CANYON FUEL COMPANY, LLC

SKYLINE MINES
C/007/005

NORTH LEASE SUBSIDENCE PERMIT MODIFICATION

RESPONSE TO TA LETTER #2246

AUGUST 2005

Mine # C/007/0005
File Incoming
Record # 0085
Doc. Date 8·30·05
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Springs in the Blackhawk Formation are fed from perched water in shallow sandstone lenses underlain with shale well above the regional ground water level.

Useable quantities of water from wells in either the Storrs Sandstone or the lower tongues of the Star Point Sandstone are unlikely unless a fracture zone is encountered. Drawdown and recovery tests, which were conducted at two different depths in an open test well located in the proposed portal area, indicated that the transmissivity of the Blackhawk Formation is approximately 18 gallons per day per foot (Volume A-1, Hydrology). No significant difference in transmissivity exists between the coal zone and the Aberdeen Sandstone. The low transmissivities and discharge rates (approximately 5 gallons per minute) indicate that the Blackhawk Formation is, at best, a poor aquifer.

Potentiometric surfaces are below the ground surface, even in the canyon bottoms, with the deeper holes under the Blackhawk showing a generally higher potentiometric surface than the shallower holes. East of the permit area, where the Star Point Sandstone is exposed, the potentiometric surface intersects the ground surface in the canyons, thereby producing springs along the bottoms of the canyons. Water table

conditions exist primarily in shallow alluvial deposits along larger perennial streams. Potentiometric surfaces, as currently understood, are shown on Plate 2.3.4-2 and

shales of the Blackhawk Formation in the permit area are irregularly bedded and due to their tendency to swell when wet, they should, in most cases, form an effective barrier to vertical movement of ground water.

A sample of the claystone from the Blackhawk Formation was obtained from an in-mine hole and was analyzed and determined to contain 58 percent montmorillonite. Two drill logs were evaluated for the amount of claystone/mudstone present as a demonstration of the swelling capabilities of the formation. Drill hole 74-26-3 (SW/NW, Sec. 26, T13S, R6E) was selected due to is proximity to Burnout Canyon Creek, and Well 91-35-1 (SW/SW, Sec.35, T12S, R6E) being located in the North Lease area between Winter Quarters and Woods Canyons. In drill hole 74-26-3, mudstone was interbedded throughout the entire 1400-foot depth at a rate of 26-feet per every 100-feet of depth, or 26.3 percent. Similarly, Well 91-35-1 averaged 27.2 percent claystone throughout its entire 1500-foot drill depth. Table 2.3.1 illustrates the distribution of claystone/mudstone in the two drill holes. Studies in Burnout Canyon Creek have also demonstrated the self-sealing nature - inhibiting vertical movement of flow through the bedrock in the area. Based on the claystone/mudstone component observed in Well 91-35-1, the same effects are anticipated when undermining portions of Winter Quarters and Woods Canyon creeks.

Table 2.3.1

Depth (ft)	D.H. 74-26-3 (amount of claystone in ft.)	D.H. 91-35-1 (amount of claystone in ft.)
0-100	9	25
100-200	40	18
200-300	19	17.5
300-400	10	11
400-500	20	49
500-600	36	16

600-700	27	14.5
700-800	44	33.5
800-900	47	20.8
900-1000	22	21
1000-1100	27	37
1100-1200	17	29
1200-1300	21	43
1300-1400	29	34.5
1400-1500		39

The youngest geologic unit in the permit area is the Castlegate Sandstone, found only in a small area in the northwestern portion of the permit area. This unit consists of massive medium to coarse grained sandstones with interbedded conglomerates near the base.

Faults within the permit area commonly occur as zones of parallel to in-echelon fault segments with individual slips containing gouge zones ranging from 6 inches to 4 feet wide. Displacements are normally small (less than 20 feet) with the exception of the Connelville fault zone which forms the eastern boundary of the permit area It is suspected that faults have only local hydrologic importance within the Blackhawk formation because of its clay content in the permit area. Water emerged from the Star Point Sandstone along 2 faults encountered in Skyline Mine 3, resulting in some water drainage from the floor but no water dripped from the roof. As mining in Mine 2 progressed down dip and two the west, several north-south trending fractures and faults (with minimal offset) were encountered that produced hundreds of gallons a minute of water from the floor. The location of the major inflows are illustrated on Drawing PHC A-2 in the July 2002 Addendum to the PHC. The flow from these features only slowly diminishes over time. Age dating analysis of the water indicate the flow from these fractures do not have modern water (tritium analysis) and contain water 6,000 to

25,000 years old (carbon 14 dating). Studies by consultants to Skyline Mine suggest the water is stored in the Star Point Sandstone and released through the fractures.

Significant inflows of ground waters were encountered in the 10 Left area of the mine (Drawing PHC A-2). This resulted in Skyline Mine drilling three mine dewatering wells in James Canyon. The first well, JC-1, was pumped at a rate of approximately 2100 gpm from November 2001 to October 2002. At that time, a new pump and motor was placed in the well and produced approximately 4200 gpm. JC-2 well was only capable of producing approximately 300 gpm and was shut in shortly after completion. The details of the two wells are discussed in detail in the July 2002 Addendum to the PHC. A third well, JC-3, was drilled and completed by PacifiCorp in March-April of 2003 to discharge water from the 10 Left area of the mine to Electric Lake. Details of the well are included in Section 3.2.11(a) of this M&RP. JC-3 is anticipated to produce approximately 4,700 gpm of mine water when completed.

In most cases it appears the faults within the Blackhawk Formation in the permit area are not allowing significant vertical movement of ground water. The most logical cause of this apparently low permeability along most of the faults is clay content. However, as discussed in Section 2.2, the north-south trending faults in the Mine 2 area appear to be the result of extensional forces acting upon the formations and resulting in pathways for the water to move upward out of the Star Point and into Mine 2. The formations in Mine 3 and North Lease areas are under compression and the east-west trending faults in the area do not create pathways for the upward migration of ground water. Therefore, as mining proceeds to the North Lease area, it is likely water encountered in the mine will come mainly from the draining of sandstone channels in the mine roof, as was the case in the previously mined portions of Mine 3.

A detailed discussion of the geological characteristics of the project area is presented in the preceding section (Section 2.2).

2.3.2 Characteristics of Seeps and Springs

As a result of field investigations during 1978, 174 seeps and springs were located on and immediately adjacent to the Skyline project area (Volume A-1, Hydrology). This equates to an average of one water source for approximately every 40 acres existing in the area. The quality of the subsurface water was evaluated at select springs and is shown in Appendix Volume A-1. Additional ground water quality data may be found in the tabulations submitted regularly to the Division of Oil, Gas and Mining and in Volume 4. The travel distance between water supplies is short for the wildlife and sheep which utilize the area. Should a frequently-used spring dry up, animals using the water supply should have other options for water in the area.

Seep and spring surveys were conducted in 1991, 1992, and 1993 in the North Lease/Winter Quarters area in preparation of leasing the federal coal underlying the area. The results of the surveys are contained with the Winters Quarters Canyon Data Adequacy documents that were submitted to the BLM and Manti LaSal National Forest. A copy of the document is also present in the Division's Public Information Center (PIC). The location, flows, and water quality data information is included in data adequacy documents. The PHC addendum prepared by Mayo and Associate in 1996 is included in Appendix A-1, Volume 2. It contains detailed information regarding the possible hydrologic consequences to mining in the North Lease area. A brief update to the Mayo document is included in the Appendix following the Mayo PHC.

A seep and spring investigation was conducted in 1997 of the Flat Canyon area and the UP&L tract. Thirty-seven seeps and springs were located on the UP&L tract (Volume A-1, Hydrology). This equates to an average of one water source for approximately every 25 acres existing in the area. Two springs have been selected for baseline monitoring, 2-413 and 3-290 (Plate

23-6-1). These springs have been monitored since October 1997. A summary of the water quality and quantity data is provided in Volume A-1, Hydrology. Spring 2-413 was selected for monitoring because of its proximity to the Connellville Fault, mining activity, and accessibility while 3-290 was selected because it is located in an area where mining will not occur for some time (minimum of 5 to 6 years) and can be used as an 'undisturbed' site for comparison with 2-413.

The operator conducted a survey of springs in the South Fork of Eccles Creek area where mining will take place. This survey, conducted during August of 1988, varies slightly in locations from that found in the consultant's report. The differences are most likely the result of mapping errors. The results of this survey may be found on Figure 2.3.2-1.

Geologic conditions play an important role in the occurrence of springs in the project area. A majority of the springs issue from west-facing slopes, often at a sandstone-shale interface considerably above the adjacent stream bed. Apparently, water which infiltrates into the soil and is not consumptively used percolates down until an impeding shale lens is met. It then follows the shale member downdip until an outlet is reached (either the surface or a discontinuous sandstone member). Thus, deep ground water recharge is apparently slow in the project area due to the presence of large amounts of shale.

Very few seeps and springs in the project area appear to be fault-related, due to the sealing ability of the Blackhawk Formation. Instead, spring water appears to originate in the small surface depressions or basins in the immediate vicinity.

Sustained flows from individual springs tend to be low. Only four of the springs were measured having flows greater than or equal to 10

gallons per minute during the fall, low-flow inventory. Most measurements were two gallons per minute or less. Approximately 30 percent of the sources were seeps. Some of these had dried entirely during previous summers. Flows at a given spring may vary by as much as one order of magnitude during the year, with the higher flows occurring during the snowmelt season. This observation further substantiates the theory that water supplying the springs is generally very local in origin. Water originating from a deeper, more regionalized source would normally provide a more constant flow. It also implies that flows from springs are quite sensitive to the amount of precipitation received during the previous winter.

Drawing 2.3.4-2 also illustrates a potentiometric surface of the water in the Star Point Sandstone in the North Lease area. The potentionmeteric surface is based on data from wells completed in the Star Point Sandstone throughout the permit area. The water levels in wells 91-35-1 and 91-26-1 have not changed significantly since they were drilled and originally appeared not to be reacting to the mine dewatering taking place in Mine #2. The hydrologic disconnect appeared to be the result of the east-west fault that roughly separates the Mine #3 area and North Lease area from the Mine #2 area as discussed in Section 2.2.6. However, the numeric hydrologic model presented in the PHC Appendix J and K suggest the regional gradient is from south to north.

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Surface water stations in Eccles Canyon were sampled more frequently than those on Huntington Creek during the initial phases of mining.

Eccles Canyon stream stations are shown on Table 2.3.7-3 and are analyzed for those constituents identified in Tables 2.3.7-2 and Table 2.3.7-2A with an annual monitoring as per Table 2.3.7-1. South Fork tributary station CS-15 will be monitored for flow only beginning fall 1988. The purpose of this station is to check for subsidence effects from longwall mining.

Sampling will continue at all surface water stations throughout the post-mining period and until the reclamation effort is determined successful by the regulatory authority. Samples will also continue to be analyzed for the parameters outlined in Tables 2.3.7-1, 2.3.7-2, 2.3.7-2A and 2.3.7-3A throughout the post-mining period, unless deletions in the list of parameters is determined to be appropriate.

Several monitoring stations were added to the monitoring schedule with the incorporation of the North Lease Tract. CS-19 and CS-21 have been added to monitor the quantity and quality of the water in Woods Canyon Creek and CS-20 has been added to monitor the quantity and quality of the water in Winter Quarters Creek.

As part of the Skyline Mine subsidence monitoring plan, a total of 42~~40~~ new water monitoring sites have been identified in the North Lease area (Table 2.3.7-2A). Sites NL-1 through NL-~~40~~42 have been selected to monitor flows on the perennial reaches of both Winter Quarters and Woods Canyon drainages one year prior to , during,

and one year following longwall undermining of the perennial section of stream . The sites will be monitored monthly in June through October. If

2.4 SURFACE WATER HYDROLOGY

As previously discussed, the Skyline permit area is located in the headwaters of the Price and San Rafael River Basins. Snowmelt is the primary source of water for the perennial streams in the two basins, with only a small amount of the total flow in the region being derived from rainfall. As a result, flow volumes per unit area are high in the headwaters and low near the mouths of the two basins.

The quality of surface water in the headwaters region is excellent, with total dissolved solids (TDS) concentration normally varying between 100 and 400 milligrams per liter. However, this quality deteriorates rapidly as the streams cross the saline Mancos Shale downstream and receive irrigation return flows from Mancos-derived soils. TDS concentrations in the Price and San Rafael Rivers, near their confluence with the Green River, generally vary between 1,500 and 4,000 milligrams per liter. Sediment yields in the two basins experience similar geographic variations, with the bulk of the sediment yielded at the mouths of the two major rivers coming from those areas which are underlain by the highly erodible Mancos Shale. Data summaries presented in this section are taken from the Skyline water quality monitoring program, Mundorff (1972) and Southeastern Association of Governments (1979). Information presented in this section summarizes and updates the original consultant's reports found in Appendix Volume A-1.

2.4.1 Drainage Basin Characteristics

Portions of five perennial watersheds drain the Skyline project area and include the Eccles Canyon, Green Canyon, Winter Quarters Canyon, Woods Canyon (all tributaries of Mud Creek in the Price River Basin) and Upper Huntington Creek (a tributary of the San Rafael River). Channels draining the permit area form dendritic patterns, with stream channels of

the area flowing in all four major directions. All surface streams have been classified by the Utah Division of Health as follows:

- 1C - protected for domestic use with prior treatment process,
- 2B - protected for secondary contact recreation,
- 3A - protected for cold water aquatic life, and
- 4 - protected for agricultural uses including stock watering.

Electric Lake has been classified as 2B, 3A and 4 while Scofield Reservoir has been classified as 1C, 3A, 4, and 2B.

Slopes on the permit area are steep, averaging approximately 31 percent. Dominant drainage aspects are to the west in the Huntington Creek Basin and to the east in the Price River Basin. The landscape varies greatly, with most of the permit area being covered with conifer and aspen vegetative communities.

Because of the climatological conditions of the area (high precipitation and low evapotranspiration resulting in excess water), there are numerous water sources in the Skyline project area. Most of these are undeveloped springs, seeps and streams. The one notably developed water body located partially in the project area is Electric Lake, a 31,200 acre-foot reservoir whose upstream tip covers a small portion of the southwest corner of the project area in the Huntington Creek Basin. This reservoir is owned and operated by Utah Power and Light Company as a storage facility for water used at coal-fired power plants.

The thick vegetative cover on the project area has resulted in a well-maintained soil of high organic matter content, thus developing a more open soil structure with high infiltration rates. As a result, the potential for runoff from a rainfall event on the project area is low. Thus, snowmelt produces most of the runoff from the area during periods when soils are frozen and/or saturated.

2.4.2 Flow Characteristics

The seasonal distribution of flows in the perennial streams draining the project area is typical of western high elevation, snowmelt streams, where the majority of the flow occurs within a relatively short period of time in late spring and early summer (April, May and June). Flows in Huntington Creek above Electric Lake can be expected to vary from 1 to 100 cubic feet per second while those of Eccles Creek above Mud Creek normally vary between 1 and 50 cubic feet per second and those in Mud Creek vary between 5 and 380 cubic feet per second.

The watersheds draining the project area yield an average of approximately 13.5 inches of water annually to the Price River Basin. However, because the relatively impermeable Blackhawk Formation underlies all of the Huntington Creek Basin above the southern boundary of the project area (either on the surface or directly beneath the surface member), the yield to the San Rafael River Basin is slightly higher (averaging approximately 16 inches per year).

A significant surface water quality sampling program has been conducted in Eccles Creek, Burnout Creek, and Huntington Creek as well as in a representative sampling of seeps and springs in the Skyline permit area. The following briefly describes the major water quality characteristics of the permit area.

Surface water in the Skyline project area is of a calcium bicarbonate type. Total dissolved solids concentrations in the area are generally lowest during the months of April through June when flows are highest and affected by the diluting effect of direct snowmelt. As flows decrease and the majority of the flow is derived from seepage of local groundwater systems, the dilution effect becomes less pronounced and dissolved solids concentrations tend to increase. As a result, the dissolved solids content of surface water in the area varies from less than 100 milligrams

per liter (headwaters of Huntington Creek during the high flow season) to slightly greater than 500 milligrams per liter (Eccles Creek during low flow conditions). Suspended solids concentrations in the area tend to vary proportionately with flow rate. During the snowmelt runoff season, concentrations are also naturally higher in Eccles Canyon than in the Huntington Creek drainage basin. Channel erosion, although relatively low throughout the area, appears to be more extensive in the steeper Eccles Canyon than in the Huntington Creek Basin and is probably the source of most of the increased sediment concentrations. Mud slides, when present, add considerably to the suspended solids concentration. Hydrogen ion activity (pH) tends to be rather constant in the surface waters on and adjacent to the Skyline project area, varying normally between 6.5 and 8.6. The basic condition of the water with low acidity and high alkalinity indicates that acid drainage problems do not develop as a result of mining in the permit area.

Total and dissolved iron measurement values vary widely throughout the area, with the potential source being the iron contained in Blackhawk Formation cementing agents. Total iron, which varied in measurements from less than 0.01 to over 45 milligrams per liter during the observation period, tends to be somewhat directly related to the flow rate, and is associated with sediment loading. In contrast, dissolved iron tends to be much more constant.

Total manganese concentrations in the area were low, varying normally between 0.01 and 2.0 milligrams per liter with occasional higher concentrations associated with sediment loading. No distinct seasonal variations were noted.

The Burnout Creek area was the subject of a subsidence study directed by the U.S.F.S. A portion of the study continues and includes monitoring the flows in the stream biweekly and performing annual stream gradient surveys. Four surface water monitoring points were monitored in this

area and in the adjacent Upper Huntington Creek since 1981 as a part of the surface water monitoring program. Eight flumes, F-1 through F-8 (Plate 2.3.6-1) were installed and are presently being monitored as part of the modified subsidence study. However, only one flume, F-5, is currently part of the quarterly water monitoring program. Flume F-5 is the same sampling point as CS-7 of the quarterly water monitoring program. In general, stream flow rates in this part of the permit area are decreasing. This is likely due to the present drought conditions (Climatology, Volume 4). Water samples from all four monitoring stations are of a calcium-bicarbonate character. Chemical concentrations have remained relatively consistent through time.

Baseline concentrations of various constituents were normally well within the State of Utah standards for waters of the Skyline project area.

A summary documenting the water quality data in the mine area may be found in Volume 4.

Additional baseline data has been collected in the James Canyon drainage as part of the Burnout Canyon study. Flows have been obtained from flume F-9 since 1993 in James Canyon. This information is contained in Volume A-1, Hydrology. Water quality samples have not been collected from this stream since no surface facilities are located in this drainage. Also, water quality samples collected since the early 80's and 90's from streams that have been undermined by the Skyline Mines (Burnout, Eccles, other tributaries of Upper Huntington Creek, Plate 2.3.6-1 and 2.3.6-1a) indicate water quality is not noticeably affected by underground mining activities.

Prior to March 1999, Skyline Mine discharged water to Eccles Creek at an average rate of approximately 350 gpm. From March 1999 through November 2002, the discharge rate gradually increased to between 9,500 and 10,500

gpm. The increase in discharge rate is related to increased ground water inflow to the Mine #2 area of the Skyline Mine. A flow of 10,500 gpm in Eccles Creek due to the increased mine discharge is approximately 42 times the minimum measured base flow (approximately 250 gpm) of Eccles Creek. The increased flow to Mud Creek of the 10,500 gpm of mine water discharge represents an increase of approximately 10.5 times the minimum measured base flow (approximately 1,000 gpm measured in 1981) at the USGS flow gaging station located below the confluence of Mud and Winter Quarters Creeks. The average daily flow of Mud Creek at the USGS gaging station from 1979 to 2001 is approximately 2,700 gpm. The mine discharge rate of 10,500 gpm is about 4 times average daily flow of Mud Creek. The discharge to Eccles Creek diminished after July 2003 when the JC-3 well was completed by PacifiCorp. The JC-3 well was completed in the 10 Left area of the mine and pumps mine water to Electric Lake. The rate of discharge from JC-3 has varied between approximately 1,500 and 5,100 gpm. The rate of discharge to Eccles Creek after July 2003 has subsequently varied between 900 gpm and 6,000 gpm, dependant upon the operation of JC-3 and allowing of portions of the mine to flood. The anticipated changes to mine inflow volumes is discussed in greater detail in the July 2002 Addendum to the PHC, Appendix F and K.

An ongoing study of the effects of the increased flows on Eccles and Mud Creeks was initiated in the winter of 2001. EarthFax Engineering, Inc. was contracted with to establish six monitoring stations on Mud Creek and three on Eccles Creeks. The flow, water chemistry, stream channel morphology, vegetation are monitored at these sites for any significant changes that could be related to the increase in mine water discharge. Initial results of the study indicate that no significant effects have been noted at the monitoring sites due to increased discharges. However, the study will continue until the mine discharge volumes return to pre-

March 1999 levels. Data collected will be included in the mine's annual report.

2.4.3 Sediment Yield

Prior to March 1999, the Skyline project area had a sediment yield which averaged approximately 0.44 acre-feet per square mile per year, based on methods developed by the Pacific Southwest Inter-Agency Committee (1968) (Volume A-1, Hydrology, page 49). This converts to a total annual yield of 1.25 acre-feet of sediment to the Price River Basin and 3.07 acre-feet of sediment to the San Rafael River Basin. The majority of this sediment is yielded as suspended sediment, with only a small fraction occurring as bedload. After March of 1999, the sediment yield to the Price River basin through Mud Creek increased by approximately 7%. This increase in load was determined by the Division using the results of TSS monitoring at Valley Camp sites VC-1 and VC-9 on Mud Creeks and Skyline site CS-6 on Eccles Creek. The Division calculated an average sediment yield for Eccles and Mud Creeks at 2,710 tons/year prior to March 1999 and 2,908 tons/year since March 1999 through June of 2002. The sediment yield will be monitored for Eccles and Mud Creeks and reported each year in the mine's annulal report.

The suspended load in the stream flow of Eccles and Mud Creeks is being monitored as a result of the increased mine discharge. In addition to the stations already monitored on Eccles Creek as part of the existing monitoring program, six new sites have been added. These sites are MC-1, MC-2, MC-3, MC-4, MC-5 and MC-6. As discussed in the previous section, the sites are monitored for TSS. The first sampling of these sites occurred in June 2002 and the results reported to the Division. No significant increase to the TSS levels above background were noted during

the initial sampling. (Site MC-5 is located on Mud Creek above the confluence with Eccles Creek and assumed to represent background).

2.4.4 Monitoring Program

The surface water monitoring program outlined in this section has been updated based on the findings and conclusions of the 1996 PHC by Mayo and Associates and as a result of a cooperative effort between the operator, the Division, and the Forest in an effort to better understand and monitor the effect of increased ground water inflows to the mine and mine discharge. It incorporates practices designed to provide the baseline data necessary to validate the determination of the probable hydrologic consequences of proposed and existing mining and reclamation operations. The program also is designed to meet site specific requirements and have the flexibility for change if necessary. Specific attention has been given to insure that proper upstream and downstream monitoring is included within the monitoring program for all disturbed areas, and that adequate sampling of potentially impacted flow regimes is completed. Selection of the monitoring sites was an arduous process using 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 compiled for the North Lease area 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.

A PHC study completed in 1996 entitled "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" by Mayo and Associates, recommended some changes to the original monitoring plan. These changes were made by Mayo and Associates after a careful review of local hydrogeology, monitoring conditions, sampling parameters, and sampling data. The changes proposed by Mayo and Associates are considered valid and reasonable and are therefore incorporated herein. An evaluation of UPDES and waste rock disposal site monitoring stations were not included within the scope of work completed by Mayo, but continue to be an integral part of the water monitoring program.

A copy of the 1996 PHC evaluation is included within Appendix A-1 Volume 2 of this MRP. An update to the PHC, "Addendum to the PHC, July 2002" has also been included in this M&RP. Since the modifications to the PHC have taken place over time and conditions within the mine have changed, it should be assumed that where the most recent text conflicts with text in earlier modifications or original text, the latest supercedes the earlier.

Surface water monitoring programs are conducted at each of the appropriate stations identified in Tables 2.3.7-1, 2.3.7-2, 2.3.7-2A and 2.3.7-3 and shown on Drawings 2.3.6-1 and 2.3.6-2. Except where noted, samples are obtained at the monitoring sites three times a year. The monitoring periods are defined by the seasons. Samples are collected during the high flow season, April through June and the low flow season in August through September. Late fall samples are obtained in October through November. These time periods were selected because the sites are usually inaccessible until late June and after November due to snow depth and frozen water courses. Several sites on Eccles Creek are monitored in December through February since they are adjacent to a maintained road and the water discharged from the mine normally keeps the stream from freezing over.

Surface water stations in Eccles Canyon were sampled more frequently than those on Huntington Creek during the initial phases of mining.

Eccles Canyon stream stations are shown on Table 2.3.7-3 and are analyzed for those constituents identified in Tables 2.3.7-2 and Table 2.3.7-2A with an annual monitoring as per Table 2.3.7-1. South Fork tributary station CS-15 will be monitored for flow only beginning fall 1988. The purpose of this station is to check for subsidence effects from longwall mining.

Sampling will continue at all surface water stations throughout the post-mining period and until the reclamation effort is determined successful by the regulatory authority. Samples will also continue to be analyzed for the parameters outlined in Tables 2.3.7-1, 2.3.7-2, 2.3.7-2A and 2.3.7-3A throughout the post-mining period, unless deletions in the list of parameters is determined to be appropriate.

Several monitoring stations were added to the monitoring schedule with the incorporation of the North Lease Tract. CS-19 and CS-21 have been added to monitor the quantity and quality of the water in Woods Canyon Creek and CS-20 has been added to monitor the quantity and quality of the water in Winter Quarters Creek.

As part of the Skyline Mine subsidence monitoring plan, a total of 42 new water monitoring sites have been identified in the North Lease area (Table 2.3.7-2A). Sites NL-1 through NL-42 have been selected to monitor flows on the perennial reaches of both Winter Quarters and Woods Canyon drainages one year prior to , during,

and one year following longwall undermining of the perennial section of stream . The sites will be monitored monthly in June through October. If

accessible earlier than June or later than October, the mine will monitor the sites. The results of the monitoring will be reported with the other required monitoring data. The purpose of this monitoring is to determine the effects, if any, on the stretches of perennial streams in the Winter Quarters Creek and Woods Canyon Creek drainage that will be subsided due to mining. Monitoring points, in perennial reaches running perpendicular to the longwall panels, are positioned above the gate-roads and center of each panel. Longwall panels are approximately 850-feet wide, creating a flow-monitoring spacing of approximately 425-feet. Monitoring points in perennial reaches running parallel to the longwall panels are spaced at approximately 850-feet. Since monitoring is dependent on the timing of mining, monitoring points will be added and dropped as mining advances. As mining advances through the perennial sections of the drainage, and the monitoring indicates no affects to flow, the Permittee may modify the spacing of the monitoring points. This monitoring will also help indicate if mitigation is required for loss of surface or ground water and, subsequently, habitat associated with the water.

Skyline has conducted field studies to determine the location of the perennial portions of both Winter Quarters and Woods Canyon Creeks, though no mining is currently planned within the next five years in the Woods Canyon drainage. The perennial nature of the streams were determined using a variety of parameters including vegetation and surface flow monitoring. Field studies were initiated and completed in October and November 2002 and October 2003. Copies of the studies are included in Volume A-1 Hydrology Section. The studies will be used by the Forest in their environmental assessment of the potential effects of undermining Winter Quarters and Wood Canyon Creeks.

Sampling will continue according to Tables 2.3.7-1, 2.3.7-2, 2.3.7-2A, and 2.3.7-3 as approved at all surface water stations throughout the post-mining period and until the reclamation effort is determined

successful by the regulatory authority. Changes will be made to the monitoring program only when additions or deletions to the list of parameters and/or schedule is determined to be appropriate, and when approved by the regulatory agency.

In addition to the above outlined monitoring program, UPDES discharge permits have been acquired as necessary. Monitoring and operation of all surface water discharges are conducted in accordance with conditions of this permit. Discharges of water from disturbed areas will be in compliance with all Utah and federal water quality laws and regulations and with effluent limitations for coal mining contained in 40 CFR part 434. A copy of this permit (UPDES No UT-0023540) is appended to Volume A-1, Hydrology Section. The monitoring locations are shown on Map 2.3.6-1.

As required, water quality data collected from the surface water monitoring stations will be submitted to the Utah Division of Oil, Gas, and Mining. Such reports will normally be submitted within 90 days of the completion of each quarterly monitoring program.

The Permittee conducted a search for seeps or springs in the downslope area west of the rock disposal site in the spring of 1984 and found no seeps or springs. Should surface flow occur, surface water monitoring will be carried out, though the exceedingly ephemeral nature of the water flows in the area will necessarily affect the frequency of sampling. The Permittee commits to the following surface water monitoring program when surface flow is present.

1. Four monitoring stations will be established: two stations on the drainage from the east and two sites on the drainage from the south.

Stations will be located both above and below the rock waste disposal site in each of the drainages. (See Drawing 2.3.6-1.)

2. When flow is present, these stations will be monitored, when accessible, at the same frequency and for the same constituents as the stations in Eccles Creek. The data will be tabulated and reported in the same manner as the Skyline water quality data.

3. The data from these stations will be evaluated for non-point source contribution from ground water aquifers. This procedure offers the best potential for detection of ground water contamination.

The Upper O'Connor seam required a breakout to improve ventilation. The breakout is on a south facing slope in a side canyon of the South Fork of Eccles Creek (see map no. 3.2.11-1). A new road was built across this canyon to gain access to the breakout area. The canyon flows water in all but the driest of years. During construction, the creek was sampled above and below the site on a daily basis. The samples were tested for total suspended solids and settleable solids as an aid in regulating construction activities and in implementing control measures. Construction related solids fluctuations were encountered throughout this phase of the project.

The volume of water discharged from the mine increased significantly in August 2002 after large volumes of ground water were encountered within the mine. The mine was concerned about what effects the increased flows might have on Eccles and Mud Creeks. EarthFax Engineering, Inc. was contracted to perform a stream bank stability analysis on the streams using flows ranging between 5,000 and 30,000 gpm. The initial results of the report indicated that the stream banks would be stable at flows up to 30,000 gpm. Further study was requested by the Division and EarthFax was again contracted to continue the study of the effects on Mud and Eccles Creeks of sustained increased discharges from the Skyline Mine. The

study will continue as long as the mine is discharging flows in excess of the pre-September 2001 rates plus one year. The study consists of the following:

Reference sites have been established on Eccles and Mud Creeks corresponding to cross sections used in previous investigations (EarthFax Engineering, 2002). The reference sites were established in general conformance to the recommendations of Harrelson et al. (1994). This involved the following:

- Establishing benchmarks at each site. Benchmarks will consist of cement or boulder monuments, with a metal marker stamped with the site number.
- Establishing monumented cross sections. The endpoints of cross sections will be marked with roof bolts or steel reinforcing bar that has been driven into the ground. These bars will be painted to increase visibility.
- Surveying the channel at each site. Surveying will be performed using a level and survey rod, with both the cross section and longitudinal profile of the stream being surveyed.
- Establishing photo points. As recommended by Harrelson et al. (1994), convenient locations will be selected to take photographs upstream, downstream, and across the channel at each cross section location.
- Collecting streamflow data. The flow will be measured at each site, using standard procedures, with a rotating-cup flow meter. Indicators of bankfull stage will also be gathered.

