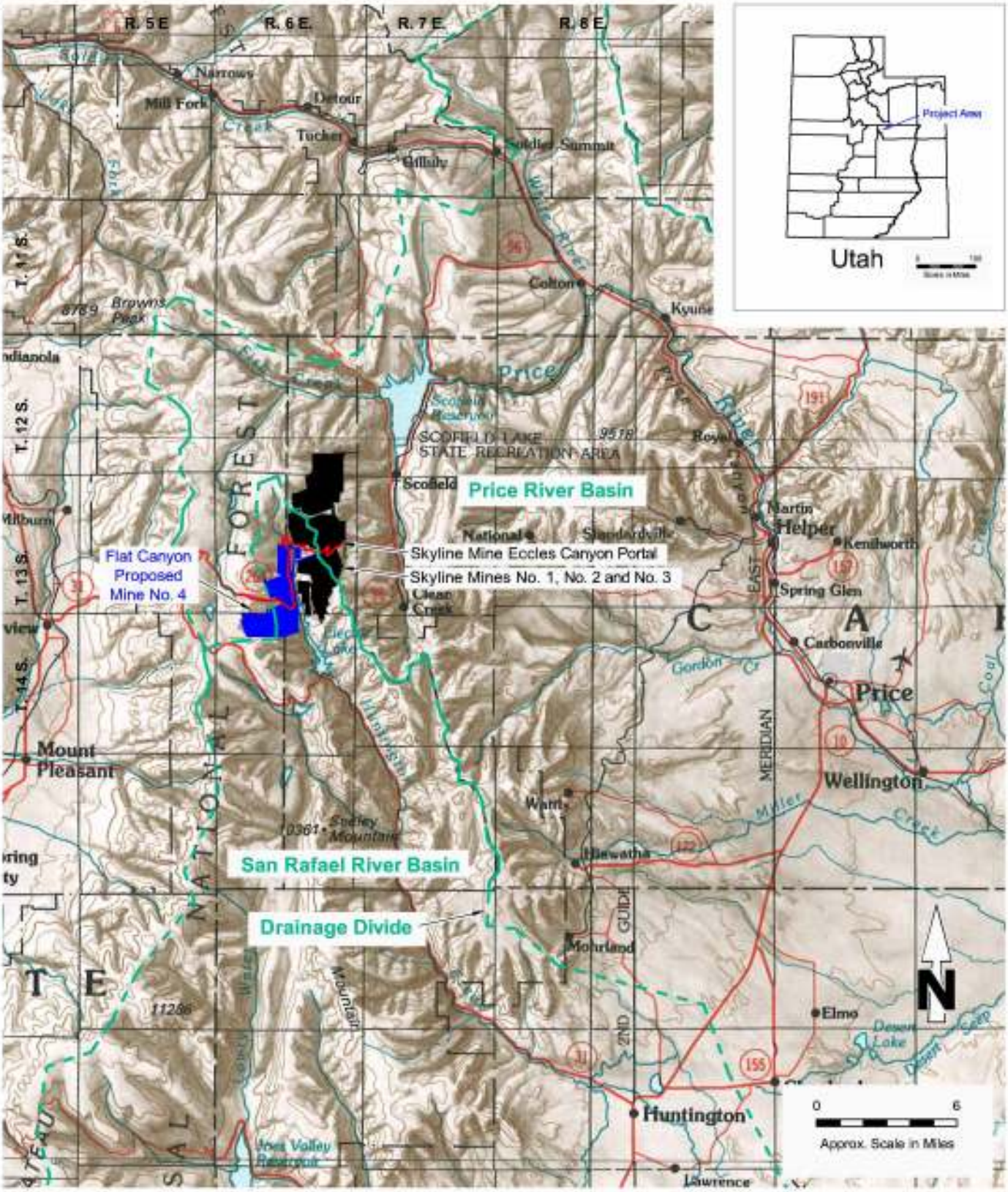
Table 2
Water Rights Within The Flat Canyon Lease Boundaries

WR Number	Diversion Type	Well Log	Location	Distance	from	Section	Township	Range	grid	Status	Priority	Uses	CFS	ACFT	Address	Owner Name	Latitude	Longitude
93-399	Point to Point		S660	W1980	E4	3	14S	6E	SL	P	1902	S	0	0	ATTN: CLAUDIA CONDER	PACIFICORP DBA UTAH POWER	39.63	-111.236
93-399	Point to Point		S660	E660	N4	3	14S	6E	SL	P	1902	S	0	0	ATTN: CLAUDIA CONDER	PACIFICORP DBA UTAH POWER	39.63729	-111.236
93-553	Point to Point		S660	W660	E4	3	14S	6E	SL	P	1902	S	0	0	ATTN: MS. JODY L. WILLIAMS	PACIFICORP DBA UTAH POWER	39.63001	-111.231
93-82	Point to Point		S660	W660	E4	3	14S	6E	SL	P	1902	S	0	0	ATTN: MS. JODY L. WILLIAMS	PACIFICORP DBA UTAH POWER	39.63001	-111.231
93-1534	Point to Point		S660	W660	N4	4	14S	6E	SL	P	1875	S	0.011	0	324 25TH STREET	USA FOREST SERVICE	39.63741	-111.26
93-1547	Point to Point		N660	W660	E4	4	14S	6E	SL	P	1875	S	0	0	324 25TH STREET	USA FOREST SERVICE	39.63375	-111.25
93-19	Point to Point		N660	E660	W4	4	14S	6E	SL	P	1875	S	0	0	324 25TH STREET	USA FOREST SERVICE	39.63385	-111.264
93-95	Point to Point		S660	E660	NW	4	14S	6E	SL	P	1875	S	0.011	0	324 25TH STREET	USA FOREST SERVICE	39.6375	-111.264
93-205	Surface		S1388	W593	N4	21	13S	6E	SL	P	1860	DO	0	1.06	ATTN: NATURAL RESOURCE SEF	CHURCH OF JESUS CHRIST OF LA	39.67928	-111.26
93-90	Surface		S523	E861	W4	21	13S	6E	SL	P	1868	IO	0	7.89	ATTN: NATURAL RESOURCE SEF	CORPORATION OF THE PRESIDIN	39.67504	-111.264
93-90	Surface		S1388	W593	N4	21	13S	6E	SL	P	1868	IO	0	7.89	ATTN: NATURAL RESOURCE SEF	CORPORATION OF THE PRESIDIN	39.67928	-111.26
93-12	Point to Point		N660	E1980	W4	22	13S	6E	SL	P	1875	S	0	0	324 25TH STREET	USA FOREST SERVICE	39.67799	-111.241
93-8	Point to Point		N660	E1980	W4	22	13S	6E	SL	P	1875	S	0	0	324 25TH STREET	USA FOREST SERVICE	39.67799	-111.241
93-9	Point to Point		N660	E1980	W4	22	13S	6E	SL	P	1875	S	0	0	324 25TH STREET	USA FOREST SERVICE	39.67799	-111.241
93-1538	Point to Point		S660	W660	E4	27	13S	6E	SL	P	1875	S	0.011	0	324 25TH STREET	USA FOREST SERVICE	39.65979	-111.231
93-11	Point to Point		N660	E660	W4	28	13S	6E	SL	P	1875	S	0	0	324 25TH STREET	USA FOREST SERVICE	39.66354	-111.264
93-1001	Point to Point		S660	E1980	W4	33	13S	6E	SL	P	19390628	D	0.002	0	324 25TH STREET	USA FOREST SERVICE	39.64503	-111.259
93-1535	Point to Point		S660	W660	E4	33	13S	6E	SL	P	1875	S	0.011	0	324 25TH STREET	USA FOREST SERVICE	39.64495	-111.25
93-1536	Point to Point		S660	W1980	E4	33	13S	6E	SL	P	1875	S	0.011	0	324 25TH STREET	USA FOREST SERVICE	39.64494	-111.255
93-18	Point to Point		N660	E1980	W4	33	13S	6E	SL	P	1875	S	0	0	324 25TH STREET	USA FOREST SERVICE	39.64866	-111.259
93-20	Point to Point		S660	W660	E4	33	13S	6E	SL	P	1875	S	0	0	324 25TH STREET	USA FOREST SERVICE	39.64495	-111.25
93-21	Surface		S350	W1650	E4	33	13S	6E	SL	P	1875	S	0	0	324 25TH STREET	USA FOREST SERVICE	39.64579	-111.254
93-3332	Point to Point		N20	E990	W4	33	13S	6E	SL	P	1891	S	0	0	546 SOUTH 8TH STREET	KENT COX	39.64689	-111.263
93-3332	Point to Point		N660	E660	W4	33	13S	6E	SL	P	1891	S	0	0	546 SOUTH 8TH STREET	KENT COX	39.64865	-111.264
93-3333	Point to Point		N20	E1070	W4	33	13S	6E	SL	P	1891	S	0	0	1369 EAST NICHOLES ROAD	BONNIE COX GUNNELL	39.64689	-111.263
93-3333	Point to Point		N20	E990	W4	33	13S	6E	SL	P	1891	S	0	0	1369 EAST NICHOLES ROAD	BONNIE COX GUNNELL	39.64689	-111.263
93-3334	Point to Point		N30	E1200	W4	33	13S	6E	SL	P	1891	S	0	0	RT 1, BOX 96	DAWNA COX HARRIS	39.64692	-111.262
93-3334	Point to Point		N20	E1070	W4	33	13S	6E	SL	P	1891	S	0	0	RT 1, BOX 96	DAWNA COX HARRIS	39.64689	-111.263
93-3335	Point to Point		N660	E660	W4	33	13S	6E	SL	P	1891	S	0	0	5020 WEST FRANKLIN ROAD	LYNETTE COX MURRAY	39.64865	-111.264
93-3335	Point to Point		N30	E1200	W4	33	13S	6E	SL	P	1891	S	0	0	5020 WEST FRANKLIN ROAD	LYNETTE COX MURRAY	39.64692	-111.262
93-3364	Point to Point		N660	E660	W4	33	13S	6E	SL	P	1875	S	0.011	0	5020 WEST FRANKLIN ROAD	LYNETTE COX MURRAY	39.64865	-111.264
93-3365	Point to Point		N660	E660	W4	33	13S	6E	SL	P	1875	S	0.011	0	5020 WEST FRANKLIN ROAD	LYNETTE COX MURRAY	39.64865	-111.264
93-3740	Underground	25460	N2036	E1238	SW	33	13S	6E	SL	P	1875	DI	0	1.25	ROY F. AND JEANETTE D. HATCI	THE HATCH FAMILY TRUST	39.64491	-111.262
93-55	Surface		S570	E150	W4	33	13S	6E	SL	P	1891	IS	0.015	0	C/O STANLEY COX	COX INCORPORATED	39.64527	-111.266
93-60	Surface		S570	E150	W4	33	13S	6E	SL	P	1891	IS	0.015	0	SHIRLEY S. COX TRUSTEE	COX MARITAL TRUST	39.64527	-111.266
93-61	Surface		S770	E420	W4	33	13S	6E	SL	P	1891	IS	0.07	0	SHIRLEY S. COX TRUSTEE	COX MARITAL TRUST	39.64472	-111.265
93-62	Surface		S770	E420	W4	33	13S	6E	SL	P	1891	IS	0.07	0	1496 NORTH 200 WEST	SANDRA LYNN SHELLEY	39.64472	-111.265
93-68	Surface		S770	E420	W4	33	13S	6E	SL	P	1891	DIS	0.07	0	163 WEST 600 NORTH	ANNA LEE JENSEN	39.64472	-111.265
93-69	Surface		N315	E540	W4	33	13S	6E	SL	P	1891	DIS	0.045	0	3083 SOUTH 100 WEST	ORA WATSON	39.6477	-111.265
93-70	Surface		N315	E540	W4	33	13S	6E	SL	P	1891	IS	0.045	0	390 NORTH 300 EAST	DOROTHY LUND	39.6477	-111.265
93-71	Surface		N390	E200	W4	33	13S	6E	SL	P	1891	IS	0.015	0	SHIRLEY S. COX TRUSTEE	COX MARITAL TRUST	39.6479	-111.266
93-72	Surface		N390	E200	W4	33	13S	6E	SL	P	1891	IS	0.015	0	163 WEST 600 NORTH	ANNA LEE JENSEN	39.6479	-111.266
93-73	Surface		N315	E540	W4	33	13S	6E	SL	P	1891	DIS	0.045	0	1096 CONCORD STREET	HAROLD REX COX	39.6477	-111.265
93-74	Surface		N315	E540	W4	33	13S	6E	SL	P	1891	IS	0.045	0	163 WEST 600 NORTH	ANNA LEE JENSEN	39.6477	-111.265
93-75	Surface		N315	E540	W4	33	13S	6E	SL	P	1891	IS	0.045	0	1496 NORTH 200 WEST	SANDRA LYNN SHELLEY	39.6477	-111.265

