UNDERGROUND MINING PERMIT APPLICATION
MINIMUM REQUIREMENTS FOR INFORMATION ON ENVIRONMENTAL RESOURCES IN THE PERMIT AND ADJACENT AREAS

Permanent Regulatory Program
Subchapter G - Part 783

Volume II

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ACKNOWLEDGEMENT OF THE STATE OF UTAH'S GENERAL REQUIREMENTS FOR QUALIFICATIONAL FORMAT AND CONTENT

On November 3, 1980, the State of Utah, Department of Natural Resources, Division of Oil, Gas, and Mining issued a revised general guideline for organizational format and content for permit applications. The permit applications will be for underground coal mining operations pursuant to the Utah Coal Mining and Reclamation Act and rules and regulations promulgated thereunder.

At the date of this revision Valley Camp of Utah, Inc.'s permit application was substantially complete and had been organized on the basis of the OSM permanent regulatory program. The organization of the application is explained on pages v and vi of this Volume II of the permit application.

In an effort to relate the permit application with the State of Utah's revised guidelines for organizational format and content and also in an effort to permit efficient review of the application a new Table of Contents has been provided on the following page. This new Table of Contents relates the State of Utah's general guidelines to the previously completed Valley Camp of Utah, Inc.'s permit application.

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INTRODUCTION

Volume II of this application addresses Part 783 of Subchapter G, OSM Permanent Rules and Regulations and presents the baseline data describing the Mine Plan Area and adjacent areas with respect to geology, hydrology, climate, vegetation, fish and wildlife resources, soil resources, and land use information. Sources of the data have been Federal and State agencies, general literature, and site specific studies by consultants.

Additional information on environmental resources is included in Volume IV, Maps and Cross Sections. This information is referenced throughout Volume II. Appendices of backup data are also included as part of this volume.

Some sections on environmental resources require prior regulatory authority decisions. In those instances the correspondance with the regulatory authority is referenced and included in Appendix G. Adjacent area determination is based on consultant opinion and regulatory authority guidance (Appendix G).

783.11 - GENERAL REQUIREMENTS

The existing premine environmental resources are described in the sections of this volume of the application. These sections are 783.12 through 783.21 and include geology, ground water, surface water, climate, vegetation, fish and wildlife, and soils.

Land use is described in Section 783.22 and a negative determination of prime farm land is described in Section 783.27.

783.12 GENERAL ENVIRONMENTAL RESOURCES

The size, sequence, and timing of the subareas of the mine plan area for which individual permits will be requested over the total life of the mine is shown on the Operations Map, Map C-5 and Map C, Volume IV. In general each individual permit area will include five years of mining and the associated surface disturbance area. The preparation area, the office area and the portal facilities will all be included on each permit application.

The mine plan area general mining direction is from north to south, starting near Eccles Canyon and ending near Cox Canyon. The original portal sites, included in this permit, will be used as long as they are economically feasible. Any additional portal facilities will be addressed in succeeding permit applications.

There are no public or private cemeteries in the area and there are no cultural or historical resources listed or eligible for listing on the National Register of Historic Places.

There are seven archeological or historic sites within or adjacent to the mine plan area all of which are in poor condition (Hauck and Weder, 1980). Hauck and Weder estab-

lished the following site reference numbers for these historic sites: 270N/1; 270U/1; 270U/2; 381N/1; 381N/2; 381N/3; and 381N/4. Only two of these sites, 381N/1 and 381N/3, could be directly affected by mining operations of Valley Camp. These sites are both old mining sites on private property. The other sites listed are susceptible only to indirect impact from vandalism. This information is based on state and federal agency information and private consultant findings. The complete archeological report by Hauck and Weder can be found in this volume as Appendix C.

Valley Camp of Utah, Inc. does not anticipate a significant disturbance of any of the sites listed. If such disturbance is necessary photographic documentation will be made and monitoring procedures will be implemented.

783.13 DESCRIPTION OF HYDROLOGY AND GEOLOGY: GENERAL REQUIREMENTS

Valley Camp of Utah, Inc. has utilized all available government information for the hydrology and geology section, Sections 783.14-783.17, of this permit. The Hydrology information was supplemented by the work of consultants familiar with the area.

Both the Hydrology and Geology sections describe the general area including the mine plan area and the site specific permit area. The written information is supplemented with maps and cross sections in Volume IV.

A complete bibliography of references sited and consulted for these sections is included as a part of this volume.

783.14 GEOLOGY DESCRIPTION

The general description of the geology down to and including the first aquifer to be affected below the lower O'Connor seam begins with the Starpoint sandstone. Figure 2-1 shows the generalized columnar section for the mine plan area and affected surface area including the depth and classification of the overburden. A written description of this Figure follows.

The Star Point Sandstone, which extends slightly onto the mine plan area on the surface in the east canyons, is about 1000 feet thick and nearly devoid of shale (Doelling, 1972). This yellow-gray (salt and pepper) beach sandstone is massive and medium-grained (Spieker, 1931). The unit is the basal formation of Mesaverde Group in the Wasatch Plateau.

Immediately overlying the Star Point Sandstone is the Blackhawk Formation, an interbedded formation of sandstones and shales, which is Utah's chief coal producer (Stokes, 1964). The sands in this 1900-foot thick member are fine to medium grained and cemented by either calcite or silica with some iron discoloration. They are more irregular than the sandstones of the Star Point, tending to be local in extent and having locally high clay contents (Spieker, 1931;

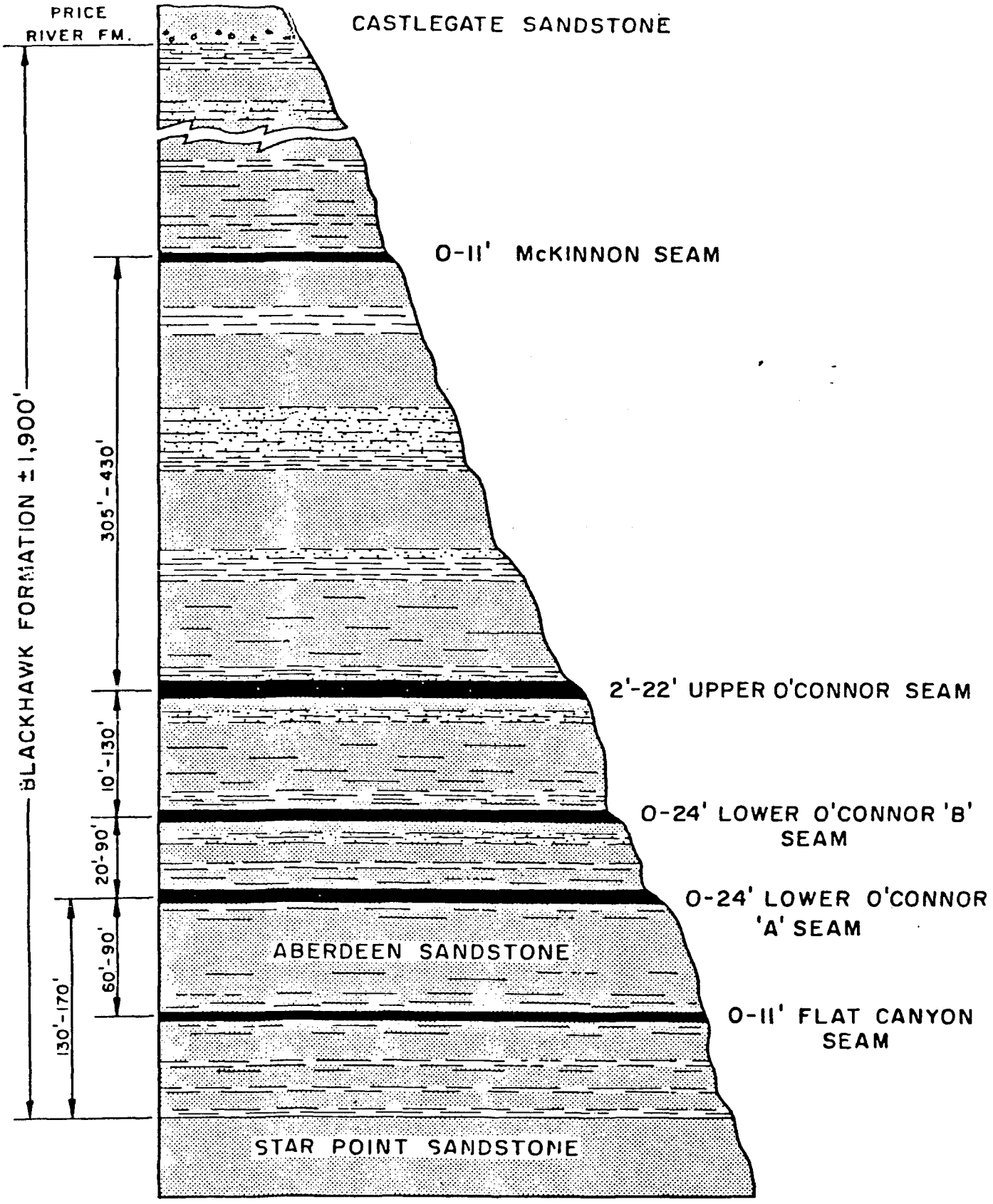

Figure 2-1
GENERALIZED COLUMNAR SECTION -
VALLEY CAMP OF UTAH, INC.
ECCLES CANYON AREA

Doelling, 1972). An exception to this is the Aberdeen sandstone, a coarse-grained, light-colored sand with a thickness of 20 to 80 feet, which can be traced throughout the region (Spieker, 1931). This sandstone allows a tripartite division of the Blackhawk into a lower coal-bearing unit, the Aberdeen Sandstone unit and an upper coal-bearing unit.

The lower coal-bearing unit of the Blackhawk consists of 100 feet of fine-grained sandstones and siltstones, with zones of dark, carbonaceous shale and siltstone. The uppermost carbonaceous zone contains, in places, one or more thin lenticular coal beds. The thickest of these beds is usually referred to as the Flat Canyon seam. No detailed megascopic descriptions of the seam are available.

The Aberdeen Sandstone Member occurs 130 to 170 feet above the top of the Star Point Sandstone, in the lower part of the Blackhawk Formation. The Aberdeen Sandstone ranges in thickness from 20 to greater than 60 feet, and is similar in appearance to the Star Point Sandstone previously described. No marine shale is apparent at the base of the sandstone, although a thin tongue of Mancos Shale is reported (Young 1966, p. 13) as being present in the Book Cliffs. The Aberdeen Sandstone tends to grade upward from fine-grained at the base to medium and course grained at the top and contains thin shaley intervals near the base. The con-

spicuously white upper few feet of the sandstone is significant because it generally lies immediately beneath the lowest coal seam to be mined. The chalky white appearance and the texture of this interval is similar to the uppermost part of the Star Point. The white color is imparted by the presence of the clay matrix which apparently formed diagenetically due to the action of acid waters from the overlying coal swamp (Young, 1966 p. 13) or as a result of subaerial weathering Up to five percent clay matrix is present in the top few feet of this predominantly quartz sandstone.

In sharp contact with the Aberdeen Sandstone is the overlying, upper coal-bearing unit of the Blackhawk Formation. Based on geophysical borehole logs and observations by Full (1979) the similar features of the two areas include:

1) A basal zone of sandstones, siltstones, carbonaceous shales, and economically important coal beds;

2) An interval several hundred feet above the underlying littoral sandstone with very lenticular coal beds which may thicken from less than four feet to more than eight feet within a horizontal distance of less than 1000 feet;

3) -Very thin and lenticular coal beds interspersed throughout the Blackhawk Formation;

4) Sandstone bodies which can be differentiated on the basis of grain size, thickness, structure, and type of basal contact; and

5) An upward increase in the frequency of large, lenticular sandstone bodies.

Three mineable coal seams are present in the basal coal zone of the upper coal-bearing unit of the Blackhawk Formation. In ascending order, they are the Lower O'Connor, the Upper O'Conner and the McKinnon seams. These coal seams are described as attrital, with midlustrous attrital being the most common coal lithotype (Hoover, 1979).

The upper coal zone of the upper coal-bearing unit of the Blackhawk Formation generally contains carbonaceous shales and thin coal beds. This zone occurs from 480 to 590 feet above the Aberdeen Sandstone Member. These coals are discontinuous with only local development of mineable thickness. The uppermost seam, the McKinnon seam, appears to be of mineable thickness in the southwest corner of the

mine plan area. The names, coal surface contours (strike and dip), and croplines for each coal seam are shown on Coal Maps, Map B, Volume IV.

The Castlegate Sandstone is the basal member of the Price River Formation, and is the sedimentary unit in the area. The course-grain tan to brown sands with minor amounts of conglomerate contrast with the finer-grain sandstones and shales of the Blackhawk Formation. The contact is easily mapped where the Castlegate has not been completely eroded.

The geology of surficial deposits on lands affected by surface disturbance is shown on, Soils Map, Map E, Volume IV and described in Section 783.21, Soils Information.

Subsurface water will be encountered over most of the mine plan area. These areas were mapped by plotting cross sections of the regional water table and the coal seams to be mined. The cross sections are shown as Maps F-1 and F-2 with the Hydrology Map, Map F, Volume IV. All available information was included on the cross sections. As more information becomes available the cross sectons will be updated.

The depth and classification of the overburden is shown on Figure 2-1. The structure of the overburden is shown on the Columnar Sections B-1 a, B-1 b, Volume IV.

The pyritic and alkalinity potential of materials found in the roof stratum for each of the mineable seams has not been analyzed to date, but this information should already be available and submitted to the regulatory authorities by Coastal States Energy Company in their Skyline Mine permit application. The Skyline Mine Permit Area is adjacent to the Valley Camp Permit area along Valley Camp's west boundary. The submitted Skyline Permit application showed slight alkalinity and low sulfur content in roof strata. It is our belief that the same condition applies to the Valley Camp, Inc. application as well and are already available to the regulatory authorities via the Skyline Permit application.

Information concerning the clay content of floor samples for Valley Camp, Inc. should also be available via the Skyline Permit Application which reported that the lithology of the stratum immediately below the mineable coals varied from bore hole to bore hole. Also, clay content should range from near 100% in pure claystone, to less than 5% in submature or mature sandstone.

The dominant fault trends in the Valley Camp Mine Plan area are northeast-southwest. The faults within the Blackhawk Formation occur basically as zones (Doelling, 1972) with individual slips usually being clean, sharp displacements with little gouge (Sanders Associates, Inc., no date). Both major faults in the property area are down dropped to the west and tend to die out to the north (U. S. Geological Survey, 1979). The Connelville Fault forms the western boundary of the mine plan are with a drop which varies from 190 feet at the western central mine plan boundary to 75 feet near Eccles Canyon (U.S. Geological Survey, 1979). The other major fault in the area, the O'Connor Fault, extends through the center of the mine plan area and has a drop of about 350 feet (U.S. Geological Survey, 1979). The Pleasant Valley Fault is another major fault which lies east of the mine plan area. Other faulting in the area has resulted in only small displacements.

A formal request for a waiver of the required information in Section 783.14 (a) (1) concerning test borings is included as part of this application as Figure 2-2. Complete analyses of the three seams to be mined are shown in Figure 2-3 thru Figure 2-7. The core holes that these were taken from are also shown on Drill Map, Map H, Volume IV.

Figure 2-2
Request for Waiver on Borehole Information

VALLEY CAMP OF UTAH, INC.
Scofield Route
Helper, Utah 84526

July 16, 1980

Jim Smith
Coordinator
Department of Natural Resources
Division of Oil, Gas, and Mining
1588 West North Temple
Salt Lake City, Utah 84116

Dear Mr. Smith:

Section 783.14 (b) of the permanent program rules and regulations states that the requirements of 783.14 (a) (1) may be waived by the Regulatory Authority. By means of this letter Valley Camp of Utah is formally requesting that the requirements of 783.14 (a) (1), the results of the analysis from test borings, be waived for our proposed five year permit application.

Equivalent information is accessible to the regulatory authority in satisfactory form in the Coastal States Energy Company, Skyline Coal Mine permit, granted June 24, 1980.

The attached diagram demonstrates the proximity of the Skyline Mine to the Valley Camp of Utah Belina mines.

We appreciate your consideration in this matter.

Sincerely,

VALLEY CAMP OF UTAH, INC.

Trevor Whiteside

/jee

Figure 2-3
Valley Camp of Utah, Inc.
Drill Hole 74-36-1B

Coal quality analysis of cored interval
of the McKinnon seam 648'-658'

Note: 1.5' Difference between core and thickness & wireline log thickness

		Proximate Analysis (As Received)			
648'					
	Sample No. 74-36-1 M-A & B	Moisture	6.09	Fixed Carbon	43.96
		Ash	6.25	BTU	12,602
		Volatile	43.70	Sulfur	0.45
650'					
	Sample No. 74-36-1 M-C & D	Moisture	6.68	Fixed Carbon	44.70
		Ash	7.09	BTU	12,069
		Volatile	41.53	Sulfur	0.33
652'					
	Sample No. 74-36-1 M-E & F	Moisture	6.77	Fixed Carbon	47.61
		Ash	3.20	BTU	12,773
		Volatile	42.42	Sulfur	0.35
654'					
	Sample No. 74-36-1 M-G & H	Moisture	7.41	Fixed Carbon	49.45
		Ash	2.95	BTU	12,616
		Volatile	40.19	Sulfur	0.33
656'					
	Sample N. 74-36-1 M-I & J	Moisture	6.31	Fixed Carbon	50.59
		Ash	3.19	BTU	12,681
		Volatile	50.59	Sulfur	0.38
658'					

Core Diagram

Figure 2-4
Valley Camp of Utah, Inc.
Drill Hole 73-31-4CC

Coal quality analysis of cored interval of the Upper O'Connor seam. 540'-561'

CORED INTERVAL
Note: Depths from driller 7.0' deeper than depths by wireline log

	Proximate Analysis (As Received)			
540'				
Sample No. 540	Moisture	5.49	Fixed Carbon	40.26
	Ash	9.89	BTU	11,985
	Volatile	44.36	Sulfur	0.50
542'				
Sample No. 542	Moisture	7.28	Fixed Carbon	45.16
	Ash	4.52	BTU	12,205
	Volatile	43.04	Sulfur	0.42
544'				
Sample No. 544	Moisture	7.02	Fixed Carbon	45.28
	Ash	3.31	BTU	12,526
	Volatile	44.39	Sulfur	0.38
546'				
Sample No. 546	Moisture	6.43	Fixed Carbon	44.40
	Ash	5.14	BTU	12,550
	Volatile	44.03	Sulfur	0.41
548'				
Sample No. 548	Moisture	7.34	Fixed Carbon	44.88
	Ash	4.73	BTU	12,153
	Volatile	43.05	Sulfur	0.40
550'				
Sample No. 550	Moisture	7.14	Fixed Carbon	43.86
	Ash	5.15	BTU	12,286
	Volatile	43.85	Sulfur	0.59
552'				
Sample No. 552	Moisture	6.79	Fixed Carbon	43.86
	Ash	4.71	BTU	12,326
	Volatile	44.82	Sulfur	0.48
554'				
Sample No. 554	Moisture	6.76	Fixed Carbon	43.05
	Ash	5.62	BTU	12,371
	Volatile	44.57	Sulfur	0.42
556'				
Sample No. 556	Moisture	5.78	Fixed Carbon	43.75
	Ash	5.42	BTU	12,292
	Volatile	45.05	Sulfur	0.44
558'				
Sample No. 558	Moisture	6.48	Fixed Carbon	45.18
	Ash	3.64	BTU	12,483
	Volatile	44.70	Sulfur	0.43
560'				
Sample No. 561	Moisture	5.97	Fixed Carbon	38.85
	Ash	16.15	BTU	10,813
	Volatile	39.03	Sulfur	0.48

Core Diagram

Figure 2-5
Valley Camp of Utah, Inc.
Drill Hole 73-31-4CC

Composite analysis of cored interval of
Upper O'Connor seam 540'-561'

Proximate Analysis

	As Received	Dry Basis
Moisture	6.56%	-
Ash	6.84%	7.32%
Volatile	43.08%	46.10%
Fixed Carbon	43.52%	46.58%
	100.00%	100.00%
Btu	12,109	12,959
Sulfur	0.49%	0.52%

Ultimate Analysis

	As Received	Dry Basis
Moisture	6.56%	-
Carbon	68.18%	72.97%
Hydrogen	4.97%	5.32%
Nitrogen	1.23%	1.32%
Chlorine	0.01%	0.01%
Sulfur	0.49%	0.52%
Ash	6.84%	7.32%
Oxygen (Diff.)	11.72%	12.54%
	100.00%	100.00%

Fusion Temperature of Ash

	Reducing	Oxidizing
Initial Deformation	2180° F	2250° F
Softening (H=W)	2220° F	2280° F
Softening (H=1/2W)	2240° F	2320° F
Fluid	2290° F	2370° F

Hardgrove Grindability Index: 47.9 @ 4.96% moisture

Free Swelling Index: 1

Mineral Composition of Ash

Phos. pentoxide, P_2O_5	0.36%
Silica, SiO_2	56.00%
Ferric oxide, F_2O_3	6.03%
Alumina, Al_2O_3	13.52%
Titania, TiO_2	0.66%
Lime, CaO	12.68%
Magnesia, MgO	1.69%
Sulfur trioxide, SO_3	7.11%
Potassium oxide, K_2O	1.16%
Sodium oxide, Na_2O	0.40%
Undetermined	0.39%
	100.00%

Figure 2-6
Valley Camp of Utah, Inc.
Drill Hole 73-31-4CC

Coal quality analysis of cored interval of the Lower O'Connor seam 593.2'-610.4'

CORED INTERVAL

Note: Depths from driller 9.2' deeper than depths by wireline logs

Core Diagram

	Proximate Analysis (As Received)			
593.2'				
Sample No. 593	Moisture	5.21	Fixed Carbon	42.90
	Ash	7.85	BTU	11,863
	Volatile	44.04	Sulfur	0.64
595'				
Sample No. 595	Moisture	6.17	Fixed Carbon	42.22
	Ash	8.85	BTU	12,063
	Volatile	42.76	Sulfur	0.42
597'				
Sample No. 597	Moisture	6.78	Fixed Carbon	45.17
	Ash	4.37	BTU	12,340
	Volatile	43.68	Sulfur	0.28
599'				
Sample No. 599	Moisture	7.63	Fixed Carbon	47.37
	Ash	3.89	BTU	12,274
	Volatile	41.11	Sulfur	0.34
601'				
Sample No. 601	Moisture	6.88	Fixed Carbon	45.86
	Ash	3.35	BTU	12,843
	Volatile	43.91	Sulfur	0.34
603'				
Sample No. 603	Moisture	7.08	Fixed Carbon	44.83
	Ash	5.69	BTU	11,946
	Volatile	42.40	Sulfur	0.56
605'				
Sample No. 605	Moisture	6.05	Fixed Carbon	46.43
	Ash	4.50	BTU	12,721
	Volatile	43.02	Sulfur	0.42
607'				
Sample No. 607	Moisture	6.88	Fixed Carbon	49.78
	Ash	3.32	BTU	12,559
	Volatile	40.02	Sulfur	0.63
610.4'				

Figure 2-7
Valley Camp of Utah, Inc.
Drill Hole 73-31-4CC

Composite analysis of cored interval of
Lower O'Connor seam 593.2'-610.4'

Proximate Analysis

	As Received	Dry Basis
Moisture	6.57%	-
Ash	5.28%	5.65%
Volatile	42.11%	45.07%
Fixed Carbon	46.04%	49.28%
	100.00%	100.00%
Btu	12,432	13,306
Sulfur	0.43%	0.46%

Ultimate Analysis

	As Received	Dry Basis
Moisture	6.57%	-
Carbon	69.77%	74.68%
Hydrogen	5.14%	5.50%
Nitrogen	1.01%	1.08%
Chlorine	0.01%	0.01%
Sulfur	0.43%	0.46%
Ash	5.28%	5.65%
Oxygen (Diff.)	11.79%	12.62%
	100.00%	100.00%

Fusion Temperature of Ash

	Reducing	Oxidizing
Initial Deformation	2170° F	2240° F
Softening (H=W)	2190° F	2280° F
Softening (H=1/2W)	2220° F	2310° F
Fluid	2320° F	2380° F

Hardgrove Grindability Index: 45.5 @ 4.85% moisture

Free Swelling Index: 1

Mineral Composition of Ash

Phos. pentoxide, P_2O_5	0.07%
Silica, SiO_2	60.76%
Ferric oxide, Fe_2O_3	5.35%
Alumina, Al_2O_3	9.04%
Titania, TiO_2	0.59%
Lime, Ca O	13.39%
Magnesia, Mg O	1.94%
Sulfur Trioxide, SO_3	7.24%
Potassium oxide, K_2O	0.46%
Sodium oxide, Na_2O	0.53%
Undetermined	0.63%
	100.00%

783.15 GROUND WATER INFORMATION

The horizontal extent and depth below the surface of the water table and aquifers are shown in cross sections as part of the Hydrology Map, Map F and cross sections F-1, F-2, Volume IV based on a study by Vaughn Hansen Associates. (Hansen, 1980).

According to the U.S. Geological Survey (1979), ground water in the Valley Camp, Inc. Mine Plan Area exists under water table, artesian, and perched conditions. Water table conditions exist primarily in shallow alluvial deposits along larger perennial streams and in relatively flat lying sedimentary rocks. Artesian conditions exist at greater depths where a confining layer overlies a more permeable member. Perched or impeded conditions exist where the confining layer lies beneath the water bearing strata.

The principal factor controlling the occurrence and availability of ground water in any area is lithology. Nearly all of the region surrounding the Valley Camp, Inc. mine plan area is underlain by rocks of continental and marine origin, consisting predominately of interbedded sandstones and shales. (Price and Waddel 1973). Although some of the

sandstones in the region serve as the principal water bearing strata, their ability to yield water for extended periods of time is largely controlled by the existence of the relatively impermeable interbedded shale layers, which prevent the downward movement of a significant amount of water.

Therefore, the thickness of water bearing strata, aquifers, is continuous or undefineable. Once a well encounters water, the rock will be wet intermittenly continuously below the first encounter. Unlike areas in other parts of the country the specific aquifers, depth and thickness, are not easily defined. All known information is shown in plan and cross section on the Hydrology Map, Map F, and cross sections F-1 and F-2, Volume IV.

Ground water in the Valley Camp, Inc. mine plan area is used for watering livestock and for providing irrigation.

The quality of ground water in the Price and San Rafael river basins deteriorates with distance downstream. Dissolved solids contents in ground water range from less than 250 milligrams per liter near the lease area to 3,000 milligrams per liter near the confluence of the rivers with the Green River (Price and Waddel, 1973). This increase in dissolved solids concentration is the result of increased

contact of water and rock as travel distance increases, with saline shales contributing the major portion of the dissolved constituents.

As an index of ground water hydrologic conditions in the mine plan area, an inventory was made of existing seeps and springs on and adjacent to the mine plan area during the months of September and October, 1978; September, 1979 (i.e. the low flow season); and June and July, 1979 (i.e. the high flow season). During this time, the mine plan area was covered on foot and all seeps and springs that were found are noted on the Hydrology Map, Map F, Volume IV. In addition, an estimate was made of the discharge, and a water quality sample was collected. Determinations were made of water temperature and specific conductance. Based on these data, selected samples were chosen which were representative of flow, quality, and geographic variations over the property and sent to the laboratory to be analyzed for calcium, magnesium, potassium, sodium, bicarbonate, chloride, sulfate, and total dissolved solids. The results of these analyses can be found in Appendix A of this volume. A summary of the maximum, minimum, and average concentrations of acidity, alkalinity, iron manganese, and pH are shown on Figure 2-8. Chemical analysis of wells in and adjacent to the mine plan area into the ground water is shown in Figure 2-9.

Figure 2-8

Maximum, Minimum, and Average Concentrations of Various Constituents in Springs

Parameter	Spring Samples Concentration in mg/l			Well and Mine Samples Concentration in mg/l		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Acidity, as $CaCO_3$	20.0	12.0	15.4	----	----	----
Alkalinity, as $CaCO_3$	240	126	169	----	----	----
Iron, Total	1.20	0.15	0.49	2.45	0.225	1.07
Iron, Dissolved	0.010	0.010	0.010	1.85	0.015	0.93
Manganese, Total	0.005	0.001	0.002	0.114	0.091	0.10
pH	7.4	7.1	7.3	7.49	7.35	7.4
Phenol*	0.004	0.004	0.004	0.01	0.01	0.01
Total Diss. Solids	330	165	255	480	182	335

*of the springs, only S36-3 was tested for phenol.

Figure 2-9

Chemical Anaylsis of Ground Water Samples
from Wells in or near Valley Camp Mine Plan Area

	O'Connor Mine	Alpine Well	Belina No. 1 Mine	Belina No. 1 Mine	Upper Eccles Well (W13-1)	Lower Eccles Well (W17-1)	Whiskey Canyon Well (W19-1)
Date of Sample	March, 1979	March, 1979	March, 1979	October, 1979	November, 1979	November, 1979	December, 1979
Parameter	Concentration, in milligrams per liter						
Arsenic	----	0.004	----	----	----	----	----
Barium	----	0.06	----	----	----	----	----
Bicarbonate	241.56	197.64	258.64	312.32	278.60	329.40	309.88
Cadmium	----	<0.001	----	----	----	----	----
Calcium	82.40	32.00	92.00	69.60	43.20	112.80	75.20
Chloride	2.0	2.0	2.0	<1.0	<1.0	3.0	4.0
Chromium	----	<0.001	----	----	0.005	----	----
Conductivity	510	285	580	370	740	540	500
Fluoride	0.17	0.84	----	0.11	----	0.13	----
Iron	----	0.530	----	----	0.225	2.450	0.465
Lead	----	<0.001	----	----	----	----	----
Magnesium	25.92	9.60	12.00	21.12	30.72	11.52	21.12
Mercury	----	<0.0002	----	----	<0.00005	<0.00005	<0.0002
Nitrate	----	<0.02	----	----	<0.01	<0.01	0.24
Orthophosphate	----	<0.01	----	----	----	----	----
Potassium	2.213	1.289	3.65	0.836	12.50	2.117	1.419
Selenium	----	<0.001	----	----	----	----	----
Silver	----	<0.001	----	----	----	----	----
Sodium	1.84	21.32	25.65	1.75	76.50	3.89	2.51
Sulfate	118	6.0	115	6.0	185	63.0	26.0
TDS	335	182	380	250	480	384	300
pH	7.47	7.39	7.30	7.49	7.35	7.40	7.60

Notes: Conductivity in micromhos per centimeter at 25°C; pH in standard units.

Because of the high annual precipitation, the Book Cliffs and the adjacent Wasatch Plateau (where the Valley Camp Mine Plan area is located), act as recharge areas for regional ground water systems (Price and Arnow, 1974). However, only a small portion of the annual precipitation, probably much less than five percent, recharges the ground water supply (Price and Arnow, 1974; U.S. Geological Survey, 1979). Although the depth of water infiltrating through the surface to saturated beds is small (due to the presence of the relatively impermeable shale layers near the surface over much of the area), the total recharge volume is rather significant because of the areal extent of the zone of recharge.

The computation of long-term average annual ground water discharge of Eccles Creek above Pleasant Valley Creek is shown in Figure 2-10.

Properly constructed wells in the Price and San Rafael river basins would have only limited yields (normally less than 50 gallons per minute) (Price and Arnow, 1974).Wells immediately adjacent to the mine plan area could normally be expected to yield less than 10 gallons per minute. Increased yields could be expected from wells penetrating highly fractured sandstones.

Figure 2-10

Computation of long-term average annual ground water discharge of Eccles Creek above Pleasant Valley Creek.

Duration Curve Percentage			Discharge (cfs)	
Limits	Interval	Mean of Interval	Q for Mean of Limits	Increment in Interval
0-15	15	-	3.3	0.50
15-25	10	20	5.6	0.56
25-35	10	30	4.6	0.46
35-45	10	40	4.1	0.41
45-55	10	50	3.8	0.38
55-65	10	60	3.6	0.36
65-75	10	70	3.3	0.33
75-85	10	80	2.5	0.25
85-95	10	90	1.6	0.16
95-99	4.0	97	1.3	0.05
99-99.6	0.6	99.3	1.3	0.01
99.6-100.0	0.4	99.8	1.3	0.01
Total	100	-	-	3.47

Rocks in the mountainous areas near the mine plan area generally have low specific yields (0.2 to 0.7 percent) and low hydraulic conductivities (Price and Waddel, 1973). The volume of recoverable water in the area is small, averaging less than 600 acre-feet per square mile in the upper 100 feet of saturated rock (Price and Arnow, 1974).

783.16 SURFACE WATER INFORMATION (Hansen, 1980)

The effluent from the portal area sedimentation pond drains into Whiskey Canyon and flows downstream to the confluence with Eccles Canyon Creek, a perennial stream, downstream to the confluence with Mud Creek (Pleasant Valley Creek). The sedimentation pond from the effluent Utah #2 load-out facilities area discharges into Pleasant Valley Creek downstream from the confluence of Eccles Canyon Creek. Pleasant Valley Creek flows into the Price River Basin, which flows to the Green River.

The location of all surface bodies of water are located on the Hydrology Map, Map F, Volume IV.

The surface drainage system for the Valley Camp, Inc., mine plan area includes three perennial streams, Eccles Canyon Creek, Boardinghouse Creek, and Huntington Creek. These streams, along with several ephemeral streams, drain the mine plan area forming dendritic patterns over the entire area.

The seasonal variations in quality and quantity were determined by year round sampling of surface monitoring points. The results of sampling are shown in Appendix B, Results of Baseline Surface Water Quality and Quantity Analysis. The following stations are shown in Appendix B and their locations are shown on the Hydrology Map, Map F-3, Volume IV.

V.C. 1 . . . . . Table 2
V.C. 2 . . . . . Table 3
V.C. 4 . . . . . Table 4
V.C. 5 . . . . . Table 5
V.C. 6 . . . . . Table 6
V.C. 7 . . . . . Table 7
V.C. 8 . . . . . Table 8
V.C. 9 . . . . . Table 9
V.C. 10 . . . . . Table 10
C.S. 1 . . . . . Table 11
C.S. 7 . . . . . Table 12
UPL 3 . . . . . Table 13
UPL 10 . . . . . Table 14

The maximum, minimum, and average discharge conditions, which identify critical low flows and peak discharge rates of streams sufficient to identify seasonal variations are shown in Figures 2-11 and 2-12. Figure 2-11 is for Finn, Boardinghouse, and Slaughterhouse Canyon streams. Figure 2-12 is for Eccles, and Huntington Creeks. The maximum, minimum and average flow regimes have been calculated using correlations of concurrent flow events.

Figure 2-11

Critical Low and Peak Discharge Rates for
Finn, Boardinghouse, and Slaughterhouse Canyons.*

Stream	Channel Bar Width, in feet	25-Year Peak, in cfs	50-Year Peak, in cfs
Finn Creek above Pleasant Valley Creek	0.8	2.6	2.7
Boardinghouse Creek Above Pleasant Valley Creek	2.7	17.6	18.7
Slaughterhouse Creek above Pleasant Valley Creek	1.0	3.7	3.9

Estimated critical lows for all canyon streams is 1.0 cfs

*Because of lack of gauging, estimates of peak flow recurrence intervals in the property area were made based on techniques presented by Fields (1975). According to Fields (1975), the 25- and 50-year recurrence interval flood discharges of Utah streams are related to channel geometry characteristics. Specifically, for the area of the Valley Camp permit, the following relationship were found to apply:

(1) $q_{25} = 3.7W^{1.57}$ (2) $q_{50} = 3.9W^{1.58}$

where W is the width of the channel bar cross section, in feet, and q_{25} and q_{50} are the 25- and 50-year recurrence interval flood discharges, respectively. The respective standard errors associated with equations 1 and 2 are 28 and 33 percent.

Figure 2-12

Critical Low and Peak Discharge Rates
For Eccles and Huntington Canyons

Stream	Regression Equation	Max. flow cfs	Min. flow cfs	Ave. flow cfs
*Huntington Creek	$Q_1 = 1.05\ Q_2 - 0.1$ Q_1 = Huntington Flow Q_2 = Measured Oak Creek Flow	222	1.1	10.90
**Eccles Creek	$Q_3 = 0.028\ Q_4 + 3.15$ Q_3 = Eccles Creek Flow Q_4 = Measured Fish Creek Flow	35.6	1.0<	4.44

* Correlating stream is Oak Creek near Fairview ($r^2 = 0.98$ for a near regression). Values based on a 14 year published record 1965 to 1978.

** Correlating stream is Fish Creek above Scofield Reservoir ($r^2 = 0.85$ for a linear regression). Values based on a 40 year published record 1937 to 1978.

The water-quality of surface water in and adjacent to the mine plan area is listed in detail in Appendix A. Seasonal variations of selected parameters is shown on the Hydrology Map, Map F-3, Volume IV. Total dissolved solids concentrations in the area are lowest during the months of April thru June when flows are highest and affected by the diluting effect of direct snowmelt. As flows decrease later in the year the majority of the flow is derived from seepage out of local ground water systems. This dilution effect becomes less pronounced and concentrations tend to increase.

Suspended solid concentrations in the area tend to increase with an increase in flow rate. As a result, concentrations are higher during the snowmelt run-off period than during that portion of the year when baseflow conditions exist. As an example, the average suspended solids concentration for the period of record during the months of April through June equaled 178 milligrams per liter at VC-9 (6 samples), but during the months of October through December the average concentration dropped to 11.0 milligrams per liter (2 samples).

Hydrogen ion activity (pH) over the Valley Camp, Inc. mine plan area tends to be rather constant, varying normally between 7.5 and 8.5 The slightly basic waters in the area

result from the high bicarbonate concentrations (American Public Health Association et al., 1976). Although pH values tend to be slightly higher during the spring and summer months (probably due to the increased dissolved carbon dioxide uptake by aquatic plants organisms during daylight hours), the relatively constant and basic pH indicates that waters in the area are not significantly influenced by pollution (Hem, 1970). The basic condition of the water, together with the low acidity (Maximum measured was 32 mg/l as calcium carbonate) and the relatively high aklalinity, indicates that acid drainage problems should not develop as a result of mining in the property area.

Both total and dissolved iron concentrations vary widely over the area, with the source likely being the cementing agents in the Blackhawk Formation. Total iron tends to be somewhat related to flow rate (i.e. higher concentrations exist during the snowmelt runoff period), as might be expected, due to the probable association of iron with sediment, which tends to increase with flow. Total iron concentrations also tend to be higher in Eccles Canyon than in Pleasant Valley Creek above Eccles Creek.

Seasonal concentrations of dissolved iron at a given station appear to be much more variable than total iron. As a

result, no specific patterns can be detected. About 80 percent of the measured dissolved iron concentrations were less than 30 percent of the concurrent total iron concentration. The difference is greatest during the spring when total iron concentrations are greatest.

Total manganese concentrations measured in the area are low, varying from less thant 0.001 to 0.19 milligrams per liter (with the exception of one sample at station VC-5 which had a concentration of 1.53 milligrams per liter). The low manganese concentrations are likely associated with the low acidity (Hem, 1970). No distinct seasonal variations can be discerned.

Figure 2-13 shows the range and mean of concentrations of dissolved solids, suspended solids, acidity, pH, total and dissolved iron, and manganese as measured at each of the thirteen surface water monitoring stations.

The Utah Division of Health has classified all water in the Valley Camp, Inc. mine plan area as 1C (protected for domestic use with prior treatment by standard complete treatment processes), 2B (protected for recreational uses excluding swimming,) 3A (protected for cold water aquatic life), and 4 (protected for agricultural uses).

Figure 2-13

Results of laboratory analyses of selected water quality parameters

Parameter	TDS			TSS			Acidity			pH			Total Iron			Dissolved Iron			Total Manganese		
Station	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
																.05					
VC-1	550	210	369	111	2	24	14	6	10	8.3	7.1	7.7	3.428	.09	.418	.095	.05	.07	.142	.01	.041
VC-2	510	209	374	84	2.2	21	16	10	12	8.5	7.1	7.8	2.236	.103	.433	.08	.01	.04	.118	.003	.038
VC-4	222	84	129	85	10	49	10	6	8	8.3	7.0	7.8	1.15	.128	.59	---	---	---	.168	.001	.084
VC-5 over Eccles intersection	510	138	274	3910	1	942	10	1.0	5	8.4	7.1	8.0	88.5	.039	11.40	---	---	---	1.532	.013	.226
VC-6	540	160	309	88	2	16	18	2	10	8.4	7.1	7.8	.627	.001	.23	.024	.010	.018	.190	.001	.025
VC-7	520	410	445	---	---	---	---	---	---	8.5	7.6	8.1	.194	.078	.14	---	---	---	.033	.017	.025
VC-8	655	432	541	---	---	---	---	---	---	8.5	7.7	8.0	.305	.093	.20	---	---	---	.102	.068	.085
VC-9	495	162	334	309	10	77	22	10	16	8.45	7.1	7.9	5.84	.040	0.88	.036	.020	.026	.187	.012	.055
VC-10	275	139	227	89	4	16	28	2	16	8.4	7.3	7.8	.540	.045	.25	.050	.020	.032	.074	.004	.023
UPL-3	400	145	184	105	4	10	12	12	12	8.45	7.05	7.6	.418	.067	.18	.02	.03	.04	.109	.001	.037
UPL-10	226	125	172	15	1	6	13	6	9	8.9	7.25	7.9	.62	.144	.36	.114	.060	.087	.040	.004	.020
CS-1	254	190	238	13	4	8	24	12	17	8.4	7.4	7.9	.330	.045	.14	.20	.022	.074	.005	.002	.003
CS-7	240	185	209	9	1	5	16	2	8	9.15	7.2	7.9	.27	.09	.21	.058	.012	.030	.021	.002	.009

783.17 ALTERNATIVE WATER SUPPLY INFORMATION

The existing mining activities have not resulted in contamination, diminution, or interruption of an underground or surface source of water within the proposed mine plan or adjacent area for domestic, agricultural, industrial, or other legitimate use. Therefore, the need for an alternative water supply is not anticipated. However, in the event of such an occurrence, the following alternative means of water supply could be utilized to replace an interrupted supply of any legal owner of such rights.

1. Private contractors living within the district could be retained to haul water to specific locations from applicant owned surface sources located within Pleasant Valley.
2. The applicant has three (3) producing water wells within the mine plan area which could also supply supplemental amounts of water for both private and industrial use.

Further, a monitoring program is underway and will continue in order to ensure the continuing maintenance of the water quality should it be impacted by the mining activities.

783.18 CLIMATOLOGICAL DATA

The proposed Mine Plan Area has a mean annual precipitation of 20 to 25 inches. Most precipitation falling on the Mine Plan Area is received in the form of snowfall during the months from October through March. Mean annual rainfall data collected at the Clear Creek National Weather Station (latitude 39°39', longitude 111°09', elevation 8300 feet) in 1956 was 21.56 inches. The mean annual rainfall collected at Scofield (latitude 39°44', longitude 111°09', elevation 7900 ft.) was 19.46 inches for the period 1893 through 1924 (U.S. Geological Survey, 1978). A national weather service recording precipitation gauge has been installed in Eccles Canyon (latitude 39°41', longitude 111°11', elevation 8080 feet). The first year's data at this station shows rainfall of 29.8 inches during 1980.

Local air patterns in the central Utah Coal Basin area tend to follow the general drainage patterns; night breezes tend to flow down-drainage, due to the inducement of denser, cool air, while day time breezes tend to flow up-drainage due to surface heating effects. Generally, however, the winds in the study area are from the west and northwest. Winds generally do not exceed 20 miles per hour (U.S. Geological Survey, 1978).

Temperatures in the area are seasonal, with the high mean monthly temperature occurring in July and the low mean monthly temperature occurring in January. The summer season is short, with maximum high temperatures in July in the low 80's, Farenheit; in winter, maximum lows are in the range of -20 to -30 degrees Farenheit in January.

783.19 VEGETATIVE INFORMATION (Welsh, et. al., 1980)

General Description

The Valley Camp, Inc. properties and adjacent areas occur within an aspen-spruce-fir phase of the boreal forest biome, with representatives of cool desert shurb, riparian, and, to a lesser extent, mountain brush community types present as significant though minor components.

