784.14(a)(3) Description of Changes in the Quantity of Surface and Groundwaters

Surface water flows will not be adversely impacted by underground mining. Groundwater encountered in the mine and subsequently discharged to the surface will increase the flow in East Spring Canyon during mining. This increase in flow will extend downstream through the general area. Surface waters from undisturbed areas in the East Spring Canyon and Mud Spring Hollow drainages are routed under surface mining facilities in East Spring Canyon. Routing of these surface waters has not, and will not affect the quantity of water flowing from undisturbed area. After completion of mining, reclamation will result in a return to natural condition in the mine portal area, and there will be no impacts on surface water quantity. which was?

Mining related impacts may occur to groundwater at a spring in East Spring Canyon (Site 001). This spring may be diminished, or cease to flow because of subsidence due to underground mining. The plan for an alternate water supply for this source is described in Section 783.17. There is a good possibility that this spring will not be adversely impacted by mining due to the natural sealing of shales and mudstones present in strata underlying this spring.

Mining will remove groundwater from formations adjacent to and overlying the coal seam. This is due to the inflow of groundwater into underground workings as coal is removed. As described in Section 783.14(a)(1)(i), drainage of water from fractures probably is the major mechanism for movement of groundwater into the mine. No other adverse impacts to groundwaters in the mine plan or adjacent areas are expected.

784.14(b)(1) Provide Plan for Control of Surface and Groundwater

Control of groundwater drainage is discussed in 784.14(a)(1). Plans for hydrologic tests of aquifers are discussed in 783.15.

784.14(c) Discussion of Probable Hydrologic Consequences of Underground Mining

Mining activities in the mine plan area and adjacent area will have minimal hydrological consequences to surface waters. The only area where surface waters interact with mining activity is in the portal area. In this area, surface water flows are transported under the mine surface facilities by means of large, corrugated metal pipes. Other drainages in the mine plan area will not be affected by mining, except a few small drainages that are underlain by subsidence areas. Subsidence, due to mining under these small drainages, will cause small changes in stream gradient, but these changes should have minimal impact on surface water resources. The only other impact on surface waters will be from discharge of groundwater encountered in the underground workings. Water pumped from the mine must meet NPDES permit effluent limitations; thus, surface water quality will not be adversely impacted. These groundwater discharges will increase the flow of East Spring Canyon during mining. (what about after mining ?)

Groundwater resources in the mine plan area will be affected in zones adjacent to, or overlying areas having subsidence due to mining. As a result of subsidence, groundwater is drained from strata adjacent to and overlying the mine, and is removed from the mine workings by pumps. This causes a decrease in the quantity of groundwater present in strata above and adjacent to the mine. The areal extent of strata affected by dewatering is not well known. Some dewatering will be associated with vertical fracturing due to subsidence. These fractures, however, may seal themselves in a short time period and will reestablish hydraulic barriers in the overlying strata. At the completion of mining, the underground workings will be sealed, and the groundwater system will reestablish itself in the mined area. Hypothetical guess ?!

784.16(a)(1)(iv) Provide Updated Report of Subsidence Monitoring

As part of the SUFCo room and pillar mining operation, coal pillars are removed after a room has otherwise been mined out. This technique increases the percentage of coal resource recovery, and results in subsidence of overlying materials. Overburden thickness above the coal varies with the plateau and canyon-type topography, but averages about 800 feet. The first subsidence at the SUFCo #1 Mine occurred in May, 1977, as a result of underground mining. Areas also subsided in 1978, 1979, and 1980, and additional subsidence is planned as mining progresses.

The subsidence process comprises two different stress-yield conditions in response to the excavation of coal resources:

1) Compression arches tend to occur above and below the mine panels. Such stresses transfer the overburden load in coal-extraction areas to adjacent solid coal boundaries or barrier pillars. As extraction progresses, the compression arches migrate higher in the overburden strata and may eventually reach the surface. The rate of upward migration is a function of the thickness and strength of overburden strata, duration and rate of mining, mine geometry, and mining sequence.

2) Caving and flexure of strata into the mine cavities is a function of the distressed zones within the compression arches. This flexure produces tensile and compressive stresses within lithologic units and shear stresses across lithologic boundaries. (Dunrud, 1976)

The Geneva Mine is an underground coal mining operation in the Book Cliffs of east-central Utah. Subsidence activities have been studied in detail at this mine site (Dunrud, 1976). The findings of this study are applicable to the SUFCo #1 Mine because of similar geologic environments at the two mines; Mesaverde Group Lithologies (Upper Cretaceous), gently dipping strata, joint and fault systems, and depth of overburden.

Tension cracks and compression features were observed at the Geneva Mine during a three-year period. The chronological sequence of surface deformation was as follows:

1) Formation of tension cracks above barrier pillars a few months after mining.

2) Appearance of compression bulges and anticlines on surface about one and a half to two years after completion of mining.

3) Additional formation of tension cracks as the surface subsided to a final profile, about three years after completion of mining.

In areas of tension features, the ground surface extended as much as five feet (fractures less than one inch to three feet in width). These cracks divert surface and groundwater flows to lower strata or to the mine workings. Areas of compression features shortened as much as three feet at the ground surface.

Subsidence activities began in 1977, at the SUFCo #1 Mine. Surface deformation, resulting from subsidence activities at the SUFCo #1 Mine, are expected to be similar to the deformation observed at the Geneva Mine described above.

Ground subsidence may alter groundwater and surface water systems in the vicinity of the mine, and could affect vegetation and wildlife dependent upon existing water resources. Therefore, in 1977, Coastal

States Energy Company initiated investigation of environmental factors in the mine area which would permit evaluation of potential effects of subsidence on hydrology, vegetation, and wildlife.

These investigations were begun in September, 1977. Additional data were collected in 1978 and 1979 field seasons, and annual assessment reports were prepared each year. Work in 1980 is ongoing.

Subsidence at the surface above the SUFCo Mine is characterized by fracture zones, which are generally made up of a series of paralleling fractures (en echelon in places) that roughly outline the mined area. Individual displacements along fractures are less than one foot both vertically and laterally. A total vertical displacement of about nine feet has been measured at the center of some subsidence panels, and a draw angle of less than 30 degrees is estimated for this panel.

Detailed on-the-ground examination of subsidence panels in 1977, 1978, 1979, and 1980 have shown no mining related impacts to hydrologic systems. Subsidence cracks in soil surfaces usually were filled or healed by the following year. Rock fractures observed in September, 1977, in the East Spring Canyon sandstone outcrops remained unchanged in subsequent years. Further, few if any additional rock fractures were observed in 1978, 1979, or 1980.

Springs at Sites 001 and 033 (Plate H-II) could be impacted as subsidence activities progress. These springs obtain water from the base of the Castlegate sandstone. This unit has undergone significant vertical fracturing and displacement as a result of planned subsidence. Such fracturing may interrupt lateral groundwater movement within the unit and cause related springs and seeps to have reduced flows or dry up completey.

Several seeps have been identified as having sources in the Blackhawk formation. These seeps are located in the canyons within the mine plan plate. Additional subsidence activities could diminish or deplete these flows. Such impacts would be caused by vertical fracturing and displacement within the unit, resulting in the interruption of lateral groundwater movement.

Ephemeral drainages could also be affected by continued subsidence. Flows could be intercepted by subsidence fractures and percolate downward to the groundwater regimen. If such diversion occurred above a runoff catchment pond (stock pond), the amount of water available for pond retention would be reduced. If vertical displacements occurred in ephemeral drainage bottoms, small depressions could form. These could become small ponds depending on soil transmissibility and extent of downward percolation along the fracture.

Although subsidence impacts on hydrological systems can occur, three years of observation at the SUFCo Mine area have shown no subsidence related impacts.

785.19 Alluvial Valley Floor Determination

This section of OSM's Permanent Regulatory Program is applicable to surface coal mining and may not be applicable to underground mines. It is appropriate, however, to describe the relationship of SUFCo No. 1 Mine to potential alluvial valley floors (AVF).

As shown on Plate H-II, the mine permit area consists of plateaus and deep canyons. Evaluation of the minet permit area and OSM rules for AVF's (Section 785.19(c)(2)) show:

1) Unconsolidated streamlaid deposits holding streams are present in the following drainages:

Mine Permit Area, Mine Plan Area and Affected Area (see Plates H-I and H-II)

A. North Fork Quitchupah Creek. This drainage is deep and very steep and is narrow at the bottom. Streamlaid deposits are present only in small, discontinuous narrow patches. Bedrock is exposed in much of the canyon bottom and the stream cascades over exposed bedrock outcrops.

B. East Spring Canyon. Characteristics of unconsolidated alluvium are the same as in North Fork Quitchupah Canyon.

C. Duncan Draw. This drainage within the permit boundary is narrow and steep with a few small (less than 1 acre) patches of alluvium present. Bedrock is exposed in much of the drainage.

D. Unnamed tributary to Duncan Draw. (T21S, R5E, Section 31E½). This drainage is steep, but contains narrow patches of unconsolidated alluvium. This drainage has not been investigated in detail, but areas underlain by unconsolidated alluvium are estimated to aggregate a few acres in size.

E. Unnamed tributaries to East Spring Canyon. These small drainages are east of Section 1, R4E, T22S, and are tributaries to East Spring Canyon (Plate H-II). These drainages are narrow and steep, but have a few scattered patches of unconsolidated alluvium. No detailed investigation of these drainages has been made, but areas underlain by unconsolidated alluvium are estimated to aggregate only a few acres in size.

Adjacent Area

There are several drainages in the adjacent area (Plate H-II) that contain unconsolidated streamlaid deposits. These are:

A. North Fork Quitchupah Creek downstream from mine permit area. While the canyon is steep and narrow, there are unconsolidated alluvial deposits toward the lower end. Similarly, in the adjacent area at the upper end of North Fork Quitchupah Canyon and its South Fork tributary are small narrow areas underlain by consolidated alluvium. None of these deposits have been mapped in detail.

B. Duncan Draw and Mud Springs Hollow. The segments of Duncan Draw and Mud Spring Hollow in the adjacent area contain some small areas underlain by unconsolidated alluvium. Both these canyons are narrow and steep, and probably there are no areas in the canyon where unconsolidated alluvium underlies more than 10 acres.

C. Convulsion Canyon and Quitchupah Creek. These drainages contain narrow deposits of unconsolidated alluvium. The canyon bottoms are narrow, but alluvium may be as much as 75 feet thick. Streams are deeply incised into the alluvium creating steep banks with a narrow stream channel in the bottoms. These unconsolidated deposits have not been mapped in detail.

2. There is no flood irrigation in the mine plan area or the the adjacent area, and no evidence of historical use of flood irrigation.

3. Flood irrigation may be possible on a few small patches of alluvium in drainages in the mine permit area. Mud Hollow, Duncan Draw, and the uppermost segment of East Spring Canyon all have small areas underlain by alluvium that could be flood irrigated. Due to small size, steepness, water availability, land ownership, and short growing season, these areas are not practical for flood irrigation. In this region, flood irrigation is not practiced in such high mountain drainages.

In the adjacent area, flood irrigation may be possible in a few - locations. This includes:

A. North Fork Quitchupah Creek and Quitchupah Creek. In the lower segments of these drainages are narrow alluvial deposits. Due to their small size, steepness, deeply incised streams and rough terrain, flood irrigation is not feasible. Regionally, relatively flat, wide drainage bottoms are flood irrigated. Alluvium in drainages with characteristics similar to Quitchupah Creek and its North Fork, however, are not flood irrigated.

B. Duncan Draw, Mud Spring Hollow and small tributaries of the upper segment of North Fork Quitchupah Creek and its South Fork may have small areas capable of flood irrigation. Due to small size, steepness, land ownership, and short growing season, these areas are not practical for flood irrigation. In this region, flood irrigation is not practiced in such high mountain drainages.

4. Subirrigated lands are present in both the mine permit and adjacent areas where agriculturally useful vegetation is dependent on moisture supplied by groundwater or frequent flood flows. In the mine permit area, small areas (less than 2 acres) are present along Duncan Draw and the uppermost end of East Spring Canyon. There are small, narrow areas where riparian vegetation is present along streambanks that are subirrigated.

   In the adjacent area, small areas of subirrigated rangeland are present. The upper segment of Duncan Draw, Mud Spring Hollow, Convulsion Canyon, and North Fork Quitchupah Creek and its South Fork contain small subirrigated areas. Narrow strips of riparian vegetation present along streambanks are subirrigated.

General Area

A potential AVF exists along portions of Quitchupah Creek from the adjacent area boundary downstream to the general area boundary. This area has not been investigated in detail; however, flood irrigation is practiced on approximately 110 acres and an additional 25 acres may have been irrigated in the past (Plate H-II). Quitchupah Creek in this segment is deeply incised into the alluvium creating steep banks with a narrow stream channel. Thickness of the alluvium is unknown, but probably is greater than 50 feet.

Conclusions

Based on hydrology and geology of the mine permit area and the adjacent area, there appear to be no alluvial valley floors in these areas. A possible AVF exists in the general area along Quitchupah Creek downstream of the adjacent area boundary. Approximately 110 acres are being irrigated at this location (Plate H-II). There appear to be no other potential alluvial valley floors in the general area.