WATER RIGHTS SEARCHdirectly below FCL

Table 2
Water Rights Within The Flat Canyon Lease Boundaries

WR Number	Diversion Type	Well Log	Location	Distance	from	Section	Township	Range	grid	Status	Priority	Uses	CFS	ACFT	Address	Owner Name	Latitude	Longitude
93-772	Point to Point		S660	E660	W4	33	13S	6E	SL	P	1891	S	0	0	1096 CONCORD STREET	HAROLD REX COX	39.64502	-111.264
93-772	Point to Point		S50	E800	W4	33	13S	6E	SL	P	1891	S	0	0	1096 CONCORD STREET	HAROLD REX COX	39.6467	-111.264
93-773	Point to Point		S150	E440	W4	33	13S	6E	SL	P	1891	S	0	0	SHIRLEY S. COX TRUSTEE	COX MARITAL TRUST	39.64642	-111.265
93-773	Point to Point		S660	E660	W4	33	13S	6E	SL	P	1891	S	0	0	SHIRLEY S. COX TRUSTEE	COX MARITAL TRUST	39.64502	-111.264
93-774	Point to Point		S130	E530	W4	33	13S	6E	SL	P	1891	S	0	0	163 WEST 600 NORTH	ANNA LEE JENSEN	39.64648	-111.265
93-774	Point to Point		S150	E440	W4	33	13S	6E	SL	P	1891	S	0	0	163 WEST 600 NORTH	ANNA LEE JENSEN	39.64642	-111.265
93-775	Point to Point		S80	E620	W4	33	13S	6E	SL	P	1891	IS	0	0	1496 NORTH 200 WEST	SANDRA LYNN SHELLEY	39.64662	-111.264
93-775	Point to Point		S130	E530	W4	33	13S	6E	SL	P	1891	IS	0	0	1496 NORTH 200 WEST	SANDRA LYNN SHELLEY	39.64648	-111.265
93-777	Point to Point		S60	E710	W4	33	13S	6E	SL	P	1891	S	0	0	3083 SOUTH 100 WEST	ORA WATSON	39.64667	-111.264
93-777	Point to Point		S80	E620	W4	33	13S	6E	SL	P	1891	S	0	0	3083 SOUTH 100 WEST	ORA WATSON	39.64662	-111.264
93-778	Point to Point		S50	E800	W4	33	13S	6E	SL	P	1891	S	0	0	390 NORTH 300 EAST	DOROTHY LUND	39.6467	-111.264
93-778	Point to Point		S60	E710	W4	33	13S	6E	SL	P	1891	S	0	0	390 NORTH 300 EAST	DOROTHY LUND	39.64667	-111.264
93-85	Point to Point		S660	W660	E4	33	13S	6E	SL	P	1875	S	0	0	324 25TH STREET	USA FOREST SERVICE	39.64495	-111.25
93-85	Point to Point		N660	E1980	W4	33	13S	6E	SL	P	1875	S	0	0	324 25TH STREET	USA FOREST SERVICE	39.64866	-111.259
93-991	Surface		S690	W1730	E4	33	13S	6E	SL	P	19471011	O	3	31.92	1594 WEST NORTH TEMPLE, ST	STATE OF UTAH DIVISION OF WI	39.64486	-111.254
93-12	Point to Point		N660	E660	S4	34	13S	6E	SL	P	1875	S	0	0	324 25TH STREET	USA FOREST SERVICE	39.64092	-111.236
93-1547	Point to Point		S660	E660	W4	34	13S	6E	SL	P	1875	S	0	0	324 25TH STREET	USA FOREST SERVICE	39.64496	-111.246
93-18	Point to Point		N660	E660	S4	34	13S	6E	SL	P	1875	S	0	0	324 25TH STREET	USA FOREST SERVICE	39.64092	-111.236
93-19	Point to Point		N660	E660	S4	34	13S	6E	SL	P	1875	S	0	0	324 25TH STREET	USA FOREST SERVICE	39.64092	-111.236



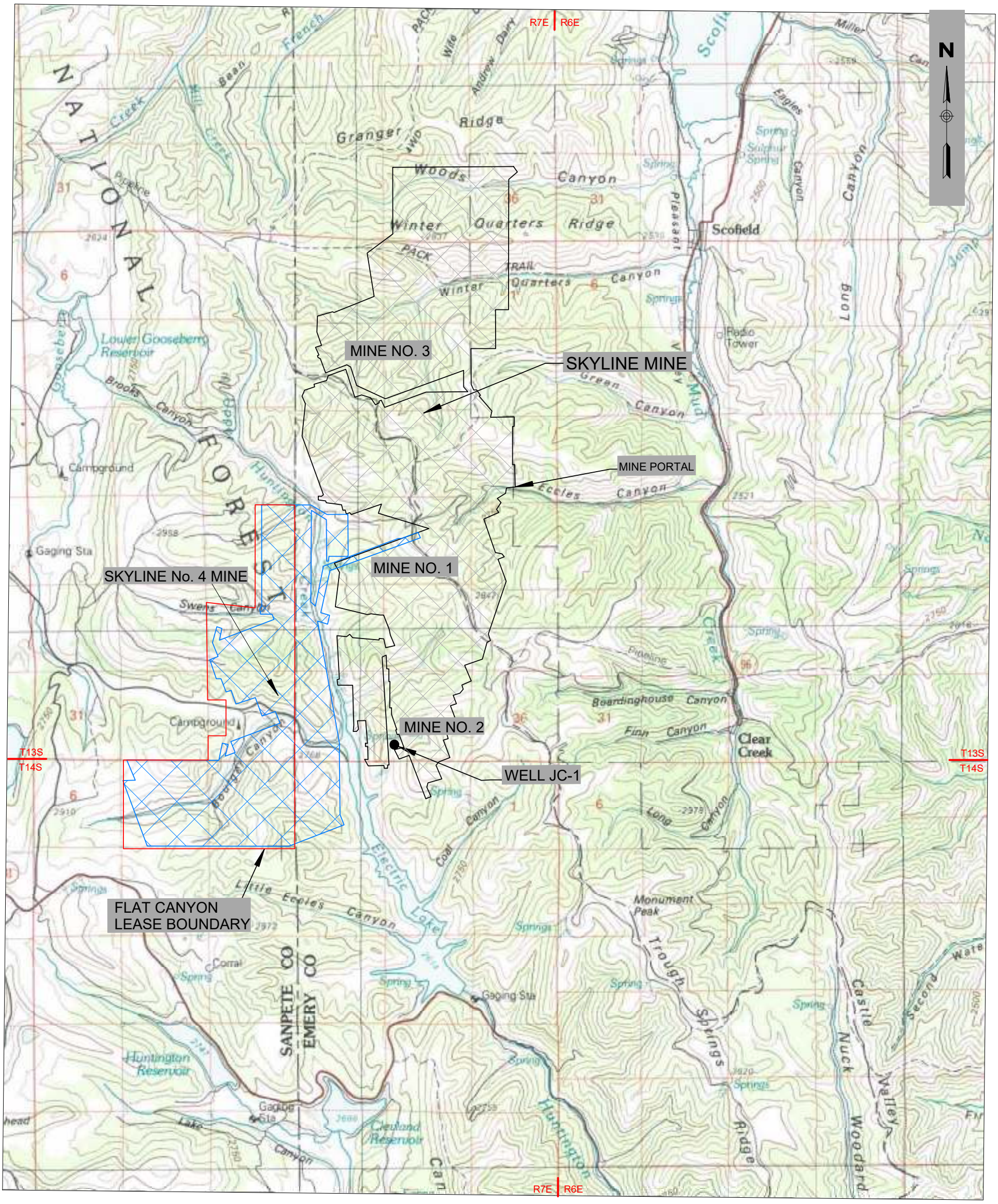
Base map: "State of Utah Shaded Relief Map".
U.S. Geological Survey (1988).
Contour interval 500 feet.