The spruce-fir community, a type mainly of north-facing slopes is dominated by Engelmann spruce and subalpine fir, with variants supporting admixtures of aspen and wet meadow subtypes characterized by species of sedges and grasses. Often broad transitional zones occur between the dense spruce-fir forest and adjacent aspen communities. Occasionally stands of the spruce-fir type are almost entirely single species dominants due to past logging or other successional influence. In greater abundance are stands containing all age classes of both spruce and fir species. The spruce-fir type, including areas transitional into aspen, constitutes some 40 percent of the lease and general conveyor corridor area (Figure 2-14). The forest floor is frequently subjected to dense shade promoting a near-complete lack of understory foliage. Grasses and sedges are most commonly represented by Agropyron Caninum, Stipa spp.,

Figure 2-14

Plant Communities of the Valley Camp, Inc. mine plan area by percent of area covered

Vegetation Type	Map Description	Percent
Spruce-Fir	SF	37.8
Aspen	A	21.0
Grass-Forb-Elderberry	GFE	12.8
Sagebrush	SB	21.9
Fringed Sage	FS	0.4
Disturbed	D	6.1
	Total	100.0%

For specific vegetation type locations, see Vegetation Map, Map G, Volume IV.

Bromus carinatus, and Carex hoodii. Principal forbs in the spruce-fir community include Arnica cordifolia, Lathyrus lanzwertii, Ozmorhiza depauperata, and Fragaria virginiana. Common understory shrubs are Rosa woosdii, Sheperdia canadensis, and Symphoricarpos oreophilus. See Appendix F for a complete species list by community type. Some 94 species are reported present in the spruce-fir type.

The aspen community is a forest type with Populus tremuloides as the principal tree species. About 23 percent of the lease area is dominated by aspen alone; south-facing slopes and ridges are main localities of this community. Rather large open areas are interspersed among the aspen stands and are dominated by grasses, forbs, and elderberry. These grass-forb-elderberry communities occupy about 16 percent of the lease area. Species diversity in the aspen community is great, with 20 species reported present. The main ground layer species are much the same as those of the grass-forb-elderberry community, with which the aspen community is considered transitional. The combined aspen and grass-forb-elderberry community is very large, constituting about 39 percent of the general lease area and conveyor corridor.

The sagebrush and fringed sagebrush vegetative types occupy 22 percent of the mine plan area, and occur mainly on shallow soils. Collectively, they are remarkably diverse, with some 110 species of vascular plants reported. Snowberry is often a major component in the sagebrush community. Fringed sagebrush is dominant only on rocky semi-barrens of ridge crests at high elevations.

The riparian community type consists of continuous narrow strips of wetland vegetation along the major drainages, as in the valley bottoms of Eccles Canyon, and along minor tributaries. Total area extent of the riparian type is very small. Dominant species on these wetlands are redtop grass, silver sagebrush, sedge species, grasses, and numerous forbs.

Disturbed areas, constituting six percent of the lands studied, are present in the proposed mine plan area, some of which have been treated to reclamation procedures. Both introduced and native species were observed growing along pipeline corridors, roadways and drill pads.

The most recent planting and re-vegetation of portions of the disturbed areas within the mine permit area were completed in November, 1980, following grading and topsoil redistribution

procedures. Certain previously re-vegetated and reclaimed areas were also treated.

In pursuing a suitable, permanent and diverse vegetative cover, a seed mix and plant species list was developed on the basis of requirements and recommendations issued by the U. S. Forest Service; the Division of Oil, Gas and Mining; Division of Wildlife Resources; and the Bureau of Land Management. Consideration was also given to influencing situations such as velocity and direction of wind, annual precipitation and snow depth, slope stability and exposure, present and potential soil productivity, and land use objectives.

Seeding of flat and south-facing slopes with angles of 2h:1v or less, was accomplished using a cyclone spreader. Seeding of steeper and north-facing slopes was accomplished by using a hydro-seeder and chemical binder additive.

On all but the steeper slopes, a weed-free straw mulch was blown on top of the re-seeded areas to enhance the moisture retention required for seed germination.

South-facing slopes at the Belina Mines site were also planted with 13-inch hand-set plantings of Serviceberry, Chokecherry, Red Elderberry, Mountain Big Sage, Mountain Snowberry, Mountain Mahogany, Quaking Aspen and Big Sagebrush, on six foot centers.

The north-facing slope of the sedimentation pond (No. 4) at the Belina Mines site was also planted with 13-inch, hand-set plantings of Engleman Spruce and Blue Spruce on ten foot centers.

Also included in the planting of each seedling was a 20 gram slow-release fertilizer tablet which will feed the plants for up to two years while not promoting weeds.

A total of 14.0 acres was re-seeded at a rate of 30 lbs. of pure live seed per acre, and 1,775 plants were placed.

Vegetation Summary for the Proposed Conveyor Route Disturbance Area

The lower mine and office areas are disturbed to the extent that little if any natural communities are fully represented. The immediate environs of the mine area had supported before disturbance a sagebrush--grass type similar to the sagebrush communities studied along the Eccles Canyon portion of the conveyor route, where 34 species contributed to a total cover of 130 percent. Shrub species, with *Artemisia tridentata* dominant, contributed a composition percentage of 61; *Agropyron spicatum* and other grasses contributed 31 percent. See Appendix H, Tables 3 through 32 for transect data summaries. Table 33 summarizes tree growth data. Locations of transects are shown on the Vegetation Map, Map G, Volume IV.

A total of 19 species occurred along the transect in the lower canyon spruce-fir understory with grasses and sedges providing the most cover at 46 percent. These species were low in frequency percentages and sparse enough to contribute little if any forage. Forb and grass productivity measurements were thus eliminated in this type. The overstory of spruce and fir provided a high (near 100%) canopy cover, and their average productivity (diameter increase) of 0.38mm per year was approximately that of other spruce-fir types measured along the conveyor route and at the upper area. The com-

position of trees in this forest type was near equal with spruce having a relative frequency of 52 percent and 163 trees per acre while fir had a 48 percent frequency and 150 trees per acre. The stand was considered a dynamic stand as both species had representatives in all size classes studied (Appendix H, Tables 4 and 6).

Aspen stands along the conveyor line comprised about 32 percent of the total conveyor line area. In the aspen stands along the lower conveyor line total cover of understory species was 97 percent, with 90 percent of the total attributable to grass species. Usually the well developed aspen stands are the most productive for forage but this stand only contributed approximately 390 pounds per acre. Aspen tree growth was sparse in having 496 trees per acre with a diameter growth increment of only 0.32 mm per year. Further evidence of the unproductive nature of this stand was observed in the size class distribution study; no trees were found in the small or large size classes, all trees being either 3-6 or 6-12 inches in diameter. Rotten centers were found in 67 percent of the trees sampled and thus the stand could be considered decadent and not likely to become a dynamic and productive stand of aspen.

Openings along the aspen stands at one time were dominated by palatable species of grass, forbs, and elderberry. Due to excessive grazing, palatable species have been largely

replaced by undesirable species such as stinging nettle, sneezeweed, stickseed, and thistle. These areas constituted about three percent of the total proposed conveyor line route.

Where the proposed conveyor route is parallel to the Skyline Project conveyor corridor, the vegetation was mostly sagebrush, with a mixture of six grasses contributing 85 percent cover and the many palatable forbs contributing 47 percent cover. This sagebrush type was the most common of any along the conveyor route and comprised 34 percent of the total. Transect data indicates a total cover of 162 percent with 25 species contributing. Productivity values of the sagebrush type was greatest among sites studied with 1375 pounds per acre (Appendix H, Tables 15 and 18).

Along the Whiskey Canyon proposed conveyor route, both aspen and spruce-fir communities were encountered. The aspen community was among the most diverse in species with a total of 28 species contributing to the understory cover of 162 percent. The species contributing most to forage production were grasses. Forage production of grasses and forbs combined provided 595 pounds per acre (Appendix H, Table 20). Aspen trees here were more productive, with the stands containing some mature trees greater than 15 inches in diameter, as well as numerous intermediate sized down to 1 inch in diameter. All core samples appeared healthy and little evidence of diseased trees was found. The average increment of growth was 0.24 mm per year.

Sample data in the Whiskey Canyon spruce-fir community included four species of trees with spruce and aspen being most abundant. The stand could be considered successional with spruce being the potential climax. Intermediate size classes of aspen were most abundant, with few large trees and very few small replacement trees evident. Douglas fir was apparently giving way to the spruce climax as there were only a few large trees, with little evidence of seedling replacement. Tree density for all species was 434 trees per acre with the growth rate for spruce and fir at 0.34 mm per year and 0.27 mm per year respectively. The understory species, limited by dense shade, comprised a total of 28 percent.

The reference area for the spruce-fir type was established adjacent and above the portal area; construction activities preclude the establishment of validation sites. The community was dominated by fir trees which constituted a density of 173 trees per acre. These trees were abundant in all size classes indicating a permanent and near-climax community of spruce and fir. Spruce trees, although less abundant (115 trees per acre), were also represented in all size classes. Growth rates for these trees was 0.38 mm per year for spruce and 0.48 mm per year for fir. The understory consists of 21 species, having a total cover percentage of only 38.

The portal aspen reference area studies were also taken adjacent to and above the disturbance areas, on the south-facing slope. Here there were 22 species with grasses contributing 86 percent of the total cover of 110 percent. Total forb productivity was 738 lbs. per acre, which is somewhat more than that measured in the aspen stand along the Whiskey Canyon corridor. Trees averaged a diameter increase of 0.50 mm per year, which is greatest for all trees sampled.

A summary of data for the permanent reference sites for the proposed conveyor line is as follows:

Transect Mapping No.	Location	Total Cover %	No. of Species	Prod lb/ Acre	Trees per Acre
1	Lower Canyon Spruce-Fir	53	19	--	313
2	Aspen opening (nettle)	163	18	--	--
3	Lower Canyon Aspen	97	18	389	633
4	Sagebrush	129	34	1375	--
5	Whiskey Canyon Aspen	165	25	595	357
6	Whiskey Canyon Spruce-Fir	57	2	--	433
7	Portal Spruce-Fir	38	21	--	288
8	Portal Aspen	110	22	738	63

For specific reference area locations, see Vegetation Map, Map G, Volume IV.

Sample Adequacy. In preliminary studies prior to actual sampling it was determined that approximately twenty 2 x 5 plots would be adequate; with this number of plots a 10 percent increase in the number of plots fails to yield to a 10 percent increase in number of species. Sample size is believed adequate to reveal diversity of species along the transect.

Results of adequacy of sample and site similarity calculations are summarized in Figure 2-15. In stands where the understory cover was very spotty such as in the dense shade of spruce, quadrate cover data were extremely variable, resulting in a calculated requirement for a prohibitively large number of quadrats. It should be noted that overstory canopy data are not included in transect cover data; inclusion of such data would greatly diminish the variability of sample means as well as the projected required sample size.

A map delineating existing vegetative types is enclosed as Vegetative Map, Map G, Volume IV. Revegetation plans are described in Volume III.

Figure 2-15

Adaquacy of Sample and Site Similarity for Cover Analysis of the Valley Camp Mine Plan Area

Transect Mapping No.	Location and Vegetative Type	No. of Quadrats	Projected Required Sample Size	Similarity Index
1.	Lower Canyon, Spruce-Fir			
	Validation	20	201	
	Reference	20	339	.56
2.	Conveyor, Aspen Opening (nettle)			
	Validation	20	18	
	Reference	20	23	.73
3.	Lower Canyon, Aspen			
	Validation	20	18	
	Reference	20	19	.57
4.	Conveyor, Sagebrush			
	Validation	30	37	
	Reference	60	57	.60
5.	Whiskey Canyon Conveyor, Aspen			
	Validation	20	49	
	Reference	20	12	.71
6.	Whiskey Canyon Conveyor, Spruce-Fir			
	Validation	20	202	
	Reference	20	200	.72
7.	Portal Yard, Spruce-Fir	20	206	
8.	Portal Yard, Aspen	20	36	

Threatened and Endangered Plant Species

Passage of the Endangered Species Act of 1973 (Public Law 23-205) provided the legal basis for establishment of lists of endangered and threatened plant species. Such lists were prepared under direction of the Smithsonian Institution, and were published subsequently in the Federal Register (40: 27824-27924, 1975; and 41: 24524-24572, 1976). Work on endangered and threatened plants of Utah has been reviewed by Welsh, Atwood, and Reveal (1975), and re-evaluated by Welsh (1978). More recently an illustrated manual of endangered and treatened plants of Utah was written by Welsh and Thorne (1979).

The region under investigation was included in a report on threatened and endangered species of the Central Coal lands of Utah (Welsh, 1976).

A survey of the literature has failed to indicate the presence of any of the proposed endangered or threatened plant species in the area. This lack of critical or unique species is supported by the field surveys of the lease areas during this investigation, and during investigation of adjacent and coincident lands of the Skyline Project lease and corridor

area. The region was searched by walking parallel transects on a quarter-section by quarter-section basis, with each community type within each quarter-section being traversed. None of the proposed threatened or endangered species were encountered in either the lease area or in the surrounding areas.

evident that James Canyon Creek will be impacted, this stream will at that time be inventoried and described as per Eccles Creek.

The other streams mentioned in Figure 2-16 are of marginal fisheries values. Since they will receive no surface disturbance impacts, no further study of these streams is recommended at this time.

Eccles Creek runs along the north edge of the permit area and within the adjacent area. Eccles Creek provides habitat for naturally reproducing resident populations of cutthroat trout. Scofield Reservior receives cutthroat trout recruitment stock from small feeder tributaries including Eccles Creek.

Discharges in Eccles Creek frequently go as low as less than 1 cfs during late summer, fall and winter seasons, and yearly high flows seldom exceed 36 cfs, even at the mouth. Pleasant Valley Creek flows are similar to Eccles Creek in seasonal regime, but flows are higher.

Water temperatures fluctuate greatly in Eccles and Pleasant Valley Creeks because the turbulence from the rough channel coupled with low flows allows the water temperature to quickly equilibrate with existing air temeratures. During

November to March, the water temperature remains fairly constant, staying between 0-2° C. In the warmer months it is not uncommon to have a daily fluctuation of 12-15°C, but the daily high temperatures seldom exceed 20°C. Water temperatures in Pleasant Valley Creek are similar to those in Eccles Creek, except maximum temperatures are probably 2-5° C higher. The aquatic organisms of Eccles and Pleasant Valley Creeks have evolved with tolerances to these natural thermal fluctuations but most are susceptible to changes (20-25° C fluctuations or extremes above 25° C) beyond their natural evolutionary exposure (Lowe & Heath, 1963, Welch & Wojtalik, 1968).

Eccles Creek intersects mostly the Black Hawk Group and Castlegate Sandstone formations. These formation are chiefly sandstone with some mudstone, shale and coal. Through natural erosion during runoff periods, Eccles Creek becomes quite turbid, but due to steep channel gradients and high water velocities during these periods, the fine sediments are generally carried out of the canyon rather than being deposited on coarser substrate materials. Pleasant Valley Creek has a lower gradient than Eccles Creek with an expected higher level of fine sediments.

The aquatic communities, fish and macroinvertebrates, of Eccles and Pleasant Valley Creeks have adapted to natural stream sediment levels, but during recent history, man-controlled activities -- sheep and cattle grazing, unpaved roads, mining, fires and recreation -- have resulted in some watershed degradation and erosion. This has resulted in above natural sedimentation of these streams with occasional reduction in numbers of, or elimination of, aquatic macro-invertebrates and one or more age classes of fishes.

The macroinvertebrate communities of Eccles Creek have considerable species diversity Appendix E, Tables 2 through 8). Representatives include all trophic levels: algal scrapers - Baetis and Cinygmula mayflies; shredders - Zapada, Capniidae and Taenionema stoneflies; collectors - Ephemerella gradis and E. inermis mayflies; filter feeders - Macrasema and Hydropsyche caddisflies and Simuliidae black flies; and predators - Megarcys, Isoperla and Chloroperlidae stoneflies, and Rhyacophila caddisflies. The large number of Ephemeroptera, Plecoptera and Trichoptera taxa are evidence of the high quality waters of Eccles Creek.

Water quality of Eccles Creek is excellent for most uses. Eccles Creek has adequate nitrate nitrogen for good algal growth most of the year, but phosphate levels are generally

low. Scofield Reservior has periodic nuisance level algal blooms. Nutrient inputs from recreation, cattle and sheep, and domestic sources are frequently high enough to bring the total nutrient input of Scofield Reservior to excessive levels (Southeast Associates of Governments, 1976). According to survey results, Eccles Creek to date has not had excessive nutrient levels, and thus contributes only slightly to the algal blooms in Scofield Reservior.

Macroinvertebrate Communities

Eccles Creek-1979. The samples of macroinvertebrates from Eccles Creek during May, June, August and October, 1979, contained numerous taxa (Appendix E, Tables 2, 3, 5, and 7). Included in the communities were fragile forms found only in high quality waters - *Cinygmula*, *Epeorus* and *Paraleptophlebia* mayflies; *Zapada*, *Megarcys*, *Skwala*, *Diura* and chloroperlid stoneflies; *Rhyacophila*, *Arctopsyche*, *Parapsyche*, *Neothremma*, *Oligophlebodes*, *Brachycentrus* and *Micrasema* caddisflies; and *Antocha*, *Dicranota* and *Pericoma* flies. The majority of taxa collected are tolerant to moderate sedimentation loads, typical of small streams in Utah that are subject to low flows, shale and sandstone formations and grazing impacts.

In 1979 several taxa exhibited an evident response to the land slough along the turn-off road to the Valley Camp, Inc. Mine in Whiskey Gulch. The result of the slough has been an increased sediment load in Eccles Creek below the slough. Most of the stream substrates had a visible covering of fine sediments in August, 1979, during the fish shocking surveys. Twenty-four taxa, through reduced number or absence from samples at Station EC05, as compared with upstream stations, showed an impact from these sediments. Included were: copepod and ostracod zooplankton; turbellarian worms; Baetis, Cinygmula, Paraleptophlebia, Ephemerella grandis and E. coloradensis mayflies; Zapada, Taenionema, Prostoia, Megarcys and capniid stoneflies; Oligophlebodes and Micrasema caddisflies; elmid riffle beetles; and Dicranota, Holorusia, and simuliid and stratiomyid flies (Appendix E, Tables 3, 5, and 7). Seven taxa at Station EC04 showed similar responses as at EC05 although the changes were not as severe. Aquatic macroinvertebrates are active drifters, being carried downstream by the stream currents. This helps account for the continued diversity at Station EC04 in 1979 (Appendix E, Table 5).

Samples taken from Station EC04 and EC05 in May, 1979, Appendix E, Tables 5 and 7) were before the major emergence period when the macroinvertebrate larvae were nearly all late instar (large) larvae. The larger larvae can tolerate

more sedimentation than smaller or earlier instar larvae. This helps explain the relatively small community change in May, 1979, below the land slough. By the August, 1979, adult stage, mated, laid their eggs and died. The small early instar larvae resulting from the hatch of eggs entered a harsh environment due to the presence of increased fine sediment levels. These small larvae, being unable to tolerate the levels of sediments, were eliminated resulting in the more drastic community change in August, 1979, compared to May, 1979 (Appendix E, Tables 5 and 7).

A new macroinvertebrate community evaluation tool (community tolerance quotient, CTQ_a) developed by the author (Winget and Mangum, 1979 being prepared for publication) shows a change in species composition at Stations EC04 and EC05. The CTQ_a is the arithmetic mean of the tolerance quotients (TQ) of the actual taxa of macroinvertebrates sampled from the stream station on the given date. The tolerance quotient is a value assigned each taxon based upon its tolerance and selectivity for various substrate materials, stream gradients, levels of alkalinity and sulfate concentrations. TQ's range from 2 (very fragile, narrow tolerance limits) to 108 (wide tolerance limits for all 4 parameters).

In 1979 the macroinvertebrates of lower Eccles Creek, especially at Station EC05, showed a trend towards a more tolerant, less diverse macroinvertebrate community (CTQ_a

increased to 67, number of taxa dropped to only 18 and number/m^2 dropped to only 2,526). Stream substrates were covered with fine silts which probably caused the reduced fish spawn success and macroinvertebrate community condition. Stabilization of the hillside at Whiskey Gulch and completion of the culverts and sedimentation pond upstream will eliminate future sedimentation from those sources.

Eccles Creek-1980. Eccles Creek stations were sampled 3 times in 1980. The results of the spring set of samples are contained in this report (Appendix E, Tables 4, 6, and 8). As in 1979 the sample data in 1980 from Station EC05, compared with 1979 EC05 data and 1979 and 1980 EC04 data, showed a degradation in community condition (Appendix E, Tables 5, 6, 7, and 8): reduced numbers and weight per m^2; and increased CTQ_a to 70 from 57-67 in 1979. Changes in community structure at EC05 were similar to those discussed for 1979, only more severe indicating suspected degradation trends appears a reality in the lower reaches of Eccles Creek.

Station EC04 in April, 1980, showed a reduction in number of taxa compared with May, 1979, (Appendix E, Tables 5 and 6) but the change did not show up in a change in community tolerance (CTQ_a). There may yet be a change in species

composition occuring at Station EC04. The summer and fall, 1980, samples should help clear this up. Evidence indicates several important taxa are under stress and may perhaps be eliminated if the stress continues for a long period of time or increases in severity - reduction in number of Baetis ($6,779/m^2$ in 1979 to only 732 in 1980), Cinygmula ($369/m^2$ in 1979 to 11 in 1980), E. gradis (75 to 22), Zapada (223 to 32) and Micrasema (135 to 0). Associated with the drop in density of the forementioned taxa was an obvious increase in chironomid midges ($861/m^2$ in 1979 to $2,249/m^2$ in 1980) and capniid stonefiles (a burrowing, sediment tolerant taxon).

There appears to be a trend in the Eccles Creek macroinvertebrate communities towards a more tolerant assemblage of species.

less diverse!

Pleasant Valley Creek, 1976 and 1979. Appendix E, Table 9 gives a summary of the results of the 1979 macroinvertebrate samples taken from Station PVC02, above the mouth of Eccles Creek. There was little change in actual community structure other than the natural seasonal changes due to emergence and egg hatch. The community is in fair condition, especially considering the periodic low flows occurring in Pleasant Valley Creek above the confluence with Eccles Creek.

Appendix E, Table 10 contains a data summary for samples taken from Station PVC01, 2 Km below the confluence with Eccles Creek. In 1976 (11 May) 29 taxa were collected compared with only 23 in 1979; density in 1976 was 16,995/m^2 compared with only 2,176 in 1979; and the CTQ_a was 58 in 1976 compared with 62 in 1979, a small change by itself but significant when compared with the other community descriptors. There appears to have been some significant impacts on the community between May 1976, and May 1979. Of special interest is the presence of Arctopsyche caddisflies above Eccles Creek and the obvious lack of them below - Arctopsyche being found only in high qaulity streams.

Substrate Composition

Eccles Creek-1979. Sediments of Eccles Creek at certain locations may at times not be suitable for trout spawning. Figure 2-17 presents sediment composition at 3 stations on Eccles Creek. There was more gravel and less fine sand in upper Eccles Creek (Station EC02) than at either lower station (Stations EC04 and EC05). The levels of silt and clay were the same at all stations. Fine sand is the first fraction of suspended sediments to settle as stream gradients are reduced. It is not surprising to see deposition of fine

sands at stations below the Whiskey Springs hillside land slough since these stations have section of reduced gradient with reduced water velocities.

During the fish shocking survey conducted the 20th and 21st of August, 1979, numerous young-of-the-year (y-o-y) cutthroat trout were observed from Whiskey Springs upstream to the forest boundary but y-o-y trout were not seen below Whiskey Springs. They may have been present below Whiskey Springs and just not observed, but the substrates below were covered with a heavier layer of fine sediments than was seen above. This may have caused a reduced cutthroat reproductive success below Whiskey Springs.

Figure 2-18 contains a summary of stream substrate composition at three station at Eccles Creek. Substrates are divided as percent stream bottom cover for six classes of materials. Determinations are occular estimates made on site.

Eccles Creek-1980. Sediment samples were taken on two dates in 1980. Data analysis is not yet complete. Data will be included in future reports of monitoring results.

Pleasant-Valley Creek-1979. Figure 2-17 presents the analysis of one set of sediment samples taken on 24 August, 1979, at two stations on Pleasant Valley Creek. Sediment composition was nearly identical at both stations. The percent fines (less than 0.850 mm diameter) was 15.7 and 15.2, above and below Eccles Creek, respectively. These values indicate gravels may be suitable for trout spawning but level of fines is close to the limiting level, using 15% as maximum acceptable level.

Pleasant Valley Creek-1980. Sedimentation impacts from Eccles Creek have appeared to be greater in 1980 than during previous years. Two sets of sediment samples have been taken from Pleasant Valley Creek in 1980 (one set in August, 1980, and a second set in September, 1980). The resultant data should help determine the accumulative affect from these sediments on the substrates of Pleasant Valley Creek.

Stream Channel

Eccles Creek. Channel gradient is listed as a decimal of the number of vertical feet drop per linear feet of stream length. Tortuosity is the actual stream length between two points divided by the shortest distance between the same two points. Appendix E, Table 11 gives gradient and tortuosity values for 4 stream reaches.

Figure 2-17

Sediment composition of potential gravel spawning beds as Percent by Weight for five size classes at five stations (1) EC02, Eccles Creek above South Fork; (2) EC04, Eccles Creek below Whiskey Springs; (3) EC05, Eccles Creek at the mouth; (4) PVC02, Pleasant Valley Creek above Eccles Creek; and (5) PVC01, Pleasant Valley Creek below Eccles Creek. Samples taken 24 August 1979.

Particle Size	Station EC02	EC04	EC05	PVC02	PVC01
Gravel > 4.75 mm	73.6	70.8	70.6	71.9	71.6
Coarse Sand 2.0-4.75 mm	8.7	8.5	9.2	7.3	9.0
Medium Sand 0.50-1.99 mm	5.5	5.2	6.1	7.6	5.8
Fine Sand 0.074-0.49 mm	12.0	15.3	13.9	12.9	13.2
Silt/Clay < 0.074 mm	0.2	0.2	0.2	0.3	0.4
Fines < 0.850 mm	13.5	16.9	15.8	15.7	15.2

Figure 2-18

Substrate composition of Eccles Creek listed as percent cover. Surveyed 11 June 1979.

Substrate Type, Diameter	Station EC02	EC04	EC05
Boulder > 31 cm	0	5	5
Lg. Rubble 15.1-31 cm	20	20	15
Sm. Rubble 7.7-15.0 cm	30	25	20
Lg. Gravel 2.6-7.6 cm	20	15	15
Sm. Gravel 0.5-2.54 cm	20	15	20
Sand/Silt < 0.5 cm	10	20	25

Upper forks of Eccles Creek forks, from approximately the forest boundary upstream, are typically steep (over 10% gradient), narrow, low tortuosity streams (Figure 2-19). Their potential for supporting a trout fishery is almost nil due to summer/fall/winter low flows.

From the forest boundary downstream the stream has lower gradients plus areas of increased tortousity. This allows formation of higher quality pools that are essential to fish survival during low flow periods and unusually high run-offs. Channel width ranges from 20 to 55 ft. wide (tall bank to tall bank) with the watered width being limited to 2 to 5 ft. most of the year. Water depths seldom exceed 1 ft. except in infrequent deep pools which have maximum depths of 3 ft. Mean depth at EC02 was o.51 ft. at 3.5 cfs and at EC05 mean depth was 0.62 ft. at 6.3 cfs (measurements taken on 11 June, 1979). Yearly mean flows are considerably less than those on 11 June, thus mean depths are frequently less than the reported 0.5 to 0.6 ft.

Stream banks are steep along most of the canyon, but except for localized problems, the banks are largely stable with established dense riparian vegetation. The stream channel, through bank erosion has lost some of its previous meanders in one canyon section between Whiskey Springs and South Forest. Active beaver activity has resulted in some high

Figure 2-19

Stream channel characteristics of Eccles Creek as measured 11 June 1979 at: EC02, Eccles Creek above South Fork Eccles Creek; EC05, Eccles Creek above mouth of canyon. Measurements taken 11 June 1979.

	EC02	EC03	EC04	EC05
Channel gradient	0.04			0.03
Channel turtuosity	1.22			1.40
Watered channel mean width at Q	2.8 ft @ 3.5 cfs			3.6 ft @ 6.3 cfs
Mean depth at Q	0.51 ft @ 3.5 cfs			0.62 ft @ 6.3 cfs
Tall bank mean width	37.0 ft			26.2 ft opening onto a wide meadow
Riffle: Pool ratio	3:2			3:2
Mean bank stability	90%			85%
Bank vegetation in order of dominance	grasses shrubs evergreens dec. trees			grasses evergreens shrubs dec. trees

beaver dam structures immediately above Whiskey Springs that have become silted in upstream and caused downstream vertical drops (up to 5 ft. vertical) too high for fish passage upstream. This has isolated the fish above Whickey Springs by preventing upstream migration, indicating a self sustaining population of cutthroat trout in this short upper Eccles Creek reach.

Pleasant Valley Creek. From the mouth of Eccles Creek downstream, Pleasant Valley Creek is mostly a willow-lined meandering valley stream. Cattle grazing is common along the stream but stream banks are mostly stable (75%) with fairly good vegetative cover. There are isolated areas with exposed banks and sedimentation problems. The habitat at stations PVC02 (100 m above Eccles Creek) and PVC01 (2 Km downstream) will be evaluated and described in September/October, 1980. It appears that Pleasant Valley Creek is more water limited (quantity) than habitat limited for a fisheries development.

Fisheries

Eccles Creek. Eccles Creek is classified by Utah Division of Wildlife Resources as a Class III stream with natural reproduction. It is categorized no higher than a Class III stream because of its small size and its inability to sup-

port a quality fishery under moderate fishing pressures without stocking of additional fish. Fish surveys by Utah Division of Wildlife Resources in 1968, 1971, 1977, and 1979 all found cutthroat trout resulting from in-stream reproduction as there has been no stocking of trout in the stream since 1967. Fish are mostly small in size -- on 25 August, 1971, at one station, 21 fish at 0-3.5 inches, 15 at 3.5-4.5 inches, 18 at 4.5-6.5 inches and 3 at 6.5-8.5 inches were collected. Similar size distribution was observed during 1977 and 1979.

A summary of "Age-Growth of Cutthroat Trout Taken in Eccles Creek from Two Sections" appears in Figure 2-20 (taken from UDWR field collections records, 25 August, 1971). Eccles Creek habitat and fisheries resources as measured by UDWR personnel on 25 August, 1971 are summarized in Appendix E, Table 15 and 16. On 20 and 21 August, 1979, UDWR personnel surveyed Eccles Creek to determine: 1) number of cutthroat trout compared to previous surveys; 2) reproductive success; and 3) range of fish in the drainage.

Cutthroat trout in August, 1979 were found at EC05 and EC03 (Figure 1) in similar densities (20-30/0.1 mile) as during previous surveys. Size distributions were also similar (1971 results in Appendix E, Table 15 and 16, 1979 results

Figure 2-20

Age-Growth of Cutthroat Trout taken in Eccles Creek from Two Sections (UDWR Field Records, 8/25/71).

Age Class	Mean Size (mm)	Range (mm)	Mean Weight (gms)	Range (gms)	No.	%
0	56	45-67	7.5	5-10	2	3
1	118	78-175	27.3	10-60	68	79
2	198	180-228	95.0	75-125	15	17
3	257	---	170.0	---	1	1
					86	

Comments:

1. Possibly some 1+ are 2+ fish
2. 0+ age class were not recovered, due to size
3. No non-game species were collected.

not tabularized to date) indicating continuing reproductive success of cutthroat trout in Eccles Creek.

In the area of the coal handling facilities near the mouth of the canyon, cutthroat trout are present, are reproducing, and are dependent upon being able to traverse the stream channel upstream to spawn and downstream to gain access to Scofield Reservior. Mr. John Livesay, of the Price Office, UDWR reported (personal communication) that in Scofield Reservior, approximately 25% of the fish sampled in 1979 were cutthrouat trout, although all fish plants since poisoning in 1977 have been rainbow trout. The likely source of cutthroat trout in Scofield Reservior would be the 3-6 small tributary streams, like Eccles Creek, that have naturally reproducing populations in them.

Pleasant Valley Creek. Pleasant Valley Creek, from Eccles Creek downstream, has been under agricultural use and coal handling impacts for may years. Stream banks are approximately 60% stable with riparian vegetation mostly willows. Substrates are mostly cleaned of fine materials each spring but by fall sediment build-up is apparent in low-gradient stream reaches.

Cutthroat trout apparently migrate from Scofield Reservior via Pleasant Valley Creek to Eccles Creek during their

yearly spawning runs. It is not known if these trout spawn in Pleasant Valley Creek, but the present opinion is that Pleasant Valley Creek is more important as a migratory route and as a source of food for the reservior fishes than spawning habitat.

Birds (White, 1980)

Ornithological investigations have been accomplished over several time periods in the Scofield -- Skyline -- Valley Camp coal mining region. Specifically, these periods have been: December 1, April 7-8, April 25-26, May 17-18, June 13-14, and July 26-29. During these periods a record has been maintained on (1) threatened or endangered species, (2) raptors seen and nests located, (3) occurrences of species of high Federal interest and (4) migratory birds in general. The obvious time period where observations are missing are during the major autumn migration periods September-October. This may represent a critical block of time. For example, the peak of raptor migration, as seen along the Wasatch Front 60 miles north of Scofield, revealed a total of 308 migration raptors recorded between September 9 and October 4 with the peak seemingly around mid to late September (Mosher, et al, 1978). Prior to the drawing of any final conclusions, that autumn time period will be examined.

The nature of the raptor fauna correlated with the earlier findings (Jones, 1979) on the Manti Division, Manti--LaSal National Forest to the south of the Scofield area.

Materials and Methods

The survey method consisted entirely of visual observations. A one kilometer strip surrounding the potential conveyor belt route, mine portals and other disturbance areas were walked. All birds were noted and old nests were marked where appropriate on USGS topographic maps.

Raptor Surveys. No particularly unique nor innovative methods are used to survey for raptors except when examining cliffs for nests. There one must look at each specific ledge or pothole for the presence of fecal "whitewash" matter. The one kilometer area was systematically walked and likely nesting areas (eg. particularly dense wood lots, cliffs) were thoroughly searched or otherwise examined with binoculars. Several hours were spent sitting quitely at selected locations listening for courtship or other calls of accipiter or buteo. Regions where several hours of careful observation and listening were spent were the conflunces of Whiskey and Eccles Canyon and around the mine portals.

Species of the High Federal Interest. Any habitat peculiar to the three woodpeckers and one bluebird of high Federal interest was given special attention. Habitat characteristic of these species is given special attention. Habitat characteristic of these species is generally wanting in the Valley Camp, Inc. area. The elevation is generally either too high in the case of one or of a different floral type in the case of two (see Results for a discussion of this).

Results

Raptors. In addition to the Bald Eagle that occurs near Scofield during migration, but which we did not record, we found nine species of diurnal raptors and one owl. Two active nests were found in Eccles Canyon, one of the Goshawk and one of the Cooper's Hawk. The Cooper's Hawk is also a species of high Federal interest. These two species can generally tolerate considerable human impact (Hennessy 1978). The Golden Eagle was seen on every survey period, but no active nest was found. It is also a species of high Federal interest.

Rare and Endangered Species. The Bald Eagle is seen in migration in the Scofield area, but none has been recorded within the one kilometer around disturbance area. The

Peregrine Falcon has been seen once during the winter of 1976 (L. Dalton, personal communication) but its occurrence there must be considered rare. It did not nest historically, as far as is know, within 25 miles of the mine area.

Species of High Federal Interest. The three woodpecker species that have been identified for special attention, Williamson's Sapsucker, Lewis' Woodpecker and Pileated Woodpecker, have not been observed to date. These three species present special problems with regard to Eccles Canyon. The habitat within the canyon along the mine route is more typical of Yellow-bellied Sapsucker habitat than the coniferous forest (spruce fir or yellow pine) type more typically used by Williamson's Sapsucker. Although Lewis' Woodpecker may occur in Eccles Canyon during migration, it normally breeds in riparian cottonwood or yellow pine stands or habitat not typical of Eccles Canyon. The Pileated Woodpecker usually occurs in mature hardwood or conifer stands and may occur anywhere in Utah although it is certainly of sporadic and rare occurence (see Behle and Perry, 1975).

The Western Bluebird is normally a species of yellow pine forests in Utah and may be common where it does occur. It appears, however, to have limited distribution and none have

been identified to date in the Eccles Canyon area although it occurs further south.

The Prairie Falcon has not been seen in the immediate vicinity of the mining property nor are there records for this location (L. Dalton, personal communication).

Migratory Non-game Species. To date 49 species have been identified from our surveys. All are common species typical of the area. Twenty-five of the species were passerines and four were woodpeckers.

The information that follows concerning Amphibians, Reptiles, and Mammals has been obtained from the State of Utah, Division of Wildlife Resources, Southeastern Regional Office, Price, Utah.

Amphibians--Species Occurrence and Use Areas (See pgs 8-10 - Appendix I)

Six species of amphibians, all of which are protected, are known to inhabit the biogeographic area in which the mine plan and adjacent areas are located. It is probable that all of these species inhabit the project area (Reference the Division Publication No. 78-16). Only the tiger salamander has been determined to be of high interest to the State of Utah (Appendix A).

The tiger salamander is a yearlong resident animal of the project area. The substantial value use area for the adult form is represented by any moist underground site or any similar habitat such as inside rotten logs, cellars, or animal burrows. Such sites can be found within any wildlife habitat extending from the cold desert (upper Sonoran life zone) through the submontane (Transition life zone) and into the montane (Canadian life zone) ecological association. The larval form, often referred to as a mud-puppy, is a gilled animal that must remain in water within the above described ecological associations. It is interesting to note that the larva may fail to transform into an adult, even after their second season, and they can breed in the larva condition.

Once the larva is transformed into the adult form the animal is primarily terrestrial. Salamanders do migrate to water in the spring for breeding and may remain there during much of the summer. Such an intensive use area would be ranked as being of high-priority value to the animal. In September the newly transformed animals leave the water to find suitable places to spend the winter.

The tiger salamander breeds from March through June and is sexually mature after one year. The male deposits a small tent-shaped structure containing a myriad of sperm on the pool bottom. During courtship the female picks up this structure in her cloaca; then the eggs are fertilized internally before or just at the time they are laid. The eggs, singly or in small clusters, adhere to submerged vegetation; after 10 to 12 days they hatch. Obviously, a critical period for maintenance of the population is when breeding salamanders, eggs or their larva are inhabiting a water.

Post-embryonic development of a salamander's larval form progresses at a pace somewhat controlled by water temperature; in some cold waters the larva may not transform into an adult and drying up of a pool may hasten the process.

Migration to or from water usually occurs at night, during or just after a rain storm. When inhabiting terrestrial sites the tiger salamander is most active at night, particularly on rainy nights, from March through September.

Larva, when small feed on aquatic invertebrates and become predacious to the point of cannibalism when they are larger. Food items for adults include insects, earthworms and occasionally small vertebrates.

No amphibians have relative abundances that are so low to have caused the animal to be federally listed as a threatened or endangered species.

Reptiles--Species Occurrence and Use Areas - (See pgs. 8-13, Appendix I)

Eighteen species of reptiles, all of which are protected, are known to inhabit the biogeographic area in which the mine plan and adjacent areas are located. It is probable that sixteen of these species inhabit the project area (Reference the Division Publication No. 78-16). Only two species of the reptiles inhabiting the project area have been determined to be of high interest to the State of Utah (Appendix A).

The Utah milk snake is a yearlong resident animal of the project area. Its substantial value use area encompasses all wildlife habitats extending from the upper Sonoran (cold desert life zone) through the submontane (Transition life zone) and into the montane (Canadian and possibly Hudsonian life zone) ecological associations. Although its use area spans a multitude of habitats, the animal is extremely secretive, mostly nocturnal and is often found inside or under rotten logs, stumps, boards, rocks or within other hiding places. At night they can be found in the open where they hunt for small rodents, lizards and other small snakes. Occasionally, the milk snake may take small birds or bird eggs.

The milk snake may live beyond twenty years and it becomes sexually mature during its third spring season. After mating, which occurs during spring or early summer when they are leaving the den, female milk snakes produce clutches which average seven eggs. The eggs are secreted in a moist warm environ and then abandoned; incubation lasts 65 to 85 days. The site where an individual snake has deposited its clutch of eggs is of critical value to maintenance of the species.

The Utah mountain kingsnake is a yearlong resident animal of the project area. Its substantial value use area encompasses all wildlife habitats extending from the submontane (Transition life zone) into the montane (Canadian and possibly Hudsonian life zones) ecological association. Little is known concerning this animal except that it frequents areas of dense vegetation and that it is often found near water. Its life history and food habits parallel

that described for the Utah milk snake.

To date snake dens, which are protected and of critical value to snake populations, have not been identified on or adjacent to the project area. It is important to note that inventory for such has not been attempted. If the Company at some later time discovers a den it should be reported to the Utah Division of Wildlife Resources. If a den(s) is currently known, its location must be included with the permit application.

No reptiles have relative abundances that are so low to have caused the animal to be federally listed as a threatened or endangered species.

Mammals--Species Occurrence and Use Areas - (See pgs. 48-61, Appendix I)

Eighty-four species of mammals, of which 27 percent are protected, are known to inhabit the biogeographic area in which the project and adjacent areas are located. It is probable that fifty-four of these species inhabit the project area (Reference the Division Publication No. 78-16). Nineteen species of the mammals inhabiting the project area have been determined to be of high interest to the State of Utah (Appendix A).

The dwarf (least) shrew is a yearlong inhabitant of the biogeographic area that surrounds the project site. This animal's substantial valued use area is characterized as open grass covered areas of any wildlife habitat in the submontane and montane (Canadian life zone) ecological associations. Since this shrew has a relative abundance determined to be limited, its use areas should be ranked as being of high-priority value to the animal.

The western big-eared bat is a yearlong resident of the biogeographic area that surrounds the project site. This animal roosts and hibernates within caves, mine tunnels or suitable buildings located in the pinion-juniper, shrubland and low elevation spruce-fir habitats of the submontane and montane (Canadian life zone) ecological association. Such areas represent this bats substantial valued

use area.

The snowshoe hare is a yearlong resident of the biogeographic area that surrounds the project site. Its relative abundance has been determined to be limited, since its substantial valued use area is restricted to the spruce-fir and nearby aspen and riparian habitats of the montane (Canadian and Hudsonian life zones) ecological association. Such areas are ranked as being of high-priority value to the animal during its breeding season which spans the period between early April and mid-August.

The cottontail rabbit (mountain cottontail inhabits sites lying between 7,000 and 9,000 feet in elevation and the desert cottontail inhabits sites lower than 7,000 feet in elevation) is a yearlong resident of the biogeographic area that surrounds the project site. The entire project area represents a substantial valued use area for cottontails. Their young are born between April and July. This is a crucial period for maintenance of the cottontail population.

The northern flying squirrel is a yearlong resident of the biogeographic area that surrounds the project site. Currently, its relative abundance is unknown. Its substantial valued use area is restricted to spruce-fir or other mixed conifer habitats of the montane (Canadian and Hudsonian life zones) ecological association. This specie is the only nocturnal squirrel in Utah. The flying squirrel may build its nest within an old woodpecker hole or it may build an outside nest of leaves, twigs and bark. Mating occurs twice in each year--February through March and June through July. Afterwhich, two to six young are born after a gestation period of 40 days--April through May and August through September. These periods are of crucial value to maintenance of their populations. During winter flying squirrels are gregarious; 20 or more have been known to den together.

Beaver are yearlong inhabitants the biogeographic area that surrounds the project site. Their substantial valued use area is restricted to riparian and

adjacent aspen habitats (those located within 100 meters of the riparian zone) in the cold desert, submontane and montane (Canadian life zone) ecological associations. These animals construct a conical shaped lodge in which a family group lives throughout the year. The lodge is of critical value to maintenance of the beaver population. One litter of kits is produced each year; they are born between late April and early July after a gestation period of 128 days. Kits and yearlings coinhabit the lodge with the adult pair. When they attain 2 years of age they are forced to leave; females can breed at 2.5 years of age. Due to the animals dependancy upon flowing water and the associated riparian vegetation, the riparian wildlife habitat is ranked as being of critical value to beaver populations.

The red fox is a yearlong inhabitant of the biogeographic area that surrounds the project site. The substantial valued use area for the red fox would include all wildlife habitats extending from the cold desert into the montane (Canadian life zone) ecological association. Almost nothing is known of their population dynamics. Without doubt a crucial period for this species is when they are caring for young in the den. Dens while being inhabited are a critical use area.