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APPENDIX H-A

WATER QUALITY DATA

APPENDIX H-A

ANALYSIS OF WATERS OF QUITCHUPAH CREEK FROM SUFCO MINE TO MUDDY RIVER AT I70

Sampling Station	1	4	2	6			3	7	8	9	10	11
	Underground Flow		Main	Mine	Utah Standards For Class C Water Quality		At Quitchupah Creek		Quitchupah Creek At Browning Mine	Muddy River At I-70 Bridge		
	West Spring	East Spring	Sump	Effluent			At Mine	At Ivie Creek				
Sample No.	75-2875							75-327		555-042	555-042	555-042
Date	7/15/75	7/28/75	7/31/75	7/31/75	Recommended	Mandatory	7/15/75	3/14/75	4/14/75	8/14/73	1/22/74	5/1/74
Turbidity (JTU)	1.20	1.70	24.0	24.0			0.95	220	441	260	160	2400
Conductivity (umhos/cm)	624.0	658.0	566.0	589.0			1018.0	1990	2330	3400	2530	1480
pH (lab)	7.70	7.20	7.70	7.70			7.69	7.10	6.80	8.0	7.20	8.2
Total Dissolved Solids	406	428.0	368.0	383	500	-	662.0	1494	1717	2740	2364	1060
Aluminum	0.05	<0.01	0.30	<0.01			0.06					
Arsenic	<0.01	<0.01	<0.01	<0.01	0.01	0.05	<0.01	0.00	0.00	0.00	0.02	0.01
Barium	0.04	<0.01	0.03	<0.01	-	1.0	0.07	0.0	0.0	0.0	3.0	0.0
Boron	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	0.0	0.13	0.075	0.10	0.2
Cadmium	0.002	<0.001	<0.001	<0.001	-	0.01	<0.001	0.004	0.008	0.000	0.000	0.007
Calcium	60.80	63.50	50.40	51.20	-	-	86.40	116	88	130.0	160	90
Chromium, Hexavalent	<0.01	<0.01	<0.01	<0.01	-	0.05	<0.01	0.000	0.003	0.002	0.003	0.003
Copper	<0.01	<0.01	<0.01	<0.01	1.0	-	<0.01	0.00	0.01	0.00	0.00	0.00
Iron-Dissolved	0.10	0.01	0.13	0.02	-	-	0.19	0.22	0.02	0.00	0.00	0.01
Total Iron	0.25	0.01	0.24	0.04	0.3	-	0.25	9.90	13.0	5.60	5.10	54.0
Lead	0.01	<0.01	<0.01	<0.01	-	0.05	0.02	0.012	0.010	0.000	0.000	0.000
Magnesium	27.36	25.92	28.30	25.44	-	-	45.60	88	90	137	125	66
Manganese	0.02	<0.01	<0.01	<0.01	0.05	-	0.03	0.00	0.02	0.00	0.01	0.00
Mercury, Susp. & Diss.	<0.001	<0.001	<0.001	<0.001	-	-	<0.01	0.0	0.0		0.00000	0.00000
Nickel	-	-	-	-	-	-	-	0.028	0.32	0.00000	0.012	0.003
Potassium	1.36	0.68	1.69	1.22	-	-	3.14	6	1.6	0.02	5	5
Selenium	<0.01	<0.01	<0.01	<0.01	-	0.01	<0.01	0.00	0.00	8	0.000	0.000
Silver	<0.001	<0.001	<0.001	<0.001	-	0.05	<0.001	0.002	0.004	0.000	0.000	0.000
Sodium	1.84	6.39	2.00	11.10	-	-	16.70	235	360	0.000	310	150
Zinc	<0.01	0.02	<0.01	<0.01	5.0	-	0.03	0.02	-	390.0	0.00	0.01
Silica	12.50	1.50	8.50	3.40	-	-	4.50	7	7	0.00	11	9
Total Alkalinity	-	-	-	-	-	-	-	-	266	13	323	252
Total Hardness	266.0	266.0	246.0	234.0	-	-	406.0	650	590	247	915	495
Bicarbonate	283.60	288.45	237.5	237.5	-	-	436.30	327	324	1014	394	304
Carbon Dioxide	-	-	-	-	-	-	-	-	82	298	39	3
Carbonate as CO_3	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	-	0	4.7	0	0
Chloride	8.0	6.0	10.0	8.0	250	-	18.0	-	55	1.6	110	32
Carbonate Alk'y as $CaCO_3$	234.0	133.0	196.0	196.0	-	-	360.0	268	160	66	194	151
Fluoride	0.15	0.16	0.13	0.20	1.0	2.0	0.27	0.27	0.40	148	0.45	0.31
Hydroxide	-	-	-	-	-	-	-	0	0	0.48	0	0
Nitrate as NO_3	0.11(NO_3-N)	0.05	0.13	0.14	45	-	0.13	2.15	-	0.02 as N	2.00 as N	1.25 as N
Nitrite as N	-	-	-	- -	-	-	-	0.00	-	4.45 as N	0.05 as N	0.00 as N
Orthophosphorus as P	0.13(PO_4)	0.18(PO_4)	0.24(PO_4)	0.03	-	-	0.28(PO_4)	0.00	-	0.0	0.00	0.02
Sulfate as SO_4	25.0	39.0	40.50	50.0	-	-	58.50	758	940	0.10	1252	495
Surfactant MBAS	<0.01	<0.01	<0.01	<0.01	0.5	-	<0.01	0.00	0.00	1525	0.00	0.00
Ammonia N as NH_4	-	-	-	-	-	-	-	0.0	0.17 as N	0.00	0.05	0.00
Oil and Grease	*	-	*	2.5	-	-	*	-	-	-	*	*
Discharge Q (cfs)										3	4.71@	44
pH (field)										8.5	*	8.6
Temp (field) °C				12.2			16.7			27.0	0	11.5
Total Suspended Solids	1.5		75.8							570	300	8120
Biochemical Oxyden Demand	1.6	2.0	1.5	2.4		5	2.0			2.0	1.1	7.6
Dissolved Oxygen	6.50	7.15	7.80	8.2		5.5 min.	6.9			6.8	*	11.8
MPN Coliform/100 ml	<3		<3	<3		5000/100	<3			2300	230	9300
MPN Fecal Coliform/100 ml										150	93	9300
Cyanide											*	
Phenol	<0.001	<0.001	<0.001	0.001	0.001	-	<0.001					
Cyanide as CN	<0.01	<0.01	<0.01	<0.01	0.01	0.02	<0.01					
Suspended Solids	1.5		75.8	20.0			7.6					
Coliform Extract	N.A.		N.A.		0.2							

LEGEND: Less Than *Not Analyzed @Estimated Units are milligrams per liter unless otherwise specified.

SOURCE OF DATA: (a) Stations 1, 2, 3, 4, and 6. Sampled by Dames & Moore and analyzed by Ford Laboratories. Station 5 not analyzed.
(b) Station 7. Sampled by Keith Welch March 14, 19 ?, and analyzed by the Utah Division of Health.

APPENDIX H-A RESULTS OF LABORATORY DETERMINATIONS OF WATER QUALITY FROM WATERS IN THE VICINITY OF THE SUFCO NO. 1 MINE NEAR SALINA, UTAH FOR 1978

Note: All Quantities in mg/l unless otherwise noted

* location shown on map

Site No.	Site Description*	Date Sampled	Flow	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Total Dissolved Solids (meas.)	Conductivity (μmhos/cm) at 25°C	Total Suspended Solids	pH (Lab)	Temp. °C
001	Spring in Duncan Draw	6/04/78	2 gpm	60.0	19.2	16.7	1.40	<0.01	244	20	30	263	410	<1		7.5
001	" " "	9/26/78	2.2 gpm	56.8	21.6	16.1	1.42	<0.01	244	36	20	278	420		7.93	7.5
005	Seep in Trib. of E. Spring Can.	6/04/78	1 gpm	76.0	43.2	22.5	1.60	<0.01	410	42	30	406	620	5		9.0
006	S. Fk. Quitchupah	6/04/78	0.887cfs	56.0	24.5	38.6	1.86	<0.01	290	68	18	353	540	162		15
006	" "	9/26/78	2.0 gpm	68.0	38.9	73.4	2.72	<0.01	402	120	26	525	810		7.59	15
007	Quitchupah Ck.	6/04/78	6.5 cfs	56.0	19.7	15.7	1.01	<0.01	253	22	12	256	390	86		6.5
007	" "	9/26/78	100 gpm	55.2	19.2	30.3	1.36	<0.01	288	17	19	284	435		7.88	18
009	Trib. to N. Fk. Quitchupah	6/04/78	11.8 gpm	51.0	21.1	20.2	2.02	<0.01	188	62	26	274	410	5		8.0
021	Mine Effluent	6/05/78	280± gpm	56.8	35.5	16.7	2.00	<0.01	278	80	16	339	510	14		14.5
021	" "	9/26/78	315 gpm	55.2	38.9	21.6	2.08	<0.01	259	110	12	368	560		7.92	16.8
033	Seep in Trib. of E. Spring Can.	6/04/78	1.8± gpm	15.2	0.48	7.0	0.48	<0.01	41	8	12	60	100	<1		-
041	Quitchupah Ck. Above N. Fk.	6/05/78	.65 cfs	36.0	38.9	189.3	3.32	<0.01	329	238	42	712	1090	47		17
041	" " "	9/25/78	525 gpm	28.0	35.5	91.1	2.78	<0.01	271	150	28	470.	770		7.57	17.5
042	N. Fork Quitchupah	6/05/78	6.7 cfs	52.0	21.6	23.6	1.37	<0.01	254	44	12	280	420	143		14
042	" "	9/25/78	88 gpm	48.8	34.5	42.0	2.05	<0.01	232	119	34	398	610			17.5
045A	Quitchupah ds from drain field	6/03/78	-	76.8	60.9	47.0	3.34	<0.01	376	172	40	580	900	5		8.0
046	Convulsion Can. above Pumphouse	9/26/78	8.4 gpm	75.2	60.5	40.0	5.03	<0.01	456	110	26	549	845			8.5
047	Pumphouse Effluent	6/03/78	60 gpm	88.0	42.7	37.6	3.45	<0.01	432	82	22	493	760	1		24
047	" "	9/26/78	49.4 gpm	85.6	90.7	25.1	3.14	<0.01	422	70	14	440	670			24.2
047A	E. Spring Can. above Convulsion Can.	9/26/78	385 gpm	72.8	31.2	18.7	2.31	<0.01	290	90	12	370	568			10.5

Source: Botz, 1979

Note: All quantities in mg/l unless otherwise noted.

* Location shown on map

Site No.	Site Description*	Date Sampled	Fluoride (F)	Nitrate Plus Nitrate as (NO_3-N)	Total Kjeldahl Nitrogen	Total Phosphate (PO_4-P)	Silica (SiO_2)	Total Iron (Fe)	Total Manganese (Mn)	Total Zinc (Zn)	Total Arsenic (As)	Total Cadmium (Cd)	Total Selenium (Se)
001	Spring in Duncan Draw	6/04/78	0.20	0.27	0.10	0.025	10.5	0.006	<0.001		<0.001	<0.001	<0.001
001	" " "	9/26/78	0.19	0.30	<0.10	0.024		0.683	0.004	0.019	<0.001	<0.001	<0.001
005	Seep in Trib. of E. Spring Can.	6/04/78	0.26	0.02	0.12	0.022	9.4	0.011	0.015		<0.001	<0.001	<0.001
006	S. Fork Quitchupah	6/0[illegible]/78	0.45	0.02	0.40	0.024	5.9	0.393	0.074		<0.001	<0.001	<0.001
006	" "	9/26/78	0.30	0.07	0.20	0.026		0.206	0.043	0.009	<0.001	<0.001	<0.001
007	N. Fork Quitchupah Ck.	6/04/78	0.26	0.05	0.20	0.035	5.4	0.168	0.036		<0.001	<0.001	<0.001
007	" " "	9/26/78	0.25	0.02	<0.10	0.022		<0.001	0.015	0.012	<0.001	<0.001	<0.001
009	Trib. to N. Fk. Quitchupah	6/04/78	0.17	0.02	0.10	0.020	10.0	0.012	0.002		<0.001	<0.001	<0.001
021	Mine Effluent	6/05/78	0.20	0.02	0.13	0.022	9.3	0.008	0.005		<0.001	<0.001	<0.001
021	" "	9/26/78	0.25	0.06	<0.10	0.023		0.141	0.008	0.010	<0.001	<0.001	<0.001
033	Seep in Trib. of E. Spring Can.	6/04/78	0.04	0.02	0.10	0.020	7.0	0.068	0.009		<0.001	<0.001	<0.001
041	Quitchupah Ck. Above N. Fk.	6/05/78	0.32	0.03	0.14	0.035	9.9	0.121	0.010		<0.001	<0.001	<0.001
041	" " "	9/25/78	0.30	0.03	<0.10	0.020		0.035	0.011	0.004	<0.001	<0.001	<0.001
042	N. Fork Quitchupah	6/05/78	0.26	0.02	0.18	0.038	5.2	0.326	0.061		<0.001	<0.001	<0.001
042	" "	9/25/78	0.36	0.02	<0.10	0.023		<0.001	0.006	0.004	<0.001	<0.001	<0.001
045A	Quitchupah ds from drain field	6/3/78	0.19	0.03	0.14	0.026	10.5	0.121	0.033		<0.001	<0.001	<0.001
046	Convulsion Can above Pumphouse	9/26/78	0.23	0.03	<0.10	0.024		0.111	0.101	0.017	<0.001	<0.001	<0.001
047	Pumphouse Effluent	6/03/78	0.20	0.04	0.15	0.020	13.5	0.045	0.105		<0.001	<0.001	<0.001
047	" "	9/26/78	0.24	0.02	<0.10	0.020		0.201	0.069	0.007	<0.001	<0.001	<0.001
047A	E. Spring Can. Above Convulsion Can.	9/26/78	0.25	0.02	<0.10	0.045		0.234	0.027	0.014	<0.001	<0.001	<0.001