Samples of the bed and bank materials were collected at the newly established stations to evaluate geomorphic and stability relationships at those locations. Similar samples were collected in February 2002 at the remaining sites (EarthFax Engineering, 2002) and are still considered valid.

The depth to groundwater was determined at each of the reference sites. In areas where the flood plain is narrow (along all of Eccles Creek and the upper portion of Mud Creek), this was accomplished with one temporary piezometer installed in the alluvium adjacent to the stream. The piezometer was installed using portable flighted augers and a hammer drill. Perforated PVC pipe was installed in the hole and the water table allowed to stabilize for a period of at least 4 hours prior to measuring the depth to water. The relative elevation of the piezometer was established by standard surveying techniques from the previously-established benchmark at each site.

Flow data on file with the U.S. Geological Survey was gathered for Eccles Creek near Scofield, Utah (station 09310600) and for Mud Creek below Winter Quarters Canyon at Scofield, Utah (station 09310700).The data were provided to the Division in electronic form.

Historic aerial photographs were gathered of Pleasant Valley between the town of Scofield and the confluence of Mud Creek and Eccles Creeks. Both private sources (on file with aerial photography companies) and government sources (USDA, USGS, EROS) were searched. These photographs were evaluated to assess historic land use in this reach of Pleasant Valley. This information, together with the additional data collected as part of this study, were used to evaluate whether or not Pleasant Valley could be classified as an Alluvial Valley Floor. The Division used this study along with the EarthFax Eccles and Mud Creek study and made a determination that portions of Pleasant Valley could be considered alluvial valley floor but the increased discharge from the mine would not have a significant impact on the valley sediments or vegetation.

Water-quality samples are collected at the monitoring points. In addition to the collection of flow data as indicated in Section 2.1, these samples are analyzed for total dissolved solids (TDS), total suspended solids (TSS), and total phosphorus.

As field information is gathered, sufficient data will be gathered to determine the bank erodibility hazard (Rosgen, 1996; 2001) for each reference site. These data will include measurements of the following values:

- Bank height
- Bankfull depth
- Rotting depth
- Root density
- Bank slope
- Degree of surface protection of the bank

The in-stream velocity gradient (between the core of maximum velocity and the stream bank) and the ratio of average hydraulic stress and near-bank hydraulic stress will also be calculated. Each of these indexes will be compared with typical values provided by Rosgen (1996; 2001) to provide another assessment of bank stability in addition to that provided previously (EarthFax Engineering, 2002).

Flow and water-quality data (TDS, TSS, total phosphorus) are collected at the monitoring points on a seasonal basis and will continue to be until one year following a sustained reduction in mine-water discharge to a rate of 5,000 gpm or less (i.e., pre-September 2001 levels). Channel cross sections and longitudinal profiles will be collected from each reference site annually during the same period.

LITERATURE CITED

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Pacific Southwest Inter-Agency Committee. 1968. Factors Affecting Sediment Yield in the Pacific Southwest Area. Water Management Subcommittee. Sedimentation Task Force.

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2.5 HYDROLOGICAL IMPACTS OF MINING ACTIVITIES

Presented in the following subsections are summaries of the hydrological impacts of the mining activities of the Skyline project. The details backing the conclusions stated in this section and supplemental discussion can be found in the PHC evaluations included as part of this section, and within the Hydrology Section of Appendix Volume A-1 Volumes 1 and 2. Details of the consultant's flow calculations may be found in the flood plan calculations also in Appendix Volume A-1. The PHC was also updated in July 2002 October 2002, April 2003, and June 2004 by the addition of the Addendum to the PHC associated with the drilling of the wells in James Canyon, the significant inflows to Mine #2, and the ground water model prepared by HCI.

The potential hydrologic impacts discussed herein represent the latest information available and, generally, correspond to the consultant's original report. (See General Hydrologic Consideration Related to Coal Development and Subsequent Impacts, Vaughn Hansen Associates, February 1981, found in Appendix Volume A-1. Updated analyses of the "Probable Hydrologic Consequences" reflecting all current data are appended to this section.

- **Exhibit A of Section 2.5**, "Probable Hydrologic Consequences of Mining at the Skyline Mines, Carbon and Emery Counties, Utah"; prepared by Earthfax Engineering, Inc., Salt Lake City, Utah; dated September 30, 1992.
- **Addendum to the Probable Hydrologic Consequences, July 2002 (James Canyon Update - further updated in October 2002, April 2003, and June 2004).**
- **Appendix A-1, Volume 2** (September 2002), "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".

2.5.1 Potentially Affected Water Rights

Surface and groundwater rights in the general project area are primarily for stockwatering and irrigation. Stockwatering rights are located almost entirely and directly on the streams. The

nearest irrigation rights are centered around the two areas of Scofield and in Flat Canyon, southwest of the permit area. Irrigated lands consist primarily of pasture. Only stockwatering rights are present in the Skyline permit area. A limited number of wells are located in the general area, none of which are located directly on the property or within the permit area. Recent large mine inflows to Mine #2 has resulted in concern voiced by local government and private interests that water entering the mine is coming from nearby Electric Lake. However, data collected and analyzed by Skyline Mine for the purpose of determining the source of the inflows strongly indicates there is no significant connection between the surface waters and the mine waters. As discussed in the July 2002 Addendum to the PHC (modified in October 2002, April 2003, and June 2004), the Star Point does not transmit water easily. Fractures within the Star Point in the mine area has allowed the sandstone to begin dewatering by discharging to the mine. The Star Point does not appear to have a significant discharge point located immediately down gradient of the mine. Indeed, the age of the water in the sandstone suggests it takes several thousand years to move through the aquifer in spite of the high transmissivity of the fractures within the sandstone. Therefore, it is unlikely any surface or ground water rights are being adversely affected. Because it is not certain that the ground water discharges into the Huntington Creek drainage, there is no evidence that water is being removed from that drainage to Eccles Creek, part of the Price River drainage. Tritium analysis of the water in the 10 Left area of Mine #2 and water from the James Canyon well JC-1 indicates a minor amount of modern water is being pumped from the well and the mine. However, this water is not necessarily originating from Electric Lake. Therefore, there does not appear to be a significant volume of surface water being transferred between drainage basins.

2.5.2 Mining Impact on Water Quantity

Due to the high shale content of the Blackhawk Formation, recharge to the deep ground water system through the Blackhawk Formation is slow. Fractures in the formation seal readily due to swelling of the bentonitic shale when wet. As a result, the impact of mining (including subsidence) on the quantity of water in the permit area will be minimal. This has been verified through the results of the subsidence study in Burnout Canyon. (A discussion of the mining impacts on the aquatic resources may be found in Section 2.8.) The Burnout Canyon study resulted in the determination that no significant impacts had occurred to the stream drainage as a result of mining induced subsidence. While the gradient of the stream was flattened in a few locations and slightly increased in others, the overall change in the stream morphology was not significantly different than changes that occur in

similar stream systems naturally. Biweekly flow monitoring and aerial photographic surveys continue each year as mining continues in the area. Additionally, three years of macroinvertabrate studies and two years of fish population surveys have been conducted starting in 2000. These studies are described in greater detail in Section 2.8.1.

The purpose of the Burnout Canyon study was to determine the impacts of undermining perennial streams in the Skyline Mine area. The intent of the study was to determine if significant impacts would occur by undermining the Burnout stream and, if no significant impacts occurred, then the Forest would consider allowing the undermining of perennial streams with similar geologic and geomorphic conditions to occur. Skyline Mine intends to undermine Winter Quarters Canyon based on the positive results of the Burnout Canyon study. Skyline has collected or committed to collect additional baseline data necessary to adequately monitor environmental parameters possibly affected by subsiding Winter Quarters Canyon.

When subsidence occurs, the subsidence cracks tend to seal rapidly, preventing the deep percolation and subsequent loss of water previously destined for springs and other water sources. The location of a spring may change by a few feet, but no significant loss of water is anticipated. The sealing of potential cracks will be accelerated where subsidence occurs under stream bodies, due to the natural deposition of silt in the stream channel along with the swelling of the shale.

Although the Blackhawk Formation contains partially or completely saturated sandstone channels above the proposed mine workings, a relatively small quantity of water is being encountered in the mine due to the impermeable nature of the formation, which limits the recharge rate and the ability of the rock to readily yield water. Ground water within the Blackhawk formation above the mine workings was determined in the 1996 PHC to be found within highly localized perched aquifers. The 1996 PHC evaluation failed to locate a regional ground water aquifer within the immediate area. The relatively small quantity of water being encountered in the mine was believed due to 1) the general impermeable nature of the formation, which limits the recharge rate and the ability of the rock to readily yield water, and 2) the local nature of local perched aquifer systems.

The inflow to the mine had been less than 100 gallons per minute per active face, with mine entries generally dry approximately 100 to 200 feet up-dip from the face. Some roof bolt holes, however, continued to flow up to 2 GPM for an extended period of time. However, in 2002 a fractured

channelized sandstone was encountered during mining of the southwestern permit area which produced approximately 1,400 gpm. This was repeated at several locations in areas of Mine #2 until the mine was discharging approximately 8,500 to 9,500 gpm in August 2002 and 9,000 to 10,500 gpm in October 2002. Even though the large inflows have significantly subsided since October 2002, the near future mining activities have been directed toward the North Lease area.

The PHC for the Skyline Mine was updated by an Addendum to the PHC dated July 2002 and further updated in October 2002, April 2003, and June 2004. The addendum contains significant information regarding the large inflows to the mine. To better understand the hydrologic system and the water within the Star Point Sandstone, Skyline Mine contracted with Hydrologic Consultants, Inc. of Lakewood, Colorado produce a ground water model of the Star Point Sandstone. This model endeavored to delineate the possible areal extent of the aquifer, the volume of water contained in the aquifer, and the potential sources and discharge locations of the aquifer. The model has been used to help determine what, if any, impacts are occurring to the waters available in the mine area, including State appropriated water rights. The model was completed and improved in June 2004 and a copy of the report describing the results of the modeling effort has been added to the PHC.

As described in the July 2002 Addendum to the PHC, draining of the ground water contained within the Star Point Sandstone does not appear to have a significant impact on discharges of ground water in the mine or adjacent area nor does it appear that the water entering the mine is causing a loss of surface water in the Huntington or Price River drainages. The majority of the flows into the mine enter through faults and fractures that trend generally north-south to northeast-southwest. The flows move up through the floor of the mine in almost all cases. The water is apparently stored in the Star Point Sandstone under significant potentiometric head. Ages of the water indicate that water moves very slowly through the Star Point system in spite of the fractures and faults that appear to be open enough to allow water to flow freely into the mine in isolated locations. This suggests that the aquifer does not have a discharge point that releases large volumes of water nor is the aquifer replenished at a high rate of inflow. While the

Star Point is exposed in out crop north, south, and east of the mine, significant volumes of water would need to be entering the system at an elevation great enough to create the potentiometric head encountered in the Star Point beneath the Mine #2 workings. Skyline continues to monitor stream flows in Winter Quarters, Eccles, and Mud Creeks to identify any impacts if they occur in these drainages related to the mine inflows.

No springs or water production wells in the mine permit or adjacent areas have reportedly been negatively impacted by the large mine inflows. There has been some concern voiced by local government and private interests that water entering the mine is coming from nearby Electric Lake. However, data collected and analyzed by Skyline Mine for the purpose of determining the source of the inflows strongly indicates there is no significant connection between the surface waters and the mine waters. As stated previously, this is discussed at length within the July 2002 Addendum to the PHC.

Water encountered in the mine is either utilized underground as processed water or is pumped from the mine. Procedures for handling of mine water are discussed in detail in Section 3.2. Indigenous water associated with the coal will be removed from the area. This, however, will represent only a small fraction compared to the water flowing from the Wasatch Plateau. The water pumped from the mine is added to the flow of Eccles Creek and into Electric Lake and has a positive effect on the aquatic flow systems.

The construction of surface facilities utilized in conjunction with the Skyline Mines (yard areas, roads, conveyor lines, etc.) resulted in temporary increases in the suspended sediment concentration of the adjacent stream. However, because of the regulatory requirement that sediment control measures be provided for all areas of surface disturbance, concentrations of suspended material were significantly reduced. Minimization efforts, however, met with varying degrees of success.

Over long periods of time, groundwater in the Wasatch Plateau can be expected to flow towards the lowlands if not removed, passing through saline shales and emerging to augment streamflow with a dissolved solids content that significantly exceeds the concentrations found in the headwaters area. Because the Skyline Mines will act as interceptor drains, the groundwater that is brought to the surface from the mines has a much lower dissolved solids content than would have existed if the water was to continue its downward movement through shaley layers. Thus, the mines will have some beneficial impact on the chemical quality of water in the region.

The increased stream flow resulting from mine discharges, particularly during the summer low flow period, appears to benefit the Eccles Creek fishery by creating flow and temperature stabilization. The increased flows to Scofield Reservoir most likely benefitted the fish population in the lake by maintaining a sufficient level of dissolved oxygen to avoid a general fish kill that frequently occurs in the lake during periods of drought periods, such as has been occurring in the mine area since 2000. The mine has also been discharging large volumes of water since August 2002 with TDS concentrations only slightly higher than background levels. This good quality water flows to and is

stored in Scofield Reservoir. The water stored in Scofield Reservoir is used for culinary and irrigation purposes in Helper, Price, and Wellington, Utah. The State Engineers office in Price, Utah indicated that without the additional discharge from Skyline Mine to the Price River drainage, the reservoir would have been at a dead pool level in late August of 2002, thus cutting short the irrigation season downstream.

Similarly, discharges to Electric Lake will be an overall benefit to the water users on Huntington Creek. The discharge of high quality water from mine dewatering wells JC-1 and JC-3 will increase the volume of water in Electric Lake, provide additional cooling water for the Huntington Power Plant, and provide additional irrigation water for agricultural uses in Emery County. Without the additional discharge of water to Electric Lake from the James Canyon wells, it is possible that in the summer and fall of 2003, the Huntington Power Plant would need to significantly scale back the production of electrical power due to insufficient cooling water. A reduction in power generation from the plant would have significant economic impacts on Carbon and Emery Counties from the loss of jobs and an increase in power rates for consumers of power generated by PacifiCorp.

The completion and operation of JC-3 will not result in an overall increase of mine water discharge from the Skyline Mine. Operation of the well will decrease the amount of mine water discharged to Eccles Creek and result in additional water discharged to Electric Lake.

The large volume of ground water inflow to the mine has resulted in the mine discharging significantly greater volume of water than were initially anticipated when the mine was planned and opened. The current mine UPDES permit was written when flows were expected to be less than 1000 gpm and limits on total dissolved solids (TDS) were created based on this volume of flow. A 7.1 ton/ day limit of TDS was assigned to the mine with a maximum TDS concentration of 1310 mg/l TDS. It was not unusual for the mine, prior to March 1999, to discharge water with 1000 mg/l TDS. However, after the large inflows into the mine were encountered in March 1999, the volume of water discharged increased steadily and the concentration of TDS decreased. Also at that time, the mine began to have trouble passing the chronic Ceriodaphnia dubia toxicity test required by the UPDES permit. It was determined through extensive testing that the toxicity test was failed due to a slight increase in the nickel concentration in the water. The toxic limit of dissolved nickel concentration appeared to be 15 ug/l or greater and the water discharged from the mine in late 1999 until the end of 2001 contained a maximum of 42 ug/l dissolved nickel. These concentrations of dissolved nickel are well below drinking water standards. The significant inflow to the mine from the 10 Left area and changes of how water was handled underground resulted in a decline in TDS and dissolved nickel over time. As a result,

the mine has been able to pass its chronic water testing.The Utah Division of Water Qualityrecently modified the mine's UPDES discharge permit to include a limit of 500 mg/l TDSand no total ton per day limit or the mine would discharge less than 7.1 tons per day of TDS if the water had a TDS concentration greater than 500 mg/l.

A UPDES permit was obtained by PacifiCorp to operate the JC-3 mine dewatering well in James Canyon. This well will discharge high quality mine water to Electric Lake. However, since it is mine water, Skyline will be obligated under SMCRA to assure the quality of the water discharged is within the UPDES permit limits assigned to JC-3. Skyline will submit the required DMRs to the Division as required in Section 2.3.7.

Periodically, due to difficult recovery conditions or roof collapse, mining equipment is abandoned underground. Prior to leaving equipment underground, hazardous materials and lubricating fluids are drained when possible. Since the equipment is steel and not too different compositionally from the roof support throughout the mine, contamination to ground water from abandoned equipment is not anticipated. A map illustrating the location of equipment left underground is provided as Drawing 2.3.6-3. The drawing includes a description of each piece of equipment.

Because of the high alkalinity and low acidity concentrations in the area (differing normally by two orders of magnitude), acid drainage problems do not occur as a result of mining. This is supported by the fact that coal in the area has a low sulphur content.

Skyline Mine anticipates potentially discharging approximately 2,800 gpm of mine water to Eccles Creek after the completion of mining and subsequent abandonment of the 11 Left, 12 Left A and B, and 6 Left B panels in 2004. However, this rate may vary with changes in the operation of JC-3 and because of the steady decline in potentiometric head within the aquifer discharging into Mine #2. Assumptions used in developing the discharge amount can be found in July 2002 Addendum to the PHC in Appendix F.

The water consumed in operating underground equipment, dust suppression, and evaporation is obtained from ground water sources within the mine. These underground water sources are not connected to the surface waters in the area. Extensive research has been performed by the mine to verify that water currently entering the mine is not coming from the surface or depleting surface waters. The recent July 2002 Addendum to the PHC presents data supporting this statement. The

data suggests the water intercepted underground is at least 4,000 to 25,000 years old and, based on the results of tritium analyses from most of the mine waters, does not typically contain water that has been exposed to the atmosphere in the past 50 years. Additionally, the steady rate of decline in ground water levels in monitoring wells within the permit area and the results of age-dating the ground water inflows to the mine indicating the water is not getting appreciably younger, suggests that the aquifer is not receiving significant recharge of "young" surface waters.. Continued monitoring by the mine of the surface waters and seeps and springs flows in the permit and adjacent areas have shown no discernable impacts due to the increased mine inflows that were encountered in March 1999 and have continued through November 2002. It is the operator's position that the water consumed in operating Skyline Mine is not depleting surface water sources. In fact, there is an overall net gain to local river systems discharging to the Colorado River as a result of Skyline Mine discharge.

The following information is supplied as required by the Windy Gap process as it applies to existing coal mines in the Upper Colorado River basin:

Mine Consumption: (culinary well - Water Right 91-5010) =41.69 ac-ft (2004 consumption)

Ventilation Consumption / Evaporation:

(assumes 70 deg. F, 60 total days annually, 20% humidity air intake, 95% humidity air out-take; air density difference of 0.001 lbs/ft)

(353,312 cu-ft/min) (.001)(0.1198) = 42 gal/min.

= 11.21 ac-ft annually

Coal Producing Consumption / Coal Moisture Loss:

- 6.1% Inherent moisture
- 8.54 % run-of-mine moisture
- 2.44% moisture added to coal by cutting (8.54-6.1)

Projected 2005 Tonnage 237, 500 tons

Projected 5 yr Average 1,898,672 tons

Tons water/year = (1,898,672)(0.0244)= 46,328 tons water/year

Lbs water/year = 92,656,000

Gallons/year = 92,565,000 (0.1198)=11,100,189 gallons/year

=34.06 ac-ft annually

Sediment Pond Evaporation:

Evaporation estimate calculation uses evaporation data from Pacificorp evaporation pan located at Electric Lake spillway. Data was from 1998 through 2003.

Pond 001 (Mine Site) - 0.39 acre (surface area)

- 0.15 ac-ft/month (ET)
- 345,715 (gallons/year)
- 1.06 ac-ft/yr

Pond 002 (Rail Loadout) - 0.44 acre (surface area)
- 0.15 ac-ft/month (ET)
- 390,037 gallons/year
- 1.20 ac-ft/yr

Pond 003 (Refuse Pile) - 0.27 acre (surface area)
- 0.15 ac-ft/month (ET)
- 239,341 gallons/year
- 0.73 ac-ft/yr

Total Annual Pond Evaporation = 2.99 ac-ft

Springs and Seeps Effects From Subsidence - Not Applicable

Alluvial Aquifer Abstractions into Mine - Not Applicable

Deep Aquifer Pumpage - Not Applicable

Postmining Inflow - (0)

Direct Diversions - Not Applicable

Dust Suppression - 5,000 gallons/truck load. Data based on 2003 use; last fully active year. = 3.7 ac-ft/yr

Mine Discharge - last 6 month average = 3,757 gpm = 6,059 ac-ft/yr

Using the Windy Gap Process at the Mine site, water depletions include Mine Consumption, Ventilation Consumption, Coal Producing Consumption, Sediment Pond Evaporation, and Dust Suppression totaling approximately 94 acre-feet per year. The only addition to the system, as defined by the Windy Gap process is the mine discharge which is currently averaging approximately 6,060 acre-feet per year, indicating the Skyline Mine has a net gain of approximately 5,966 acre-feet year to the Colorado River drainage system.

2.5.3 Alternative Water Supply

OSM Regulation 30 CFR 783.17 requires that alternative sources of water supply be identified if mining impacts will result in the contamination, diminution, or interruption of existing sources. Because no significant adverse hydrologic impacts are expected as a result of mining in the Skyline permit area, no individual or collective source of alternative water supply has been identified.

However, the Permittee presently owns approximately 556 acre-feet of water rights in the Scofield Reservoir. Of these water rights, water sufficient for the Permittee's needs has been exchanged for rights from wells located near the mine site and at the mouth of Eccles Canyon for use in culinary and dust suppression water systems. Of this 556 acre-feet, a 148 acre-foot exchange has already been approved by the State Engineer of Utah.

It is recognized that seeps and springs are important to wildlife, particularly to small, less mobile species, and that flow reduction could potentially negatively impact these species. While flow reduction from mining related activities, including subsidence, is not expected to cause a problem, however, should such a loss be documented, mitigation measures will be taken after consultation with the Division of Oil, Gas and Mining and the Division of Wildlife Resources.

The Permittee will replace the water supply of any land owner if such a water supply proves to be contaminated, diminished or interrupted as a result of the Skyline mining operations. First, a determination will be made by the Division in accordance with R645 - 301 - 731.800 as to whether or not material damage has occurred. Then, in accordance with Regulation R645-301-525.510, Skyline will correct any material damage resulting from subsidence caused to surface lands (which includes water rights), to the extent technologically and economically feasible, by restoring the land to a condition capable of maintaining the value and reasonably foreseeable uses that it was capable of supporting before subsidence damage. Negotiations will be held immediately with the impacted party to determine the appropriate mitigation activities. The restoration of water flows to impacted sources will be accomplished using the Best Technology Currently Available (BTCA). These activities may include, but not necessarily be limited to: piping or trucking water to the location of the loss; sealing surface fractures to prevent further losses (i.e., stream floors on bed rock or in shallow alluvium), and; construction of a ground water well and the installation of pumps to restore flows. If the above efforts are not successful, then Skyline will explore the transferring water rights to the injured party in flow equal to the determined loss and/or monetary reimbursement for proven material damages.

Historically, the mining activities at Skyline Mine have not resulted in the loss of surface waters or significant changes in the discharge of seeps and springs within the permit area. While significant volumes of ground water have been encountered while mining in the west and southwest portions of the permit area, no impacts to surface discharges of seeps and springs, the flow of streams, or bodies of water have been found. Age-dating of samples of water obtained from the mine indicate the water has been in place for several thousands of years. This suggests that ground water is moving very slowly through the area strata and does not discharge at a significant rate down gradient of the mine.

Very little ground water was encountered while mining in the northern portion of the existing permit area prior to the addition of the North Lease. The same geologic and hydrogeologic conditions are anticipated to occur in the North Lease as occurred in the northern portion of the existing permit area (Mine 3). Therefore, no significant inflows of ground water are anticipated as mining progresses into the North Lease area. Selected surface discharges of ground water and stream flows in the areas that could be impacted by mining activities will be monitored. Mining related subsidence is the only surface impact anticipated since no new surface facilities are currently planned for the North Lease area. If impacts to the waters within the permit area are determined to have occurred, mitigation will be implemented immediately using BTCA as described previously.

There has been some concern that Electric Lake has been impacted by the inflows of ground water to the Skyline Mine since 1998. As presented in the Addendum to the Probable Hydrologic Consequences, July 2002 and updated in October 2002, April 2003, and June 2004, a direct connection between the water in Electric Lake and the mine inflows cannot be found. However, the water flowing into the 10 Left area of the mine and discharging from the James Canyon JC-1 well contains a slight percentage of tritium. No other significant inflows of ground water into the mine contained tritium levels that would suggest a modern component of recharge. As stated by Petersen (Appendix A, Addendum to the Probable Hydrologic Consequences, July 2002, Updated October 2002):

> "It is calculated that the maximum modern component in the fault-related system could range from approximately 6.9 to 12.4 percent. It is also apparent that since routine sampling of the 10 Left groundwater system began in May 2002, the percentage of modern recharge in the groundwater system has not increased. Based on the potential modern recharge percentage calculations presented above, it is determined that of the total inflow to the 10 Left region (approximately 3,800 gpm), a maximum of approximately 262 to 471 gpm could have originated as modern recharge. Inasmuch as Canyon Fuel has been pumping approximately 2,200 gpm from the 10 Left groundwater system into Electric Lake since September 2001, the potential net impact to the Electric Lake watershed, were it occurring, would be completely mitigated by the current pumping. Additionally, groundwater that would not otherwise be available for use without the pumping activity is being added to the watershed. Since October 2002, PacifiCorp has increased the pumping rate at JC-1 to more than 4,000 gpm. Thus, currently, the amount of groundwater being pumped into Electric Lake from JC-1 represents

a volume approximately one order of magnitude greater than that which could potentially be derived from modern sources. It should be noted that there is currently **no** information that would indicate that the potential modern component in the fault-related mine inflows is directly or indirectly related to losses from Electric Lake."

Based on the above information and assuming the same percentages of modern versus ancient water applies to the water pumped from the JC-1 well at a rate of 2,200 gpm, a maximum of approximately 152 gpm to 273 gpm could have originated as modern recharge. The maximum estimated volumes of modern recharge water being discharged to the mine and from the James Canyon well would have been 744 gallons. This volume is still less than the approximately 2,200 gpm that JC-1 discharged to Electric Lake from September 2001 through September 2002.

October 2002, PacifiCorp negotiated with Skyline Mine to install a higher capacity pump in JC-1 well. The discharge after the new pump was installed was approximately 4,200 gpm. The rate of discharge from JC-1 dropped to approximately 3,900 gpm in March of 2003 and should be sustained at approximately that rate through 2004. The cause of the decline in the pumping rate is unknown but may be related to changes in well or pump efficiency.

After the new pump was installed in JC-1, the tritium concentrations in the water discharged from the well increased slightly. It appears that since January 7, 2003 the tritium concentration in the JC-1 well water has slightly increased, ranging between 1.83 and 2.34 TU. This suggests that between 6 and 22 percent of the water now being pumped from the JC-1 well has a component of water that could be considered younger than 50 years old (The percentages are based on a comparison of 2.34 TU in the well water with tritium concentrations measured in water samples from area springs and Electric Lake that range between 8.6 and 30 TU. Table 2 of Appendix G). Assuming the calculated range of 7.8 to 27.2 percent represents the portion of young water discharged from JC-1 when the well is operated at a pumping rate of 3,900 gpm, the range of modern water discharged from JC-1 is between 304 gpm to 1,061 gpm.

The 10 Left area of the mine was sealed in October 2002 and additional uncontaminated samples of the water inflows in that area can no longer be obtained. Calculations of the percentage of modern water in the 10 Left inflows can no longer be based on actual sample data. If it is assumed the JC-1 water is representative of the 10 Left inflows, the JC-1 well water is not being "contaminated" with

modern water from sources that do not normally flow into the mine, and the inflow rate of ground water to 10 Left is approximately 3,000 gpm (as estimated in March 2004), the inflow rate of modern water to 10 Left might be between 234 gpm and 816 gpm. Combining the calculated inflow rates of modern water from JC-1 and the 10 Left area results in a range of 538 gpm to 1,877gpm of a total of 6,900 gpm of water removed from the ground from JC-1 and the mine.

JC-3 pumps water from the flooded portions of the mine that include the 6 Left through 12 Left A and B panel areas. Water from the 11 Left and 12 Left A and B areas do not appear to contain modern waters. Without the JC-3 well, the from these flooded portion of the mine would be pumped to Eccles Creek and not Electric Lake. The pumping of the JC-3 well could be considered to further mitigate for the maximum possible inflow of modern water to the mine. The JC-3 well is expected to be operated for at least several years or until the persistent drought conditions end.

If a determination were made that Skyline Mine impacted Electric Lake and upper Huntington Creek waters, the JC-1 and JC-3 wells would continue to be operated by the mine to discharge water into the Huntington Creek drainage. Thus, through the mine's effort to dewater the Star point Sandstone to allow for the continuation of mining in the southwest portions of Mine 2, specifically to maintain the West Mains, any potential mitigation for the loss of water has been and continues to be accomplished.

Osmorhiza occidentalis	4.00	2.74
Penstemon strictus	**1.00**	**13.59**
Viguiera multiflora	**0.15**	**3.63**
GRASSES[2]		
Bromus carinatus	**2.00**	**4.59**
Elymus glaucus	**2.00**	**5.05**
Elymus trachycaulus	**1.50**	**5.51**
Festuca idahoensis	**0.50**	**5.17**
Festuca ovina	**0.30**	**4.68**
Phleum alpinum	**0.50**	**11.48**
Poa pratensis	0.10	5.00
Poa secunda	0.30	6.37
TOTALS	34.05	99.13
[1]= Broadcast Rate [2]= Species changes may be made by a qualified botanist based on availability. PLS = Pure Live Seed		

2.7.6 VEGETATION OF THE NORTH LEASE TRACT AREA

The North Lease Tract Area is located adjacent to the northernmost boundaries of the current Skyline Mine permit area. Much of this area is located within and adjacent to Winter Quarters Canyon.

Because no surface disturbance is planned for this area, no quantitative data were compiled of the vegetation. Instead, a review of the existing information and data of the North Lease Tract and adjacent areas was done.

During August 2002 aerial photographs, collecting both infrared and black and white images, were taken of the North Lease Tract area to provide baseline vegetation data. Aerial photographs are taken annually, and will continue to be taken to detected variances from the baseline. Annual photographs will be interpreted by a qualified person and a report prepared for inclusion in the annual report.