LOUGHLIN WATER ASSOCIATES, LLC

DOGM

Regional Location Map

Figure 1



REFERENCE: 1:100,000 SCALE METRIC
30 X 60 MINUTE TOPOGRAPHIC MAP
OF NEPHI, UTAH, USGS, DATED 1981

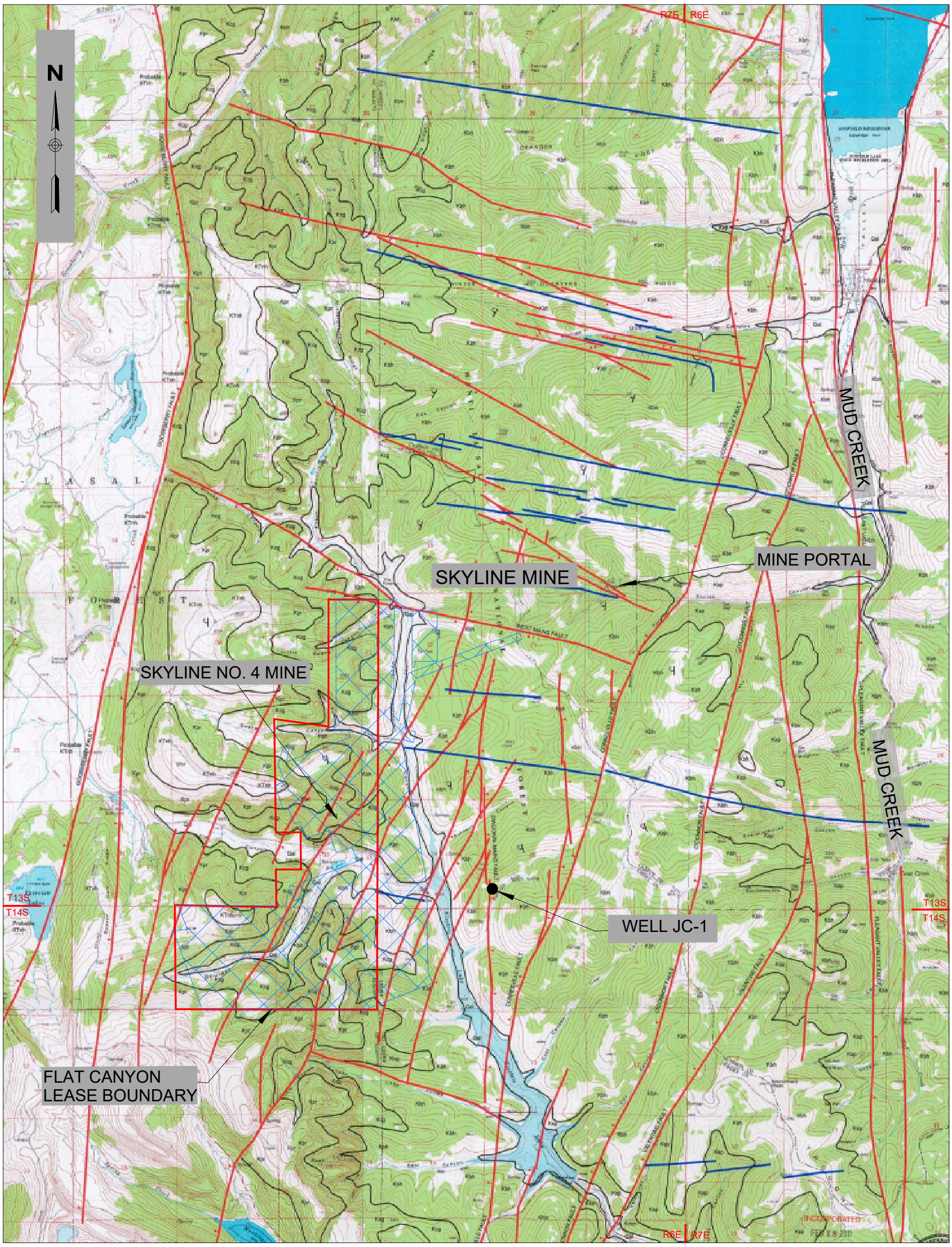
0 1.0 2.0

Approximate Scale in Miles

UTAH DIVISION OF
OIL, GAS AND MINING

LOCATION MAP OF THE
SKYLINE MINE AND THE
FLAT CANYON LEASE

Figure 2



KEY TO GEOLOGIC UNIT SYMBOLS PROVIDED IN TEXT OF REPORT

REFERENCE: SKYLINE MINE PERMIT AREA
CANYON FUEL COMPANY LLC DRAWING 2.2.1-1
REVISION 5, DATED AUGUST 8, 2010

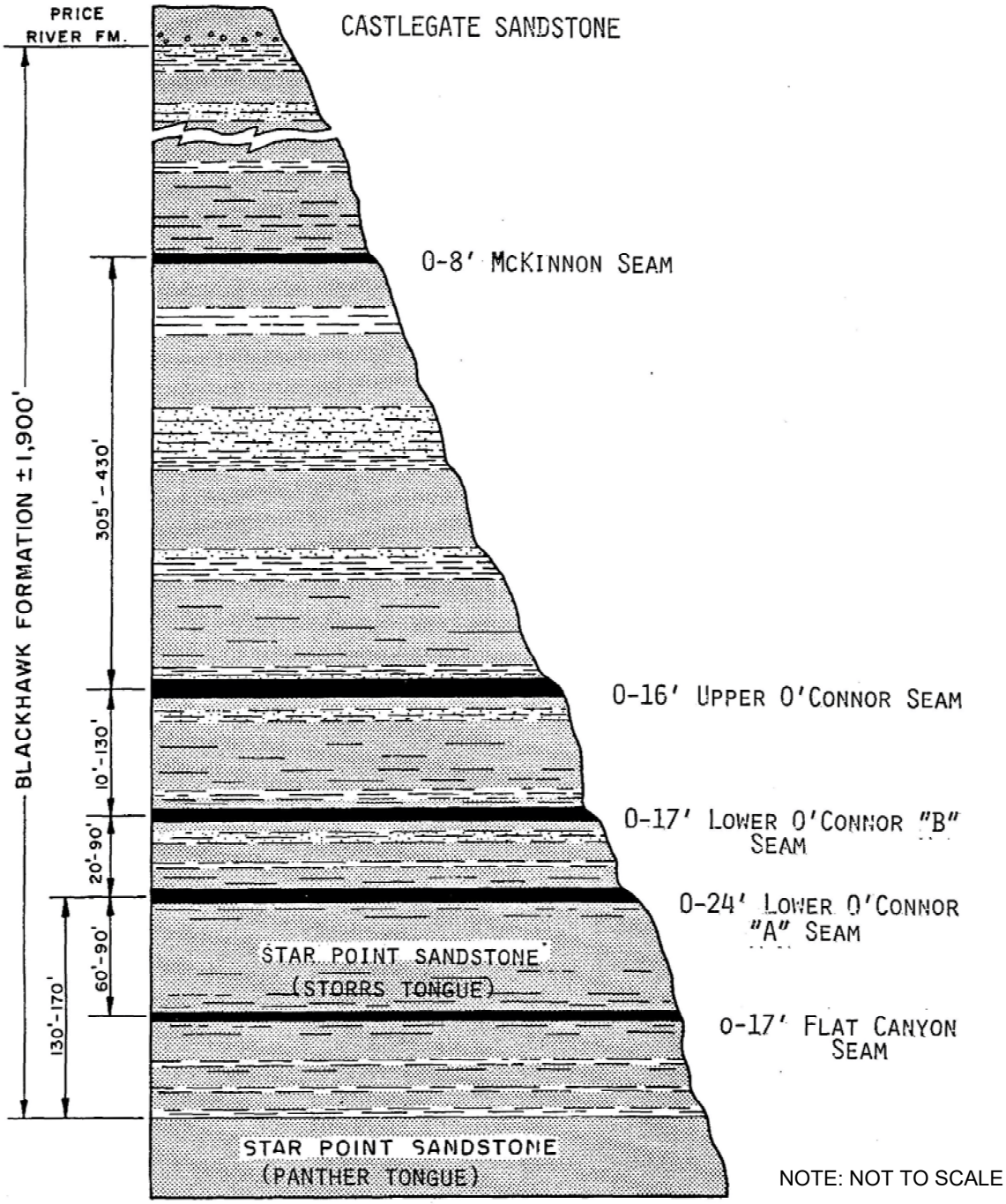
Approximate Scale in Miles

0 0.5 1.0

UTAH DIVISION OF
OIL, GAS AND MINING

GEOLOGIC MAP OF
THE FLAT CANYON LEASE
AND THE SKYLINE MINE AREA

Figure 3



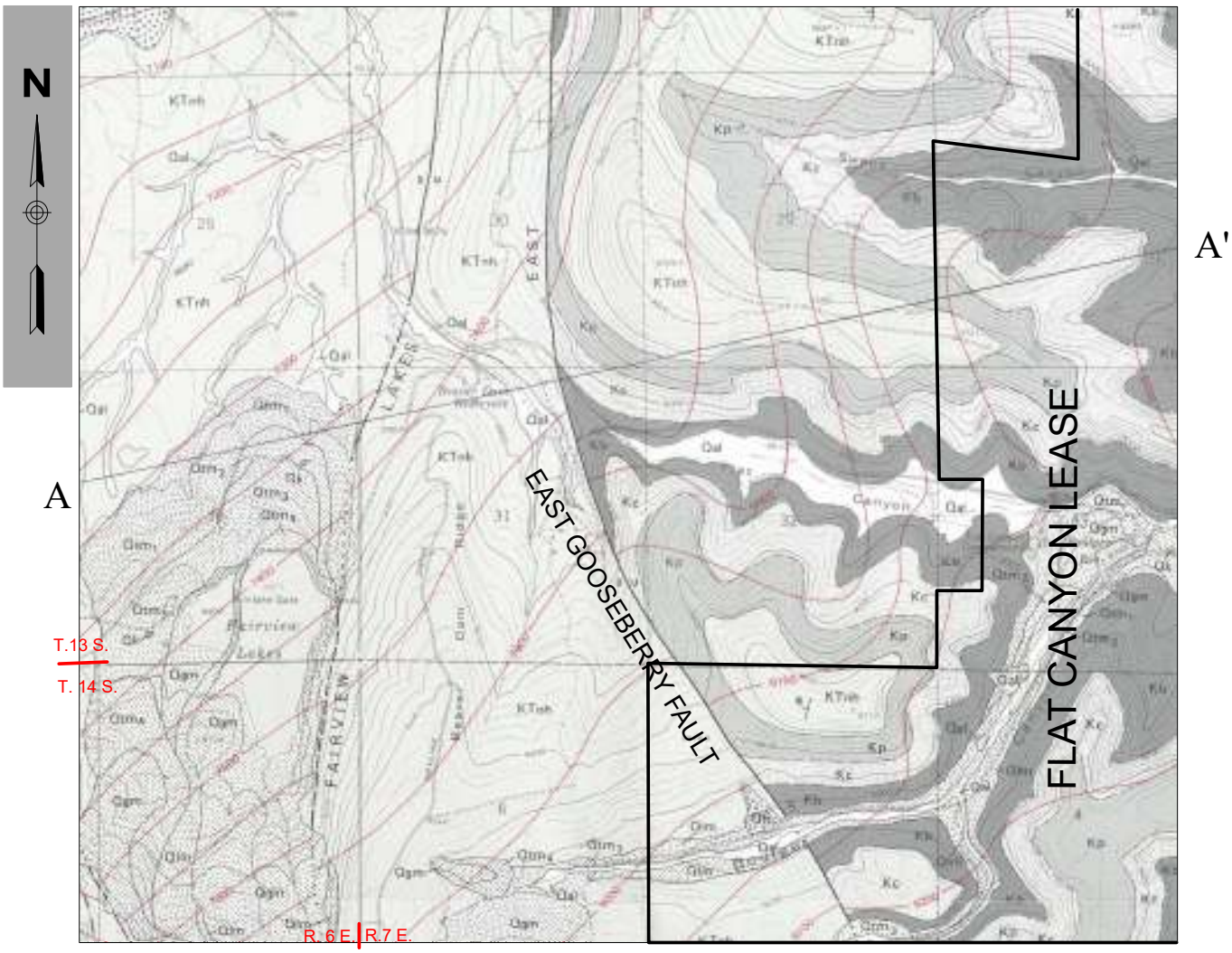
NOTE: NOT TO SCALE