Site No.	Location	Site Description	Date Sampled	Flow (gpm)	Field Water Temp-°C	Est. Field Turbidity (NTU)	pH (SU) Field	pH (SU) Lab	Conductivity (µhmos/cm @ 25°C) Field	Conductivity (µhmos/cm @ 25°C) Lab	(Ca)	(Mg)	(Na)	(K)	(CO_3)
001	21S04E36DCD	Spring in Duncan Draw (East Spring)	7/4/79	2.4	18	-	-	-	477	400	58.4	19.7	12.0	1.45	<0.01
			10/6/79	2.1	9	-	-	7.10	406	550	57.3	20.4	39.0	1.14	<0.01
006	21S04E24CAC	S. Fork Quitch-upah Ck.	7/3/79	956	13	-	-	-	484	500	55.2	29.8	17.9	1.28	<0.01
			10/5/79	99	10	3-5	-	7.60	584	600	53.8	29.4	33.4	1.83	<0.01
007	21S04E13ADC	N. Fork Quitch-upah Ck.	7/3/79	911	14	-	-	-	-	670	45.6	64.3	12.7	0.68	<0.01
			10/5/79	90	13	~2	-	7.80	498	520	44.1	32.3	43.0	1.38	<0.01
021	22S04E12BAD	Mine Effluent	7/3/79	187	16	-	-	-	669	580	61.6	35.5	20.9	2.16	<0.01
			10/6/79	205	2	~5	-	7.50	593	570	65.4	35.2	17.8	2.06	<0.01
041	22S05E16DDA	Quitchupah Ck. above N. Fork	7/4/79	402	27	-	-	-	875	970	45.6	48.0	103.0	2.89	<0.01
			10/6/79	359	11	12-15	-	7.80	943	900	41.3	44.5	96.1	2.62	<0.01
042	22S05E16DAD	N. Fork Quitch-upah above mouth	7/4/79	1778	25	-	-	-	530	460	46.4	27.4	22.7	1.14	<0.01
			10/6/79	103	2	≤2	-	7.60	661	780	43.9	41.7	57.1	2.25	<0.01
046	22S04E12CDB	Convulsion Can-yon above pump-house	7/3/79	4.5	19	-	-	-	1000	1000	96.0	74.4	34.4	4.3	<0.01
			10/6/79	1.5 (E)	4	≤2	-	-	1007	-	-	-	-	-	-
047	22S04E12CDA	Pumphouse Effluent	7/3/79	Not Flowing	10	-	-	-	720	-	-	-	-	-	-
			10/6/79	29.3	7	~0	-	7.20	851	710	78.0	51.0	25.0	3.40	<0.01
047A	22S04E12CDA	E. Spring Canyon above Convulsion Canyon	7/3/79	417	-	-	-	-	-	-	-	-	-	-	-
			10/6/79	202	6	8-10	-	7.50	691	650	61.3	43.6	20.1	2.32	<0.01

Notes:

All quantities in mg/l unless otherwise noted

(E) = estimated

Source: Botz and Braico, 1980

Site No.	Date Sampled	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Total Dissolved Solids (meas.)	Total Suspended Solids	Fluoride (F)
001	7/4/79	251	21	20	260	9	0.18
	10/6/79	246	21	76	360	3	0.13
006	7/3/79	229	100	6	328	87	0.42
	10/5/79	283	90	14	396	6	0.35
007	7/3/79	210	210	2	438	45	0.23
	10/5/79	303	45	18	340	1	0.20
021	7/3/79	251	116	12	380	33	0.33
	10/6/79	256	112	12	375	6	0.19
041	7/4/79	266	260	30	631	5	0.31
	10/6/79	329	188	34	598	4	0.22
042	7/4/79	220	78	10	299	45	0.30
	10/6/79	266	164	24	511	3	0.24
046	7/3/79	503	157	34	652	95	0.26
	10/6/79	-	-	-	-	-	-
047	7/3/79	-	-	-	-	-	-
	10/6/79	407	68	20	712	72	0.14
047A	7/3/79	-	-	-	-	-	-
	10/6/79	295	110	14	422	12	0.18

more effluent

Site No.	Date Sampled	Nitrate as (NO_3-N)	Total Kjeldahl Nitrogen	Phosphate (PO_4-P)	Silica (SiO_2)	Iron (Fe)	Total Manganese (Mn)	Total Arsenic (As)	Total Cadmium (Cd)	Total [illegible] (Se
001	7/4/79	0.10	0.22	0.030	2.4	0.010	0.008	<0.001	<0.001	0.[illegible]
	10/6/79	<0.01	0.10	0.180	7.5	0.040	0.003	<0.001	<0.001	0.[illegible]
006	7/3/79	0.04	0.25	0.060	6.3	0.470	0.050	0.002	<0.001	<0.[illegible]
	10/5/79	<0.01	0.10	0.100	7.5	0.150	0.024	0.002	<0.001	0.[illegible]
007	7/3/79	0.02	0.20	0.100	1.5	0.170	0.020	<0.001	<0.001	<0.[illegible]
	10/5/79	<0.01	<0.01	0.060	8.5	0.020	0.014	<0.001	<0.001	<0.[illegible]
021	7/3/79	0.25	0.30	0.060	3.5	0.110	0.004	<0.001	<0.001	0.[illegible]
	10/6/79	0.10	0.15	0.060	10.0	0.090	0.005	<0.001	<0.001	0.[illegible]
041	7/4/79	0.12	0.20	<0.010	4.5	0.080	0.011	<0.001	<0.001	0.[illegible]
	10/6/79	<0.01	0.10	0.050	11.0	0.310	0.009	0.001	<0.001	0.[illegible]
042	7/4/79	0.10	0.30	<0.010	2.9	0.290	0.027	0.001	<0.001	<0.[illegible]
	10/6/79	0.05	0.12	0.080	7.9	0.060	0.002	<0.001	<0.001	0.[illegible]
046	7/3/79	0.10	0.25	0.100	5.1	1.230	0.181	<0.001	<0.001	<0.[illegible]
	10/6/79	-	-	-	-	-	-	-	-	-
047	7/3/79	-	-	-	-	-	-	-	-	-
	10/6/79	<0.01	<0.01	0.060	12.5	0.050	0.037	<0.001	<0.001	0.[illegible]
047A	7/3/79	-	-	-	-	-	-	-	-	-
	10/6/79	<0.01	<0.01	0.060	9.5	0.120	0.012	<0.001	<0.001	0.[illegible]

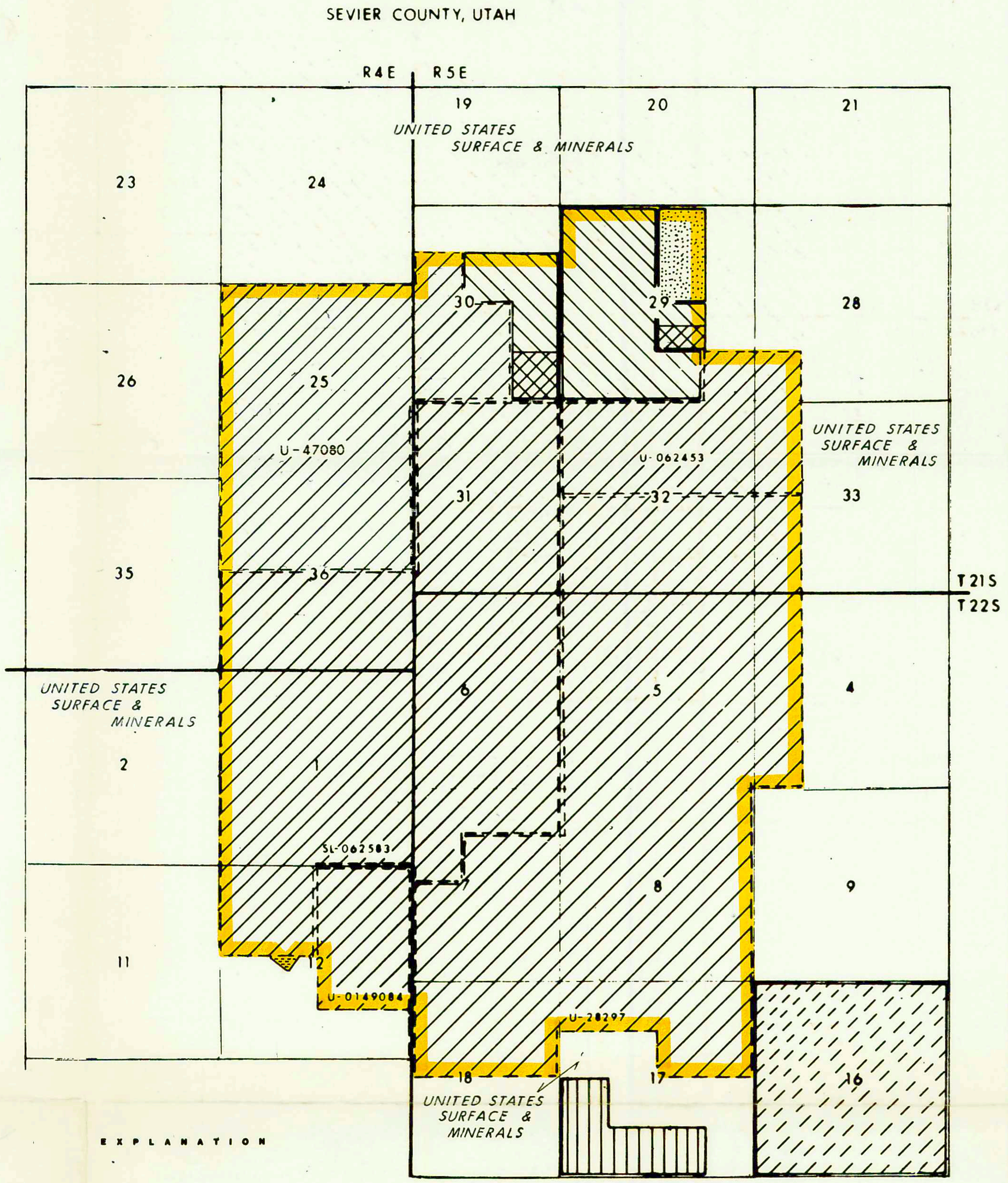
Site No.	Location	Site Description	Date Sampled	Flow (gpm)	Field Water Temp-°C	Est. Field Turbidity (NTU)	pH(SU) Field	pH(SU) Lab	Conductivity (uhmos/cm @ 25°C) Field	Conductivity (uhmos/cm @ 25°C) Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)
001	21S04E36DCD	Spring in Duncan Draw (East Spring)	6/19/80	2.9	8.9	0	-	8.0	485	460	52.8	22	31	1.2	<0.01
006	21S04E24CAC	S. Fork Quitchupah	6/19/80	570	19.9	≤2	-	8.1	679	470	47.2	31.7	30	1.9	<0.01
007	21S04E13ADC	N. Fork Quitchupah	6/19/80	4037	13.9	>30	-	8.2	331	350	44.8	13.9	41	1.3	<0.01
021	22S04E12BAD	Mine Effluent	6/20/80	570	-	≤2	-	7.6	-	500	47.2	35.5	19	2.1	<0.01
041	22S05E16DDA	Quitchupah Creek above N. Fork	6/20/80	555	25.0	5-8	-	8.1	1130	870	43.2	16.4	72	2.7	<0.01
042	22S05E16DAD	N. Fork Quitchupah above mouth	6/20/80	4108	18.8	>30	-	8.2	504	550	44.0	20.2	58	2.2	<0.01
046	22S04E12CDB	Convulsion Canyon above pumphouse	6/19/80	5, est.	20.5	10	-	7.2	1165	950	82.4	44.2	35	3.7	<0.01
047	22S04E12CDA	Pumphouse Fffluent	6/19/80	48	26.4	≤2	-	7.4	826	680	84.0	73.0	25	3.2	<0.01
047A	22S04E12CDA	E. Spring Canyon above Convulsion Canyon	6/19/80	44	18.0	5-8	-	7.6	959	810	97.6	55.7	21	2.5	<0.01
060		Haulage Way 42LE	7/1/80			060		7.9		690	64.0	50.2	15	2.1	7.20
061		Haulage Way 6L	7/1/80			061		7.9		430	53.6	31.2	10	1.6	0.01
062		#1 Entry-ZN	7/1/80			062		7.8		450	55.2	32.0	9.3	1.9	0.01
063		#6 Entry-N. Main	7/1/80			063		8.0		400	52.8	25.0	7.1	1.4	2.40

mine discharge

Site No.	Date Sampled	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Total Dissolved Solids (meas.)	Total Suspended Solids	Fluoride (F)
001	6/19/80	234	30	46	300	4	0.22
006	6/19/80	300	40	18	310	40	0.42
007	6/19/80	266	30	4	230	236	0.23
021	6/20/80	239	87	18	325	12	0.20
041	6/20/80	305	200	42	570	14	0.21
042	6/20/80	220	118	80	360	196	0.24
046	6/19/80	403	195	34	620	48	0.32
047	6/19/80	427	60	20	445	1.5	0.12
047A	6/19/80	439	110	26	528	44	0.25
060	7/1/80	161	220	14	450		0.49
061	7/1/80	300	18	16	282		0.13
062	7/1/80	278	40	16	294		0.21
063	7/1/80	242	28	14	255		0.16

[illegible] mine

Site No.	Nitrate as (NO_3-N)	Total Kjeldahl Nitrogen	Phosphate (PO_4-P)	Silica (SiO_2)	Iron (Fe)	Total Manganese (Mn)	Total Arsenic (As)	Total Cadmium (Cd)	Total Selenium (Se)
001	.35	0.10	.20	10.0	0.166	0.015	<0.001	<0.001	0.002
006	.02	0.10	.10	7.8	.158	.030	<0.001	<0.001	<.001
007	.02	0.01	.26	8.2	0.028	.090	<0.001	<0.001	<.001
021	<0.01	0.18	0.100	10.5	0.095	0.006	<0.001	<0.001	<0.001
041	<0.01	0.20	.10	11.5	0.299	.010	<0.001	<0.001	.002
042	.02	0.15	.16	6.0	0.077	.070	<0.001	<0.001	.002
046	0.02	<0.01	0.100	12.9	0.025	0.04	<0.001	<0.001	<0.001
047	<0.01	0.25	0.080	12.8	0.058	0.03	<.001	<0.001	0.002
047A	<0.01	<0.01	0.060	9.6	0.116	0.01	<0.001	<0.001	<0.001
060	0.01		.060	22.0	.120	0.01	0.001	0.001	0.001
061	.03		.030	7.7	.100	0.02	0.001	0.001	0.001
062	0.01		.060	12.0	2.500	0.07	0.001	.002	0.001
063	.02		.030	9.4	.190	0.01	-	0.001	0.001



EXPLANATION

SURFACE-NEAL MORTENSEN-ET AL
MINERALS-COASTAL STATES ENERGY CO.

SURFACE-NEAL MORTENSEN WITH CERTAIN RIGHTS RESERVED TO COASTAL STATES ENERGY CO.
MINERALS-COASTAL STATES ENERGY CO.

SURFACE-UNITED STATES
MINERALS-COASTAL STATES ENERGY CO (FEDERAL COAL LSE.)

SURFACE - KEMMERER COAL CO.
MINERALS - KEMMERER COAL CO.