PLANT COMMUNITIES

A report was prepared earlier by *Mt. Nebo Scientific, Inc.* (Collins 1992) of the vegetation of the Winter

Quarters Canyon area (North Lease Tract Area). This report was submitted to the USDA Forest Service. The report has been included in Appendix A-2.

Methodologies for this previous study relied on general vegetation mapping done by using existing information and limited ground-truthing techniques. Most of the mapping was done using existing maps and data from range analyses prepared by the USDA Forest Service (Manti-LaSal National Forest, Price, Utah).

Plant community named in the aforementioned study were revised to be consistent with the existing vegetation map of the permit area (Drawing 2.7.1-1a). The existing vegetation map of the area was revised using both black and white and color aerial photography. No field work or ground-truthing methods were implemented.

In October 2002 the vegetation at specific sites along the perennial streams within the North Lease was ground-truthed. This information is included in Appendix A-2 titled, "Riparian Plant Community Survey near Scofield, Utah - Winter Quarters and Woods Canyon 2002". Also in Appendix A-2 is "Biological Studies in Winter Quarters Canyon Creek and Woods Canyon Creek - A Study Plan" dated April 2005. The Study Plan outlines the method to be used to collect both qualitative and quantitative data to delineate areas of riparian vegetation. Using USFS Level III protocol transect lines will be established perpendicular to the stream channel at approximately 800-foot intervals for a baseline vegetation survey. Two years prior to longwall undermining any section of perennial streams, the transect interval will be increased to approximately 400-feet and surveyed each subsequent year through two years after mining has been completed for each longwall panel. The combined increase in transect interval and surveying the transects on an annual basis will provide adequate monitoring of the riparian areas. In addition, since riparian vegetation is closely related to the available flow in the perennial sections of the stream, additional flow monitoring sites have been established in the perennial sections of the stream that correspond to the longwall panels and areas of possible subsidence (See section 2.4.4 for monitoring plan details, Figure 2.3.6-2 for locations).Subsequent to the data collection outlined in the "Biological Studies Plan" in 2005, the baseline information will be submitted to the Division, to be included in Appendix A-2. All additional information will be submitted on an annual basis or as the information becomes available.

Aspen

The Aspen community was the most common vegetation type of the Winter Quarters Tract Area.

Aspen (*Populus tremuloides*) was the dominant overstory species, whereas, depending on the area and environmental variables, snowberry (*Symphoricarpos oreophilus*) or Oregon grape (*Mahonia repens*) were the dominate understory species.

Conifer Timber

Also important by relative number of acres, these communities were dominated by Engelman spruce (*Picea engelmanii*) and subalpine fir (*Abies lasiocarpa*). Understory varied from relatively little to moderate ground cover, and often was comprised of gooseberry currant (*Ribes montigenum*).

Sagebrush

The Sagebrush communities that were mapped were dominated by Vasey sagebrush (*Artemisia tridentata* var. *vaseyana*) and various grass species i.e. slender wheatgrass (*Elymus trachycaulus*) and subalpine needlegrass (*Stipa columbiana*). Other common species of the community were low rabbitbrush (*Chrysothamnus viscidiflorus*), Louisiana sagewort (*Artemisia ludoviciana*), aster (*Aster* spp.), yarrow (*Achillea millefolium*) and Indian paintbrush (*Castilleja* spp.).

Although surface disturbances are not planned and the submittal of quantitative data was not necessary for the North Lease Tract Area, baseline quantitative data of many of the same communities located near the Skyline Mine site have been taken for previous studies. These additional data sets have also been included in Appendix Volume A-2 of the Skyline Mine MRP.

THREATENED & ENDANGERED PLANT SPECIES

Per personnel communication with Bob Thompson, USFS Botanist on November 1, 2002, "none of the currently listed USFS threatened, endangered or sensitive species are found in the Winter Quarter's Lease area". In addition to their being no species of concern in the USGFS Winter Quarter's Lease area, no surface disturbance is planned for the area.

HABITAT LOSS

In the unlikely event it is determined that mining-related subsidence causes material damage or a loss

of riparian habitat, the Permittee commits to using the best technology currently available (BTCA)to mitigate the damage. The repair efforts will be coordinated and agreed upon by Mine, DOGM, and USFS personnel. Repairs related to disruption of a water supply are addressed in Section 2.5.3.

Huntington Creek has a diverse aquatic community with macroinvertebrate taxa representing all trophic levels. The successful cutthroat trout spawning and high number of resident trout evidence the high quality waters and habitat of Huntington Creek plus the ability of the macroinvertebrate community to support quality fisheries. Cutthroat trout, according to Utah Division of Wildlife Resources (UDWR) surveys, are increasing in numbers in Huntington Creek above Electric Lake. Trout produced in Huntington Creek provide an important part of the total number of fish in Electric Lake.

Winter Quarters Canyon Creek

As indicated in the 1995 environmental assessment prepared by the Forest Service and the Bureau of Land Management Winters Quarters Canyon Creek has a moderate population of macroinvertebrates. Perennial flow in the canyon has produced Stonefly larvae as far up as Box and Bob's Canyons. Mayfly nymphs were also found present in waters tested. Cutthroat trout were found within the creek east of the Forest Boundary on June 7, 1994 indicating fish are likely within perennial sections of the creek containing significant flows. A survey conducted in Winter Quarters Canyon Creek in October 2002 indicated similar conditions and species (See Appendix Volume A-3, Volume 2).

Woods Canyon Creek

As indicated in the 1995 Environmental Assessment, Mayfly nymphs were found within the upper portions of Woods Canyon Creek in higher quantities than those found within Winter Quarters Canyon. Stonefly larvae were also found as high as the fork in the stream near the center of Section 34 (T 12 S, R 6 E). No fish were seen during the 1994 field survey although some may have been present. A survey conducted in Woods Canyon Creek in October 2002 indicated similar conditions (See Appendix Volume A-3, Volume 2).

Revised: 8-24-05

James and Burnout Creeks

A fish and macroinvertebrate monitoring program for James and Burnout Creeks will be implemented prior to undermining the lower portion of James Canyon. The fish survey consists of multi-pass electro fishing to estimate fish populations in the streams for one year and then every third year thereafter. The fish surveys will be performed in the fall of each third year on or about the same date, and will continue through a minimum of two (2) years following active subsidence (2008). The fish survey was initiated on October 16, 200~~1~~0.

A macroinvertebrate survey of Burnout Creek will be performed twice a year for two consecutive years and then every three years thereafter. This survey will be performed in the fall and spring of each year, with the fall macroinvertebrate survey will being performed in conjunction with the fall fish survey. The macroinvertebrate survey was initiated on October 16, 200~~1~~0.

A macroinvertebrate survey of James Creek initiated on October 16, 200~~1~~0 will be performed twice a year for two consecutive years and then every three years thereafter or for a period determined by Canyon Fuel Company, LLC, DOGM, USFS and the DWR, to be long enough to provide data to establish population trends . This survey will be performed in the fall and spring of each year on or about the same date. The fall macroinvertebrate survey will be performed in conjunction with the fall fish survey.

The following methods have been used previously on this creek and will continue to be used for future macroinvertebrate sampling. Slight variations to the methods may occur during the field work or based on comments from regulatory agencies.

Three benthic sites will be sampled. They will be located beginning approximately 162 meters (528 feet) above the reservoir. Refer to Plate 2.8.1-1 for all macroinvertebrate sample site locations. Note that macroinvertebrate sites sample reaches of a stream - site locations are plotted at the approximate mid-point of the reach of the sample site.

Quantitative samples will be taken with a modified box sampler. The three samples taken will be field preserved in 70% ethyl alcohol and returned to the laboratory for processing. The samples will be sorted and invertebrates identified to the lowest possible taxonomic level using the keys of Merritt and Cummins (1996). Those of questionable identity will be further examined and identified under

magnification. The mean, standard deviation, density per square meter, and standing crop will be calculated and estimated using the same methods as in previous analysis.

Calculations of the USFS Biotic Condition Index (Winget and Mangum 1979) will be completed using the abundances of the benthic taxa to generate the dominance weighted community tolerant quotient (CTQd). The predicted community tolerant quotient (CTQp) will be calculated using water chemistry data provided in Winget (1972) for the Huntington Creek drainage.

Cluster analysis will be run using the Bray-Curtis dissimilarity index with the UPGM clustering algorithm.

Winter Quarters Canyon and Woods Canyon Creeks

~~During the~~From Fall of 2002 ~~and~~ through early Summer of 200~~3~~4 fish and baseline macroinvertebrate data for the perennial reaches within Winter Quarters Canyon and Woods Canyon Creeks in the North Lease area were gathered. Copies of the reports are included in Appendix Volume A-3, Volume 2.

A macroinvertebrate survey of portions of Winter Quarters Canyon and Woods Canyon Creeks will be performed twice a year for two consecutive years and then every third year thereafter or for a period determined by Canyon Fuel Company, LLC, DOGM, USFS, and the DWR, to be long enough to provide data to establish population trends. This survey will be performed in the fall and spring of each year on or about the same date. ~~The fall macroinvertebrate survey will be performed in conjunction with a fish survey.~~

The following methods have been and will be used for macroinvertebrate sampling. Slight variations to the methods may occur during the field work or based on comments from regulatory agencies.

Three benthic sites will be sampled in each creek. Following the first survey a map with these stations will be prepared and submitted with the next sample report (included in the following year's annual report). Quantitative samples will be taken with a modified box sampler. The samples taken will be field preserved in 70% ethyl alcohol and returned to the laboratory for processing. The samples will be sorted and invertebrates identified to the lowest possible taxonomic level using the keys of Merritt and Cummins (1996). Those of questionable identity will be further examined and identified under magnification. The mean, standard deviation, density per square meter, and

standing crop will be calculated and estimated.

Calculations of the USFS Biotic Condition Index (Winget and Mangum 1979) will be completed using the abundances of the benthic taxa to generate the dominance weighted community tolerant quotient (CTQd). The predicted community tolerant quotient (CTQp) will be calculated using water chemistry data provided in Winget (1972) for the Huntington Creek drainage.

Cluster analysis will be run using the Bray-Curtis dissimilarity index with the UPGM clustering algorithm.

An electro fishing study~~ies will~~ was conducted in 2002 to examine 1) the species present in Winter Quarters Canyon; 2) determine if fish were present in Woods Canyon; and 3) determine how far upstream fish extended into either canyon. The one-time survey was conducted on request by the U.S. Forest Service (See Appendix A-3, Volume 2 for report). ~~consists of multi-pass electro fishing to estimate fish populations in the stream for one year and then every third year thereafter or for a period determined by Canyon Fuel Company, LLC, DOGM and the DWR, to be long enough to provide data to establish population trends. The fish studies will be performed in the fall of each year. The study will be included in the annual report.~~

The above described ~~fish and~~ macroinvertebrate studies will continue for two years after active mining and subsidence stops in the applicable drainages unless statistical analysis demonstrates impacts have occurred or may occur to these streams. In the event subsidence causes quantifiable damages to fish populations, stream flows, or other negative impacts on fish or wildlife habitat, the mine will identify, research and implement measures sufficient to correct the problems. If monitoring data suggests potential adverse impacts have occurred but cannot be conclusively demonstrated by the three years of collected data, a new monitoring plan to determine the type and extent of the impact will be developed by DOGM, DWR, USFS and Skyline Mine. The additional monitoring will continue until such impacts are either demonstrated or dismissed by joint consent of DOGM, DWR, USFS, and Skyline Mine. Areas where there is potential for habitat loss from subsidence are shown on Plate 4.17.3-1a. The consumption rate of water from mining activities is provided in Section 2.5.2.

Future aquatic monitoring is planned only on an as needed basis. Need will be established in conjunction with UDWR personnel and will be required only in case of a major perturbation in fish populations or other anomalous conditions. Monitoring data will be reviewed for mining related

impacts, and, if found, a mitigation plan will be developed in conjunction with UDWR and UDOGM personnel. The Permittee will cooperate with UDWR in the investigation of any such conditions. This approach to future monitoring is consistent with the requirements recommended by the UDWR, Price office.

Eccles Creek

To determine the impacts to Eccles Creek , if any, related to discharge of mine water, semi-annual macroinvertebrate studies will be conducted. The studies will start in the spring of 2002 and will continue for three (3) consecutive years or for a period determined by Canyon Fuel Company, LLC, DOGM and the DWR, to be long enough to provide data to establish population trends.

The following methods have been used previously on this creek and will be used for future sampling. Slight variations to the methods may occur during the field work or based on comments from regulatory agencies.

Four samples will be taken at intervals separated by approximately 20 to 30 m. Samples will continue to be taken from three stations on the stream, with five replicates per station. These stations on Eccles Creek are located above South Fork (site 1), Eccles Creek at Whisky Canyon (site 2), and Lower Eccles Creek (site 3). A map with these stations has been added to the Aquatic Wildlife section of Volume A-3.

A box sampler will be used to collect the samples. Samples will be taken in areas with rubble or cobble substrates to insure that similar habitats are examined. When possible, samples will be taken from parts of the stream channel that had been submerged continuously throughout the year. The substrate will be stirred to a depth of approximately 5 cm. Rocks within the area of the sampler will be removed and washed to insure quantitative assessment of the invertebrates. The box sampler will have a net mesh of approximately 250 microns. The samples will be concentrated on a screen with a mesh of approximately 64 microns and field preserved in ethyl alcohol.

In the laboratory the samples will be sorted in a pan illuminated from below. All invertebrates will be removed and identified to the lowest possible taxonomic level using the keys of Merritt and Cummins (1996). The mean density and standard deviation per sample will be calculated for each taxon and the mean values will be used to determine the density per square meter.

The collected data will be compared to the previous data collected in 1979 through 1983 and included in Appendix A-3, Volume 2. After comparing historical data with data obtained in the three

2.8 AQUATIC WILDLIFE RESOURCES

Introduction

Both Huntington Creek and Eccles Creek flow through the project area and both provide habitat for reproducing resident populations of cutthroat trout. Cutthroat trout from Electric Lake use upper Huntington Creek for spawning and nursery activities. Scofield Reservoir, although stocked with rainbow trout exclusively, has numerous cutthroat trout which have been produced in Eccles Creek and other tributary streams such as Winter Quarters, Woods Creek, Lost Creek, Fish Creek, Pondtown Creek, Pleasant Valley Creek and possibly Boardinghouse Creek.

Eccles Creek

Eccles Creek is a small mountain stream draining west to east into Pleasant Valley Creek which flows north approximately 3 miles where it empties into Scofield Reservoir. Discharges in Eccles Creek are frequently as low as 2 cfs during late summer, fall and winter months; and high flows seldom exceed 50 cfs, even at the creek mouth. Water temperatures of streams such as Eccles Creek fluctuate because of turbulence from the rough channels. During November to March, water temperatures remain between 0-2° C. In the summer, water temperatures often fluctuate from 12-15° C daily although high temperatures seldom exceed 20° C.

Through natural erosion of mudstone, sandstone and shale deposits, Eccles Creek has periods of high total suspended solids (sedimentation). This occurs, however, during periods of high runoff when the stream waters have sufficient energy (velocity) to carry the fine sediments out of the canyon rather than depositing them on the coarser substrate materials. During normal runoff years, there are numerous clean trout spawning gravel beds in Eccles Creek. During low runoff years, fine sediments may not be flushed from the spawning grounds. Maintenance of this resource is dependent upon a continuation of flow, adequate substrate, food base and water quality conditions.

The existing aquatic species of Eccles Creek, fish and macroinvertebrates, have adapted to tolerate natural temperature fluctuations and sediment loads. The macroinvertebrate communities of Eccles Creek have a high diversity of species representing all major trophic groups. There are

species found only in high quality water streams indicating the high water quality of Eccles Creek. There are also environmentally resistant taxa present. This high diversity represents a resiliency to environmental change, especially short term changes.

Upper Eccles Creek above the White Oak Mine Road (at sampling stations ECO3, ECO2, UPMF, UPSF, Figure 2.8-A), have numerous taxa of macroinvertebrates found only in high quality waters and stable habitats. Lower Eccles Creek (Stations ECO4 and ECO5) has a more tolerant macroinvertebrate community with taxa tolerant to sedimentation dominating the community.

Cutthroat trout have historically maintained naturally reproducing populations in Eccles Creek from the National Forest boundary downstream to the creek mouth. Recent migrations, however, have been impeded by obstacles unrelated to mining, such as, irrigation diversions, and numerous beaver dams. There are no fish in the upper forks of Eccles Creek.

Construction activities caused sufficient sediment loading into Eccles Creek resulting in a significant reduction in fish populations. Cooperative efforts with DWR, however, resulted in habitat improvement by 1986 sufficient for near recovery of these populations. (See DWR report, "Recovery of the Cutthroat Trout (Salmo Clarki) Fishery in Eccles Creek, Utah From Coal Mining Impacts", Donaldson & Dalton, Volume A-3, under Aquatic Wildlife.)

Huntington Creek

Huntington Creek above Electric Lake is a small mountain stream draining north to south into Electric Lake. Discharges are frequently as low as 1.5 cfs, with spring high flows sometimes reaching 100 cfs. Water temperatures fluctuate during summer months, although daily highs seldom exceed 20°C. During winter months water temperatures seldom exceed 2°C and the stream is nearly completely iced over.

Through natural erosion of existing stream channel geological formations and adjoining hillsides, Huntington Creek waters have high loads of fine sediments during runoff periods. This occurs when runoff is high and these sediments are carried into Electric Lake rather than being deposited on spawning gravels or other coarse substrate materials. Huntington Creek has numerous clean trout spawning gravel beds and the amount of fine sediments is not high enough to hinder spawning.

Huntington Creek has a diverse aquatic community with macroinvertebrate taxa representing all trophic levels. The successful cutthroat trout spawning and high number of resident trout evidence the high quality waters and habitat of Huntington Creek plus the ability of the macroinvertebrate community to support quality fisheries. Cutthroat trout, according to Utah Division of Wildlife Resources (UDWR) surveys, are increasing in numbers in Huntington Creek above Electric Lake. Trout produced in Huntington Creek provide an important part of the total number of fish in Electric Lake.

Winter Quarters Canyon Creek

As indicated in the 1995 environmental assessment prepared by the Forest Service and the Bureau of Land Management Winters Quarters Canyon Creek has a moderate population of macroinvertebrates. Perennial flow in the canyon has produced Stonefly larvae as far up as Box and Bob's Canyons. Mayfly nymphs were also found present in waters tested. Cutthroat trout were found within the creek east of the Forest Boundary on June 7, 1994 indicating fish are likely within perennial sections of the creek containing significant flows. A survey conducted in Winter Quarters Canyon Creek in October 2002 indicated similar conditions and species (See Appendix Volume A-3, Volume 2).

Woods Canyon Creek

As indicated in the 1995 Environmental Assessment, Mayfly nymphs were found within the upper portions of Woods Canyon Creek in higher quantities than those found within Winter Quarters Canyon. Stonefly larvae were also found as high as the fork in the stream near the center of Section 34 (T 12 S, R 6 E). No fish were seen during the 1994 field survey although some may have been present. A survey conducted in Woods Canyon Creek in October 2002 indicated similar conditions (See Appendix Volume A-3, Volume 2).

Project Impacts on Fisheries Resources

The surface facility disturbances in the portal area encroached on sections of all three upper Eccles Creek forks. In order to reduce sedimentation of these stream segments and the main stream, the tributaries and a section of Eccles Creek proper immediately below the tributary confluences were diverted into closed culverts. This modified approximately 4,200 feet of total stream habitat but did not reduce available fish habitat since fish were not found above the U.S. Forest boundary, prior to the diversion. Downstream drift of macroinvertebrates from the upper reaches of these forks still occurs as before.

At the coal loadout facilities near the mouth of the canyon (Station ECO5), approximately 600 feet of stream was moved to the north into a new channel. The new channel is 100 feet shorter but has nearly the same gradient (3 feet additional vertical drop/1,000 feet horizontal channel).

Degredation of Eccles Creek between the National Forest boundary and the coal loadout facilities should continue to be minimal since road and conveyor plans were developed and are being implemented to minimize effects on the stream.

Water being discharged from the mine is augmenting the Eccles Creek stream flow. This increased stream flow is especially beneficial during summer months when normal stream flows are low. Water temperatures are also moderated by this increased flow.

There should be little impact on Huntington Creek above Electric Lake. Impacts to date have been associated only with the construction of a new UDOT highway. Sediment control measures minimized the impact during the construction activity.

At this point in time there are believed to be no potential impacts on either Winter Quarters or Woods Canyon Creeks since no surface mining impacts are planned.

2.8.1 Aquatic Monitoring Program

An aquatic monitoring program has been conducted to meet the intent of the requirements of R614-301-311. The main purpose of the monitoring program is to gain sufficient knowledge to prevent and/or minimize impacts through wise project planning. Monitoring has: (1) described existing resources; (2) detected existing perturbations; and (3) provided the basis for wise project planning, operation and resource restoration.

The biological (macroinvertebrate and fish) and habitat (sediment and channel surveys) monitoring stations on Eccles Creek are shown in Figure 2.8-A. Sampling dates are limited by weather, but June and late October samplings are usually possible. Two seasonal sampling dates per year are required to differentiate natural seasonal intrastand variance from impact induced changes. Samples were taken annually through the project planning and early development. The biological sampling has been performed in conjunction with normal stream water monitoring so that comparative analysis is possible.

Seven stations on Eccles Creek were selected in relation to impact areas, UDWR fish sampling stations, existing macroinvertebrate and sediment stations, and water quality monitoring stations. At each station on the scheduled sample date (Table 2.8-1), four macroinvertebrate samples were taken from selected optimal substrates with a modified Surber Sampler. Three sediment samples were taken from potential spawning grounds. Replicate samples were taken to enable an analysis of variance between samples.

Habitat surveys, following methodologies used by USBLM and USDFS fisheries habitat specialists, were made annually throughout construction at critical Eccles Creek stations (Table 2.8.1). Measurements included: stream bank stability, channel substrate composition; stream gradient; riparian vegetation (type, relative cover); water width, depth and velocity at various discharges (Q) and channel width and tortuosity.

Fish surveys are conducted by UDWR personnel out of the Price office. Fish surveys are usually made in August so year class I fish will be large enough to sample and young-of-year fish are large enough to observe. Fish are measured as to total length and weight, counted and then released. These data are compared with earlier UDWR collection records, thus illustrating present fish population conditions compared with years past.

Table 2.8-2 summarizes the stream monitoring data. A summary of the sediment composition data, taken in accordance with the schedule on Table 2.8-1, is shown on Table 2.8-3. The UDWR reports have been added to the Aquatic Wildlife section of Volume A-3.

James and Burnout Creeks

A fish and macroinvertebrate monitoring program for James and Burnout Creeks will be implemented prior to undermining the lower portion of James Canyon. The fish survey consists of multi-pass electro fishing to estimate fish populations in the streams for one year and then every third year thereafter. The fish surveys will be performed in the fall of each third year on or about the same date, and will continue through a minimum of two (2) years following active subsidence (2008). The fish survey was initiated on October 16, 2000.

A macroinvertebrate survey of Burnout Creek will be performed twice a year for two consecutive years and then every three years thereafter. This survey will be performed in the fall and spring of each year, with the fall macroinvertebrate survey will being performed in conjunction with the fall fish survey. The macroinvertebrate survey was initiated on October 16, 2000.

A macroinvertebrate survey of James Creek initiated on October 16, 2000 will be performed twice a year for two consecutive years and then every three years thereafter or for a period determined by Canyon Fuel Company, LLC, DOGM, USFS and the DWR, to be long enough to provide data to establish population trends . This survey will be performed in the fall and spring of each year on or about the same date. The fall macroinvertebrate survey will be performed in conjunction with the fall fish survey.

The following methods have been used previously on this creek and will continue to be used for future macroinvertebrate sampling. Slight variations to the methods may occur during the field work or based on comments from regulatory agencies.

Three benthic sites will be sampled. They will be located beginning approximately 162 meters (528 feet) above the reservoir. Refer to Plate 2.8.1-1 for all macroinvertebrate sample site locations. Note that macroinvertebrate sites sample reaches of a stream - site locations are plotted at the approximate mid-point of the reach of the sample site.

Quantitative samples will be taken with a modified box sampler. The three samples taken will be field preserved in 70% ethyl alcohol and returned to the laboratory for processing. The samples will be sorted and invertebrates identified to the lowest possible taxonomic level using the keys of Merritt and Cummins (1996). Those of questionable identity will be further examined and identified under

magnification. The mean, standard deviation, density per square meter, and standing crop will be calculated and estimated using the same methods as in previous analysis.

Calculations of the USFS Biotic Condition Index (Winget and Mangum 1979) will be completed using the abundances of the benthic taxa to generate the dominance weighted community tolerant quotient (CTQd). The predicted community tolerant quotient (CTQp) will be calculated using water chemistry data provided in Winget (1972) for the Huntington Creek drainage.

Cluster analysis will be run using the Bray-Curtis dissimilarity index with the UPGM clustering algorithm.

Winter Quarters Canyon and Woods Canyon Creeks

From Fall of 2002 through early Summer of 2004 fish and baseline macroinvertebrate data for the perennial reaches within Winter Quarters Canyon and Woods Canyon Creeks in the North Lease area were gathered. Copies of the reports are included in Appendix Volume A-3, Volume 2.

A macroinvertebrate survey of portions of Winter Quarters Canyon and Woods Canyon Creeks will be performed twice a year for two consecutive years and then every third year thereafter or for a period determined by Canyon Fuel Company, LLC, DOGM, USFS, and the DWR, to be long enough to provide data to establish population trends. This survey will be performed in the fall and spring of each year on or about the same date.

The following methods have been and will be used for macroinvertebrate sampling. Slight variations to the methods may occur during the field work or based on comments from regulatory agencies.

Three benthic sites will be sampled in each creek. Following the first survey a map with these stations will be prepared and submitted with the next sample report (included in the following year's annual report). Quantitative samples will be taken with a modified box sampler. The samples taken will be field preserved in 70% ethyl alcohol and returned to the laboratory for processing. The samples will be sorted and invertebrates identified to the lowest possible taxonomic level using the keys of Merritt and Cummins (1996). Those of questionable identity will be further examined and identified under magnification. The mean, standard deviation, density per square meter, and

standing crop will be calculated and estimated.

Calculations of the USFS Biotic Condition Index (Winget and Mangum 1979) will be completed using the abundances of the benthic taxa to generate the dominance weighted community tolerant quotient (CTQd). The predicted community tolerant quotient (CTQp) will be calculated using water chemistry data provided in Winget (1972) for the Huntington Creek drainage.

Cluster analysis will be run using the Bray-Curtis dissimilarity index with the UPGM clustering algorithm.

An electro fishing study was conducted in 2002 to examine 1) the species present in Winter Quarters Canyon; 2) determine if fish were present in Woods Canyon; and 3) determine how far upstream fish extended into either canyon. The one-time survey was conducted on request by the U.S. Forest Service (See Appendix A-3, Volume 2 for report).

The above described macroinvertebrate studies will continue for two years after active mining and subsidence stops in the applicable drainages unless statistical analysis demonstrates impacts have occurred or may occur to these streams. In the event subsidence causes quantifiable damages to fish populations, stream flows, or other negative impacts on fish or wildlife habitat, the mine will identify, research and implement measures sufficient to correct the problems. If monitoring data suggests potential adverse impacts have occurred but cannot be conclusively demonstrated by the three years of collected data, a new monitoring plan to determine the type and extent of the impact will be developed by DOGM, DWR, USFS and Skyline Mine. The additional monitoring will continue until such impacts are either demonstrated or dismissed by joint consent of DOGM, DWR, USFS, and Skyline Mine. Areas where there is potential for habitat loss from subsidence are shown on Plate 4.17.3-1a. The consumption rate of water from mining activities is provided in Section 2.5.2.

Future aquatic monitoring is planned only on an as needed basis. Need will be established in conjunction with UDWR personnel and will be required only in case of a major perturbation in fish populations or other anomalous conditions. Monitoring data will be reviewed for mining related impacts, and, if found, a mitigation plan will be developed in conjunction with UDWR and UDOGM personnel. The Permittee will cooperate with UDWR in the investigation of any such conditions. This approach to future monitoring is consistent with the requirements recommended by the UDWR, Price office.

Eccles Creek

To determine the impacts to Eccles Creek, if any, related to discharge of mine water, semi-annual macroinvertebrate studies will be conducted. The studies will start in the spring of 2002 and will continue for three (3) consecutive years or for a period determined by Canyon Fuel Company, LLC, DOGM and the DWR, to be long enough to provide data to establish population trends.

The following methods have been used previously on this creek and will be used for future sampling. Slight variations to the methods may occur during the field work or based on comments from regulatory agencies.

Four samples will be taken at intervals separated by approximately 20 to 30 m. Samples will continue to be taken from three stations on the stream, with five replicates per station. These stations on Eccles Creek are located above South Fork (site 1), Eccles Creek at Whisky Canyon (site 2), and Lower Eccles Creek (site 3). A map with these stations has been added to the Aquatic Wildlife section of Volume A-3.

A box sampler will be used to collect the samples. Samples will be taken in areas with rubble or cobble substrates to insure that similar habitats are examined. When possible, samples will be taken from parts of the stream channel that had been submerged continuously throughout the year. The substrate will be stirred to a depth of approximately 5 cm. Rocks within the area of the sampler will be removed and washed to insure quantitative assessment of the invertebrates. The box sampler will have a net mesh of approximately 250 microns. The samples will be concentrated on a screen with a mesh of approximately 64 microns and field preserved in ethyl alcohol.

In the laboratory the samples will be sorted in a pan illuminated from below. All invertebrates will be removed and identified to the lowest possible taxonomic level using the keys of Merritt and Cummins (1996). The mean density and standard deviation per sample will be calculated for each taxon and the mean values will be used to determine the density per square meter.

The collected data will be compared to the previous data collected in 1979 through 1983 and included in Appendix A-3, Volume 2. After comparing historical data with data obtained in the three year study starting in 2002, a determination will be made if the macroinvertebrate in Eccles Creek are impacted by the mine water discharge. If impacts are found, the significance of the impacts will be determined and appropriate mitigation is necessary will be performed.

Fish studies will be conducted on Eccles Creek in 2003.The fish study consists of multi-pass electro fishing to estimate fish populations in the stream for one year and then every third year

thereafter. The fish studies will be performed in the fall of each year. Results from sampling will be compared with all available historic studies done on this creek.

Aquatic Monitoring Summary

Aquatic monitoring data have been accumulated for a period of six years. Summaries of these data are presented in Tables 2.8.2 and 2.8.3. Backup data for these summaries, including the consultants original report and subsequent summary reports, may be found in Appendix Volume A-3, Aquatic Wildlife.