REFERENCE: CFC MINING AND RECLAMATION PLAN
FIGURE 2.2-A AUGUST 26, 2016

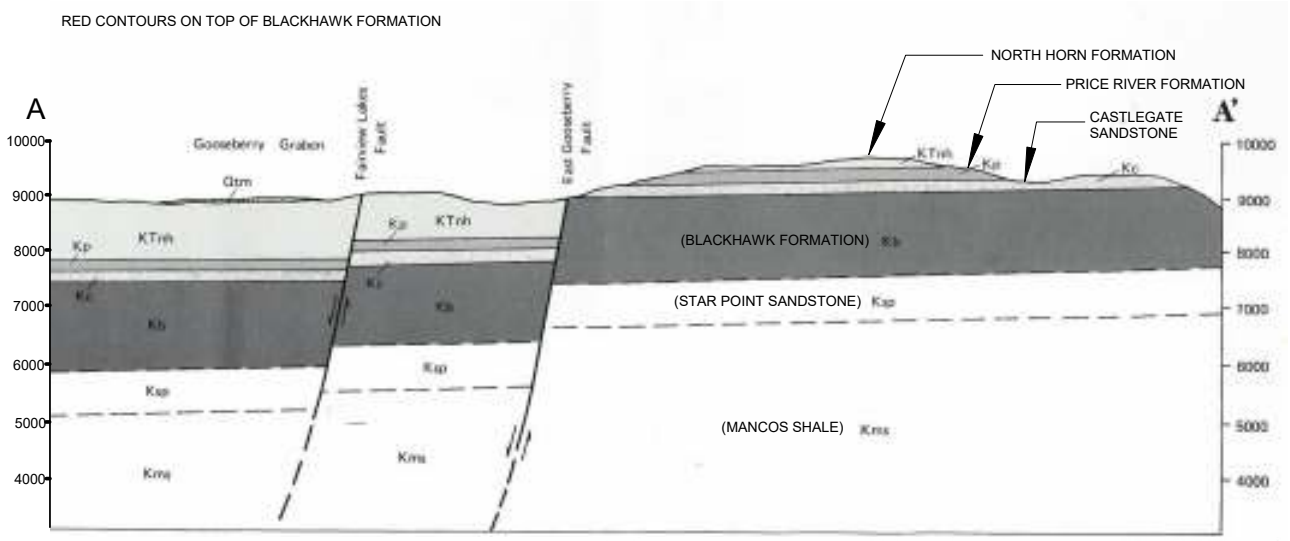
UTAH DIVISION OF
OIL, GAS AND MINING

GENERALIZED STRATIGRAPHIC
SECTION OF GEOLOGY
IN THE FLAT CANYON LEASE AREA

Figure 4



RED CONTOURS ON TOP OF BLACKHAWK FORMATION



REFERENCE:STATE OF UTAH DEPARTMENT OF NATURAL RESOURCES UTAH GEOLOGICAL AND MINERAL SURVEY GEOLOGY OF THE FAIRVIEW LAKES QUADRANGLE: SANPETE COUNTY, UTAH GARY G. OBERHANSLEY, 1980

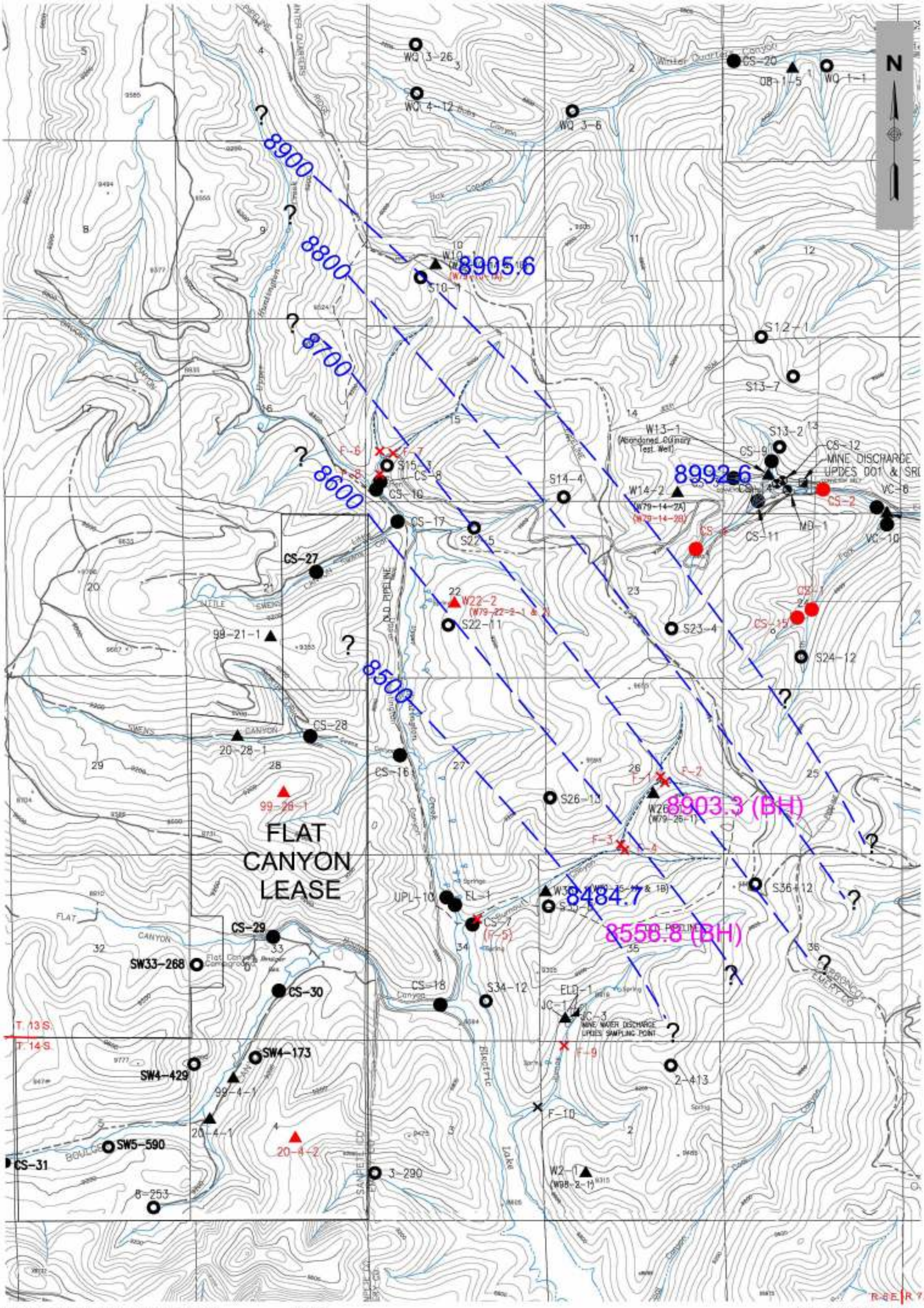
Approximate Scale in Miles

0 0.5 1.0

UTAH DIVISION OF OIL, GAS AND MINING

GEOLOGY AND CROSS SECTION OF THE EAST GOOSEBERRY FAULT

Figure 5



REFERENCE: SKYLINE MINE LOCATION OF HYDROLOGIC MONITORING POINTS - CANYON FUEL COMPANY LLC DRAWING 2.3.6-1 REVISION 17, DATED JUNE 30, 2016

KEY

8500 ?