SURFACE-STATE OF UTAH
MINERALS-STATE OF UTAH

SURFACE-R.E. NIELSEN ET UX, BILL NIELSEN ET UX
MINERALS-COASTAL STATES ENERGY CO.

SURFACE - UNITED STATES
MINERALS - UNITED STATES
(USFS SPECIAL USE PERMIT)

ALL UNDESIGNATED - UNITED STATES SURFACE & MINERALS

ADDRESSES OF ALL OWNERS LISTED IN VOLUME 3, RESPONSES TO COMMENTS 782.13(a)(2) AND 782.13(e)

SUFCO PERMIT AREA

MAP NO. 80-1

COASTAL STATES ENERGY COMPANY

COAL AND SURFACE OWNERSHIP OF S.U.F.CO. AND ADJACENT AREA

SCALE : 2" = 1 MILE

Revised 6/24/83

1981 SUPPLEMENT

FEDERAL COAL LEASE NO. U-47080

SOUTHERN UTAH FUEL COMPANY MINE NO. 1 MINE PLAN
HYDROLOGY SECTION ADDITION

for

Mr. Allon C. Owen, P.E.
Hydrologist
Southern Utah Fuel Company
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Kevin Yocum
Coastal States Energy Corp.
Coastal Towers
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Mr. Loren A. Williams, Vice Pres.
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Coastal States Energy Corp.
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by

HYDROMETRICS, INC.
1300 Cedar Street
Helena, Montana 59601
406/443-4150

June 5, 1981

Table of Contents

ADDITION TABLES

ADDITION APPENDIX

ADDITION FIGURE

ADDITION PLATES

Introduction

This addition describes hydrologic resources and mining related impacts for the emergency lease area (Lease U - 47080). The addition format follows the OSM Permanent Regulatory Program for Surface Coal Mining and Reclamation operations and is consistent with Utah's Division of Oil, Gas and Mining (DOGM) guidelines. This addendum has been prepared so that it can be reviewed as a separate document.

783.11 General Requirements

This addition includes a description of existing pre-mining hydrologic resources within the emergency lease area and adjacent areas that may be affected or impacted by the proposed underground mining activities.

783.13 Description of Hydrology and Geology: General Requirements

The SUFCo mining permit application of which this addition is a part contains a description of hydrology including water quality and water quantity on all lands within the proposed mine plan area, the adjacent area, and the general area. The description is applicable to the emergency lease area. The description includes information on characteristics of all surface and groundwaters within the general area, and any water which flows into or receives discharges of water from the general area. The description was prepared according to requirements in OSM Sections 783.13 through 783.16.

The permit area is that area enclosed by the mine permit boundary (Addition Plate H-I) and is modified by this addition to include that area within Lease U - 47080 (the emergency lease area). The mine plan area and the affected area are considered to have the same boundaries as the mine permit area. The adjacent area (Addition Plate H-I) boundary varies from about 0.2 mile to 1.5 miles outside the mine permit boundary and includes most water quality monitoring sites. These area definitions are consistent with Section 701.5 of the OSM Permanent Regulatory Program Surface Coal Mining and Reclamation Operations. General area (Addition Plate H-I) is not defined in Section 701.5. Therefore, the following definition is used:

> General area means with respect to hydrology, the topographic and groundwater basins surrounding a mine plan area which is of sufficient size, including aerial extent and depth, to include one or more watersheds containing perennial streams and groundwater systems and to allow assessment of the probable cumulative impacts on the quantity and quality of surface and groundwater systems in the basin.

Addition Figure H-1 is a plan map of the surface water drainage system in the SUFCo Mine No. 1 area near Salina, Utah.

783.14 Geology Description

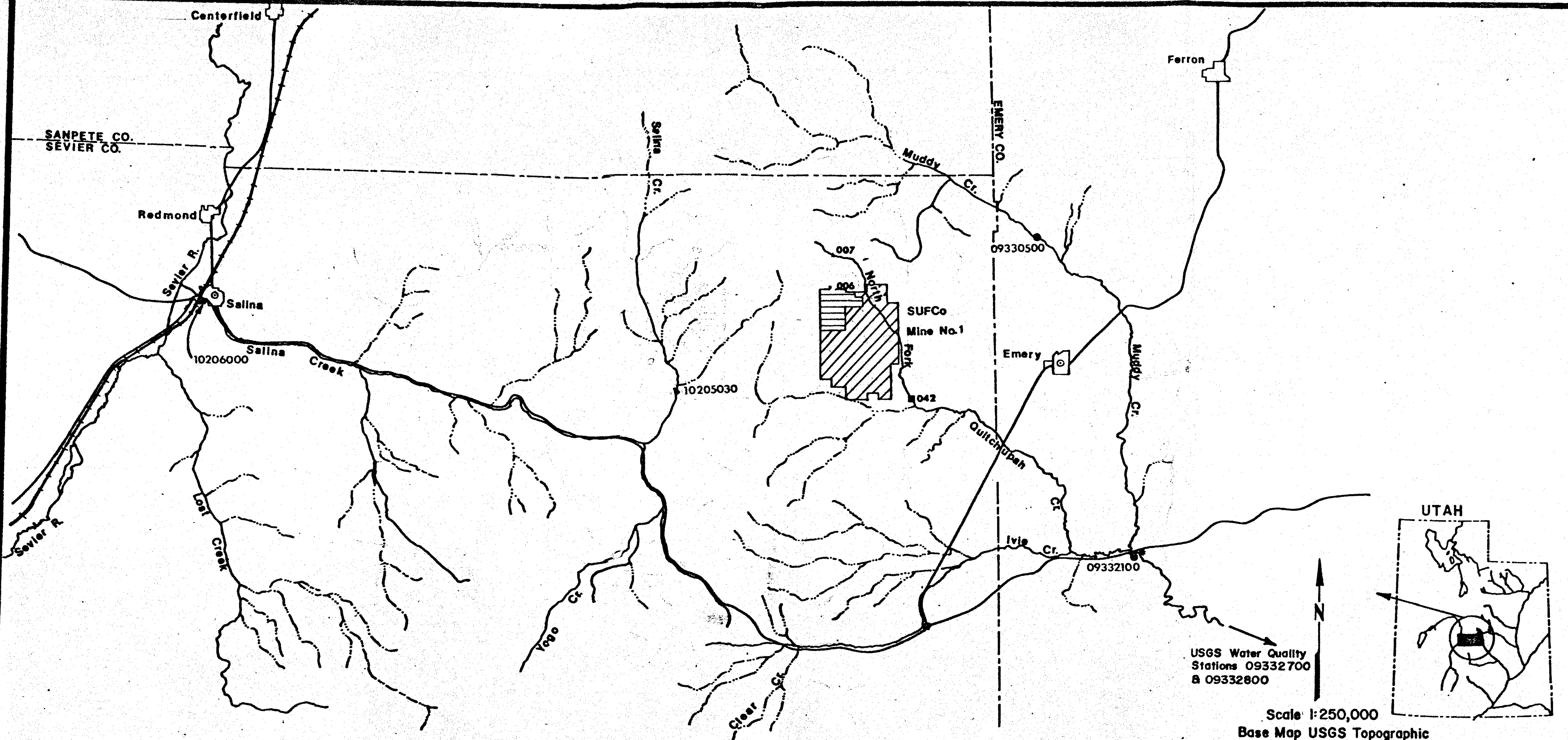
Geology of the mine permit area is described in detail in Section 783.14 of the permit application. Aquifers below the lowest coal seam to be mined are described in detail in Section 783.15 of the permit application.

The general description of subsurface water contained in Section 783.14 of the original permit application is applicable to Lease U - 47080.

783.15 Groundwater Information

A detailed description of groundwater and its relationship to geology in the mine permit area is described in detail in Section 783.15 of the mine permit application. However, to provide specific information on groundwater resources within Lease U - 47080, observation wells will be installed in the emergency lease area. Number, location and aquifers to be monitored will be coordinated with hydrologists from the Utah Division of Oil, Gas and Mining.

Seven observation wells (Addition Table H-1 and Addition Plate H-II) were tested by water injection in the fall of 1980. Pumping tests could not be conducted because five of the seven monitoring wells were dry and because of



LEGEND

- ● USGS Gaging Station
- ■ SUFCo Gaging Station
- ⊙ NOAA Met. Station
- ▨ Mine Plan Area
- • USGS Water Quality Station

FISHLAKE NATIONAL FOREST

▤ Boundary of Emergency Lease Area

Prepared by
HYDROMETRICS
1300 Cedar St.
Helena, MT 59601
(406) 443-4150

July 80
by: JB

PROFESSIONAL SEAL

SOUTHERN UTAH FUEL Co.
A SUBSIDIARY OF
COASTAL STATES ENERGY Co.

SURFACE WATER DRAINAGE SYSTEM
IN THE
SUFCo MINE No. 1 AREA
NEAR SALINA, UTAH

JOB No.		ADDITION FIGURE H-I
DWG No.	REVISIONS	

ADDITION TABLE H-1. CHARACTERISTICS OF OBSERVATION WELLS (Revised 2/6/81)

Obs. Well No.	Location*	Total Drilled Depth (ft)	Total Depth Measured (ft)	Total Depth Cased (ft)	Casing I.D. (in.)	Perfor- ations (ft)	Elevation Casing Top	Formation Monitored	State Plane Coordinates E	State Plane Coordinates N
US-77-7	21S05E31ABC	1220	294	-	1¼	-	8494	-	-	-
US-77-8	22S05E6BB	1140	NM	160	1¼	110	8422	Castlegate	2,023,925	220,450
US-77-9	21S04E36DBB	1075	NM	100	1¼	75	8379	Upper Blackhawk/ Lower Castlegate	2,023,200	220,550
US-79-9	22S05E8BB	970	860	860	2	20	8540	U-Hia Coal	2,031,540	214,460
US-79-10	22S05E8AC	990	885	880	2	20	8551	U-Hia Coal	2,033,870	214,590
US-79-12	22S05E5CAD	990	860	860	2	20	8521	U-Hia Coal	2,033,540	216,110
US-79-13	22S05E5CB	1010	705	705	2	20	8526	Sandstone in Blackhawk	2,032,000	217,320

Observation Well No.	June 3, 1978 Depth to SWL** (ft)	June 3, 1978 Elev. of SWL (ft)	October 5, 1979 Depth to SWL** (ft)	October 5, 1979 Elev. of SWL (ft)	June 20, 1980 Depth to SWL** (ft)	June 20, 1980 Elev. of SWL (ft)	October 30, 1980 Depth to SWL** (ft)	October 30, 1980 Elev. of SWL (ft)
US-77-7	260.3	8234	Dry	-	Dry	-	Dry	-
US-77-8	143.1	8279	140.4	8282	142.67	8279	142.08	8280
US-77-9	>300	<8079	273.6	8105	269.83	8109	271.71	8107
US-79-9	-	-	858.5	7682	Dry	-	Dry	-
US-79-10	-	-	878.1	7673	Dry	-	Dry	-
US-79-12	-	-	-	-	Dry	-	Dry	-
US-79-13	-	-	705.3	7821	Dry	-	Dry	-

* See Plate H-I for location

** Static Water Level (SWL) is measured from ground surface.

SOURCE: Coastal States Energy Company

the small casing diameters (1¼ to 2 inches). Injection testing results (Addition Table H-2) show:

1) All wells are hydraulically connected to the strata penetrated.
2) Water levels declined in all wells, indicating that if aquifer static water levels were sufficiently high, the wells would indicate those water levels.
3) Reactions of the well to water slugs suggest low to moderate transmissivities.

The slug method can be used to evaluate aquifers with low transmissivities but could not be used to quantitatively assess hydrologic characteristics of the Castlegate and Blackhawk formations for the following reasons:

1) The "slug" technique assumes the slug is injected instantaneously. In actuality, the water injected required several minutes to enter the well and reach the bottom of the well.
2) The drilled diameter of the wells was 4-5/8 inches and the casing inside diameter varied from 1¼ to 2 inches. This left an open or partially filled annulus which could adversely affect the testing.
3) The wells have caved below the cased portion. The caved in zone could influence the aquifer testing results.

Semi-annual water level monitoring of observation wells in Lease U - 47080 will begin in 1981. Aquifer testing, if appropriate, will be attempted on one or more of the wells.

There are no known uses of subsurface water within Lease U - 47080. Quality of subsurface waters in the emergency lease area are expected to be similar to that present in East Spring (Site 001), the mine discharge, and selected sites within the underground workings of the mine (Addition Plate H-III). A detailed discussion of the quality of subsurface waters is in Section 783.15 (a)(4) of the mine permit application. Laboratory analyses of water quality samples at these sites during late October and early November 1980 are tabulated in Addition Appendix H-A. Laboratory results for samples collected prior to fall 1980 are tabulated in Appendix H-A of the permit application.

ADDITION TABLE H-2. RESULTS OF AQUIFER TESTING USING THE "SLUG" TEST

Well Number	Total Measured Depth (Feet)*	Cased Diameter (Inches)	Static Water Level Feet Below Ground Surface	Water Added (Gallons)	Rate of Water Level Decline in Well
US-77-7	294	1¼	Dry	10	Moderate
US-77-8	Not Measured	1¼	142.08	10	Slow
US-77-9	Not Measured	1¼	271.71	35	Very Slow
US-79-9	860	2	Dry	55	Moderate
US-79-10	885	2	Dry	55	Slow
US-79-12	860	2	Dry	55	Moderate
US-79-13	705	2	Dry	110	Very Rapid**

* Total depth drilled and total depth cased are shown in Table 6.
Holes have caved-back to cased depths.

** Significant flow of air into well observed.

Date tested: October 31 and November 1, 1980.

783.16 Surface Water Information

Quantity and quality including seasonal variations within the mine plan area, adjacent area, and the mine permit area have been described in detail in Section 783.16 of the permit application. Additional water quality samples were collected in late October and early November 1980. Laboratory and field results for these water quality samples are summarized in Addition Appendix H-A. Laboratory and field results for samples collected prior to fall 1980 are tabulated in Appendix H-A of the permit application. In addition, a field survey of stock ponds in the emergency lease and nearby area was conducted in June 1980 (Addition Table H-3). The emergency lease area is drained by ephemeral tributaries of the South Fork Quitchupah Creek and by ephemeral tributaries of East Spring Canyon (Addition Plate H-I).