During a 23 year time span macro-invertebrate data was collect on 24 site visits to Eccles Creek and compiled into a report entitled "A Compilation and Comparison of Eccles Creek Macro-Invertebrate Data for the Period of 1979 - 2002" prepared by Dennis Shiozawa, Ph.D., Professor of Fisheries Biology at Brigham Young University, Provo, Utah. The report documents that Eccles Creek has undergone changes in the benthic community structure through the years of study and demonstrates the resilience and adaptability of the creek to disturbance by multiple sources. Burnout, James, Eccles, Winter Quarters, and Woods canyon creeks have continued Aquatic monitoring reports that are submitted to the Division of Oil, Gas, and Mining in the required Annual Report when the information is compiled. These reports are available for review at the Division of Oil, Gas and Mining public library.

Other recent literature pertinent to this report are: Schmidt (1953); Stebbins (1954 and 1966); W. Tanner (1953, 1957a and b, 1966-with Banta, 1969-with Morris, and 1972-with Fisher and Willis); and Woodbury (1952).

The area of concern in this report is located in the upper edges of sagebrush (Artemisia) and into the Aspen-Spruce-Fir plant communities.

Amphibians

Based on the extensive literature review and limited field work it was determined that probably four and potentially six species of amphibians (Table 2.9-3) inhabit the area of concern that provides substantial value habitat for all species listed. All amphibians are protected, but since the species listed are all widespread throughout the mountains of Utah, none are treated as high-interest species, and, therefore, are not individually discussed. It is doubtful if the development action would seriously impact populations but rather localized individuals in the areas of total habitat destruction. An exception to this would result if subsidence interrupted underground aquifers and caused drying of present wet or riparian habitats essential to reproduction.

Amphibian surveys, focusing on locating the Spotted Frog and Boreal Toad, will be conducted in Spring and Summer 2005 depending on the appropriate survey time. The survey for the Spotted Frog will only focus on areas that will be longwall undermined in 2005, additional surveys will be conducted as longwall mining advances, if necessary. The entire survey for the Boreal Toad will be conducted in both Winter Quarters Canyon and Woods Canyon in 2005. During the Boreal Toad survey, an assessment will be made whether suitable Spotted Frog habitat exists in the two drainages and whether additional Spotted Frog surveys are necessary. A detailed description of the Amphibian Studies outlining survey timing, optimum season, and methods is located in Appendix A-2, "Biological Studies in Winter Quarters Canyon Creek and Woods Canyon Creek - A Study Plan". In the event either or both of the amphibians are encountered, the Permittee commits to implementing suitable protection methods, in consultation with the appropriate regulatory agencies (DOGM, USFS, DWR, etc.).

Reptiles

Based on the literature search and limited field work it was determined that probably 10 and potentially 15 species of reptiles (Table 2.9.3) occupy the mine land area that is considered as substantial value habitat for all 15 species. All reptiles are protected, but since the species listed are all widespread throughout montane habitats in Utah, none are treated as high- interest species and therefore, are not individually discussed. It is doubtful if the development action would seriously impact populations but it will destroy the habitat for individuals living in the areas of total habitat destruction surrounding the mine portal, conveyor, storage facilities and access roads.

Mammals

At least 73 mammal species potentially occur in the area on a seasonal or year-round basis.

Furbearers

Approximately 10 furbearers potentially occur within the North Tract Lease or adjacent areas including beaver, mink, bobcat, ringtail, long-tailed weasel, badger, striped and spotted skunk.

Game Species

At least 5 big game species (mountain lion, black bear, elk, moose, mule deer)are known to occur in the project area. Three of these species (elk, moose and mule deer) occur on a regular basis. The area has been categorized as high value summer habitat for mule deer, critical value summer habitat for elk, and high value winter habitat of moose. DWR classifies hunts for mountain lion and black bear as "special", because hunting is only allowed by special limited permit, under special circumstances determined by the DWR.

Birds

No site-specific lists of birds have been prepared for the area, however, a list of potential species for the project was included in the study. This list included 147 species that may occur seasonally or year long. Of these species, at least 67 may be considered permanent residents. The general area has several species of migratory waterfowl and shoreland birds due to its proximity to wetland, riparian and open waters. Herons, egrets and migrant passerines are likely to be seen using the area. Several species of upland game birds are also known to occur in the foothill regions of the area including chukar, blue grouse, ruffed grouse, and sage grouse. Mourning doves may also be common summer residents and nest in small trees of riparian areas.

Surveys to determine the presence of the Northern Goshawk and the Northern Three-toed Woodpecker will be conducted in the North Lease area in Spring 2005, prior to any longwall mining being conducted. Details of the timing of the surveys and methods to be used are outlined in Appendix A-2, "Biological Studies in the Winter Quarters Canyon Creek and Woods Canyon Creek - A Study Plan". In the event either or both of the birds are located, the Permittee commits to implementing suitable protection method, in consultation with the appropriate regulatory agencies (DOGM, USFS, DWR, etc.).

THREATENED & ENDANGERED SPECIES

Because no surface disturbance in planned for the North Lease Tract Area, no impact to endangered, threatened, or otherwise sensitive species should occur.

2.10.2 RAPTORS OF THE NORTH LEASE TRACT AREA

A raptor study was conducted by White (1980) for the Skyline Mine area and summarized in Section 2.10 of this document. The raptor report White (1980) can be found in Appendix Volume A-2. Prime emphasis was given to the threatened or endangered species -- the peregrine falcon and the bald eagle, but other raptors were also recorded during the field work of the study.

Another raptor survey was performed at the time of the wildlife study by Parrish (1992). Within this report a table was formulated that comprised 15 diurnal raptors and 10 species of nocturnal raptors that potentially occur in the project area. An aerial survey by helicopter was performed on March 5, 1992 where 11 raptor nests were mapped, five of which were within the boundaries of project area. The remaining nests were within 1 mile of the area. A large nest, probably used by golden eagles, was located in Woods Canyon, just outside the permit boundaries.

A subsequent ground-truthing study was done to check the presence or absence of raptors in the 11 nests on July 4-5, 1992. Adult and/or juvenile raptors were found to be present in the general vicinity and 4 nest sites were within the project area. Two of these active nests were being used by red-tailed hawks, with signs of nesting activity. The two additional sites were occupied by Northern goshawks, one of which had signs of nesting activities.

Of the remaining 7 nests, attempts to locate 2 of them were not made because of time constraints, 1 was inaccessible and the remaining 4 were unoccupied by raptors and lacked evidence of nesting activities. During the field study additional raptor observations were made including one juvenile and two adult red-tailed hawks, and two goshawks.

During a survey by the USFS in 2002 a goshawk nest was located. The permittee was not given the exact location of the nest but was given an activity exclusion zone of ½ mile radius with the diameter center being the ½ section on the South section line of Section 3, Township 13 South, Range 6 East.

Because no surface disturbance is planned in the North Lease Tract Area, critical habitat for raptors should remain unaffected.

An additional baseline Northern goshawk survey will be conducted in the North Lease area prior to

July 1, 2005. Details of the method of the survey are outlined in Appendix A-2, "Biological Studies in Winter Quarters Canyon Creek and Woods Canyon Creek - A Study Plan". Results of the survey will be provided in Appendix A-2, Volume 2 when completed.

Although minimal cliff habitat exists in the North Lease area, and the likelihood of subsiding those areas even less, Canyon Fuel Company, LLC commits to conducting an additional raptor survey in areas of cliff habitat within one year of undermining the cliff area. Additional annual surveys will be conducted if any nests are located during the baseline survey. The raptor-nest survey will be conducted via helicopter. Results of the survey will be provided in Appendix Volume A-2.

A raptor survey will be performed during 2003, however because no surface disturbance is planned in the North Lease Tract Area, critical habitat for raptors will remain unaffected by the proposed new area.

THREATENED & ENDANGERED SPECIES

Because no surface disturbance in planned for the North Lease Tract Area, no impact to endangered, threatened, or otherwise sensitive species should occur.

Recreation

Recreational use of the lease area affected by surface operations consists primarily of hunting big game, game birds, and small game species; fishing in Eccles Canyon below the portal area; from the south fork to the mouth of the canyon sightseeing, snowmobiling, and cross country skiing. Limited camping and picnicking also occurred in the mouth of Eccles Canyon (U.S. geological Survey, 1979).

Eccles Canyon Road provides the only direct access from Scofield Reservoir to Huntington Canyon and is used as an access route from the Scofield Reservoir recreation area to the recreational use areas at higher elevations in the northern end of the Wasatch Plateau (U.S. Geological Survey, 1979).

Natural Gas Transmission

A natural gas pipeline traverses the permit area from southeast to northwest. Additionally, an abandoned gas well is located in the Eccles Canyon portion of the permit area. A small building associated with Gas Well No. 8 is located in Eccles Canyon. The location of these features are all shown on Map 2.12.1-1.

Forestry

Forest uses are limited primarily to cutting firewood and fenceposts. Occasional timber sales from National Forest lands are made to salvage insect-killed spruce timber. One such sale, totalling 2.5 million board feet, was made in the Kitchen Creek drainage basin on the west side of the coal lease area in 1977.

TBR (Timber) Management Unit - Emphasis is on management for production and use of wood - fiber for a variety of wood products.

UC (Utility Corridor) Management Unit - Emphasis is on providing transportation corridors for major cross-country pipelines, electrical transmission lines and telephone lines. This unit currently contains a gas transmission pipeline constructed and operated under a Forest Service special-use permit issued to Questar Pipeline Company (main line 41).

RPN (Riparian) Management Unit - Emphasis is on management of riparian areas and all the component ecosystems. The units consist of a zone approximately 100 feet measured horizontally from the edge of all perennial streams and springs, and from the shores of lakes and other still water bodies.

MMA (Minerals Management Area) Management Unit - Emphasis is on making land surface available for existing and potential major mineral developments.

In the "Land and Resource Management Plan" the Forest Service lists specific objectives pertaining to management of resources and resource uses on National Forest System lands. The Forest Service portion of the disturbed area (portal area) is currently identified as a Minerals Management (MMA) Unit. After completion of coal mining activity, the area will revert to a Range (RNG) Management unit.

COMPATIBILITY OF MINING OPERATION WITH FOREST SERVICE MANAGEMENT EMPHASIS AND OBJECTIVES

All mining activities related to the Forest Service "Land and Resource Management Plan" will be coordinated with the appropriate Forest Service personnel prior to implementation. While the mine is located on the Forest Service land boundary, creating primarily visual and traffic pattern related impacts, these effects are considered to be rather short term and will be essentially eliminated upon mine closure.

ARCHAEOLOGY AND PALEONTOLOGY IMPACTS

State and Federal laws require protection of certain cultural resources. The mining operation is considered compatible with the requirements of all agencies in this area, since to date, there are no known archaeological or paleontological sites within the proposed disturbed areas. Section 2.1.1 and Appendix Volume A-3 contain additional discussion and documentation on these cultural resources.

BUILDINGS, PUBLIC ROADS, AND OTHER MAN-MADE FACILITIES

There are few man-made features located within the Skyline Mine permit area. One abandoned gas well is located within the permit area in Eccles Canyon. The only building located within the permit area is a small structure associated with Gas Well No.8. A natural gas pipeline traverses the permit area and an associated gas tank is located east of the southeastern boundary of the lease area. The location of public roads, including SR-264, within and adjacent to the lease area are illustrated in Map 2.12.1-1. A USGS gauging station was located near the mouth of Eccles Canyon but was removed during the summer of 1985. (See also the reclamation discussion in Part 4.)

CEMETERIES, NATIONAL TRAILS AND WILD RIVERS

There are no cemeteries, national trails, or wild rivers located within or adjacent to the Skyline Mine lease and permit areas.

LAND USE OF THE NORTH LEASE TRACT AREA

The North Lease Tract Area is located north and adjacent to the Skyline Mine. Consequently, the landuse of the North Lease Tract Area is very similar to that described in Section 2.12 for the Skyline property.

The general area of the Skyline property lies within both Carbon and Emery counties, whereas, the North Lease Tract lies only within Carbon County.

Land uses of the areas consist of wildlife habitat, grazing, recreation, natural gas transmission and forestry.

Wildlife Habitat

A listing of wildlife that inhabit the North Tract Area can be found in Section 2.9.5 with additional details about the general mine area in Appendix Volume A-2.

Grazing

National Forest Sheep allotments are maintained in the area. Private lands are grazed by similar numbers of sheep.

Recreation

Recreational use of the area consists primarily of hunting (big game, game birds, and small game species), sightseeing, snowmobiling, and cross country skiing. Limited camping and picnicking also occurs.
9/04/02

Farming

As indicated in the soil section of the North Lease Tract Area, farming in the area is prohibited by the steep and rocky terrain of the area.

Alluvial Valley Fill

Winter Quarters Canyon / Woods Canyon

Minor amounts of Alluvial Valley Fill (AVF) are located in the mouths of Winter Quarters Canyon and Wood Canyon. The AVF determination was based on elevation of mapped alluvial sediments located in Mud Creek, existing surface irrigation ditches located in Woods Canyon, and field observations. In Winter Quarters Canyon the AVF is delineated by mapped alluvial sediments located at the same elevation in the Mud Creek drainage, and surface irrigation ditches that divert water off of Winter Quarters Creek. In Woods Canyon, the AVF is delineated by sediments located in the mouth of the canyon located at the same elevation of the alluvial sediments in the Mud Creek

drainage. A total of 44 acres are located in Winter Quarters Canyon and approximately 3 acres are located in Woods Canyon. The crop grown in both canyons (pasture grass) is not harvested for sale. It is consumed in place by livestock.

Mud Creek

EarthFax (2002) evaluated the erosional stability of the Mud Creek channel from Eccles Creek to the town of Scofield. As part of this evaluation, the channel roughness was determined for selected channel cross-sections using the Manning's methodology. The Manning's 'n' values ranged from

0.029 below the Eccles Creek confluence (MC-1) to 0.042 just south of the Town of Scofield (MC-3). The roughness of the floodplain was estimated to be 0.06, typical of other vegetated flood plains.

The longitudinal profiles of Pleasant Valley and the Mud Creek channel from above its confluence with Eccles Creek to the inlet to Scofield Reservoir are discussed below under geometry and physical characteristics.

Mt. Nebo (2002) conducted a riparian vegetation study along Eccles and Mud Creeks and found that the vegetation generally consists of grasses, rushes, sedges, and willows. Vegetation was determined to be generally stable with no severe riparian degradation. Some areas were visually observed to have minor unstable segments evidenced by exposed roots, slight undercutting, and erosion.

EarthFax (2002) collected channel bank and bottom samples from three locations on Mud Creek. The samples were analyzed for physical parameters (sieve analysis, unit weight, direct shear, and Atterberg limits). The sample results are presented in Appendix B of the February 2002 report (located in Addendum to PHC, July 2002, Appendix D). These results show the bank soils to be silty sands to clayey silts. The report indicated that the channel banks and bed materials are structurally and erosionally stable.

The Soil Conservation Service classified the soils in the Pleasant Valley as belonging to the Silas and Silas-Brycan Series. Both are deep to very deep soils in alluvial valleys, derived from the sandstone and shale of the Blackhawk Formation. Soil pH ranged from 6.6 to 8.4 and salinity values were less than 2 mmhos/cm (SCS, 1988).

Descriptions of typical pedons of the Brycan and Silas series, as published by the Soil Conservation Service (1988), are provided in Attachment 2. According to these descriptions, subsurface soils (below

a depth of about 24 inches) generally consist of loam to silty loam or sandy clay loam with a subangular blocky structure. The soil tends to be slightly hard to hard, firm, with very fine roots and a pH of approximately 7-8.

Geometry and Physical Characteristics. Attachment 1 presents the longitudinal profiles of Pleasant Valley and the Mud Creek channel from above its confluence with Eccles Creek to the inlet to Scofield Reservoir. Based on the overall distances and the change in elevation, the slope of the valley is 0.0128 ft/ft and the slope of the channel is 0.0091 ft/ft. The difference in the slopes is due to the increased length of the channel. The channel meanders through the valley and follows a longer path. The sinuosity ratio of the channel is 1.6. This indicates that the channel is approximately 60 percent longer than the valley. In a preliminary estimate of sinuosity for Mud Creek (EarthFax Report provided in Appendix D, Table 4, July 2002 Addendum to the PHC) an average sinuosity of 1.1 was shown in Table 4, however updated information from aerial photography indicates a considerably longer flow path than previously estimated. Thus the 1.6 sinuosity ratio is felt to represent actual conditions of the creek.

Attachment 1 also presents cross-sections of the valley. Six valley cross-sections are presented to show the various sections of the valley. The cross-section locations are presented in Figure 2.12-B. Cross-section 1681 represents the upper narrow portion of the valley where the stream is incised and confined. Cross valley slopes toward the stream channel in this upper section were determined to range from 0.05 to 0.22 ft/ft. In the lower valley cross-sections, the valley broadens and the valley bottom cross-slopes flatten to 0.02 to 0.10 ft/ft, allowing channel incision to reduce. These slopes are consistent with slopes determined from the collar elevations between the water level monitoring piezometers installed at the current EarthFax study cross-sections.

Appendix D of the EarthFax (2002) report(located in Addendum to PHC, July 2002, Appendix D) presents channel cross-sections which are representative of the various channel reaches of Mud Creek. The channel width of Mud Creek ranges from 15 to 20 feet. Based on visual observation of the creek, the channel is slightly incised and low flow terraces are limited in extent and discontinuous. In some places, no low flow terraces exist at all.

A broad flood plain does not exist for this creek. As shown by the valley cross-sections in Attachment 1 and the cross-sections in Appendix D of the EarthFax report, the creek channel is slightly incised in the bottom of the valley. The valley bottom has a generally moderate (2 to 10 percent) cross slope toward the creek. This configuration results in a limited flood area adjacent to the creek with high capacity. For flooding to extend out of this limited area requires a significant

flood, notably greater than the combined flow of the natural runoff plus the mine discharge. Therefore, the field areas adjacent to Mud Creek are not likely to be affected by flooding from the combined flows.

EarthFax (2002) conducted an evaluation of the hydrologic conditions and erosional stability of the channel banks. Based on the combined mine discharge of approximately 10,000 gallons per minute and natural flows, the channel flows at approximately bankfull conditions. Structural stability evaluations using the bank and channel bed samples with the GEOSLOPE computer program demonstrated that the banks are stable and unlikely to fail due to the combined flow in the channel. Erosional stability evaluations using maximum allowable velocity methods for channel, bank, and flood plain, indicated that channel materials, consisting of silty sands and clayey silts and which are well vegetated with various natural grasses and willows, are able to handle the combined flow without significant erosion.

Very little sinuosity of the stream channel exists in both Winter Quarters and Woods Canyons. In Winter Quarters, the channel length measured approximately 10 percent longer than the length of the property, indicating a sinuosity of 1.1. The channel width of Winter Quarters ranges from 6 to 8 feet. Based on visual observation of the creek, the channel is slightly incised and low flow terraces are limited in extent and discontinuous. In most places, no low flow terraces exist at all. The alluvial sediments in Woods Canyon are limited in extent and were not measured.

Stream Flow. The US Geological Survey has been monitoring long-term stream flow on Mud Creek below the Winter Quarters Confluence at Scofield, Utah since 1979. A plot of the daily mean flow is presented in Figure 2.12-C. Although the period of record is 1979 through 2002, a break in the record occurred between 1986 and 1991, during which time no flow data were collected. Flows during the period of record have ranged from a maximum of 389 cfs in May 1984 to a low of 1.6 cfs in January 1980. The periods of high flow generally occur during the spring snow melt period in May through June lasting for a duration of approximately 30 to 45 days. Following the snowmelt period, the stream flow drops gradually to the low flow period which occurs generally during fall and winter months. Some minor short-term events occur, but the duration is generally less than a day and the flows have historically not been greater than the snowmelt events.

In August 2002, EarthFax, as part of an on-going study, installed a series of piezometers at six locations along Mud Creek. The piezometers were located on both sides of the stream to identify the water table and determine the potential for groundwater movement toward or away from the creek. The location of the piezometers and the corresponding water levels are shown on the valley cross-sections in Attachment 1. Of the valley cross-sections only four correspond to piezometers which were measured.

Upon completion of the EarthFax report all piezometer information will be provided. Based on the water levels from the piezometers, it is apparent that the lower portion of Mud Creek is a stream with the groundwater table beneath the adjacent alluvium elevated relative to the water surface in the stream channel.

Therefore, groundwater contributes to the creek flow through the lower portion of the Pleasant Valley. This is further supported by the wetland and spring areas adjacent to the stream identified by Mt. Nebo in Reaches 4 and 5 (Eccles Creek confluence to Scofield Reservoir).

A field study currently underway by EarthFax shows that the lower reaches of Mud Creek are gaining stream flow. This is evidenced by the piezometer water levels being higher than the water surface in the stream(see valley cross sections presented in Attachment 1). Under such conditions, the groundwater flow direction is from the pastures toward the stream. Given the steep slope of the valley bottom toward the stream and the associated relatively steep slopes of the groundwater surface toward the stream, any increase in the water surface of the stream will only raise the potentiometric surface beneath the valley within a relatively small zone adjacent to the stream. Thus, there is no significant potential for the combined flow in the stream channel to increase the groundwater table under a substantial portion of the pastures.

Utilizing the US Geologic Survey stream flow data, the base flow contribution to Mud Creek was estimated. Using the fall and winter data for the early portion of the flow record, before significant mining activity and discharge occurred the base flow for Mud Creek is estimated to range between 1.6 and 5 cfs. The variation in flow is based on the prior year's precipitation, with wet years yielding higher base flows.

Based on the flow readings in the stream channel at MC-1 (18.24 cfs) thru MC-3 (24.44 cfs), the stream flow increases in a downstream direction. While there are some interferences with inflows from contributing surface stream flow and irrigation return flows, the major portion of the increase likely represents base flow contribution. The flow difference between MC-1 and MC-3 is 6.6 cfs. Assuming that approximately 2 to 3 cfs is contributed from the side drainages, the base flow contribution would be on the order of 3 to 4 cfs. This fall is within the range estimated from the US Geologic Survey records.

Stream flow in Winter Quarters, measured quarterly at the western property boundary over the last few years, ranges from 108 to 871 gpm and averages 342 gpm. Stream flow in Woods Canyon, measured

quarterly at the mouth of the canyon over the last few years ranges from 23 to 410 gpm, and averages 120 gpm.

Monitoring Plan. In coordination with the Division of Oil, Gas, and Mining, Canyon Fuel has developed a work plan to evaluate mine-water discharge impacts in Mud Creek. The plan requires characterization of the existing channel and groundwater conditions, gathering and monitoring of stream flow data, evaluation of historic land use, collection of water quality data, evaluation of bank stability, and performance of long-term monitoring.

A copy of the plan is included in Attachment 3 for both EarthFax Engineering, Inc and Mt. Nebo Scientific. The sampling results are incorporated into Appendix B of the February 2002 report (located in Addendum to PHC, July 2002, Appendix D) and will continue to be incorporated into the Addendum to the PHC as sampling results become available.

As indicated in the work plan:

Flow and water-quality data (TDS, TSS, total phosphorus) will be collected at monitoring points MC-2 through MC-5 four times per year (i.e., seasonally), when accessible, for a period of one year following a sustained reduction in mine-water discharge to a rate of 5,000 gpm or less (i.e., pre-September 2001 levels). Channel cross sections and longitudinal profiles will be collected from each reference site annually during the same period. Flow and water-quality data will also be collected any time there is an increase in discharge rates from the mine of at least 25% above the average rate for the prior month.

Fields and Crops. The farms and field areas in Pleasant Valley are delineated on Figure 2.12-D. Table 2.12.3 shows the ownership, crop grown, size, and yield for each of the farms. Information concerning land ownership was obtained from Plate 1.6-1. The crop grown on each parcel was determined from field observations over a period of several years. The size of each parcel was determined from field observation, using Plate 1.6-1 as a basis. Historical yield information is not available for the private land. However, Mr. Ray Jensen, Range Specialist for the BLM, indicated that the area owned by the U.S.A. is classified as sub-irrigated grazed land with a historical yield for the site of about 2-3 tons per acre of grass (Jensen, personal communication). This exceeds the Soil Conservation Service (1988) production estimates of 1.25 to 1.75 tons per acre for the range sites in the bottom of the Pleasant Valley. Although the yield varies from year to year depending on precipitation and management, it was assumed for this response that the average yield estimated by the BLM (i.e., 2.5 tons per acre) would be applicable to all areas in Table 2.12.3. The anticipated annual yield for each farm was calculated

using this value.

TABLE 2.12.3

FARM OWNERSHIP, SIZE, AND YIELD

Land Owner	Crop Grown	Size (ac)	Annual Yield (tons)
Robert Rodakovich, Trust	Pasture Grass	68	170
U.S.A.	Pasture Grass	40	100
Utahna Pace Jones Trust	Pasture Grass	322	805
Fred & Shiela Jensen	Pasture Grass	88	220
William A. & Mattie Cornaby	Pasture Grass	6	15
Rudman Land and Livestock	Pasture Grass	3	7.5

The crop grown in the subject area (pasture grass) is not harvested for sale. Rather, it is consumed in place by livestock. Therefore, its value must be calculated based on the replacement cost of imported feed if the pasture grass becomes unavailable.

Standard ranching practices suggest that a grazing cow or horse requires approximately 0.75 tons of feed per month while a fed animal requires about 0.5 ton of feed per month. The difference is due to the reduced energy output of an animal that is given its feed versus that which must forage for feed. Based on a cost of $100/ton of hay, and a consumption rate of 0.5 tons per animal per month, the cost of feed ranges from approximately $50 to $75/animal/month.

Impacts which may result would be either the loss of production and income as a result of flooding or increased saturation of the root zone. Flooding impacts would occur if the pasture land were inundated for extended periods. Saturation impacts would occur if the water table underlying the pastures were raised for extended periods of the growing season.

Based on the information presented by EarthFax (2002), the flooding potential from the combined flow of natural runoff and mine discharges is very small. The combined flow only reaches bankfull stage and does not reach the top of bank or flood plain areas. Therefore, no flooding impact is expected to the adjacent pastures/farming activities along and adjacent to Mud Creek.

- Electro-telluric surveys to determine coal seam thickness and depth and aid in prediction of fault displacement.

- Premining analysis of interseam strata to determine site-specific thickness, stratigraphical and chemical characteristics. In establishing the extracting limitation based on coal seam thickness, both conservation of the coal resource and the economy of operation were considered.

- Mining methods involving both longwall and room and pillar extraction have been considered to achieve the maximum safe and economic recovery of the coal resources.

3.1.2 Mine Development Plan

The selected mine portal sites for the Upper O'Connor and Lower O'Connor "A" seams are located at outcrops of coal of mineable thickness.

The outcrops of the Upper O'Connor and Lower O'Connor "A" seams allow access to the two seams through drift entries. This selection of portal location is additionally enhanced by its reasonable proximity to railroad transportation facilities available in Pleasant Valley and the availability of at least some relatively flat acreage adjacent to the outcrop. The Lower O'Connor "B" seam will be reached via underground rock slopes from entries in the Upper O'Connor or Lower O'Connor "A" seams.

Five portals were used at Mine No. 3 drift entry location for the intake of air, the transportation of mining crews and materials, and exhaust air. One additional entry portal in Mine No. 3 is used for the conveyance of coal from the mine. Mine No. 1 has four portals.

The Upper O'Connor seam also utilize~~s~~d a breakout to improve the ventilation. The Breakout ~~is~~ was located on a south facing slope in a side canyon of the South Fork of Eccles Creek (see map no. 3.2.11-1). ~~No exhaust fans or permanent activity is planned for this area.~~ The portal was backfilled

and reclaimed in 2003.

The size of portals vary to conform to the mineable height of the Upper O'Connor seam and the Lower O'Connor "A" seam.

A series of parallel underground openings called entries, separated by blocks of coal providing support, called pillars, are driven from the portal location and are called "main entries", or "mains". These entries are comparable to the main avenues of a city, and allow access for the provision of power, piping, haulage, ventilation, and support services. The design of the mains and the layout of the mines for the Skyline project have been engineered after careful review of the many conditions that can affect the mining operations.

A large number of parallel headings has been determined necessary to maintain air velocities within required acceptable limits (usually less than 800 ft/min. for the 4-6 tons of air required to be circulated through the mine for every ton of coal mined). The final number of developed entries will be based on the requirements of the mine area to be accessed.

Since the Permittee considers five feet to be the minimum seam height which can be economically extracted due to machinery limitation and coal quality, maps show mining areas which are at this time predicted to be greater than five feet in height and have more than 40 feet of interburden to the next mineable seam. The interburden thickness is variable throughout the mine plan area and varies depending upon local overburden. As new drill hole data, seismic studies, actual mining conditions, etc., become available, the geologic structure maps will change to reflect this new information. In addition, the mine projections will be modified to incorporate this new information. Further advances in technology may also cause the mine projections to be modified.

The irregular areal extent of the coal seams has been considered in mine planning in order to extract coal in blocks which are not overlain by a successively higher coal seam. This procedure has made it

The mains developed to access the North Lease area will be driven through the SW1/4 SW 1/4 of Section 12, Township 13 South, Range 6 East. Multiple entries will be driven north from existing workings within the unsealed southeastern portion of Mine 3 workings (Drawing 3.1.8-2). As the mains approach the northeast portion of the abandoned Mine 3 workings, they will be angled downward to go under the abandoned workings instead of through. This portion of Mine 3 was flooded by pumping water from Mine 2 into Mine 3 beginning in March 1999. This pumping continued until August 2002. At that time, the water level in the abandoned Mine 3 was reduced in the abandoned portion of Mine 3 to an elevation below the northeast corner of Mine 3 and at or below the level of the new entries. Draining of Mine 3 continues as mining advances north, west and down dip of the Mine 3 workings. Removing the water from the abandoned portion of Mine 3 removes the risk of flooding the new entries from water in Mine 3.

The abandoned Winter Quarters Mine workings are illustrated on Drawing 3.1.8-2. The new entries to the North Lease area ~~will be~~ are driven at least 300 feet horizontally from the closest point in the abandoned Winter Quarters Mine. As required by MSHA, exploratory drilling was conducted at required intervals to ensure Skyline Mine does not intercept the abandoned Winter Quarters Mine.

~~No second mining of the entries driven to the North Lease area will occur. Therefore, not surface subidence or disturbance is planned or projected into this area.~~ In the North Lease, longwall mining is scheduled to commence in early 2006. Undermining of portions of Winter Quarters Creek and Woods Canyon creek are planned, but only minor surface subsidence is anticipated. A portion of land, approximately 397-acres, located on the north side of Winter Quarters Creek is identified as a potential first-mining area. Based on BLM recommendations for Maximum Economic Recovery (MER), the area will be mined by conventional methods should suitable conditions exist. No subsidence is anticipated in this area, should this area be determined to be mineable.

3.1.3 Method of Mining

- Electro-telluric surveys to determine coal seam thickness and depth and aid in prediction of fault displacement.