The gray wolf is a historic inhabitant of the biogeographic area that surrounds the project site. Currently its relative abundance is so low that the animal is listed as endangered with extinction. The wolf's substantial valued use area would be represented by any remote habitat in any ecological association.

Black bears are inhabitants of the biogeographic area that surrounds the project site. Their substantial valued use area is represented by all natural wildlife habitats (excluding the pasture and fields and urban or parks types) extending from the submontane into the montane (Canadian and Hudsonian life zones) ecological associations. These animals go into a semi-hibernation during winter. During this crucial period, which may last from December through March, the animal secrets itself in a den in order to conserve body energy reserves. The young are born in the den during January or February. Dens while being inhabited represent a critical valued use area for bears.

Many of the members of the family mustelidae are known to inhabit the biogeographic area that surrounds the project site. They are all protected and classified as furbearers--short-tailed and long-tailed weasles, mink, wolverine, black-footed ferret, marten, badger, striped and spotted skunks and the river otter. Additionally, raccoon and muskrat, although not furbearers, are also inhabitants of the biogeographic area that surrounds the project site. All of these species are of high interest due to their value in the fur market.

The substantial valued use area for short-tailed and long-tailed weasles, mink, river otter, muskrat and raccoons is the riparian habitat. Weasles, which are inhabitants of the project site, do make some use of other habitats that are proximal to riparian zones. Muskrats and raccoons are restricted to riparian habitats of the cold desert and submontane ecological association; thus, they are not found on the project area. The long-tailed weasle can be found from the cold desert up into the montane (Canadian and Hudsonian life zones) ecological association. The short-tailed weasle, river otter and mink populations extend their use from the submontane into the montane ecological association. It is important to note that the weasle is restricted to the Canadian life zone; where as the river otter and mink utilize the Canadian and Hudsonian life zones. The river otter is not known to inhabit the environs of the project area, but mink are present.

The substantial valued use area for marten and wolverine is the montane ecological association; the marten does not utilize the Alpine life zone but the wolverine can be found at that elevation. Both species could be found in the environs of the project site.

The black-footed ferret is a species primarily dependant upon prairie dogs as a prey source. Currently, the ferret's relative abundance is so low that the animal is endangered with extinction. Utah lies on the western edge of the black-footed ferrets historic range. The substantial value use area for this specie is restricted to prairie dog colonies. Prairie dog colonies are found within a multitude of wildlife habitats within the cold desert, submontane and montane (Canadian life zone) ecological associations. It should be noted that the project site

does not provide habitat for prairie dogs, thus ferrets would also be absent.

The substantial valued use area for badger and skunks span all wildlife habitats other than dense forests in the cold desert, submontane and montane (Canadian life zone) ecological associations. Skunks show some afinity for habitats proximal to water. Skunks and badgers are dependant upon a suitable prey source.

A crucial period for maintenance of all furbearers, raccoons and muskrat populations is when they have young in a nest, den or lodge. Such sites are critical for reproductive success.

Bobcat, Canada lynx and cougar are known to inhabit the biogeographic area that surrounds the project site. For all of these species a crucial period for maintenance of their population is when the female has her young secreted at a den site. Such sites are of critical value when being utilized. It is also crucial to their survival that a female accompanied by young not be killed or harassed.

The substantial valued use area for bobcats extends from the cold desert through the submontane and into the montane (Canadian life zone) ecological association. The bobcat is normally associated with percipitous terrain, but has been observed in every wildlife habitat within the aforementioned ecological associations. Their primary prey source is represented by small mammals and birds or any other small animal they can catch. It is important to note that bobcats occasionally do kill the young of big game animals.

The substantial valued use area for the Canada lynx is restricted to the Canadian and Hudsonian life zones of the montane ecological association. Normally, this cat would only be expected to utilize riparian and forested wildlife habitats. The lynx is similar in predation habits to the bobcat.

The substantial valued use area for the cougar (locally known as mountain lion) extends from the submontane into the montane (Canadian and Hudsonian life zone) ecological association. Due to the dependancy of the cougar upon mule deer as a prey source, a ranking of the lion's seasonal distribution parallels that

of the deer.

Mule deer are inhabitants of the biogeographic area that surrounds the project site. Their substantial valued use area spans all wildlife habitats extending from the cold desert through the submontane and montane ecological associations. In some situations deer show altitudinal migrations in response to winter conditions. There are, however, habitats where deer reside on a yearlong basis.

Migration of mule deer from summer range to winter range is initiated during late October; probably, the annual disturbance of the fall hunting season coupled with changing weather conditions is the initial stimulus. The onset of winter weather reinforces the deer's urge to migrate and continued adverse weather keeps the deer on the winter range.

The project site only represents summer range for mule deer. Winter ranges for these mule deer are at least nine miles distance from the project site.

Deer begin their migration back to summer range during mid-May and remain there throughout October. Summer ranges on the project area represent deer herd Units 32 and 34. They are ranked as being of high-priority value to mule deer.

There are ranges that support mule deer on a yearlong basis. None of these type of ranges are associated with the project. It is important to note that such ranges are even more distal to the project site than winter ranges.

Mule deer fawn during the month of June. The continum of wildlife habitats extending from the pinion-juniper through the shrubland and into the aspen type probably represents the fawning area. All riparian areas are of critical value for fawning and maintenance of the deer population. To date no specific areas showing annual use for fawning are known. It is probable that such areas exist; they would be ranked as being of critical value to deer. It is important to note that June represents a crucial period for maintenance of deer populations.

Moose are inhabitants of the biogeographic area that surrounds the project site. Their substantial valued use area spans all wildlife habitats in the mon-

tane ecological association except those associated with the Alpine life zone. In some situations moose show altitudinal migrations in response to winter conditions. All riparian habitats associated with the project have at one time or another supported moose on a yearlong basis.

Migration of moose from summer range to winter range is initiated during late November; probably, changing weather conditions is the initial stimulus. The onset of winter weather reinforces the moose's urge to migrate and continued adverse weather keeps the animal on the winter range.

Portions of the project site represents winter range for the Southeastern Utah moose herd--Scofield and Huntington drainages. To date, only riparian habitats on the project area have been identified as winter range. Winter ranges for moose that are characterized as riparian habitats are ranked as being of critical value, where as the remainder of the winter ranges are ranked as being of high-priority value to the animal. Winter ranges are usually inhabited by moose between December 1 and May 15 each year. During winters with severe conditions the higher elevation portion of the winter range becomes unavailable to moose due to snow depth. Critical valued sites must be protected from man's disturbance when the moose are physically present on the range.

Moose begin their migration back to summer range during mid-May and remain there throughout November. The entire project area represents summer range. Summer ranges on the project area support animals from the Scofield and Huntington drainages of the Southeastern Utah moose herd. Those summer ranges are ranked as being of high-priority value.

Ranges that support moose on a yearlong basis are ranked as being of critical value.

Moose calf during late May and June. Calving takes place in the riparian or adjacent forest habitats. Without doubt, all riparian areas are of critical value for calving and maintenance of the moose population. To date no specific areas showing annual use for calving are known. It is probable that such areas

exist; they would be ranked as being of critical value to moose. It is important to note that June represents a crucial period for maintenance of moose populations.

Rocky mountain elk are inhabitants of the biogeographic area that surrounds the project site. Their substantial valued use area spans all wildlife habitats extending from the submontane through the montane ecological association. Elk do not show as strong of altitudinal migration as mule deer do in response to winter conditions, but they do migrate to wintering areas.

Migration of elk from summer range to winter range is initiated during late October; probably, the annual disturbance of the fall hunting seasons coupled with changing weather conditions is the initial stimulus. The onset of winter weather reinforces the elk's urge to migrate and continued adverse weather keeps elk on the winter range.

The project site only represents summer range for the Manti elk herd--Unit 12. Winter ranges for these elk are at least eight miles distance from the project site.

Elk begin their migration back to summer range during mid-May and remain there throughout October. Summer ranges on the project area support the Manti elk herd--Unit 12; they are ranked as being of high-priority value.

Elk calf during the month of June. Their prefered calving areas are best described as aspen forests with lush understory vegetation. All riparian areas on the summer range are of critical value for calving and maintenance of the elk population. To date no specific areas showing annual use for calving are known. It is probable that such areas exist; they would be ranked as being of critical value to elk. It is important to note that June represents a crucial period for maintenance of elk populations.

Currently, there are no other known high interest wildlife species or their habitat use areas on or adjacent to the project area. It is not unreasonable to suspect that in the future, some additional species of wildlife may become of high

interest to the local area, Utah or the Nation. If such is the case, the required periodic updates of project permits and reclamation plans can be adjusted and appropriate recommendations made.

783.20 FISH AND WILDLIFE RESOURCE INFORMATION

Resource information has been gathered for the area within the mine plan area and for those portions of the adjacent areas where effects on the resource may be expected to occur.

The information presented is based on the regulatory authority's determination as to level of detail required and the area of study to be involved (Appendix G). It includes published data and site specific information gathered by the applicant and various consultants.

Fish (Winget, 1980)

Figure 2-16 summarizes the status of the streams which could possibly be impacted by the Belina Project. The only streams of importance to the fisheries as reproductive habitat are Eccles Creek and James Canyon creek. The other streams may have an importance as sources of food organisms for the fisheries downstream but not as spawning, nursery or maintenance habitat.

James Canyon should not be impacted from this project, but its extreme upper reaches could be affected. If it becomes

Figure 2-16

Aquatic resource status of streams

Stream	Length (miles)	Status
Eccles Creek (E.C.)	1.5	P,F,R
Whiskey Springs	1.0	I
Slaughterhouse Creek	1.0	I
Boardinghouse Canyon Creek	2.5	P/I
Finn Canyon Creek	2.4	I
Long Canyon Creek	2.5	I
Long Canyon Creek above E.C.	2.0	P/I
Pleasant Valley Creek below E.C.	4.0	P,F,R
James Canyon Creek	1.5	P,F,R

P = perrenial
I = intermittent
F = trout fishery
R = natural fish reproduction

783.21 SOIL RESOURCES INFORMATION (Welsh, et al., 1980)

Valley Camp, Inc. lease area soils are developed in vegetation types and topographic features similar in all major respects to the adjacent Skyline lease area soils. Corresponding soils data presented here for the Valley Camp, Inc. lease area are based on previous extensive studies of the adjacent Skyline lease area and additional study of the Valley Camp area.

Soil Mapping and Description

A soils map of the mine plan area has been prepared and is included as the Soils Map, Map E, Volume IV. Mapping unit descriptions follow in the text. The soils are also classified by the vegetation type with which they are correlated, as is recommended by the Soil Conservation Service.

On the soils map a solid line outline designates the lease area. Soil mapping units of the lease area are designated by upper case letters A to E and are mapped at an Order Three intensity. Taxonomic classification of the soil samples is summarized as follows:

Map Unit	Taxonomic Classification	Sample Site
A	Loamy-skeletal, mixed Mollic Cryoboralfs	3
B	Fine loamy, mixed Argic Pachic Cryoborolls	11
C	Loamy-skeletal, mixed Argic Cryoborolls	12
D	A complex of units B and C	
E	A complex of units A, B, and C	

Conveyor line soils are designated by lower case letters a to v and are mapped at an Order Two intensity. A dashed line enclosed these mapping units, summarized below.

Map Unit	Taxonomic Classification	Sample Site
a	Loamy-skeletal, mixed Mollic Cryobofalfs	
b	Fine loamy, mixed Argic Pachic Cryoborolls	11
f	Similar to B with 30% of the soils having a slope greater than 60% and as much as 50% rock fragments below 12 inches	11
g	Coarse loamy, mixed Pachic Cryoborolls	10
h	Rock outcrops	
i	Loamy-skeletal, mixed Typic Cryoborolls	8
k	Course-loamy, mixed Cumulic Cryoborolls	6
l	Loamy-skeletal, mixed Typic Cryoboralfs	5
m	Loamy-skeletal, mixed Typic Cryoboralfs	4
p	Coarse-loamy, mixed Mollic Cryofluvent	2
q	Coarse-loamy, mixed Cumulic Cryoborolls	1
r	Coarse-loamy, mixed frigid Typic Argiborolls	15

s	Complex of 10% r, 45% t, and 35% u	
t	Coarse-loamy, mixed frigid Mollic with 15% u and 5% q	17
u	Coarse-loamy, mixed frigid Typic Haploborolls with 5% r	18
v	Loamy-skeletal, mixed Lithic Cryocrepts	7

Map Unit A and a

These units consist of deep well drained soils that have formed in colluvium and residuum. They are on steep north-facing mountain slopes ranging from 35 to 60 percent. The typical pedon is described in Appendix D, Table 1. Included is 5 percent rock outcrop and 5 percent similar soils.

The surface texture is loam or very fine sandy loam. Thickness of the mollic epipedon ranges from 2 to 4 inches. The A2 horizon ranges from striping of ped faces to a leached horizon 4 inches thick. Depth of the argillic horizon is 12 to 15 inches. Depth of C horizon is 18 to 22 inches. Percent of rock fragment by volume in the upper 20 inches ranges from 5 to 15 percent. The lower portion ranges 35 to 55 percent.

Erosion hazard is slight at present, but severe if distrubed due to surface textures and steep slopes.

The potential rating for borrow topsoil is poor due to thin surface layers, rock fragment content, and steep slopes. There is no topsoil to store when this area is developed.

Map Unit B7 b and f

These units consist of deep well drained soils that have formed in residuum and colluvium. They are on steep mountain slopes and benches with slopes of 35 to 50 percent. The typical pedon is described in Appendix D, Table 2. Included is 4 percent moderately deep similar soils.

Surface texture ranges from loam to a find sandy loam. The argillic horizon texture ranges from a loam to clay loam. The texture of the C horizon is variable due to location of weathered sandstone fragments ranging from clay to loam to a sandy clay. There is 5 to 10 percent by volume rock fragments throughout the profiles. Thickness of surface horizons ranges 8 to 14 inches. Depth of the argillic horizon ranges 12 to 18 inches. Depth to C horizon ranges 26 to 30 inches, and depth to bedrock ranges 48 to over 60 inches.

Erosion hazard is moderate at present. Soil creep is evident. If disturbed, erosion hazard is severe due to steep slopes and a past history of down-slope movement.

Potential rating for borrow topsoil is poor due to steep slope; otherwise, this is a good source. The top 24 inches (average) of the dark surface could be stored for reclamation.

Predominant vegetation is aspen.

Argic?

Map Unit C-

This unit consists of moderately deep, well drained soils that have formed in residuum and colluvium. They are on steep mountain slopes of 35 to 50 percent. The typical pedon is described in Appendix D, Table 3. Included in this unit are 5 percent similar shallow soils, 5 percent rock outcrop, and 3 percent similar deep soils.

Surface texture is silt loam to clay loam. Thickness of the surface ranges 7 to 11 inches. Depth to the argillic ranges 15 to 20 inches. Depth to sandstone bedrock ranges 30 to 40 inches. There is 0 to 5 percent rock fragment by volume in the upper 30 inches. The C horizon ranges 35 to 55 percent rock fragment by volume.

Erosion hazard is moderate at present and severe if disturbed due to steep slopes.

Potential rating for borrow topsoil is poor due to steep slopes. The dark surface soil which averages 20 inches in depth should be stored for reclamation uses when these areas are developed.

Present vegetation is predominantly a grass and forb mixture with a few snowberry and elderberry bushes.

Map Unit g

This unit consists of moderately deep, well drained soils that have formed in colluvium. They are on steep mountain sides with slopes of 35 to 50 percent. The typical pedon is described in Appendix D, Table 4. Included in this unit is 6 percent of map unit k, Cumulic Cryoborolls, and 2 percent rock outcrop.

Surface texture ranges from a loam to a fine sandy loam. C horizon texture ranges from a loamy very fine sand to a fine sand. Percent rock fragment by volume ranges 10 to 15 in the surface and 35 to 70 in the C horizon. Depth to sandstone bedrock ranges 25 to 38 inches.

Erosion hazard is moderate at present and severe if disturbed due to surface texture and steepness of slope.

The potential rating for borrow topsoil is poor due to slope steepness, and rock fragment content below 20 inches makes reclamation of borrow area difficult. On the average the first 12 inches can be stored for reclamation uses. Present predominant vegetation is aspen.

Map Unit h

This unit consists of rock outcrops with less than 5 percent soil associated within the area. The soils dispersed among the rocky areas are similar to those described in Appendix D, Table 14. Because of the similarities no chart of soils features has been prepared for this mapping unit.

Map Unit i

This unit consists of deep, well drained soils that have formed in residuum. They are on moderately steep mountain slopes of 15 to 35 percent. The typical pedon is described in Appendix D, Table 5. Included in this unit is 8 percent of similar soil with 4 to 8 inches of mollic epipedon and 3 percent of a similar soil with 16 to 26 inches of mollic epipedon.

Textures in the surface are loam to very fine sandy loam. Textures in the C horizon are very fine sandy loam to loamy fine sand. Thickness of the surface horizons ranges 8 to 14 inches. Depth to the C horizon ranges 20 to 40 inches. Rock fragment content by volume is 5 to 15 percent in the surface horizon, 15 to 30 percent in the B horizon and 35 to 50 percent in the C.

Erosion hazard rating for borrow topsoil is fair due to percent rock fragment and slope steepness. In some places where the surface layer is less than 20 inches the rating is poor. When developed, the dark surface soil, averaging 10 inches in depth, could be stored and used for reclamation.

At present the predominant vegetation is aspen and grass.

Map Unit k-

This unit consists of very deep, well drained soils that have formed in alluvium and colluvium. They are on toe slopes of steep and very steep mountain sides. Slopes range from 15 to 35 percent. The typical pedon is described in Appendix D, Table 6. Included is 3 percent of a similar soil with 15 to 25 percent cobbles throughout the profile.

Surface horizon textures are silt loam, loam, or very fine sandy loam. The C horizon textures are very fine sandy loam to loamy fine sand and begin at 30 to 36 inches. Rock fragment by volume ranges from 0 to 15 percent in the surface and 15 to 35 percent in the lower horizons.

Erosion hazard is moderate at present and will be moderate if disturbed due to location of fans.

The potential rating for borrow topsoil is good. There is a thick surface and there are few rock fragments in the top 40 inches. When developed, the dark surface soil, averaging 30 inches in depth, should be stored for reclamation purposes.

Predominant vegetation at present is aspen, snowberry and elderberry.

Map Unit 1-

This unit consists of moderately deep, excessively drained soils that have formed in residuum and colluvium. They are on very steep south facing mountain slopes of 60 percent and more. The typical pedon is described in Appendix D, Table 7. There is 30 percent rock outcrop and 10 percent shallow soils, as described in map unit v, included in this unit.

Surface texture is loam to very fine sandy loam. The mollic epipedon ranges from 7 to 11 inches thick. Depth of sandstone bedrock varies between 24 and 40 inches. Percent rock fragment by volume ranges 15 to 30 percent in the surface horizons and 35 to 65 percent in the lower horizons.

Erosion hazard is moderate at present and severe if disturbed due to steep slopes and sparse ground cover.

The potential rating for borrow topsoil is poor due to thin surface layers, large percent of rock fragments, and very steep slopes. There is no topsoil to store when these areas are disturbed.

Presently, predominant vegetation is sagebrush and grass.

Map Unit m-

This unit consists of deep, well drained soils that have formed in colluvium and residuum. They are on steep slopes that range from 35 to 60 percent. The typical pedon is described in Appendix D, Table 8. There is 8 percent similar soils included in this unit and 3 percent rock outcrop.

The surface texture is loam or clay loam. The surface is 6 to 10 inches thick. The C horizon begins at 18 to 20 inches. The percent of rock fragment by volume ranges from 5 to 10 in the upper 20 inches and 35 to 75 below 20 inches.

Erosion hazard is moderate at present and severe if disturbed due to steepness of slopes.

The potential rating for borrow topsoil is poor. There is a large rock fragment content, the surface layer is stony and the slopes are steep. There is no topsoil to store when this area is developed.

Present vegetation is mostly big sagebrush, snowberry and an understory of grass.

Map Unit p-

This unit consists of deep, somewhat poorly drained soils that have formed in recent stream alluvium. These soils are on stream floodplains. Slopes range from 0 to 3 percent. The typical pedon is described in Appendix D, Table 9. There is 8 percent inclusion of soil with gravel layers at a depth of 40 inches and 2 percent inclusion of soils that are better drained.

The ground water table is seasonally high with spring runoff at 8 to 10 inches. Texture throughout the profile range from silt loam to loamy fine sand. Thickness of lenses fluctuates between 2 and 8 inches. There is an area of 1/2 acre where there is a gravel layer at 2 to 4 inches. This is believed to have been hauled into a corral area.

There is a good potential rating for borrow topsoil where the water table is below 12 inches; otherwise wetness is restrictive. All material removed from these areas during development should be stored for reclamation purposes.

At present, the predominant vegetation is a grass and forb mixture.

Map Unit q-

This unit is moderately deep to gravel, and moderately well drained. These soils have formed in recent alluvium, and area on stream terraces. Slopes range 0 to 3 percent. The typical pedon is described in Appendix D, Table 10. There is 10 percent inclusion of similar soils in this unit.

The ground water is seasonably high with spring runoff at 18 to 24 inches. The surface texture is silt loam to loam. The C texture is loam to loamy very fine sand. Depth to the gravel ranges 28 to 36 inches.

Erosion hazard is slight at present and will remain slight if disturbed.

There is a fair potential rating for borrow topsoil. The course texture in some lenses may be too sandy and the increase of coarse fragments below 40 inches makes reclamation potential of the borrow area fair. The top 30 inches in most pedons could be stored for reclamation use when these are developed.

The present predominant vegetation is a mixture of sagebrush, grasses and forbs.

Map Unit r-

This type consists of well drained soils that have formed in colluvium and residuum. Slope ranges from 8 to 15 percent. Elevation ranges from 8000 to 8100 feet. Present vegetation is predominately stinging neetle.

Chemcial analysis and a representative profile description are on Appendix D, Table 11.

Erosion is slight at present and erosion will be slight if disturbed.

Suitability rating for topsoil is fair due to depth to bedrock. When disturbed the first 12 inches (average) should be stored and used for reclamation topsoil.

Range of characteristics include a surface layer 3 to 5 inches thick with 5 to 15 percent rock fragments by volume. The topsoil is 6 to 10 inches thick with 10 to 20 percent rock fragment by volume. Texture of the subsoil is loam or sandy clay loam. The substratum is moderately deep to bedrock at a depth of 30 to 36 inches. There is 35 to 55 percent rock fragment by volume and a texture of loam or sandy loam in the substratum.

Included in this unit are 10 percent of the soils described in unit p and 5 percent of a deep similar soil.

Map Unit s-

This is a complex consisting of 45 percent of the soil described in unit t, 35 percent of the soil described in unit u, and 10 percent of the soil described in unit r.

Map Unit t

This unit consists of well drained soils that have formed is residuum. Slopes range 8 to 15 percent. Elevation ranges from 8000 to 9100 feet. Present vegetation is predominately Douglas fir and Engelmann spruce.

Chemical analysis and a representative profile description are on Appendix D, Table 12.

Erosion is slight to moderate at present and the erosion hazard will be moderate if disturbed.

Suitability rating for topsoil is fair due to depth to bedrock. When disturbed the average first 20 inches should be stored and used for reclamation topsoil.

Range of characterstics include a surface layer 1 to 4 inches thick with 0 to 5 percent rock fragments by volume. The subsoil is 15 to 20 inches thick with 0 to 5 percent rock fragments by volume. The texture of the subsoil is sandy loam or loam. The substratum is moderately deep to bedrock at a depth of 30 to 36 inches. There is 20 to 35 percent rock fragment by volume and a texture of loam to sandy clay loam in the substratum.

Included in this unit are 15 percent of the soil described in unit u to 5 percent of the soil described in unit q.

Map Unit u

This unit consists of well drained soils that have formed in residuum. Slope ranges from 2 to 8 percent. Elevation ranges from 8000 to 8900 feet. Present vegetation is predominately aspen.

Chemical analysis and a representative profile, description are on Appendix D, Table 13.

Erosion is slight at present and th erosion hazard will be slight when disturbed.

Suitability rating for topsoil is fair due to depth to bedrock. When disturbed the average first 30 inches should be stored and used for reclamation purposes.

Range of characteristics include a surface layer 8 to 12 inches thick with 0 to 5 percent rock fragment by volume. The substratum is moderately deep to bedrock at a depth of 35 to 40 inches. Texture is clay loam or sandy clay loam; rock fragment by volume ranges 10 to 20 percent.

Included in this unit are 10 percent of a similar deep soil and 5 percent of the soil described in unit t.

Map Unit v

This type consists of shallow, excessively drained soils that have formed in colluvium and residuum. They are on steep to very steep mountain sides. Slopes are 35 to 60 percent. The typical pedon is described in Appendix D, Table 14. Included is 3 percent of a moderately deep similar soil and 8 percent rock outcrop. Textures range from loam to loamy very fine sand. Depth to fractured bedrock is 14 to 20 inches. Rock fragments range from 35 to 55 percent.

Erosion is moderate at present and the erosion hazard will be severe if disturbed due to sparse vegetation coverage and steep slopes.

The potential rating for borrow topsoil is poor due to steep slopes, thin surface layer and the amount of rock fragment. There is no topsoil to store when this area is developed.

Predominant vegetation is sagebrush with a grass understory.

Present and Potential Productivity of Existing Soils

Local climatic data suggests crylic and frigid temperature regimes. The cryic regime is typically conifer-aspen related, and includes as well some high meadows. These areas are too cold for cultivation of crop plants by ordinary means. Frigid designation is given to soils typical of sagebrush types; some crops can be grown on these soils. Most of the soils are in the ustic (moisture arriving in summer) regimes.

All soils have textures ranging from sandy loams to clay loams, and are considered neither unusual for the area in general nor for the vegetation types those soils support. A comparison of spruce-fir and aspen soils, which as broad categories make up more than 80% of the lease area soils, shows that the pH and salinity measurements are probably normal for this climatic regime with the pH range from sonewhat acidic to neutral for spruce-fir and aspen soils. There is a slight difference in soils reaction between spruce-fir (pH 5.0) and aspen (pH 6.0) soils; it is characterictic that evergreen conifer types are more acidic than the deciduous forest of aspen.

Even the most saline soil measured in the lease area, with an EC x 10 measurement of 1.88, is considered extremely low when compared to agricultural soils. A slight difference

between soils is noted when depths are compared. The solum of aspen extends to an average depth of 20 inches at nine locations and to 18 inches at seven location of the spruce-fir type. Ths corresponds to the average depths of measurements in aspen of 19.9 inches and of 18.1 inches in spruce-fir soils.

It is also apparent that soils in apsen communities are more fertile in the commonly applied fertilizer elements nitrogen, phosphorus, and potassium, and also in most micro-nutrients. The levels of iron, magnesium, and manganese are considered to be adequate for growth of native vegetation, even though somewhat below amounts reported for average soils in the western United States (Shacklette, et al. 1971). Moderate amounts of zinc, calcium, and potassium indicate that adequate quantities of these minerals are present, except in sagebrush soils.

High amounts of calcium, especially in the B-horizon of spruce-fir soils are not considered a problem in immobilization of phosphorus due to the acid pH for these soils. Concentrations of calcium in sagebrush and aspen soils could become a problem in phosphorus relations if soils are altered to become more basic. Nitrate nitrogen is low in quantity, as was expected for these soil types. Average amounts of nitrate nitrogen are inadequate in all soils of the region, and in all horizons. All areas would respond to addition of nitrogen.

17. UMC 783.22 LAND-USE INFORMATION

The discussion of post-mining land-use appears to omit wildlife as planned for use. Was this intentional? It would appear that it was an unintentional omission.

17. COMMENTS

Most of the disturbed areas will be returned to pre-law land use. The Belina portal site will be upgraded to recreational use, which is compatible to either Carbon County's land use plan, or the land owners desire for a cattle holding facility. Both of these uses somewhat preclude a wildlife use, although they are not exclusive of such use.

783.22 LAND-USE INFORMATION

Eccles Canyon serves as the boundary between two livestock grazing allotments. The USDA Forest Service completed a range analysis map for both areas. These maps were used to compile the premining land capability as well as premining land use. This information is shown on Premining Land Use Map, Map I and I-1, Volume IV.

The area around the mine plan area is rich in mining history. For a number of years prior to the reactivation of mining by Valley Camp, Inc. in 1974, there was limited mining activity in the area. However, early commercial production was initiated in the region in the latter part of the nineteenth century. The Pleasant Valley Coal Company and others began mining operations in the Scofield area first. Wagon roads and then a narrow gauge railroad moved the coal northwestward to the population centers in Utah and Salt Lake valleys.

The oldest mine in the district, the Utah #1 Mine, is situated on properties now held by Valley Camp, Inc. just south of the loadout facilities on the east side of Pleasant Valley Creek about three miles south of Scofield (shown on

the Coal_Map, Map B, Volume IV). It was opened in 1878 and was originally called the Mud Creek Mine. The portal of the mine was at tipple height above the railroad. Much of the coal was mined for use by the railroad. The principal operator was Utah Fuel Company, a subsidiary of the Denver and Rio Grande Railroad. The mine had several periods of activity but the workings are not extensive. Doelling (1972) estimates total production at 713,800 tons.

The Union Pacific Mine just east of Scofield Townsite was opened in 1884 in a coal seam that had a thickness in excess of 30 feet. This thick seam split to the north and two benches were mined. An upper seam with about 100 feet of separation was also mined to some extent. Mining was terminated after the lower seam caught fire. It is still burning.

The Winter Quarters Mine, about one and one-half miles west of Scofield, developed into the biggest mine in the district. Speiker (1931) described the mine in 1923 as having five separate openings. These operations were also owned by the Utah Fuel Company. Eventually there were at least six openings which produced nearly 11 million tons of coal. The mine was the site of a major disaster on May 1, 1900 when more than 200 men were killed by a dust explosion.

Several other mines were opened in the vicinity of Scofield. The only other mine of major significance was the Kinney Mine northeast of the town boundaries. A later operation, the Colombine Mine, was near the same locality.

The Clear Creek Mines were opened in 1899. Most of the work was in the lower of two seams exposed on the east side of the main valley. Extensive mining moved eastward until terminated by a major fault zone. A 1700-foot rock tunnel was driven across the fault zone into coal on the other side and mining continued to the outcrop in upper Bob Wright Canyon.

In Eccles Canyon about one-half mile west of the Connelville Block, there was a small mining operation in the Lower O'Connor seam. Nothing is known about this mine or the period of activity. Production is assumed to have been small.

The Bentley, Huntington and Loucks mines were opened in 1874 in Huntington Canyon. The Huntington Mine was the only significant producer. Production of coal exceeded 44,000 tons during sporatic operations between 1895 and the early 1940's (Doelling, 1972). These mines are located within the southern projection of the Connelville Block.

An early-wagon mine, the Black Diamond Mine, (shown on the Coal Map, Map B, Volume IV) was operated in Upper Finn Canyon west of Clear Creek Townsite. The period of activity and the production are not known for certain but it was probably operated intermittently between 1923 and 1941. Mining from Boardinghouse Canyon later connected with these old workings.

Other mines closely associated with the Connelville Block are the O'Connor mines (also located on the Coal Map, Map B, Volume IV). These mines lie immediately to the east across the O'Connor fault. At these mines two seams, the Upper and Lower O'Connor seams were mined. Each seam had a thickness of about 18 feet at the outcrop. Coal was shipped to the Castlegate preparation plant and washed.

In 1974 Valley Camp, Inc. reactivated mining activity in the Green Canyon Area with the opening of the Utah Number 2 mine. This mine was projected to produce between 500,000 and 750,000 tons per year. Unexpected severe faulting caused Valley Camp, Inc. to cease operations. In 1976 construction for the Belina mines began in Whiskey Canyon off Eccles Canyon.

The area of the Valley Camp, Inc. mines and facilities has been used extensively for mining in the past and is zoned for mining by Carbon and Emery counties (see Volume I, Section 782.16). At the time of filing for this mining permit the use of the land is for mining activities.

The premining land uses existing within the Valley Camp, Inc. mine permit area at the time of filing this application are shown on the Premining Land Use Maps, Maps I and I-1, in Volume IV. The land use around the Belina Mine Sites has changed within the past five years. As shown on the Premining Land Use Map, Map I-1, in Volume IV, the historical land use in the Belina Mines' area was for shrub and brush rangeland or mixed forest land. But as previously stated the current land use for the Belina Mines' area (since 1976) is industrial land use for mining.

The land use around the Utah #2 Mine Site which is the location of Valley Camp's loadout facilities has historically been industrial land use for mining.

The historical land uses along the proposed conveyor route are shrub and brush rangeland, mixed forest transitional area, and industrial as shown on the Premining Land Use Map, Map I-1, Volume IV.

The analysis of land capability and productivity is based on soils studies, USDA information, and consultant work. The capability before mining of the land affected or proposed to be affected by Valley Camp's surface operations and facilities was to support mixed forests and shrub and brush rangeland. The specific vegetation in the affected areas is explained in detail in Section 783.19, Vegetation Information and shown on the Vegatation Map, Map G, Volume IV.

The affected land historically has been unsuitable for any type of agricultural development and has not been capable of supporting forests in quantities of any great enconomic value. The land was not developed agriculturally or otherwise due to the mountainous topography of the area, small amounts of very dry soil material available (See Section 783.21, Soil Resource Information, for details), short growing seasons, and moderate rainfall (area streams generally only flow as a result of precipitation events). See Section 783.18, Climatological Information, for further information.

Productivity data for vegetation associated with affected lands can be found in Appendix H of this volume.

The land use classifications under local law for the mine plan area are as follows:

Carbon County

All of the mine plan area situated in Carbon County is zoned for Recreation, Forestry and Mining, with the exception of the W½ SW¼ Section 9, T13S, R7E. This portion is zoned Critical Environmental (CE-1). An application to change this zoning from CE-1 back to RF&M is presently being prepared.

Emery County

All of the mine plan area situated in Emery County is zoned for Recreation, Forestry and Mining. Re-zoning is presently taking place that may change the zoning classification to Critical Environmental, CE-1 and CE-2 in certain sections.

783.27 PRIME FARMLAND INVESTIGATION

Based on the results of this investigation, Valley Camp requests a negative determination for the affected surface lands within the Mine Plan Area. This request is based on the following reasons:

1. The land has not been historically used as cropland.
2. The slope of the affected areas is 10 percent or greater.
3. The land is not irrigated.
4. The land is very rocky, and in general is not conducive to agricultural development.

Refer also to 783.19, Vegetation Information, and 783.21, Soil Resource Information.

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APPENDIX A

Results of Spring Inventory

Water Quality Analyses

Table 1. Results of chemical analyses of water samples collected from selected springs.

Spring	2-2	6-3	6-3	6-12	7-11	7-11	19-10	24-12	24-12	24-6	25-5	25-5	25-13
Date of Discharge	9-06-78	7-17-79	10-01-79	7-17-79	7-17-79	10-01-79	6-26-79	6-25-79	10-03-79	10-26-78	6-25-79	10-03-79	10-26-78
PARAMETER													
Discharge (cfs)	0.027	0.022	<0.001	0.001	0.013	<0.002	0.009	0.007		0.002	0.029		0.007
Temperature, Water	10	5.5	6	6	7	4	7	6		5	4		2.5
Acidity, as $CACO_3$			14.0			14.0							
Alkalinity, as $CaCO_3$			160.00			200.00							
Arsenic			<.001			<.001							
Barium, Total			.020			.010							
Bicarbonate	258.6	158.6	195.20	151.28	134.20	244.00	197.64	353.80	305.00	290.4	212.28	319.64	283.0
Boron, Total			<.001										
Cadmium, Total			<.001			<.001							
Calcium	71.2	46.4	64.00	46.40	35.20	84.00	48.00	78.40	96.80	79.2	58.40	105.60	71.2
Chloride	8.0	<0.1	2.0	<0.1	<0.1	6.0	2.0	<0.1	34.0	.01	<.1	28.0	.01
Chromium, Total			<.001			.002							
Conductivity	395	255	370	240	194	490	320	535	490	352	310	500	430
Copper, Total			.004			.001							
Fluoride			.07			.11							
Iron, Dissolved			.010			.010							
Iron, Total			.640			.660							
Lead			<.001			<.001							
Magnesium	8.1	5.76	14.00	2.88	5.28	19.20	12.48	22.08	5.76	9.60	6.72	2.88	13.44
Manganese, Total			.003			<.001							
Mercury, Total			<.0002			<.0002							
Nitrate, NO_3 as N			.06			26							
Oil and Grease													
Phenol													
Phosphate, PO^4 as P			.110			.060							
Potassium	3.56	0.478	.779	.377	.335	.693	1.275	1.283	1.240	1.257	.338	1.540	0.808
Selenium, Total						.001							
Silver, Total						<.001							
Sodium	2.1	1.43	1.88	1.68	2.30	2.13	3.05	2.33	19.50	2.95	1.50	16.00	1.93
Sulfate	4.0	10.0	55.0	8.0	6.0	80.0	13.0	10.0	14.2	9.0	<3.0	11.1	10.0
Total Dissolved Solids	213	143	238	145	119	316	220	320	323	190	200	330	232
Zinc, Total			.020			.006							
pH	7.35		7.40			7.40			6.90	7.5		7.40	7.5

Table 1. Continued.

Spring	25-13	25-13	25-15	25-17	25-18	25-20	29-1	29-2	30-13	30-15	31-13	31-13	31-13
Date of Discharge	6-26-79	10-01-79	6-26-79	9-06-79	10-26-78	6-25-79	7-25-79	7-17-79	6-26-79	7-18-79	6-17-79	7-17-79	10-04-79
PARAMETER													
Discharge (cfs)	0.056	0.001	0.07	0.004	0.009	0.011	0.004	0.004	0.002	0.004	0.017	0.004	
Temperature, Water	7	11	8	5	4	5	8	7	6	5	5	6	
Acidity, as $CACO_3$		16.0											
Alkalinity, as $CaCO_3$		126.00											
Arsenic		<.001											
Barium, Total		.010											
Bicarbonate	36.60	153.72	41.48	278.1	231.8	36.60	297.68	309.88	336.72	192.76	241.56	258.64	278.16
Boron, Total													
Cadmium, Total		<.001											
Calcium	1.60	56.00	1.60	70.4	62.4	12.80	84.0	74.40	84.80	46.40	62.40	68.00	94.40
Chloride	<.1	<.1	2.0	6.0	.01	<.1	24.0	<0.1	16.0	4.0	2.0	<0.1	20.0
Chromium, Total		<.001											
Conductivity	71	300	176	405	322	69	515	560	640	300	370	420	410
Copper, Total		.003											
Fluoride		.11											
Iron, Dissolved		.010											
Iron, Total		.260											
Lead		<.001											
Magnesium	.48	9.60	.48	11.0	9.60	.96	4.40	25.44	32.64	12.00	14.40	14.40	4.80
Manganese, Total		.001											
Mercury, Total		<.0002											
Nitrate, NO_3 as N		.24											
Oil and Grease													
Phenol													
Phosphate, PO^4 as P		.060											
Potassium	.555	.633	.236	2.95	0.664	.634	1.987	1.643	1.527	0.703	0.999	0.979	1.146
Selenium, Total		.001											
Silver, Total		<.001											
Sodium	10.20	1.15	17.10	4.10	2.10	1.19	7.24	4.13	9.36	4.40	1.41	1.63	4.00
Sulfate	<3.0	53.0	7.6	4.0	14.0	8.5	13.0	49.0	63.0	13.0	17.0	6.0	12.2
Total Dissolved Solids	32.0	199	52.0	219	174	43.0	310	310	380	179	227	233	272
Zinc, Total		.005											
pH		7.40											

Table 1. Continued.

Spring	32-2	35-10	35-13	35-13	36-1	36-3	36-3	36-7	36-7	36-17	36-19	36-19	36-21	36-23
Date of Discharge	7-17-79	6-25-79	6-26-79	10-01-79	6-27-79	6-27-79	10-01-79	6-27-79	10-01-79	10-04-79	7-16-79	10-01-79	7-16-79	7-20-79
PARAMETER														
Discharge	<0.001	0.011	0.013	<0.002	0.009	0.083	<0.001	0.018	0.001			0.001	0.011	0.004
Temperature, Water	9	8	6	7	4	3	3	6	5			6	7	9
Acidity, as $CACO_3$				20.0			18.0		12.0			14.0		
Alkalinity, as $CaCO_3$				240.00			172.00		150.00			134.00		
Arsenic				<.001			<.001		<.001			<.001		
Barium, Total				.030			.030		.020			.010		
Bicarbonate	466.04	207.40	253.76	292.80		80.52	209.84	102.48	183.00	268.40	168.36	163.48	251.32	234.24
Boron, Total							.060							
Cadmium, Total				<.001			<.001		<.001			<.001		
Calcium	75.20	54.40	72.00	84.00		24.80	68.00	34.40	48.00	81.60	40.80	44.00	61.60	64.8
Chloride	28.0	<0.1	2.0	2.0		<.1	2.0	2.0	4.0	18.0	2.0	2.0	2.0	2.0
Chromium, Total				.001			<.001		<.001			<.001		
Conductivity	800	300	360	380	390	128	360	182	250	430	230	300	385	315
Copper, Total				.001			.005		.003			.002		
Fluoride				.13			.08		.11			.09		
Iron, Dissolved				.010			.010		.010			.010		
Iron, Total				.270			.230		1.200			.150		
Lead				<.001			<.001		.003			<.001		
Magnesium	21.12	10.08	4.80	12.00		2.40	12.00	1.92	7.20	5.76	3/36	19.20	10.08	9.12
Manganese, Total				<.001			.003		.005			<.001		
Mercury, Total				<.0002			<.0002		<.0002			<.0002		
Nitrate, NO_3 as N							.77							
Oil and Grease							<1.0							
Phenol							.004							
Phosphate, PO^4 as P				.060			.080		.110			.060		
Potassium	2.013	0.444	.383	.583		.537	.726	.664	.914	1.110	0.349	.521	0.479	0.491
Selenium, Total				<.001			<.001		.001			<.001		
Silver, Total				<.001			<.001		<.001			<.001		
Sodium	75.30	1.62	4.20	2.09		1.32	2.17	1.64	3.00	10.00	13.90	1.33	8.0	1.86
Sulfate	21.0	9.6	4.0	20.0		8.0	45.0	10.3	6.0	10.5	6.0	50.0	6.0	6.0
Total Dissolved Solids	528	184	215	250		81.0	233	150	165	280	155	198	219	206
Zinc, Total				.004			.008		.003			.005		
pH				7.30			7.10		7.20	7.80		7.20		

APPENDIX B

Results of Baseline Surface Water Quality and Quantity Analyses

Table 2. Results of chemical analyses of surface water quality samples collected at Station VC-1.