783.17 Alternative Water Supply Information

Underground mining impacts to surface and groundwater within the emergency lease are possible diminuation or cessation of flow from a minor intermittant spring and interception of surface runoff in ephemeral drainages (Addition Plate H-1). The spring discharges (estimated less than 1 gpm) near a Forest Service road from the adjacent hillside in early summer but typically is dry in late summer or early fall. Evidence of stock and wildlife use has not been observed. A small catchment pond for trapping spring runoff is located in the drainage approximately 0.4 mile downstream of the spring. South Fork Quitchupah Creek is located in a steep canyon approximately 0.3 mile downstream of the pond. However, the creek is readily accessible to livestock a short distance upstream.

Subsidence in the emergency lease area could adversely affect surface and groundwater flows because flows in ephemeral drainages could be intercepted by subsidence fractures and subsequently percolate downward to the groundwater system. Since there are ponds impounding runoff in and adjacent to the emergency lease area, such interception could reduce the amount of water available to these ponds, and reduce streamflow in the upper portion of the drainage. Ponds in Duncan Draw probably would be little affected by flow interception. Tributary areas for Duncan Draw ponds are mostly outside the emergency lease area boundary. The potential impact on ponds located in ephemeral tributaries of South Fork Quitchupah Creek cannot be predicted. However, a small pond adjacent to Corral Knoll does not appear to have been impacted by previous subsidence.

783.24 Maps: General Requirements

Maps, having the required scales, have been prepared showing hydrologic features of the mine plan area and mine plan adjacent area (Addition Plate H-I). The emergency lease area also is shown on these maps.

There are no water supply intakes, diversions or discharges in surface waters within the emergency lease area.

783.25 Cross Sections, Maps and Plans

The elevations and locations of monitoring stations used to gather water quality and quantity data are shown on Addition Plates H-I and H-II. A detailed discussion of subsurface water in the mine permit area is given in Section 783.15 of the mine permit application. Additional discussion is found in Section 783.15 of this Addition. Cross sections and structural maps of geologic units in the mine permit area are described in the geology section (783.14) of the permit application.

Location of surface water bodies such as streams, lakes, ponds, springs, constructed or natural drains, and irrigation ditches within the proposed mine plan and adjacent areas are shown on Addition Plate H-I.

There are no gas, oil or water wells (other than groundwater observation wells) within the emergency lease area, the mine plan area or adjacent area. Additional discussion of oil, gas and water wells within the general area are described in Section 783.25 (j) of the permit application.

784.14 Reclamation Plan (Protection of Surface and Groundwater Quality)

The quality of surface water within the emergency lease area will not be adversely affected by underground mining. The only area in which changes in surface water quality may occur is in the mine portal and coal loading area (Addition Plate H-I).

ADDITION TABLE H-3. STOCK POND DATA - SOUTHERN UTAH FUEL COMPANY MINE NO. 1 NEAR SALINA, UTAH

Location	Date Examined	Maximum Depth (ft)	Est. Water Depth When Examined (ft)	Area When Full-Acres	Remarks - Spring 1980
T21S,R5E,S31C	6/19/80	5	3	0.02	No flow in stream channel below stock pond.
T21S,R4E,S36D	6/19/80	1	Dry		Shallow depression probably collects limited seepage in early spring.
T22S,R4E,S2A	6/20/80			0.07	Minor amount of water in bottom.
T21S,R4E,S35DA	6/22/80	10	5	0.43	No surface flow out of pond; 10 gpm (est.) inflow.
T21S,R4E,S35AB	6/22/80	0	Dry	0	Marshy area with no storage.
T21S,R4E,S26BD	6/22/80	2	2	0.09	Estimated outflow is 10-15 gpm. Estimated inflow is 10-15 gpm. Established aquatic plant community in pond bottom.
T21S,R4E,S25AB	6/22/80	5	Dry		Bottom well vegetated except for patch of mud approx. 20 ft. in diameter. Therefore stores water only briefly.
T22S,R5E,S6AC	6/22/80	6	Dry	0.02	Damp mud bottom. Probably stores water only briefly after runoff event.
T22S,R4E,S3A (West Pond)	6/22/80	0.3	2.5	0.02	No storage; pond embankment has been breached by erosion. No outflow.
T22S,R4E,S3A (East Pond)	6/22/80	6-7	4-5	0.17	Est. turbidity 10-12 T.U.; due to substantial cattle use. No surface inflow or outflow.
T22S,R4E,S3C (NW Pond)	6/22/80	6	3-4	0.02	Est. turbidity 6-8 T.U.; due to moderately heavy stock use. Mud bottoms with some reeds around edges.
T22S,R4E,S3C (SE Pond)	6/22/80	6-7	3-4	0.04	Extensive mud bottom with some aquatic vegetation in pond center. No inflow or outflow. Moderate stock usage. Est. turbidity 6-8 T.U. Some evidence of salts accumulation along pond banks.

Groundwater quality will not be affected in the emergency lease except where groundwater enters underground workings and is discharged from the workings. As described in the permit application, infiltrating groundwater is collected and impounded in sumps inside the mine. The water is then pumped from the sumps to the portal in East Spring Canyon where it is discharged.

After mining, there should be no adverse impacts on groundwater or surface water quality. Groundwater encountered in the mine and subsequently discharged to the surface will increase the flow of East Spring Canyon during mining. Flows attributable to mining in the emergency lease area are expected to be similar to flows encountered in other portions of the mine. Flows in the SUFCo Mine No. 1 are described in detail in section 783.14 (a) (1) (i) of the mine permit.

Only one intermittent spring has been identified in the emergency lease area (Addition Plate H-I). This spring may receive occasional wildlife and livestock use. Underground mining in the emergency lease area may cause the spring to be diminished or cease to flow because of subsidence. Other impacts to groundwaters in the emergency lease area are limited to possible interception of runoff in ephemeral tributaries by subsidence cracks. Impacts to the surface and groundwaters are further discussed in section 784.14 (a) (1) and (3) of the permit application.

784.16 Reclamation Plan (Subsidence Effects)

Control of groundwater drainage is discussed in section 784.14 (a) (1) of the permit application. Tentative plans for hydrologic testing of aquifers in the emergency lease area are discussed in addition section 783.15.

Probable hydrologic consequences of underground mining are discussed in detail in section 784.14 (c) of the permit application. Expansion of underground mining into the emergency lease area are not expected to alter conclusions presented in section 784.14.

The mechanism of subsidence in the vicinity of the SUFCo No. 1, including hydrologic impacts is discussed in section 784.16 (a) (1) (iv). Additional subsidence monitoring in late October and early November 1980 have not altered the conclusions presented. However, in June 1980, a subsidence crack not observed in previous years was observed on the flank of Corral Knoll and extended toward the exclosure area near the base of Little Duncan Mountain. Inspection of the area in November 1980 indicated the crack had extended east to the road. No other cracks were observed in this vicinity. The hydrologic impact of this single crack on the surface water system will be very minor since the small ephemeral stream bottom shows little evidence of streamflow.

Subsidence effects on the ground surface in the west one-half of Section 1 (T22S, R4E) immediately west of East Spring Canyon increased between June and October 1980. Several subsidence cracks observed in this area in the spring of 1980 ranged from five to seventy-five feet in length and vary from 2 to 8 inches in width. Vertical displacement was minimal. By fall, 1980, numerous cracks were present with their lateral extent ranging from five to two hundred feet and widths to twelve inches. Vertical displacement remained minimal. The cracks generally are parallel and trent southwest-northeast. Total depth of any individual crack could not be measured but several cracks exceeded seven feet in depth. Subsidence in the emergency lease area could adversely affect surface and groundwater flows because flows in ephemeral drainages could be intercepted by subsidence fractures and subsequently percolate downward to the groundwater system. Since there are ponds impounding runoff in Duncan Draw and in ephemeral tributaries of South Fork Quitchupah Creek, such interception could reduce the amount of water available to these ponds, and reduce streamflow in the upper portion of the drainage. In 1980, a portion of the streamflow in the upper portion of Duncan Draw was intercepted and piped to a stock tank.

Section 785.19 Alluvial Valley Floor Determination

As discussed in Section 785.19 of the mine permit application, Duncan Draw is the only drainage within the adjacent area and near the emergency lease area which contains small areas of alluvium. There appear to be no other potential alluvial valley floors within or immediately adjacent to the emergency lease area. Reconnaissance examination of Duncan Draw suggests this drainage does not contain an alluvial valley floor.

ADDITION APPENDIX H-A.

Water Quality Data Summary for Streams and Springs in the Vicinity of the SUFCo No. 1 Mine Near Salina, Utah

WATER QUALITY DATA FOR STREAMS AND SPRINGS IN THE VICINITY OF THE SUFCo NO. 1 MINE NEAR SALINA, UTAH

Site No.	Location	Site Description	Date Sampled	Flow (gpm)	Field Water Temp-°C	Est. Field Turbidity (NTU)	pH(SU) Field	pH(SU) Lab	Conductivity (uhmos/cm @ 25°C) Field	Conductivity (uhmos/cm @ 25°C) Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)
001	21S04E36DCD	Spring in Duncan Draw (East Spring)	6/19/80	2.9	8.9	0	-	8.0	485	460	52.8	22	31	1.2	<0.01
006	21S04E24CAC	S. Fork Quitchupah	6/19/80	570	19.9	≤2	-	8.1	679	470	47.2	31.7	30	1.9	<0.01
007	21S04E13ADC	N. Fork Quitchupah	6/19/80	4037	13.9	>30	-	8.2	331	350	44.8	13.9	41	1.3	<0.01
021	22S04E12BAD	Mine Effluent	6/20/80	570	-	≤2	-	7.6	-	500	47.2	35.5	19	2.1	<0.01
041	22S05E16DDA	Quitchupah Creek above N. Fork	6/20/80	555	25.0	5-8	-	8.1	1130	870	43.2	16.4	72	2.7	<0.01
042	22S05E16DAD	N. Fork Quitchupah above mouth	6/20/80	4108	18.8	>30	-	8.2	504	550	44.0	20.2	58	2.2	<0.01
046	22S04E12CDB	Convulsion Canyon above pumphouse	6/19/80	5, est.	20.5	10	-	7.2	1165	950	82.4	44.2	35	3.7	<0.01
047	22S04E12CDA	Pumphouse Effluent	6/19/80	48	26.4	≤2	-	7.4	826	680	84.0	.73.0	25	3.2	<0.01
047A	22S04E12CDA	E. Spring Canyon above Convulsion Canyon	6/19/80	44	18.0	5-8	-	7.6	959	810	97.6	55.7	21	2.5	<0.01
060	Underground	Haulage Way 42LE	7/1/80			060		7.9		690	64.0	50.2	15	2.1	7.20
061	Underground	Haulage Way 6L	7/1/80			061		7.9		430	53.6	31.2	10	1.6	' 0.01
062	Underground	#1 Entry-ZN	7/1/80			062		7.8		450	55.2	32.0	9.3	1.9	0.01
063	Underground	#6 Entry-N. Main	7/1/80			063		8.0		400	52.8	25.0	7.1	1.4	2.40

WATER QUALITY DATA FOR STREAMS AND SPRINGS IN THE VICINITY OF THE SUFCo NO. 1 MINE NEAR SALINA, UTAH (continued)

Site No.	Date Sampled	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Total Dissolved Solids (meas.)	Total Suspended Solids	Fluoride (F)
001	6/19/80	234	30	46	300	4	0.22
006	6/19/80	300	40	18	310	40	0.42
007	6/19/80	266	30	4	230	236	0.23
021	6/20/80	239	87	18	325	12	0.20
041	6/20/80	305	200	42	570	14	0.21
042	6/20/80	220	118	80	360	196	0.24
046	6/19/80	403	195	34	620	48	0.32
047	6/19/80	427	60	20	445	1.5	0.12
047A	6/19/80	439	110	26	528	44	0.25
060	7/1/80	161	220	14	450		0.49
061	7/1/80	300	18	16	282		0.13
062	7/1/80	278	40	16	294		0.21
063	7/1/80	242	28	14	255		0.16

Site No.	Nitrate as (NO_3-N)	Total Kjeldahl Nitrogen	Phosphate (PO_4-P)	Silica (SiO_2)	Iron (Fe)	Total Manganese (Mn)	Total Arsenic (As)	Total Cadmium (Cd)	Total Selenium (Se)
001	.35	0.10	.20	10.0	0.166	0.015	<0.001	<0.001	0.002
006	.02	0.10	.10	7.8	.158	.030	<0.001	<0.001	<.001
007	.02	0.01	.26	8.2	0.028	.090	<0.001	<0.001	<.001
021	<0.01	0.18	0.100	10.5	0.095	0.006	<0.001	<0.001	<0.001
041	<0.01	0.20	.10	11.5	0.299	.010	<0.001	<0.001	.002
042	.02	0.15	.16	6.0	0.077	.070	<0.001	<0.001	.002
046	0.02	<0.01	0.100	12.9	0.025	0.04	<0.001	<0.001	<0.001
047	<0.01	0.25	0.080	12.8	0.058	0.03	<.001	<0.001	0.002
047A	<0.01	<0.01	0.060	9.6	0.116	0.01	<0.001	<0.001	<0.001
060	0.01		.060	22.0	.120	0.01	0.001	0.001	0.001
061	.03		.030	7.7	.100	0.02	0.001	0.001	0.001
062	0.01		.060	12.0	2.500	0.07	0.001	.002	0.001
063	.02		.030	9.4	.190	0.01	-	0.001	0.001

WATER QUALITY DATA FOR STREAMS AND SPRINGS IN THE VICINITY OF THE SUFCo NO. 1 MINE NEAR SALINA, UTAH (continued)