- Premining analysis of interseam strata to determine site-specific thickness, stratigraphical and chemical characteristics. In establishing the extracting limitation based on coal seam thickness, both conservation of the coal resource and the economy of operation were considered.

- Mining methods involving both longwall and room and pillar extraction have been considered to achieve the maximum safe and economic recovery of the coal resources.

3.1.2 Mine Development Plan

The selected mine portal sites for the Upper O'Connor and Lower O'Connor "A" seams are located at outcrops of coal of mineable thickness.

The outcrops of the Upper O'Connor and Lower O'Connor "A" seams allow access to the two seams through drift entries. This selection of portal location is additionally enhanced by its reasonable proximity to railroad transportation facilities available in Pleasant Valley and the availability of at least some relatively flat acreage adjacent to the outcrop. The Lower O'Connor "B" seam will be reached via underground rock slopes from entries in the Upper O'Connor or Lower O'Connor "A" seams.

Five portals were used at Mine No. 3 drift entry location for the intake of air, the transportation of mining crews and materials, and exhaust air. One additional entry portal in Mine No. 3 is used for the conveyance of coal from the mine. Mine No. 1 has four portals.

The Upper O'Connor seam also utilized a breakout to improve the ventilation. The Breakout was located on a south facing slope in a side canyon of the South Fork of Eccles Creek (see map no. 3.2.11-1). The portal was backfilled and reclaimed in 2003.

Main entries in the mines are advanced so that mining panels may be developed on one or both sides. These panels are usually 2,500 to 7,000 feet long and 400 to 800 feet wide. The panels will be mined by driving rooms or by retreat-type operations where coal is mined as Room and Pillar Mining. Where feasible, the coal will be removed by a longwall operation. The panels will then be "pulled" consecutively to the barrier, leaving the main entries intact.

The mains developed to access the North Lease area will be driven through the SW1/4 SW 1/4 of Section 12, Township 13 South, Range 6 East. Multiple entries will be driven north from existing workings within the unsealed southeastern portion of Mine 3 workings (Drawing 3.1.8-2). As the mains approach the northeast portion of the abandoned Mine 3 workings, they will be angled downward to go under the abandoned workings instead of through. This portion of Mine 3 was flooded by pumping water from Mine 2 into Mine 3 beginning in March 1999. This pumping continued until August 2002. At that time, the water level in the abandoned Mine 3 was reduced in the abandoned portion of Mine 3 to an elevation below the northeast corner of Mine 3 and at or below the level of the new entries. Draining of Mine 3 continues as mining advances north, west and down dip of the Mine 3 workings. Removing the water from the abandoned portion of Mine 3 removes the risk of flooding the new entries from water in Mine 3.

The abandoned Winter Quarters Mine workings are illustrated on Drawing 3.1.8-2. The new entries to the North Lease area are driven at least 300 feet horizontally from the closest point in the abandoned Winter Quarters Mine. As required by MSHA, exploratory drilling was conducted at required intervals to ensure Skyline Mine does not intercept the abandoned Winter Quarters Mine.

In the North Lease, longwall mining is scheduled to commence in early 2006. Undermining of portions of Winter Quarters Creek and Woods Canyon creek are planned, but only minor surface subsidence is anticipated. A portion of land, approximately 397-acres, located on the north side of Winter Quarters Creek is identified as a potential first-mining area. Based on BLM recommendations for Maximum Economic Recovery (MER), the area will be mined by conventional methods should suitable conditions exist. No subsidence is anticipated in this area, should this area be determined to be mineable.

3.1.3 Method of Mining

In order to achieve maximum coal reserve recovery and enhance overall production rates, the mining plan, as developed to date and herein proposed, involves two mining methodologies most appropriate for

Skyline's coal reserves. The mines are developed using continuous miners to drive entries which are connected with cross cuts. Continuous miners are also used for retreat room and pillar mining. The room and pillar method of mining is being implemented in particular situations for which longwall mining is inappropriate. The longwall mining system will be used to extract the majority of the Skyline coal.

Longwall Mining

Longwall mining is proposed for the extraction of large uniform blocks of mineable coal, resulting in increased production rates and overall recovery. Mine layouts are based on longwall mining in areas where the panels generally are more than 2,500 feet in length and where a suitable longwall panel can be constituted. The 2,500 foot length is used however only as a guideline, and may vary significantly depending upon physical as well as economic factors. Recoverable coal reserves in longwall mining areas are based on mining a maximum thickness of fifteen feet.

The longwall mining operation utilizes at least two sizes of equipment in order to mine the variations in seam thickness locally encountered. Lower equipment will be used for mining down to 5 feet of coal thickness, and larger equipment will be used to mine thicknesses of at least 15 feet.

In areas where coal is thicker than the height capacity of the mining equipment, the unmined coal will be left in the bottom of the bed, unless economic or safety conditions or operation constraints warrant otherwise.

A high overall recovery of reserves can be expected as the longwall unit retreats through a panel. Pillars in developed entries will be left to protect adjacent panels. Longwall mining results in controlled surface subsidence in that small coal pillars and stumps are not left behind resulting in unpredictable surface behavior. A predictable uniform lowering of the surface will occur.

result of subsidence, the expected maximum amount of subsidence, locations of water rights, and the area where the overburden is 700 feet or less over the mineable coal seam, the Lower O'Connor "A". No buildings, pipelines, or maintained roads were found in the areas to be subsided as a result of implementing the current North Lease mine plan. The only mapped pack trail in the North Lease area runs east-west on the ridge between Winter Quarters Canyon and Woods Canyon, dropping down into Winter Quarters Canyon. The trail is outside the area to be subsided, therefore, no subsidence related impact is anticipated on the trail.

As discussed in detail in Section 2.2 of this M&RP, the rocks in the North Lease area are in compression. The state of compression of the rocks in the North Lease area will likely allow the subsidence forces to be transmitted across fault and fracture planes thus resulting in uniform subsidence.
Previous mining in Mine #3, where the rocks are also under compression, did not result in focused subsidence along faults or fractures. Indeed, in the southern portion of the mine permit area where the rocks are subjected to extensional forces, focused subsidence did not take place.
Drilling and field work conducted in the North Lease by Skyline geologist Mr. Mark Bunnell indicates the Castlegate Sandstone in the head of Winter Quarters and Woods Canyons in the permit area consist of two thin sandstone units, separated by slope-forming shale and siltstone. Because of the thinner, "ledge and slope" nature of the Castlegate in the permit area, the potential for subsidence-induced escarpment failures or landslides is minimal (3/3/05 M.Bunnell memo).
As discussed in Section 4.17.3 and illustrated in Drawing 4.17.3-1A, the combination of geology, depth of cover, and mine plan should keep

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subsidence affects to a minimum (See Section 2.2 for detailed geology discussion). Drawings 4.17.1-1 and 4.17.1-2 illustrate that, if the maximum subsidence does occur, no reduction or significant alteration of the perennial stream flow should occur. This is due primarily to the existing stream gradient, projected worst-case subsidence, depth of cover, and depth of alluvium within the drainage corridor. Although the gradient is reduced in some areas, no significant ponding or over-steepening of the gradient is anticipated. Potential areas of *minor* cracking, as illustrated on Drawing 4.17.3-1A, are primarily a function of the advancement direction of the longwall panel, steepness of slope, the lack of confining pressure, and how the bedrock subsides into the void left by longwall mining.

The mine will not subside any of the perennial streams in the North Lease without approval from the Forest and Division. The Burnout Canyon Study (Appendix A-1, Volume 2), conducted in cooperation with Canyon Fuel Company, LLC, and The Manti-Lasal National Forest, was completed in July 1998. The study was specifically designed as a demonstration for successful undermining of perennial streams. Stream flow measurements taken in Burnout Canyon during and subsequent to the study and compared to flows in drainages outside the permit area also demonstrate any changes in flow in Burnout Creek areas likely related to climatic changes (drought) and not mining activities (DOGM EDI). The stratigraphy, depth of cover, and general dip of the formations in Woods and Winter Quarters Canyons are very similar to Burnout Canyon. The permittee believes the Burnout Canyon Study can be used to predict the

the same grid scale as the baseline to show the elevational deviation from the baseline elevations. The digitized information will be submitted annually to the regulatory agency after subsidence commences.

An on-the-ground visual inspection will be made of the ground surface of subsidence areas (including angle of draw)where the potential for tension cracks or fissures exist. The inspection will be conducted between six (6) and 12 months after mining has occurred. This information is supplemented with the annual subsidence report and corresponding map supplied to the Division.

This inspection will attempt to locate, photograph, and document the presence of subsidence effects to surface improvements, tension cracks, fissures and other surface effects.

The subsidence monitoring data could be used to determine: 1) the critical width across the pressure arch; 2) the draw angle; 3) the ratio of observed subsidence to predicted maximum subsidence (S/Smax); 4) the relationship between mining and onset of subsidence and the correspondence between the face advance and subsidence profile development; and 5) the bulking factor.

Table 4.17.5A illustrates subsidence points in both Mine #3 (where single-seam mining has occurred) and Mines #1 and #2 (where two-seam mining has occurred, and compares the anticipated subsidence (Section 4.17.3) with actual subsidence that has occurred. All the subsidence locations used were located where a creek crosses the center of a panel. These sites were used due since there is typically better ground

4.17 SUBSIDENCE CONTROL PLAN

This section describes in further detail the Permittee's mine plan design, ensuring subsidence effects of the Skyline Mine produce minimum environmental impact. Section 3.1 - SKYLINE MINING OPERATION PLAN describes in detail the proposed methods of coal extraction and mine development which were selected partly on subsidence and nonsubsidence criteria. Section 2.2 presents the detailed geological information which provided an analytical base for mine plan and subsidence control design. The following subsections describe the principal factors involved in measuring and controlling subsidence resultant of the proposed mining operations.

4.17.1 Subsidence Probability Survey

Prior to mining, a careful review of the permit area shows that the following areas could face potential subsidence impact which may be of concern: Mountain Fuel Supply gas pipeline, U-264, Burnout Creek and James Creek which cross the permit area. Upper reaches of Electric Lake Reservoir, upper Huntington Creek, Bolger Creek and South Fork of Eccles Creek will not be subsided. The gas line was moved to Burnout Canyon in the early 1990's to allow for undermining the previous location. The gas line was re-established in its original location in the fall of 2000 and a second gas line was placed in the corridor in the fall of 2001.

A pre-subsidence survey was conducted in the fall of 2002 of the North Lease area (Winter Quarters Lease). A map was generated to illustrate the locations of any structures, water rights, and renewable resource lands that could be adversely affected by subsidence. This map is included as Drawing 4.17.3-1A and illustrates the locations where surface cracks may appear as a result of subsidence, the expected maximum amount of subsidence, locations of water rights, and the area where the overburden is 700 feet or less over the mineable coal seam,

the Lower O'Connor "A". No buildings, pipelines, or maintained roads were found in the areas to be subsided as a result of implementing the current North Lease mine plan. The only mapped pack trail in the North Lease area runs east-west on the ridge between Winter Quarters Canyon and Woods Canyon, dropping down into Winter Quarters Canyon. The trail is outside the area to be subsided, therefore, no subsidence related impact is anticipated on the trail.

As discussed in detail in Section 2.2 of this M&RP, the rocks in the North Lease area are in compression. The state of compression of the rocks in the North Lease area will likely allow the subsidence forces to be transmitted across fault and fracture planes thus resulting in uniform subsidence. Previous mining in Mine #3, where the rocks are also under compression, did not result in focused subsidence along faults or fractures. Indeed, in the southern portion of the mine permit area where the rocks are subjected to extensional forces, focused subsidence did not take place.
Drilling and field work conducted in the North Lease by Skyline geologist Mr. Mark Bunnell indicates the Castlegate Sandstone in the head of Winter Quarters and Woods Canyons in the permit area consist of two thin sandstone units, separated by slope-forming shale and siltstone. Because of the thinner, "ledge and slope" nature of the Castlegate in the permit area, the potential for subsidence-induced escarpment failures or landslides is minimal (3/3/05 M.Bunnell memo). As discussed in Section 4.17.3 and illustrated in Drawing 4.17.3-1A, the combination of geology, depth of cover, and mine plan should keep subsidence affects to a minimum (See Section 2.2 for detailed geology discussion). Drawings 4.17.1-1 and 4.17.1-2 illustrate that, if the maximum subsidence does occur, no reduction or significant alteration of the perennial stream flow should occur. This is due primarily to the existing

stream gradient, projected worst-case subsidence, depth of cover, and depth of alluvium within the drainage corridor. Although the gradient is reduced in some areas, no significant ponding or over-steepening of the gradient is anticipated. Potential areas of *minor* cracking, as illustrated on Drawing 4.17.3-1A, are primarily a function of the advancement direction of the longwall panel, steepness of slope, the lack of confining pressure, and how the bedrock subsides into the void left by longwall mining.

The mine will not subside any of the perennial streams in the North Lease without approval from the Forest and Division. The Burnout Canyon Study (Appendix A-1, Volume 2), conducted in cooperation with Canyon Fuel Company, LLC, and The Manti-Lasal National Forest, was completed in July 1998. The study was specifically designed as a demonstration for successful undermining of perennial streams. Stream flow measurements taken in Burnout Canyon during and subsequent to the study and compared to flows in drainages outside the permit area also demonstrate any changes in flow in Burnout Creek areas likely related to climatic changes (drought) and not mining activities (DOGM EDI). The stratigraphy, depth of cover, and general dip of the formations in Woods and Winter Quarters Canyons are very similar to Burnout Canyon. The permittee believes the Burnout Canyon Study can be used to predict the impacts of undermining both Winter Quarters and Woods Canyons and that mining in the North Lease area can be conducted with minimal impacts to perennial streams due to subsidence.

The Forest has indicated that the forest land is considered to have renewable resources related to wildlife and grazing. The timber resources are extremely limited and isolated in this

area of the forest and will likely never be harvested (Carter Reed, Manti-La Sal National Forest, Oral Communication 10-2002).

4.17.2 Mining Methods

The mining methods to be used by the Permittee include longwall mining, room and pillar mining with pillar removal, and room and pillar mining with pillars left in place. Certain room and pillar mining systems are designed to provide full support and will prevent subsidence. Subsection 3.1.5 contains descriptions of the mining methods to be implemented.

Full extraction areas include room and pillar panels with pillar removal and longwall panels. Subsidence prediction work has shown the expected maximum planned and controlled subsidence will vary from 0 to 24 feet, assuming that the total cumulative extraction from the three mineable seams will not exceed 30 feet.

4.17.3 Subsidence Effect Prevention Measures

It is anticipated that the planned subsidence will result in a generally uniform lowering of the surface lands in broad areas, thereby limiting the extent of material effect to those lands and causing no appreciable change to present land uses and renewable resources. The Permittee established a subsidence monitoring program in the early stage of mining for use in reviewing the surface effect of mining and as an aid in future mine planning.

In areas where mining related subsidence would damage resources, room and pillar mining methods will be used. Wherever the pipeline and creek buffer zones coincide, creek buffer zone requirements take precedence. Where the yield pillar/barrier system is used, the

critical area will not influence the surface. The width of the area of supportive mining is equal to 50 feet (25 feet on each side of the pipeline centerline no surface movement) plus the tangent of 22° draw angle as shown in the 1988 Annual Report and included in Vol. 4, multiplied by the overburden depth of the mined coal bed:

- Nonsubsidence Mining Width = 50 feet + (2 X tan 22° x depth)

The width of the supportive mining area will be adjusted, as appropriate, when future information and monitoring shows it to be necessary.

The 22 degree draw angle is conservative and conforms to the Permittee's data on permit area subsidence as well as experience from other comparable mining activity in the Wasatch Plateau (Plate 4.17.3-1).

There will be no mining caused subsidence under either the Electric Lake Reservoir, Upper Huntington Creek and Bolger Creek inlets to the reservoir, and no mining from which subsidence at a 22-degree (from vertical) angle of draw would influence either these reservoir inlets or the high-water level of Electric Lake Reservoir. The width of the buffer zone was calculated as follows:

- Buffer zone width = tan 22° x overburden depth

The width of the buffer zone has been calculated using the overburden depths to the coal seams.

There is a very substantial tonnage of coal which lies to the west of Upper Huntington Creek and Electric Lake Reservoir, which the Permittee plans to mine.

Mains under the Huntington Creek (Drawing 3.1.8-3) will be a full support room and pillar mining system. These mains will be designed to avoid short or long-term surface affects from mining. Prior to abandonment of these mains,

measures will be taken to ensure no surface subsidence is induced due to failure of the entries, as mutually agreed with regulatory agencies. The entries in Skyline Mine No. 2 will enter the Huntington Creek buffer zone for a short distance as approved by the Division/U.S. Forest Service

No mining will be conducted beneath Electric Lake.

Full extration mining techniques under the creek buffer zones will only be proposed if evidence shows surface effects, if any, can be mitigated. Full extraction mining techniques and associated mitigation plans must first be approved by the Division/U.S. Forest Service.

Drill holes show that there are clay rich shale layers present which will likely swell into an impervious clay when wet. This characteristic is expected to seal possible subsidence cracks to prevent downward migration of water and subsequent loss of springs and other water sources based on information supplied by Roy Full (Volume A-3)and supported by the Burnout Canyon Study (Appendix 1-A, Vol.2).

Extensive experience with mining-induced subsidence at Skyline Mine indicates the subsidence factor (SF) relative to mining height is as follows:

Overburden 200-500' ~ SF 0.7
Overburden 500-1000' ~ SF 0.5
Overburden 1000-1500' ~ SF 0.3
Overburden 1500-2000' ~ SF 0.15

Approximately 20-30 percent of the planned subsidence will be occurring where overburden thickness ranges from 500 to 1000 ft. and 70-80 percent of the subsidence occurring where overburden thicknesses are greater than 1000 ft(3/3/05 M. Bunnell memo). Given the projected mining thickness is 9-11 feet, and the approximate minimum overburden is 600 feet in the North Lease area, the maximum subsidence anticipated is less than 6 feet. Drawing 4.17.3-1A illustrates most of the subsidence will be in the 2 to 4 ft. range. Areas identified as having 6-feet of subsidence were rounded-upward to provide a six-foot contour line. Six-feet of subsidence is generally a worse-case scenario.

A section of a natural gas pipeline in the Burnout Canyon-Huntington Creek area was decommissioned in October 2000. Its replacement section was constructed in the pre-existing pipeline right-of-way on top of Trough Spring Ridge. Since the Trough Springs Ridge area will not be undermined again and subsidence from previous mining under this area is essentially complete, the Burnout Canyon-Huntington Creek portion of the pipeline is labeled as "old pipeline" on the mine maps and is still owned by Questar. However, it has been decommissioned by Questar to allow undermining by Skyline Mine. The future utilization and status of decommissioned portion of the pipeline is Questar's responsibility.

4.17.4 Mitigation of Subsidence Effects

Surface structures which may be effected by subsidence include the Permittee's buildings and facilities incidental to the coal operation, the natural gas pipeline which crosses the coal lease area, and roads within the area. No additional structures are located within the new UP&L lease area.

Should subsidence damage any of the surface structures despite the planned subsidence prevention measures, the Permittee will arrange for their repair. Any subsidence related damage to SR 264 will be repaired by the Permittee in accordance with the DOT Subsidence Impact Agreement dated July 17, 1989 (see Exhibit 1).

Hydrologic information during a four year period (1984-1989) at the Skyline Mine indicates that there is a reasonably good correlation between the amount of mine water discharged from Mine #3 and the amount of coal mined (see Drawing 4.11.4-A). The mine water historically encountered in Mine #3 was produced from the Blackhawk Formation. Data from the approved water monitoring program indicate mine dewatering is not affecting any surface springs or seeps. Water monitoring data suggests the migration of water through the aquifer in Mine #3 is extremely slow to the extent that the water should be considered "perched or trapped water." Since the North Lease mining will be occurring in the area adjacent to the previous Mine #3 workings and under the same geologic environment, similar inflow conditions are anticipated.

If it is determined that subsidence causes material damage or a loss of flow in a perennial stream, the Permittee commits to using the best technology currently available (BTCA)to mitigate the damage. Methods may include backfilling with surrounding native material, incorporating bentonite or other water-retaining native material into the backfill, or possibly even temporarily bypassing/piping flow through impacted areas until mitigation is achieved.

Subsidence Impact Letter Agreement to Dyke LeFevre - EXHIBIT 1

At this point in time it is difficult to suggest specific mitigation of impacts or reclamation on renewable resources that are impacted by undermining, since we can only assume those impacts and their effect. Mitigation measures are site-specific, and will be contingent upon the findings of the subsidence monitoring program. Subsidence data is available on Drawing 4.17.3-1 and is updated in annual reports submitted to DOGM. Mining in the area has been conducted since 1982, providing over twenty (20) years of subsidence data. As noted in Section 4.17.3 and substantiated within the Burnout Canyon study (Appendix A-1,Volume 2), the amount of subsidence is directly related to surface and subsurface geology and depth of cover. To date, the only areas where mitigation efforts have been implemented are in areas where two-seam mining was conducted. Tension cracks formed in areas where a barrier between panels was present in both seams - effectively creating a 20-foot pedestal. These associated cracks were mitigated by backfilling using a dozer and/or a trackhoe. As data are collected, methods of mitigation will be formulated. This will be done in coordination with appropriate regulatory agencies. Since subsidence may continue to occur after final mining, the monitoring program will continue until it is determined by the Permittee in cooperation with the regulatory agency that it is no longer needed, or subsidence has stopped.

Impacted water rights, if any, will be replaced as discussed in Section 2.5.2.

4.17.5 Subsidence Monitoring Program

The Permittee has chosen to establish a subsidence monitoring program using aerial photogrammetrics patterned after a program developed by the Manti-LaSal National Forest to determine the effects of underground coal mining on surface

renewable resources and surface improvements. The monitoring program secures adequate baseline data prior to any subsidence to quantify the existing surface renewable resources and surface improvements on and immediately adjacent to the permit area. The baseline data was established so that future programs of observation can be incorporated at regular intervals for comparison. The monitoring program establishes a system to locate, measure, and quantify the progressive and final affect of underground mining activities on the surface renewable resources and surface improvements. The system utilizes techniques which will provide a continuing record of change over time and an analytical method for location and measurement of a number of points over the permitted area. The continuum of data shall incorporate and be an extension of the baseline data.

A network of control monuments consistent with the desired photogrammetric map accuracy are being established over both the permit area and the immediate adjacent areas not expected to be disturbed by subsidence. The monuments are constructed as survey control points for monitoring the effects of subsidence on surface renewable resources and surface improvements (Map 4.17.5-1). The monuments are located and tied to a state plane coordinate system which is the same for both the surface and mine control surveys. This allows the surface survey to be superimposed over the subsurface mine workings. The monuments have the X, Y, and Z coordinates accurately measured and established by ground survey methods.

The initial aerial photography covers the entire permit area and will be either color or black and white, flown at a scale such that elevations to within one foot vertically and horizontally (± 0.5') can be attained by photogrammetric

methods. It is anticipated that the nominal or mean scale will be 1:6,000 for a 6" focal length camera, unless aerial constraints such as safety dictate flying at a high altitude, but will not exceed 1:7,200. This photography was used for constructing the initial baseline surface map. It also provides the master base to assist in documenting changes caused by subsidence.

To aid in the collection of additional base data on surface renewable resources, color infrared aerial photography (CIR) of the permit area may be utilized. If this technique is used, the photographs will be of the same scale as the other aerial photography.

Subsequent annual black and white or color photography for subsidence monitoring will cover the area mined and the area to be mined in the next 18 months (plus angle of draw). Subsequent CIR photography for monitoring surface resource trends will be flown as needed.

On all aerial photography for both the baseline data and subsequent flights, a photographic overlap of 30 percent between adjacent flight lines and an average of 60 percent overlap of photographs along the same flight line will be obtained. The baseline data will be digitized to show the undisturbed pre-subsided ground elevations and will use a grid with a nominal mean grid scale of 200 x 200 feet. The subsequent flights for subsidence will also be digitized using the same grid scale as the baseline to show the elevational deviation from the baseline elevations. The digitized information will be submitted annually to the regulatory agency after subsidence commences.

An on-the-ground visual inspection will be made of the ground surface of subsidence areas (including angle of draw)where the potential for tension cracks or fissures exist. The inspection will be conducted between six (6) and 12 months after mining has occurred. This information is supplemented with the annual subsidence report and corresponding map supplied to the Division.

This inspection will attempt to locate, photograph, and document the presence of subsidence effects to surface improvements, tension cracks, fissures and other surface effects.

The subsidence monitoring data could be used to determine: 1) the critical width across the pressure arch; 2) the draw angle; 3) the ratio of observed subsidence to predicted maximum subsidence (S/Smax); 4) the relationship between mining and onset of subsidence and the correspondence between the face advance and subsidence profile development; and 5) the bulking factor.

Table 4.17.5A illustrates subsidence points in both Mine #3 (where single-seam mining has occurred) and Mines #1 and #2 (where two-seam mining has occurred, and compares the anticipated subsidence (Section 4.17.3) with actual subsidence that has occurred. All the subsidence locations used were located where a creek crosses the center of a panel. These sites were used due since there is typically better ground control in a stream channel versus a slope, and the concerns related to subsiding streams.

Table 4.17.5A

Subsidence Location	CalculatedSubsidence	**Actual Subsidence**
Mine#3, panel 7R	4.8-ft	5-ft
Mine#3, panel R6	1.95-ft	2-ft
Mine#3, panel 6R	3.9-ft	4-5-ft
Mine#3, panel R5	3.9-ft	4-ft
Mine#3, Panel R4	3.9-ft	3-ft
Mine#2/1, pan. 6L/7L	11.5-ft	12-ft
Mine#2/1, pan. 5L/6L	14-ft	12-ft
Mine#2/1, pan. 4L/5L	12-ft	12-ft
Mine#2, panel 11L	6-ft	6-ft
Mine#2, panel 8L	6-ft	6-ft

Table 4.17.5B cites examples of the maximum extent of subsidence observed at specific sites within the Skyline Mine permit area.

Table 4.17.5B

Subsidence Location	Subsidence Buffer Angle	Actual Maximum Extent of Subsidence
Mine#3 Panel 7R	22°	18°
Mine#2 Panel 9L	22°	20.5°
Mine #2 Panel 11L	22°	22°

It is important to understand the points of zero subsidence used to calculate the angle of draw are somewhat subjective due to the accuracy of the survey method. The points of zero subsidence used in these calculations are very conservative, potentially resulting in a greater angle of draw than actually may exist.

The following monitoring program was initiated as part of the Burnout Canyon Study:

	Description	Who	When
1.	Install parshall flumes for stream flow monitoring as shown on plate 2.3.6-1.	Skyline	July 91
2.	Select and install monitoring for spring flows in the subsidence areas as shown on plate 2.3.6-1.	Skyline	July 91
3.	Install subsidence monitoring adjacent to stream drainages on a maximum 200 ft. centers as shown on plate 2.3.6-1. Points will be 3' rebar with no concrete.	Skyline	July 91
4.	Develop summary report of observed subsidence effects on stream drainages as well as surface and subsurface hydrology to date.	Skyline	Dec. 91
5.	Monitor stream, spring, and subsidence points -- monthly during field season. Map any surface cracks that form.	Skyline	June-Nov. 91 June-Nov. 92 June-Nov. 93*?
6.	Year-end summary reports	Skyline	Jan. 92 & 93
7.	Final report	Skyline	Jan. 94
8.	Evaluation and review	Skyline, DOGM & USFS	Feb. 94

4.17.6 Subsidence Control

The Permittee plans to conduct the underground mining operations so as to prevent subsidence from causing material effect to the surface and to maintain the value and reasonable foreseeable use of that surface in accordance with the preceding subsidence control plan.

4.17.7 Public Notice

Since the surface ownership of the areas of planned subsidence is vested in the United States and is under the authority of the U.S. Forest Service, the annual subsidence monitoring report will be provided to them and to the regulatory authority.

4.17.8 North Lease

Infrared aerial photographs (CIR) will be taken either in August or September of each year. An interpretation of the photographs will be made and a written report will be included in the Skyline Mine Annual Report. If a reduction in renewable resources is noted because of subsidence, the appropriate agencies will be notified and mitigation measures will be developed.

SKYLINE MINES
MINING AND RECLAMAION PLAN
C/007/005

CANYON FUEL COMPANY, LLC

AUGUST 2005

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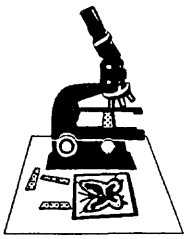

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INTRODUCTION

This reports the second year of sampling of the benthos of the streams in both Woods Canyon and Winter Quarters Canyon. The coal underlying these two drainages is scheduled to be mined in the near future. These data will help establish baseline conditions against which any impacts due to the mining and subsequent subsidence can be compared.

METHODS

Sample placement was determined by examination of the stream systems on USGS 7.5 minute quadrangles. Two to three reaches were examined on each stream, with each reach being defined by the inflow of a side stream and the general distance from the previous reach. The lowest reaches in the two streams were established on USDA Forest Service land above the boundary with private grazing lands. The location of each reach is given in Table 1. Four riffles were sampled within each reach in the fall of 2002, but this was increased to 8 riffles beginning in the spring of 2003. Two samples were taken at each riffle and were bulked together in the field.

Table 1. Location of Reach Stations on Each Stream.

Canyon	Reach	GPS coordinates	Elevation
Woods	Upper	N 39° 44.340' W 111° 13.471' UTM4398045 12S0480808	2609 m (8560 ft)
Woods	Lower	N 39° 44.071' W 111° 12.592'	2552 m (8374 ft)
Winter Quarters	Upper	N 39° 42.763' W 111° 13.907'	2587 m (8488 ft)
Winter Quarters	Middle	N 39° 42.933' W 111° 13.378'	2571 m (8434 ft)
Winter Quarters	Lower	N 39° 43.126' W 111° 12.807'	2519 m (8265 ft)

Physical characteristics recorded for each reach in Woods Canyon (Table 2) and Winter Quarters Canyon (Table 3) included pH, conductivity, in micro-Siemens/cm (uS/cm), alkalinity, and hardness. Alkalinity and hardness were measured with a Hach water chemistry kit. Slope was recorded with an inclinometer, across a 100 meter length of stream, beginning at the first (starting downstream) riffle. The stream channel within each reach was characterized by measuring the width, depth, and velocity of the stream every five meters over 50 meters of stream channel, beginning with the first riffle. Three depth and velocity measures were taken at each five meter interval, these being at the center and approximately 10% of the width from either shore. The data presented are the mean depths and widths for the entire measured reach. A rough estimate of discharge was generated from the mean velocity, depth and width of each reach.