Parameter	Units	8-6-75	12-26-75	1-26-76	3-9-76	4-28-76	6-14-76
FIELD MEASUREMENTS							
Discharge	cfs			14.0	8.1	8	15
Dissolved Oxygen	mg/l			10.0	8.4	6.8	7.1
pH	units						
Specific Conductance	umhos/cm @ 25° C	641	730	670	780	700	640
Temperature, Air	°C			-4.0	2.0	10	4
Temperature, Water	°C			0	1.0	6	2
LABORATORY MEASUREMENTS							
Acidity, as $CaCO_3$	mg/l						
Alkalinity, as $CaCO_3$	mg/l	218	258	216	278	236	218
Ammonia, NH_3 as N	mg/l						
Arsenic, Total	mg/l	<0.01	<0.001	0.007	0.003	0.002	<0.001
Arsenic, Dissolved	mg/l						
BOD, 5 Day	mg/l						
Barium, Total	mg/l	<0.01	0.03	0.084	0.065	0.044	0.023
Barium, Dissolved	mg/l						
Bicarbonate	mg/l	264.20	314.76	263	339.1	287.9	265.9
Boron, Total	mg/l	<0.01	<0.01	<0.001	<0.001	0.005	<0.001
Boron, Dissolved	mg/l						
Cadmium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Dissolved	mg/l						
Calcium	mg/l	68.0	77.6	59.2	78.4	72.8	63.2
Chloride	mg/l	6.0	8.0	9.0	8.0	6.0	6.0
Chromium, Total	mg/l	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001
Chromium, Dissolved	mg/l						
Copper, Total	mg/l	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001
Copper, Dissolved	mg/l						
Cyanide	mg/l	<0.01	<0.01				
Fluoride	mg/l	0.18	0.23	0.23	0.36	0.25	0.28
Gross Alpha Radioactivity	pCi/l						
Gross Beta Radioactivity	pCi/l						
Iron, Total	mg/l	0.05	0.095				
Iron, Dissolved	mg/l						
Lead, Total	mg/l	<0.01	<0.001	0.018	0.004	<0.001	<0.001
Lead, Dissolved	mg/l						
MPN Fecal Coliform	MPN/100 ml						
MPN Total Coliform	MPN/100 ml						
Magnesium	mg/l	25.55	26.4	28.3	32.16	20.16	20.16
Manganese, Total	mg/l	<0.01	0.01	0.042	0.040	0.050	0.058
Mercury, Total	mg/l	<0.001	<0.001	<0.0001	<0.0001	<0.0001	<0.0002
Nitrate, NO_3 as N	mg/l	0.08	0.04	0.173	0.145	0.140	0.17
Oil and Grease	mg/l			<1.0		<1.0	<1.0
Phenol	mg/l						
Phosphate, PO_4 as P	mg/l	0.05	0.02	0.07	0.155	0.150	0.160
Potassium	mg/l	2.01	2.28	2.87	2.78	2.88	1.63
Selenium, Total	mg/l	<0.01	<0.01	0.055	0.012	0.015	0.019
Selenium, Dissolved	mg/l						
Silver, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Silver, Dissolved	mg/l						
Sodium	mg/l	3.72	5.0	12.1	3.50		19.4
Sulfate	mg/l	49.70	45.0	65.0	46.0	56.0	
Suspended Solids	mg/l						
Total Dissolved Solids	mg/l						
Total Organic Carbon	mg/l			12.0	14.0	12.0	10.0
Turbidity	NTU	1.70	1.4	0.16	2.60	0.60	1.30
Zinc, Total	mg/l	0.05	0.009	0.430	0.032	0.029	0.021
Zinc, Dissolved	mg/l						

Table 2. Continued.

Parameter	Units	8-26-76	9-30-76	10-27-76	11-29-76	12-28-76
FIELD MEASURMENTS						
Discharge	cfs	6	9	4.5	5.5	8
Dissolved Oxygen	mg/l	8.0	9.2	10.4	9.9	9.8
pH	units	8.2	7.2	7.4	7.0	7.8
Specific Conductance	umhos/cm @ 25° C	720	520	760	840	750
Temperature, Air	°C	15	19	0	-4	-5
Temperature, Water	°C	15	9	1.5	1.0	0
LABORATORY MEASUREMENTS						
Acidity, as $CaCO_3$	mg/l					
Alkalinity, as $CaCO_3$	mg/l	260	102	294	306	290
Ammonia, NH_3 as N	mg/l					
Arsenic, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, Dissolved	mg/l					
BOD, 5 Day	mg/l					
Barium, Total	mg/l	0.025	0.012	0.009	0.004	0.007
Barium, Dissolved	mg/l					
Bicarbonate	mg/l	317.2	124.4	358.7	373.3	353.8
Boron, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Boron, Dissolved	mg/l					
Cadmium, Total	mg/l					
Cadmium, Dissolved	mg/l					
Calcium	mg/l	69.0	69.1	52.0	40.0	68.8
Chloride	mg/l	12.0	98.0	4.0	6.0	6.0
Chromium, Total	mg/l					
Chromium, Dissolved	mg/l					
Copper, Total	mg/l	0.005	0.009	0.010	0.015	0.003
Copper, Dissolved	mg/l					
Cyanide	mg/l					
Fluoride	mg/l	0.39	0.27	0.12	0.20	0.19
Gross Alpha Radioactivity	pCi/l	<1				<1
Gross Beta Radioactivity	pCi/l	<3				<2
Iron, Total	mg/l	0.310	0.220	0.223	0.275	0.228
Iron, Dissolved	mg/l					
Lead, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, Dissolved	mg/l					
MPN Fecal Coliform	MPN/100 ml					
MPN Total Coliform	MPN/100 ml					
Magnesium	mg/l	25.0	19.60	42.0	64.8	31.68
Manganese, Total	mg/l	0.049	0.015	0.016	0.010	0.012
Mercury, Total	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l	0.18	0.12	0.10	0.08	0.06
Oil and Grease	mg/l	<1.0	4.0	2.6	2.4	<1.0
Phenol	mg/l					
Phosphate, PO_4 as P	mg/l	0.165	0.200	0.160	0.130	0.150
Potassium	mg/l	2.51	2.54	2.51	3.23	2.46
Selenium, Total	mg/l	0.016	0.004	<0.001	<0.001	<0.001
Selenium, Dissolved	mg/l					
Silver, Total	mg/l					
Silver, Dissolved	mg/l					
Sodium	mg/l	17.0	8.10	12.0	4.7	12.0
Sulfate	mg/l	37.6	33.0	33.8	61.0	39.0
Suspended Solids	mg/l		18.0	21.0	11.0	7.0
Total Dissolved Solids	mg/l	470	350	500	550	510
Total Organic Carbon	mg/l	11.0	12.0	3.0	2.6	3.0
Turbidity	NTU	6.50	5.10	2.40	0.48	2.0
Zinc, Total	mg/l	0.019	0.015	0.025	0.034	0.027
Zinc, Dissolved	mg/l					

Table 2. Continued.

Parameter	Units	3-17-77	6-16-77	6-28-77	8-23-78	10-25-78	12-27-78
FIELD MEASURMENTS							
Discharge	cfs	6	2.4	19	3	4.7	2.9
Dissolved Oxygen	mg/l	10.15	8.8		8.5	11.0	10.4
pH	units	7.5	7.6	7.1	8.3	7.5	7.86
Specific Conductance	umhos/cm @ 25° C	670	450	325	390	540	
Temperature, Air	°C	3	21	20	27	5	-17
Temperature, Water	°C	5	12	16	15	3	0
LABORATORY MEASUREMENTS							
Acidity, as $CaCO_3$	mg/l						
Alkalinity, as $CaCO_3$	mg/l	244	262				
Ammonia, NH_3 as N	mg/l	0.15	0.25				
Arsenic, Total	mg/l	<0.001	<0.001	<0.001	0.004	<0.001	<0.001
Arsenic, Dissolved	mg/l						
BOD, 5 Day	mg/l						
Barium, Total	mg/l	0.006	0.056				
Barium, Dissolved	mg/l						
Bicarbonate	mg/l	297.6	319.6	195.2	253.7	295.2	336.7
Boron, Total	mg/l	<0.001	0.017				
Boron, Dissolved	mg/l						
Cadmium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Dissolved	mg/l						
Calcium	mg/l	65.6	68.0	48.8	57.6	74.4	84.0
Chloride	mg/l	4.0	10.0	10.0	10.0	8.0	12.0
Chromium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium, Dissolved	mg/l						
Copper, Total	mg/l	0.013	0.015	0.005	0.004	0.015	0.010
Copper, Dissolved	mg/l						
Cyanide	mg/l		<0.01				
Fluoride	mg/l	0.17	0.27	0.14	0.15	0.16	0.16
Gross Alpha Radioactivity	pCi/l		2				
Gross Beta Radioactivity	pCi/l		6				
Iron, Total	mg/l	0.201	0.146	0.099	0.237	0.170	0.139
Iron, Dissolved	mg/l						
Lead, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, Dissolved	mg/l						
MPN Fecal Coliform	MPN/100 ml			<20			
MPN Total Coliform	MPN/100 ml			110			
Magnesium	mg/l	28.32	28.32	11.52	24.5	24.0	26.4
Manganese, Total	mg/l	0.014	0.047	0.049	0.025	0.030	0.053
Mercury, Total	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l	0.02	0.01	0.20			
Oil and Grease	mg/l	<1.0	<1.0	<1.0	1.3	1.6	1.1
Phenol	mg/l		0.009	0.009	0.008	0.028	0.006
Phosphate, PO_4 as P	mg/l	0.042	0.035				
Potassium	mg/l	2.53	2.30	1.155	2.09	2.450	2.215
Selenium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium, Dissolved	mg/l						
Silver, Total	mg/l	<0.001	<0.001	<0.001	<0.001		
Silver, Dissolved	mg/l						
Sodium	mg/l	5.33	5.66	18.0	4.14	4.00	8.5
Sulfate	mg/l	43.0	22.0	28.0	31.5	38.0	46.0
Suspended Solids	mg/l	13.0	22.0	12.8	2.0	4.0	16.0
Total Dissolved Solids	mg/l	440	320	210	255	295	346
Total Organic Carbon	mg/l	3.0	8.0	18.0			
Turbidity	NTU	1.50	7.50				
Zinc, Total	mg/l	0.018	0.013	0.007	0.010	0.007	0.004
Zinc, Dissolved	mg/l						

Table 2. Continued.

Parameter	Units	2-28-79	4-18-79	6-20-79	8-23-79	10-31-79
FIELD MEASURMENTS						
Discharge	cfs	5.7	12.6	12.3	4.8	2.7
Dissolved Oxygen	mg/l	10.0	10.0	10.0	9.0	9.0
pH	units	7.8	7.72	7.95	8.0	7.9
Specific Conductance	umhos/cm @ 25° C	440	480	375	510	550
Temperature, Air	°C	-7	13	10	11	-1
Temperature, Water	°C	0.2	6.5	4	8.0	7.9
LABORATORY MEASUREMENTS						
Acidity, as $CaCO_3$	mg/l			10.0	6.0	14.0
Alkalinity, as $CaCO_3$	mg/l	236	238	190	228	220
Ammonia, NH_3 as N	mg/l					
Arsenic, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, Dissolved	mg/l					
BOD, 5 Day	mg/l					
Barium, Total	mg/l					0.210
Barium, Dissolved	mg/l					
Bicarbonate	mg/l	287.92	292.8	231.8	278.16	286.40
Boron, Total	mg/l					0.050
Boron, Dissolved	mg/l					
Cadmium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Dissolved	mg/l					
Calcium	mg/l	61.6	77.6	56.0	96.0	63.20
Chloride	mg/l	<0.1	14.0	4.0	1.0	8.0
Chromium, Total	mg/l	<0.001	<0.001	<0.001		<0.001
Chromium, Dissolved	mg/l					
Copper, Total	mg/l	0.003	0.004	0.002	0.007	0.010
Copper, Dissolved	mg/l					
Cyanide	mg/l					
Fluoride	mg/l	0.18	0.16	0.24	0.25	0.17
Gross Alpha Radioactivity	pCi/l					
Gross Beta Radioactivity	pCi/l					
Iron, Total	mg/l	0.406	3.428	1.080	0.390	0.320
Iron, Dissolved	mg/l					
Lead, Total	mg/l	<0.001	0.003	0.004	<0.001	<0.001
Lead, Dissolved	mg/l					
MPN Fecal Coliform	MPN/100 ml					
MPN Total Coliform	MPN/100 ml					
Magnesium	mg/l	24.48	20.16	14.4	4.32	26.88
Manganese, Total	mg/l	0.088	0.142	0.051	0.051	0.049
Mercury, Total	mg/l	<0.0002	<0.0002	0.0003	<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l	0.10	0.11	0.24	0.04	<0.01
Oil and Grease	mg/l	1.2	1.4	3.2	<1.0	<1.0
Phenol	mg/l	<0.001	0.008	<0.001	0.108	<0.001
Phosphate, PO_4 as P	mg/l					
Potassium	mg/l	2.001	2.318	1.105	2.203	2.250
Selenium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium, Dissolved	mg/l					
Silver, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Silver, Dissolved	mg/l					
Sodium	mg/l	10.2	8.83	4.10	9.80	9.60
Sulfate	mg/l	45.0	38.0	18.0	52.0	54.0
Suspended Solids	mg/l	51.0	111	19.0	27.0	27.0
Total Dissolved Solids	mg/l	290	315	219	300	310
Total Organic Carbon	mg/l					
Turbidity	NTU					
Zinc, Total	mg/l	0.008	0.012	0.004	0.005	0.006
Zinc, Dissolved	mg/l					

Table 3. Results of chemical analyses of surface water quality samples collected at Station VC-2.

Parameter	Units	8-26-75	12-26-75	1-26-76	3-9-76	4-28-76	6-14-76
FIELD MEASUREMENTS							
Discharge	cfs			14.0	8.4	8.0	15.0
Dissolved Oxygen	mg/l			9.9	11.2	6.5	8.0
pH	units	7.80	7.63	7.9	8.3	8.2	8.5
Specific Conductance	umhos/cm @ 25° C						
Temperature, Air	°C						
Temperature, Water	°C						
LABORATORY MEASUREMENTS							
Acidity, as $CaCO_3$	mg/l						
Alkalinity, as $CaCO_3$	mg/l						
Ammonia, NH_3 as N	mg/l						
Arsenic, Total	mg/l	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, Dissolved	mg/l						
BOD, 5 Day	mg/l						
Barium, Total	mg/l	<0.01	0.06	0.008	0.006	0.009	0.012
Barium, Dissolved	mg/l						
Bicarbonate	mg/l	239.97	295.24	239.1	302.5	263.35	253.7
Boron, Total	mg/l	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001
Boron, Dissolved	mg/l						
Cadmium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Dissolved	mg/l						
Calcium	mg/l	62.40	70.4	51.2	71.2	56.0	58.4
Chloride	mg/l	6.0	8.0	6.0	4.0	6.0	2.0
Chromium, Total	mg/l	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001
Chromium, Dissolved	mg/l						
Copper, Total	mg/l	0.02	<0.01	<0.001	<0.001	<0.001	<0.001
Copper, Dissolved	mg/l						
Cyanide	mg/l	<0.01	<010.				
Fluoride	mg/l	0.14	0.25	0.25	0.34	0.30	0.27
Gross Alpha Radioactivity	pCi/l						
Gross Beta Radioactivity	pCi/l						
Iron, Total	mg/l	0.13	0.160	0.130	0.210	0.244	0.250
Iron, Dissolved	mg/l	0.01	0.080				
Lead, Total	mg/l	<0.01	<0.001	0.002	0.001	<0.001	<0.001
Lead, Dissolved	mg/l						
MPN Fecal Coliform	MPN/100 ml						
MPN Total Coliform	MPN/100 ml						
Magnesium	mg/l	20.16	27.36	27.8	29.76	24.0	23.0
Manganese, Total	mg/l	<0.01	<0.01	0.035	0.024	0.050	0.058
Mercury, Total	mg/l	<0.001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001
Nitrate, NO_3 as N	mg/l	0.10	0.04	0.069	0.130	0.135	0.16
Oil and Grease	mg/l			<1.0		<1.0	<1.0
Phenol	mg/l						
Phosphate, PO_4 as P	mg/l	0.07	0.05	0.12	0.120	0.165	0.165
Potassium	mg/l	1.85	2.52	2.10	1.91	1.94	1.42
Selenium, Total	mg/l	<0.01	<0.01	<0.001	<0.001	0.009	0.008
Selenium, Dissolved	mg/l						
Silver, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Silver, Dissolved	mg/l						
Sodium	mg/l	3.52	12.0	19.0	4.87	16.0	6.5
Sulfate	mg/l	41.85	55.0	80.0	56.0	50.0	46.0
Suspended Solids	mg/l						
Total Dissolved Solids	mg/l	374.0	469.0	420.0	467.0	416.0	380.0
Total Organic Carbon	mg/l				8.0	17.0	18.0
Turbidity	NTU	1.50	0.84	0.24	2.30	0.50	1.40
Zinc, Total	mg/l	0.02	0.015	0.013	0.015	0.015	0.005
Zinc, Dissolved	mg/l						

Table 3. Continued.

Parameter	Units	8-27-76	9-30-76	10-27-76	11-29-76	12-28-76
FIELD MEASUREMENTS						
Discharge	cfs	5.6	4.0	5.0	4.3	2.0
Dissolved Oxygen	mg/l	8.8	7.3	10.5	10.2	9.3
pH	units	8.2	7.3	7.5	7.1	7.8
Specific Conductance	umhos/cm @ 25° C	660.0	740.0	760.0	780.0	750.0
Temperature, Air	°C	19.0	20.0	2.0	-2.0	0
Temperature, Water	°C	8.2	7.3	7.5	7.1	7.8
LABORATORY MEASUREMENTS						
Acidity, as $CaCO_3$	mg/l					
Alkalinity, as $CaCO_3$	mg/l	234.0	262.0	282.0	306.0	278.0
Ammonia, NH_3 as N	mg/l					
Arsenic, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, Dissolved	mg/l					
BOD, 5 Day	mg/l					
Barium, Total	mg/l	0.010	0.004	0.002	0.004	0.004
Barium, Dissolved	mg/l					
Bicarbonate	mg/l	285.4	319.6	334.0	373.3	339.2
Boron, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Boron, Dissolved	mg/l					
Cadmium, Total	mg/l					
Cadmium, Dissolved	mg/l					
Calcium	mg/l	65.0	76.8	52.0	40.0	77.6
Chloride	mg/l	8.0	8.0	4.0	6.0	4.0
Chromium, Total	mg/l					
Chromium, Dissolved	mg/l					
Copper, Total	mg/l	0.006	0.012	0.008	0.002	0.003
Copper, Dissolved	mg/l					
Cyanide	mg/l					
Fluoride	mg/l	0.35	0.25	0.20	0.20	0.18
Gross Alpha Radioactivity	pCi/l					
Gross Beta Radioactivity	pCi/l					
Iron, Total	mg/l	0.280	0.300	0.310	0.260	0.270
Iron, Dissolved	mg/l					
Lead, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, Dissolved	mg/l					
MPN Fecal Coliform	MPN/100 ml					
MPN Total Coliform	MPN/100 ml					
Magnesium	mg/l	24.0	18.60	42.0	64.8	24.9
Manganese, Total	mg/l	0.048	0.017	0.018	0.017	0.012
Mercury, Total	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l	0.10	0.06	0.05	0.06	0.005
Oil and Grease	mg/l	<1.0	<1.0	<1.0	<1.0	<1.0
Phenol	mg/l					
Phosphate, PO_4 as P	mg/l	0.140	0.165	0.095	0.085	0.110
Potassium	mg/l	2.14	2.27	2.21	3.23	2.09
Selenium, Total	mg/l	0.006	0.004	<0.001	<0.001	<0.001
Selenium, Dissolved	mg/l					
Silver, Total	mg/l					
Silver, Dissolved	mg/l					
Sodium	mg/l	10.0	18.0	11.0	4.70	10.0
Sulfate	mg/l	40.0	39.0	41.0	61.0	35.0
Suspended Solids	mg/l		8.0	7.0	6.0	4.0
Total Dissolved Solids	mg/l	430.0	480.0	498.0	510.0	489.0
Total Organic Carbon	mg/l	15.0	11.0	9.0	6.0	6.0
Turbidity	NTU	9.90	3.40	2.00	0.54	1.9
Zinc, Total	mg/l	0.006	0.011	0.002	0.005	0.018
Zinc, Dissolved	mg/l					

Table 3. Continued.

Parameter	Units	3-17-77	6-16-77	6-28-78	8-23-78	10-25-78	12-27-78
FIELD MEASURMENTS							
Discharge	cfs	3.5	2.3	16.0	1.5	3.2	5.7
Dissolved Oxygen	mg/l	9.75	7.1		8.6	10.0	11.1
pH	units	7.6	7.6	7.2	8.0	7.2	7.92
Specific Conductance	umhos/cm @ 25° C	690.0	425.0	335.0	395.0		500.0
Temperature, Air	°C	-1.0	21.0	24.0	26.0	3.0	-11.0
Temperature, Water	°C	2.0	13.0	16.0	12.0	3.0	0
LABORATORY MEASUREMENTS							
Acidity, as $CaCO_3$	mg/l						
Alkalinity, as $CaCO_3$	mg/l	244.0	240.0				
Ammonia, NH_3 as N	mg/l	0.13	0.13				
Arsenic, Total	mg/l	<0.001	<0.001	<0.001	<0.00o	<0.001	<0.001
Arsenic, Dissolved	mg/l						
BOD, 5 Day	mg/l						
Barium, Total	mg/l	0.005	0.018				
Barium, Dissolved	mg/l						
Bicarbonate	mg/l	297.7	292.8	207.4	270.8	297.6	329.4
Boron, Total	mg/l						
Boron, Dissolved	mg/l						
Cadmium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Dissolved	mg/l						
Calcium	mg/l	68.0	67.2	51.2	57.6	72.0	80.8
Chloride	mg/l	4.0	12.0	10.0	4.0	9.0	6.0
Chromium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium, Dissolved	mg/l						
Copper, Total	mg/l	0.002	0.007	0.005	0.006	0.009	0.001
Copper, Dissolved	mg/l						
Cyanide	mg/l		<0.01				
Fluoride	mg/l	0/16	0.20	0.14	0.14	0.16	0.17
Gross Alpha Radioactivity	pCi/l		0				
Gross Beta Radioactivity	pCi/l		0				
Iron, Total	mg/l	0.223	0.137	0.103	0.164	0.188	0.200
Iron, Dissolved	mg/l						
Lead, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, Dissolved	mg/l						
MPN Fecal Coliform	MPN/100 ml						
MPN Total Coliform	MPN/100 ml						
Magnesium	mg/l	26.40	25.92	11.50	26.90	25.90	26.40
Manganese, Total	mg/l	0.017	0.003	0.050	0.026	0.030	0.047
Mercury, Total	mg/l						
Nitrate, NO_3 as N	mg/l	0.03	0.01	0.20			
Oil and Grease	mg/l	<1.0	<1.0	<1.0	1.5	2.0	1.2
Phenol	mg/l		<0.001	0.008	0.002	0.004	0.003
Phosphate, PO_4 as P	mg/l	0.062	0.025				
Potassium	mg/l	2.18	2.28	1.289	1.82	1.80	2.176
Selenium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium, Dissolved	mg/l						
Silver, Total	mg/l	<0.001	<0.001	<0.001	<0.001		
Silver, Dissolved	mg/l						
Sodium	mg/l	8.63	4.78	14.0	3.96	3.90	4.46
Sulfate	mg/l	52.0	28.3	26.0	31.0	39.0	43.0
Suspended Solids	mg/l	8.0	3.0	2.2	6.0	5.0	22.0
Total Dissolved Solids	mg/l	450.0	280.0	216.0	260.0	298.0	328.0
Total Organic Carbon	mg/l	4.0	3.5	19.0			
Turbidity	NTU	1.50	3.50				
Zinc, Total	mg/l	0.017	0.011	0.005	0.012	0.009	0.006
Zinc, Dissolved	mg/l						

Table 3. Continued.

Parameter	Units	2-28-79	4-18-79	6-20-79	8-23-79	10-31-79
FIELD MEASUREMENTS						
Discharge	cfs	5.1	12.0	13.6	8.4	5.0
Dissolved Oxygen	mg/l	9.6	9.1	9.5	8.3	10.0
pH	units	7.7	7.73	7.9	8.1	7.3
Specific Conductance	umhos/cm @ 25° C	490.0	490.0	358.0	510.0	550.0
Temperature, Air	°C	-6.0	9.0	14.0	12.0	2.0
Temperature, Water	°C	0.2	6.5	4.7	6.0	1.0
LABORATORY MEASUREMENTS						
Acidity, as $CaCO_3$	mg/l			10.0	10.0	16.0
Alkalinity, as $CaCO_3$	mg/l	266.0	238.0	184.0	244.0	228.0
Ammonia, NH_3 as N	mg/l					
Arsenic, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, Dissolved	mg/l					
BOD, 5 Day	mg/l					
Barium, Total	mg/l					0.217
Barium, Dissolved	mg/l					
Bicarbonate	mg/l	324.57	292.8	224.48	297.88	278.16
Boron, Total	mg/l					0.060
Boron, Dissolved	mg/l					
Cadmium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Dissolved	mg/l					
Calcium	mg/l	72.0	80.8	57.6	96.0	65.60
Chloride	mg/l	<0.1	14.0	4.0	2.0	8.0
Chromium, Total	mg/l		<0.001	<0.001		<0.001
Chromium, Dissolved	mg/l					
Copper, Total	mg/l	0.006	0.002	0.003	0.011	0.012
Copper, Dissolved	mg/l					
Cyanide	mg/l					
Fluoride	mg/l	0.17	0.17	0.16	0.24	0.18
Gross Alpha Radioactivity	pCi/l					
Gross Beta Radioactivity	pCi/l					
Iron, Total	mg/l	0.519	2.236	1.150	1.210	0.860
Iron, Dissolved	mg/l					
Lead, Total	mg/l	<0.001	0.002	<0.001	<0.001	<0.001
Lead, Dissolved	mg/l					
MPN Fecal Coliform	MPN/100 ml					
MPN Total Coliform	MPN/100 ml					
Magnesium	mg/l	24.96	19.20	12.96	9.60	29.76
Manganese, Total	mg/l	0.079	0.118	0.053	0.066	0.052
Mercury, Total	mg/l	<0.0002	<0.0002	0.0002	0.0002	0.0002
Nitrate, NO_3 as N	mg/l	0.12	0.20	0.28	<0.01	<0.01
Oil and Grease	mg/l	<1.0	<1.0	5.2	<1.0	<1.0
Phenol	mg/l	<0.001	0.010	<0.001	0.008	<0.001
Phosphate, PO_4 as P	mg/l					
Potassium	mg/l	2.243	2.234	1.048	2.134	2.240
Selenium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium, Dissolved	mg/l					
Silver, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Silver, Dissolved	mg/l					
Sodium	mg/l	14.0	8.85	2.63	4.92	5.85
Sulfate	mg/l	40.0	41.0	14.8	44.1	60.0
Suspended Solids	mg/l	55.0	54.0	14.0	84.0	40.0
Total Dissolved Solids	mg/l	316.0	318.0	209.0	310.0	320.0
Total Organic Carbon	mg/l					
Turbidity	NTU					
Zinc, Total	mg/l	0.005	0.009	0.006	0.004	0.007
Zinc, Dissolved	mg/l					

Table 4. Results of chemical analyses of surface water quality samples collected at Station VC-4.

Parameter	Units	9-30-76	10-27-76	11-29-76	12-28-76	3-17-77	6-16-77
FIELD MEASURMENTS							
Discharge	cfs	0	0	0	0	0	0
Dissolved Oxygen	mg/l						
pH	units						
Specific Conductance	umhos/cm @ 25° C						
Temperature, Air	°C						
Temperature, Water	°C						
LABORATORY MEASUREMENTS							
Acidity, as $CaCO_3$	mg/l						
Alkalinity, as $CaCO_3$	mg/l						
Ammonia, NH_3 as N	mg/l						
Arsenic, Total	mg/l						
Arsenic, Dissolved	mg/l						
BOD, 5 Day	mg/l						
Barium, Total	mg/l						
Barium, Dissolved	mg/l						
Bicarbonate	mg/l						
Boron, Total	mg/l						
Boron, Dissolved	mg/l						
Cadmium, Total	mg/l						
Cadmium, Dissolved	mg/l						
Calcium	mg/l						
Chloride	mg/l						
Chromium, Total	mg/l						
Chromium, Dissolved	mg/l						
Copper, Total	mg/l						
Copper, Dissolved	mg/l						
Cyanide	mg/l						
Fluoride	mg/l						
Gross Alpha Radioactivity	pCi/l						
Gross Beta Radioactivity	pCi/l						
Iron, Total	mg/l						
Iron, Dissolved	mg/l						
Lead, Total	mg/l						
Lead, Dissolved	mg/l						
MPN Fecal Coliform	MPN/100 ml						
MPN Total Coliform	MPN/100 ml						
Magnesium	mg/l						
Manganese, Total	mg/l						
Mercury, Total	mg/l						
Nitrate, NO_3 as N	mg/l						
Oil and Grease	mg/l						
Phenol	mg/l						
Phosphate, PO_4 as P	mg/l						
Potassium	mg/l						
Selenium, Total	mg/l						
Selenium, Dissolved	mg/l						
Silver, Total	mg/l						
Silver, Dissolved	mg/l						
Sodium	mg/l						
Sulfate	mg/l						
Suspended Solids	mg/l						
Total Dissolved Solids	mg/l						
Total Organic Carbon	mg/l						
Turbidity	NTU						
Zinc, Total	mg/l						
Zinc, Dissolved	mg/l						

Table 4. Continued.

Parameter	Units	5-10-78	6-14-78	7-12-78	8-23-78	10-25-78	12-27-78
FIELD MEASUREMENTS							
Discharge	cfs	0	1.0	0.07	0	0	0
Dissolved Oxygen	mg/l		9.4	7.3			
pH	units		7.0	7.7			
Specific Conductance	umhos/cm @ 25° C		120.0	130.0			
Temperature, Air	°C		20.0	21.0			
Temperature, Water	°C		4.0	14.0			
LABORATORY MEASUREMENTS							
Acidity, as $CaCO_3$	mg/l						
Alkalinity, as $CaCO_3$	mg/l						
Ammonia, NH_3 as N	mg/l		0.10				
Arsenic, Total	mg/l		<0.001	<0.001			
Arsenic, Dissolved	mg/l						
BOD, 5 Day	mg/l						
Barium, Total	mg/l						
Barium, Dissolved	mg/l						
Bicarbonate	mg/l		73.2	92.72			
Boron, Total	mg/l						
Boron, Dissolved	mg/l						
Cadmium, Total	mg/l		<0.001				
Cadmium, Dissolved	mg/l						
Calcium	mg/l		23.2	11.2			
Chloride	mg/l		8.0	<1.0			
Chromium, Total	mg/l		<0.001				
Chromium, Dissolved	mg/l						
Copper, Total	mg/l		0.007				
Copper, Dissolved	mg/l						
Cyanide	mg/l						
Fluoride	mg/l		0.08				
Gross Alpha Radioactivity	pCi/l						
Gross Beta Radioactivity	pCi/l						
Iron, Total	mg/l		0.128	0.215			
Iron, Dissolved	mg/l						
Lead, Total	mg/l		<0.001	<0.001			
Lead, Dissolved	mg/l						
MPN Fecal Coliform	MPN/100 ml						
MPN Total Coliform	MPN/100 ml						
Magnesium	mg/l		1.92	1.92			
Manganese, Total	mg/l		0.013	0.011			
Mercury, Total	mg/l		<0.0002	<0.0002			
Nitrate, NO_3 as N	mg/l						
Oil and Grease	mg/l		0.10				
Phenol	mg/l		<0.001				
Phosphate, PO_4 as P	mg/l						
Potassium	mg/l		0.439	0.618			
Selenium, Total	mg/l		<0.001	<0.001			
Selenium, Dissolved	mg/l						
Silver, Total	mg/l		<0.001	<0.001			
Silver, Dissolved	mg/l						
Sodium	mg/l		5.5	28.0			
Sulfate	mg/l		8.0	24.0			
Suspended Solids	mg/l		85.0	10.0			
Total Dissolved Solids	mg/l		84.0	110.0			
Total Organic Carbon	mg/l		10.0				
Turbidity	NTU						
Zinc, Total	mg/l		0.006	0.018			
Zinc, Dissolved	mg/l						

Table 4. Continued.

Parameter	Units	2-28-79	4-18-79	6-20-79	8-23-79	10-31-79
FIELD MEASUREMENTS						
Discharge	cfs	0	0	0.1	0.01	0
Dissolved Oxygen	mg/l			8.1	7.4	
pH	units			8.0	8.3	
Specific Conductance	umhos/cm @ 25° C			112.0	360.0	
Temperature, Air	°C			16	17	
Temperature, Water	°C			7	7.5	
LABORATORY MEASUREMENTS						
Acidity, as $CaCO_3$	mg/l			6.0	10.0	
Alkalinity, as $CaCO_3$	mg/l			60.0	202.0	
Ammonia, NH_3 as N	mg/l					
Arsenic, Total	mg/l			<0.001	<0.001	
Arsenic, Dissolved	mg/l					
BOD, 5 Day	mg/l					
Barium, Total	mg/l					
Barium, Dissolved	mg/l					
Bicarbonate	mg/l			73.20	246.44	
Boron, Total	mg/l					
Boron, Dissolved	mg/l					
Cadmium, Total	mg/l			<0.001	<0.001	
Cadmium, Dissolved	mg/l					
Calcium	mg/l			21.60	72.0	
Chloride	mg/l			<1.0	<0.1	
Chromium, Total	mg/l				<0.001	
Chromium, Dissolved	mg/l					
Copper, Total	mg/l			0.007	0.011	
Copper, Dissolved	mg/l					
Cyanide	mg/l					
Fluoride	mg/l			0.10	0.20	
Gross Alpha Radioactivity	pCi/l					
Gross Beta Radioactivity	pCi/l					
Iron, Total	mg/l			0.880	1.150	
Iron, Dissolved	mg/l					
Lead, Total	mg/l			<0.001	<0.001	
Lead, Dissolved	mg/l					
MPN Fecal Coliform	MPN/100 ml					
MPN Total Coliform	MPN/100 ml					
Magnesium	mg/l			8.16	4.80	
Manganese, Total	mg/l			<0.001	0.168	
Mercury, Total	mg/l					
Nitrate, NO_3 as N	mg/l			0.12	<0.01	
Oil and Grease	mg/l			1.4	<1.0	
Phenol	mg/l			<0.001	0.004	
Phosphate, PO_4 as P	mg/l					
Potassium	mg/l			0.575	0.733	
Selenium, Total	mg/l			<0.001	<0.001	
Selenium, Dissolved	mg/l					
Silver, Total	mg/l			<0.001	<0.001	
Silver, Dissolved	mg/l					
Sodium	mg/l			0.65	3.50	
Sulfate	mg/l			28.6	10.0	
Suspended Solids	mg/l			64.0	35.0	
Total Dissolved Solids	mg/l					
Total Organic Carbon	mg/l					
Turbidity	NTU					
Zinc, Total	mg/l			0.004	0.035	
Zinc, Dissolved	mg/l					

Table 5. Results of chemical analyses of surface water quality samples collected at Station VC-5.

Parameter	Units	6-14-76	8-2-76	9-30-76	10-27-76	11-29-76	12-28-76
FIELD MEASUREMENTS							
Discharge	cfs	0.7	0.1	0	0	0	0
Dissolved Oxygen	mg/l	6.8	8.6				
pH	units	8.4	8.4				
Specific Conductance	umhos/cm @ 25° C	490.0	490.0				
Temperature, Air	°C	8.0	24.0				
Temperature, Water	°C	5.0	10.0				
LABORATORY MEASUREMENTS							
Acidity, as $CaCO_3$	mg/l						
Alkalinity, as $CaCO_3$	mg/l	162.0	190.0				
Ammonia, NH_3 as N	mg/l						
Arsenic, Total	mg/l						
Arsenic, Dissolved	mg/l		<0.001				
BOD, 5 Day	mg/l						
Barium, Total	mg/l						
Barium, Dissolved	mg/l		0.210				
Bicarbonate	mg/l	197.6	231.8				
Boron, Total	mg/l		0.015				
Boron, Dissolved	mg/l						
Cadmium, Total	mg/l		<0.001				
Cadmium, Dissolved	mg/l						
Calcium	mg/l	48.8	54.0				
Chloride	mg/l	2.0	6.0				
Chromium, Total	mg/l		<0.001				
Chromium, Dissolved	mg/l						
Copper, Total	mg/l		0.130				
Copper, Dissolved	mg/l						
Cyanide	mg/l		<0.01				
Fluoride	mg/l	0.14	0.37				
Gross Alpha Radioactivity	pCi/l						
Gross Beta Radioactivity	pCi/l			<3			
Iron, Total	mg/l		0.250				
Iron, Dissolved	mg/l						
Lead, Total	mg/l		<0.001				
Lead, Dissolved	mg/l						
MPN Fecal Coliform	MPN/100 ml						
MPN Total Coliform	MPN/100 ml						
Magnesium	mg/l	13.44	17.0				
Manganese, Total	mg/l		0.042				
Mercury, Total	mg/l		0.0002				
Nitrate, NO_3 as N	mg/l		0.10				
Oil and Grease	mg/l		<1.0				
Phenol	mg/l			<0.001			
Phosphate, PO_4 as P	mg/l		0.120				
Potassium	mg/l	1.01	1.10				
Selenium, Total	mg/l		<0.001				
Selenium, Dissolved	mg/l						
Silver, Total	mg/l		<0.001				
Silver, Dissolved	mg/l						
Sodium	mg/l	16.0	2.20				
Sulfate	mg/l	46.0	11.0				
Suspended Solids	mg/l		18.0				
Total Dissolved Solids	mg/l	320.0	320.0				
Total Organic Carbon	mg/l	19.0	8.0				
Turbidity	NTU	20.00	2.50				
[illegible]al	mg/l		0.039				
[illegible]olved	mg/l						

Table 5. Continued.

Parameter	Units	3-17-77	6-16-77	5-10-78	6-14-78	7-12-78	8-23-78
FIELD MEASURMENTS							
Discharge	cfs	0	0	1.4	1.6	0.3	0.01
Dissolved Oxygen	mg/l			9.9	9.0	8.1	8.2
pH	units			7.5	7.1	8.3	8.4
Specific Conductance	umhos/cm @ 25° C			310.0	250.0	355.0	320.0
Temperature, Air	°C			170	250	27.0	22.0
Temperature, Water	°C			2.5	10.0	20.5	8.0
LABORATORY MEASUREMENTS							
Acidity, as $CaCO_3$	mg/l						
Alkalinity, as $CaCO_3$	mg/l						
Ammonia, NH_3 as N	mg/l					0.12	
Arsenic, Total	mg/l			<0.001	<0.001	<0.001	<0.001
Arsenic, Dissolved	mg/l						
BOD, 5 Day	mg/l						
Barium, Total	mg/l						
Barium, Dissolved	mg/l						
Bicarbonate	mg/l			50.0	134.2	202.52	219.6
Boron, Total	mg/l						
Boron, Dissolved	mg/l						
Cadmium, Total	mg/l			<0.001	<0.001		
Cadmium, Dissolved	mg/l						
Calcium	mg/l			47.3	38.4	32.5	49.6
Chloride	mg/l			10.0	8.0	2.0	<1.0
Chromium, Total	mg/l				<0.001	<0.001	
Chromium, Dissolved	mg/l						
Copper, Total	mg/l			0.002	0.009		0.006
Copper, Dissolved	mg/l						
Cyanide	mg/l						
Fluoride	mg/l			0.19	0.14		0.12
Gross Alpha Radioactivity	pCi/l						
Gross Beta Radioactivity	pCi/l						
Iron, Total	mg/l			0.039	1.442	0.098	0.011
Iron, Dissolved	mg/l						
Lead, Total	mg/l			<0.001	<0.001	<0.001	<0.001
Lead, Dissolved	mg/l						
MPN Fecal Coliform	MPN/100 ml						
MPN Total Coliform	MPN/100 ml						
Magnesium	mg/l			8.64	5.76	0.80	19.2
Manganese, Total	mg/l			0.015	0.013	0.070	0.011
Mercury, Total	mg/l			<0.0002	<0.0002	<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l				1.12	0.46	
Oil and Grease	mg/l			15.2	<1.0	16.0	12.0
Phenol	mg/l					0.005	0.250
Phosphate, PO_4 as P	mg/l						
Potassium	mg/l			1.364	1.032	1.436	1.481
Selenium, Total	mg/l			<0.001	<0.001	<0.001	<0.001
Selenium, Dissolved	mg/l						
Silver, Total	mg/l			<0.001	<0.001	<0.001	<0.001
Silver, Dissolved	mg/l						
Sodium	mg/l			3.79	7.5	62.0	2.97
Sulfate	mg/l			102.0	10.0	78.0	26.0
Suspended Solids	mg/l			2640.0	869.0	75.0	8.0
Total Dissolved Solids	mg/l			200.0	138.0	283.0	210.0
Total Organic Carbon	mg/l			9.0	23.0		20.1
Turbidity	NTU						
Zinc, Total	mg/l			0.008	0.008	0.014	0.017
Zinc, Dissolved	mg/l						

Table 5. Continued.

Parameter	Units	10-25-78	12-27-78	2-28-79	4-18-79	6-20-79
FIELD MEASURMENTS						
Discharge	cfs	0	0	0	0.3	0.6
Dissolved Oxygen	mg/l	20.1			6.0	
pH	units					
Specific Conductance	umhos/cm @ 25° C					
Temperature, Air	°C					
Temperature, Water	°C					
LABORATORY MEASUREMENTS						
Acidity, as $CaCO_3$	mg/l					<1.0
Alkalinity, as $CaCO_3$	mg/l				190.0	174.0
Ammonia, NH_3 as N	mg/l					
Arsenic, Total	mg/l	<0.001			0.004	<0.001
Arsenic, Dissolved	mg/l				-	
BOD, 5 Day	mg/l					
Barium, Total	mg/l					
Barium, Dissolved	mg/l					
Bicarbonate	mg/l				770.0	360.0
Boron, Total	mg/l					
Boron, Dissolved	mg/l					
Cadmium, Total	mg/l					<0.001
Cadmium, Dissolved	mg/l					
Calcium	mg/l				77.6	56.0
Chloride	mg/l				12.0	0.16
Chromium, Total	mg/l					<0.001
Chromium, Dissolved	mg/l					
Copper, Total	mg/l				0.007	<0.001
Copper, Dissolved	mg/l					
Cyanide	mg/l					
Fluoride	mg/l				0.20	0.16
Gross Alpha Radioactivity	pCi/l					
Gross Beta Radioactivity	pCi/l					
Iron, Total	mg/l				88.5	0.750
Iron, Dissolved	mg/l					
Lead, Total	mg/l				0.006	<0.001
Lead, Dissolved	mg/l					
MPN Fecal Coliform	MPN/100 ml					
MPN Total Coliform	MPN/100 ml					
Magnesium	mg/l				11.04	12.48
Manganese, Total	mg/l				1.532	0.063
Mercury, Total	mg/l				<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l				1.09	0.20
Oil and Grease	mg/l				1.8	2.2
Phenol	mg/l				0.008	<0.001
Phosphate, PO_4 as P	mg/l					
Potassium	mg/l				2.532	1.321
Selenium, Total	mg/l				<0.001	<0.001
Selenium, Dissolved	mg/l					
Silver, Total	mg/l				<0.001	<0.001
Silver, Dissolved	mg/l					
Sodium	mg/l				5.58	2.85
Sulfate	mg/l				191.0	32.5
Suspended Solids	mg/l				390.0	18.0
Total Dissolved Solids	mg/l				510.0	210.0
Total Organic Carbon	mg/l				6.0	
Turbidity	NTU					
Zinc, Total	mg/l				0.108	0.015
Zinc, Dissolved	mg/l					

Table 5. Continued.

Parameter	Units	8-23-79	10-31-79
FIELD MEASURMENTS			
Discharge	cfs	0.09	0
Dissolved Oxygen	mg/l	8.8	
pH	units	8.1	
Specific Conductance	umhos/cm @ 25° C	450.0	
Temperature, Air	°C	16.0	
Temperature, Water	°C	5.5	
LABORATORY MEASUREMENTS			
Acidity, as $CaCO_3$	mg/l	10.0	
Alkalinity, as $CaCO_3$	mg/l	198.0	
Ammonia, NH_3 as N	mg/l		
Arsenic, Total	mg/l	<0.001	<0.001
Arsenic, Dissolved	mg/l		
BOD, 5 Day	mg/l		
Barium, Total	mg/l		
Barium, Dissolved	mg/l		
Bicarbonate	mg/l	241.56	
Boron, Total	mg/l		
Boron, Dissolved	mg/l		
Cadmium, Total	mg/l	<0.001	<0.001
Cadmium, Dissolved	mg/l		
Calcium	mg/l	56.0	85.6
Chloride	mg/l	4.0	4.0
Chromium, Total	mg/l	<0.001	
Chromium, Dissolved	mg/l		
Copper, Total	mg/l	<0.001	0.013
Copper, Dissolved	mg/l		
Cyanide	mg/l		
Fluoride	mg/l	0.16	0.22
Gross Alpha Radioactivity	pCi/l		
Gross Beta Radioactivity	pCi/l		
Iron, Total	mg/l	0.750	0.110
Iron, Dissolved	mg/l		
Lead, Total	mg/l	<0.001	<0.001
Lead, Dissolved	mg/l		
MPN Fecal Coliform	MPN/100 ml		
MPN Total Coliform	MPN/100 ml		
Magnesium	mg/l	12.48	6.24
Manganese, Total	mg/l	0.063	0.060
Mercury, Total	mg/l	<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l	<0.01	
Oil and Grease	mg/l	<1.0	
Phenol	mg/l	0.086	
Phosphate, PO_4 as P	mg/l		
Potassium	mg/l	1.321	1.800
Selenium, Total	mg/l	<0.001	<0.001
Selenium, Dissolved	mg/l		
Silver, Total	mg/l	<0.001	<0.001
Silver, Dissolved	mg/l		
Sodium	mg/l	2.85	4.73
Sulfate	mg/l	44.9	
Suspended Solids	mg/l	1.0	
Total Dissolved Solids	mg/l	275.0	
Total Organic Carbon	mg/l		
Turbidity	NTU		
Zinc, Total	mg/l	0.015	<0.001
Zinc, Dissolved	mg/l		

Table 6. Results of chemical analyses of surface water quality samples collected at station VC-6.