Site No.	Location	Site Description	Date Sampled	Flow (gpm)	Field Water Temp-°C	Est. Field Turbidity (NTU)	pH(SU) Field	pH(SU) Lab	Conductivity (uhmos/cm @ 25°C) Field	Conductivity (uhmos/cm @ 25°C) Lab	Hardness ($CaCO_3$)	Calcium (Ca)	Magnesium (Mg)
001	21S04E36DCD	Spring in Duncan Draw (East Spring)	11/1/80	2.8	6	< 2		7.5		450	218	57.60	17.76
006	21S04E24CAC	S. Fork Quitchupah	11/1/80	100	0	15.20		7.8		740	298	73.60	27.36
007	21S04E13ADC	N. Fork Quitchupah	11/1/80	240	0	> 30		7.8		590	244	84.00	8.16
021	22S04E12BAD	Mine Effluent	11/1/80	Not measured	-	--		7.5		590	296	64.80	32.16
041	22S05E16DDA	Quitchupah Creek above N. Fork	11/1/80	83.3	9	25-30		8.0		850	318	88.00	23.52
042	22S05E16DAD	N. Fork Quitchupah above mouth	11/1/80	229	3	8-10		7.9		970	334	72.80	36.48
046	22S04E12CDB	Convulsion Canyon above pumphouse	11/1/80	10, est.	8	< 2		7.6		940	476	106.40	50.40
047	22S04E12CDA	Pumphouse Effluent	11/1/80	16	27	< 2		7.0		700	364	87.20	35.04
047A	22S04E12CDA	E. Spring Canyon above Convulsion Canyon	11/1/80	512	11	2-5		7.9		580	310	70.40	32.16
060		Haulage Way 42LE	12/80					7.2		545	318	52.80	44.64
061		Haulage Way 6L	12/80					7.4		530	322	79.20	29.76
062		#1 Entry-ZN	12/80					7.3		430	246	58.40	24.00
063		#6 Entry-N. Main	12/80					7.3		410	228	52.00	23.52

. WATER QUALITY DATA FOR STREAMS AND SPRINGS IN THE VICINITY OF THE SUFCo NO. 1 MINE NEAR SALINA, UTAH (continued)

Site No.	Date Sampled	Sodium (Na)	Potassium (K)	Acidity ($CaCO_3$)	Alkalinity ($CaCO_3$)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Carbon Dioxide (CO_2)	Hydroxide (OH)	Sulfate (SO_4)	Chloride (Cl)	Total Dissolved Solids (meas.)	Total Suspended (meas)	Fluoride (F)	Ammonia (NH_3-N)
001	11/1/80	9.90	1.02	14.0	212.00	<.01	258.64	<.01	<.01	16.4	7.8	230		.14	<.01
006	11/1/80	73.00	1.86	40.0	372.00	<.01	453.84	<.01	<.01	63.0	18.1	480		.31	<.01
007	11/1/80	95.00	1.59	28.0	332.00	<.01	405.04	<.01	<.01	25.5	10.1	386		.25	<.01
021	11/1/80	20.00	2.09	20.0	232.00	<.01	283.04	<.01	<.01	106	4.6	390		.24	<.01
041	11/1/80	75.00	3.50	14.0	282.00	<.01	344.04	<.01	<.01	181	13.6	556		.25	<.01
042	11/1/80	100.00	2.17	22.0	320.00	<.01	390.40	<.01	<.01	207	19.3	630		.24	<.01
046	11/1/80	44.00	4.36	36.0	406.00	<.01	495.32	<.01	<.01	147	15.5	610		.20	<.01
047	11/1/80	36.00	3.22	42.0	374.00	<.01	456.28	<.01	<.01	64.5	7.3	455		.18	<.01
047A	11/1/80	19.50	2.23	34.0	250.00	<.01	305.00	<.01	<.01	96.0	5.3	378		.23	<.01
060	12/80	68.00	1.85		270.00	2.64	275.72	<.01	<.01	190	4.4	500		.20	<.01
061	12/80	28.00	1.20		360.00	2.16	395.28	<.01	<.01	19.0	6.0	360		.10	<.01
062	12/80	26.00	1.29		264.00	1.92	283.04	<.01	<.01	38.0	4.5	300		.08	<.01
063	12/80	17.00	1.45		236.03	1.68	253.76	<.01	<.01	30.0	4.9	265		.11	<.01

WATER QUALITY DATA FOR STREAMS AND SPRINGS IN THE VICINITY OF THE SUFCo NO. 1 MINE NEAR SALINA, UTAH (continued)

Site No.	Date Sampled	Nitrate + Nitrite (NO_3-N)	Total Kjeldahl Nitrogen	Phosphate (PO_4-P)	Total Arsenic (As)	Total Barium (Ba)	Silica (SiO_2)	Total Boron (B)	Total Iron (Fe)	Dissolved Iron (Fe)	Total Manganese (Mn)	Total Cadmium (Cd)	Total Chronium (Cr)	Hex. Chromium (Cr)	Total Mercury (Hg)	Total Selenium (Se)
001	11/1/80	.38		.060	<.001	.060	15.00	.070	.610	.188	.030	<.001	<.001	<.001	.00150	<.001
006	11/1/80	.04		.100	.002	.120	14.50	.080	1.300	.460	.100	<.001	<.001	<.001	.00100	<.001
007	11/1/80	.02		<.001	.001	.260	13.00	.060	6.000	.940	.100	<.001	<.001	<.001	<.00020	<.001
021	11/1/80	.02		.070	<.001	.100	16.00	.280	.110	.080	<.001	<.001	<.001	<.001	<.00020	.005
041	11/1/80	.10		.120	.001	.080	16.00	.270	9.650	3.500	.140	<.001	<.001	<.001	.00070	<.001
042	11/1/80	<.01		.080	<.001	.090	14.00	.090	.660	.250	.030	<.001	<.001	<.001	.00080	<.001
046	11/1/80	<.01		.020	<.001	.050	21.00	.170	.090	.050	.030	<.001	<.001	<.001	.00070	<.001
047	11/1/80	.06		.040	<.001	.080	19.50	.110	.030	.020	.060	<.001	<.001	<.001	.00100	<.001
047A	11/1/80	<.01		.140	.001	.100	15.50	.270	.340	.210	.020	<.001	<.001	<.001	.00050	<.001
060	12/80	.24		<.001	.002	.041	9.90	.010	.125	.054	.014	<.001	<.001	.002	<.00020	<.001
061	12/80	.02		.030	<.001	.069	7.35	.006	.110	.036	.026	<.001	<.001	<.001	<.00020	<.001
062	12/80	.04		<.001	<.001	.268	8.10	.008	.885	.650	.026	<.001	<.001	<.001	<.00020	<.001
063	12/80	.07		<.001	<.001	.075	8.90	.011	.234	.110	.011	.002	<.001	<.001	<.00020	<.001

WATER QUALITY DATA FOR STREAMS AND SPRINGS IN THE VICINITY OF THE SUFCo NO. 1 MINE NEAR SALINA, UTAH (continued)

Site No.	Date Sampled	Total Silver (Ag)	Total Zinc (Zn)	REMARKS
001	11/1/80	<.001	.010	
006	11/1/80	<.001	<.001	
007	11/1/80	<.001	.010	
021	11/1/80	<.001	<.001	
041	11/1/80	<.001	.020	
042	11/1/80	<.001	<.001	
046	11/1/80	<.001	<.001	
047	11/1/80	<.001	<.001	
047A	11/1/80	<.001	.010	
060	12/80	<.001	.015	
061	12/80	<.001	.006	
062	12/80	<.001	.017	
063	12/80	<.001	.016	

1981 SUBMITTAL

RESPONSE TO APPARENT COMPLETENESS REVIEW
SOUTHERN UTAH FUEL COMPANY
ACT /041/002
SEVIER COUNTY, UTAH

for:

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SOUTHERN UTAH FUEL COMPANY
CONVULSION CANYON MINE
ACT /041/002
SEVIER COUNTY, UTAH

783.13

Applicant should present a discussion concerning the direction of ground-water flow and possible discharge areas for aquifers identified and/or encountered within the permit area.

The applicant should indicate the areas of inflow into the mine on the underground map. The applicant states that the mine is dry on Page 30, Vol. 2, this contradicts a 600 gpm discharge rate.

The applicant should further discuss the role of the aquicludes which prevent inflow of ground water into mine. What evidence is available to support this contention?

RESPONSE

The aquifer system in the SUFCo area generally transmits small quantities of groundwater. Results of the exploratory drilling and the well and spring inventory show that local formations have a limited ability to yield water. Measured spring flows and estimated water yields from drill holes are nearly all less than three gpm. Overall consideration of the probable groundwater flow patterns indicates that water is probably contained in the overlying sandstone members of the Price River Formation, particularly the basal Castlegate Sandstone, and in the sandstone members of the Blackhawk Formation which overlie the Upper Ivie Coal Seam. Despite the presence of aquifers above the workings, the mine has remained essentially dry (except for stored water contained in fractures) relative to commonly acknowledged "wet" mines because the sandstone sequence contains several shale and silt members and partings which serve as aquicludes to retard the vertical percolation of the ground water and to form perched aquifers above the coal. A particularly effective seal is obtained by a 20-foot thick stratum of bluish-gray bentonitic shale which directly overlies the producing coal seam. As these sandstone members crop out on the sides of the cliffs and along the slopes of the canyons they would normally be drained by horizontal percolation downdip and along the strike of the sandstone beds until released by slow seepage to the surface and lost through evapotranspiration or by release into the surface water regime.

Water-bearing units in this region are generally sandstones with fair to good primary permeability. The Castlegate Sandstone is the primary water-bearing unit in the mine area. It is the source of 12 springs inventoried and yielded water to at least two drill holes. Low flows associated with the Castlegate unit probably result from a combination of factors: (1) A coarse-grained sandstone (such as the Castlegate) will generally have good primary permeability. However, inter-granular cementation may reduce permeability and limit movement of groundwater within the unit. The Castlegate is fairly well cemented, as evidenced in its resistant cliff-forming appearance. Detailed aquifer testing would be necessary to determine the actual permeability of this unit. (2) Precipitation affects the amount of water available to the groundwater system. The Castlegate unit may receive significant local recharge due to its broad plateau exposure. If this is the case, climatic fluctuations such as the on-going drought (Richardson, 1977), could limit the availability of water for recharge to the groundwater system. Long-term monitoring of the Castlegate flow system and local precipitation would be necessary to define such a relationship. (3) The highlands northwest of the mine area receive precipitation in excess of 30 inches per year. This water could recharge the Castlegate unit through downward percolation. However, impermeable beds overlying the Castlegate probably would limit the amount of recharge reaching the unit. Quantitative determination of this relationship would be difficult. Small groundwater flows present in the Castlegate Sandstone probably are influenced to some degree by each of the above factors.

As described above, groundwater movement within the Castlegate unit is generally directed from the plateau area to the canyon outcrops. This flow is perched above impermeable units of the underlying Blackhawk Formation, as indicated by the number of springs and seeps located at the base of the Castlegate unit.

Fractured units of coal or interbedded sandstone and shale may also transmit groundwater due to secondary permeability. This type of groundwater flow was evidenced in several springs and seeps.

The underground mining operation has intercepted groundwater along several fractures (northwest-southeast trends). Significant flows have been encountered, but these flows have rapidly decreased and nearly all have gone dry. This sequence is probably a result of intercepting stored groundwater along a fracture (or group of fractures), and the gradual depletion of this stored water. Groundwater inflow into the mine is very dependent on water encountered in new headings that encounter stored groundwater in fractures. Cumulatively, the amount of groundwater intercepted at all of the mine working faces totals approximately 600 gallons per minute as a discharge source. Individual source contribution (single working face) varies from extremely high to zero gallons within a short period of time.

Plate H-III (Volume 4, Hydrology) illustrates the location of groundwater pump monitoring locations in the vicinity of the working faces. It should be pointed out that locations and pumping rates will be variable as new headings are developed and old workings are passed. Completed panels in mined areas are additionally monitored for groundwater inflow and it is found that such panels receive very little groundwater inflow. Future operations will increasingly involve retreat mining procedures and thereby stabilize the increasing (1978-1981) number of active headings encountering groundwater. Due to this aspect of mine planning, future cumulative water discharge should approximate the limit of 600 gpm.

It appears that the water-bearing units in the mine area are recharged from the highlands to the west. Groundwater movement is generally toward the bedrock outcrops in the canyons or toward areas of spring discharge. Movement is laterally controlled by impermeable strata with downward percolation primarily due to regional and local fracture systems. The lateral directional preference of water movement in groundwater systems is very common. This normally gives rise to springs at contacts between permeable and impermeable layers and greatly retards or prevents downward movement of groundwater. The presence of springs and the limited continuous groundwater inflow into underground workings clearly demonstrates the significant influence of aquicludes ground workings clearly demonstrates the significant influence of aquiclude in the groundwater system at the Convulsion Canyon Mine. Areas of inflow to the mine during 1980 are shown on Plate H-III (Volume 4, Hydrology).

783.15

(b) The recharge areas should be identified for springs sites being monitored at the surface and from within the mine.

The applicant states that various faults and fractures are producing the increasing amounts of water intercepted within the mine (600 gpm at present). Has any attempt been made to map the areas producing significant amounts of inflow? This information may provide a means of projecting and identifying potential surface recharge areas.

It is necessary for the applicant to provide the water well injection information stated to be derived from tests during the fall of 1980. This was to be compiled on four observation wells showing the extent of the hydraulic connection within the Blackhawk Formation. (p. 18, vol. 4)

Have the holes in the 001 springs area been completed yet? If so, information thus attained should be submitted along with a monitoring schedule.

Will mining or subsidence effect the domestic spring 048; if so, what is an alternate water supply (UMC 783.17)?

RESPONSE

Monitoring study design has been formulated on the basis of projected mine development including planned subsidence control. The surface water body of primary interest in the mine permit area, relative to potential impact upon springs, is East Spring. Flow measurements are made and water quality samples are collected from East Spring on a semi-annual (late spring and fall) basis. The spring discharges from the Castlegate Sandstone which is the basal member of the Price River Formation. The Castlegate Sandstone overlies the Blackhawk Formation which contains the coal beds of economic interest. Recharge area for East Spring probably is in Duncan Draw.

Mapping of areas producing significant amounts of inflow has been done in the mine workings (see Plate H-III). Observations by underground mine personnel show that almost all water is produced at working faces and that as the working faces are advanced, flow decreases rapidly and often drys up. Fractures, joints, and faults appear to be the most important conduits for movement of groundwater into the coal from overlying strata.