WATER LEVEL CONTOUR AND ELEVATION ON THE STAR POINT SANDSTONE AQUIFER QUERIED WHERE UNCERTAIN

8407.12 BH - WATER LEVEL ELEVATION IN THE BLACKHAWK FORMATION

Approximate Scale in Miles

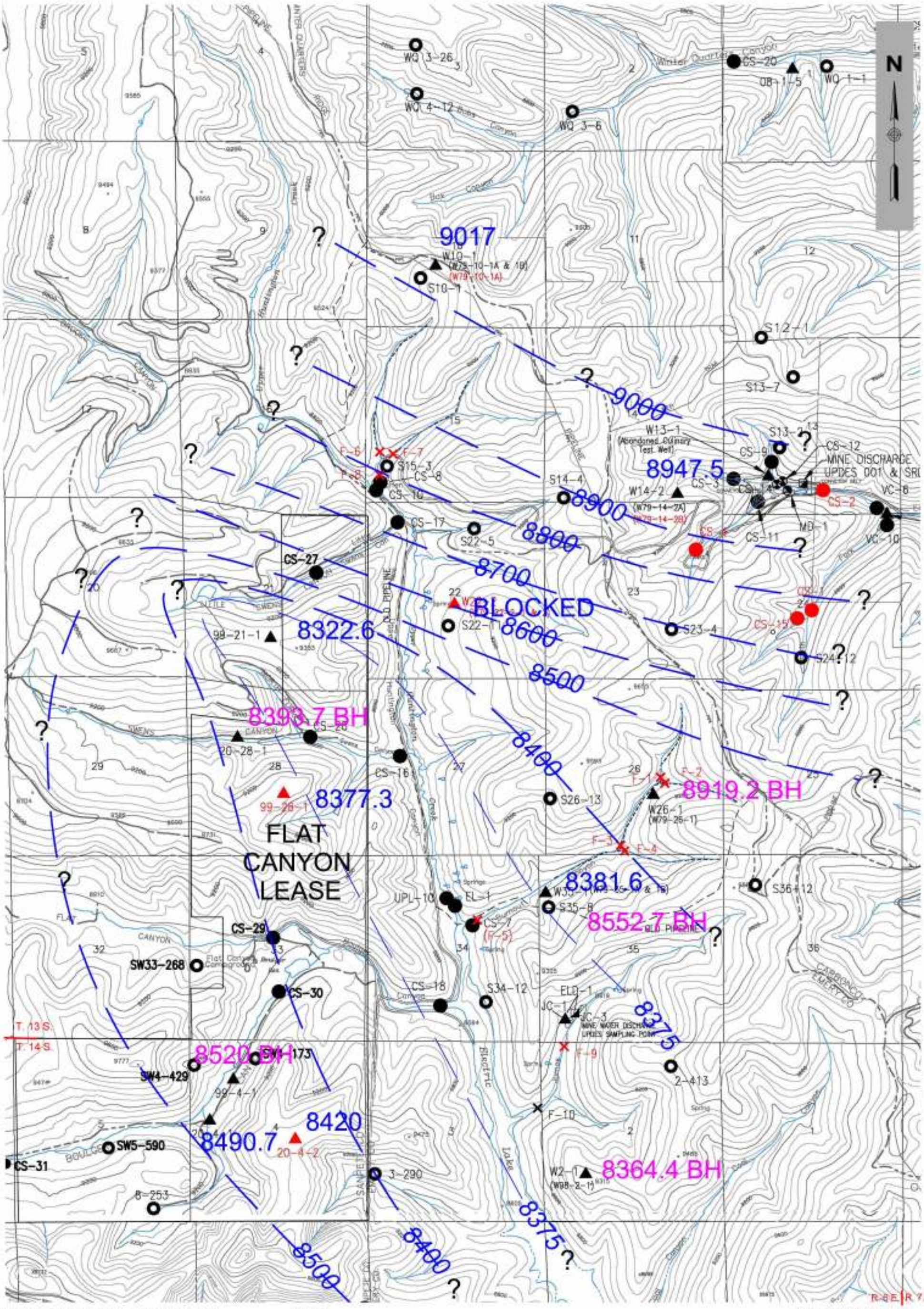
0 0.5 1.0

UTAH DIVISION OF OIL GAS AND MINING

LOUGHLIN WATER ASSOCIATES, LLC

SKYLINE MINE JUNE 1997
WATER LEVEL MAP

Figure 6



REFERENCE: SKYLINE MINE LOCATION OF HYDROLOGIC MONITORING POINTS - CANYON FUEL COMPANY LLC DRAWING 2.3.6-1 REVISION 17, DATED JUNE 30, 2016

KEY

8500 ? WATER LEVEL CONTOUR AND ELEVATION ON THE STAR POINT SANDSTONE AQUIFER QUERIED WHERE UNCERTAIN

8407.12 BH - WATER LEVEL ELEVATION IN THE BLACKHAWK FORMATION

Approximate Scale in Miles

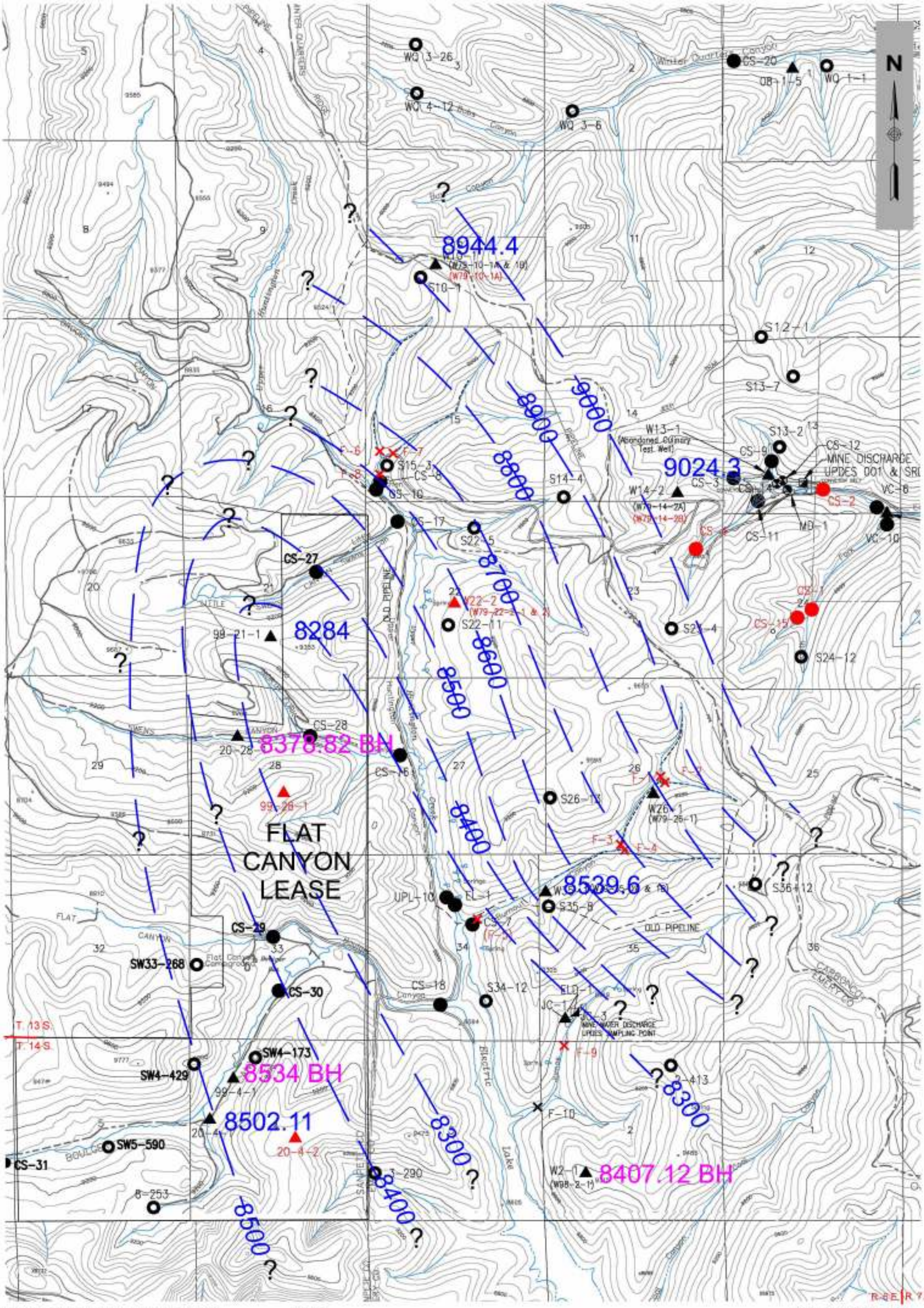
0 0.5 1.0

UTAH DIVISION OF OIL GAS AND MINING

LOUGHLIN WATER ASSOCIATES, LLC

SKYLINE MINE SEPTEMBER 2002 GROUNDWATER LEVEL MAP

Figure 7



REFERENCE: SKYLINE MINE LOCATION OF HYDROLOGIC MONITORING POINTS - CANYON FUEL COMPANY LLC DRAWING 2.3.6-1 REVISION 17, DATED JUNE 30, 2016