Parameter	Units	6-14-76	8-2-76	9-30-76	10-27-76	11-29-76	12-28-76
FIELD MEASUREMENTS							
Discharge	cfs	3.7	1.7	1	1.7	1	0.6
Dissolved Oxygen	mg/l	6.9	8.4	9.6	10.0	9.5	8.8
pH	units	8.3	8.1	7.6	7.7	7.4	7.6
Specific Conductance	umhos/cm @ 25° C	530	660	830	720	720	700
Temperature, Air	°C	8	24	18	4	-5	-4
Temperature, Water	°C	7	12	9	2	1	2.5
LABORATORY MEASUREMENTS							
Acidity, as $CaCO_3$	mg/l						
Alkalinity, as $CaCO_3$	mg/l	188	248	306	278	278	266
Ammonia, NH_3 as N	mg/l						
Arsenic, Total	mg/l		<0.001	<0.001		<0.001	<0.001
Arsenic, Dissolved	mg/l						
BOD, 5 Day	mg/l						
Barium, Total	mg/l		0.017	0.040		0.012	0.013
Barium, Dissolved	mg/l						
Bicarbonate	mg/l	229.3	302.5	373.3	339.2	399.2	324.5
Boron, Total	mg/l		<0.001	<0.001		<0.001	<0.001
Boron, Dissolved	mg/l						
Cadmium, Total	mg/l		<0.001	<0.001		<0.001	<0.001
Cadmium, Dissolved	mg/l						
Calcium	mg/l	56.8	70.0	77.4	84.0	44.8	70.4
Chloride	mg/l	2.5	8.0	12.0	4.0	6.0	2.0
Chromium, Total	mg/l		<0.001	<0.001		<0.001	<0.001
Chromium, Dissolved	mg/l						
Copper, Total	mg/l		0.079	0.006		0.002	0.009
Copper, Dissolved	mg/l						
Cyanide	mg/l						
Fluoride	mg/l	0.27	0.34	0.25	0.19	0.18	0.15
Gross Alpha Radioactivity	pCi/l						
Gross Beta Radioactivity	pCi/l						
Iron, Total	mg/l		0.364	0.055		0.338	0.380
Iron, Dissolved	mg/l						
Lead, Total	mg/l		<0.001	<0.001		<0.001	<0.001
Lead, Dissolved	mg/l						
MPN Fecal Coliform	MPN/100 ml						
MPN Total Coliform	MPN/100 ml						
Magnesium	mg/l	18.72	21.0	16.0	15.8	47.0	26.4
Manganese, Total	mg/l		0.190	<0.001		0.011	0.012
Mercury, Total	mg/l		<0.0002	<0.0002		<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l		0.09	0.05		0.12	0.17
Oil and Grease	mg/l			<1.0		<1.0	<1.0
Phenol	mg/l						
Phosphate, PO_4 as P	mg/l		0.220	0.175		0.080	0.078
Potassium	mg/l	1.28	2.34	2.11	1.94	2.75	2.23
Selenium, Total	mg/l		0.005	<0.001		<0.001	<0.001
Selenium, Dissolved	mg/l						
Silver, Total	mg/l		<0.001	<0.001		<0.001	<0.001
Silver, Dissolved	mg/l						
Sodium	mg/l	4.18	4.00	37.0	12.0	3.80	6.0
Sulfate	mg/l	38.0	25.3	25.0	21.4	32.6	33.5
Suspended Solids	mg/l			2.0	10.0	9.0	5.0
Total Dissolved Solids	mg/l	350	430	540	470	470	460
Total Organic Carbon	mg/l			2.5	4.0	1.5	10.0
Turbidity	NTU	3.50	13.0	2.00	2.10	0.39	1.9
Zinc, Total	mg/l		0.032	0.028		0.022	0.059
Zinc, Dissolved	mg/l						

Table 6. Continued.

Parameter	Units	3-17-77	6-16-77	5-10-78	6-14-78	7-12-78	8-23-78	10-25-78
FIELD MEASUREMENTS								
Discharge	cfs	0.6	0.3	4.5	8.5	2.1	0.4	0.3
Dissolved Oxygen	mg/l	9.0	7.0	9.0	9.3	8.0	8.6	11.1
pH	units	7.8	7.7	8.0	7.4	8.3	8.1	7.1
Specific Conductance	umhos/cm @ 25° C	630	350	385	260	386	335	440
Temperature, Air	°C	0	18	15	22	21	20	3
Temperature, Water	°C	1	14	4	9	14.5	12.5	0.5
LABORATORY MEASUREMENTS								
Acidity, as $CaCO_3$	mg/l							
Alkalinity, as $CaCO_3$	mg/l	244	206					
Ammonia, NH_3 as N	mg/l	0.21	0.18		0.10			
Arsenic, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, Dissolved	mg/l							
BOD, 5 Day	mg/l							
Barium, Total	mg/l	0.020	0.045					
Barium, Dissolved	mg/l							
Bicarbonate	mg/l	297.7	251.3	238	156.1	222.04	236.7	263.5
Boron, Total	mg/l	0.003	0.014					
Boron, Dissolved	mg/l							
Cadmium, Total	mg/l	<0.001	<0.001	<0.001	<0.001			<0.001
Cadmium, Dissolved	mg/l							
Calcium	mg/l	73.6	64.0	63.2	45.6	28.0	60.0	65.6
Chloride	mg/l	4.0	6.0	8.0	10.0	2.0	2.0	1.5
Chromium, Total	mg/l	<0.001	<0.001	<0.001	<0.001			<0.001
Chromium, Dissolved	mg/l							
Copper, Total	mg/l	0.010	0.009	0.006	<0.001		0.006	0.005
Copper, Dissolved	mg/l							
Cyanide	mg/l		<0.01					
Fluoride	mg/l	0.16	0.24	0.14	0.13		0.14	0.15
Gross Alpha Radioactivity	pCi/l		0					
Gross Beta Radioactivity	pCi/l		0					
Iron, Total	mg/l	0.609	0.625	0.029	0.161	0.062	<0.001	0.056
Iron, Dissolved	mg/l							
Lead, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead, Dissolved	mg/l							
MPN Fecal Coliform	MPN/100 ml							
MPN Total Coliform	MPN/100 ml							
Magnesium	mg/l	18.72	14.40	13.92	6.24	5.28	14.4	20.10
Manganese, Total	mg/l	0.018	<0.001	0.016	0.032	0.010	0.002	0.005
Mercury, Total	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l	0.15	0.05	1.05	0.49			
Oil and Grease	mg/l	<1.0	<1.0	10.4		5.8	1.0	1.5
Phenol	mg/l		<0.001		0.004		0.010	0.003
Phosphate, PO_4 as P	mg/l	0.055	0.310					
Potassium	mg/l	1.34	1.31	1.176	0.688	1.005	1.178	1.220
Selenium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium, Dissolved	mg/l							
Silver, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Silver, Dissolved	mg/l							
Sodium	mg/l	6.15	2.19	3.88	7.0	54.0	3.00	3.21
Sulfate	mg/l	28.0	10.8	14.0	14.0	27.0	20.0	19.0
Suspended Solids	mg/l	10.0	3.0	88.0	42.0	8.0	6.0	4.0
Total Dissolved Solids	mg/l	412	230	248	160	228	220	255
Total Organic Carbon	mg/l	6.0	5.0	6.0	28.0		26.0	
Turbidity	NTU	3.50	2.00					
Zinc, Total	mg/l	0.060	0.012	0.009	01004	0.010	0.007	0.008
Zinc, Dissolved	mg/l							

Table 6. Continued.

Parameter	Units	11-8-78	12-27-78	5-11-79	6-20-79	7-20-79	8-23-79
FIELD MEASUREMENTS							
Discharge	cfs	0.5	0.1	1.5	2.4	1.1	0.7
Dissolved Oxygen	mg/l	11.8	11.0	9.3	8.8	7.4	8.8
pH	units	7.4	7.22	8.4	8.4	7.52	8.3
Specific Conductance	umhos/cm @ 25° C	462		390	370	410	410
Temperature, Air	°C	2.0	-2	0	16	24	20
Temperature, Water	°C	0.3	2	0.3	9	12	9.0
LABORATORY MEASUREMENTS							
Acidity, as $CaCO_3$	mg/l			12.0	2.0	10.0	12.0
Alkalinity, as $CaCO_3$	mg/l			202	174	194	204
Ammonia, NH_3 as N	mg/l			<0.10	<0.01	<0.01	0.10
Arsenic, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, Dissolved	mg/l			<0.001	<0.001	<0.001	<0.001
BOD, 5 Day	mg/l						
Barium, Total	mg/l	<0.001	0.002	0.050	0.060	0.025	0.031
Barium, Dissolved	mg/l			0.02	0.030	0.020	0.020
Bicarbonate	mg/l	283.04	302.56	246.4	212.28	236.68	248.83
Boron, Total	mg/l			0.095	0.050	0.095	0.070
Boron, Dissolved	mg/l			0.090	0.020	0.080	<0.001
Cadmium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Dissolved	mg/l			<0.001	<0.001	<0.001	<0.001
Calcium	mg/l	72.8	73.6	65.60	62.40	61.60	78.40
Chloride	mg/l	2.0	10.0	6.0	<1.0	4.0	6.0
Chromium, Total	mg/l	<0.001	<0.001	0.005	0.003	0.003	0.006
Chromium, Dissolved	mg/l			<0.001	<0.001	<0.001	<0.001
Copper, Total	mg/l	0.004	0.127	0.005	0.070	0.008	0.010
Copper, Dissolved	mg/l			0.003	0.001	0.005	0.003
Cyanide	mg/l	<0.01		0.002	<0.001	<0.001	<0.001
Fluoride	mg/l	0.13	0.16	0.11	0.19	0.06	0.21
Gross Alpha Radioactivity	pCi/l				3.1		<2.0
Gross Beta Radioactivity	pCi/l				12.5		3.5
Iron, Total	mg/l	0.091	0.100	0.627	0.300	0.140	0.160
Iron, Dissolved	mg/l			0.024	0.020	0.010	0.015
Lead, Total	mg/l		<0.001	0.001	0.002	0.003	<0.001
Lead, Dissolved	mg/l			<0.001	<0.001	<0.001	<0.001
MPN Fecal Coliform	MPN/100 ml				<2.0		63.0
MPN Total Coliform	MPN/100 ml				70.0		790
Magnesium	mg/l	17.28	19.64	13.44	9.60	15.84	4.80
Manganese, Total	mg/l	0.014	0.012	0.007	0.007	0.007	0.004
Mercury, Total	mg/l		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l	0.59	0.74	2.40	0.66	0.05	0.89
Oil and Grease	mg/l		1.6	<1.0	3.0	<1.0	<1.0
Phenol	mg/l		<0.001	0.042	<0.001	0.014	0.008
Phosphate, PO_4 as P	mg/l			0.06	0.018	0.020	0.080
Potassium	mg/l	1.387	1.272	1.151	0.833	1.004	1.110
Selenium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium, Dissolved	mg/l			<0.001	<0.001	<0.001	<0.001
Silver, Total	mg/l	<0.001	<0.001	0.004	0.004	0.002	<0.001
Silver, Dissolved	mg/l			<0.001	<0.001	<0.001	<0.001
Sodium	mg/l	3.33	7.50	2.74	2.41	3.02	3.50
Sulfate	mg/l	23.0	22.0	9.0	24.0	23.0	13.0
Suspended Solids	mg/l	11.0	16.0	22.0	9.0	4.0	20.0
Total Dissolved Solids	mg/l	260	286	260	210	229	231
Total Organic Carbon	mg/l	8.0	19.0	10.0	3.0	8.50	2.80
Turbidity	NTU			4.0	5.0	3.50	3.0
Zinc, Total	mg/l	0.003	0.004	0.015	0.012	0.016	0.008
Zinc, Dissolved	mg/l			0.007	0.008	0.009	0.005

Table 6.- Continued.

Parameter	Units	9-26-79	10-31-79	11-30-79
FIELD MEASUREMENTS				
Discharge	cfs	0.4	0.3	0.6
Dissolved Oxygen	mg/l	7.2		9.2
pH	units	7.50	7.80	7.3
Specific Conductance	umhos/cm @ 25° C	405.0	505.0	475
Temperature, Air	°C	16.0	-1.0	-5
Temperature, Water	°C	7.5	0.25	0.3
LABORATORY MEASUREMENTS				
Acidity, as $CaCO_3$	mg/l	10.0	18.0	
Alkalinity, as $CaCO_3$	mg/l	196.0	216.0	
Ammonia, NH_3 as N	mg/l	<0.01		<0.01
Arsenic, Total	mg/l	<0.001	<0.001	
Arsenic, Dissolved	mg/l			
BOD, 5 Day	mg/l			
Barium, Total	mg/l	0.036	0.195	
Barium, Dissolved	mg/l			
Bicarbonate	mg/l	239.12	263.52	297.68
Boron, Total	mg/l	0.070	0.060	
Boron, Dissolved	mg/l			
Cadmium, Total	mg/l	<0.001	<0.001	
Cadmium, Dissolved	mg/l			
Calcium	mg/l	60.50	68.80	80.00
Chloride	mg/l	3.0	6.0	4.0
Chromium, Total	mg/l	<0.001	<0.001	
Chromium, Dissolved	mg/l			
Copper, Total	mg/l	0.025	0.010	
Copper, Dissolved	mg/l			
Cyanide	mg/l	<0.001		
Fluoride	mg/l	0.14	0.15	
Gross Alpha Radioactivity	pCi/l			
Gross Beta Radioactivity	pCi/l			
Iron, Total	mg/l	0.020		0.180
Iron, Dissolved	mg/l			
Lead, Total	mg/l	<0.001	<0.001	
Lead, Dissolved	mg/l			
MPN Fecal Coliform	MPN/100 ml			
MPN Total Coliform	MPN/100 ml			
Magnesium	mg/l	12.40	18.72	14.88
Manganese, Total	mg/l	0.020	0.089	0.012
Mercury, Total	mg/l	<0.0002	<0.0002	
Nitrate, NO_3 as N	mg/l	0.20	0.39	
Oil and Grease	mg/l		2.3	
Phenol	mg/l	<0.001	<0.001	0.062
Phosphate, PO_4 as P	mg/l	<0.001		0.080
Potassium	mg/l	0.42	3.00	1.291
Selenium, Total	mg/l	<0.001	<0.001	
Selenium, Dissolved	mg/l			
Silver, Total	mg/l	<0.001	<0.001	
Silver, Dissolved	mg/l			
Sodium	mg/l	5.00	8.10	3.32
Sulfate	mg/l	15.0	40.0	22.0
Suspended Solids	mg/l	1.0	24.0	24.0
Total Dissolved Solids	mg/l	212.0	288.0	277
Total Organic Carbon	mg/l	3.0	10.0	
Turbidity	NTU		3.10	
Zinc, Total	mg/l	0.05	0.005	
Zinc, Dissolved	mg/l			

Table 7. Results of chemical analyses of surface water quality samples collected at station VC-7.

Parameter	Units	1-26-76	4-28-76	8-2-76	10-27-76	11-29-76
FIELD MEASUREMENTS						
Discharge	cfs	1.2	2.0	0.3	0.5	1.5
Dissolved Oxygen	mg/l	9.8	9.0	8.2	9.5	9.8
pH	units	8.5	8.2	8.2		7.6
Specific Conductance	umhos/cm @ 25° C	630.0	640.0	660.0		800.0
Temperature, Air	°C	-2.0	12.0	0.3	0.5	1.5
Temperature, Water	°C	2.0	10.0	11.0	4.0	1.0
LABORATORY MEASUREMENTS						
Acidity, as $CaCO_3$	mg/l					
Alkalinity, as $CaCO_3$	mg/l	194.0	230.0	242.0		304.0
Ammonia, NH_3 as N	mg/l					
Arsenic, Total	mg/l	<0.001		<0.001		
Arsenic, Dissolved	mg/l					
BOD, 5 Day	mg/l					
Barium, Total	mg/l	0.028		0.220		
Barium, Dissolved	mg/l					
Bicarbonate	mg/l	236.6	280.6	295.2		370.9
Boron, Total	mg/l	0.005		<0.001		
Boron, Dissolved	mg/l					
Cadmium, Total	mg/l	<0.001		<0.001		
Cadmium, Dissolved	mg/l					
Calcium	mg/l	52.0	2-.8	72.0		18.4
Chloride	mg/l					
Chromium, Total	mg/l	<0.001		<0.001		
Chromium, Dissolved	mg/l					
Copper, Total	mg/l	<0.001	0.006			
Copper, Dissolved	mg/l					
Cyanide	mg/l					
Fluoride	mg/l	0.23	0.21	0.39		0.27
Gross Alpha Radioactivity	pCi/l					
Gross Beta Radioactivity	pCi/l					
Iron, Total	mg/l	0.078		0.194		
Iron, Dissolved	mg/l					
Lead, Total	mg/l					
Lead, Dissolved	mg/l	0.015		<0.001		
MPN Fecal Coliform	MPN/100 ml					
MPN Total Coliform	MPN/100 ml					
Magnesium	mg/l	36.90	43.6	23.0		42.70
Manganese, Total	mg/l	0.016		0.033		
Mercury, Total	mg/l	<0.0002		<0.0002		
Nitrate, NO_3 as N	mg/l	0.075		0.05		
Oil and Grease	mg/l					
Phenol	mg/l					
Phosphate, PO_4 as P	mg/l	0.11		0.150		
Potassium	mg/l	2.24	1.67	1.70		2.38
Selenium, Total	mg/l		0.004		0.015	
Selenium, Dissolved	mg/l					
Silver, Total	mg/l	<0.001		<0.001		
Silver, Dissolved	mg/l					
Sodium	mg/l	2.70	22.0	6.00		52.0
Sulfate	mg/l	69.0	50.0	32.6		35.0
Suspended Solids	mg/l					
Total Dissolved Solids	mg/l	410.0	418.0	430.0		520.0
Total Organic Carbon	mg/l	5.0	19.0	6.0		5.0
Turbidity	NTU	0.19	20.0	2.0		0.48
Zinc, Total	mg/l	0.067		0.008		
Zinc, Dissolved	mg/l					

Table 8. – Results of chemical analyses of surface water quality samples collected at station VC-8.

Parameter	Units	1-26-76	4-28-76	6-14-76	8-2-76	9-30-76
FIELD MEASURMENTS						
Discharge	cfs	1.7	3.0	6.4	2.1	1.0
Dissolved Oxygen	mg/l	9.6		8.0	8.8	11.8
pH	units	8.5	8.2	8.2	8.2	
Specific Conductance	umhos/cm @ 25° C	730.0	660.0		770.0	
Temperature, Air	°C	-2.0	12.0	5.0	18.0	19.0
Temperature, Water	°C	2.5	8.0	5.0	11.0	12.0
LABORATORY MEASUREMENTS						
Acidity, as $CaCO_3$	mg/l					
Alkalinity, as $CaCO_3$	mg/l	218.0	226.0		268.0	
Ammonia, NH_3 as N	mg/l					
Arsenic, Total	mg/l	0.006			0.004	
Arsenic, Dissolved	mg/l					
BOD, 5 Day	mg/l		4.8	4.8	3.0	4.5
Barium, Total	mg/l					
Barium, Dissolved	mg/l	0.131			0.450	
Bicarbonate	mg/l	265.9	271.2		326.9	
Boron, Total	mg/l	0.012			0.018	
Boron, Dissolved	mg/l					
Cadmium, Total	mg/l					
Cadmium, Dissolved	mg/l	<0.001			<0.001	
Calcium	mg/l	68.0	60.0		86.0	
Chloride	mg/l	2.0	6.0		10.0	
Chromium, Total	mg/l	<0.001			<0.001	
Chromium, Dissolved	mg/l					
Copper, Total	mg/l					
Copper, Dissolved	mg/l	0.015			0.015	
Cyanide	mg/l					
Fluoride	mg/l	0.25	0.27		0.40	
Gross Alpha Radioactivity	pCi/l					
Gross Beta Radioactivity	pCi/l					
Iron, Total	mg/l	0.093			0.305	
Iron, Dissolved	mg/l					
Lead, Total	mg/l					
Lead, Dissolved	mg/l	0.006			<0.001	
MPN Fecal Coliform	MPN/100 ml		230.0	430.0	2300.0	430.0
MPN Total Coliform	MPN/100 ml		4300.0	430.0	4300.0	2300.0
Magnesium	mg/l	26.40	28.3		27.0	
Manganese, Total	mg/l	0.068			0.102	
Mercury, Total	mg/l	<0.0001			<0.0002	
Nitrate, NO_3 as N	mg/l	0.180			0.11	
Oil and Grease	mg/l					
Phenol	mg/l					
Phosphate, PO_4 as P	mg/l	0.30			0.330	
Potassium	mg/l	1.67	2.57		2.54	
Selenium, Total	mg/l	0.005			0.019	
Selenium, Dissolved	mg/l					
Silver, Total	mg/l					
Silver, Dissolved	mg/l	<0.001			<0.001	
Sodium	mg/l	18.0	9.0		4.20	
Sulfate	mg/l	96.0	56.0		55.0	
Suspended Solids	mg/l					
Total Dissolved Solids	mg/l	476.0	432.0		500.0	
Total Organic Carbon	mg/l					
Turbidity	NTU	0.34	0.52		2.2	
Zinc, Total	mg/l					
Zinc, Dissolved	mg/l	0.046			0.017	

Table 8. Continued.

Parameter	Units	10-27-76	11-20-76	12-28-76	3-17-77	6-16-77
FIELD MEASURMENTS						
Discharge	cfs	0.9	0.9	1.0	0	29.0
Dissolved Oxygen	mg/l	10.8	8.7	9.6	9.4	8.8
pH	units	7.7	7.7	7.7		
Specific Conductance	umhos/cm @ 25° C	1000.0		980.0		
Temperature, Air	°C	4.0	-4.0	2.0	0	29.0
Temperature, Water	°C	7.0	3.0	5.0	5.0	16.0
LABORATORY MEASUREMENTS						
Acidity, as $CaCO_3$	mg/l					
Alkalinity, as $CaCO_3$	mg/l	312.0		306.0		
Ammonia, NH_3 as N	mg/l					
Arsenic, Total	mg/l					
Arsenic, Dissolved	mg/l					
BOD, 5 Day	mg/l	2.4	3.4	3.5	2.6	1.5
Barium, Total	mg/l					
Barium, Dissolved	mg/l					
Bicarbonate	mg/l	380.06		373.3		
Boron, Total	mg/l					
Boron, Dissolved	mg/l					
Cadmium, Total	mg/l					
Cadmium, Dissolved	mg/l					
Calcium	mg/l	90.4		89.6		
Chloride	mg/l	4.0		4.0		
Chromium, Total	mg/l					
Chromium, Dissolved	mg/l					
Copper, Total	mg/l					
Copper, Dissolved	mg/l					
Cyanide	mg/l					
Fluoride	mg/l	0.39		0.35		
Gross Alpha Radioactivity	pCi/l					
Gross Beta Radioactivity	pCi/l					
Iron, Total	mg/l					
Iron, Dissolved	mg/l					
Lead, Total	mg/l					
Lead, Dissolved	mg/l					
MPN Fecal Coliform	MPN/100 ml	2300.00	2300.0	2300.0	23000.0	43000.0
MPN Total Coliform	MPN/100 ml	9300.0	93000.0	9300.0	930.0	7500.0
Magnesium	mg/l	32.16		35.04		
Manganese, Total	mg/l					
Mercury, Total	mg/l					
Nitrate, NO_3 as N	mg/l					
Oil and Grease	mg/l					
Phenol	mg/l					
Phosphate, PO_4 as P	mg/l					
Potassium	mg/l	2.88		2.90		
Selenium, Total	mg/l					
Selenium, Dissolved	mg/l					
Silver, Total	mg/l					
Silver, Dissolved	mg/l					
Sodium	mg/l	33.0		28.6		
Sulfate	mg/l	117.0		110.0		
Suspended Solids	mg/l					
Total Dissolved Solids	mg/l	655.0		640.0		
Total Organic Carbon	mg/l					
Turbidity	NTU	2.20		0.75		
Zinc, Total	mg/l					
Zinc, Dissolved	mg/l					

Table 9. Results of chemical analyses of surface water quality samples collected at station VC-9.

Parameter	Units	1-26-76	3-9-76	4-28-76	6-14-76	8-2-76
FIELD MEASUREMENTS						
Discharge	cfs	4.0	1.4	4.3	5.7	2.4
Dissolved Oxygen	mg/l	9.6	9.8	8.1	7.0	8.4
pH	units	7.9	8.3	8.1	8.3	8.3
Specific Conductance	umhos/cm @ 25° C	760	680	595	600	630
Temperature, Air	°C	-4.0	-5.0	12	12	18
Temperature, Water	°C	1.0	2.0	7	6	14
LABORATORY MEASUREMENTS						
Acidity, as $CaCO_3$	mg/l					
Alkalinity, as $CaCO_3$	mg/l	202	238	204	208	224
Ammonia, NH_3 as N	mg/l					
Arsenic, Total	mg/l	0.005	0.002	0.008		
Arsenic, Dissolved	mg/l					
BOD, 5 Day	mg/l					
Barium, Total	mg/l	0.151	0.131	0.157		
Barium, Dissolved	mg/l					
Bicarbonate	mg/l	246.4	290.3	248.8	253.7	273.2
Boron, Total	mg/l	0.013	0.010	0.015		
Boron, Dissolved	mg/l					
Cadmium, Total	mg/l	<0.001	<0.001	<0.001		
Cadmium, Dissolved	mg/l					
Calcium	mg/l	55.2	63.2	50.4	57.6	65.0
Chloride	mg/l	5.0	<0.01	2.0	2.0	8.0
Chromium, Total	mg/l	<0.001	<0.001	<0.001		<0.001
Chromium, Dissolved	mg/l					
Copper, Total	mg/l	<0.001	<0.001	0.008		0.098
Copper, Dissolved	mg/l					
Cyanide	mg/l					
Fluoride	mg/l	0.18	0.50	0.25	0.21	0.43
Gross Alpha Radioactivity	pCi/l					
Gross Beta Radioactivity	pCi/l					
Iron, Total	mg/l	0.135	0.142	0.228		0.427
Iron, Dissolved	mg/l					
Lead, Total	mg/l	0.013	0.008	<0.001		<0.001
Lead, Dissolved	mg/l					
MPN Fecal Coliform	MPN/100 ml					
MPN Total Coliform	MPN/100 ml					
Magnesium	mg/l	9.60	26.88	27.3	18.72	23.0
Manganese, Total	mg/l	0.052	0.040	0.049		0.063
Mercury, Total	mg/l	<0.0001	<0.0001	<0.0001		<0.0002
Nitrate, NO_3 as N	mg/l	0.260		0.165		0.15
Oil and Grease	mg/l					
Phenol	mg/l					
Phosphate, PO_4 as P	mg/l	0.13		0.180		0.140
Potassium	mg/l	1.64	1.24	2.20	1.04	2.02
Selenium, Total	mg/l	0.002	<0.001	<0.001		0.013
Selenium, Dissolved	mg/l					
Silver, Total	mg/l	<0.001	<0.001	<0.001		<0.001
Silver, Dissolved	mg/l					
Sodium	mg/l	66.0	12.1	8.0	17.00	5.00
Sulfate	mg/l	117	55.8	50.0	46.0	35.8
Suspended Solids	mg/l					
Total Dissolved Solids	mg/l	495	448	387	395	410
Total Organic Carbon	mg/l	8.0	6.0	19.0	18.0	5.0
Turbidity	NTU	0.20	0.91	0.35	1.10	4.0
Zinc, Total	mg/l	0.017	0.015	0.013		0.016
Zinc, Dissolved	mg/l					

Table 9. Continued.

Parameter	Units	9-30-76	10-27-76	11-29-76	12-28-76
FIELD MEASUREMENTS					
Discharge	cfs	2.1	3.5	2.2	1.8
Dissolved Oxygen	mg/l	8.7	10.6	9.7	9.6
pH	units	7.5	7.6	7.2	7.8
Specific Conductance	umhos/cm @ 25° C	640	690	670	670
Temperature, Air	°C	20	-1	-1	6
Temperature, Water	°C	11	2	1.0	1
LABORATORY MEASUREMENTS					
Acidity, as $CaCO_3$	mg/l				
Alkalinity, as $CaCO_3$	mg/l	230	256	254	254
Ammonia, NH_3 as N	mg/l				
Arsenic, Total	mg/l		<0.001		<0.001
Arsenic, Dissolved	mg/l				
BOD, 5 Day	mg/l				
Barium, Total	mg/l		0.027		0.005
Barium, Dissolved	mg/l				
Bicarbonate	mg/l	280.6	312.3	309.9	309.9
Boron, Total	mg/l		<0.001		<0.001
Boron, Dissolved	mg/l				
Cadmium, Total	mg/l				
Cadmium, Dissolved	mg/l				
Calcium	mg/l	66.9	72.0	24.8	63.2
Chloride	mg/l	8.0	4.0	4.0	4.0
Chromium, Total	mg/l				
Chromium, Dissolved	mg/l				
Copper, Total	mg/l		0.010		0.017
Copper, Dissolved	mg/l				
Cyanide	mg/l				
Fluoride	mg/l	0.20	0.40	0.27	0.24
Gross Alpha Radioactivity	pCi/l				
Gross Beta Radioactivity	pCi/l				
Iron, Total	mg/l		0.333		0.410
Iron, Dissolved	mg/l				
Lead, Total	mg/l		<0.001		<0.001
Lead, Dissolved	mg/l				
MPN Fecal Coliform	MPN/100 ml				
MPN Total Coliform	MPN/100 ml				
Magnesium	mg/l	15.80	21.10	48.90	30.72
Manganese, Total	mg/l		0.063		0.012
Mercury, Total	mg/l		<0.0002		<0.0002
Nitrate, NO_3 as N	mg/l		0.12		0.06
Oil and Grease	mg/l				
Phenol	mg/l				
Phosphate, PO_4 as P	mg/l		0.110		0.170
Potassium	mg/l	1.91	1.97	2.54	2.02
Selenium, Total	mg/l		0.002		<0.001
Selenium, Dissolved	mg/l				
Silver, Total	mg/l				
Silver, Dissolved	mg/l				
Sodium	mg/l	19.0	13.0	14.0	2.80
Sulfate	mg/l	36.0	36.4	40.0	35.0
Suspended Solids	mg/l				
Total Dissolved Solids	mg/l	420	450	438	440
Total Organic Carbon	mg/l	15.0	3.0	4.0	16.0
Turbidity	NTU	2.80	4.30	0.45	2.20
Zinc, Total	mg/l		0.018		0.081
Zinc, Dissolved	mg/l				

Table 9. Continued.

Parameter	Units	3-17-77	6-16-77	5-10-78	6-14-78	7-12-78
FIELD MEASUREMENTS						
Discharge	cfs	3.5	1.7	5.0	11.3	3.4
Dissolved Oxygen	mg/l	9.5	7.8	8.2	8.6	8.0
pH	units	7.8	7.6	7.9	7.3	8.0
Specific Conductance	umhos/cm @ 25° C	640	410	380	290	418
Temperature, Air	°C	0	22	14	25	27
Temperature, Water	°C	2	15	10	11.5	17
LABORATORY MEASUREMENTS						
Acidity, as $CaCO_3$	mg/l					
Alkalinity, as $CaCO_3$	mg/l					
Ammonia, NH_3 as N	mg/l	0.27	0.14		0.10	
Arsenic, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, Dissolved	mg/l					
BOD, 5 Day	mg/l					
Barium, Total	mg/l	0.009	0.063			
Barium, Dissolved	mg/l					
Bicarbonate	mg/l	273.3	275.7	242	163.48	236.68
Boron, Total	mg/l	<0.001	0.025			
Boron, Dissolved	mg/l					
Cadmium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	
Cadmium, Dissolved	mg/l					
Calcium	mg/l	64.0	58.4	67.2	51.2	28.0
Chloride	mg/l	4.0	6.0	8.0	10.0	4.0
Chromium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	
Chromium, Dissolved	mg/l					
Copper, Total	mg/l	0.015	0.005	0.007	0.004	
Copper, Dissolved	mg/l					
Cyanide	mg/l		<0.01			
Fluoride	mg/l	0.16	0.23	0.16	0.14	
Gross Alpha Radioactivity	pCi/l					
Gross Beta Radioactivity	pCi/l					
Iron, Total	mg/l	0.092	0.346	0.040	1.887	0.122
Iron, Dissolved	mg/l					
Lead, Total	mg/l	<0.001	<0.001	<0.001	0.003	<0.001
Lead, Dissolved	mg/l					
MPN Fecal Coliform	MPN/100 ml					
MPN Total Coliform	MPN/100 ml					
Magnesium	mg/l	24.96	26.88	16.32	4.80	7.68
Manganese, Total	mg/l	0.053	0.050	0.012	0.141	0.043
Mercury, Total	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l	0.05	0.03	0.72	0.36	
Oil and Grease	mg/l	<1.0	<1.0	9.6		1.2
Phenol	mg/l		<0.001		0.003	
Phosphate, PO_4 as P	mg/l	0.038	0.130			
Potassium	mg/l	1.90	1.98	1.676	1.887	1.488
Selenium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium, Dissolved	mg/l					
Silver, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Silver, Dissolved	mg/l					
Sodium	mg/l	7.10	4.24	4.92	3.49	53.0
Sulfate	mg/l	50.0	28.0	33.0	10.0	26.0
Suspended Solids	mg/l	23.0	14.0	309	247	27.0
Total Dissolved Solids	mg/l					
Total Organic Carbon	mg/l	11.0	4.0	19.0	18.0	
Turbidity	NTU	3.50	2.20			
Zinc, Total	mg/l	0.033	0.014	0.016	0.015	0.013
Zinc, Dissolved	mg/l					

Table 9. Continued.

Parameter	Units	8-23-78	10-25-78	12-27-78	2-28-79	4-18-79
FIELD MEASUREMENTS						
Discharge	cfs	1.5	3.2	1.3	2.1	2.6
Dissolved Oxygen	mg/l	6.8	10.4	12.4	9.7	9.4
pH	units	8.0	7.1	7.91	8.0	7.72
Specific Conductance	umhos/cm @ 25° C	370	470	460	490	470
Temperature, Air	°C	21.5	4	-10	-1	9
Temperature, Water	°C	13.5	4	0.5	2	6
LABORATORY MEASUREMENTS						
Acidity, as $CaCO_3$	mg/l					
Alkalinity, as $CaCO_3$	mg/l				252	232
Ammonia, NH_3 as N	mg/l					
Arsenic, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, Dissolved	mg/l					
BOD, 5 Day	mg/l					
Barium, Total	mg/l					
Barium, Dissolved	mg/l					
Bicarbonate	mg/l	251.3	280.6	297.7	307.44	283.04
Boron, Total	mg/l					
Boron, Dissolved	mg/l					
Cadmium, Total	mg/l		<0.001	<0.001	<0.001	<0.001
Cadmium, Dissolved	mg/l					
Calcium	mg/l	56.8	57.6	73.6	68.8	72.0
Chloride	mg/l	4.0	5.0	6.0	<0.1	8.0
Chromium, Total	mg/l		<0.001	<0.001	<0.001	<0.001
Chromium, Dissolved	mg/l					
Copper, Total	mg/l	0.003	0.003	0.003	0.004	0.002
Copper, Dissolved	mg/l					
Cyanide	mg/l					
Fluoride	mg/l	0.15	0.15	0.18	0.17	0.16
Gross Alpha Radioactivity	pCi/l					
Gross Beta Radioactivity	pCi/l					
Iron, Total	mg/l	0.216	0.241	0.354	0.380	5.840
Iron, Dissolved	mg/l					
Lead, Total	mg/l	<0.001	<0.001	<0.001	<0.001	0.002
Lead, Dissolved	mg/l					
MPN Fecal Coliform	MPN/100 ml					
MPN Total Coliform	MPN/100 ml					
Magnesium	mg/l	22.1	28.3	24.0	22.56	21.12
Manganese, Total	mg/l	0.038	0.011	0.066	0.076	0.187
Mercury, Total	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l				0.10	0.40
Oil and Grease	mg/l	2.0	1.3	<1.0	<1.0	3.8
Phenol	mg/l	0.080	0.010	0.004	<0.001	0.004
Phosphate, PO_4 as P	mg/l					
Potassium	mg/l	1.988	1.520	1.995	2.229	1.952
Selenium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium, Dissolved	mg/l					
Silver, Total	mg/l	<0.001			<0.001	<0.001
Silver, Dissolved	mg/l					
Sodium	mg/l	3.14	8.50	3.41	14.30	4.09
Sulfate	mg/l	28.0	40.0	43.0	38.0	40.0
Suspended Solids	mg/l	11.0	12.0	10.0	23.0	217
Total Dissolved Solids	mg/l	240	279	302	311	305
Total Organic Carbon	mg/l	14.0		7.0		
Turbidity	NTU					
Zinc, Total	mg/l	0.014	0.012	0.004	0.005	0.013
Zinc, Dissolved	mg/l					

Table 9. -Continued.

Parameter	Units	5-11-79	6-20-79	7-20-79	8-23-79
FIELD MEASUREMENTS					
Discharge	cfs	5.2	7.1	4.9	2.4
Dissolved Oxygen	mg/l	8.3	8.45	8.6	9.1
pH	units	8.45	8.4	7.4	8.0
Specific Conductance	umhos/cm @ 25° C	490	450	480	490
Temperature, Air	°C	5	16	9	13
Temperature, Water	°C	9	4.5	8	5.5
LABORATORY MEASUREMENTS					
Acidity, as $CaCO_3$	mg/l	22.0	10.0	26.0	14.0
Alkalinity, as $CaCO_3$	mg/l	236	216	228	234
Ammonia, NH_3 as N	mg/l	0.20	< 0.01	< 0.01	< 0.05
Arsenic, Total	mg/l	0.002	< 0.001	< 0.001	< 0.001
Arsenic, Dissolved	mg/l	< 0.001	< 0.001	< 0.001	< 0.001
BOD, 5 Day	mg/l		< 1.0		1.6
Barium, Total	mg/l	0.550	0.060	0.053	0.020
Barium, Dissolved	mg/l	0.51	0.045	0.050	0.016
Bicarbonate	mg/l	287.92	263.52	278.16	285.48
Boron, Total	mg/l	0.110	0.063	0.090	0.075
Boron, Dissolved	mg/l	0.105	0.060	0.030	0.060
Cadmium, Total	mg/l	< 0.001	< 0.001	< 0.001	< 0.001
Cadmium, Dissolved	mg/l	< 0.001	< 0.001	< 0.001	< 0.001
Calcium	mg/l	70.40	60.80	63.20	96.00
Chloride	mg/l	6.0	2.0	6.0	2.0
Chromium, Total	mg/l	0.014	0.002	0.003	0.005
Chromium, Dissolved	mg/l	< 0.001	< 0.001	< 0.001	< 0.001
Copper, Total	mg/l	0.017	0.005	0.005	0.006
Copper, Dissolved	mg/l	0.017	0.002	0.003	< 0.001
Cyanide	mg/l	0.002	0.001	< 0.001	< 0.001
Fluoride	mg/l	0.13	0.14	0.15	0.23
Gross Alpha Radioactivity	pCi/l		3.5		< 2.0
Gross Beta Radioactivity	pCi/l		10.0		3.5
Iron, Total	mg/l	5.780	1.040	0.760	0.190
Iron, Dissolved	mg/l	0.022	0.036	0.010	0.040
Lead, Total	mg/l	0.006	0.005	0.002	< 0.001
Lead, Dissolved	mg/l	< 0.001	< 0.001	< 0.001	< 0.001
MPN Fecal Coliform	MPN/100 ml		8.0		13.0
MPN Total Coliform	MPN/100 ml		79.0		330
Magnesium	mg/l	18.72	11.52	22.08	3.36
Manganese, Total	mg/l	0.043	0.053	0.036	0.004
Mercury, Total	mg/l	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nitrate, NO_3 as N	mg/l	1.48	0.33	0.14	0.01
Oil and Grease	mg/l	< 1.0	1.8	< 1.0	< 1.0
Phenol	mg/l	0.022	< 0.001	0.010	< 0.001
Phosphate, PO_4 as P	mg/l	0.24	0.020	< 0.001	
Potassium	mg/l	5.33	1.151	1.786	4.100
Selenium, Total	mg/l	< 0.001	< 0.001	< 0.001	< 0.001
Selenium, Dissolved	mg/l	< 0.001	< 0.001	< 0.001	< 0.001
Silver, Total	mg/l	0.002	0.003	< 0.001	< 0.001
Silver, Dissolved	mg/l	< 0.001	< 0.001	< 0.001	< 0.001
Sodium	mg/l	7.01	12.50	3.36	4.10
Sulfate	mg/l	30.0	14.0	27.0	32.0
Suspended Solids	mg/l	258	24.0	26.0	10.0
Total Dissolved Solids	mg/l	300	240	268	290
Total Organic Carbon	mg/l	5.0	2.0	15.0	4.0
Turbidity	NTU	6.50	10.00	1.00	2.00
Zinc, Total	mg/l	0.061	0.016	0.008	0.013
Zinc, Dissolved	mg/l	0.502	0.012	0.007	0.006

Table 9. Continued.

Parameter	Units	9-26-79	10-31-79	11-30-79
FIELD MEASUREMENTS				
Discharge	cfs	3.0	1.7	1.8
Dissolved Oxygen	mg/l	8.0	9.8	10.9
pH	units	7.65	7.70	6.9
Specific Conductance	umhos/cm @ 25° C	510.0	560.0	525
Temperature, Air	°C	6.0	0	-7
Temperature, Water	°C	6.0	2.0	0.3
LABORATORY MEASUREMENTS				
Acidity, as $CaCO_3$	mg/l	15.0	18.0	
Alkalinity, as $CaCO_3$	mg/l	230.0	210.0	
Ammonia, NH_3 as N	mg/l	<0.001		<0.01
Arsenic, Total	mg/l	<0.001	<0.001	
Arsenic, Dissolved	mg/l			
BOD, 5 Day	mg/l			
Barium, Total	mg/l	0.024	0.220	
Barium, Dissolved	mg/l			
Bicarbonate	mg/l	280.60	256.20	292.80
Boron, Total	mg/l	0.050	0.050	
Boron, Dissolved	mg/l			
Cadmium, Total	mg/l	<0.001	<0.001	
Cadmium, Dissolved	mg/l			
Calcium	mg/l	64.20	57.60	74.40
Chloride	mg/l	4.0	2.0	4.0
Chromium, Total	mg/l			
Chromium, Dissolved	mg/l	<0.001	<0.001	
Copper, Total	mg/l	0.019	0.015	
Copper, Dissolved	mg/l	0.001		
Cyanide	mg/l			
Fluoride	mg/l	0.17	0.17	
Gross Alpha Radioactivity	pCi/l			
Gross Beta Radioactivity	pCi/l			
Iron, Total	mg/l	0.340	0.296	0.670
Iron, Dissolved	mg/l			
Lead, Total	mg/l	<0.001	<0.001	
Lead, Dissolved	mg/l			
MPN Fecal Coliform	MPN/100 ml			
MPN Total Coliform	MPN/100 ml			
Magnesium	mg/l	6.20	24.48	22.56
Manganese, Total	mg/l	0.005	0.062	0.095
Mercury, Total	mg/l	<0.0002	<0.0002	
Nitrate, NO_3 as N	mg/l	0.02	<0.01	
Oil and Grease	mg/l		1.2	
Phenol	mg/l	<0.001	<0.001	0.008
Phosphate, PO_4 as P	mg/l	<0.001		0.070
Potassium	mg/l	1.560	2.850	2.112
Selenium, Total	mg/l	<0.001	<0.001	
Selenium, Dissolved	mg/l			
Silver, Total	mg/l	<0.001	<0.001	
Silver, Dissolved	mg/l			
Sodium	mg/l	34.6	7.20	3.41
Sulfate	mg/l	32.0	44.0	40.0
Suspended Solids	mg/l	5.0	24.0	23.5
Total Dissolved Solids	mg/l	286.0	270.0	298
Total Organic Carbon	mg/l	3.0		
Turbidity	NTU	2.6		
Zinc, Total	mg/l	0.048	0.036	
Zinc, Dissolved	mg/l			

Table 10. Results of chemical analyses of surface water quality samples collected at station VC-10.