To assess hydrological continuity with the strata penetrated and to assess transmissivity in the Castlegate and Blackhawk formations, injection tests of the monitoring wells using the slug method described by Lohman (1979) were conducted in the fall of 1980. Pumping tests could not be conducted because five of the seven monitoring wells were dry and because of the small casing diameter (1¼ to 2 inches). Injection testing results (Table 1) showed that

1) All wells are hydraulically connected to the strata penetrated.
2) Water levels declined in all wells, indicating that if natural aquifer static water levels were sufficiently high, the wells would indicate these water levels.

TABLE 1. RESULTS OF AQUIFER TESTING USING THE "SLUG" TEST

Well Number	Total Measured Depth (Feet)	Cased Diameter (Inches)	Static Water Level Feet Below Ground Surface	Water Added (Gallons)	Rate of Water Level Decline in Well
US-77-7	294	1¼	Dry	10	Moderate
US-77-8	Not Measured	1¼	142.08	10	Slow
US-77-9	Not Measured	1¼	271.71	35	Very Slow
US-79-9	860	2	Dry	55	Moderate
US-79-10	885	2	Dry	55	Slow
US-79-12	860	2	Dry	55	Moderate
US-79-13	705	2	Dry	110	Very Rapid*

* Significant flow of air into well from top of casing.

Date tested: October 31 and November 1, 1980.

3) Reactions of the well to the water slugs suggest low to moderate transmissivities.

The "slug" method can be used to evaluate aquifers with low transmissivities but could not be used to quantitatively assess hydrologic characteristics of the Castlegate and Blackhawk Formations for the following reasons:

1) The slug test method assumes the wells are fully penetrating. At SUFCO, the wells are perforated only in the bottom section.
2) The technique assumes the slug is injected instantaneously. In actuality, the water injected required several minutes to enter the well and reach the bottom of the well.
3) Drilled diameter of the wells was 4-5/8-inches, and the casing inside diameter varies from 1¼ to 2-inches. This leaves an open or partially filled annulus which adversely affects the testing.

4) The wells have caved below the cased portion. The caved in zone could influence the aquifer testing results.

Hydrological observation wells in the vicinity of East Spring (Site 001) are planned and probably will be completed in the summer or fall of 1981. Mining and subsequent subsidence will not affect domestic spring 048. This spring is at least two miles from any planned subsidence and does not appear to be connected to the groundwater system affected by the mine.

783.16

The applicant has provided semi-annual surface water monitoring data to identify seasonal variation. Extra-polated data has also been generated from empirical formulas for the Quitchupah Creek drainage area. These data are apparently complete, but may be technically deficient (i.e., specific information delineating similarities between watersheds has not been provided).

RESPONSE

The surface water monitoring program extensively conducted to date has emphasized the quantitative characterization of the watershed singularly influenced by development of the SUFCo Mine, specifically the Quitchupah Creek Watershed area as diagrammed on Plate H-II in Volume 4, Hydrology. This emphasis has included the utilization of an end-point effect monitoring station (Station 042, Plate H-II) and assuring data collection sufficient to assess mine resultant impacts to the surface hydrologic regime. To provide an expanded degree of quantitative and also qualitative investigations, the program described in the following has been implemented.

Three streamflow gaging stations using flumes have been installed in the vicinity of the mine to depict seasonal variation in streamflows. These stations were instrumented in 1980 (June through November) and again in 1981 with Leupold Steven Type F-1 water level recorders. Recorders typically cannot be installed before June because roads are impassable. Recorders are removed during winter months because there is no access and flow measurements would not be accurate because of freezing problems. Peak flows which scour out and remove flume installations have been a particular problem at the

North Fork Quitchupah Creek near mouth (station 042) because of sandy soils. The flume at this site was reinstalled in June 1981, and is being used to calibrate a conventional streamflow gaging station. Streamflow data collected during 1980 at the gaging stations are summarized in Table 2 and Figures 1 through 3. Data for 1981 are not available.

Surface water quality samples collected in spring (June) and fall (October or November), will be augmented with an additional set of water quality samples collected in mid-summer beginning in 1981. Collections of surface water quality samples is not realistic at most sites from November through May or early June of most years because Forest Service roads are not passable.

FIGURE 1.

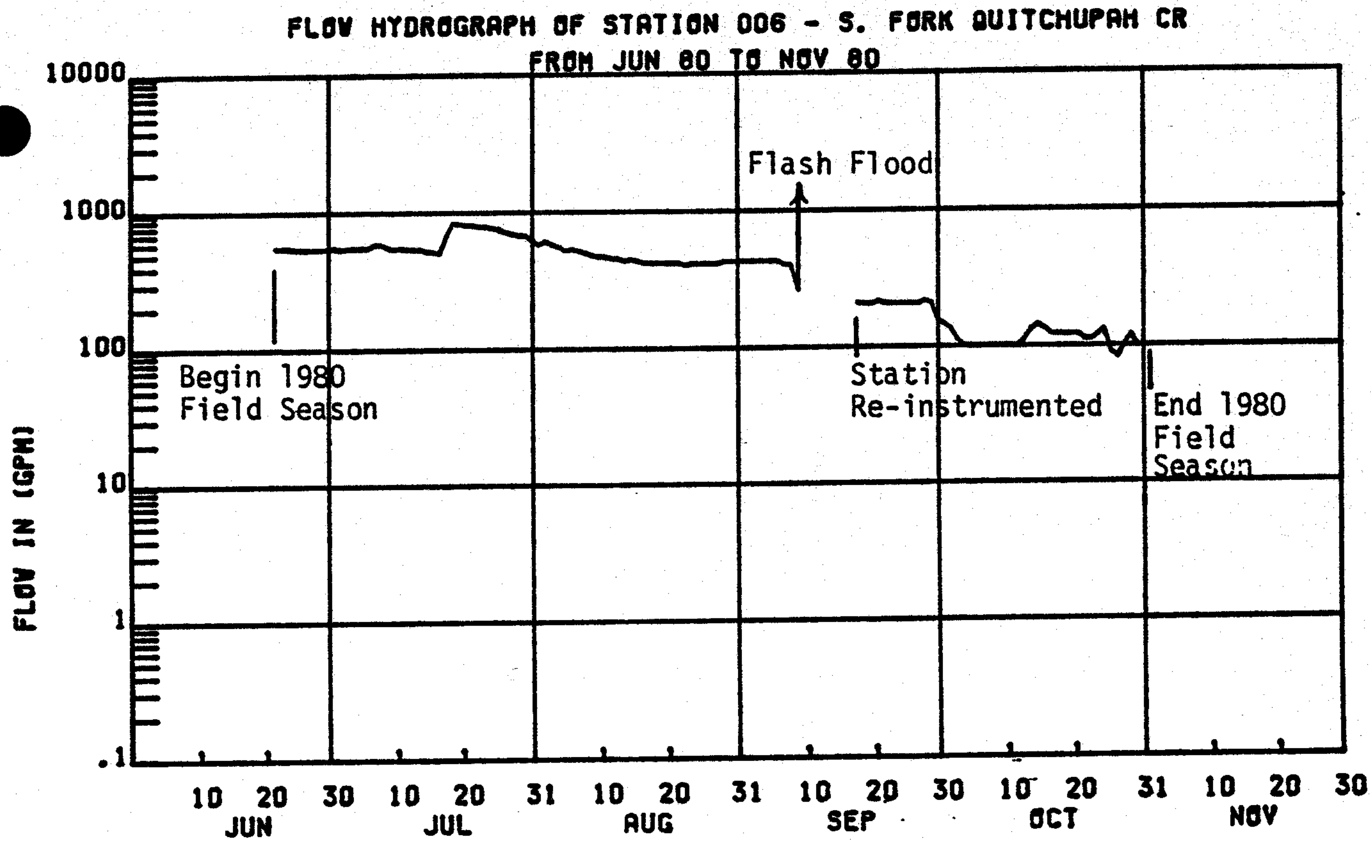


FIGURE 2.

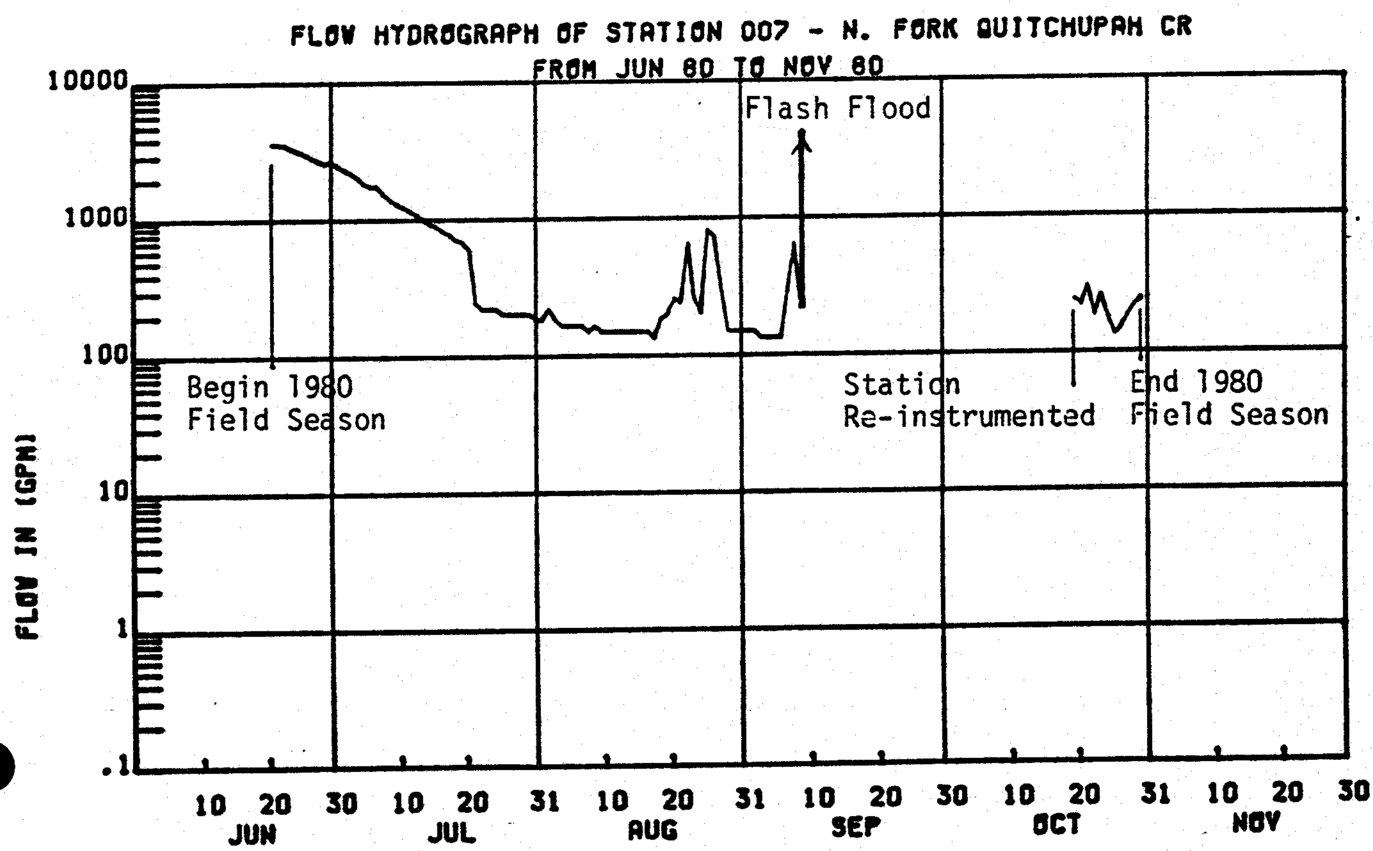
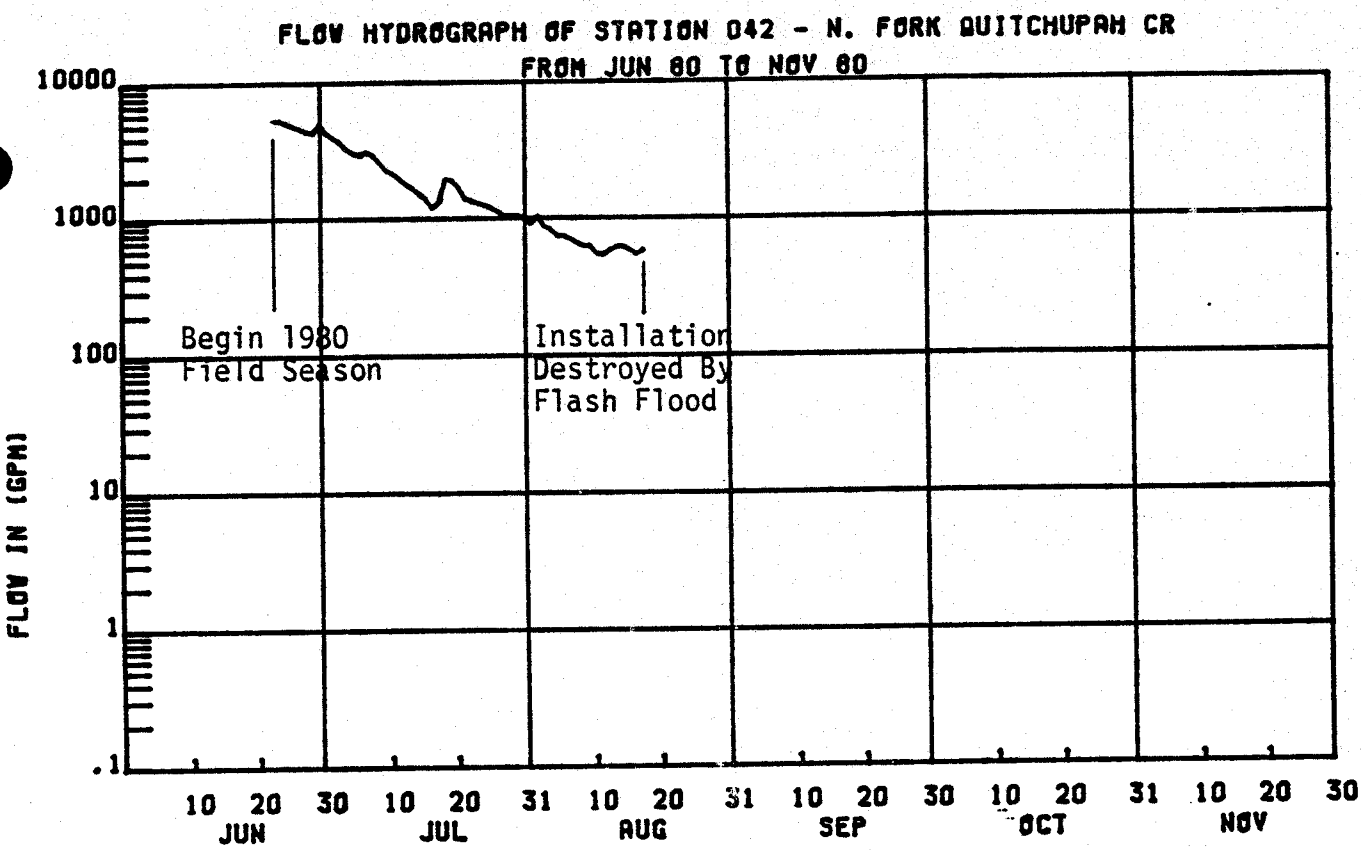


FIGURE 3.