KEY

8500 ? WATER LEVEL CONTOUR AND ELEVATION ON THE STAR POINT SANDSTONE AQUIFER QUERIED WHERE UNCERTAIN

8407.12 BH - WATER LEVEL ELEVATION IN THE BLACKHAWK FORMATION

Approximate Scale in Miles

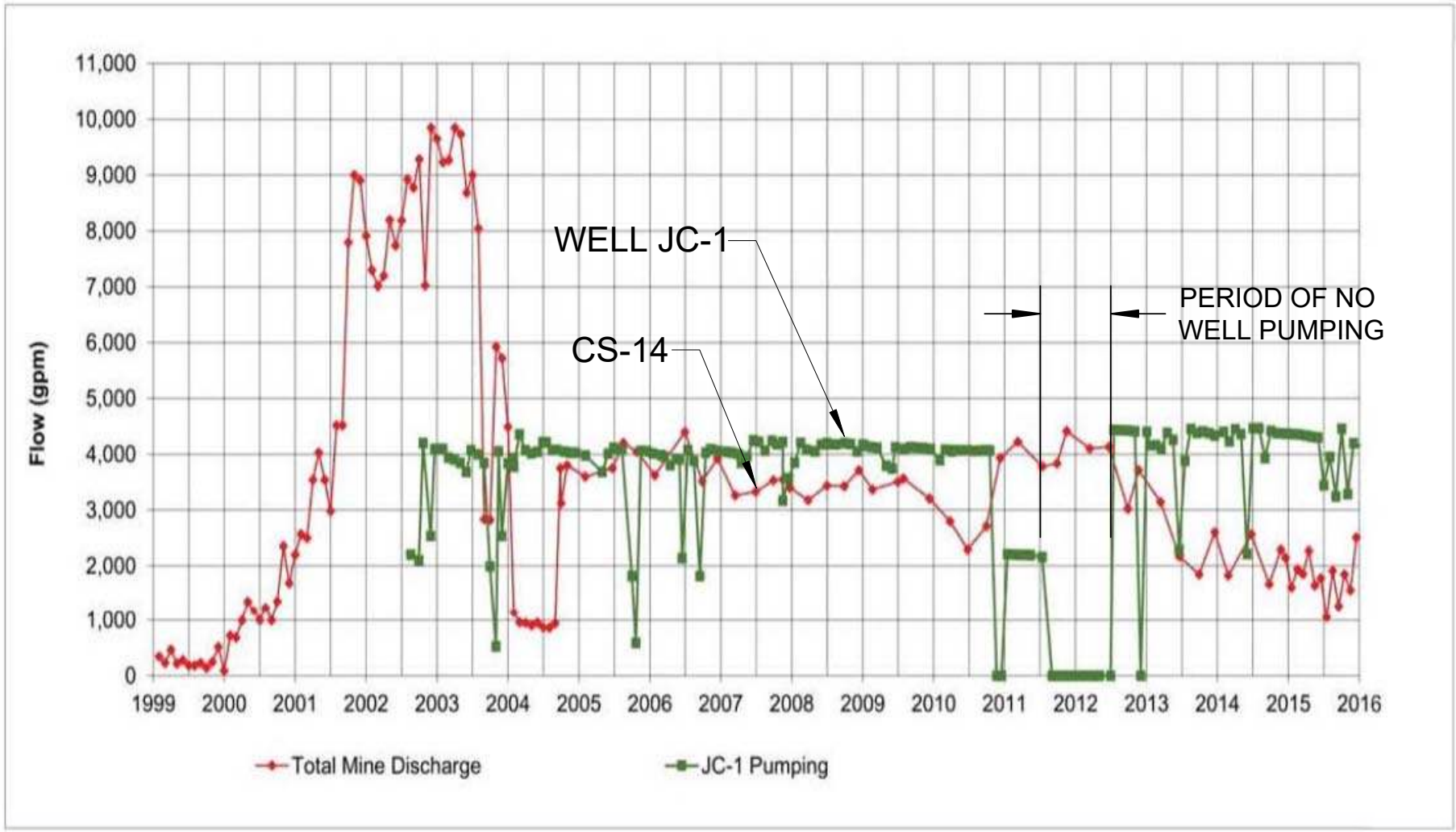
0 0.5 1.0

UTAH DIVISION OF OIL GAS AND MINING

LOUGHLIN WATER ASSOCIATES, LLC

SKYLINE MINE JUNE 2014 GROUNDWATER LEVELS MAP

Figure 8

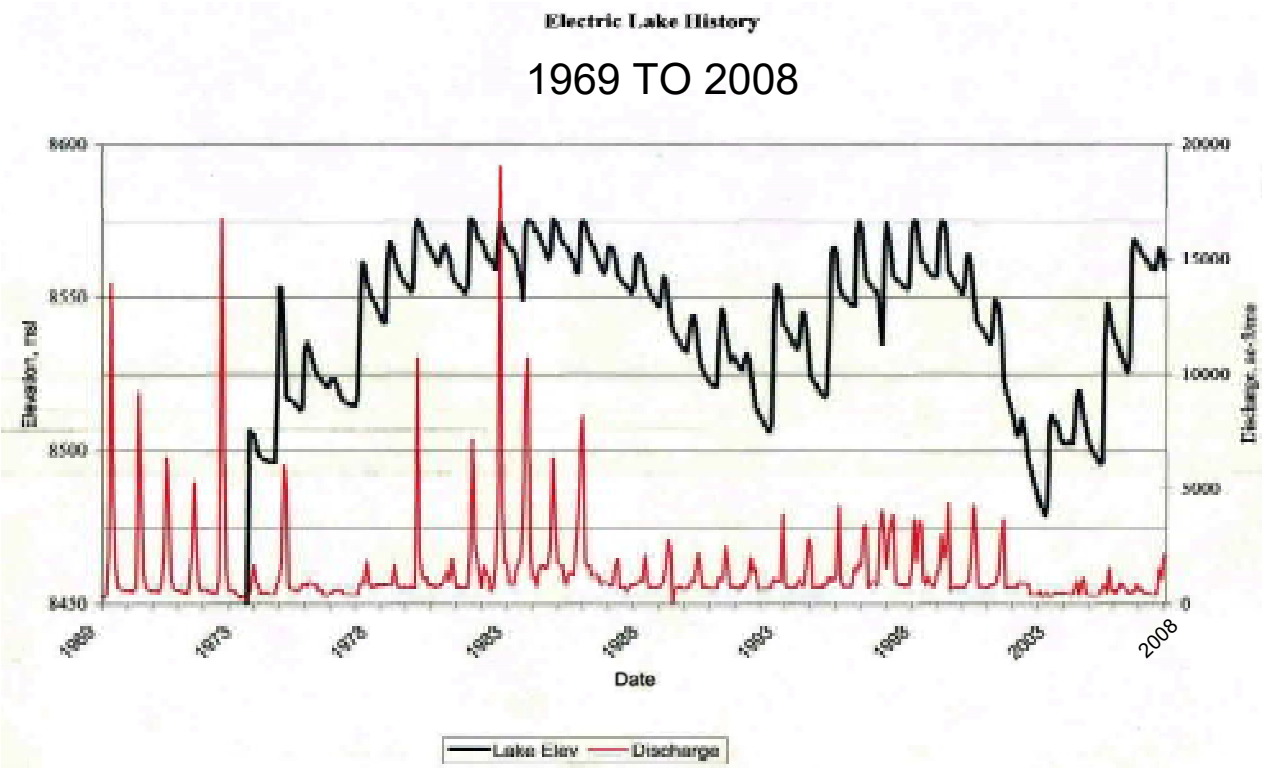


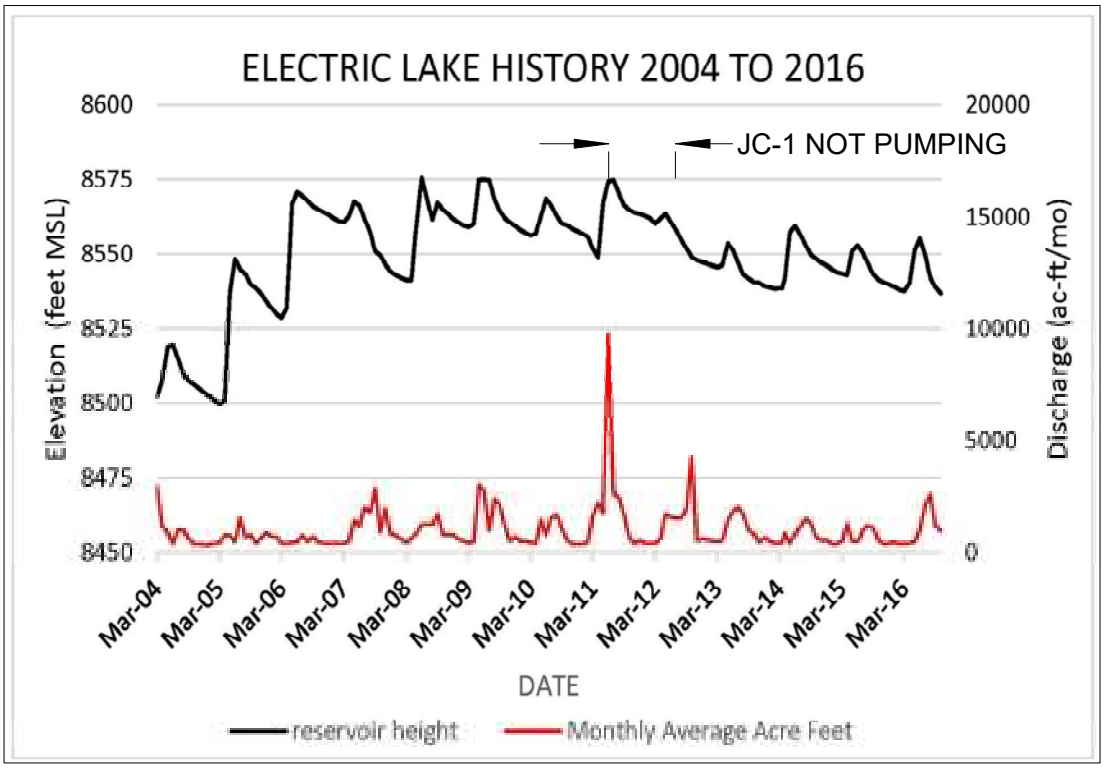
REFERENCE: RESULTS OF GROUNDWATER FLOW MODEL UPDATE FOR SKYLINE MINE, UTAH, FIGURE 3, SRK 2016