Parameter	Units	6-14-78	7-12-78	8-23-78	10-25-78	11-8-78	12-27-78
FIELD MEASUREMENTS							
Discharge	cfs	8.5	1	0.2	0.3	0.3	0.2
Dissolved Oxygen	mg/l	9.0	7.4	8.1	11.3	11.4	10.9
pH	units	7.3	8.3	8.0	7.4	7.5	7.65
Specific Conductance	umhos/cm @ 25° C	210	346	305	420	425	395
Temperature, Air	°C	22	21	20	3	2	-2
Temperature, Water	°C	9	16	12	0.5	0.2	2
LABORATORY MEASUREMENTS							
Acidity, as $CaCO_3$	mg/l						
Alkalinity, as $CaCO_3$	mg/l						
Ammonia, NH_3 as N	mg/l						
Arsenic, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, Dissolved	mg/l						
BOD, 5 Day	mg/l						
Barium, Total	mg/l					0.030	0.026
Barium, Dissolved	mg/l						
Bicarbonate	mg/l	251.28	219.6	241.5	261.08	283.04	290.36
Boron, Total	mg/l						
Boron, Dissolved	mg/l						
Cadmium, Total	mg/l	<0.001			<0.001	<0.001	<0.001
Cadmium, Dissolved	mg/l						
Calcium	mg/l	41.6	26.4	52.8	59.2	66.4	18.24
Chloride	mg/l	8.0	<1.0	<0.10	<1.0	2.0	6.0
Chromium, Total	mg/l	0.001			<0.001	<0.001	<0.001
Chromium, Dissolved	mg/l						
Copper, Total	mg/l	<0.001		0.002	0.003	0.002	0.003
Copper, Dissolved	mg/l						
Cyanide	mg/l					< 0.01	
Fluoride	mg/l	0.13		0.13	0.14	0.12	0.15
Gross Alpha Radioactivity	pCi/l						
Gross Beta Radioactivity	pCi/l						
Iron, Total	mg/l	0.519	0.045	0.052	0.086	0.119	0.079
Iron, Dissolved	mg/l						
Lead, Total	mg/l	<0.001	<0.001	<0.001	< 0.001		<0.001
Lead, Dissolved	mg/l						
MPN Fecal Coliform	MPN/100 ml						
MPN Total Coliform	MPN/100 ml						
Magnesium	mg/l	7.68	5.76	18.2	20.10	19.2	18.24
Manganese, Total	mg/l	0.022	0.005	0.016	0.004	0.019	0.012
Mercury, Total	mg/l	<0.0002	<0.0002	<0.0002	<0.0002		
Nitrate, NO_3 as N	mg/l	0.18				0.12	0.26
Oil and Grease	mg/l	<1.0	<1.0	2.2	<1.0		1.0
Phenol	mg/l	0.002		0.004	0.011		<0.001
Phosphate, PO_4 as P	mg/l						
Potassium	mg/l	0.577	0.914	0.937	0.890	1.027	0.939
Selenium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium, Dissolved	mg/l						
Silver, Total	mg/l	<0.001	<0.001	<0.001		<0.001	<0.001
Silver, Dissolved	mg/l						
Sodium	mg/l	2.00	47.0	2.05	3.2	2.24	4.30
Sulfate	mg/l	4.0	15.0	10.0	19.0	12.0	14.0
Suspended Solids	mg/l	89.0	6.0	4.0	4.0	9.0	18.0
Total Dissolved Solids	mg/l	139	205	200	231	245	256
Total Organic Carbon	mg/l	27.0		22.0		11.0	4.0
Turbidity	NTU						
Zinc, Total	mg/l	0.003	0.018	0.015	0.019	0.002	0.003
Zinc, Dissolved	mg/l						

Table 10. Continued.

Parameter	Units	5-11-79	6-20-79	7-18-79	8-23-79
FIELD MEASUREMENTS					
Discharge	cfs	0.9	3.8	1.2	0.6
Dissolved Oxygen	mg/l	9.3	8.7	8.0	8.3
pH	units	8.9	8.18	7.72	8.15
Specific Conductance	umhos/cm @ 25° C	410	340	420	410
Temperature, Air	°C	0	16	24	20
Temperature, Water	°C	2.5	5.5	9	8.0
LABORATORY MEASUREMENTS					
Acidity, as $CaCO_3$	mg/l	6.0	2.0	28.0	12.0
Alkalinity, as $CaCO_3$	mg/l	230	182	220	214
Ammonia, NH_3 as N	mg/l	<0.10	<0.01	<0.01	<0.05
Arsenic, Total	mg/l	<0.001	<0.001	<0.001	<0.001
Arsenic, Dissolved	mg/l	<0.001	<0.001	<0.001	<0.001
BOD, 5 Day	mg/l				
Barium, Total	mg/l	0.040	0.045	0.030	0.040
Barium, Dissolved	mg/l	0.02	0.040	0.020	0.012
Bicarbonate	mg/l	280.6	222.04	268.40	261.08
Boron, Total	mg/l	0.080	0.030	0.090	0,050
Boron, Dissolved	mg/l	0.070	0.015	0.075	0.002
Cadmium, Total	mg/l	<0.001	<0.001	<0.001	<0.001
Cadmium, Dissolved	mg/l	<0.001	<0.001	<0.001	<0.001
Calcium	mg/l	68.0	54.4	64.8	82.4
Chloride	mg/l	6.0	<1.0	2.0	<0.1
Chromium, Total	mg/l	0.003	0.002	0.002	0.004
Chromium, Dissolved	mg/l	<0.001	<0.001	<0.001	0.002
Copper, Total	mg/l	0.003	0.003	0.006	0.004
Copper, Dissolved	mg/l	0.002	<0.001	0.006	0.002
Cyanide	mg/l	<0.001	<0.001	<0.001	<0.001
Fluoride	mg/l	0.11	0.15	0.15	0.20
Gross Alpha Radioactivity	pCi/l		2.5		<2.0
Gross Beta Radioactivity	pCi/l		12.0		4.2
Iron, Total	mg/l	0.350	0.260	0.230	0.250
Iron, Dissolved	mg/l	0.023	0.020	0.050	0.046
Lead, Total	mg/l	0.002	0.002	<0.001	<0.001
Lead, Dissolved	mg/l	<0.001	<0.001	<0.001	<0.001
MPN Fecal Coliform	MPN/100 ml		<2.0		8.0
MPN Total Coliform	MPN/100 ml		70.0		2300
Magnesium	mg/l	13.92	12.48	13.92	3.36
Manganese, Total	mg/l	0.007	0.009	0.022	0.002
Mercury, Total	mg/l	<0.0002	<0.0002	<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l	1.32	0.05	0.10	0.06
Oil and Grease	mg/l	1.6	<1.0	<1.0	<1.0
Phenol	mg/l	0.076	<0.001	0.010	<0.001
Phosphate, PO_4 as P	mg/l	0.06	0.040	0.030	0.090
Potassium	mg/l	1.002	0.691	0.902	0.910
Selenium, Total	mg/l	<0.001	<0.001	<0.001	<0.001
Selenium, Dissolved	mg/l	<0.001	<0.001	<0.001	<0.001
Silver, Total	mg/l	<0.001	0.002	0.001	<0.001
Silver, Dissolved	mg/l	<0.001	<0.001	<0.001	<0.001
Sodium	mg/l	6.30	1.71	2.02	2.26
Sulfate	mg/l	5.0	10.0	5.0	10.0
Suspended Solids	mg/l	11.0	7.0	7.0	16.0
Total Dissolved Solids	mg/l	270	196	225	232
Total Organic Carbon	mg/l	8.0	1.0	12.0	3.1
Turbidity	NTU	5.50	6.00	4.20	1.80
Zinc, Total	mg/l	0.011	0.016	0.017	0.010
Zinc, Dissolved	mg/l	0.004	0.004	0.009	0.003

Table 10. Continued.

Parameter	Units	9-26-79	10-31-79
FIELD MEASURMENTS			
Discharge	cfs	16.0	-1.0
Dissolved Oxygen	mg/l	6.8	9.4
pH	units	7.70	7.90
Specific Conductance	umhos/cm @ 25° C	420.0	38.0
Temperature, Air	°C	16.0	-1.0
Temperature, Water	°C	8.5	0
LABORATORY MEASUREMENTS			
Acidity, as $CaCO_3$	mg/l	19.0	24.0
Alkalinity, as $CaCO_3$	mg/l	218.0	222.0
Ammonia, NH_3 as N	mg/l	<0.01	
Arsenic, Total	mg/l	<0.001	<0.01
Arsenic, Dissolved	mg/l		
BOD, 5 Day	mg/l		
Barium, Total	mg/l	0.050	0.214
Barium, Dissolved	mg/l		
Bicarbonate	mg/l	265.96	270.84
Boron, Total	mg/l	0.050	0.030
Boron, Dissolved	mg/l		
Cadmium, Total	mg/l	<0.001	<0.001
Cadmium, Dissolved	mg/l		
Calcium	mg/l	63.85	68.80
Chloride	mg/l	2.0	4.0
Chromium, Total	mg/l	<0.001	<0.001
Chromium, Dissolved	mg/l		
Copper, Total	mg/l	0.015	0.016
Copper, Dissolved	mg/l		
Cyanide	mg/l	<0.001	
Fluoride	mg/l	0.19	0.15
Gross Alpha Radioactivity	pCi/l		
Gross Beta Radioactivity	pCi/l		
Iron, Total	mg/l	0.050	0.030
Iron, Dissolved	mg/l		
Lead, Total	mg/l	<0.001	<0.001
Lead, Dissolved	mg/l		
MPN Fecal Coliform	MPN/100 ml		
MPN Total Coliform	MPN/100 ml		
Magnesium	mg/l	14.10	16.80
Manganese, Total	mg/l	0.036	0.050
Mercury, Total	mg/l	<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l	0.03	<0.01
Oil and Grease	mg/l		1.0
Phenol	mg/l	<0.001	<0.001
Phosphate, PO_4 as P	mg/l	0.020	
Potassium	mg/l	0.530	2.800
Selenium, Total	mg/l	<0.001	<0.001
Selenium, Dissolved	mg/l		
Silver, Total	mg/l	<0.001	<0.001
Silver, Dissolved	mg/l		
Sodium	mg/l	4.90	8.50
Sulfate	mg/l	10.0	31.0
Suspended Solids	mg/l	4.0	24.0
Total Dissolved Solids	mg/l	227.0	275.0
Total Organic Carbon	mg/l	1.0	
Turbidity	NTU	4.20	4.40
Zinc, Total	mg/l	0.055	0.022
Zinc, Dissolved	mg/l		

Table 11. Results of chemical analyses of surface water quality samples collected at station CS-1.

Parameter	Units	11-8-78	5-11-79	6-20-79	7-18-79	8-23-79
FIELD MEASUREMENTS						
Discharge	cfs	0.4	0.6	3.6	0.4	0.3
Dissolved Oxygen	mg/l	11.5		8.7	8.4	8.7
pH	units	7.4	8.4	8.4	7.62	7.8
Specific Conductance	umhos/cm @ 25° C	440	410	325	420	420
Temperature, Air	°C		1	16	21	18
Temperature, Water	°C		1	7	7.5	5
LABORATORY MEASUREMENTS						
Acidity, as $CaCO_3$	mg/l		14.0	12.0	24.0	16.0
Alkalinity, as $CaCO_3$	mg/l		234	178	210	240
Ammonia, NH_3 as N	mg/l		<0.10	<0.01	<0.01	<0.05
Arsenic, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, Dissolved	mg/l		<0.001	<0.001	<0.001	<0.001
BOD, 5 Day	mg/l			<1.0		2.3
Barium, Total	mg/l	0.012	0.010	0.050	0.030	0.020
Barium, Dissolved	mg/l		0.01	0.050	0.020	0.013
Bicarbonate	mg/l	287.92	285.48	217.16	256.20	292.80
Boron, Total	mg/l		0.110	0.059	0.077	0.015
Boron, Dissolved	mg/l		0.105	0.040	0.050	0.010
Cadmium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Dissolved	mg/l		<0.001	<0.001	<0.001	<0.001
Calcium	mg/l	62.4	77.0	55.2	61.6	83.2
Chloride	mg/l	1.0	6.0	2.0	4.0	0.1
Chromium, Total	mg/l	<0.001	0.003	0.003	0.003	0.005
Chromium, Dissolved	mg/l		<0.001	<0.001	<0.001	<0.001
Copper, Total	mg/l	0.005	0.003	0.003	0.008	0.005
Copper, Dissolved	mg/l		0.003	0.003	0.005	0.001
Cyanide	mg/l	<0.01	0.006	0.005	<0.001	<0.001
Fluoride	mg/l	0.13	0.12	0.12	0.16	0.20
Gross Alpha Radioactivity	pCi/l			2.9		<2.0
Gross Beta Radioactivity	pCi/l			9.5		4.0
Iron, Total	mg/l	0.045	0.081	0.330	0.100	0.149
Iron, Dissolved	mg/l		0.022	0.200	0.030	0.045
Lead, Total	mg/l		0.003	0.009	0.001	<0.001
Lead, Dissolved	mg/l		<0.001	<0.001	<0.001	<0.001
MPN Fecal Coliform	MPN/100 ml			2.0		4.0
MPN Total Coliform	MPN/100 ml			49.0		700
Magnesium	mg/l	15.84	17.28	11.52	14.64	3.84
Manganese, Total	mg/l	0.003	0.002	0.005	0.005	0.002
Mercury, Total	mg/l		<0.0002	<0.0002	<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l	0.15	1.28	0.18	0.08	0.09
Oil and Grease	mg/l		<1.0	<1.0	<1.0	<1.0
Phenol	mg/l		0.010	0.001	0.024	<0.001
Phosphate, PO_4 as P	mg/l		0.05	0.015	0.020	0.120
Potassium	mg/l	1.022	0.962	0.677	0.909	1.140
Selenium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium, Dissolved	mg/l		<0.001	<0.001	<0.001	<0.001
Silver, Total	mg/l	0.001	0.005	0.003	0.001	<0.001
Silver, Dissolved	mg/l		<0.001	<0.001	<0.001	<0.001
Sodium	mg/l	13.68	2.10	1.67	3.11	9.00
Sulfate	mg/l	14.0	10.0	6.0	10.0	6.0
Suspended Solids	mg/l	11.0	4.0	13.0	5.0	6.0
Total Dissolved Solids	mg/l	252	270	190	223	254
Total Organic Carbon	mg/l	4.0	8.00	3.00	10.50	9.00
Turbidity	NTU		0.85	10.00	3.90	2.00
Zinc, Total	mg/l	0.004	0.009	0.017	0.020	0.031
Zinc, Dissolved	mg/l		0.006	0.010	0.018	<0.001

Table 12. Results of chemical analyses of surface water quality samples collected at station CS-7.

Parameter	Units	11-8-78	5-11-79	6-20-79	7-20-79	8-23-79
FIELD MEASUREMENTS						
Discharge	cfs	0.5	1.3	5.5	2.0	0.5
Dissolved Oxygen	mg/l	11.6	9.2	7.4	7.3	7.4
pH	units	7.4	7.8	8.3	9.15	7.2
Specific Conductance	umhos/cm @ 25° C	370	360	290	345	370
Temperature, Air	°C	14	1	16	21	
Temperature, Water	°C	1.5	2	12	13	12.5
LABORATORY MEASUREMENTS						
Acidity, as $CaCO_3$	mg/l		16.0	2.0	16.0	4.0
Alkalinity, as $CaCO_3$	mg/l		186	170	190	184
Ammonia, NH_3 as N	mg/l		<0.10	<0.01	<0.01	<0.01
Arsenic, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, Dissolved	mg/l		<0.001	<0.001	<0.001	<0.001
BOD, 5 Day	mg/l					
Barium, Total	mg/l	<0.01	0.010	0.040	0.020	0.025
Barium, Dissolved	mg/l		0.010	0.040	<0.001	0.002
Bicarbonate	mg/l	239.12	226.92	207.40	231.81	224.48
Boron, Total	mg/l		0.065	0.046	0.095	<0.005
Boron, Dissolved	mg/l		0.060	0.015	0.090	0.045
Cadmium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Dissolved	mg/l		<0.001	<0.001	<0.001	<0.001
Calcium	mg/l	59.2	65.60	58.40	60.00	73.60
Chloride	mg/l	<0.01	6.0	<1.0	2.0	<0.1
Chromium, Total	mg/l	<0.001	0.006	0.001	0.001	0.004
Chromium, Dissolved	mg/l		<0.001	<0.001	<0.001	0.002
Copper, Total	mg/l	0.001	0.013	0.005	0.004	0.006
Copper, Dissolved	mg/l		0.004	0.005	<0.001	<0.001
Cyanide	mg/l	<0.01	<0.001	<0.001	0.001	<0.001
Fluoride	mg/l	0.09	0.10	0.52	0.14	0.17
Gross Alpha Radioactivity	pCi/l			2.4		<2.0
Gross Beta Radioactivity	pCi/l			12.0		4.0
Iron, Total	mg/l	0.090	0.201	0.270	0.240	0.250
Iron, Dissolved	mg/l		0.012	0.020	0.030	0.058
Lead, Total	mg/l		0.003	0.001	0.015	<0.001
Lead, Dissolved	mg/l		<0.001	<0.001	<0.001	<0.001
MPN Fecal Coliform	MPN/100 ml			<2.0		
MPN Total Coliform	MPN/100 ml			170		
Magnesium	mg/l	6.24	9.12	8.64	10.08	2.88
Manganese, Total	mg/l	0.021	0.010	0.007	0.012	0.002
Mercury, Total	mg/l		<0.0002	<0.0002	<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l	0.78	4.00	0.62	0.71	0.97
Oil and Grease	mg/l		<1.0	<1.0	<1.0	<1.0
Phenol	mg/l		<0.001	<0.001	0.034	0.008
Phosphate, PO_4 as P	mg/l		0.08	0.015	0.020	0.020
Potassium	mg/l	0.090	0.793	0.708	0.759	0.790
Selenium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium, Dissolved	mg/l		<0.001	<0.001	<0.001	<0.001
Silver, Total	mg/l	<0.001	0.003	0.003	<0.001	<0.001
Silver, Dissolved	mg/l		<0.001	<0.001	<0.001	<0.001
Sodium	mg/l	15.82	2.07	1.98	2.20	2.80
Sulfate	mg/l	9.0	8.0	14.0	6.0	13.0
Suspended Solids	mg/l	7.0	8.0	9.0	4.0	3.0
Total Dissolved Solids	mg/l	210	240	185	200	210
Total Organic Carbon	mg/l		13.00	1.50	7.00	7.50
Turbidity	NTU		0.85	5.00	5.00	5.00
Zinc, Total	mg/l	0.002	0.013	0.013	0.011	0.015
Zinc, Dissolved	mg/l		0.004	0.010	0.007	0.008

Table 12. Continued.

Parameter	Units	9-25-79
FIELD MEASUREMENTS		
Discharge	cfs	0.4
Dissolved Oxygen	mg/l	
pH	units	7.25
Specific Conductance	umhos/cm @ 25° C	370.0
Temperature, Air	°C	15.0
Temperature, Water	°C	9.0
LABORATORY MEASUREMENTS		
Acidity, as $CaCO_3$	mg/l	4.0
Alkalinity, as $CaCO_3$	mg/l	182.0
Ammonia, NH_3 as N	mg/l	<0.01
Arsenic, Total	mg/l	<0.001
Arsenic, Dissolved	mg/l	
BOD, 5 Day	mg/l	
Barium, Total	mg/l	0.028
Barium, Dissolved	mg/l	
Bicarbonate	mg/l	222.00
Boron, Total	mg/l	0.140
Boron, Dissolved	mg/l	
Cadmium, Total	mg/l	<0.001
Cadmium, Dissolved	mg/l	
Calcium	mg/l	75.60
Chloride	mg/l	<0.1
Chromium, Total	mg/l	0.006
Chromium, Dissolved	mg/l	
Copper, Total	mg/l	0.010
Copper, Dissolved	mg/l	
Cyanide	mg/l	0.005
Fluoride	mg/l	0.13
Gross Alpha Radioactivity	pCi/l	
Gross Beta Radioactivity	pCi/l	
Iron, Total	mg/l	0.030
Iron, Dissolved	mg/l	
Lead, Total	mg/l	<0.001
Lead, Dissolved	mg/l	
MPN Fecal Coliform	MPN/100 ml	
MPN Total Coliform	MPN/100 ml	
Magnesium	mg/l	2.14
Manganese, Total	mg/l	0.003
Mercury, Total	mg/l	<0.0002
Nitrate, NO_3 as N	mg/l	0.73
Oil and Grease	mg/l	1.6
Phenol	mg/l	0.003
Phosphate, PO_4 as P	mg/l	0.020
Potassium	mg/l	0.710
Selenium, Total	mg/l	<0.001
Selenium, Dissolved	mg/l	
Silver, Total	mg/l	<0.001
Silver, Dissolved	mg/l	
Sodium	mg/l	2.54
Sulfate	mg/l	18.3
Suspended Solids	mg/l	1.0
Total Dissolved Solids	mg/l	210.0
Total Organic Carbon	mg/l	4.0
Turbidity	NTU	5.30
Zinc, Total	mg/l	0.019
Zinc, Dissolved	mg/l	

Table 13. Results of chemical analyses of surface water quality samples collected at station UPL-3.

Parameter	Units	7-31-74	9-5-74	10-3-74	11-3-74	12-2-74	1-3-75	2-4-75
FIELD MEASUREMENTS								
Discharge	cfs	16	15.3	10		7.65	7.80	7.0
Dissolved Oxygen	mg/l	7.60	7.75	7.15	7.20	8.2	8.45	7.90
pH	units	7.80	7.55	7.60	7.65	7.45	7.22	7.20
Specific Conductance	umhos/cm @ 25° C							
Temperature, Air	°C	21	17	8		12	-5	-4.4
Temperature, Water	°C	6	5	6		4	3	3.5
LABORATORY MEASUREMENTS								
Acidity, as $CaCO_3$	mg/l							
Alkalinity, as $CaCO_3$	mg/l	122.0	112.0	144.0	128.0	152.0	140.0	142.0
Ammonia, NH_3 as N	mg/l							
Arsenic, Total	mg/l			0.0000				0.000
Arsenic, Dissolved	mg/l							
BOD, 5 Day	mg/l			3.5				3.1
Barium, Total	mg/l			0.0000				0.0000
Barium, Dissolved	mg/l							
Bicarbonate	mg/l							
Boron, Total	mg/l							
Boron, Dissolved	mg/l							
Cadmium, Total	mg/l			0.0015				0.0012
Cadmium, Dissolved	mg/l							
Calcium	mg/l							
Chloride	mg/l			2.0				1.6
Chromium, Total	mg/l			< 0.010				< 0.010
Chromium, Dissolved	mg/l							
Copper, Total	mg/l							
Copper, Dissolved	mg/l							
Cyanide	mg/l							
Fluoride	mg/l			0.14				0.13
Gross Alpha Radioactivity	pCi/l							
Gross Beta Radioactivity	pCi/l							
Iron, Total	mg/l			0.130				0.159
Iron, Dissolved	mg/l							
Lead, Total	mg/l			0.0000				0.0000
Lead, Dissolved	mg/l							
MPN Fecal Coliform	MPN/100 ml	<3	<3	<3	<3	<3	<3	<3
MPN Total Coliform	MPN/100 ml	<3	<3	4	<3	<3	<30	<3
Magnesium	mg/l							
Manganese, Total	mg/l			0.062				0.076
Mercury, Total	mg/l			0.0000				0.0000
Nitrate, NO_3 as N	mg/l	1.10	0.85	0.90	0.82	0.65	0.80	0.68
Oil and Grease	mg/l							
Phenol	mg/l			0.0000				0.0000
Phosphate, PO_4 as P	mg/l	0.40	0.27	0.25	0.21	0.155	0.19	0.15
Potassium	mg/l							
Selenium, Total	mg/l			0.0000				0.0000
Selenium, Dissolved	mg/l							
Silver, Total	mg/l			0.0000				0.0000
Silver, Dissolved	mg/l							
Sodium	mg/l							
Sulfate	mg/l			8.0				8.1
Suspended Solids	mg/l	5.0	11.0	13.0	17.8	3.0	5.0	3.0
Total Dissolved Solids	mg/l			168.0				165.0
Total Organic Carbon	mg/l							
Turbidity	NTU	24.0	8.20	3.90	41.0	3.3	4.0	5.40
Zinc, Total	mg/l			0.001				0.017
Zinc, Dissolved	mg/l							

Table 13. Continued

Parameter	Units	3-5-75	4-2-75	5-1-75	6-3-75	7-22-75	10-13-75	11-12-75
FIELD MEASUREMENTS								
Discharge	cfs	7.8	7.6	7				
Dissolved Oxygen	mg/l	7.50	7.2	7.1	7.4		7.2	9.24
pH	units	7.36	7.64	7.18	7.54		7.84	7.56
Specific Conductance	umhos/cm @ 25° C							
Temperature, Air	°C	-14.5	-12.0	2.0	15	23	12	6
Temperature, Water	°C	4.0	3.5	4.0	4.5	3.5	6.5	5
LABORATORY MEASUREMENTS								
Acidity, as $CaCO_3$	mg/l							
Alkalinity, as $CaCO_3$	mg/l	168.0	156.0	144	140		98.0	104.0
Ammonia, NH_3 as N	mg/l							
Arsenic, Total	mg/l					0.0000		
Arsenic, Dissolved	mg/l							
BOD, 5 Day	mg/l					4.0		
Barium, Total	mg/l					0.0000		
Barium, Dissolved	mg/l							
Bicarbonate	mg/l							
Boron, Total	mg/l							
Boron, Dissolved	mg/l							
Cadmium, Total	mg/l					0.0023		
Cadmium, Dissolved	mg/l							
Calcium	mg/l							
Chloride	mg/l					4.0		
Chromium, Total	mg/l					<0.010		
Chromium, Dissolved	mg/l							
Copper, Total	mg/l							
Copper, Dissolved	mg/l							
Cyanide	mg/l							
Fluoride	mg/l					0.21		
Gross Alpha Radioactivity	pCi/l							
Gross Beta Radioactivity	pCi/l							
Iron, Total	mg/l					0.244		
Iron, Dissolved	mg/l							
Lead, Total	mg/l					0.0000		
Lead, Dissolved	mg/l							
MPN Fecal Coliform	MPN/100 ml	<3	<3	<3	<3	<3	<3	<3
MPN Total Coliform	MPN/100 ml	73	36	<3	15	<3	29	<3
Magnesium	mg/l							
Manganese, Total	mg/l					0.083		
Mercury, Total	mg/l					0.0000		
Nitrate, NO_3 as N	mg/l	0.40	0.21	0.30	0.26	0.64	0.39	0.33
Oil and Grease	mg/l							
Phenol	mg/l					0.0000		
Phosphate, PO_4 as P	mg/l	0.17	0.16	0.20	0.07		0.99	0.02
Potassium	mg/l							
Selenium, Total	mg/l					0.0000		
Selenium, Dissolved	mg/l							
Silver, Total	mg/l					0.0000		
Silver, Dissolved	mg/l							
Sodium	mg/l							
Sulfate	mg/l					8.7		
Suspended Solids	mg/l	4.5	4.0	5.20	105.0		<1.0	4.6
Total Dissolved Solids	mg/l					145.0		
Total Organic Carbon	mg/l							
Turbidity	NTU	1.60	1.70	2.5	6.2		4.00	1.10
Zinc, Total	mg/l							
Zinc, Dissolved	mg/l							

Table 13. Continued

Parameter	Units	2-5-76	3-3-76	3-31-76	6-15-76	8-3-76	10-1-76	10-28-76
FIELD MEASUREMENTS								
Discharge	cfs		8.4		20	34	37	21
Dissolved Oxygen	mg/l	9.30	9.30		6.8	5.8	6.7	8.5
pH	units	7.16	7.20	7.18	7.4	8.2	7.3	7.6
Specific Conductance	umhos/cm @ 25° C			320	300	320	410	350
Temperature, Air	°C	0	-4		20	13	16	7
Temperature, Water	°C	3	3		7	9	10	7
LABORATORY MEASUREMENTS								
Acidity, as $CaCO_3$	mg/l							
Alkalinity, as $CaCO_3$	mg/l	110.0	112.0	122	110	108	124	128
Ammonia, NH_3 as N	mg/l			0.35				
Arsenic, Total	mg/l			< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Arsenic, Dissolved	mg/l							
BOD, 5 Day	mg/l							
Barium, Total	mg/l			0.017	0.016	0.018	0.007	0.002
Barium, Dissolved	mg/l							
Bicarbonate	mg/l			148.8	148.8	131.7	151.3	156.1
Boron, Total	mg/l			0.013	0.002	0.005	< 0.001	< 0.001
Boron, Dissolved	mg/l							
Cadmium, Total	mg/l			< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cadmium, Dissolved	mg/l							
Calcium	mg/l			40.8	27.2	45.0	36.8	41.6
Chloride	mg/l			0.5	0.50	8.0	10.0	1.8
Chromium, Total	mg/l			< 0.001	< 0.001	< 0.001		
Chromium, Dissolved	mg/l							
Copper, Total	mg/l			< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Copper, Dissolved	mg/l							
Cyanide	mg/l							
Fluoride	mg/l			0.14	0.11	0.13	0.17	0.09
Gross Alpha Radioactivity	pCi/l							
Gross Beta Radioactivity	pCi/l							
Iron, Total	mg/l			0.290	0.210	0.167	0.173	0.210
Iron, Dissolved	mg/l							
Lead, Total	mg/l			< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Lead, Dissolved	mg/l							
MPN Fecal Coliform	MPN/100 ml	< 3	< 3					
MPN Total Coliform	MPN/100 ml	< 3	20					
Magnesium	mg/l			9.12	5.76	6.0	3.80	8.6
Manganese, Total	mg/l			0.008	0.010	< 0.001	< 0.001	0.003
Mercury, Total	mg/l			< 0.001	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nitrate, NO_3 as N	mg/l	0.240	0.290	0.200	0.200	0.40	0.21	0.20
Oil and Grease	mg/l							
Phenol	mg/l							
Phosphate, PO_4 as P	mg/l	0.055	0.057	0.330	0.160	0.130	0.145	0.140
Potassium	mg/l			1.23	0.72	0.89	1.00	0.81
Selenium, Total	mg/l			< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Selenium, Dissolved	mg/l							
Silver, Total	mg/l			< 0.001	< 0.001	< 0.001		
Silver, Dissolved	mg/l							
Sodium	mg/l			2.48	18.00	1.10	19.0	6.00
Sulfate	mg/l			15.0	9.20	21.0	11.0	25.3
Suspended Solids	mg/l	36.6	4.0					
Total Dissolved Solids	mg/l			210	200	210	270	230
Total Organic Carbon	mg/l							
Turbidity	NTU	0.53	0.70	0.79	0.80	1.20	6.10	1.10
Zinc, Total	mg/l			0.029	0.025	0.019	0.070	0.013
Zinc, Dissolved	mg/l							

Table 13. Continued

Parameter	Units	11-30-76	12-29-76	2-1-77	3-3-77	4-7-77	5-10-77	6-2-77
FIELD MEASUREMENTS								
Discharge	cfs	18	18	12	5	13	5	18
Dissolved Oxygen	mg/l	8.2	8.0	7.9	8.2	7.7	8.4	8.5
pH	units	8.2	7.5	7.4		7.7	7.0	7.3
Specific Conductance	umhos/cm @ 25° C	400	320	350	330	330	370	360
Temperature, Air	°C	-2	6	-3	-6	9	12	24
Temperature, Water	°C	4	3	4	4	5	6	9
LABORATORY MEASUREMENTS								
Acidity, as $CaCO_3$	mg/l							
Alkalinity, as $CaCO_3$	mg/l	146	128	130	124	126	146	124
Ammonia, NH_3 as N	mg/l							
Arsenic, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, Dissolved	mg/l							
BOD, 5 Day	mg/l							
Barium, Total	mg/l	0.004	0.002	0.003	<0.001	<0.001	0.003	0.004
Barium, Dissolved	mg/l							
Bicarbonate	mg/l	178.1	156.2	158.6	153.3	153.7	178.1	151.3
Boron, Total	mg/l	<0.001	<0.001	<0.001	0.005	0.013	0.010	0.011
Boron, Dissolved	mg/l							
Cadmium, Total	mg/l	<0.001	<0.001	<0.001				
Cadmium, Dissolved	mg/l							
Calcium	mg/l	51.2	40.8	45.6	42.4	44.0	34.1	41.6
Chloride	mg/l	4.0	1.5	1.0	<0.01	2.0	<0.01	<0.01
Chromium, Total	mg/l							
Chromium, Dissolved	mg/l							
Copper, Total	mg/l	0.008	0.013	0.007	0.006	0.009	0.004	0.005
Copper, Dissolved	mg/l							
Cyanide	mg/l							
Fluoride	mg/l	0.10	0.09	0.10	0.11	0.18	0.19	0.11
Gross Alpha Radioactivity	pCi/l							
Gross Beta Radioactivity	pCi/l							
Iron, Total	mg/l	0.117	0.115	0.113	0.090	0.083	0.136	0.124
Iron, Dissolved	mg/l							
Lead, Total	mg/l	<0.001	<0.001	<0.001				
Lead, Dissolved	mg/l							
MPN Fecal Coliform	MPN/100 ml							
MPN Total Coliform	MPN/100 ml							
Magnesium	mg/l	10.08	3.29	7.68	9.12	6.72	16.80	13.44
Manganese, Total	mg/l	0.002	0.003	0.004	0.019	0.015	0.085	0.082
Mercury, Total	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l	0.26	0.22	0.20	0.15	0.10	0.02	0.04
Oil and Grease	mg/l							
Phenol	mg/l							
Phosphate, PO_4 as P	mg/l	0.130	0.180	0.110	0.110	0.092	0.085	0.060
Potassium	mg/l	0.96	0.75	1.00	0.90	1.30	1.04	1.13
Selenium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium, Dissolved	mg/l							
Silver, Total	mg/l							
Silver, Dissolved	mg/l							
Sodium	mg/l	1.5	9.80	1.75	1.63	1.92	3.17	2.33
Sulfate	mg/l	18.0	10.0	20.0	21.0	16.0	20.00	36.9
Suspended Solids	mg/l							
Total Dissolved Solids	mg/l	260	210	230	219.3	220	250	240
Total Organic Carbon	mg/l							
Turbidity	NTU	0.49	0.90	0.50	0.30	14.0	1.50	1.5
Zinc, Total	mg/l	0.009	0.014	0.016	0.018	0.019	0.016	0.013
Zinc, Dissolved	mg/l							

Table 13. Continued

Parameter	Units	7-7-77	8-4-77	9-9-77	10-13-77	11-10-77
FIELD MEASUREMENTS						
Discharge	cfs	18	60	21		22
Dissolved Oxygen	mg/l	9.2	8.4	8.2		9.3
pH	units	8.1	8.2	8.3	7.07	7.6
Specific Conductance	umhos/cm @ 25° C	230	263	230	380	248
Temperature, Air	°C	26	23	25	19	8
Temperature, Water	°C	13	15	17	9	6
LABORATORY MEASUREMENTS						
Acidity, as $CaCO_3$	mg/l					
Alkalinity, as $CaCO_3$	mg/l	130	130	128	142	132
Ammonia, NH_3 as N	mg/l					
Arsenic, Total	mg/l	<0.001	<0.001			
Arsenic, Dissolved	mg/l					
BOD, 5 Day	mg/l					
Barium, Total	mg/l	0.003	0.014	0.033	0.021	0.006
Barium, Dissolved	mg/l					
Bicarbonate	mg/l	158.6	158.6	156.2	173.4	161.1
Boron, Total	mg/l	0.009	0.055	0.10	0.15	0.33
Boron, Dissolved	mg/l					
Cadmium, Total	mg/l					
Cadmium, Dissolved	mg/l					
Calcium	mg/l	45.60	46.4	46.4	45.6	47.2
Chloride	mg/l	1.8	<0.01	4.0	<0.01	<0.01
Chromium, Total	mg/l					
Chromium, Dissolved	mg/l					
Copper, Total	mg/l	0.002	0.003	0.004	0.003	0.002
Copper, Dissolved	mg/l					
Cyanide	mg/l					
Fluoride	mg/l	0.13	0.12	0.09	0.08	0.88
Gross Alpha Radioactivity	pCi/l					
Gross Beta Radioactivity	pCi/l					
Iron, Total	mg/l	0.190	0.092	0.163	0.114	0.044
Iron, Dissolved	mg/l					
Lead, Total	mg/l					
Lead, Dissolved	mg/l					
MPN Fecal Coliform	MPN/100 ml					
MPN Total Coliform	MPN/100 ml					
Magnesium	mg/l	6.24	5.76	6.24	12.00	9.12
Manganese, Total	mg/l	0.019	0.005	0.006	0.019	0.004
Mercury, Total	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l	0.03	0.02	0.03	0.04	0.05
Oil and Grease	mg/l					
Phenol	mg/l					
Phosphate, PO_4 as P	mg/l	0.050	0.105	0.090	0.086	0.050
Potassium	mg/l	0.90	0.80	1.84	1.02	1.01
Selenium, Total	mg/l	<0.001	<0.001			
Selenium, Dissolved	mg/l					
Silver, Total	mg/l					
Silver, Dissolved	mg/l					
Sodium	mg/l	1.39	9.50	1.81	24.30	1.4
Sulfate	mg/l	9.0	30.0	12.5	74.0	23.0
Suspended Solids	mg/l					
Total Dissolved Solids	mg/l	140	172	150	243	160
Total Organic Carbon	mg/l					
Turbidity	NTU	1.50	0.80	0.36	0.82	15.0
Zinc, Total	mg/l	0.012	0.004	0.011	0.015	0.002
Zinc, Dissolved	mg/l					

Table 13. Continued

Parameter	Units	12-15-77	1-12-78	2-7-78	3-9-78	4-13-78	5-11-78	6-15-78
FIELD MEASUREMENTS								
Discharge	cfs	8.5	9	19	16	14	27	56
Dissolved Oxygen	mg/l	12.8	9.4	9.3	9.8	9.1	8.9	9.5
pH	units	7.6	7.7	8.1	8.0	7.7	7.3	7.5
Specific Conductance	umhos/cm @ 25° C	252	248	272	268	275	230	240
Temperature, Air	°C	3	2	0	5		11	
Temperature, Water	°C	5	3	2.5	11	3.5	4	7.5
LABORATORY MEASUREMENTS								
Acidity, as $CaCO_3$	mg/l							
Alkalinity, as $CaCO_3$	mg/l	142	150	148	146	152	124	124
Ammonia, NH_3 as N	mg/l							
Arsenic, Total	mg/l							< 0.001
Arsenic, Dissolved	mg/l							
BOD, 5 Day	mg/l							
Barium, Total	mg/l	0.013	0.140	0.030	0.070	0.020	0.022	0.040
Barium, Dissolved	mg/l							
Bicarbonate	mg/l	173.2	183	180.5	178.1	185.44	151.28	151.28
Boron, Total	mg/l	0.04	0.12	0.04	0.06	0.05	0.05	0.09
Boron, Dissolved	mg/l							
Cadmium, Total	mg/l							
Cadmium, Dissolved	mg/l							
Calcium	mg/l	47.2	48.0	49.6	48.0	49.6	45.6	40.8
Chloride	mg/l	6.0	2.0	6.0	< 0.01	2.0	6.0	8.0
Chromium, Total	mg/l					< 0.001		< 0.001
Chromium, Dissolved	mg/l							
Copper, Total	mg/l	0.011	0.002	0.006	0.006	0.003	0.002	0.001
Copper, Dissolved	mg/l							
Cyanide	mg/l							
Fluoride	mg/l	0.16	0.10	0.11	0.07	0.11	0.09	0.09
Gross Alpha Radioactivity	pCi/l							
Gross Beta Radioactivity	pCi/l							
Iron, Total	mg/l	0.270	0.43	0.329	0.331	0.067	0.029	0.123
Iron, Dissolved	mg/l							
Lead, Total	mg/l					< 0.001		< 0.001
Lead, Dissolved	mg/l							
MPN Fecal Coliform	MPN/100 ml							
MPN Total Coliform	MPN/100 ml							
Magnesium	mg/l	9.12	9.60	9.60	9.60	10.08	5.28	7.2
Manganese, Total	mg/l	0.095	0.109	0.081	0.071	0.041	0.047	0.018
Mercury, Total	mg/l	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nitrate, NO_3 as N	mg/l	0.07	0.10	0.06	0.11	0.20	0.30	0.57
Oil and Grease	mg/l							
Phenol	mg/l							
Phosphate, PO_4 as P	mg/l	0.030	0.030	0.030	0.032	0.035	0.030	0.076
Potassium	mg/l	0.99	1.36	1.05	2.51	1.328	1.000	0.819
Selenium, Total	mg/l					< 0.001		< 0.001
Selenium, Dissolved	mg/l							
Silver, Total	mg/l							< 0.001
Silver, Dissolved	mg/l							
Sodium	mg/l	2.0	1.0	4.0	4.0	4.13	3.10	8.0
Sulfate	mg/l	12.0	8.0	18.0	22.0	22.0	12.0	16.0
Suspended Solids	mg/l							
Total Dissolved Solids	mg/l	162	166	176	172	180	150	160
Total Organic Carbon	mg/l							
Turbidity	NTU	0.85	1.6	2.20	2.4	2.8	2.20	1.60
Zinc, Total	mg/l	0.046	0.011	0.004	0.014	0.017	0.015	0.003
Zinc, Dissolved	mg/l							

Table 13. Continued

Parameter	Units	7-13-78	8-10-78	9-14-78	10-10-78	11-9-78	12-14-78
FIELD MEASUREMENTS							
Discharge	cfs	67	24	13	28	48	41
Dissolved Oxygen	mg/l	7.7	8.5	7.2	8.4	8.2	10.4
pH	units	7.6	7.3	7.6	7.05	7.65	
Specific Conductance	umhos/cm @ 25° C	230	235	220	230	250	285
Temperature, Air	°C	27	26	12	21	14	1
Temperature, Water	°C	12	7.5	10	11	6.5	4
LABORATORY MEASUREMENTS							
Acidity, as $CaCO_3$	mg/l						
Alkalinity, as $CaCO_3$	mg/l	122	118	118	120	142	136
Ammonia, NH_3 as N	mg/l						
Arsenic, Total	mg/l		< 0.001	<0.001	<0.001	<0.001	
Arsenic, Dissolved	mg/l						
BOD, 5 Day	mg/l						
Barium, Total	mg/l	0.019	0.120	0.05	0.037	0.040	
Barium, Dissolved	mg/l						
Bicarbonate	mg/l	148.8	143.9	143.9	146.4	173.24	165.92
Boron, Total	mg/l	0.04	0.04	0.090	0.550	0.090	
Boron, Dissolved	mg/l						
Cadmium, Total	mg/l						
Cadmium, Dissolved	mg/l						
Calcium	mg/l	21.6	44.0	44.0	48.0	47.2	56.0
Chloride	mg/l	2.0	<0.1	4.0	<0.01	2.0	<0.01
Chromium, Total	mg/l			<0.001			
Chromium, Dissolved	mg/l						
Copper, Total	mg/l	0.011	0.001	0.003	0.008	< 0.001	
Copper, Dissolved	mg/l						
Cyanide	mg/l						
Fluoride	mg/l	0.08	0.06	0.08	0.10	0.07	
Gross Alpha Radioactivity	pCi/l						
Gross Beta Radioactivity	pCi/l						
Iron, Total	mg/l	0.105	0.151	0.093	0.089	0.096	
Iron, Dissolved	mg/l						
Lead, Total	mg/l			<0.001			
Lead, Dissolved	mg/l						
MPN Fecal Coliform	MPN/100 ml						2
MPN Total Coliform	MPN/100 ml						8
Magnesium	mg/l	3.36	7.2	6.7	5.28	8.16	7.20
Manganese, Total	mg/l	0.019	0.031	0.025	0.018	0.018	
Mercury, Total	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
Nitrate, NO_3 as N	mg/l	0.39	0.39	0.26	0.10	0.21	
Oil and Grease	mg/l						
Phenol	mg/l						
Phosphate, PO_4 as P	mg/l	0.028	0.030	0.024	0.030	0.025	
Potassium	mg/l	0.889	0.902	0.172	0.914	0.958	0.978
Selenium, Total	mg/l		<0.001		<0.001		
Selenium, Dissolved	mg/l						
Silver, Total	mg/l			<0.001			
Silver, Dissolved	mg/l						
Sodium	mg/l	31.0	2.96	1.59	1.65	4.0	1.79
Sulfate	mg/l	14.0	25.0	15.0	23.0	17.0	38.0
Suspended Solids	mg/l						8.0
Total Dissolved Solids	mg/l	150	155	145	150	165	185
Total Organic Carbon	mg/l						
Turbidity	NTU	1.60	1.2	0.60	0.85	0.46	1.50
Zinc, Total	mg/l	0.011	0.002	0.012	0.003	0.004	
Zinc, Dissolved	mg/l						