Quantitative invertebrate samples were taken with a modified box sampler (Shiozawa 1986) or a Surber-type sampler frame modified to have the same area dimensions as the box sampler, but without the plexiglass sides and large base. This device is more appropriate for sampling under shallow water conditions as predominate in the stations in these two streams. The Box sampler requires water at least 5 cm deep to sample quantitatively. Both samplers use a capture net with a net mesh of 253 microns. Samples were taken from each of the three reaches in Winter Quarters Canyon and the two reaches in Woods Canyon. Samples were concentrated in the field in sieves with 63 micron mesh, preserved with ethyl alcohol, and were returned to the laboratory for processing. In the laboratory the samples were sorted in an illuminated pan. After the samples were sorted in the pan they were reconcentrated and subsampled with a Hensen-Stempel pipette and the subsamples were processed under magnification so that small invertebrates missed by the initial sorting could be assessed. Organisms were identified to the lowest taxonomic unit possible. Small specimens and those of questionable identity were examined under magnification. Identification was based on the keys of Merritt and Cummins (1994), Wiggins (1977), Edmunds, Jensen, and Berner (1976), and Stewart, and Stark (1993). The mean values for each taxon were used to determine the density of invertebrates per square meter. Standing crop was estimated from wet weights of total invertebrates collected at each reach.

The USFS Biotic Condition Index (Winget and Mangum 1979) was calculated with the community tolerance quotient (CTQa). The predicted community tolerance quotient (CTQp), based on water chemistry data provided in Winget (1972) for the Huntington Creek drainage, is 80. Diversity was calculated for each reach using the Shannon-Weiner index (Pielou 1977). Diversity indices take the number of taxa and their individual densities into account, generating a single value for each station. The greater the number of species or taxa and generally the more even the distribution of densities between taxa, the higher the diversity index value.

Cluster analysis was run with NTSYS-pc (Rolf 2000), using the Bray-Curtis dissimilarity index with the UPGM clustering algorithm. Data from all reaches for the first four sampling periods (fall 2002 through spring 2004) from both Woods Canyon Creek and Winter Quarters Canyon Creek were included in the cluster analysis.

Since these samples are to be used to establish pre-mining base-line information, the most important information for future assessment will be the actual densities and taxa lists. The CTQa, diversity indices, and cluster analysis will serve to help understand relative associations between the two streams, seasonality effects, and within stream trends. As with all field collected data, annual variations in weather patterns (e.g. the ongoing drought in Utah) will need to be taken into account in interpreting the data.

Table 2. Physical characterization of Woods Canyon Creek.

Date	Site*	Alkalinity mg/L $CaCO_3$ equvalents	Hardness mg/L $CaCO_3$ equvalents	Conductivity (uS/cm)	pH	slope	$\bar{x}$ depth (cm)	$\bar{x}$ width (m)	$\bar{x}$ velocity (m/s)	estimated discharge (m^3/s)
10/19/02	U	136.8	273.6	415	8.30	4.0°	3.6	1.213	0.268	0.0117
	L	188.1	324.9	452	8.23	3.5°	4.333	1.157	0.327	0.0164
6/27/03	U	119.7	222.3	351	8.18	4.0°	5.267	1.645	0.187	0.0173
	L	136.8	239.4	393	8.42	3.5°	6.250	1.345	0.276	0.0232
10/13/03	U	220	320	380	8.63	4.0°	2.650	1.048	0.140	0.0039
	L	260	320	440	7.73	3.5°	3.66	1.038	0.118	0.0045
6/28/04	U	220	240	340	8.52	4.0°	5.56	1.919	0.174	0.0186
	L	240	240	405	8.36	3.5°	4.76	1.580	0.244	0.0183

* U - Upper site L - Lower Site

Table 3. Physical characterization of Winter Quarters Canyon Creek.

Date	Site*	Alkalinity mg/L $CaCO_3$ equvalents	Hardness mg/L $CaCO_3$ equvalents	Conductivity (uS/cm)	pH	slope	$\bar{x}$ depth (cm)	$\bar{x}$ width (m)	$\bar{x}$ velocity (m/s)	estimated discharge (m^3/s)
10/18/02	U	119.7	188.1	343	8.26	4.0°	5.8	1.028	0.199	0.0119
	M	136.8	273.6	371	8.34	3.0°	6.367	1.252	0.240	0.0191
	L	136.8	256.5	390	8.32	2.5°	6.983	2.129	0.222	0.0330
6/20/03	U	51.3	136.8	239	8.39	4.0°	8.633	1.215	0.224	0.0235
	M	85.5	153.9	275	8.60	3.0°	8.3	1.799	0.333	0.0497
	L	119.7	205.2	352	8.62	2.5°	11.433	2.07	0.399	0.0944
10/15/03	U	140	240	280	8.57	4.0°	4.817	0.978	0.210	0.0099
	M	200	260	310	8.55	3.0°	6.433	1.945	0.275	0.0344
	L	180	260	280	8.58	2.5°	5.266	1.680	0.240	0.0212
6/30/04	U	160	160	260	8.60	4.0°	6.066	1.10	0.254	0.0170
	M	180	200	294	8.48	3.0°	7.133	1.45	0.348	0.0360
	L	180	240	353	8.52	2.5°	8.833	1.83	0.345	0.0558

* U - Upper site M - Middle site L - Lower Site

RESULTS AND DISCUSSION

Physical Characterization

The stream channel slopes become more shallow as the streams proceed down the canyons, a typical geomorphological profile for stream systems draining mountainous areas (Horton 1945). Channel depth and width generally increase downstream, as would be expected with the influx of additional water from the watershed. Mean velocity also increased downstream, despite the decline in the stream channel slope. The increase in velocity is likely related to the increase in discharge in the lower reaches of the stream system, the greater mean depth, and the reduced turbulence associated with the increase in depth

The chemical characteristics of the streams appear typical for high desert systems draining exposed sedimentary bedrock. As a general rule, alkalinity, hardness, and conductivity increased in the downstream reaches as the water in the channel accumulated salts from streams, springs, and seeps enters the main channel. All three are measures of ions in the water. Alkalinity is generally a measure of carbonate concentration, while hardness is a measure of divalent cations (mainly Ca and Mg). In these two streams the total hardness is consistently greater than alkalinity. If the ions in the systems were purely due to carbonates of calcium and magnesium, we would expect alkalinity to equal hardness. However higher hardness readings indicates that the remaining anions in the system are chlorides, sulfates, silicates, or nitrates (Boyd 1990). Given the origin of the bedrock it is likely that the major anions are sulfates and chlorides. It does appear that in the spring, the upper reach of Winter Quarters Canyon has a higher portion of its anions made up of these unmeasured species, even though the total ion loads are about a third of the fall concentration. This could be associated with a differential mobilization of anions during the higher discharge associate with the spring runoff.

In two cases, June 04 in Woods Canyon Creek (Table 2) and October 04 in Winters Quarters Canyon Creek (Table 3), the discharge estimates decreased. The differences in the Woods Canyon estimates were small and were likely not significant. However the Winter Quarters Canyon differences reflected about a third less water in the channel. Concurrent with this decline was a decrease in both alkalinity and conductivity at the lowest station. The general trend in the streams is for alkalinity, hardness, and conductivity to increase as the streams enter their downstream reaches. This suggests that water in the middle section of Winter Quarters was being lost to ground water and the surface water may have been influenced by inflow from springs and side streams with lower solute content. Since the samples were taken during an extended drought, this change is not a point of concern.

The pH did not show any general trends in the second year of sampling other than it tended to be between 8.2 and 8.6, with one exception in Woods Canyon Creek for fall of 2003 when a reading of 7.73 was obtained (Table 2). This reading may be an outlier, but it is also important to note that the conductivity and alkalinity were also quite high while the discharge was the lowest recorded. The pH, is generally at the high end of the normal scale for natural waters (about 8.5; Hem 1971). The upper reaches of these two stream systems often have a greater amounts of sand and that the lower reaches tend to be embedded and often somewhat cemented in by travertine, a calcium carbonate

deposit. The photosynthetic activity of algae, as well as the physical loss of carbon dioxide from the stream water will cause the precipitation of travertine on the substratum (Hynes 1972).

Biological Characterization

Density and Number of Taxa

Forty two taxa were collected from the upper site of Woods Canyon in the fall of 2003, up from the 32 taxa found the previous fall (Table 4; Appendix 1a). In the spring of 2004 37 taxa were collected, compared to 26 the previous spring. Lower Woods Canyon also had 42 taxa in the fall of 2003, 9 more than the previous fall. In the spring of 2004 39 taxa were collected at this site, about the same as were collected the previous spring. The three Winter Quarters Canyon sites had more taxa collected in the spring 2004 sample series, and the number of taxa were very similar between sites. The upper Winter Quarters station had about the same number of fall taxa in 2003 as in 2002 and six more taxa in the spring of 2004 than in the spring of 2003. The middle Winter Quarters site has seven more taxa in the fall 2003 samples relative to the fall 2002 samples and five more taxa in the spring 2004 samples relative to the spring 2003 samples. The lower Winter Quarters Canyon site had the same number of taxa in the fall 2003 samples as in the fall 2002 samples. The spring 2004 samples had 14 more taxa than the previous spring samples.

Table 4. Number of taxa* collected from Woods and Winter Quarters Canyons

	Shiozawa 2004	Shiozawa 2004	this report	this report
Sampling date	October 2002	June 2003	October 2003	June 2004
Upper Woods Canyon	32	26	42	37
Lower Woods Canyon	33	38	42	39
Upper Winter Quarters Canyon	36	37	35	43
Middle Winter Quarters Canyon	27	40	34	45
Lower Winter Quarters Canyon	37	31	37	45

* Does not include early instars, pupae, or terrestrial spp.

The upper Woods Canyon site had a mean density of 58,804 organisms per square meter in the fall of 2003, approximately 3.7 times higher than in the fall of 2002 (Table 5). The density at this site fell to 32,949 in the spring of 2004, about 6500 more than in the previous spring. The fall 2004 lower Woods Canyon station, at 62,694 organisms per square meter, had almost 3 times more organisms than it did in the fall of 2003 (21210 /m^2). In the spring of 2004 the numbers had declined by about a third, but the density estimate was very similar to that of the previous spring. The fall 2003 upper Winter Quarters station density estimate was very similar to the values recorded for the Woods

Canyon stations that same fall, but was about six-fold higher than the previous fall. The spring 2004 samples from the upper station was comparable with the lower Woods Canyon station for that same sampling period and was about 400 lower than the previous sprig sampling estimates. The middle Winter Quarters Canyon sample in October 2003 was about six fold higher than the previous fall. The 2004 spring samples from that station were about 6000 /m^2 higher than the previous spring. Lower Winter Quarters Canyon in the fall of 2003 was about three-fold higher than in the fall of 2002 but it was very similar in density to the middle Winter Quarters fall 2003 samples. The spring 2004 samples from Lower Winter Quarters were 12000/m^2 lower than in the previous spring. This station had the highest densities in the spring 2004 sample series.

Table 5. Total invertebrate densities per square meter for Woods and Winter Quarters Canyons

	Shiozawa 2004	Shiozawa 2004	this report	this report
Sampling date	October 2002	June 2003	October 2003	June 2004
Upper Woods Canyon	16078	26401	58804	32949
Lower Woods Canyon	21210	40248	62649	41852
Upper Winter Quarters Canyon	9374	36243	60471	42464
Middle Winter Quarters Canyon	8143	40680	49713	40272
Lower Winter Quarters Canyon	15972	42416	46179	54896

Generally the increase in numbers of individuals between October of 2002 and October of 2004 can be attributed to two changes. First the decision was made to include sorting subsamples with magnification in the processing protocol after the large taxa were sorted. Numerous small, often early instar, taxa were easily missed when samples were sorted by eye. Subsampling the already sorted material and examining it under a dissection microscope eliminated that bias. Second, the number of samples were increased so that a more accurate estimate of benthic densities was possible. The densities found in the springs of 2003 and 2004 were very comparable, illustrating the advantages of these adjustments.

Chironomids were the most abundant taxon in all stations in the fall of 2003. Their densities ranged from 13,500 to about 25,500 per square meter. The second most abundant taxon in Woods Canyon for the fall of 2003 was the Ostracoda, however in Winter Quarters Canyon, *Baetis* were clearly the second most abundant group. Other taxa that were abundant in the fall of 2003 include Cinygmula, early instar plecopterans, copepods, and water mites (Hydracarina). The spring 2004 abundances were dominated by mayflies, either *Baetis* (Middle Winter Quarters Canyon) or early instar mayflies (Upper Woods Canyon and Lower Winter Quarters Canyon), although at one site chironomids were the most abundant taxon and Ostracods were the most abundant group in Lower Woods Canyon. Other abundant taxa include early instar plecopterans, copepods, and simuliids. The coleopteran

Optioservus tends to be abundant in the fall while *Heterlimnius* is more abundant in the spring. Chironomids decrease by a third or more over the winter as does the mayfly *Cinygmula*.

T[illegible]6. Summary of Invertebrate densities per square meter Oct [illegible]2 - June 2004

	Upper Woods Canyon				Lower Woods Canyon				Upper Winter Quarters Canyon				Middle Winter Quarters Canyon				Lower Winter Quarters Canyon			
Taxa	Oct 2002	June 2003	Oct 2003	June 2004	Oct 2002	June 2003	Oct 2003	June 2004	Oct 2002	June 2003	Oct 2003	June 2004	Oct 2002	June 2003	Oct 2003	June 2004	Oct 2002	June 2003	Oct 2003	June 2004
Ephemeroptera: *Baetis*	708	2547	1268	2422	303	8533	483	9016	1034	3305	9702	4526	1432	5704	11139	13514	1962	13851	11940	8643
Ephemeroptera: *Cinygmula*	2257	597	5822	1049	595	835	2460	1148	159	502	3778	3087	473	1045	3110	1127	1519	828	4248	2267
Ephemeroptera: *Drunella doddsi*		172	48	23		8	64	21		123	152	21		74	258	45	4	40	89	4
Ephemeroptera: *Drunella grandis*			2			98	4			6	2	210		57	76	218	68	15	316	17
Ephemeroptera: *Epeorus iron*	311	9		32		165		102		93		356		91		161		259	23	508
Ephemeroptera: early instar *		5992	3008	7316		4206	712	2187		1261	977	1261		3664	2157	4189		1924	2074	2066 1
Ephemeroptera: *Ephemerella*	739				140			4	470	30	91	4	417	34	38	2	250	148		2
Ephemeroptera: *Heptagenia*																4				8
Ephemeroptera: *Nixe criddlei*																				4
Ephemeroptera: *Paraleptophlebia*	87	6	13	78	193		199	72	61		551	4	19		44	186	80		32	13
Ephemeroptera: *Rithrogena*	91				27				19				80				23			
Ephemeroptera: *Seratella tibialis*				53			2	15			498	1244			390	568				364
Plecoptera: *Alloperlasevera*												2		4		15				15
Plecoptera: *Classenia sabulosa*														2		34		2		
Plecoptera: *Diura knowltoni*									11											
Plecoptera: early instar *	542	303	4359	1358	129	835	328	3098	34	1165	354	1596	34	1642	536	737	49	415	436	1034
Plecoptera:*Hesperoperla pacifica*	424	159	898	250	341	142	356	191	49	25	32	6		72	180	17	15	8	62	11
Plecoptera: *Isocapina*														4						
Plecoptera: *Isogenodea*			6																	
Plecoptera: *Isoperla*	45				19	6			11	6	8	6		9	2		8		6	2
Plecoptera: *Malenka californica*							40	2				148				379				205
Plecoptera: *Megarcys signata*	4																4			
Plecoptera: *Paraperla frontalis*		42	234			9								2		195			27	
Plecoptera: *Pteronuarcella badia*					8		4										4		2	2

Plecoptera: *Sk[illegible]d parallela*			2		11		8		[illegible]5		44		19	2	85	23		[illegible]	17	
Plecoptera: *Suwallia*				2																8
Plecoptera: *Sweltza*					53		17		159		150	15	129	19	136		261	27	53	157
Plecoptera: *Zapada*	731	30	576	91	1015	49	150	686	163	17	559	2	38	23	112	133	45	8	155	64
Trichoptera: pupae *		47		8		95		9		30		19		40		36		19	4	28
Trichoptera: *Asynarchus*								2												
Trichoptera: *Arctopsyche grandis*	250	15	4		38	8	4		4	2				4			8		2	4
Trichoptera: Brachycentrus	4	72		2		78	89			2	51				133			2	21	13
Trichoptera: Chyranda									4											
Trichoptera: Dicosmoecus	4	19	65	17	4	36	305	42			11	40			208	61	8	2	36	47
Trichoptera: Dolophilodes gabriella							21			2										4
Trichoptera: Hesperophylax						6		2		2										2
Trichoptera: Hydropsyche	38		2		11	36	19		42	4	186	2	98	11	6		1004	83	667	
Trichoptera: Hydorptila									11											
Trichoptera: Lepidostoma	148		2		68				144				98				49			
Trichoptera: Limnephilus						32						2		9				6		
Trichoptera: Micrasema						2	2	2	15											
Trichoptera: Neothremma alicia	216	55	19	6	53	38	100	11	45	256	1263	57	4	278	487	2	8	13	70	
Trichoptera: Ocetis			4						95											
Trichoptera: Ochrotrichia								2												
Trichoptera: Oligophlebodes			80	4		2	299	8		72	1606	244		4	8	462			2	17
Trichoptera: Parapsyche elsis			15	30			2												30	
Trichoptera: Psychomyia flavida		106				195	303			178	184			280	900			216	153	
Trichoptera: Rhyacophila (larvae)	633	66	1351	307	314	49	312	324	57			34	129			131	261			85
Trichoptera: Rhyacophila (pupae)													42							
Trichoptera: Tinodes							17													
Coleoptera: Agabus (adult)																		6		
Coleoptera: Ampumixis				4																

Coleoptera: Cleptelmis												4				21				2
Coleoptera: Dytiscidae			2	2																2
Coleoptera: Helichus (adult)			2																	
Coleoptera: Heterlimnius (larvae)		9	600	1297		384	49	591		142		4229		27		3310			25	858
Coleoptera: Heterlimnius (adult)	34		39	68	91	27	8	11	144	38	4	288	68	2		34	45		2	53
Coleoptera: Hydrobius								11				2				2				
Coleoptera: Hydophilidae	23																			
Coleoptera: Microcylleopus												13				4				
Coleoptera: Narpus								4												
Coleoptera: Optioservus (larvae)	1011	1566	177	932	864	1083	1490	1483	1799	3070	4768	1216	1326	3314	3948	407	1125	1712	2791	237
Coleoptera: Optioservus (adult)	15	25	6	6	30	6	47	23	19	174	225	15	15	97	214		30	30	125	8
Coleoptera: Peltodytes callosus						2														
Coleoptera: Staphylinidae										2										
Diptera: pupae						4												51		
Diptera: Allognasta								2												
Diptera: Antocha	163				27	4			133	2	8		462	333	134	27	4693	2411	1011	362
Diptera: Atherix			6			8	2													4
Diptera: Caloparyphus								25								17				28
Diptera: Canace macateei										4										
Diptera: Ceratopogonidae		502	816	598	186	447	1134	254	269	795	2850	882	76	786	828	371	178	216	473	322
Diptera: Chelifera			2	4		27	142				121			102	93			59	256	2
Diptera: Chironomidae (larvae)	5405	7940	18332	4259	7655	13707	25408	5568	1288	19426	13519	8999	2079	17233	14063	4075	2504	11622	13896	8440
Diptera: Chironomidae (pupae)	23	17		6	42	144	13	186		337	4	2	19	473	203	2	38	294	261	64
Diptera: Chyrsops				2					38				8				4			
Diptera: Dicranota			4	4						19	80	8		2	55	2			70	104
Diptera: Dixa				8		13		9		2				6	2					
Diptera: Euparyphus	4		2	2	182		34	2	38			8	49		110	2	163		81	
Diptera: Hemerodromia (larvae)			15		45	2	9	2	27	6						2	8			
Diptera: Hemerodromia (pupae)				6				2												

Diptera: Hexatoma			13																	
Diptera: Limnophora					4				4								8			
Diptera: Pericoma	985		158		3553	61	655		1773	61	2937			2	1964		216	95	466	
Diptera: Simulium (larvae)	91	4	444	62	261	19	337		136	8	538	142	189	331	773	763	38	4625	163	5183
Diptera: Simulium (pupae)																				184
Diptera: Tipula	30	47	857	80	30	40	44	21	45	34	165	6	4	6	8	4	11	2	335	8
Crustacea: Cladocera			4				8	114		91	195			116		57				
Crustacea: Copepoda		3600	5668	5056		1481	5901	3352		875	3818	3189		699	2121	1988		233	687	114
Crustacea: Ostracoda	7844	581	10811	3642	4030	5865	14423	9168		1371	5863	4401	534	2195	3490	3653	708	1417	1364	1197
Arachnida: Hydracarina	114	1553	2554	2163	424	659	3547	2333	276	1638	2259	2449	34	1240	1526	1375	19	1280	2714	1663
Mollusca: Sphaerium	4	76	26	102		320	909	125	114	837	2858	833	8	619	165	184	8	481	172	
Mollusca: Gyraulus				6				2						2		4		2		
Mollusca: Lymai																2				
Annelida: Oligochaeta	42	120	286	865	288	485	2180	1415	633	231	62	1507	114	19	8	970	538	19	822	1763
Annelida: Hirudinea													8							
Turbellaria: Planariidae	72			106	114			208				1309	140			68	8			108
Collembola	49		199		64				38			76				174	4			2
Hemiptera: Corixidae										2				2						
Lepidoptera							9					2				4				
Nematoda *				625												515				
Totals	16078	26401	58804	32949	21210	40248	62649	41852	9374	36243	60471	42464	8143	40680	49713	4022	15972	42416	46179	54896

* Not included in total taxa counts or calculations for diversity

Biomass

These data are being collected to describe the baseline reference conditions. The biomass estimates show no discrete trends, other than a slight tendency to increase downstream. But the range in values are similar to those found in Burnout and James Canyon creeks (e.g. Shiozawa 2005).

Table 7. Biomass in grams, comparisons October 2002 through June 2004.*

	Date			
Location	Oct 2002	June 2003	Oct 2003	June 2004
Upper Woods Canyon	40.80 g/m^2	36.57 g/m^2	31.64 g/m^2	30.78 g/m^2
Lower Woods Canyon	40.35 g/m^2	54.58 g/m^2	49.43g/m^2	57.19 g/m^2
Upper Winter Quarters Canyon	32.43 g/m^2	39.77 g/m^2	51.82 g/m^2	47.07 g/m^2
Middle Winter Quarters Canyon	16.30 g/m^2	37.62 g/m^2	67.18 g/m^2	52.43 g/m^2
Lower Winter Quarters Canyon	51. 34 g/m^2	57.23 g/m^2	37.72 g/m^2	86.60 g/m^2

* Each sample is actually 2 samples from one riffle. Therefore total biomass was divided by 2 before calculation of the density in g/m^2

Community Tolerance Quotient

Winget and Magnum (1979) proposed a community tolerance measure as a part of their Biotic Condition Index. They assigned a tolerance value to each taxon based on a survey of benthic invertebrates collected over a wide range of habitat and water quality conditions,. Species that are capable of surviving under a range of conditions receive a tolerance value of 108. Those species requiring more pristine conditions receive a lower tolerance value. The actual community tolerance quotient, or CTQa, is the mean tolerance value for all taxa in the community surveyed. The CTQa value should increase with increasing stress on a system. They also defined the predicted community tolerance quotient (CTQp) based on observed relationships between water chemistry and community structure. We added one additional measure, the ideal CTQa based on cumulative taxa collected from within the two streams over all sample dates.

The CTQp was estimated at 80, using historic water chemistry data from a nearby stream, Huntington Creek, since sulfate levels were not measured in either Woods or Winter Quarters Canyons. The ideal stream CTQa value was 66.01 for Woods and Winter Quarters Canyons combined. The community tolerance quotient was calculated for all sampled reaches on the two streams (Table 8). The values ranged from 60.17 to 72.52, all lower than the CTQp of 80 based on Huntington Canyon water chemistry data and close to the cumulative ideal stream CTQa. These values are slightly greater than

the previous range of 49 to 67 (Shiozawa 2004). The fall samples have lower CTQa values (57.25 to 60.02) than do the spring samples (60.17 to 72.54). These data suggest the existence of a seasonal signal in the average tolerance rating of the benthic community. Some taxa in the spring community tend to be more indicative of stressed environments than those that are collected in the fall. The reason for this is not clear, but triclads (flatworms), molluscs, and nematodes are present in the spring samples and these are considered by Winget and Mangum (1979) to be highly tolerant taxa, with index values of 108.

Table 8. Tolerance quotients.

Woods and Winter Quarters Canyons Oct 2003 and June 2004 Taxa	Upper Woods Oct 2003	Lower Woods Oct 2003	Upper WQ Oct 2003	Middle WQ Oct 203	Lower WQ Oct 2003	Upper Woods June 2004	Lower Woods June 2004	Upper WQ June 2004	Middle WQ June 2004	Lower WQ June 2004	Ideal stream
Ephemeroptera: Baetidae: *Baetis spp.*	72	72	72	72	72	72	72	72	72	72	72
Ephemeroptera: early instar *	72	72	72	72	72	72	72	72	72	72	72
Ephemeroptera: Ephemerellidae: *Drunella doddsi*	4	4	4	4	4	4	4	4	4	4	4
Ephemeroptera: Ephemerellidae: *Drunella grandis*	24	24	24	24	24			24	24	24	24
Ephemeroptera: Ephemerellidae: *Ephemerella*			48	48			48	48	48	48	48
Ephemeroptera: Ephemerellidae: *Seratella tibialis*		24	24	24		24	24	24	24	24	24
Ephemeroptera: Heptageniidae: *Cinygmula*	21	21	21	21	21	21	21	21	21	21	21
Ephemeroptera: Heptageniidae: *Epeorus iron*					21	21	21	21	21	21	21
Ephemeroptera: Heptageniidae: *Heptagenia*									48	48	48
Ephemeroptera: Heptageniidae: *Nixe criddlei*										48	48
Ephemeroptera: Heptageniidae: *Rithrogena*											21
Ephemeroptera: Leptophlebiidae: *Paraleptophlebia*	24	24	24	24	24	24	24	24	24	24	24
Plecoptera: Capniidae: *Isocapina*											24
Plecoptera: Chloroperlidae: *Alloperla severa*								24	24	24	24
Plecoptera: Chloroperlidae: *Paraperla frontalis*	24				24				24		24
Plecoptera: Chloroperlidae: *Suwallia*						24				24	24
Plecoptera: Chloroperlidae: *Sweltza*		24	24	24	24			24		24	24
Plecoptera: early instar *	36	36	36	36	36	36	36	36	36	36	36
Plecoptera: Nemouridae: *Malenka californica*		36					36	36	36	36	36
Plecoptera: Nemouridae: *Zapada*	16	16	16	16	16	16	16	16	16	16	16
Plecoptera: Perlidae: *Classenia sabulosa*									6		6
Plecoptera: Perlidae: *Hesperoperla pacifica*	18	18	18	18	18	18	18	18	18	18	18
Plecoptera: Perlodidae: *Diura knowltoni*											24

Plecoptera: Perlodidae: *Isogenoides*	24										24
Plecoptera: Perlodidae: *Isoperla*			48	48	48			48		48	48
Plecoptera: Perlodidae: *Megarcys signata*											24
Plecoptera: Perlodidae: *Skwalla parallela*	18	18	18	18	18				18		18
Plecoptera: Pteronarcyidae: Pteronarcella badia		24			24					24	24
Trichoptera: pupae *					108	108	108	108	108	108	108
Trichoptera: Brachycentridae: *Brachycentrus*		24	24	24	24	24				24	24
Trichoptera: Brachycentridae: *Micrasema*		24					24				24
Trichoptera: Hydroptilidae: *Hydorptila*											108
Trichoptera: Hydroptilidae: *Ochrotrichia*							108				108
Trichoptera: Hydropsychidae: *Arctopsyche grandis*	18	18			18					18	18
Trichoptera: Hydropsychidae: *Hydropsyche*	108	108	108	108	108			108			108
Trichoptera: Hydropsychidae: *Parapsyche elsis*	6	6			6	6					6
Trichoptera: Lepidostomatidae: *Lepidostoma*	18										18
Trichoptera: Leptoceridae: *Ocetis*	54										54
Trichoptera: Limnephilidae: *Asynarchus*							108				108
Trichoptera: Limnephilidae: *Chyranda*											18
Trichoptera: Limnephilidae: *Dicosmoecus*	24	24	24	24	24	24	24	24	24	24	24
Trichoptera: Limnephilidae: *Hesperophylax*							108			108	108
Trichoptera: Limnephilidae: *Limnephilus*								108			108
Trichoptera: Philopotamidae: *Dolophilodes gabriella*		24								24	24
Trichoptera: Psychomyidae: *Psychomyia flavida*		108	108	108	108						108
Trichoptera: Psychomyidae: *Tinodes*		108									108
Trichoptera: Rhyacophilidae: *Rhyacophila*	18	18				18	18	18	18	18	18
Trichoptera: Uenoidae: *Neothremma alicia*	8	8	8	8	8	8	8	8	8		8
Trichoptera: Uenoidae: *Oligophlebodes*	24	24	24	24	24	24	24	24	24	24	24
Coleoptera: Dryopidae: *Helichus*	54										54

Coleoptera: Dytiscidae	72					72				72	72
Coleoptera: Dytiscidae: *Agabus*											72
Coleoptera: Elmidae: *Ampumixis*						108					108
Coleoptera: Elmidae: *Cleptelmis*								108	108	108	108
Coleoptera: Elmidae: *Heterlimnius*	108	108	108		108	108	108	108	108	108	108
Coleoptera: Elmidae: *Microcylleopus*								108	108		108
Coleoptera: Elmidae: *Narpus*							108				108
Coleoptera: Elmidae: *Optioservus*	108	108	108	108	108	108	108	108	108	108	108
Coleoptera: Haliplidae: *Peltodytes callosus*											54
Coleoptera: Hydrophilidae											72
Coleoptera: Hydrophilidae: *Hydrobius*							72	72	72		72
Coleoptera: Staphylinidae											108
Diptera: pupae *											108
Diptera: Athericidae: *Atherix*	24	24								108	24
Diptera: Canacidae: *Canace macateei*											108
Diptera: Ceratopogonidae	108	108	108	108	108	108	108	108	108	108	108
Diptera: Chironomidae	108	108	108	108	108	108	108	108	108	108	108
Diptera: Dixidae: *Dixa*				108		108	108				108
Diptera: Empididae: *Chelifera*	108	108	108	108	108	108				108	108
Diptera: Empididae: *Hemerodromia*	108	108				108	108		108		108
Diptera: Muscidae: *Limnophora*											108
Diptera: Psychodidae: *Pericoma*	36	36	36	36	36						36
Diptera: Simuliidae: *Simulium*	108	108	108	108	108	108		108	108	108	108
Diptera: Stratomyidae: *Allognasta*							108				108
Diptera: Stratiomyidae: *Caloparyphus*							108		108	108	108
Diptera: Stratiomyidae: *Euparyphus*	108	108		108	108	108	108	108	108		108
Diptera: Tipulidae: *Antocha*			24	24	24				24	24	24

Diptera: Tabanidae: *Chyrsops*						108					108
Diptera: Tipulidae: *Dicranota*	24		24	24	24	24		24	24	24	24
Diptera: Tipulidae: *Hexatoma*	36										36
Diptera: Tipulidae: *Tipula*	36	36	36	36	36	36	36	36	36	36	36
Crustacea: Cladocera	108	108	108				108		108		108
Crustacea: Copepoda	108	108	108	108	108	108	108	108	108	108	108
Crustacea: Isopoda											108
Crustacea: Ostracoda	108	108	108	108	108	108	108	108	108	108	108
Arachnida: Hydracarina	108	108	108	108	108	108	108	108	108	108	108
Mollusca: Lymnaidae: *Lymai*									108		108
Mollusca: Planoribidae: *Gyraulus*						108	108		108		108
Mollusca: Sphaeriidae: *Sphaerium*	108	108	108	108	108	108	108	108	108		108
Annelida: Oligochaeta	108	108	108	108	108	108	108	108	108	108	108
Tricladida: Planariidae						108	108	108	108	108	108
Collembola	108							108	108	108	108
Hemiptera: Corixidae											108
Lepidoptera		72						72	72		72
Nematoda *						108		108	108	108	108
total	2533	2587	2161	2161	2290	2728	2974	2842	3214	2888	6265
n	43	44	36	36	40	40	41	43	49	48	95
CTQa	58.91	58.80	60.02	60.02	57.25	68.20	72.54	66.09	65.59	60.17	66.01

*Not included in calculations for diversity or total taxa count.