UTAH DIVISION OF
OIL, GAS AND MINING

DEWATERING WELL JC-1
AND CS-14 DISCHARGES
THROUGH JUNE 2016

Figure 9





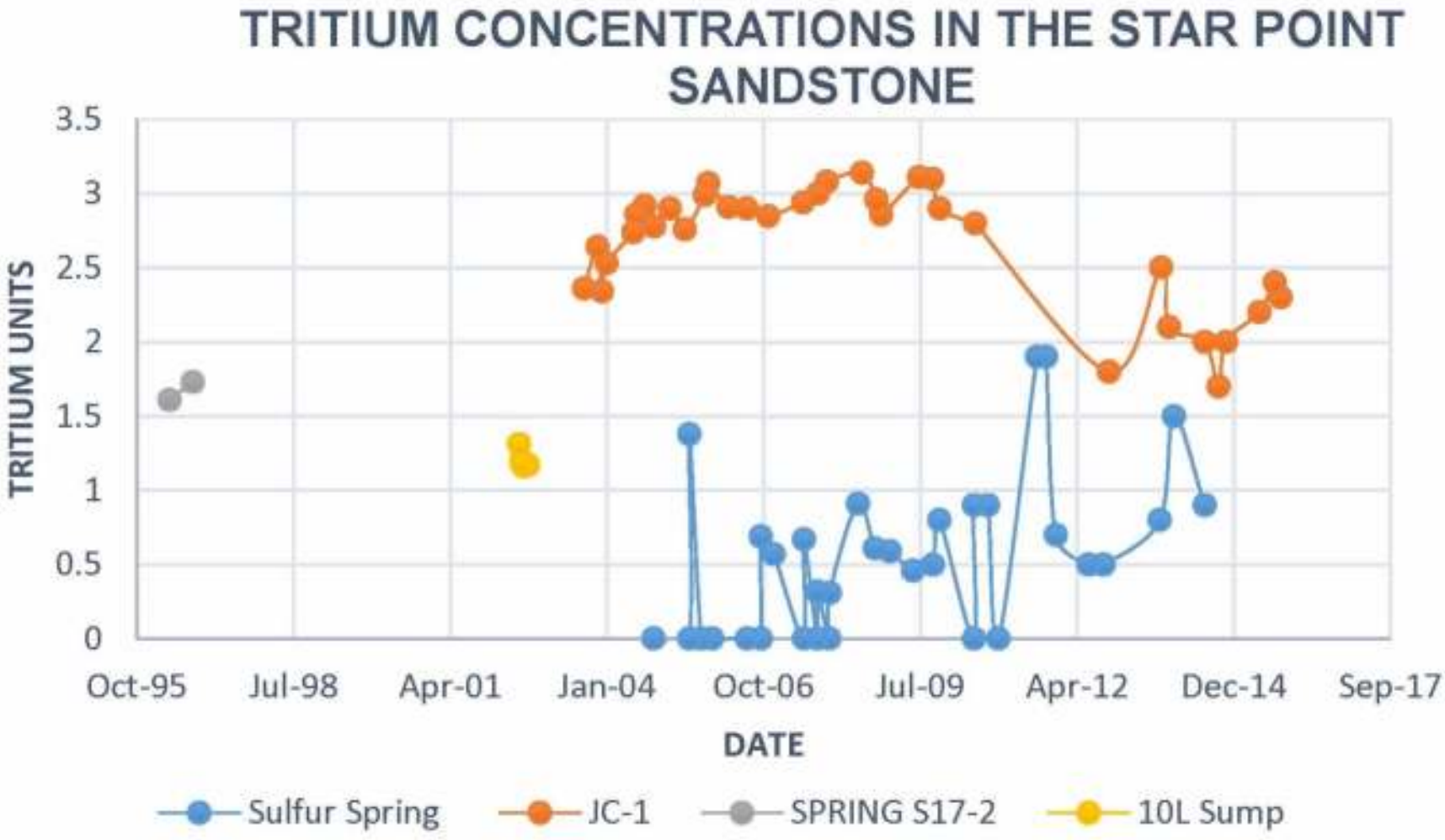
REFERENCE:

DOGM DATABASE, 2016 AND
EMERY COUNTY WATER CONSERVANCY
DATABASE, 2016

UTAH DIVISION OF
OIL, GAS AND MINING

ELECTRIC LAKE
RESERVOIR HEIGHT
AND DISCHARGE FLOWS
1969 TO 2016

Figure 10

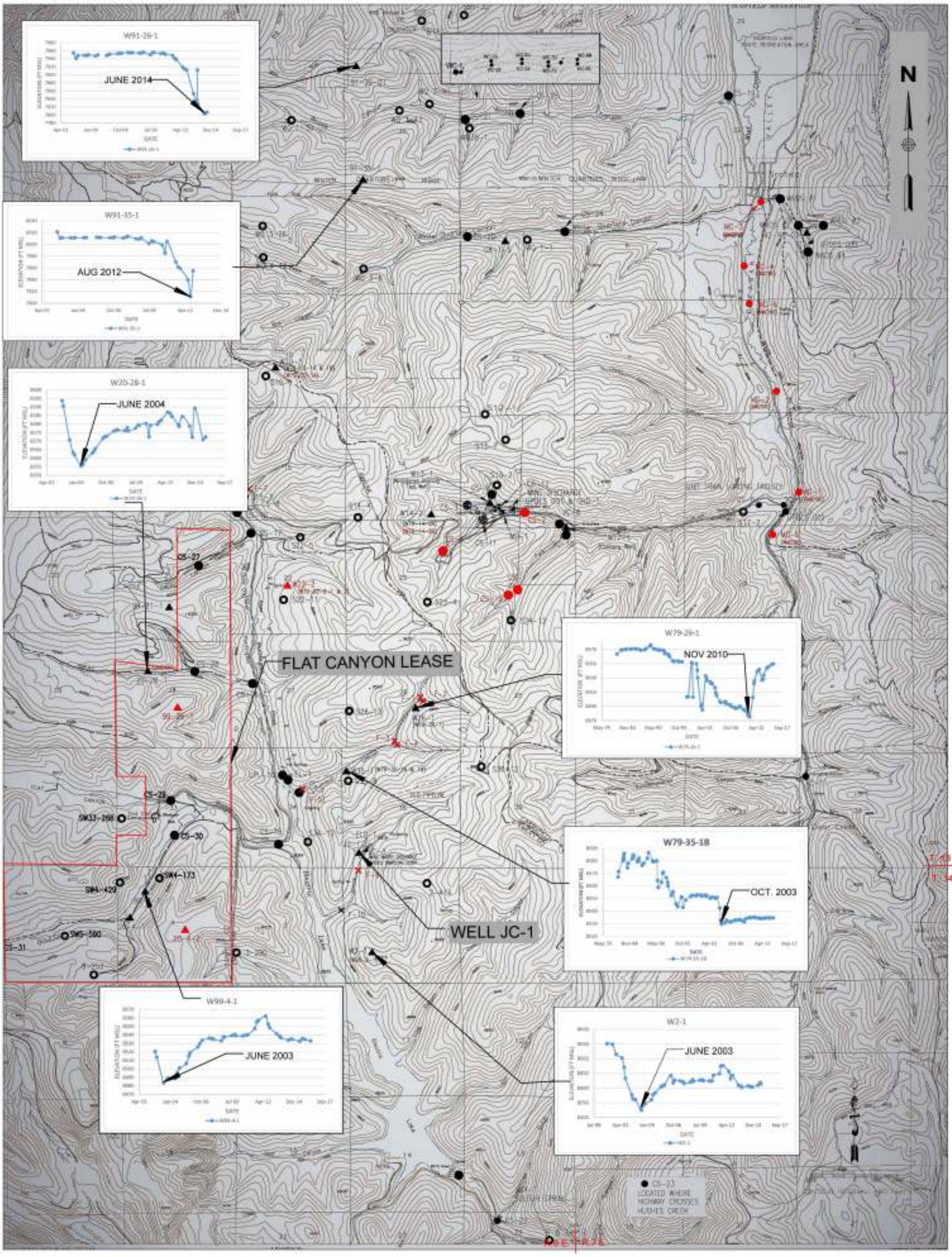


REFERENCE: DOGM DATABASE 2016

UTAH DIVISION OF
OIL, GAS AND MINING

TRITIUM CONCENTRATIONS
IN THE
STAR POINT SANDSTONE

Figure 11



REFERENCE: SKYLINE MINE LOCATION OF HYDROLOGIC MONITORING POINTS - CANYON FUEL COMPANY LLC DRAWING 2.3.6-1 REVISION 17, DATED JUNE 30, 2016

0 0.5 1.0

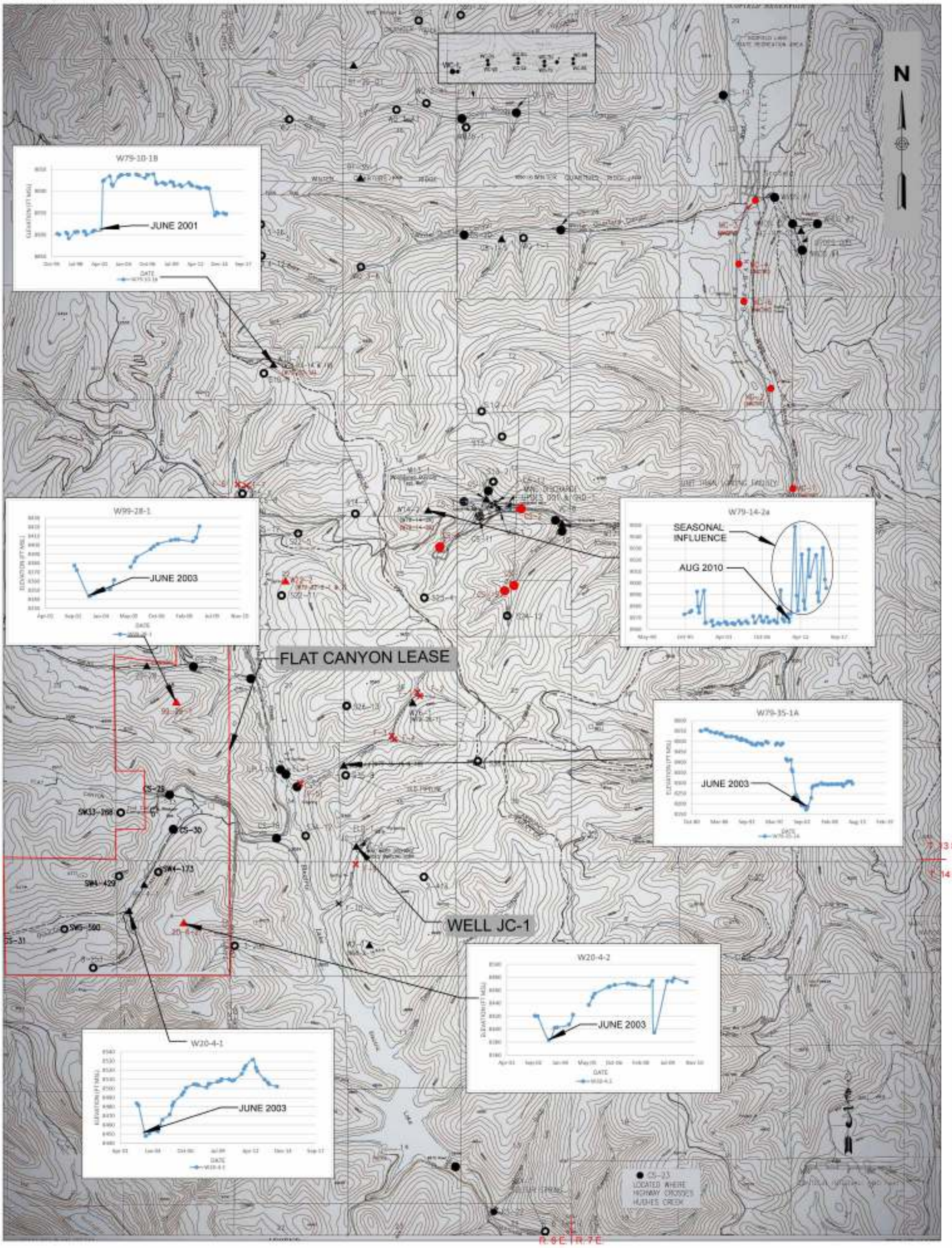
Approximate Scale in Miles

UTAH DIVISION OF OIL, GAS AND MINING

HYDROGRAPHS OF WELLS IN BLACKHAWK FORMATION

Figure 12

LOUGHLIN WATER ASSOCIATES, LLC



REFERENCE: SKYLINE MINE LOCATION OF HYDROLOGIC MONITORING POINTS - CANYON FUEL COMPANY LLC DRAWING 2.3.6-1 REVISION 17, DATED JUNE 30, 2016