Table 13. Continued

Parameter	Units	1-10-79	2-14-79	2-13-79	4-17-79	5-8-79
FIELD MEASUREMENTS						
Discharge	cfs	25.5	18.5	22	34	53.5
Dissolved Oxygen	mg/l	8.8	9.4	10.0	8.1	10.4
pH	units	7.9	7.7	8.45	7.51	8.1
Specific Conductance	umhos/cm @ 25° C	250	290	290	430	270
Temperature, Air	°C	2	0	0	9	1
Temperature, Water	°C	4.5	4	5	3	5.5
LABORATORY MEASUREMENTS						
Acidity, as $CaCO_3$	mg/l					
Alkalinity, as $CaCO_3$	mg/l	138				
Ammonia, NH_3 as N	mg/l					
Arsenic, Total	mg/l	<0.001				
Arsenic, Dissolved	mg/l					
BOD, 5 Day	mg/l	3.5				
Barium, Total	mg/l	0.030				
Barium, Dissolved	mg/l					
Bicarbonate	mg/l	168.36				
Boron, Total	mg/l					
Boron, Dissolved	mg/l					
Cadmium, Total	mg/l	<0.001				
Cadmium, Dissolved	mg/l					
Calcium	mg/l	46.4				
Chloride	mg/l	2.0				
Chromium, Total	mg/l	<0.001				
Chromium, Dissolved	mg/l					
Copper, Total	mg/l	<0.001				
Copper, Dissolved	mg/l					
Cyanide	mg/l	0.005				
Fluoride	mg/l	0.08				
Gross Alpha Radioactivity	pCi/l					
Gross Beta Radioactivity	pCi/l					
Iron, Total	mg/l	0.164				
Iron, Dissolved	mg/l					
Lead, Total	mg/l	<0.001				
Lead, Dissolved	mg/l					
MPN Fecal Coliform	MPN/100 ml	<2	<2	<2	<2.0	<2.0
MPN Total Coliform	MPN/100 ml	8	2	23	33.0	5.0
Magnesium	mg/l	10.56				
Manganese, Total	mg/l	0.035				
Mercury, Total	mg/l	<0.0002				
Nitrate, NO_3 as N	mg/l	0.28	0.17	0.18	0.06	0.10
Oil and Grease	mg/l					
Phenol	mg/l					
Phosphate, PO_4 as P	mg/l	0.040	0.055	0.020	0.04	0.050
Potassium	mg/l	0.861				
Selenium, Total	mg/l	<0.001				
Selenium, Dissolved	mg/l					
Silver, Total	mg/l	<0.001				
Silver, Dissolved	mg/l					
Sodium	mg/l	1.59				
Sulfate	mg/l	19.0				
Suspended Solids	mg/l	1.0	6.0	1.0	1.0	1.0
Total Dissolved Solids	mg/l	164	196	190	280	180
Total Organic Carbon	mg/l					
Turbidity	NTU	1.00	1.50	1.50	3.60	0.45
Zinc, Total	mg/l	0.027				
Zinc, Dissolved	mg/l					

Table 13. Continued

Parameter	Units	6-14-79	7-19-79	8-9-79	8-29-79
FIELD MEASUREMENTS					
Discharge	cfs	88	28	154	22.9
Dissolved Oxygen	mg/l	8.0	8.4	7.8	7.6
pH	units	7.8	7.1	7.0	
Specific Conductance	umhos/cm @ 25° C	260	260	220	270
Temperature, Air	°C	25	19	25	
Temperature, Water	°C	7	9.0	12	7.0
LABORATORY MEASUREMENTS					
Acidity, as $CaCO_3$	mg/l		12.0		
Alkalinity, as $CaCO_3$	mg/l		124		
Ammonia, NH_3 as N	mg/l		<0.01		
Arsenic, Total	mg/l		<0.001		
Arsenic, Dissolved	mg/l		<0.001		
BOD, 5 Day	mg/l				
Barium, Total	mg/l		0.045		
Barium, Dissolved	mg/l		0.040		
Bicarbonate	mg/l		151.28		
Boron, Total	mg/l		0.095		
Boron, Dissolved	mg/l		0.090		
Cadmium, Total	mg/l		<0.001		
Cadmium, Dissolved	mg/l		<0.001		
Calcium	mg/l		40.80		
Chloride	mg/l		<0.1		
Chromium, Total	mg/l		0.002		
Chromium, Dissolved	mg/l		<0.001		
Copper, Total	mg/l		0.009		
Copper, Dissolved	mg/l		0.003		
Cyanide	mg/l		<0.001		
Fluoride	mg/l		0.10		
Gross Alpha Radioactivity	pCi/l				
Gross Beta Radioactivity	pCi/l				
Iron, Total	mg/l		0.130		
Iron, Dissolved	mg/l		0.040		
Lead, Total	mg/l		0.017		
Lead, Dissolved	mg/l		<0.001		
MPN Fecal Coliform	MPN/100 ml	2.0	<2.0		
MPN Total Coliform	MPN/100 ml	17.0		11.0	
Magnesium	mg/l		7.68		
Manganese, Total	mg/l		0.012		
Mercury, Total	mg/l		<0.0002		
Nitrate, NO_3 as N	mg/l	0.78	0.56	0.33	
Oil and Grease	mg/l		<1.0		
Phenol	mg/l		0.194		
Phosphate, PO_4 as P	mg/l	0.060	<0.001	0.020	
Potassium	mg/l		1.072		
Selenium, Total	mg/l		<0.001		
Selenium, Dissolved	mg/l		<0.001		
Silver, Total	mg/l		<0.001		
Silver, Dissolved	mg/l		<0.001		
Sodium	mg/l		2.34		
Sulfate	mg/l		14.0		
Suspended Solids	mg/l	4.0	6.0	8.0	
Total Dissolved Solids	mg/l	170	150	120	
Total Organic Carbon	mg/l		7.00		
Turbidity	NTU	6.50	5.00	10.00	
Zinc, Total	mg/l		0.014		
Zinc, Dissolved	mg/l		0.006		

Table 13 - Continued.

Parameter	Units	9-20-79
FIELD MEASURMENTS		
Discharge	cfs	30.0
Dissolved Oxygen	mg/l	8.6
pH	units	7.6
Specific Conductance	umhos/cm @ 25° C	280.0
Temperature, Air	°C	15.0
Temperature, Water	°C	7.7
LABORATORY MEASUREMENTS		
Acidity, as $CaCO_3$	mg/l	12.0
Alkalinity, as $CaCO_3$	mg/l	142.0
Ammonia, NH_3 as N	mg/l	<0.01
Arsenic, Total	mg/l	<0.001
Arsenic, Dissolved	mg/l	
BOD, 5 Day	mg/l	
Barium, Total	mg/l	0.080
Barium, Dissolved	mg/l	
Bicarbonate	mg/l	173.24
Boron, Total	mg/l	<0.001
Boron, Dissolved	mg/l	
Cadmium, Total	mg/l	<0.001
Cadmium, Dissolved	mg/l	
Calcium	mg/l	48.00
Chloride	mg/l	2.0
Chromium, Total	mg/l	0.006
Chromium, Dissolved	mg/l	
Copper, Total	mg/l	0.008
Copper, Dissolved	mg/l	
Cyanide	mg/l	<0.001
Fluoride	mg/l	0.14
Gross Alpha Radioactivity	pCi/l	
Gross Beta Radioactivity	pCi/l	
Iron, Total	mg/l	0.030
Iron, Dissolved	mg/l	
Lead, Total	mg/l	0.001
Lead, Dissolved	mg/l	
MPN Fecal Coliform	MPN/100 ml	<2.0
MPN Total Coliform	MPN/100 ml	<2.0
Magnesium	mg/l	8.90
Manganese, Total	mg/l	0.016
Mercury, Total	mg/l	<0.0002
Nitrate, NO_3 as N	mg/l	0.23
Oil and Grease	mg/l	1.6
Phenol	mg/l	0.110
Phosphate, PO_4 as P	mg/l	0.200
Potassium	mg/l	1.100
Selenium, Total	mg/l	<0.001
Selenium, Dissolved	mg/l	
Silver, Total	mg/l	<0.001
Silver, Dissolved	mg/l	
Sodium	mg/l	12.0
Sulfate	mg/l	35.9
Suspended Solids	mg/l	3.0
Total Dissolved Solids	mg/l	197.0
Total Organic Carbon	mg/l	10.0
Turbidity	NTU	5.00
Zinc, Total	mg/l	0.0006
Zinc, Dissolved	mg/l	

Table 14. Results of chemical analyses of surface water quality samples collected at station UPL-10.

Parameter	Units	6-13-78	7-13-78	8-10-78	9-14-78	10-10-78	11-8-78
FIELD MEASUREMENTS							
Discharge	cfs	34	12.8	3.0	3.5	3.4	1.6
Dissolved Oxygen	mg/l	9.6	8.7	9.0	10.1	8.6	10.8
pH	units	7.5	8.3	7.9	7.6		7.4
Specific Conductance	umhos/cm @ 25° C	193	230	260	285	275	320
Temperature, Air	°C		28	25	13	17	12
Temperature, Water	°C	13	16	17	6	10	4
LABORATORY MEASUREMENTS							
Acidity, as $CaCO_3$	mg/l						
Alkalinity, as $CaCO_3$	mg/l	84.0	134	156	168	160	
Ammonia, NH_3 as N	mg/l						
Arsenic, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, Dissolved	mg/l						
BOD, 5 Day	mg/l						
Barium, Total	mg/l	0.010	0.010	0.070	<0.01	<0.001	<0.01
Barium, Dissolved	mg/l						
Bicarbonate	mg/l	102.48	163.4	190.3	205	190.32	197.64
Boron, Total	mg/l	0.12	0.05	0.07	0.140	0.045	
Boron, Dissolved	mg/l						
Cadmium, Total	mg/l			<0.001			<0.001
Cadmium, Dissolved	mg/l						
Calcium	mg/l	31.2	42.4	53.6	56.0	53.6	49.6
Chloride	mg/l	14.0	<0.10	<0.10	2.0	0.01	<0.01
Chromium, Total	mg/l	<0.001	<0.001	<0.001	<0.001		<0.001
Chromium, Dissolved	mg/l						
Copper, Total	mg/l	0.005	<0.001	0.003	0.002	<0.001	0.004
Copper, Dissolved	mg/l						
Cyanide	mg/l						<0.01
Fluoride	mg/l	0.08	0.11	0.07	0.11	0.11	0.09
Gross Alpha Radioactivity	pCi/l						
Gross Beta Radioactivity	pCi/l						
Iron, Total	mg/l	0.197	0.245	0.409	0.344	0.310	0.290
Iron, Dissolved	mg/l						
Lead, Total	mg/l	0.004	<0.001	<0.001	<0.001	<0.001	
Lead, Dissolved	mg/l						
MPN Fecal Coliform	MPN/100 ml						
MPN Total Coliform	MPN/100 ml						
Magnesium	mg/l	1.44	5.20	7.2	9.6	8.16	12.0
Manganese, Total	mg/l	0.017	0.004	0.040	0.023	<0.030	0.035
Mercury, Total	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l	0.17	0.20	0.21	0.02	0.21	0.26
Oil and Grease	mg/l						<1.0
Phenol	mg/l						<0.001
Phosphate, PO_4 as P	mg/l	0.045	0.025	0.028	0.075	0.022	
Potassium	mg/l	0.540	0.577	0.691	0.140	0.766	0.290
Selenium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium, Dissolved	mg/l						
Silver, Total	mg/l	0.004	<0.001	0.170	<0.001	<0.001	<0.001
Silver, Dissolved	mg/l						
Sodium	mg/l	14.0	7.0	3.35	1.00	3.0	2.08
Sulfate	mg/l	14.0	10.0	10.0	10.0	17.0	15.0
Suspended Solids	mg/l			6.0		1.0	15.0
Total Dissolved Solids	mg/l	125	149	170	185	180	165
Total Organic Carbon	mg/l						15.0
Turbidity	NTU	38.0	15.0	2.5	5.5	2.30	
Zinc, Total	mg/l	0.002		0.030	0.003	0.005	<0.001
Zinc, Dissolved	mg/l						

Table 14. Continued

Parameter	Units	12-27-78	1-25-79	3-8-79	4-3-79	5-11-79	6-20-79
FIELD MEASUREMENTS							
Discharge	cfs	4.5	6	6.6	2.6	16.4	25.5
Dissolved Oxygen	mg/l					8.5	8.3
pH	units	7.77	7.25	7.7	7.81	8.2	8.4
Specific Conductance	umhos/cm @ 25° C	285	285		350	194	200
Temperature, Air	°C	-3	-3	2	-1	1	16
Temperature, Water	°C	0	0	0	1	3	12
LABORATORY MEASUREMENTS							
Acidity, as $CaCO_3$	mg/l					6.0	6.0
Alkalinity, as $CaCO_3$	mg/l	154	164	154	152	96.0	112
Ammonia, NH_3 as N	mg/l	<0.10	<0.10		<0.01	<0.10	<0.01
Arsenic, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, Dissolved	mg/l					<0.001	<0.001
BOD, 5 Day	mg/l						
Barium, Total	mg/l	0.004	<0.010			0.020	0.060
Barium, Dissolved	mg/l					0.01	0.040
Bicarbonate	mg/l	187.88	200.08	187.88	185.44	117.12	136.64
Boron, Total	mg/l	0.105	0.180	0.030	0.150	0.085	0.060
Boron, Dissolved	mg/l					0.080	0.040
Cadmium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Dissolved	mg/l					<0.001	<0.001
Calcium	mg/l	54.4	56.8	51.20	52.0	35.2	39.20
Chloride	mg/l	6.0	2.0	8.0	2.0	6.0	<1.0
Chromium, Total	mg/l	<0.001	<0.001	<0.001	<0.001	0.005	<0.001
Chromium, Dissolved	mg/l					<0.001	<0.001
Copper, Total	mg/l	0.001	0.004	0.008	<0.001	0.016	0.007
Copper, Dissolved	mg/l					0.005	0.001
Cyanide	mg/l					<0.001	<0.001
Fluoride	mg/l	0.11	0.10			0.06	0.15
Gross Alpha Radioactivity	pCi/l						2.5
Gross Beta Radioactivity	pCi/l						10.0
Iron, Total	mg/l	0.164	0.432	0.144		0.619	0.470
Iron, Dissolved	mg/l					0.072	0.118
Lead, Total	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	0.004
Lead, Dissolved	mg/l					<0.001	<0.001
MPN Fecal Coliform	MPN/100 ml			<2			<2.0
MPN Total Coliform	MPN/100 ml			170			79.0
Magnesium	mg/l	8.64	7.68	5.76	8.16	4.00	7.68
Manganese, Total	mg/l	0.017	0.027	0.022	0.014	0.022	0.020
Mercury, Total	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l	0.42	0.36	0.74	0.49	1.70	0.15
Oil and Grease	mg/l		3.4			<1.0	<1.0
Phenol	mg/l		<0.001			<0.001	<0.001
Phosphate, PO_4 as P	mg/l	0.04	0.040	0.025	2.00	0.05	0.020
Potassium	mg/l	0.757	0.833	0.760	0.820	0.629	0.571
Selenium, Total	mg/l	<0.001	<0.001		<0.001	<0.001	<0.001
Selenium, Dissolved	mg/l					<0.001	<0.001
Silver, Total	mg/l	<0.001	<0.001		<0.001	0.001	0.004
Silver, Dissolved	mg/l					<0.001	<0.001
Sodium	mg/l	1.95	2.50	6.300	1.76	2.99	1.58
Sulfate	mg/l	10.0	16.0	6.0	14.0	7.0	19.0
Suspended Solids	mg/l	4.0	3.0		1.0	15.0	7.0
Total Dissolved Solids	mg/l	186	185	178	226	130	135
Total Organic Carbon	mg/l	2.0	14.0			6.0	9.00
Turbidity	NTU					4.0	5.00
Zinc, Total	mg/l	0.003	0.004	0.012	0.002	0.031	0.130
Zinc, Dissolved	mg/l					0.010	0.006

Table 14. Continued

Parameter	Units	7-20-79	8-23-79
FIELD MEASUREMENTS			
Discharge	cfs	5.5	1.4
Dissolved Oxygen	mg/l	6.7	7.3
pH	units	8.9	
Specific Conductance	umhos/cm @ 25° C	275	300
Temperature, Air	°C	21	
Temperature, Water	°C	15	15
LABORATORY MEASUREMENTS			
Acidity, as $CaCO_3$	mg/l	10.0	12.0
Alkalinity, as $CaCO_3$	mg/l	152	154
Ammonia, NH_3 as N	mg/l	<0.01	<0.05
Arsenic, Total	mg/l	<0.001	<0.001
Arsenic, Dissolved	mg/l	<0.001	<0.001
BOD, 5 Day	mg/l		
Barium, Total	mg/l	0.030	0.026
Barium, Dissolved	mg/l	0.020	0.013
Bicarbonate	mg/l	185.44	187.88
Boron, Total	mg/l	0.088	0.030
Boron, Dissolved	mg/l	0.080	<0.001
Cadmium, Total	mg/l	<0.001	<0.001
Cadmium, Dissolved	mg/l	<0.001	<0.001
Calcium	mg/l	53.60	58.40
Chloride	mg/l	2.0	<0.1
Chromium, Total	mg/l	0.002	0.009
Chromium, Dissolved	mg/l	<0.001	<0.001
Copper, Total	mg/l	0.007	0.005
Copper, Dissolved	mg/l	<0.001	0.003
Cyanide	mg/l	<0.001	<0.001
Fluoride	mg/l	0.10	0.15
Gross Alpha Radioactivity	pCi/l		<2.0
Gross Beta Radioactivity	pCi/l		8.0
Iron, Total	mg/l	0.620	0.310
Iron, Dissolved	mg/l	0.080	0.114
Lead, Total	mg/l	<0.001	<0.001
Lead, Dissolved	mg/l	<0.001	<0.001
MFN Fecal Coliform	MFN/100 ml		
MFN Total Coliform	MFN/100 ml		
Magnesium	mg/l	5.28	3.84
Manganese, Total	mg/l	0.024	0.004
Mercury, Total	mg/l	<0.0002	<0.0002
Nitrate, NO_3 as N	mg/l	0.24	0.30
Oil and Grease	mg/l	<1.0	<1.0
Phenol	mg/l	0.010	<0.001
Phosphate, PO_4 as P	mg/l	<0.001	0.030
Potassium	mg/l	0.694	0.950
Selenium, Total	mg/l	<0.001	<0.001
Selenium, Dissolved	mg/l	<0.001	<0.001
Silver, Total	mg/l	<0.001	<0.001
Silver, Dissolved	mg/l	<0.001	<0.001
Sodium	mg/l	1.93	1.80
Sulfate	mg/l	6.0	10.9
Suspended Solids	mg/l	7.0	1.0
Total Dissolved Solids	mg/l	164	225
Total Organic Carbon	mg/l	8.00	9.00
Turbidity	NTU	5.00	1.50
Zinc, Total	mg/l	0.009	0.012
Zinc, Dissolved	mg/l	0.006	0.004

Table 14. Continued.

Parameter	Units	9-25-79
FIELD MEASURMENTS		
Discharge	cfs	2.7
Dissolved Oxygen	mg/l	8.3
pH	units	7.7
Specific Conductance	umhos/cm @ 25° C	315.0
Temperature, Air	°C	15.0
Temperature, Water	°C	10.0
LABORATORY MEASUREMENTS		
Acidity, as $CaCO_3$	mg/l	13.0
Alkalinity, as $CaCO_3$	mg/l	158.0
Ammonia, NH_3 as N	mg/l	<0.01
Arsenic, Total	mg/l	<0.001
Arsenic, Dissolved	mg/l	
BOD, 5 Day	mg/l	
Barium, Total	mg/l	0.030
Barium, Dissolved	mg/l	
Bicarbonate	mg/l	192.70
Boron, Total	mg/l	0.030
Boron, Dissolved	mg/l	
Cadmium, Total	mg/l	<0.001
Cadmium, Dissolved	mg/l	
Calcium	mg/l	52.6
Chloride	mg/l	<0.1
Chromium, Total	mg/l	0.010
Chromium, Dissolved	mg/l	
Copper, Total	mg/l	0.008
Copper, Dissolved	mg/l	
Cyanide	mg/l	<0.001
Fluoride	mg/l	0.18
Gross Alpha Radioactivity	pCi/l	
Gross Beta Radioactivity	pCi/l	
Iron, Total	mg/l	0.060
Iron, Dissolved	mg/l	
Lead, Total	mg/l	<0.001
Lead, Dissolved	mg/l	
MPN Fecal Coliform	MPN/100 ml	
MPN Total Coliform	MPN/100 ml	
Magnesium	mg/l	3.90
Manganese, Total	mg/l	0.005
Mercury, Total	mg/l	<0.0002
Nitrate, NO_3 as N	mg/l	0.04
Oil and Grease	mg/l	22.0
Phenol	mg/l	0.005
Phosphate, PO_4 as P	mg/l	0.030
Potassium	mg/l	0.960
Selenium, Total	mg/l	8.00
Selenium, Dissolved	mg/l	
Silver, Total	mg/l	<0.001
Silver, Dissolved	mg/l	
Sodium	mg/l	8.00
Sulfate	mg/l	10.0
Suspended Solids	mg/l	1.0
Total Dissolved Solids	mg/l	182.0
Total Organic Carbon	mg/l	8.50
Turbidity	NTU	2.00
Zinc, Total	mg/l	0.015
Zinc, Dissolved	mg/l	

APPENDIX C

Archeology Documentation

INTENSIVE ARCHEOLOGICAL SURFACE EVALUATIONS IN THE PROPOSED WHISKEY CREEK CANYON-PLEASANT VALLEY PROJECT IN CARBON COUNTY, UTAH

Mine Plan Applicant:
Valley Camp of Utah, Inc.
(Coal Mine and General Service Facilities
Relative to Belina #1 and #2 and Utah #12 Mines)

F. R. Hauck, Ph.D., Principal Investigator

Report Prepared by:
F. R. Hauck, and D. G. Weder
ARCHEOLOGICAL-ENVIRONMENTAL
RESEARCH CORPORATION

PAPER NO. 21
September, 1980

Salt Lake City, Utah

ABSTRACT

In the summer of 1980, the Archeological-Environmental Research Corporation conducted an intensive cultural resource evaluation for Valley Camp Coal Company of Utah in the Pleasant Valley-Eccles Canyon locality south of Scofield, Utah. The survey consisted of a corridor evaluation extending from the proposed mine facilities in Whiskey Canyon to the Utah mine location.

A total of seven historic cultural resource sites is situated within, or adjacent to, the project area. These sites include four mine portal service areas, one sawmill site and two cabin foundations. None of the seven sites are considered eligible for nomination to the National Register of Historic Places.

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Chapter I - INTRODUCTION

A. General Data on the Project

In the spring of 1980, the Archeological-Environmental Research Corporation (AERC) of Salt Lake City was contacted by Vaughn Hansen Associates, a Salt Lake City consulting firm, on behalf of Valley Camp of Utah, Inc. and contracted to perform an intensive cultural resource evaluation of mine portal areas, transportation corridors and service areas relative to the development of mine facilities in the Whiskey Canyon-Eccles Canyon-Pleasant Valley locality of Carbon County, Utah. Mine permits involved in this locality include Belina #1 and #2 and Utah #2. Vaughn Hansen Associates (VH) in conjunction with Valley Camp of Utah, Inc., desirous of preparing a mine plan application for submission to federal and state authorities, requested that cultural resource evaluations be conducted within the potential subsidence zone which would comply with pertinent government legislation, i.e., Executive Order 11593 "Protection and Enhancement of Cultural Environment" (Federal Register, Vol. 36, No. 95, May 15, 1971), and "The Archeological and Historical Data Conservation Act of 1974", which is an amendment of "The Reservoir Salvage Act of 1960" (74 Stat. 220). For additional information, please refer to the mine plan application prepared by Vaughn Hansen Associates.

AERC's field evaluations within this project area commenced in the summer of 1975 when F. R. Hauck began conducting proposed drill location evaluations for Valley Camp but in association with Sanders Associates, a consulting firm with offices in Kaysville, Utah. AERC's consulting for Sanders Associates (see report for June 13, July 17, October 13, November 28, 1975 and July 17 and August 23, 1976) featured

specific evaluations made within the general Scofield locality although no evaluations were actually conducted within the present project area.

Beginning in September, 1978, AERC began consulting for Coastal States Energy Company upon the Skyline Project which is situated on the west and adjacent to the Valley Camp project area (see Figure 1). Reports on AERC investigations in the Coastal States project area were furnished as CSEC-78-1 (10/2/78), CSEC-79-2 (7/23/79), CSEC-79-3 (8/10/79), CSEC-79-5 (9/18/79). In 1979, AERC conducted an intensive surface evaluation of the floor of Eccles Canyon extending from the mouth of that canyon on the west into the National Forest lands (see CSEC-79-2). That survey includes the entire floor of Eccles Canyon which will be included in the present mine plan permit application. During these preliminary cultural resource evaluations, only three cultural resource sites were recorded in the general locality. These sites included two historic campsites, AERC 270U/1 and 2, and one historic mine portal, service area, AERC 270N/1. All three sites are situated in Eccles Canyon; however, only the first two sites, 270U/1 and 2, need be considered in this report. Site 270N/1 is adjacent to the National Forest boundary up the canyon from the Valley Camp project area. No other cultural resources in the Eccles Canyon-Whiskey Creek locality had been recorded prior to AERC's surface evaluations being reported in this document.

From July 22-25, 1980, AERC personnel conducted intensive evaluations of the Whiskey Creek corridor and an extension of the Eccles Canyon corridor running north from the mouth of Eccles Canyon along the west bench of Pleasant Creek to the existing service area at the mouth of Green Canyon. Some four historic sites were recorded during this recent survey. Thus, a total of six historic cultural resource sites are situated within the Valley Camp mine plan permit area.

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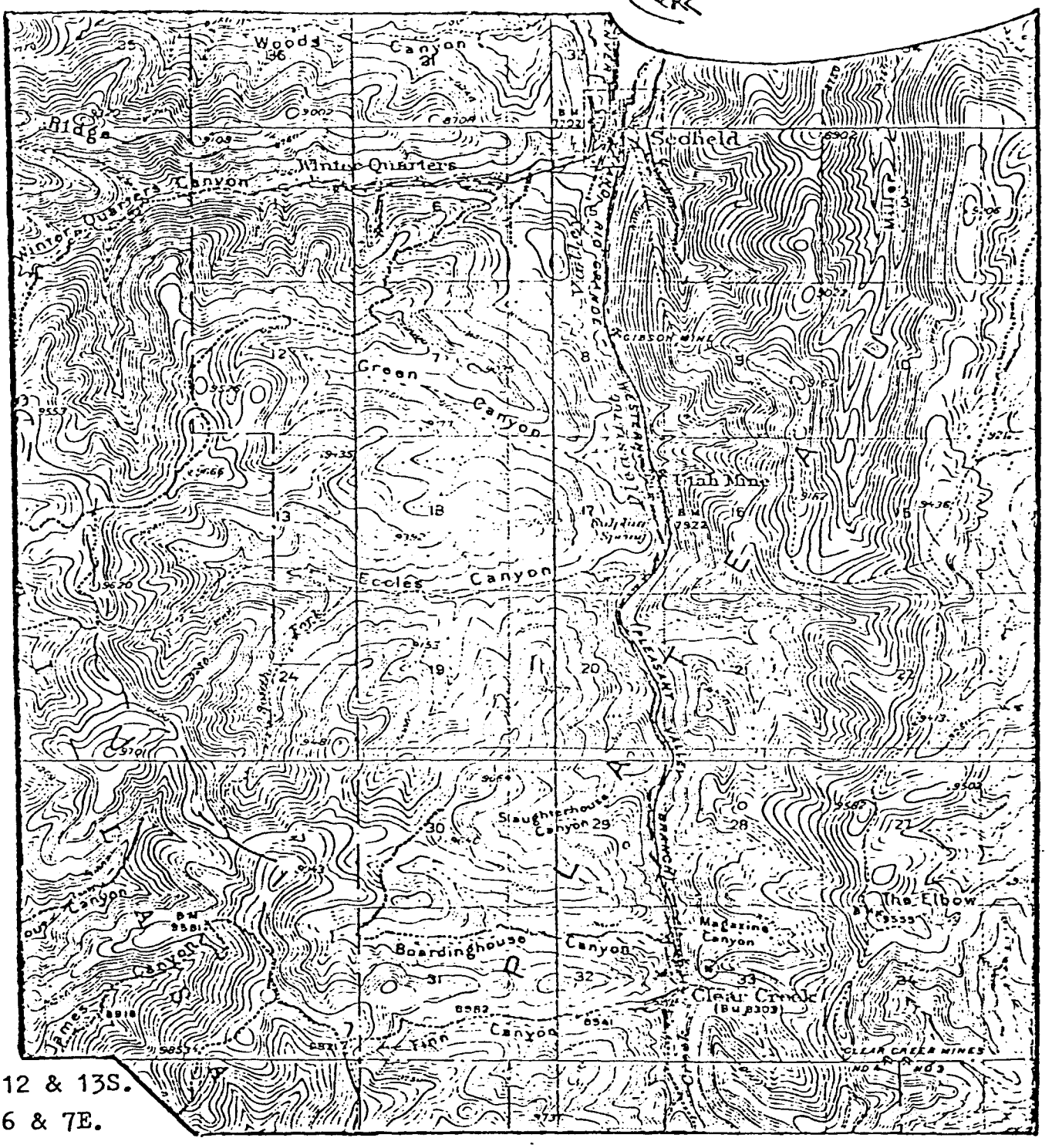

T. 12 & 13S.

R. 6 & 7E.

Meridian: Salt Lake B. & M.

Quad: Scofield, Utah 15 Minute USGS

Project: VH-80-1

Series: Central Utah

Date: 9-17-80

Figure 1

GENERAL MAP OF THE PROJECT AREA IN THE SCOFIELD LOCALITY OF CARBON COUNTY, UTAH

Legend:

N

1 0 1 2 M.

1 0 1 2K.

Scale

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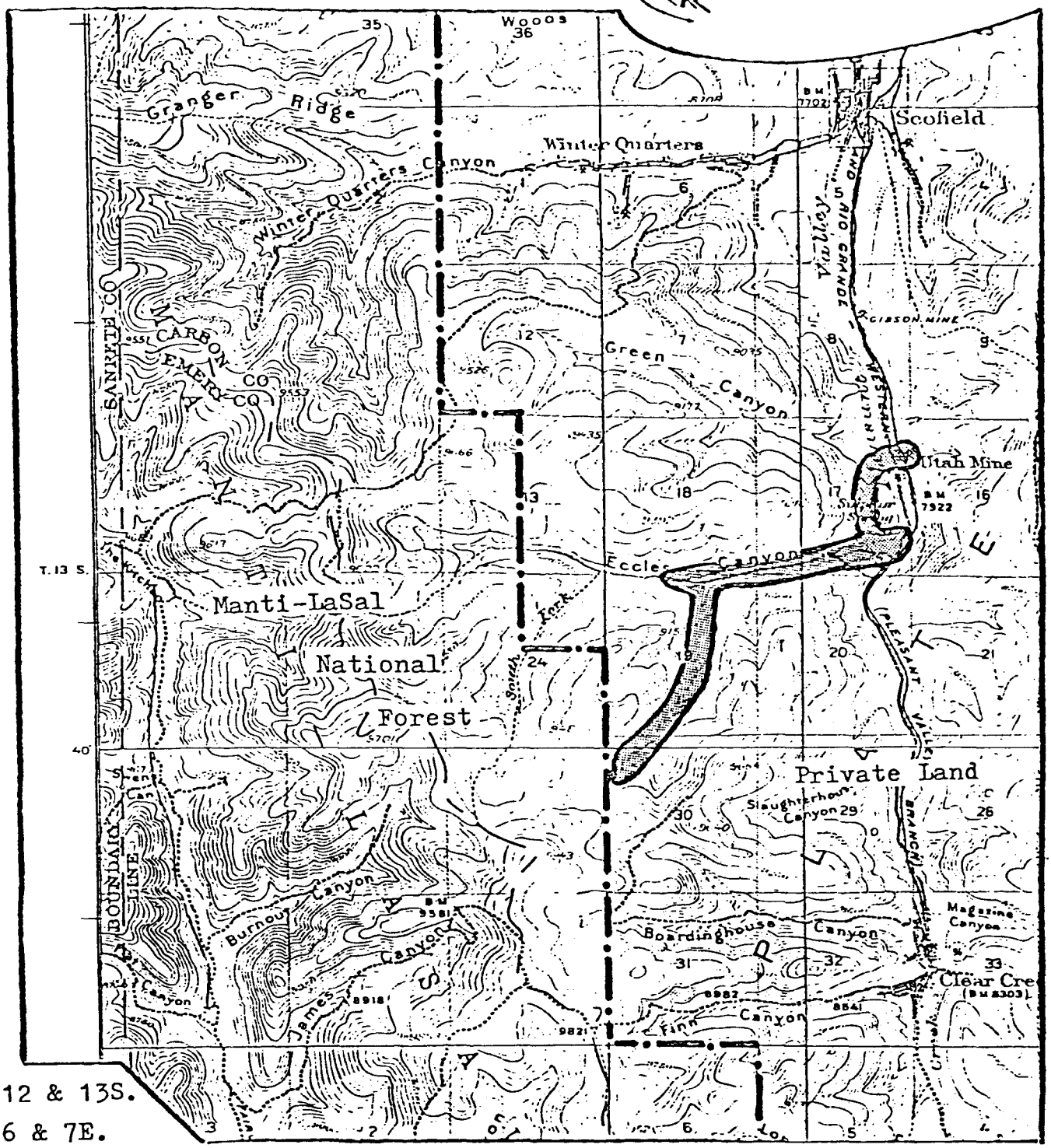


T. 12 & 13S.

R. 6 & 7E.

Meridian: Salt Lake B. & M.

Quad: Scofield, Utah 15 Minute USGS

Project: VH-80-1

Series: Central Utah

Date: 9-17-80

Figure 2

SURVEY AREA AND LAND OWNERSHIP IN THE PROJECT AREA

Legend:

Survey Corridor

1 0 1 2 M.

1 0 1 2K.

Scale

Recommendations concerning site significance and mitigational techniques relative to those six sites are provided in this report.

All surveyed areas relative to the present mine plan permit are situated on privately owned lands and no federal antiquities permits have been procured to conduct the 1980 research.

The resource inventory area for the 1980 research involves about three miles of transmission corridor of 60 meters in width extending from the northwest quarter of Section 30 in Whiskey Creek north through the center of Section 19 into the bottom of Eccles Canyon and then east through Section 18 into Pleasant Valley and north in Section 17 to the Utah Mine location in the northeast quarter of Section 17, Township 13 South, Range 7 East, Salt Lake Base and Meridian. At special request from Valley Camp, AERC personnel also examined the Nicolitus Mine, the Green Canyon sawmill site and the Gibson Mine, all located in Pleasant Valley but outside the transmission corridor. This project area is situated about two miles south of Scofield, Utah with the eastern corridor paralleling Utah State Highway No. 96 in Pleasant Valley. The Scofield, Utah U.S.G.S. 15 Minute topographic map shows the project area.

All field notes and site data are filed at AERC headquarters in Bountiful, Utah. Site reports are being submitted to all relevant state and federal agencies as an appendix to this report. Artifacts collected during the survey are being curated at the Museum of Archaeology and Ethnology at Brigham Young University in Provo, Utah.

B. Environment and Locality

The project locality is situated in several narrow canyons which drain northwards into Scofield Reservoir via

Eccles Canyon Creek and Pleasant Valley Creek. The general elevation of the project area ranges between about 7750 feet at the Gibson Mine to about 9200 feet at the head of Whiskey Canyon.

The high elevations in the project area have a strong effect on the local climate. The precipitation amounts to about 30 inches annually, but most of this precipitation falls in the form of snow since the May to September precipitation is only eight inches (Utah Water and Power Board). Elevation and exposure also determine the freeze free growing period which is as low as 20 days per year at the highest elevation, but not greater than 60 days at the lowest elevations.

The surface geology of the project locality is relatively simple. The majority of the canyon's lower surfaces consists of an exposure of the Cretaceous age Star Point Sandstone, a formation of marine, deltaic and beach deposits of interbedded sandstone and shales. Above the Star Point is exposed the Black Hawk Group, a Cretaceous age deposit which consists of sandstone, mudstone, shale and coal.

The high elevation places the project locality within the Montane floral ecozone, but topographic factors create a mosaic of different plant communities. In the Montane ecozone, the following arboreal species are typically present in the project area (Johnson 1970):

Common Arboreal Species	
Limber pine	*Pinus flexilis*
Engelmann spruce	*Picea engelmannii*
Blue spruce	*Picea pungens*
Subalpine fir	*Abies lasiocarpa*
White fir	*Abies concolor*
Douglas fir	*Pseudotsuga menziesii*
Rocky Mountain juniper	*Juniperus scopulorum*

Common juniper	Juniperus communis
Mountain mahogany	Cercocarpus ledifolius
Aspen	Populus tremuloides
Serviceberry	Amelanchier spp.

Due to topographic factors, the east-facing side and bottom of Whiskey Canyon are predominately aspen whereas the west-facing side is a mixture of evergreen species.

The floral community along the Pleasant Valley Creek bottom include mixtures of willow Salix spp., sagebrush Artemisia tridentata, rabbit brush Chrysothamnus nauseosus and grasslands grading into mountain shrub communities.

The project locality is situated in the Northern High Plateau Subcenter of the Middle Rocky Mountain Faunal area and is characterized by a wide variety of species. The mammal species known to exist in the general project area according to Durrant (1952) include the following:

Order Insectivora	
Shrews	Sorex spp.
Order Lagomorpha	
Pika	Ochotona princeps
White-tailed jack rabbit	Lepus townsendii
Snowshoe rabbit	Lepus americanus
Cottontail rabbit	Sylvilagus nuttallii
Order Chiroptera	
	Myotis spp.
Silvery-haired bat	Lasionycteris spp.
Big brown bat	Eptesicus spp.
Red bat	Lasiurus spp.
Long-eared bat	Corynorhinus spp.
Big free-tailed bat	Tadarida spp.
Order Rodentia	
Squirrels	Citellus spp.
Chipmunks	Eutamius spp.

Northern pocket gopher	Thomomys talpoides
Beaver	Castor canadensis
Western harvest mouse	Reithrodontomys megalotis
Mouse	Peromyscus
Meadow mouse	Microtus spp.
Wood rat	Neotama cinerea
Big jumping mouse	Zapus princeps
Porcupine	Erethizon dorsatum
Marmot	Marmota flaviventer
Order Carnivora	
Coyote	Canis latrans
Wolf (formerly in area)	Canis lupus
Red fox	Vulpes fulva
Gray fox	Urocyon cinereoargenteus
Grizzly bear (formerly in area)	Ursus horribilis
Black bear	Ursus americanus
Ring-tailed cat	Bassaricus astutus
Ermine	Mustela erminea
Long-tailed weasel	Mustela frenata
Marten	Martes caurina
Badger	Taxidea taxus
Striped skunk	Mephitis mephitis
Spotted skunk	Spilogale gracilis
Canada lynx	Lynx canadensis
Bobcat	Lynx rufus
Mountain lion	Felis concolor
Order Artiodactyla	
Elk	Cervus canadensis
Mule deer	Odocoileus hemionus
Mountain sheep (formerly in area)	Ovis canadensis

The montane ecozone also supports a wide variety of avian species, some of which are summer migrants. Some of these species, according to Hayward et al (1976) include the following:

Local Avian Species

Coniferous Niche		
	Red-breasted nuthatch	*Sitta canadensis* (summer)
	Golden-crowned kinglet	*Regulus satrapa*
	Ruby-crowned kinglet	*Regulus calendua*
	Yellow-rumped warbler	*Dendroica coronata* (summer)
	Western tanager	*Piranga ludoviciana* (summer)
Aspen Niche (Hole nesting)		
	Tree swallow	*Tachycineata bicolor*
	Violet green swallow	*Tachycineata thalassina* (summer)
	House wren	*Troglodytes aedon* (summer)
	Black-capped chickadee	*Parus atricapillus*
	Yellow-bellied sapsucker	*Sphyrapicus varius*
	Downy woodpecker	*Picoides pubescens*
	Common flicker	*Colaptes auratus*
	Chipping sparrow	*Spizella passerina* (summer)
	Cassin's finch	*Carpodacus cassinii* (summer)
	Black-headed grosbeak	*Pheucticus melanocephalus* (summer)
	Western wood pewee	*Contopus sordidulus* (summer)
	Mountain bluebird	*Sialia currucoides* (summer)
	Hermit thrush	*Catharus gultatus*
Predators		
	Goshawk	*Accipiter gentilis*
	Cooper's hawk	*Accipiter cooperii*
	Red-tailed hawk	*Buteo jamaicensis*
	Golden eagle	*Aquila chrysaetos*
	Great horned owl	*Bubo virginianus*

Those species which migrate into the area from out of the state are indicated as summer residents. The other species are present during the entire year but generally migrate to somewhat lower elevations during the winter months.

C. Prehistory and History of the Region

The variety of human cultures which have inhabited the project region can be examined from several perspectives. The temporal continuum extending over a range of 12,000 years involves such diverse groups as the early prehistoric big game hunters, the archaic hunter-gatherers, the semi-horticultural Fremont, the Shoshonean bands, the early historic explorers and fur trappers, the Mormon colonists, the coal and cattle barons, the final influx of farmers, small town settlers, and merchants. Man's social and technological variations mirror the complexity of economic means used to exploit the necessary resources of his changing ecological system.

The Prehistoric Period

The prehistoric period within the project region can be subdivided into four main temporal phases: Paleo Indian, Archaic, Fremont and Shoshonean.

PALEO INDIAN PHASE

The Paleo Indian phase began at approximately 12,000 B.P. and terminated by about 7000 B.P., and is generally divided into three subphases which are known as the Llano, Folsom and Plano cultures (Jennings 1974:81).

The Llano culture was characterized by the hunting of mammoth during a time period between 12,000 B.P. and 10,000 B.P. Since the Llano culture has been defined primarily from the excavation of mammoth kill sites, very little is known about the overall subsistence activities of this culture.

Evidence of the Llano culture has been found over a widespread area in the Intermountain West and Southwest.

The Clovis point, a large, lanceolate, fluted spear point, is the only artifact which can be used confidently to infer the presence of the Llano hunters. Clovis points, in association with mammoth remains, have been found in New Mexico, Oklahoma, Colorado, Arizona and Wyoming.

Based on these sites, which are characterized by mammoth-Clovis point association, the core area of the Llano culture is limited to eastern Colorado, most of New Mexico and eastern Arizona. However, the Clovis point by itself has a much larger distribution. Clovis points, or very similar fluted points, have been found throughout the entire United States.