Biotic Condition Index

The Biotic Condition Index of Winget and Magnum (1979) is the percent of the predicted community tolerance quotient found in the actual community tolerance quotient (CTQa). That is, it is the CTQp divided by CTQa times 100. The BCI values (Table 9) were all greater than 100, indicating that the stream reaches were all of higher quality than predicted by the water quality and slope parameters for the streams. These readings are consistent with the results from the previous sampling series. Winget and Magnum (1979) also define habitat quality based on the relationships between the CTQa and BCI values (Table 10). All stations rated as either high-moderate or high in habitat quality.

Table 9. CTQa and BCI values for Woods and Winter Quarters Canyons

	Shiozawa 2004	Shiozawa 2004	this report	this report
Sampling date	Oct 2002	June 2003	Oct 2003	June 2004
	CTQa / BCI	CTQa / BCI	CTQa / BCI	CTQa / BCI
Upper Woods Canyon	59/ 137	65/ 123	59/ 136	68/ 117
Lower Woods Canyon	61/ 131	65/ 123	59/ 136	73/ 110
Upper Winter Quarters Canyon	60/ 133	69/ 116	60/ 133	66/ 121
Middle Winter Quarters Canyon	67/ 120	61/ 130	60/ 133	66/ 122
Lower Winter Quarters Canyon	68/ 118	61/ 131	57/ 140	60/ 133
Average	63/ 128	64/ 124	59/ 136	67/ 121

Table 10. Habitat quality based on CTQa and BCI values for Woods and Winter Quarters Canyons

	Shiozawa 2004	Shiozawa 2004	this report	this report
Sampling date	Oct 2002	June 2003	Oct 2003	June 2004
Upper Woods Canyon	high	high-moderate	high	high-moderate
Lower Woods Canyon	high	high-moderate	high	high-moderate
Upper Winter Quarters Canyon	high	high	high	high-moderate
Middle Winter Quarters Canyon	high-moderate	high	high	high
Lower Winter Quarters Canyon	high-moderate	high	high	high-moderate

Diversity

Diversity indices combine both number of taxa and relative densities into a single measurement. High diversity index values indicate more taxa and a more even number of individuals per taxon. Low diversity values generally reflect a depauperate fauna in taxa and a tendency for the densities to be dominated by a few individual taxa. These samples are establishing baseline data for the five stations in Woods and Winter Quarters canyons. The values range between about 1.7 and 2.5 and are lower than baseline diversity values for Eccles Creek in the late 1970s (Shiozawa, 2002), where the values ranged between 2 to 3 or more. However the sustained drought conditions may play a role in the lower values recorded for Woods and Winter Quarters canyons. Diversity values for June of 2004 were clearly higher than for the previous June sample series.

Table 11. Diversity Indices, based on natural logs, for Woods and Winter Quarters Canyons.

	Shiozawa 2004	Shiozawa 2004	this report	this report
Sampling date	Oct 2002	June 2003	Oct 2003	June 2004
Upper Woods Canyon	2.382	1.951	2.037	2.327
Lower Woods Canyon	2.114	1.848	1.937	2.153
Upper Winter Quarters Canyon	2.579	1.696	2.518	2.499
Middle Winter Quarters Canyon	2.384	1.862	2.250	2.240
Lower Winter Quarters Canyon	2.313	1.889	2.125	2.161

Cluster Analysis

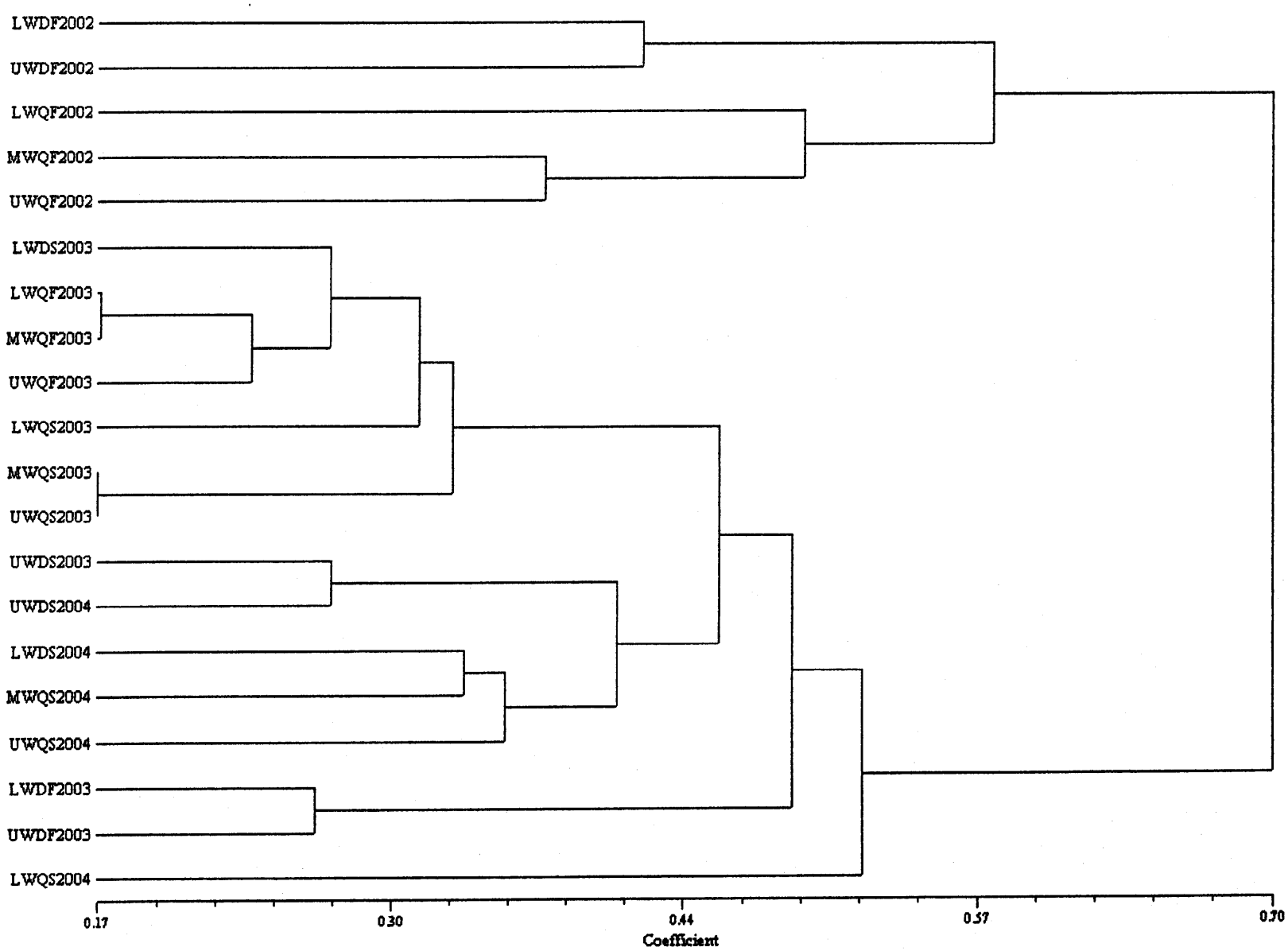
The final analysis utilized in this study was clustering. This generates a visual representation of the relationships among samples. The dissimilarity index utilized in the study considers both quantitative counts of individuals within each taxon and the relative densities of those organisms. The analysis (Figure 1) generated two main clusters. One contains all of the samples form the fall of 2002, the first sampling date. Part of the discrepancy may be related to changes in both sample number and sorting techniques in the laboratory since after this date all samples stations fall into the second cluster. The second cluster shows that lower Winter Quarters Canyon in the spring of 2004 was the most dissimilar station, but the fall 2003 samples from Woods Canyon, while similar to each other, were the next most dissimilar cluster.

The remaining cluster is subdivided into one subcluster that is predominantly composed of Winter Quarters Canyon samples (upper, middle and lower) from both the spring and fall of 2003. Lower Woods Canyon from the spring of 2003 also falls into that cluster grouping. The other subcluster contains the remaining Woods Canyon spring samples and the spring 2004 samples from middle and upper Winter Quarters Canyon. The clustering suggests a shifting of the stream communities that may be influenced by external factors, perhaps the drought. The shift can be generalized as going from the fall of 2002 (with its confounded biases), to a spring and fall 2003 group, to a spring 2004 group. Additional samples (e.g. fall 2004) would be expected to fall with the spring 2004 group and the spring 2005 samples may initiate another grouping, especially given the increased precipitation in the winter of 2005.

CONCLUSIONS

During this sampling period (Fall 203, Spring 2004) the two streams had between 34 to 45 taxa at each site. Over the full study period the sites have had between 29 and 45 taxa. Densities during this sample period ranged between 33,000/m^2 to 63,000/m^2 with the highest fall 2003 densities in Woods Canyon and the highest spring 2004 densities in Winter Quarters Canyon. The densities in the spring of 2003, ranged between 26,000/m^2 and 42,000/m^2 and were comparable to the densities recorded for the spring of 2004 samples. Chironomids are a dominant taxon, bing the most abundant group in the fall samples at all stations, and in the top 3 in the spring samples. *Baetis* are consistently abundant and *Cinygmula* are abundant in the fall samples. Microcrustaceans (copepods and ostracods) and water mites tend to be more abundant in Woods canyon than in Winter Quarters Canyon. Indices based on the presence or absence of taxa suggest that both streams are of high or high to moderate quality. Their CTQa values are all reasonably low, ranging from 57 to 73 in all sampling series. Their respective BCI values are all greater than 100%, and indicate that all stations are in much better condition than would be predicted based on water chemistry and slope. However the diversity indices, ranging between 1.9 and 2.5 during the period reported here, are lower than would be expected for streams in this region, especially when compared to the 1979 baseline Eccles Creek data. Cluster analysis reveals that the samples tend to track together over the two year period covered in this study. No strong seasonal signal is apparent. These changes could reflect responses of the communities to the same factors influencing the diversity index values. It is not clear how much the extensive drought has confounded the data. The drought undoubtedly has influenced late season water chemistry as seeps and spring would be more likely to contain higher concentrations of dissolved solids. But water chemistry changes alone do not seem to be high enough to generate major responses in the stream communities. Primary production in the riparian would also be expected to decline since soil moisture would decrease earlier in the season during the drought. Future sampling should help better understand the dynamics of the systems.

Figure 1. UPGMA Cluster dendrogram of relationships among invertebrate communities from Woods and Winter Quarters Canyon



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Appendix A. October 2003 Sample data and invertebrates per square meter for Woods Canyon.

	Upper Woods Canyon*								Lower Woods Canyon								
Taxa	1	2	3	4	5	6	8	# / m²	1	2	3	4	5	6	7	8	# / m²
Ephemeroptera: Baetis	154	180	56	30	163	3	0	1268	48	37	10	2	135	15	5	3	483
Ephemeroptera: Cinygmula	124	517	437	69	256	987	300	5822	85	224	295	169	15	15	219	187	2460
Ephemeroptera: Drunella doddsi	6	1	1	5	3	6	0	48	1	6	3	2	10	5	3	4	64
Ephemeroptera: Drunella grandis	0	0	0	0	0	1	0	2	1	0	0	1	0	0	0	0	4
Ephemeroptera: early instar**	120	84	2	26	176	607	375	3008	31	32	243	3	62	0	0	5	712
Ephemeroptera: Paraleptophlebia	0	0	3	2	0	1	0	13	17	51	10	0	12	11	0	4	199
Ephemeroptera: Seratella tibialis	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2
Plecoptera: early instar**	31	84	0	43	693	713	450	4359	4	33	5	35	76	0	1	19	328
Plecoptera: Hesperoperla pacifica	35	8	10	154	24	34	150	898	16	30	75	20	30	0	5	12	356
Plecoptera: Isogenodea	0	0	3	0	0	0	0	6	0	0	0	0	0	0	0	0	0
Plecoptera: Malenka californica	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0	0	40
Plecoptera: Paraperla	26	12	28	23	10	9	0	234	0	0	0	0	0	0	0	0	0
Plecoptera: Pteronuarcella badia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	4
Plecoptera: Skwalla parallela	0	0	0	0	0	1	0	2	2	0	1	0	0	0	1	0	8
Plecoptera: Sweltza	0	0	0	0	0	0	0	0	2	0	2	0	2	3	0	0	17
Plecoptera: Zapada	28	88	92	11	19	28	0	576	7	20	5	26	21	0	0	0	150
Trichoptera: Arctopsyche grandis	0	0	0	0	0	2	0	4	0	0	0	2	0	0	0	0	4
Trichoptera: Brachycentrus	0	0	0	0	0	0	0	0	0	2	1	0	1	0	7	36	89
Trichoptera: Dicosmoecus	0	0	15	0	0	0	15	65	30	4	0	0	127	0	0	0	305
Trichoptera: Dolophilodes gabriella	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	21
Trichoptera: Hydropsyche	0	1	0	0	0	0	0	2	1	1	0	0	5	0	1	2	19
Trichoptera: Lepidostoma	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Trichoptera: Micrasema	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2
Trichoptera: Neothremma alicia	0	1	0	2	5	1	0	19	32	1	1	1	9	0	2	7	100
Trichoptera: Oecetis	0	0	1	1	0	0	0	4	0	0	0	0	0	0	0	0	0
Trichoptera: Oligophlebodes	1	4	6	10	5	11	0	80	4	4	7	0	73	8	53	9	299
Trichoptera: Parapsyche elsis	3	1	2	0	1	0	0	15	0	0	0	1	0	0	0	0	2
Trichoptera: Psychomya flavida	0	0	0	0	0	0	0	0	0	30	0	0	127	0	3	0	303

Trichopter[illegible]acophila	38	1	13	12	350	201	0	[illegible]351	6	50	4	19	67	0	14	5	[illegible]
Trichoptera: Tinodes	0	0	0	0	0	0	0	0	0	1	0	0	0	8	0	0	17
Coleoptera: Dytiscidae (larvae)	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Coleoptera: Helichus (adult)	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Coleoptera: Heterlimnius (larvae)	4	224	22	0	0	27	0	600	0	0	0	1	0	0	0	25	49
Coleoptera: Heterlimnius (adult)	10	3	2	0	0	3	0	39	0	0	0	1	0	0	0	3	8
Coleoptera: Optioservus (larvae)	0	0	0	11	20	51	0	177	133	166	36	16	249	64	13	110	1490
Coleoptera: Optioservus (adult)	0	0	0	1	2	0	0	6	3	3	2	0	17	0	0	0	47
Diptera: Atherix	0	3	0	0	0	0	0	6	0	0	0	1	0	0	0	0	2
Diptera: Ceratopogonidae	4	53	2	14	4	150	150	816	29	22	15	3	469	15	0	46	1134
Diptera: Chelifera	0	1	0	0	0	0	0	2	33	34	5	0	3	0	0	0	142
Diptera: Chironomidae (larvae)	596	1230	297	1745	1287	1265	1950	18332	3215	3211	1879	44	1921	142	1119	1886	25408
Diptera: Chironomidae (pupae)	0	0	0	0	0	0	0	0	3	0	2	0	1	0	0	1	13
Diptera: Dicranota	0	0	2	0	0	0	0	4	0	0	0	0	0	0	0	0	0
Diptera: Euparyphus	0	0	0	1	0	0	0	2	3	3	2	0	6	0	3	1	34
Diptera: Hemerodromia	0	0	0	1	6	0	0	15	0	0	0	1	0	4	0	0	9
Diptera: Hexatoma	0	4	2	0	0	0	0	13	0	0	0	0	0	0	0	0	0
Diptera: Pericoma	5	55	5	0	7	1	0	158	59	74	80	6	63	15	13	35	655
Diptera: Simulium	66	1	48	1	8	6	75	444	8	72	4	1	90	1	1	1	337
Diptera: Tipula	1	1	0	4	2	163	225	857	3	3	0	3	5	3	4	2	44
Crustacea: Cladocera	0	0	0	1	1	0	0	4	0	1	0	0	0	0	0	3	8
Crustacea: Copepoda	90	120	80	1050	304	600	375	5668	914	395	787	1	408	11	150	450	5901
Crustacea: Ostracoda	62	200	11	902	1053	452	2325	10811	2093	1442	1299	0	1126	6	900	750	14423
Arachnida: Hydracarina	31	0	241	154	150	154	450	2554	345	365	39	0	217	2	151	754	3547
Mollusca: Sphaerium	0	2	3	5	1	1	0	26	36	101	106	0	215	10	8	4	909
Annelida: Oligochaetea	0	0	44	0	8	5	75	286	1	1	1	5	1	81	175	886	2180
Collembola	90	0	0	0	2	0	0	199	0	0	0	0	0	0	0	0	0
Lepidoptera	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4	9
Totals	1528	2879	1428	4278	4560	5483	6915		7165	6421	4919	365	5563	451	2853	5254	

* The data for riffle 7 of upper Woods was lost. Calculations are based on the other 7 riffles.

** Not included in total taxa counts or calculations for diversity

Appendix B. June 2004 Sample data and invertebrates per square meter for Woods Canyon.

	Upper Woods Canyon									Lower Woods Canyon								
Taxa	1	2	3	4	5	6	7	8	# / m²	1	2	3	4	5	6	7	8	# / m²
Ephemeroptera: Baetis	159	125	129	221	228	77	280	60	**2422**	574	579	949	375	1103	369	282	530	**9016**
Ephemeroptera: Cinygmula	137	81	42	45	65	55	91	38	**1049**	91	58	98	83	57	81	75	63	**1148**
Ephemeroptera: Drunella doddsi	0	3	0	3	0	2	2	2	**23**	0	0	2	0	1	5	1	2	**21**
Ephemeroptera: Epeorus iron	1	0	0	3	6	1	5	1	**32**	3	1	9	1	5	24	3	8	**102**
Ephemeroptera: early instar *	150	790	665	482	512	873	211	180	**7316**	158	100	185	155	184	160	122	91	**2187**
Ephemeroptera: Ephemerella	0	0	0	0	0	0	0	0	**0**	0	0	0	0	2	0	0	0	**4**
Ephemeroptera: Paraleptophlebia	0	0	4	0	2	34	0	1	**78**	2	2	1	0	31	2	0	0	**72**
Ephemeroptera: Seratella tiblalis	1	7	2	5	5	3	1	4	**53**	2	2	1	0	1	2	0	0	**15**
Plecoptera: early instar *	184	186	12	94	66	36	103	36	**1358**	334	150	375	193	257	160	91	76	**3098**
Plecoptera: Hesperoperla pacifica	5	21	36	13	15	19	11	12	**250**	12	9	12	13	17	18	5	15	**191**
Plecoptera: Malenka californica	0	0	0	0	0	0	0	0	**0**	0	0	0	0	1	0	0	0	**2**
Plecoptera: Suwallia	0	0	0	0	0	1	0	0	**2**	0	0	0	0	0	0	0	0	**0**
Plecoptera: Zapada	0	1	1	0	0	6	6	34	**91**	30	42	92	0	36	128	30	4	**686**
Trichoptera: pupae *	0	0	0	0	3	1	0	0	**8**	0	0	0	0	2	3	0	0	**9**
Trichoptera: Asynarchus	0	0	0	0	0	0	0	0	**0**	0	0	0	0	1	0	0	0	**2**
Trichoptera: Brachycentrus	0	0	0	0	0	1	0	0	**2**	0	0	0	0	0	0	0	0	**0**
Trichoptera: Dicosmoecus	3	0	0	0	0	0	0	6	**17**	0	7	1	4	1	8	0	1	**42**
Trichoptera: Hesperophylax	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	1	**2**
Trichoptera: Micrasema	0	0	0	0	0	0	0	0	**0**	0	0	0	0	1	0	0	0	**2**
Trichoptera: Neothremma alicia	0	0	0	2	0	0	1	0	**6**	3	1	0	2	0	0	0	0	**11**
Trichoptera: Ochrotrichia	0	0	0	0	0	0	0	0	**0**	1	0	0	0	0	0	0	0	**2**
Trichoptera: Oligophlebodes	0	0	1	0	1	0	0	0	**4**	0	0	0	0	0	3	0	1	**8**
Trichoptera: Parapsyche elsis	1	1	0	0	7	3	3	1	**30**	0	0	0	0	0	0	0	0	**0**
Trichoptera: Rhyacophila	9	13	22	18	42	22	22	14	**307**	38	15	12	11	65	14	8	8	**324**
Coleoptera: Ampumixis	0	0	0	0	0	2	0	0	**4**	0	0	0	0	0	0	0	0	**0**
Coleoptera: Dytiscidae	0	1	0	0	0	0	0	0	**2**	0	0	0	0	0	0	0	0	**0**

Coleopter[illegible]ilmnius (larvae)	80	150	26	101	43	47	97	[illegible]41	1297	22	7	42	36	16	53	85	[illegible]	591
Coleoptera: Heterlimnius (adult)	1	1	0	0	0	33	0	1	68	0	2	1	0	0	3	0	0	11
Coleoptera: Hydrobius	0	0	0	0	0	0	0	0	0	3	0	0	1	2	0	0	0	11
Coleoptera: Narpus	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	4
Coleoptera: Optioservus (larvae)	12	82	63	139	3	34	88	71	932	92	55	154	80	86	56	118	142	1483
Coleoptera: Optioservus (adult)	0	0	0	1	0	2	0	0	6	3	2	1	1	0	2	0	3	23
Diptera: Allognasta	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2
Diptera: Caloparyphus	0	0	0	0	0	0	0	0	0	5	1	2	1	0	1	3	0	25
Diptera: Ceratopogonidae	90	61	37	32	1	1	61	33	598	1	7	31	0	33	0	0	62	254
Diptera: Chelifera	0	0	0	0	0	0	0	2	4	0	0	0	0	0	0	0	0	0
Diptera: Chironomidae (larvae)	233	263	396	315	208	315	260	259	4259	373	567	221	346	258	295	67	813	5568
Diptera: Chironomidae (pupae)	0	0	0	0	0	2	1	0	6	30	2	0	30	1	0	1	34	186
Diptera: Chrysops	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Diptera: Dicranota	2	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
Diptera: Dixa	1	0	1	0	1	0	1	0	8	1	0	0	0	2	1	0	1	9
Diptera: Euparyphus	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	1	0	2
Diptera: Hemerodromia (larvae)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2
Diptera: Hemerodromia (pupae)	1	0	1	0	0	1	0	0	6	0	1	0	0	0	0	0	0	2
Diptera: Simulium	0	3	0	0	30	0	0	0	62	0	0	0	0	0	0	0	0	0
Diptera: Tipula	2	0	32	1	1	1	1	4	80	1	3	1	3	0	1	1	1	21
Crustacea: Cladocera	0	0	0	0	0	0	0	0	0	30	30	0	0	0	0	0	0	114
Crustacea: Copepoda	240	660	420	360	150	120	300	420	5056	420	120	150	360	210	30	0	480	3352
Crustacea: Ostracoda	210	210	571	150	210	211	91	270	3642	933	150	541	750	754	421	0	1292	9168
Arachnida: Hydracarina	90	240	90	121	150	210	121	120	2163	212	30	240	300	330	90	0	30	2333
Mollusca: Sphaerium	9	7	18	4	0	3	5	8	102	12	2	3	1	9	32	0	7	125
Mollusca: Gryaulus	0	0	0	0	0	2	1	0	6	1	0	0	0	0	0	0	0	2
Annelida: Oligochaeta	7	152	3	82	72	106	33	2	865	100	122	159	31	27	96	114	98	1415
Turbellaria	2	4	7	0	30	2	8	3	106	39	12	6	0	9	5	6	33	208
Nematoda *	60	60	60	0	120	0	0	30	625	0	0	0	0	0	0	0	0	0
Totals	1690	3123	2639	2192	1971	2226	1805	1753		3527	2079	3290	2778	3502	2063	1014	3847	

*Not included in total taxa counts or calculations for diversity.

ppendix C. October 2003 Sample data for Winter Quarters Canyon.

	Upper Winter Quarters Canyon								Middle Winter Quarters Canyon								Lower Winter Quarters Canyon							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
eroptera: Baetis	881	461	462	700	347	713	423	1136	834	100	1097	992	762	948	477	672	446	478	1129	582	509	920	858	1383
eroptera: Cinygmula	254	115	138	239	272	213	274	490	99	136	402	121	647	14	173	50	105	187	445	162	568	424	229	123
eroptera: Drunella doddsi	46	1	1	1	2	15	10	4	18	10	24	59	21	3	1	0	13	1	13	2	2	3	4	9
eroptera: Drunella grandis	0	0	1	0	0	0	0	0	4	32	1	0	0	0	1	2	31	51	1	42	6	34	2	0
eroptera: Epeorus iron	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	1	0	0	0
eroptera: Ephemerella	1	8	19	5	3	1	7	4	8	1	1	2	2	2	0	4	0	0	0	0	0	0	0	0
eroptera: early instar *	8	100	3	101	67	72	39	126	269	239	335	19	101	93	68	15	123	121	0	63	349	198	226	15
eroptera:Paraleptophlebia	14	23	2	11	71	23	101	46	0	0	4	0	4	8	6	1	2	3	0	12	0	0	0	0
eroptera: Serratella tibialis	73	20	37	9	10	31	21	62	0	0	59	55	17	41	10	24	0	0	0	0	0	0	0	0
era: early instar *	65	3	8	2	0	41	3	65	10	31	104	3	34	62	6	33	1	0	34	33	34	124	1	3
era:Hesperoperla pacifica	2	1	1	1	2	7	1	2	7	2	66	8	6	4	2	0	8	10	1	5	1	3	1	4
era: Isoperla	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	1	0	0	1	0	0	2	0	0
era: Paraperla	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	7	0	2	0	0	0	0
era: Pteronuarcella badia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
era: Skwala parallela	5	2	3	3	1	3	4	2	8	2	3	4	7	0	11	10	0	0	7	2	0	0	0	0
era: Sweltza	12	5	38	6	4	6	5	3	9	3	14	13	12	4	3	14	0	0	8	3	10	4	3	0
era: Zapada	110	81	8	14	14	26	5	37	11	0	12	5	18	4	3	6	12	13	16	6	10	4	7	14
tera: pupae *	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
tera: Arctopsyche grandis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
tera: Brachycentrus	5	0	5	10	2	2	0	3	2	0	0	2	1	63	2	0	2	2	0	1	0	0	0	6
tera: Dicosmoecus	0	0	1	5	0	0	0	0	22	5	0	33	27	0	6	17	1	0	0	1	0	0	0	17
tera: Hydropsyche	46	1	1	3	32	4	1	10	1	0	0	0	1	0	1	0	14	1	278	0	3	7	2	47
tera: Neothremma alicia	89	33	70	238	38	39	33	127	94	1	2	3	60	65	1	31	0	0	2	0	0	1	32	2
tera: Oligophlebodes	204	54	78	151	62	128	23	148	0	0	0	4	0	0	0	0	0	1	0	0	0	0	0	0

tera: Parapsyche elsis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	4	2	0	0	0	0
tera: Psychomyia flavida	36	3	5	35	3	12	0	3	5	7	15	70	81	144	114	39	3	0	34	0	3	11	10	20
era: Heterlimnius (larvae)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	1	2	0	0	1
era: Heterlimnius (adult)	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
era: Optioservus (larvae)	453	173	496	361	217	290	224	304	212	138	230	445	225	206	442	187	136	153	251	36	284	215	90	309
era: Optioservus (adult)	21	2	39	9	10	15	4	19	1	7	4	52	4	31	10	4	3	1	11	0	37	2	5	7
Antocha	1	1	0	1	0	1	0	0	2	6	2	34	7	3	6	11	0	0	83	9	34	34	281	93
Ceratopogonidae	282	152	58	282	177	136	95	323	37	11	19	144	86	74	37	29	31	41	7	37	69	17	42	6
Chelifera	0	0	1	1	0	61	1	0	35	2	3	1	2	0	3	3	0	0	0	4	61	32	4	34
Chironomidae (larvae)	1582	907	875	1035	464	587	612	1077	1186	655	609	697	948	1480	597	1254	525	447	1580	672	1097	897	949	1171
Chironomidae (pupae)	0	1	0	0	1	0	0	0	39	5	3	12	9	17	10	12	32	22	6	19	11	39	2	7
Dicranota	5	20	1	4	1	4	2	5	7	0	5	3	8	2	1	3	0	0	7	5	4	7	8	6
Dixa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Euparyphus	0	0	0	0	0	0	0	0	3	5	2	1	9	34	1	3	0	0	2	4	15	7	4	11
Pericoma	448	84	356	70	83	228	90	192	409	78	113	131	121	44	85	56	29	19	38	13	78	22	33	14
Simulium	48	42	42	34	1	66	7	44	19	83	66	23	3	170	37	7	5	0	67	0	1	11	1	1
Tipula	8	38	6	6	5	9	8	7	0	0	0	0	1	2	1	0	50	115	0	6	4	0	1	1
ea: Cladocera	0	102	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ea: Copepoda	183	768	286	222	186	125	241	5	190	183	215	30	4	221	61	216	90	0	1	60	91	121	0	0
ea: Ostracoda	372	425	544	798	212	157	366	222	509	216	100	148	156	98	82	534	60	32	30	64	281	216	31	6
da: Hydracarina	395	164	125	163	150	97	32	67	64	90	7	153	121	127	60	184	95	217	91	60	335	152	121	362
a: Sphaerium	122	115	391	269	194	56	174	188	3	1	5	3	31	34	3	7	13	2	1	5	6	1	32	31
a: Oligochaeta	0	0	30	0	1	0	2	0	2	1	1	1	2	0	0	1	45	87	3	289	2	2	3	3
	5771	3905	4131	4790	2632	3168	2810	4725	4119	2050	3523	3271	3538	3998	2321	3431	1881	2024	4159	2213	3909	3510	2982	3707

lot included in total taxa counts or calculations for diversity.