0 0.5 1.0

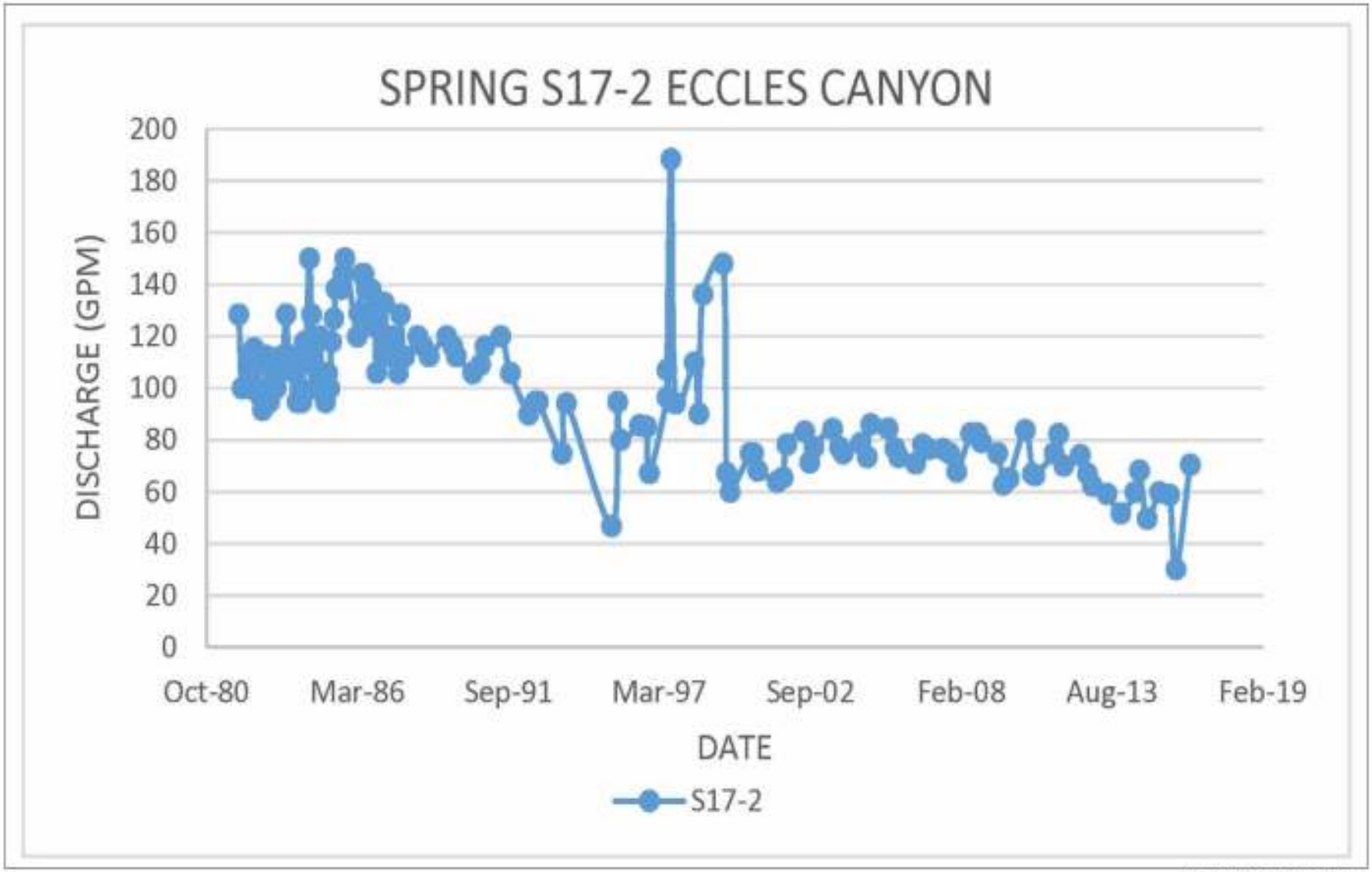
Approximate Scale in Miles

UTAH DIVISION OF OIL, GAS AND MINING

HYDROGRAPHS OF WELLS IN THE STAR POINT SANDSTONE

LOUGHLIN WATER ASSOCIATES ▲ LLC

Figure 13

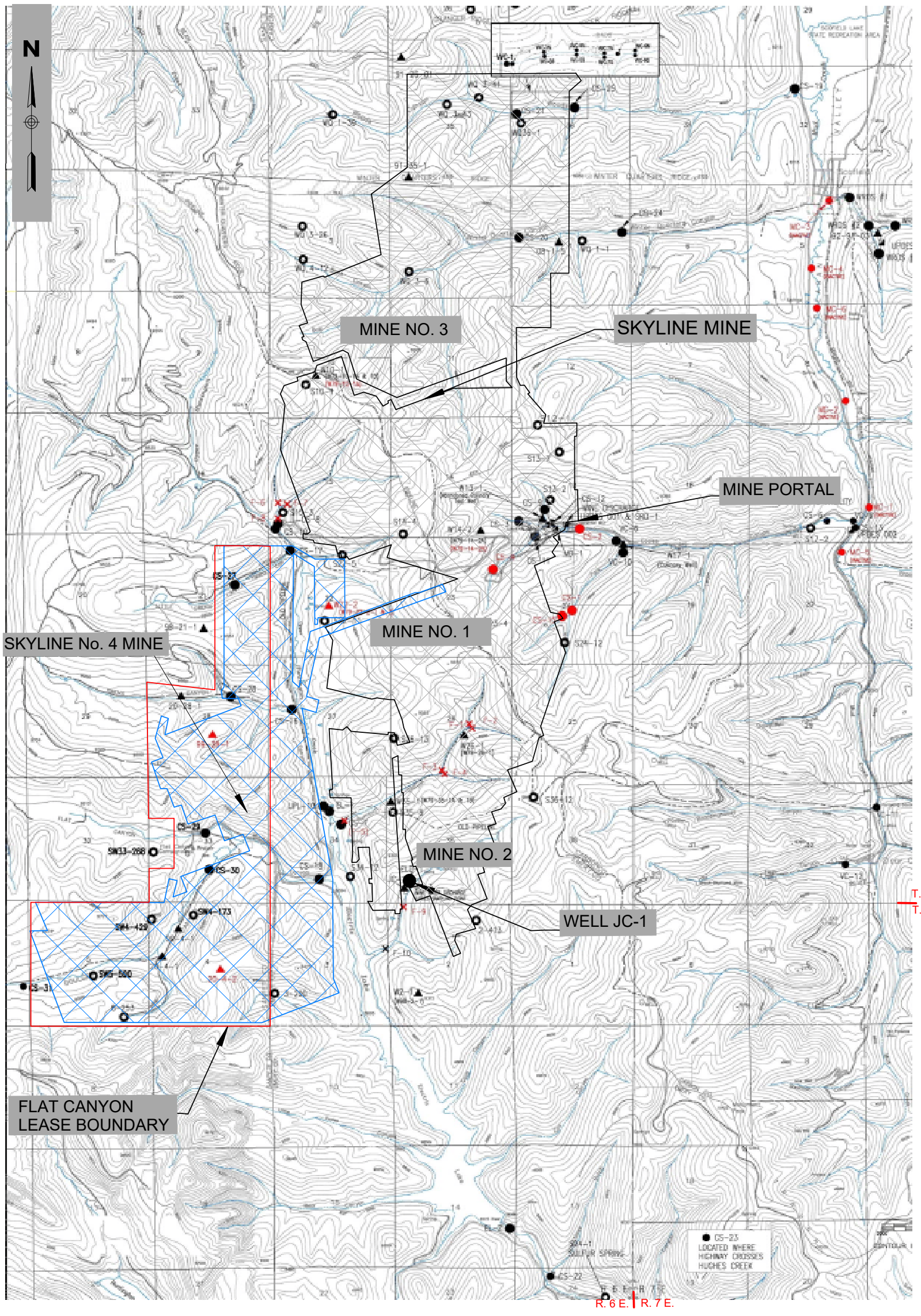


REFERENCE: DOGM DATABASE 2016

UTAH DIVISION OF
OIL, GAS AND MINING

DISCHARGE FROM SPRING
S17-2 STAR POINT SANDSTONE
IN ECCLES CANYON

Figure 14



REFERENCE: CANYON FUEL COMPANY LLC
SKYLINE MINES LOCATION MAP OF HYDROLOGIC
MONITORING STATIONS DRAWING 2.3.6-1
REVISION 17 DATED 6-30-2016

NOTE: MONITORING WELL SW 32-277 IS MISSING FROM THE MAP

KEY

CS-30	STREAM MEASURMENT LOCATION AND MONITORING STATION ID
8-253	STREAM MEASURMENT LOCATION AND MONITORING STATION ID
20-4-2	INACTIVE MONITORING WELL LOCATION AND WELL DESIGNATION
20-4-1	MONITORING WELL LOCATION AND WELL DESIGNATION

Approximate Scale in Miles

0 0.5 1.0

UTAH DIVISION OF
OIL, GAS AND MINING

MONITORING LOCATION MAP
SKYLINE MINE AND THE
FLAT CANYON LEASE

Figure 15