Streamflow records are tabulated in Appendix A.

783.25

(f) Potentiometric surface levels should be shown on a map or cross-section.

RESPONSE

It is not possible to show potentiometric surface levels. Only wells US-77-8 and US-77-9 contain water. Other wells are dry; initial indications of water in these wells (US-77-7, US-79-9, US-79-10, US-79-12 and US-79-13) probably were due to residual drilling mud and water and probably did not represent a true aquifer potentiometric surface (Table 2). The general direction of groundwater movement in the Blackhawk Formation is probably toward the steep canyon walls where the formation is exposed. Based on extensive exploration drilling and existing hydrological observation wells, the Blackhawk transmits only small quantities of groundwater and it is questionable if this unit should be considered an aquifer in the mine permit area.

TABLE 2. CHARACTERISTICS OF OBSERVATION WELLS (Revised 2/6/81)

Obs. Well No.	Location	Total Drilled Depth (ft)	Total Depth Measured (ft)	Total Depth Cased (ft)	Casing I.D. (in.)	Perforations (ft)	Elevation Casing Top	Formation Monitored	State Plane Coordinates E	State Plane Coordinates N
US-77-7	21S05E31ABC	1220	294	-	1¼	-	8494	-	-	-
US-77-8	22S05E6BB	1140	NM	160	1¼	110	8422	Castlegate	2,029,925	220,450
US-77-9	21S04E36DBB	1075	NM	100	1¼	75	8379	Upper Blackhawk/ Lower Castlegate	2,023,200	220,550
US-79-9	22S05E8BB	970	860	860	2	20	8540	U-Hia Coal	2,031,540	214,460
US-79-10	22S05E8AC	990	885	880	2	20	8551	U-Hia Coal	2,033,870	214,590
US-79-12	22S05E5CAD	990	860	860	2	20	8521	U-Hia Coal	2,033,540	216,110
US-79-13	22S05E5CB	1010	705	705	2	20	8526	Sandstone in Blackhawk	2,032,000	217,320

Observation Well No.	June 3, 1978 Depth to SWL* (ft)	June 3, 1978 Elev. of SWL (ft)	October 5, 1979 Depth to SWL* (ft)	October 5, 1979 Elev. of SWL (ft)	June 20, 1980 Depth to SWL* (ft)	June 20, 1980 Elev. of SWL (ft)	October 30, 1980 Depth to SWL* (ft)	October 30, 1980 Elev. of SWL (ft)	June, 1981 Depth to SWL* (ft)	June, 1981 Elev. of SWL (ft)
US-77-7	260.3	8234	Dry	-	Dry	-	Dry	-	279.50	8214.5
US-77-8	143.1	8279	140.4	8282	142.67	8279	142.08	8280	141.0	8281
US-77-9	>300	<8079	273.6	8105	269.83	8109	271.71	8107	271.6	8107
US-79-9	-	-	858.5	7682	Dry	-	Dry	-	Dry	-
US-79-10	-	-	878.1	7673	Dry	-	Dry	-	Dry	-
US-79-12	-	-	-	-	Dry	-	Dry	-	865.4	7655.6
US-79-13	-	-	705.3	7821	Dry	-	Dry	-	Dry	-

* Static Water Level (SWL) is measured from ground surface.

SOURCE: Coastal States Energy Company

784.14

(a) A description of potential quantitative changes in groundwater recharge and discharge should be presented.

RESPONSE

Potential changes in groundwater recharge and discharge cannot be predicted quantitatively. Development of a quantitative understanding of the existing system would be difficult and has not been undertaken. However, based on the broad exposure of the Castlegate unit relative to the mine permit area, and examination of lithological logs from drill holes and from observation of water encountered at working faces within the mine, potential long-term quantitative changes in recharge and discharge are expected to be small.

Subsidence in small ephemeral drainages could adversely affect surface and groundwater flows because flows in ephemeral drainages may be intercepted by subsidence fractures and subsequently percolate downward to the groundwater system. Exploration drill hole logs in the mine plan area indicate the existance of shale and silt members and partings which serve as aquicludes in the sandstone sequence above the coal seam. Since silts and shales often "flow" and seal fractures within a short time, it is possible that subsidence will have little or no effect on the movement of groundwater from the Castlegate sandstone into underlying strata in the area. Semi-annual examination of East Spring indicates there have been no changes in flow or water quality although subsidence has occurred within about 1000 feet of the spring.

Routine observations of groundwater encountered within the mine indicates mine water is directly associated with fracture systems within the coal which, when drained, tend to remain dry. Since mined out areas do not produce significant quantities of water after fractures are drained, long-term changes in the quantity of groundwater discharged probably will be small. Since the volume of groundwater encountered in the mine workings is directly dependent on the number of working faces, the short-term impact is to dewater the fracture system adjacent to and overlying the mine. This water is discharged from the mine and will increase flows in Quitchupah Creek during mining.

(b)(3) Applicant should present an adequate surface and groundwater monitoring plan for operational and postmining periods. Will the same schedule be utilized as for baseline monitoring? What is the monitoring frequency of the two springs identified within the mine?

RESPONSE

As described under 783.16, routine (baseline) water quality monitoring will be expanded to include sampling during mid-summer. Sampling during the winter quarter is not possible at several sites because roads are closed due to snow. The baseline sampling program is summarized in Table 3. Water quality parameters and surface and groundwater sampling sites are listed in Table 4.

TABLE 3. WATER QUALITY SAMPLING IN THE VICINITY OF THE SUFCo NO. 1 MINE

SURFACE WATERS SAMPLING SCHEDULE(2)

Site(3) No.	Description	Baseline Period	Operational Period	Post-Mining Period	Flow Measurement Method
006	South Fork Quitchupah Creek	3x/yr	3x/yr	3x/yr	Pygmy Meter where feasible or Cross section/velocity estimate
007	North Fork Quitchupah Creek	3x/yr	3x/yr	3x/yr	Pygmy Meter where feasible or Cross section/velocity estimate
041	Quitchupah Creek above North Fork	3x/yr	3x/yr	3x/yr	Pygmy Meter where feasible or Cross section/velocity estimate
046	Convulsion Canyon above pumphouse	3x/yr	3x/yr	3x/yr	Pygmy Meter where feasible or Cross section/velocity estimate
047A	East Spring Canyon above Convulsion Canyon	3x/yr	3x/yr	3x/yr	Pygmy Meter where feasible or Cross section/velocity estimate
030(4)	East Spring Canyon just above mine(3)	3x/yr	3x/yr	3x/yr	Crest Gage
022(4)	Mud Spring Canyon just above mine(3)	3x/yr	3x/yr	3x/yr	Crest Gage

(Table 3, continued on page 19)

TABLE 3. WATER QUALITY SAMPLING IN THE VICINITY OF THE SUFCO NO. 1 MINE (Continued)

GROUNDWATER SAMPLING SCHEDULE(2)

Site(3) No.	Description	Baseline Period	Operational Period	Post-Mining Period	Flow Measurement Method
001	East Spring	3x/yr	3x/yr	3x/yr	Time/Volume
062	#6 Entry - North Main	3x/yr	3x/yr	3x/yr	Time/Volume
021	Mine Effluent(1)	3x/yr	3x/yr	3x/yr	Time/Volume
047	Pumphouse Effluent	3x/yr	3x/yr	3x/yr	Time/Volume

(1) Does not include sampling to meet NPDES permit requirements.

(2) Sampling dates are May/June, August/September and October/November.

(3) Monitoring stations 060, 061 and 062 #1 Entry -2N have been discontinued since they are now inaccessible.

(4) Ephemeral stream stations 022 and 030 will have flow measurement by crest gages. Water quality monitoring, if flow occurs, will be collected during the scheduled sampling intervals either by mine personnel or by an automatic sampler. Water samples collected automatically will have the parameter list (Table 4) reduced to exclude those constituents requiring special treatment.

! REPLACES	!! TEXT !		
! Table 3 Page 19	!! Table 3	Page 19	Date 01/08/90 !

TABLE 4. WATER QUALITY PARAMETER LIST FOR ROUTINE WATER QUALITY MONITORING IN THE VICINITY OF THE SUFCo NO. 1 MINE NEAR SALINA, UTAH (Revised August, 1981) (1, 2)

PARAMETERS - FIELD

- Flow
- Temperature
- Specific Conductance
- Turbidity (estimated)

PARAMETERS - LABORATORY

- Specific Conductance
- Turbidity
- pH
- Total Hardness ($CaCO_3$)
- Total Dissolved Solids (Calculated)
- Calcium
- Magnesium
- Sodium
- Total Alkalinity
- Total Acidity
- Bicarbonate
- Carbonate
- Hydroxide
- Sulfate
- Chloride
- Phosphate (PO_4-P)
- Nitrate + Nitrite (N)
- Iron - total, dissolved
- Manganese - total, dissolved
- Boron (total)
- Barium (total)

(1) Routine water quality sampling since 1978 indicates that continued monitoring of several parameters, particularly trace metals, was unwarranted since concentrations have been very low (often less than laboratory detection limits for trace metals).

(2) Includes surface and groundwater stations but excludes Waste Rock Disposal and Quitchupah Lease site.

(c) The applicant should address the potential impacts of subsidence upon the quantity and quality of Quitchupah Creek waters utilized by downstream irrigation projects and upon the baseflow contributions from North Fork of Quitchupah Creek after cessation of mining operations.

It appears that discharges from the mine portal to East Spring Canyon will offset any impacts to baseflow which may be lost during mining operations.

RESPONSE

To date there has been no evidence of hydrological impacts due to subsidence on the quality or quantity of Quitchupah Creek water utilized by downstream irrigation projects or upon baseflow contributions from North Fork Quitchupah Creek. Subsidence planned within the mine permit boundary is not expected to alter this conclusion. East Spring Canyon has no baseflow and has not been affected by mining except for subsidence fractures along the west rim of the canyon. Groundwaters intercepted at working faces in the mine and previously discharged to the East spring Canyon near the mine portal are now discharged into the North Fork of Quitchupah Creek at site 021. Groundwater discharged from the mine during mining will increase streamflows in Quitchupah Creek.

784.20

(d) Have any plans been made to mitigate the effects of subsidence on springs 001 and 033?

RESPONSE

Spring 033 is unlikely to be impacted by subsidence. The nearest subsidence panels are 0.5 miles northwest (in the north one-half of Section 1, T22S, R4E, and no subsidence is planned in the drainage in which spring 033 is located. Therefore, no definitive plan to mitigate the effects of subsidence on spring 033 has been developed.

Spring 001 (East Spring) is the only spring identified in the mine permit area which may be impacted by subsidence. Measurement of discharge and collection of samples for water quality analyses since September 1977 indicate no change in the character of east Spring although subsidence due to mining has occurred within about 1000 feet of the spring. It is possible that underground mining will have no effect on East Spring due to the healing or swelling effect that shales in this area may have. Often, shales will "flow" and seal fractures in a short time period. This could limit the vertical movement of water from the Castlegate sandstone into underlying strata. Subsidence from mining has occurred within about 1000 feet of this spring and, to date, no impacts have been observed. This spring is used for stock watering and has a consistent flow of about 1.5 to 2.5 gpm. There are several options to provide an alternate water supply if this spring is damaged by mining. These are:

1) Drilling of a water well into abandoned mine workings. After mining ceases, a stock well could be successfully completed in underground workings of the SUFCo Mine. These underground workings, where subsidence has occurred, however, yield very little water and would be a difficult drilling target. Although the underground workings probably would yield adequate water to supply livestock, location of a drilling site to assure encountering underground water would be difficult. There would be a risk that the well would not encounter water or would not continuously produce adequate water. In addition, this alternative would require a mechanical pump which, due to lack of power in the area, would pose a problem.

2) Construction of surface water impoundment. Development of an impoundment in drainages north of Spring 001 is possible as an alternative water supply. This alternative, however, has several problems. Drainages in this area are ephemeral, and produce water only in response to snowmelt and heavy precipitation. This raises the possibility of an undependable water source during dry years. Also, runoff in the area is seasonal, with major runoff occurring in the spring. Water from the pond would need to be piped to the Spring 001 area. Due to natural variation in precipitation and possibly dry years, this alternative water supply would not be as dependable as the existing water supply and would require considerable construction.

3) <u>Development of groundwater from upper Duncan Draw.</u> Stock ponds in the upper end of Duncan Draw contain water during much of the year. A spring, present in Section 26, supplies three stock water ponds in Duncan Draw located downstream from this spring on a year-round basis. In consultation with U.S. Forest Service personnel at the Fishlake National Forest in 1978, it was concluded that a plastic pipeline connecting upper Duncan Draw to the Spring 001 area would be a feasible alternative water supply. Water quality is good in upper Duncan Draw and it appears that production of one to two gallons per minute, on a year-round basis, would be possible and would not adversely impact upper Duncan Draw. If sufficient water is developed, this alternative also would allow development of several points along the pipeline to supply water for livestock and wildlife. The pipeline would be gravity-fed and would probably offer a good alternative water supply to Spring 001. Winter operation would require consideration of frost protection during design.

Because East Spring may not be impacted by subsidence and several options for mitigation are available, no definite alternate for replacement of the spring has been selected.