ppendix D. June 2004 Sample Data for Winter Quarters Canyon

	Upper Winter Quarters Canyon								Middle Winter Quarters Canyon								Lower Winter Quarters Canyon							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
eroptera: Baetis	122	204	285	315	406	335	449	274	1588	777	1056	392	641	1252	581	849	218	252	422	736	216	272	1195	1253
eroptera: Cinygmula	37	52	183	262	192	371	254	259	59	91	54	92	64	57	97	81	20	89	114	147	105	221	147	354
eroptera: Drunella doddsi	2	0	1	2	4	0	1	1	0	0	2	0	10	1	3	8	0	0	1	1	0	0	0	0
eroptera: Drunella grandis	3	55	11	18	11	7	2	4	0	2	7	10	19	14	12	51	0	0	2	2	0	1	0	4
eroptera: Epeorus iron	18	64	3	37	23	0	4	39	8	10	31	15	8	2	8	3	20	12	42	34	4	82	14	60
eroptera: Ephemerella	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
eroptera: Heptagenia	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2	2	0	0	0	0	0	0
eroptera: Nixe criddlei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
eroptera: early instar *	210	0	0	30	120	1	91	214	0	310	96	120	346	305	343	692	1920	160	1127	930	1146	1106	1798	2723
eroptera:Paraleptophlebia	0	0	0	0	0	0	0	2	2	34	33	3	4	5	10	7	0	0	1	0	0	1	1	4
eroptera: Serratella tibialis	38	68	90	122	75	88	65	111	36	38	28	27	70	24	23	54	0	0	5	43	32	38	28	46
era: Alloperla	0	0	1	0	0	0	0	0	0	0	5	0	0	0	3	0	0	0	0	1	3	3	1	0
era: Classenia	0	0	0	0	0	0	0	0	0	4	1	1	7	3	0	2	0	0	0	0	0	0	0	0
era: early instar *	5	22	3	216	305	187	8	97	63	7	31	0	153	37	44	54	241	5	11	32	167	60	0	30
era:Hesperoperla pacifica	2	0	0	0	0	0	1	0	1	1	0	2	1	0	0	4	0	3	0	0	0	0	2	1
era: Isoperla	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
era: Malenka californica	3	1	0	0	0	8	32	34	41	11	7	33	19	14	37	38	0	1	4	34	55	5	6	3
era: Paraperla	0	0	0	0	0	0	0	0	10	17	8	5	12	8	10	33	0	0	0	0	0	0	0	0
era: Pteronuarcella badia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
era: Skwalla parallela	0	0	0	0	0	0	0	0	2	4	0	0	5	1	0	0	0	0	0	0	0	0	0	0
era: Suwallia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
era: Sweltza	0	2	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	33	4	11	3	2	30
era: Zapada	0	0	0	0	0	0	0	1	7	8	8	1	24	9	8	5	0	0	0	31	0	0	3	0

tera: pupae *	0	2	1	4	0	0	2	1	1	2	3	2	3	1	2	5	3	0	2	7	0	0	0	3
tera: Arctopsyche grandis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
tera: Brachycentrus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0
tera: Dicosmoecus	0	1	3	14	0	3	0	0	1	0	1	5	0	3	10	12	2	0	3	0	5	0	7	8
tera: Dolophilodes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
tera: Hesperophylax	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
tera: Hydropsyche	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
tera: Limniphilus	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
tera: Neothremma alicia	6	0	2	5	3	1	5	8	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
tera: Oligophlebodes	37	22	5	4	4	40	2	15	4	30	31	31	103	45	0	0	0	1	0	8	0	0	0	0
tera: Rhyacophila	2	0	2	5	2	3	1	3	10	10	11	8	10	6	5	9	8	1	5	5	0	9	7	10
era: Cleptelmis	0	1	0	1	0	0	0	0	0	0	0	3	1	0	7	0	0	0	0	0	0	0	0	1
era: Dytiscidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
era: Heterlimnius (larvae)	102	172	410	419	218	249	403	260	108	471	206	76	144	122	404	217	17	12	138	74	26	147	12	27
era: Heterlimnius (adult)	6	14	1	62	7	7	51	4	0	1	0	2	4	2	7	2	1	1	1	8	8	4	0	5
era: Hydrobius	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
era: Micorcylleopus	1	1	0	3	0	0	1	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
era: Optioservus (larvae)	19	35	78	204	102	78	111	15	18	98	18	38	4	2	31	6	0	0	7	29	20	48	5	16
era: Optioservus (adult)	0	1	0	0	2	3	1	1	0	0	0	0	0	0	0	0	0	1	0	3	0	0	0	0
Antocha	0	0	0	0	0	0	0	0	1	1	0	3	3	3	0	3	23	8	17	27	2	22	44	48
Atherix	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Caloparyphus	0	0	0	0	0	0	0	0	0	2	0	0	0	2	2	3	2	0	0	0	35	64	0	4
Ceratopogonidae	0	40	61	121	0	4	150	90	63	4	4	31	1	37	47	9	80	0	0	0	0	0	0	0
Chelifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Chironomidae (larvae)	614	24	245	238	934	1045	604	1048	282	481	227	81	195	397	244	245	2068	265	239	154	193	546	364	628
Chironomidae (pupae)	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	1	1	30
Dicranota	3	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	34	2	0	13	1	1	4
Euparyphus	0	1	0	0	0	2	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Hemerodromia	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0

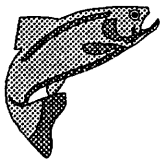
Simulium (larvae)	31	0	7	0	1	0	34	2	83	1	4	30	97	64	31	93	130	0	0	323	7	54	2094	129
Simulium (pupae)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	94	2
Tipula	0	0	0	2	0	0	1	0	0	0	1	0	0	0	0	1	0	3	0	1	0	0	0	0
ea: Cladocera	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0
ea: Copepoda	210	0	90	360	90	211	361	362	30	150	180	120	120	150	240	60	0	0	60	0	0	0	0	0
ea: Ostracoda	10	0	720	630	180	303	151	330	30	302	60	271	240	153	363	510	40	36	126	33	117	91	39	150
da: Hydracarina	120	20	122	360	91	216	180	184	90	91	60	60	63	120	182	60	80	122	34	213	8	150	61	210
a: Sphaerium	9	0	120	73	43	96	80	19	2	18	14	14	10	19	10	10	0	0	0	0	0	0	0	0
a: Gyraulus	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
a: Lymai	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
a: Oligochaeta	55	140	160	49	79	124	129	60	21	96	29	78	91	85	64	48	24	195	35	66	523	30	44	14
ola	2	0	31	0	0	1	1	5	0	30	31	0	0	0	1	30	0	0	0	0	0	0	1	0
tera	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
ria	54	91	99	89	48	83	69	158	1	0	6	4	14	10	0	1	0	0	1	4	14	30	3	5
da	0	0	0	o	0	0	0	0	0	61	0	90	0	30	31	60	0	0	0	0	0	0	0	0
	1721	1034	2736	3646	2948	3470	3246	3602	2565	3164	2285	1648	2490	2984	2861	3269	4902	1208	2433	2954	2711	2990	5982	5807

lot included in total taxa counts or calculations for diversity.

An Electrofishing Survey of Woods & Winter Quarters Canyons

October 2002

For the
Skyline mines



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INTRODUCTION

Woods and Winter Quarters Canyons, Carbon County, Utah, are situated over a coal seam that will be mined by the Canyon Fuels Corporation. In the fall of 2002, Mt. Nebo Scientific, Inc. was contracted to assess the aquatic invertebrates of the streams in these canyons. Both streams enter Mud Creek, a tributary to Scofield Reservoir. As a part of the preliminary review of the aquatic systems, personnel from the U. S. Forest Service had walked the streams in both canyons and had noted the presence of fish within the National Forest boundaries in Winter Quarters Canyon Creek.

PURPOSE

The species of fish and the distance upstream that the fish occurred was unknown. The U. S. Forest Service requested that the two streams in these canyons be further examined to 1) determine the species present in Winter Quarters Canyon, 2) to determine if fish were present in Woods Canyon, and 3) to determine how far upstream fish extended in either canyon within the Forest boundaries.

METHODS

Aquatic invertebrate samples were taken from Woods Canyon on October 14, 2002 and from Winter Quarters Canyon on October 18, 2002. At that same time a Smith-Root Model 12 battery powered

backpack electrofishing unit was taken in the field to qualitatively assess the fish presence at the research sites. No population estimates were made. Only the species present and their size range was noted. Electrofishing was conducted in each stream reach being sampled for invertebrates (Table 1). Approximately 80 meters of stream in each location was examined. Sampling was done with a single pass electrofishing and in general the fish were not handled. Instead they were immobilized only long enough to insure that their species was known.

RESULTS AND DISCUSSION

No fish were found in Woods Canyon Creek at either of the two stations. No fish were seen in lower reaches of that canyon, although no electrofishing was conducted on the private land below the forest boundary.

Table 1. Sampling station locations.

	Station	Elevation	North	West
Winter Quarters Canyon	Upper	8488 ft	N 39° 42.763'	W 111° 13.907'
Winter Quarters Canyon	Middle	8434 ft	N 39° 42.933'	W 111° 13.378'
Winter Quarters Canyon	Lower	8265 ft	N 39° 43.126'	W 111° 12.807'
Woods Canyon	Upper	8560 ft	N 39° 44.340'	W 111° 13.471'
Woods Canyon	Lower	8374 ft	N 39° 44.071'	W 111° 12.592'

Both the lower and middle stations on Winter Quarters Canyon Creek contained cutthroat trout, *Oncorhynchus clarki*, ranging up to approximately 20 cm in length. Young of the year trout were

also noted in the two sites. Only two young of the year trout were found in the upper Winter Quarters station. These two fish were in a small plunge pool formed by a debris dam.

The fish inhabiting Winter Quarters Canyon could either be resulting from the spawning of cutthroat trout from downstream resident fish in Scofield Reservoir, or Mud Creek, or they could be progeny of resident trout in the stream. If the fish are the offspring of spawners entering from lower elevation waters, then the larger trout in Winter Quarters Canyon creek , those in the 15-20 cm range, may represent residual holdovers from overwintering fry. However we have found that trout in high elevation areas where the growing season is short and water temperatures remain low in the summer, may require three to fours years to reach 20 to 25 cm in length, and may just be entering the reproductive pool at four years of age.

The cursory sampling conducted on the stream does not provide enough information to determine if the fish represent a year around, self sustaining resident population, or if the fish are part of the reproductive output of fish entering from downstream. The only exception is that the fish in the upper Winter Quarters site are most likely progeny for fish that reside further downstream, in either lower reaches of Winter Quarters Canyon, or in higher order streams below. These fish likely migrate out of the system as the upper reaches begin to freeze. It is useful to note that some beaver dams on the stream may act as partial barriers to movement and would likely impede upstream movement of spawning fish from downstream locations. But it is unlikely that beaver dams would constitute long term nonporous barriers since they can wash out with spring floods and then be repaired by beavers. Likewise, water flow within the dams may provide for fish passage.

The subspecies of the cutthroat trout was also not determined in this survey. In general the drainages coming off the east slope of the Wasatch Plateau have tended not to contain pure populations of the native Colorado River cutthroat trout because of the widespread stocking of Yellowstone cutthroat trout and rainbow trout. Determining the purity of these fish was not part of this project.

BIOLOGICAL STUDIES IN

WINTER QUARTERS CANYON CREEK
&
WOODS CANYON CREEK

A Study Plan

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RIPARIAN VEGETATION STUDIES

INTRODUCTION

Because underground coal mining is planned for the future underneath perennial streams, a study will be performed that concentrates on the riparian plant communities in Winter Quarters Canyon and Woods Canyon.

A variety of biological and other resource data can be gathered to evaluate and characterize riparian complexes including vegetation, geology, channel morphology, aquatic biology, soils, and stream flow. The primary focus of this study will be on the riparian vegetation. The data recorded will provide baseline and followup information by monitoring the riparian communities of the creeks. Regular monitoring should provide data to determine long term trends, natural variability and benchmark information including the possible impacts on the riparian plant communities from mining under the creeks.

The design of this study will not provide data that shows subtle changes to plant community structure and species composition as a result of *minor* changes to the riparian habitat. Rather, the study has been designed to be compared with subsequent years in an attempt to document *major* impacts to the plant communities along the streams in the case of catastrophic events, such as loss of water and habitat from the effects of subsidence caused from underground mining.

METHODS

The riparian vegetation of all perennial stretches in Winter Quarters Canyon and Woods Canyon including their tributaries will be surveyed. The surveys will be conducted during the growing season each year, most likely during the months of July and August. The vegetation monitoring methods of the studies have been primarily based on those described by the USDA Forest Service for a "*Level III Riparian Area Evaluation*" (Integrated Riparian Evaluation Guide, March 1992). Qualitative and quantitative data will recorded at each sample station location.

Sample Placement & Frequency

The goal of the study plan is to begin with one complete baseline data set for all riparian areas near the perennial streams in the permit area on the same year (the first year of study). For subsequent years, sample station locations will be pre-determined and mapped based on time of proposed underground mining activities. Sample frequency will be intensified in those areas where: 1) underground mining is planned for the near future, 2) where mining is currently occurring, and 3) where mining has occurred in

the recent past. Although subject to modification, the proposed sample frequency and placement have been described below.

Baseline Year: During the first study year, a Level III Survey will be conducted on all perennial streams and tributaries of Winter Quarters Creek and Woods Creek that are located in the permit area. The sample locations will be placed at regularly spaced intervals, or approximately every 800 ft over the areas – *with the exception of those areas where underground mining will initially begin* (see below). In addition, other areas, possibly outside the permit area, will be surveyed for use as potential "control sites". In other words, other comparable riparian areas may be chosen that could be monitored for changes over time along with the areas where subsidence from mining is possible.

Subsequent Years: In those years that follow the *Baseline Year* described above, the riparian vegetation surveys will concentrate on the mine or mined areas. Or, in the areas where mining activities are planned under the streams, riparian sampling will be conducted: 1) two years prior to mining these areas, 2) the year of the mining activities, and 3) two years after mining has occurred in those areas. During these study periods, sample stations will be placed at regular intervals every 400 ft.

Line transects will be placed at each station location. Locations and extent of the transects will be semi-permanently marked using numbered and flagged wooden stakes and 12-inch metal nails.

Geomorphological stream channel data outlined in the Level III protocol with not be recorded because Canyon Fuel Company has done other studies that will suffice for this information.

Qualitative Data

The "Riparian Complex Data Sheet" shown on this

RIPARIAN COMPLEX DATA SHEET

CLIENT:
COMPLEX: Riverine - Number
WATERBODY NAME:
LOCATION:
DATE:
OBSERVER(S):
QUAD NAME:
GEOLOGIC PARENT MATERIAL:
ASPECT:
VALLEY BOTTOM TYPE:
STREAM GRADIENT:
ELEVATION: .
SIZE OF COMPLEX:
SOILS INFORMATION:
ADJACENT UPLAND VEGETATION (looking downstream)
Left: Right:
VEGETATIVE DESCRIPTION (Dominance by Community Types)
SUCCESSIONAL STATUS:
APPARENT FORAGE TREND:
ESTIMATED FORAGE PRODUCTION:
BEAVER ACTIVITY:
PHOTOGRAPH TAKEN: (from right side unless otherwise stated)
LAND USE ACTIVITIES THAT COULD INFLUENCE RIPARIAN AREA:
SPECIES OBSERVED:
POOL ATTRIBUTES
% area in pools:
% pool area made up of pools > 2' deep:
AQUATIC VEGETATION
% streambed with filamentous algae:
% stream margin with rooted aquatic:
BANK TYPE & VEGETATION OVERHANG
% bank length undercut (<90°):
% bank length gently sloping (>135°):
% bank length with overhanging vegetation:
BANK CONDITION (bankfull area only)
% bank length vegetated, stable:
% bank length unvegetated, stable:
% bank length vegetated, unstable:
% bank length unvegetated, unstable:
BANK STABILITY (near water line):
CHANNEL MORPHOLOGY
NOTES:

page lists all of the qualitative data (and some of the quantitative data) that will be collected at each sample station station.

Photographic stations for documentation and future comparisons will also be established at each sample location. A sample location map will be provided in the final report.

Quantitative Data

As mentioned previously, USFS protocol will be utilized for the study.

Community Type Cover - The Community Type Cover is one method to record cover in the USFS Level III protocol. At the sample locations transects lines will be placed across (or perpendicular to) the stream channel. By design, the line transects may vary in lengths which will be based on several factors. Although sometimes limited by topographical features such as cliffs, the intent will be to make the transects long enough to cover the entire stream, its riparian communities, plus an additional 10 ft on each side of the stream to record the adjacent upland communities. Monitoring the total extent of the riparian plant communities including some upland community data should provide information about possible increases or decreases in the riparian communities relative to the adjacent upland communities.

Once the transect is placed, the line-intercept method will be employed measuring the extent of each major riparian plant community. The plant communities will named by the dominant two plant species. If only one species dominates the community by a wide margin, the plant community will be named by this single species.

AMPHIBIAN STUDIES

INTRODUCTION

These studies will be concentrated on the riparian and wetland habitats associated with Winter Quarters Canyon and Woods Canyon creeks. All activities associated with this project will be in compliance with all State and Federal policies and regulations. It is anticipated that no federally listed species occur within the project area, however, the potential for State of Utah species of special concern occurring with the project area does exist. Currently, the State of Utah has regulations regarding the collection and possession of zoological animals (R657-3) and requires that a Certificate of Registration (COR) be obtained prior to any collection activities. Since no collection of controlled species will be implemented as part of this project, a valid COR will not be necessary from the State of Utah, Division of Wildlife Resources prior to implementation of this project.

The general goal of area-based surveys is to sample for the target species that occur in all habitats or areas within the survey area. Techniques used for surveying target species will focus on methods suitable for these species. For the most part, the field techniques are methods of general observation as historically practiced by biologists. Typically, they involve searching for organisms in all possible microhabitats during the appropriate season and time of day. The general approach used for conducting this survey will be based on short-term, time-constrained visual encounter surveys (VES's). Specific methodologies used are described below. All methods for sampling the project area will be consistent with protocols and methods established by Heyer et al 1994, Corn and Bury 1990, and the State of Utah, Division of Wildlife Resources standard protocols established spotted frog and boreal toad.

METHODS

Spotted Frog Survey

Typically VES's and audio strip transects (AST's) are used to determine presence of amphibians during peak breeding activity periods. For spotted frog (*Rana lutienventris*) populations in Utah this period can occur from mid-March through late-April depending on weather conditions and elevation. Since the elevation of the survey area is between 8000 and 9000 feet, it is anticipated that surveys will be conducted in late April or early May. Peak breeding activity of other high elevation spotted frog populations (e.g. Wasatch County) will be used to target survey dates within the survey area. VES's will be conducted along the stream within a 25-30-meter corridor. All amphibian species and lifestages observed will be identified and recorded.

Boreal Toad Survey

VES's will also be used to determine presence of boreal toad (*Bufo boreas*) within the survey area during peak breeding activity periods. For boreal toad populations in Utah this period can occur from early- May through mid-July depending on weather conditions and elevation. Surveys will initially be targeted for early June since the elevation of the survey area is between 8000 and 9000 feet. Peak breeding activity of other boreal toad populations will be used to better determine survey dates within the survey area. VES's will be conducted along the streams within a 25-30-meter corridor. All amphibian species and lifestages observed will be identified and recorded. In addition, one to two night surveys may be conducted if suitable habitat is available for breeding. VES's (with flashlights) and AST's will be used for night surveys if deemed necessary.

Voucher Specimens/Verification

No voucher specimens will be collected as part of this project, however photographs will be taken of any amphibians observed within the project area.

LITERATURE CITED

Corn P.S. and R.B. Bury. 1990. Sampling methods for terrestrial amphibians and reptiles. U.S. Department of Agriculture, Forest Service, General Technical Report PHW-GTR-256,

Heyer, W.R. M.A. Donnelly, R.W. McDiarmid, L.C. Hayek, and M.S. Foster. 1994. Measuring and Monitoring Biological Diversity. Standard methods for amphibians. Smithsonian Institute. 364 pp.

MACROINVERTEBRATE STUDIES

INTRODUCTION

Macroinvertebrate sampling has been conducted in the spring and fall in Winter Quarters Canyon and Woods Canyon by *Mt. Nebo Scientific, Inc.* since October 2002. These studies will be continued in the future using the same sample stations and methodologies as the previous studies. The previous study methods and locations are described below.

METHODS

Sample placement was determined by examination of the stream systems on USGS 7.5 minute quadrangles. Two to three reaches were examined on each stream, with each reach being defined by the inflow of a side stream and the general distance from the previous reach. The lowest reaches in the two streams were established on U. S. Forest Service land above the boundary with private grazing lands. The location of each reach is given in Table 1. Four riffles were sampled within each reach in the fall of 2002, but this was increased to 8 riffles by the spring of 2004. Two samples were taken at each riffle and were bulked together in the field.

Table 1. Location of reach stations on each stream.

Canyon	Reach	GPS coordinates	Elevation
Woods	Upper	N 39° 44.340' W 111° 13.471' UTM4398045 12S0480808	2609 m (8560 ft)
Woods	Lower	N 39° 44.071' W 111° 12.592'	2552 m (8374 ft)
Winter Quarters	Upper	N 39° 42.763' W 111° 13.907'	2587 m (8488 ft)
Winter Quarters	Middle	N 39° 42.933' W 111° 13.378'	2571 m (8434 ft)
Winter Quarters	Lower	N 39° 43.126' W 111° 12.807'	2519 m (8265 ft)

Physical characteristics for each reach have been recorded. These included pH, conductivity, in micro-Siemens/cm (uS/cm), alkalinity, and hardness. Alkalinity and hardness were measured with a Hach water chemistry kit. Slope was recorded with an inclinometer, across a 100 meter length of stream,

beginning at the first (starting downstream) riffle. The stream channel within each reach was characterized by measuring the width, depth, and velocity of the stream every five meters, beginning with the first riffle. Three depth and velocity measures were taken at each five meter interval, these being at the center and approximately 10% of the width from either shore.

Quantitative invertebrate samples were taken with a modified box sampler (Shiozawa 1986) using a capture net with a net mesh of 253 microns. Samples were taken from each of the three reaches in Winter Quarters Canyon and the two reaches in Woods Canyon. Samples were concentrated in the field in sieves with 63 micron mesh, preserved with ethyl alcohol, and were returned to the laboratory for processing. In the laboratory the samples were sorted in an illuminated pan. Organisms were identified to the lowest taxonomic unit possible. Small specimens and those of questionable identity were further examined under magnification. Identification was based on the keys of Merritt and Cummins (1994). The mean values for each taxon were used to determine the density of invertebrates per square meter. Standing crop was estimated from wet weights of total invertebrates collected at the station.

The USFS Biotic Condition Index (Winget and Mangum 1979) was calculated with the community tolerance quotient (CTQa). The predicted community tolerance quotient (CTQp), based on water chemistry data provided in Winget (1972) for the Huntington Creek drainage, is 80. Diversity was calculated for each reach using the Shannon-Weiner index (Pielou 1977). Diversity indices take the number of taxa and their individual densities into account, generating a single value for each station. The greater the number of species or taxa and generally the more even the distribution of densities between taxa, the higher the diversity index value.

Cluster analysis was run with NTSYS-pc (Rolf 2000), using the Bray-Curtis dissimilarity index with the UPGM clustering algorithm. Data from all reaches for the first two sampling periods (fall 2002 and spring 2003) and from both Woods Canyon Creek and Winter Quarters Canyon Creek were included in the cluster analysis.

Since these samples are to be used to establish pre-mining base-line information, the most important information for future assessment will be the actual densities and taxa lists. The CTQa, diversity indices, and cluster analysis will serve to help understand relative associations between the two streams, seasonality effects, and within stream trends. As with all field collected data, annual variations in weather patterns (e.g. the recent drought in Utah) will need to be taken into account in interpreting the data.

LITERATURE CITED

Merritt, R. W. and K. W. Cummins. (eds.) 1996. An Introduction to the Aquatic Insects of North America. Kendall/Hunt Publishing Co. Dubuque, Iowa. 862pp.

Pielou, E. C. 1977. Mathematical Ecology. John Wiley and Sons. NY, NY. 385 pp.

Rolf, F. J. 2000. NTSpc: Numerical taxonomy and multivariate analysis system. Version 2.1. Exeter Software. Setauket, NY.

Shiozawa, D. K. 1986. The seasonal community structure and drift of microcrustaceans in Valley Creek, Minnesota. Canadian Journal of Zoology 64: 1655-1664.

Winget, R. N. 1972. Aquatic environmental impact study of Huntington Canyon generating station and Electric lake. Annual Report No. 2. Center for Environmental Studies. Brigham Young University.

NORTHERN GOSHAWK SURVEY

INTRODUCTION

The Northern Goshawk *(Accipiter gentilis)* in the western United States has been proposed for addition to the USFWS species list in the threatened category several times in the last decade, but the USFWS has consistently decided that the status of the species does not yet warrant such protection. Nevertheless, the USDA Forest Service in Utah lists Northern Goshawk as a sensitive, special status species and requires general presence-absence surveys for it in areas adjacent to proposed development projects. The purpose of this survey will be to determine if goshawks are present in the study areas of Winter Quarters Canyon and Woods Canyon.

Areas of potentially suitable nesting habitat for Northern Goshawk typically consist of coniferous forest and mixed-aspen forest types dominated by spruce, fir, pine, and aspen (Squires and Reynolds, 1997). Winter Quarters Canyon and Woods Canyon have some of these habitats. The standardized inventory and monitoring protocols developed by Kennedy and Stahlecker (1993) and Joy et al. (1994) and adopted by the Forest Service in Utah were used to conduct surveys for nesting Northern Goshawks.

The surveys will be conducted by a professional wildlife ecologist with over13 years experience. He has conducted goshawk surveys in both the Manti-La Sal and Uinta National forests as well as in Devil Canyon just outside of Monticello, Utah.

METHODS

The surveys will be conducted prior to July 1st by broadcasting playback recordings of kecking calls from stations approximately 300 meters apart in the study area between dawn and approximately midday. The observer will wait quietly at each broadcast station for one minute before initiating broadcasts of Northern Goshawk calls for 30 seconds, then repeating 10 seconds of calls for each 30 second interval (at least one in each of the four cardinal directions) thereafter for three minutes. The observer will then remain silent and scan for flying, silently responding, Northern Goshawks for one additional minute before moving on to the next station. The calling stations will be plotted on a map with the use of a GPS system. The boundaries for the calling station will be plotted with a 200 meter buffer although the calls probably travel in excess of 300 meters.

LITERATURE CITED

Joy, S.M., R.T. Reynolds, and D.G. Leslie. 1994. Northern Goshawk broadcast surveys: hawk response variables and survey costs. Studies in Avian Biology 16:24-30.

Kennedy, P.L., and D.W. Stahlecker. 1993. Responsiveness of nesting Northern Goshawks to taped broadcasts of three conspecific calls. Journal of Wildlife Management 57:249-257.

Squires, J.R., and R.T. Reynolds. 1997. Northern Goshawk (*Accipiter gentilis*). *In* The Birds of North America, No. 298 (A. Poole and F. Gills, eds.). The Academy of Natural Sciences, Philadelphia, PA, and the American Ornithologists' Union, Washington, D.C.

NORTHERN THREE-TOED WOODPECKER

INTRODUCTION

The Northern three-toed woodpecker (*Picoides tridactylus*) breeds in wooded regions from central Alaska east to Newfoundland and south to southern Oregon and central Arizona in the west, northeastern Minnesota, northern New England in the east. This species typically exists in northern coniferous forest and mixed-aspen forest types dominated by spruce, fir, pine, and aspen (Bull et al., 1986). Its preferred habitat are coniferous forests where they often choose dead trees for cavity nests. The three-toed woodpecker is a rare permanent species in Utah and is classified as a "sensitive species" in the Intermountain Region of the USDA Forest Service, and as a "species of concern" by the Utah State Division of Wildlife Resources.

METHODS

Areas of potentially suitable nesting habitat for the Northern three-toed woodpecker will be surveyed in the project area. A preliminary standardized inventory and monitoring protocol developed by Toone and Howe (undated) will be used to conduct a "General Inventory".

Surveys will be designed to coincide with the period of nest-excavation, when this species is most likely to respond to playbacks of territorial drumming (Goggan et al., 1988). For a survey with an elevation of 8,000 - 8,500 ft in Utah, this time period is estimated to be near the end of May (Toone and Howe, undated). Biologists will walk the project area and stop approximately every 300 meters to broadcast playback recordings of three-toed woodpecker's territorial drumming sounds using portable loudspeakers. Each calling period will last approximately eight minutes, with playback and listening time occurring at about 30 second intervals in each of the four cardinal directions. If territorial drumming is detected in apparent response to the playback recording, observers will try to visually confirm the species identification and then locate the nest site.

LITERATURE CITED

Bull, E.L., S.R Peterson and J.W. Thomas. 1986. Resource partitioning among woodpeckers in northwestern Oregon. USDA Forest Service, Resource Note PNW-444.

Goggan, R., R.D. Dixon, and L.C. Seminara. 1988. Habitat use by Three-toed and Black-backed Woodpeckers. Report 87-3-02, Oregon Department of Fish and Wildlife, Portland.

Toone, R., and F. Howe. Undated. Northern three-toed woodpecker (*Picoides tridactylus dorsalis*) inventory protocol. Draft Report, Utah Department of Wildlife Resources, Salt Lake City.

ATTACHMENT

AMPHIBIAN STUDIES
WINTER QUARTERS & WOODS CANYON
2005

In early May 2005, a spotted frog survey will be conducted in a tributary of Winter Quarters Canyon Creek in the area where underground mining will occur within a 2-3 year time frame. More specifically, the study area is located in the north-south drainage at Access Panels 1, 2, 3, 4, & 5 Left (T13S, R6E, Sec 11).

Additionally, and depending on weather conditions, a boreal toad survey will be conducted around the middle part of June 2005. This survey will be conducted in all perennial stream areas in Winter Quarters Canyon and Woods Canyon that have the potential of being impacted by future underground mining activities.

During the boreal toad survey, a survey for potential spotted frog habitat will also be conducted in the same areas. Although June will be after the peak breeding season for the frogs, the habitat survey will provide a guide to drive future studies of them in additional areas where mining may eventually occur under their habitat in the more distant future.