Within the project region of Utah, no characteristic Llano sites have been found, although several isolated Clovis points and one fluted point site have been reported. An isolated Clovis point was reported from Sevier County, Utah (Tripp 1966). Gunnerson (1956) performed a test excavation on a small rockshelter in Emery County (42Em8) from which a local collector had obtained a Clovis point. The test excavation did not, however, recover any additional Clovis points. An unusual fluted point very closely resembling the Cumberland fluted points commonly found east of the Mississippi River was found by an amateur collector in the San Rafael Swell and reported by Hauck (42Em677).

The Folsom culture (ca. 11,000 B.P. to 9000 B.P.) immediately followed the Llano culture, but several differences in subsistence and artifacts allow a clear distinction to be drawn. Although the primary evidence of the Folsom culture is also from kill sites, the fauna hunted and the projectile points used are different from the Llano culture. The Folsom point is a lanceolate, fluted and usually eared projectile point generally smaller and thinner than the Clovis point. In addition, the Folsom point is associated at kill sites with the extinct <u>Bison antiquus</u>.

Folsom kill sites occur predominantly within the same region as the Llano core area but isolated Folsom points are not as widely distributed as Clovis points. Isolated Folsom points are almost entirely limited to the High Plains immediately east of the Rocky Mountains. A total of 11 Folsom points has been found in Utah but only one of these, found by an amateur collector somewhere in the San Rafael Swell, is known from the project region (Tripp 1967).

The Plano subphase of the Paleo Indian phase extends from ca. 9000 B.P. to 7000 B.P. The Plano culture, like the Llano and Folsom cultures before it, was economically partially dependent on large game, bison in particular. However, the Plano culture is characterized by a great diversity of projectile point types. Plano culture projectile points are typically lanceolate, precisely flaked and non-fluted.

A new hunting technique also became widespread during the Plano subphase, the jump-kill. The jump-kill hunting technique entailed the driving of a herd of bison over the edge of a cliff or arroyo in order to injure or kill the bison.

Evidence of Plano culture inhabitation is predominately limited to the High Plains east of the Rocky Mountains. The presence of Plano culture hunters in Utah is not widely acknowledged.

The presence of Paleo Indian cultures within Utah was minimal even during the Llano subphase and tended to decrease with time. The slight Paleo Indian utilization of Utah can possibly be tied to the relative scarcity of the large game species in Utah compared to the Great Plains east of the Rocky Mountains than on the eastern side and, as a result, the large herbivorous animals utilized by the Paleo Indian cultures were present on the Great Plains in considerably greater numbers.

ARCHAIC PHASE

Because of the relatively arid conditions of Utah and the Great Basin, large mammal hunting was not a viable subsistence technique in that area. The Great Basin and adjacent Colorado Plateau of eastern Utah were occupied at an early date by Indian groups who were engaged in a subsistence pattern dependent on smaller game animals and the gathering of wild plant foods.

The utilization of caves and rockshelters by Archaic cultures in Utah has resulted in good temporal sequences for the entire Archaic phase. Radiocarbon dates from Danger Cave (Jennings 1957) verify human inhabitation of the Great Basin as early as 10,000 B.P., but the artifacts retrieved from the lowest levels of Danger Cave are not diagnostic of any recognized culture group.

In addition to Danger Cave, Hogup Cave (Aikens 1970) in the Great Basin, Sudden Shelter (Jennings, Schroedl, Holmer 1980) in the southern Wasatch Mountains and Cowboy Cave (Jennings et al n.d.) in southeastern Utah, have all supplied important data pertinent to the development of a cultural sequence for the Archaic inhabitants of Utah. The Archaic has been divided into three phases based on changes in projectile point types.

The Early Archaic Period begins at approximately 8500 B.P. and continues until about 6000 B.P. Subsistence during this period was based on generalized gathering and hunting techniques. A large variety of plant, animal and insect resources was utilized. Hunting was primarily limited to deer and mountain sheep although antelope and bison were also utilized. The trapping of rabbits and small rodents was also an important source of protein.

The prevalent utilization of caves and rockshelters as habitations in conjunction with the aridity of the area has resulted in conditions suited to the preservation of normally perishable materials. Due to the excellent preservation, it

is known that the spear thrower (atlatl) was the implement used for hunting. The atlatl was used with a two or three component shaft and stone dart point throughout the Archaic phase. The Early Archaic Period was characterized by four types of dart points, the Pinto, Humboldt, Elko and the Northern Side Notch (Holmer 1978). During this time period, the Elko point type had a limited areal extent confined primarily to the northeastern Great Basin and the northern Colorado Plateau. The Pinto and Humboldt points, generally found in close association in archeological contexts, had the same distribution as the Elko points, but are also found in sites in southern and central Idaho at this time period. The Northern Side notch point had a very wide distribution during the Early Archaic period encompassing the northern Great Basin, Columbia Plateau, Northern Colorado Plateau and Great Plains.

The Middle Archaic Period began about 6000 B.P. and ended about 4500 B.P. Subsistence techniques and the utilization of caves were the same as during the Early Archaic but dart point styles changed and also diversified. Dart points such as the Rocker Side-notched, Sudden Side-notched, McKean Lanceolate and San Rafael Side-notched were characteristic of this period (Holmer 1978). The Elko point continued to be used during this period in the same areas as it had been during the Early Archaic period. Although the Rocker Side-notched and Sudden Side-notched points were limited in their distribution to central Utah, the McKean Lanceolate and San Rafael Side-notched styles had wider distributions including the Great Plains at this time. Another point style made its appearance during the Middle Archaic, the Gypsum point (Holmer 1978). This point style was very common in the southern Great Basin and northern Colorado Plateau and continued to be utilized through the end of the Late Archaic period.

The Late Archaic period began about 4500 B.P. and ended at roughly 1700 B.P. Subsistence techniques were essentially unchanged from the earlier Archaic periods and the utilization of the Elko and Gypsum points styles was continued although the latter style is generally limited in its occurrence to the southern half of Utah. At the end of the Late Archaic period, two new technological developments occurred which mark a significant change in prehistoric subsistence patterns: the introduction of corn and the bow and arrow.

Evidence of corn horticulture in the latter part of the Late Archaic period has been found at several locations: Cowboy Cave (Jennings et al in preparation), Cottonwood Cave in western Colorado (Hurst 1948) and Clyde's Cavern in central Utah (Winter 1973, Winter and Wylie 1974). At all three locations, corn caches were found which dated generally between 1600 B.P. and 2000 B.P. The very late portion of the Late Archaic period also witnessed the advent of the bow and arrow. At Cowboy Cave (Jennings et al n.d.b), Rose Springs arrowheads were recovered from the uppermost level and were dated about 1700 B.P.

The entire Archaic phase is characterized by a gathering and hunting subsistence mode and a sequence of dart point styles which have been defined through the analysis of excavated cave and rockshelter sites. Transient habitation of these caves during the annual migratory round is the most widely accepted interpretation of the Archaic subsistence pattern.

The atlatl was the universal Archaic hunting implement until the very last centuries of the Late Archaic period. However, the advent of the bow and arrow around 1700 B.P. does not seem to have eliminated the utilization of the atlatl during the late Archaic. Gypsum dart points continued to be manufactured even after the appearance of Rose Spring arrowheads at Cowboy Cave (Holmer in Jennings et al n.d.).

addition, Anasazi tradewares are considerably more prevalent in the Fremont culture sites than in the Sevier culture sites.

The unnamed plains-derived culture of northern and northeastern Utah existed from about 1300 to 650 B.P. (Madsen and Lindsay 1977). This culture was dependent upon hunting of bison and the collecting of wild plants. The dwellings are normally shallow basin structures without any clear evidence of the type of superstructure utilized. Unlike the coiled pottery of the Sevier, Fremont and Anasazi cultures, the unnamed culture produced pottery by the paddle and anvil techniques. It is important to note that there is a considerable spatial overlap of the unnamed culture and the Fremont culture traits in the northern portion of the latter's distribution. There is insufficient data at the present to determine whether the spatial trait overlap is due to alternate occupation, simultaneous occupation by the two cultures or a combination of these two possibilities.

Hunting activities among the Sevier, Fremont and unnamed cultures are evident from the many varieties of small arrowheads which have been recovered from excavations. Small stemmed corner notched (Rose Spring) arrow points are present in the earlier phases of all three cultures, but after about 1100 B.P., numerous regional variants developed. Side notch arrow point styles (Bear River Side-notched and Uinta Side-notched) were common in the northern part of Utah while Parowan Basal-notched and Bull Creek arrow point styles were common in the southwestern and south central portions of Utah respectively. The Bull Creek points are of particular interest because they are found in high frequencies at both Kayenta Anasazi sites in southern Utah and Fremont sites along the east side of the Wasatch Mountains (Coombs Village, Bull Creek sites, Snake Rock Village, Old Woman and Poplar Knob) and probably indicate the reciprocal exchange of males for matrimonial purposes (Holmer and Weder 1980).

Dart points, the Elko series and Gypsum, in particular, are also found in association with Fremont sites. This association has been used by Schroedl (1976) to verify the indigenous development of the Fremont culture from Archaic antecedents. Dart points, during the Archaic, were used as both projectile points and knives (Weder in Jennings et al n.d.) but their function in the Fremont context has not yet been evaluated.

In reference to Utah, the Mesa Verde and Kayenta variants of the Anasazi culture are of particular importance. The San Juan Anasazi culture was centered around the Four Corners area where Colorado, New Mexico, Arizona and Utah meet. The Kayenta Anasazi inhabited the extreme southern periphery of Utah from the San Juan River west to central Utah. As has already been noted, Kayenta influence is particularly evident in a narrow band of sites running from Coombs Village northwards past the Henry Mountains to the Snake Rock Village site adjacent to Interstate 70 on the east side of the Wasatch Plateau.

SHOSHONEAN PHASE

The Shoshonean populations, who were the sole inhabitants of Utah at the time of Euro-American contact, have been in the northeastern Great Basin region since approximately 650 B.P. Their origin has been the subject of considerable controversy, however. Several hypotheses have been expressed.

One hypothesis maintains that the Shoshoneans came from the southwest of the Great Basin at about the time of the dispersal of the Sevier, Fremont and Anasazi agriculturalists (Madsen 1975b and Lamb 1958). Gunnerson's hypothesis (1962) states that the Fremont, Sevier and Virgin cultures were Shoshonean peoples who had taken up horticultural and ceramic techniques diffused from the Anasazi but later reverted to an Archaic subsistence style after a climatic change which made agricultural subsistence techniques unproductive.

Regardless of which hypothesis is correct, Shoshonean groups (Ute, Paiute, Shoshone and Bannock) were inhabiting the Great Basin into eastern Utah at ca. A.D. 1300 roughly coincident with the disappearance of the Fremont and Sevier cultures.

The Shoshonean subsistence pattern was quite similar to the Archaic adaptation. Small familial bands were engaged in a gathering and hunting subsistence utilizing a wide variety of nondomesticated plant, mammal, and insect species.

Very little archeological evidence is available for this time period. Two characteristic artifact types can generally be associated with the Shoshonean occupation of Utah. The bow and arrow was utilized for hunting and a type of arrowhead, the Desert Side Notch point, has been correlated with the Shoshonean occupation (Holmer and Weder 1980). The Shoshoneans also utilized ceramics to a small degree. Shoshonean ceramics are easily distinguished from Sevier, Fremont and Anasazi wares by the former's relative crudeness. Shoshonean ceramics are typically thick walled, have large temper particles, are poorly smoothed, exhibit little decoration and have been fired in an uncontrolled or oxidizing atmosphere.

The Protohistoric Period

The prehistoric Shoshonean occupation of the Intermountain West continued up to and through the period of Euro-American contact. The Indian groups inhabiting the area of eastern Utah within which the project locality is situated came to be called the Utes.

PRECONTACT

The Utes are a group belonging to the Shoshonean (Uto-Aztecan) linguistic family of which there are three branches: Ute-Chemehuevi, Shoshoni and Mono-Paviotso. The Ute-Chemehuevi branch includes those groups which came to be

known as the Utes, Southern Paiutes and Chemehuevi. Although there is little archeological evidence, the Utes probably were characterized by a social organization and subsistence mode quite similar to all of the other aboriginal groups in the Great Basin and Colorado Plateau. The Utes were pedestrian gatherers and hunters who utilized a relatively large area of western Colorado and eastern Utah (Steward 1974).

The Utes were grouped into loosely organized bands consisting of extended families. Leadership was present only for subsistence task groups. The Utes could be reliably distinguished from the other contemporary aboriginal groups only in terms of linguistic differences.

Group territoriality was developed only in a statistical sense. A particular Ute band might consider a certain area as a home, but the seasonal round of each band was highly variable from year to year. The area with which any band was most familiar was not exlusively utilized by that band. Intermarriage among the various Ute bands tended to maintain linguistic unity but blur the definition of territorial homeland for any particular band. Except for those Utes who were utilizing the aquatic resources around Utah Lake, local populations were small and mobile (Steward 1974).

EARLY CONTACT

The presence of the Spanish colony at Santa Fe by 1598 resulted in the first contact between the Utes and Euro-American groups. The relationship which developed between the Utes and the Spaniards was consistently friendly and resulted in the spread of the horse among the Ute bands. When the Utes obtained the horse, a change in their subsistence occurred. The equestrian Ute was able to travel more widely and more effectively and concentrate on bison hunting (O'Neill 1973).

The utility of the horse was strongly mitigated by environmental factors, however. The maintenance of a large

horse herd required substantial supplies of grass which generally limited the advantage of the horse to those areas where grass was plentiful such as western Colorado, the Uintah Basin and along the western slopes of the Wasatch Mountains. The supply of grass also determined the distribution of the bison. The horse was, therefore, not equally valuable to all of the Ute bands. The bands in Colorado were able to support their horses whereas those bands in Utah, eastern Utah in particular, were unable to utilized the horse effectively and were more likely to eat a horse than ride it.

Considerable trading activity with the Utes was occurring during the 17th and 18th Centuries. Of particular importance was slave trade (O'Neill 1973). The Utes were able to conduct slave raids on neighboring tribes (especially the Navajo) because of their equestrian status. They then exchanged their slaves for horses and other Spanish goods. Whether the slaves were exchanged with traders travelling into Ute territory or were driven by the Utes to Spanish settlements is unknown because of the lack of documented evidence. Until the 1770s, there was little official Spanish interest in the territory of the Utes. However, at that time, King Charles III of Spain decided that an exploration of the areas north of Santa Fe would be beneficial to Spanish control. His developing interest was a reaction to the growing influence and explorations by the British and French in the West. Charles III felt that it was important to ensure control of trade by the Spaniards since he considered the British and French traders as a threat to Spanish rule (O'Neill 1973).

The first documented Spanish exploration of the area north of Santa Fe was the Dominguez-Escalante Expedition of 1776-1777. This expedition was also the first officially

sponsored exploration, the purpose of which was to find a route between Santa Fe and the Spanish settlements in California. Although the expedition was unsuccessful in reaching its goal, it did extensively explore the territory occupied by the Utes who, in all recorded instances, welcomed the Spaniards.

A trail was eventually established between Santa Fe and California which came to be known as the Spanish Trail. The origins of the Spanish Trail are obscure; however, this trail was probably utilized in prehistoric times as evidenced by its association with archeological sites.

LATE CONTACT

Beginning in the early 1800s, the fur trade became active in Utah. The Arze-Garcia expedition traded for furs with the Utes at Utah Lake in 1813 and soon thereafter trappers began to actively exploit the area. Etienne Provost was a member of the Choteau-DeMun exploration of 1815 to 1817 and subsequently founded his own trapping company which operated primarily within Ute territory. He was subsequently killed by the Utes near the site of the city which now bears his name, Provo (O'Neill 1973).

During this time, more detailed information on the Shoshonean peoples of the area was recorded. In particular, specific Ute bands are mentioned with reference to their respective territories. Within the project region, the Weeminuche band conducted its yearly rounds (O'Neill 1973).

The Adams-Onis treaty of 1819, which gave Mexico its independence, resulted in an influx of Americans to Santa Fe. Most of the Americans came to engage in trapping. The newly arrived trappers caused a considerable increase in traffic along the Spanish Trail and an increase in competition for the available fur resources. This competition was not welcomed by the Utes, who were no longer consistently friendly with the Euro-Americans.

Although there were a large number of independent trappers operating in Utah, their activities have not been well documented. Antoine Robidoux was an important trapper who by 1824 was operating primarily in the Uintah Mountains. William Ashley and Peter Skene Ogden were trapping in the northern Ute territory during the summer of 1824 and, at about the same time, Jedediah Smith was exploring eastern Ute territories to evaluate their trapping potential (O'Neill 1973).

The growing traffic along the Spanish Trail had an important effect on the local Ute bands. Wakara, a Tumpanuwache leader, became quite powerful in the 1820s by conducting horse raids in southern California and returning to Utah by way of the Spanish Trail (Lyman and Denver 1970). He enhanced his power and wealth by exacting tribute from travelers along the trail and by the trading of stolen horses and Pahvant and Paiute slaves (O'Neill 1973). In addition, Wakara and his band actively engaged in fur trapping.

By the late 1830s, there was considerable competition for the fur resources of Utah and western Colorado. Robidoux established a permanent fort and trading center in 1837 near Whiterocks in the Uintah Basin to capitalize on the beaver-laden streams of the Uintah Mountains.

The prosperity of the fur trade was not destined to last very long, however. The fierce competition over trapping areas led to widespread disruptive conflicts and, most importantly, the demand for furs used to make the beaver skin hats which were fashionable in Europe and the eastern United States declined rapidly about 1840 as the fashions changed. Fort Robidoux was burned in 1844 by the Utes who apparently blamed the trappers for the declining value of their furs (O'Neill 1973; Lyman and Denver 1970).

The decline of the fur trade had a serious impact on the Ute bands of Utah. The entire economic base of the

Utes began to disintegrate after 1840. The trading activities with Santa Fe began to dwindle with the decline in the horse and slave trade. The termination of Mexican control of the area in 1846 and the subsequent loss of contact for slave trade into Mexico (Lyman and Denver 1970) were very disruptive to the relationships existing between Utah and Santa Fe.

During the declining years of the fur trade, the largest invasion of Ute territory occurred. Beginning in 1847, Mormon pioneers began to move into Utah and rapidly swelled their numbers through immigration. At first, there was little conflict with the Utes because the major Mormon settlement, Salt Lake City, was on the periphery of the Ute territory and the earliest Mormon expansion was to the north. In 1849, Fort Utah (later to become the town of Provo) was founded near Utah Lake on the traditional campsite of the Tumpanuwache band. Since the Tumpanuwache band, still under the leadersip of Wakara, had been forced to revert to their earlier mode of subsistence due to the decline of the fur trade, their utilization of the resources around Utah Lake became of vital importance. The conflicting interests in the Utah Lake vicinity escalated into a series of raids and counterraids during the 1850s which became known as the Walker War. In the end, the Utes were forced to leave the valley and moved east across the Wasatch Mountains (O'Neill 1973).

The next few years were difficult for the Utes, who were being gradually forced to split up into small bands and resume a subsistence mode similar to the precontact period. Some of the bands, however, chose to raid Mormon settlements and farms to obtain cattle so that they could avoid starvation. These raids became more prevalent during the 1860s. Raids were conducted on the Mormon settlers west of the Wasatch and the Utes returned to the unsettled areas east of the Wasatch with the stolen cattle (O'Neill 1973).

Although several bands were responsible for these raids, one man by the name of Black Hawk became the focus of the blame for all the raiding.

The areas east of the Wasatch Mountains remained under Ute domination for several years. A Mormon attempt to colonize at Moab was undertaken in 1855 but the Mormon settlers were harassed by the Utes and forced to return to Salt Lake City. It was not until 1877, by which time the Utes had been removed to the Uintah Reservation, that Mormon colonists were able to safely settle east of the Wasatch Mountains (O'Neill 1973).

The Historic Period

The history of the east-central coal areas of Utah begins with the exploration and colonization efforts of the Spanish during the last quarter of the 18th Century. East-central Utah was first explored and mapped by the Dominguez-Escalante Expedition of the 1776-1777 in its efforts to establish a line of communication between the Spanish settlements of New Mexico and Monterey, California (Miller 1968).

Though the Dominguez-Escalante Expedition failed to achieve this end, subsequent attempts from the New Mexico settlements and the travelings of Spanish and American fur trappers, traders and frontiersmen resulted in a connecting route known as the Old Spanish Trail (Miller 1968:Map 20). Along this route, which came up from Santa Fe through the San Juan country, across the Colorado River at Moab, over the Green River at the present site of Green River, across the San Rafael Desert into Castle Valley, then south through Salina Canyon to southwestern Utah and southern California, passed thousands of horses and numerous trading, trapping and Indian slave trade expeditions (Miller 1968).

By the 1830s, the trail was well established, portions of its route being followed in 1853 by explorer, John C. Fremont and government surveyor, John W. Gunnison, who reported several sets of well-worn tracks near Green River where Interstate 70 presently runs. Other sections of the trail still remain near the Big Hole Wash in Emery County. The primary route of the Old Spanish Trail, plus divergent trails to Utah Lake, Fort Robidoux and Fort Kit Carson, brought the first extended contact into the project area (Miller 1968: Map 20).

Though forts and trading posts were scattered sparsely through southern and central Utah, the first attempts at organized settlement were undertaken by the Mormon Church. In 1855, the Elk Mountain Mission passed southward through Castle Valley to the area of Moab intending to establish a permanent settlement, but Indian hostility forced a quick retreat. The combination of hostile Indians, the desolate appearance of the region, the hardships involved in securing sufficient water for irrigation and doubts about the quality of the soil caused further attempts at colonization of the eastern area of what was then Sanpete County to be dropped for over 20 years (McElprang et al 1949:16).

At a priesthood meeting at Mt. Pleasant on September 22, 1877, encouragement was given to settle Castle Valley; soon after 75 men from Sanpete Stake were called with Christian G. Larsen as leader. Very few responded, however, because of the aforementioned reasons. Orange Seely was subsequently given the responsibility of superintending the founding of settlements and another call for colonizers was issued by the Church in the fall of 1878. Some of the earliest settlers of the area who dwelt in dugouts in hills or washes until log houses could be erected were Elias and John Cox, Ben Jones, William Avery and Anthony Humbel. By the fall of 1878, the crops were sufficient and the situation stable

enough for the families of these men to join them, a sure sign of an intent to remain (McElprang et al 1949).

Work progressed on the agricultural settlements of Castle Valley and roads were built through the Wasatch Mountains to the more stable areas of western Sanpete County. Additionally, in the fall of 1878, the "Star-Mail Route" was opened between Salina and Ouray, Colorado; it followed the paths of the Old Spanish Trail and the "Gunnison" Trail of years before (McElprang et al 1949:19-21). In just three years the towns of Castle Dale, Wilsonville, Ferron, Greenriver (Blake), Huntington, Lawrence, Molen and Orangewill had been established and the Legislative Assembly in February, 1880, created Emery Coutny, which embraced all of present-day Carbon, Emery and Grand Counties (Lever 1898:593).

Though the project region was settled for its agricultural and grazing possibilities, it was the area that inspired active settlement and set the mining-dominated industrial base that central and eastern Utah retains to the present.

The first recorded discovery of coal in eastern Utah was by the Gunnison Expedition of 1853 (Powell 1976:13) when they located deposits of coal approximately three miles east of present-day Emery. The isolated location of the Gunnison find, coupled with the hope that the deposits already discovered at Coalville and Wales would prove sufficient for the territory's needs, caused Gunnison's discovery to be forgotten. The subsequent failure of the efforts at Wales to produce good coking coal, and the Union Pacific Railroad's monopolization and price-fixing on the deposits at Coalville, caused a re-evaluation of the potential coal producing areas east of the Sanpete settlements (Powell 1976:13).

As a result, the first effort to exploit the newly found eastern coal deposits was undertaken in 1875 at Connellsville in the upper reaches of Huntington Canyon. The

Fairview Coal Mining and Coke Company was organized by men from New York, Salt Lake City and Fairview. Eleven coke ovens were constructed and the coke was hauled by wagon into Springville. The expense involved with the hauling and the questionable quality of the coke produced caused the failure and abandonment of Connellsville by 1878 after only three years of operation (Powell 1976:13).

The next development of coal resources was begun in the Pleasant Valley area, also in 1875. The Pleasant Valley Coal Company, headed by Milan O. Packard, constructed a wagon road from Springville up Spanish Fork Canyon to Pleasant Valley coal lands in 1876; 1877 saw the opening of the Number 1 Mine in Winter Quarters Canyon (Powell 1976:14). A narrow gauge rail line was completed from Springville through Spanish Fork Canyon in October of 1879 by the Pleasant Valley Railroad Company as the haul to Springville by the wagon road occupied four days in good weather while in winter the road was impassable. This Pleasant Valley area proved to be extremely productive. The first three large scale mines in eastern Utah were established in this area when the Mud Creek Mine was reopened in 1882 followed by the 1884 opening of the Union Pacific Mine at Scofield just east of Winter Quarters (Powell 1976:15).

From the earliest times, the railroads sought to control the supply of coal in the territory, e.g., the Coalville resources and Union Pacific Railroad's control over that source. During the early 1880s, the Denver and Rio Grande Railroad was extending its lines from Colorado through Utah. Though originally graded through Castle Valley and Salina Canyon, the route of the railroad was altered, going through Price and Spanish Fork Canyon and thus taking in the rich coal areas of that was to become Carbon County (McElprang et al 1949:22).

Further expressing its interest in eastern Utah coal, the Denver and Rio Grande Western (Denver and Rio Grande's Utah

holdings) purchased the independently owned Pleasant Valley Railroad Company and Pleasant Valley Coal Company in 1882. Shortly thereafter, Union Pacific Railroad Company (UPRR) penetrated the Pleasant Valley area in order to protect its threatened monopoly on Utah coal (Powell 1976:16). The UPRR formed the Utah Central Coal Company in 1882 and opened the Union Pacific Mine near Scofield in 1884. With the Denver and Rio Grande's Pleasant Valley Coal development (1882), the establishment of Utah Fuel Company in 1887 and the creation of Utah Central Coal of Union Pacific, the railroad companies almost totally dominated the ownership and production of the Utah mines until the early 1900s (Reynolds et al 1948:195).

In 1888, a mine was opened at Castle Gate on the Price River near the mouth of Price Canyon. In about 1899, a new mine began operations at Sunnyside just 24 miles east of present-day Price at the base of the Book Cliffs. The Sunnyside Number 2 Mine also began its production in 1899 with the coal obtained there, and also at Castle Gate, being utilized for coking purposes (Powell 1976:17-18).

In 1906, the first of the coal operations which would remain free from railroad control began production at Kenilworth, three miles east of Helper. This enterprise was financially backed by James Wade and F. A. Sweet and was called the Independent Coal and Coke Company because of its unique ownership status. Sweet, one of Utah's most prominent coal authorities, also opened a mine on the middle fork of Miller Creek in 1908 and named the camp Hiawatha (Reynolds et al 1948:213). This locality at the foot of Gentry Mountain, about 18 miles southeast of Price, was the scene of further coal mining development in 1911 when Black Hawk mine was opened by Brown and Eccles. Just a few miles to the south in northern Emery County, a small wagon mine was purchased by the Castle Valley Fuel Company and the town, Mohrland, named from the initials of the company's four major figures--Mays, Orem, Heiner

and Rice--was begun. Mr. W. H. Wattis undertook the last development in this area in 1916 at Wattis, several miles north of Hiawatha on the flank of Castle Valley Mountain.

The decade from 1911-1920 saw an increase in activity in the coal regions of east-central Utah with many new mines being opened in hitherto undeveloped areas within the Utah coal producing regions. In 1911, Frank Cameron prospected the region around Panther Canyon on the Price River, and in 1914, the first coal was shipped out by the Utah Fuel Company which had leased the properties to Cameron for development. Cameron also developed and opened a small camp at the base of Castle Rock, about five miles northwest of Helper. Located directly on the main line of the Denver and Rio Grande Western Railroad, the camp's name was changed many times as was its ownership. Originally known as Bear Canyon, it soon was called Cameron, for its developer, then Rolapp, and finally, Royal (Reynolds et al 1948:244).

In 1912, Jesse Knight, one of the most prominent men in Utah mining history, bought 1600 acres of coal land west of Helper to provide coal for his smelting operations in the Tintic District. His mine, at what eventually became known as Spring Canyon, began production in 1913 and was the first of many mines in the Spring Canyon District, one of the most prolific coal producing areas in eastern Utah. Soon after the establishment of Storrs (Spring Canyon), F. A. Sweet opened another mine in Spring Canyon at Standardville, so called because it was considered to be the standard for the development of future mining camps. The year 1914 saw the opening of the Latuda Mine and camp by Liberty Fuel Company while mines were opened in 1916 at Peerless and Rains. The last mining development undertaken in the Spring Canyon District was Mutual Coal Company's Mutual and Little Standard operations, begun in 1921 and 1925, respectively.

The final major coal producing area to be opened in east-central Utah was the Gordon Creek District. This region had first been prospected in 1908, but was really brought to prominence in 1920 by A. E. Gibson, the superintendent of the Spring Canyon Mine. Mines were developed in this area up until 1925 by Consumers Mutual Coal Company, National Coal Company and Sweet Coal Company. The operations of all three companies ceased by 1950 (Carr 1972:81).

After the development of the Gordon Creek area, further work on the coal regions was undertaken in areas that had been opened previously. In 1922, Columbia Steel Company opened a mine at Columbia near the location of Sunnyside in order to further exploit the excellent coking coal obtainable from that region. One very late development of the same coal veins that supported the Columbia operation was initiated in Horse Canyon in 1942 by the United States government to aid steel production at its Geneva plant (Reynolds et al 1948:252). Both mine and steel plant were taken over by U.S. Steel after WWII and continue in operation to the present.

Most of the mines in east-central Utah continued production through the heavy demand years of WWI and the years of prosperity that followed but a combination of overdevelopment, the increased use of other natural fuels, rising costs associated with expensive underground haulage and the Depression of the late 1920s and early 1930s caused several camps to be abandoned. Among the first mines to succumb were the long exploited Pleasant Valley mines. Winter Quarters, near Scofield, was closed down in 1928 while Scofield and Clearcreek experienced reductions of operations during the early 1920s and 1930s, respectively. Rains was also forced to cut back on operations in 1930. Despite these setbacks, as of

1929, there were 22 coal mines operating in Carbon, Emery and Grand counties, the production of these mines providing 98% of the state's output (Sutton 1949:852).

Economic and production difficulties continued to plague Utah's coal industry during the decade of the 1930s, forcing the closure of the Mutual and Mohrland mines in 1938. World War II brought a temporary respite to the general downward trend with many mines achieving their highest production levels during the war years and immediately thereafter.

The decade of the 1950s signalled the end for a great number of the eastern Utah coal mining operations as the adaptation of coal for new uses was insufficient to keep pace with this fuel's replacement in many of its traditional roles. The increasing use of natural gas for heating homes and heavy industry use and the railroad's switch to diesel power were among the developments which severely hurt the coal industry. This bleak picture has drastically changed with the advent of America's "energy shortage", and new technologies for coal use in the future have caused an upswing in coal production in east-central Utah. Mines which were closed, or kept running with skeleton crews, have begun to increase operations during the last decade and the possibility of a new sustained burst of coal mining activity definitely exists (Alexander 1963:244-247).

D. Previous Investigations in the Region

Archeological research in the Castle Valley locality began with the Claflin Emerson Expedition. In 1929, Noel Morss and Henry Roberts conducted explorations and limited test excavations under the auspices of this expedition along the Fremont River and as far north as the Muddy River in Emery County. Morss' work resulted in the original definition of the

Fremont cultural entity (Morss 1931, Gunnerson 1969). Morss' description of Fremont sites north of the Colorado River was an important contribution to the understanding of the prehistoric horticultural adaptation in the American Southwest.

With the exception of Reagan's description of the large petroglyph panel in Buckhorn Draw (Reagan 1935), there were no archeological investigations in the Castle Valley region for the next 15 years. Between 1952 and 1957, the University of Utah conducted a series of surveys in order to better define the nature of the Fremont occupation in Utah. A large number of Fremont sites was located along the east side of the Wasatch Plateau and several of the sites were subjected to limited test excavations, including 42Em5, the Emery Site (42Em47) and Snake Rock Village (42Sv5). Each of these three sites were Fremont habitations (Gunnerson 1957). In addition to these Fremont sites, Gunnerson also tested a shallow rock shelter on Silverhorn Wash (42Em8) as a result of a local collector's report that a fluted projectile point resembling the Clovis style had been found eroding from the shelter deposits. Little additional information was obtained by the excavation, however (Gunnerson 1956).

In the 1970s, there was a significant upsurge in archeological activity in the Castle Valley region. In 1970, three sites endangered by vandalism were excavated by the University of Utah. These sites, Windy Ridge Village (42Em73), Crescent Ridge (42Em74) and Power Pole Knoll (42Em75) all proved to be Fremont habitation sites (Madsen 1975a) dating between about 980 B.P. and 1260 B.P.

During the following year, the University of Utah conducted excavations at Clyde's Cavern (42Em177). Clyde's cavern was a locus of summer plant gathering activities during the Late Archaic period, but the majority of the cultural deposits was shown to be the result of summer maize cultivation and wild plant harvesting activities during the subsequent Fremont period (Wylie 1972, Winter and Wylie 1974).

The next site to be excavated in the study area was Joe's Valley Alcove (42Em693). During the summer of 1974, the United States Forest Service excavated this site which had cultural strata, dated by both radiocarbon and typological means, from the Early Archaic, Late Archaic and Fremont Periods (E. DeBloois, personal communication). That same summer, a University of Utah field school excavated the Innocents Ridge site, which proved to be yet another Fremont habitation locus (Schroedl and Hogan 1975).

During the early fall of 1975, the Antiquities Section, Division of State History (Utah) conducted an excavation of a small rockshelter as a part of the cultural resource mitigation program for Consolidation Coal Company of Denver, Colorado. This site, known as Pint Size Shelter (42Em625), had two main cultural strata, one dated to the Late Archaic and the other dated to the early Fremont Period. Both of these occupations were evidently the result of wild plant procurement activities (Lindsay and Lund 1976).

Other Fremont habitation sites, located farther to the south, have been excavated. These sites include Snake Rock Village (Aikens 1967), Old Woman and Poplar Knob (Taylor 1957) and the Old Road Site and Ivie Ridge Site (Wilson and Smith 1976). These five sites were all Fremont period habitations although Kayenta and Mesa Verde Anasazi ceramics were recovered at low frequencies indicating that there was contact with other cultural groups located further south.

In addition to these Fremont sites, a deeply stratified rockshelter (Sudden Shelter, 42Sv6) was found to contain occupational strata spanning the entire Archaic Period, ca. 8000 B.P. to 3000 B.P. (Jennings et al 1980). The original site report indicated that Fremont diagnostics were present on the site when it was originally documented, but these artifacts were no longer present when the excavations were begun. The

Sudden Shelter site is of particular importance to the local prehistory and the prehistory of the eastern Great Basin and northern Colorado Plateau because of its numerous well-defined occupational strata which has allowed a fine-grain correlation between certain diagnostic projectile point types and the temporal phases of the Archaic period.

A test excavation of two heavily vandalized rockshelter sites (42Em959 and 42Em960) in Cottonwood Canyon conducted by AERC in 1979 seem to mirror the results of the excavations at the nearby Joe's Valley Alcove. Radiocarbon analyses have not yet been completed, but projectile point correlations indicate that these two sites were occupied during the Early Archaic period, Late Archaic and, most heavily, during the Fremont period (Weder and Hauck, n.d.).

Since 1970, the level of survey intensity has increased drastically. The various cultural resource inventories conducted during the 1970s have generally been the result of natural resource development programs and are too numerous to summarize in the present context. Summaries of these inventories performed before 1978 can be found in Sargent (1977) and Hauck (1979). The combined inventory results as of 1977 indicate that the majority of the culturally identifiable sites in the general area are Fremont although Archaic sites are also well represented. Protohistoric Numic sites are present but rare (Hauck 1979a:110).

E. Research Design

AERC's research design which has been developed to aid in project planning and resource evaluation for the east slopes of the Wasatch Mountain Range in central Utah include the following factors:

1. The determination of presence or absence of a continual sequence of Paleo-Indian, Archaic,

Fremont and Shoshonean utilization of the project area and the local manifestations of these cultural phases when present;

2. the determination of presence or absence of cultural materials which demonstrate the prehistoric utilization of drainages as access routes across the mountain range;

3. the determination of whether any specific ecozone contained a preponderance of prehistoric cultural resource sites, thus demonstrating any diversity of preference for different ecozones;

4. the determination of which types of prehistoric cultural activity were conducted in the project area based upon patterns in artifact associations or predominance of particular types of sites;

5. the determination of presence or absence of early historic Euro-American habitation, trapping, trade or travel within the project area; and

6. the determination, on a regional level, of whether the sites in the project area contained any remains, demonstrating local interaction between the San Rafael and Sevier variants of the Fremont Culture.

Since all research conducted in the Eccles Canyon locality has been oriented to identifying, recording and analyzing the historic and prehistoric remains within the project locality, only marginal artifact collection and subsurface testing has been carried out. No floral, faunal, radiocarbon, pollen or flotation specimens have been obtained for laboratory analyses. Collections have involved only the retrieval of diagnostic historic artifacts from the vicinity of the Utah Mine.

Chapter II - METHODOLOGY

A. Field Research

During late July, 1980, an intensive cultural resource inventory of a transmission corridor was conducted by AERC for Valley Camp of Utah and the Vaughn Hansen Associates consulting firm of Salt Lake City, Utah. This corridor is associated with the Pleasant Valley-Whiskey Creek project area located near Scofield, Utah.

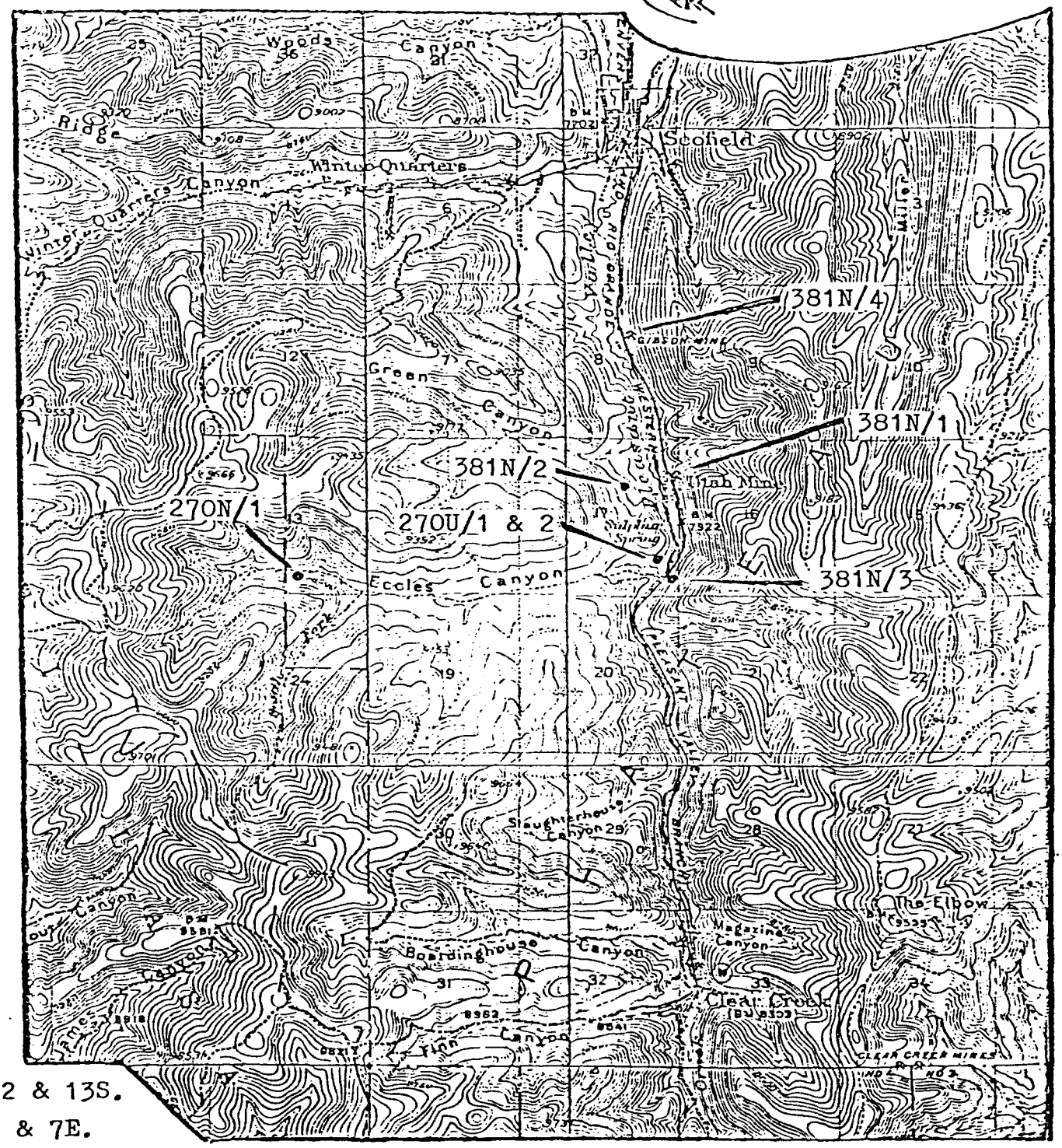
V. Garth Norman, a staff archeologist with AERC, was in charge of the field crew which included Monika Williams and Bunny Melendez. F. R. Hauck, president of AERC was principal investigator.

The survey area lies between the 7750 and 9200 foot elevations ASL within several narrow canyons where surface disturbance relative to transportation corridor development is planned. Location of the potential construction zones and the survey area is shown on Figure 3.

The purpose of the survey was twofold. An intensive evaluation of the Whiskey Canyon and Pleasant Valley corridor segments was conducted to assess the presence and significance of cultural resource sites which could be adversely affected by the development. These two corridors are linked by the eastern segment of the Eccles Canyon corridor which was evaluated by AERC in 1979 under contract to Coastal States Energy Company relative to that company's Skyline Project Mine Plan Permit application.

The second part of the survey was a surface examination and recording of three historic sites, all situated in Pleasant Valley. Although these three sites, the Green Canyon Sawmill site (AERC381N/2), the Nicolitus Mine portals (AERC381N/3) and the Gibson Mine (AERC381N/4), were evaluated by the AERC crew, they do not lie within the transmission corridor and no project-related adverse affect is planned for these sites.

ARCHEOLOGICAL - ENVIRONMENTAL RESEARCH CORPORATION



T. 12 & 13S.

R. 6 & 7E.

Meridian: Salt Lake B. & M.

Quad: Scofield, Utah

15 Minute USGS

Project: VH-80-1

Series: Central Utah

Date: 9-17-80

Figure 3

HISTORIC SITES IN THE PROJECT AREA

Legend:

Archeological Site or Historic Site •

N

1 0 1 2 M.

1 0 1 2K.

Scale

Their evaluation was considered important in providing a complete statement on the presence of important cultural resources situated adjacent to the present project permit area.

All inventoried surfaces in Whiskey Canyon, Eccles Canyon and on the west bank of Pleasant Valley were examined by team members performing parallel transects with personnel spacing ranging between 15 and 25 meters. In this manner, a three mile long corridor of about 60 meters width was intensively evaluated. Shorter intervals and zigzag transects were utilized on specific locations judged to be of high site potential.

A total of three historic sites has been recorded in the corridor zone. These sites (AERC 270U/1 and 2) include two historic cabin foundations situated at the mouth of Eccles Canyon which were recorded by AERC in 1979 (see report for CSEC-79-2 dated 7/23/79). Site AERC 381N/1 is the historic Utah Mine site which is situated at the northern end of the corridor zone.

Four other historic sites are situated in the general area but lie outside the construction corridor zone. These sites include the Eccles Canyon Coal Mine (AERC 270N/1) which is situated in the southeast quarter of Section 13, Township 13 South, Range 6 East; the Gibson Mine (AERC 381N/4) which is situated in the northeast quarter of Section 8, Township 13 South, Range 7 East; the Green Canyon Sawmill (AERC 381N/2) which is situated just west of Utah Mine in the northeast quarter of Section 17, Township 13 South, Range 7 East; and the Nicolitus Mine Portals (AERC 381N/3) which are situated in Pleasant Valley in the southeast quarter of Section 17, Township 13 South, Range 7 East. One mine portal on the Nicolitus site is situated on the west bank of Pleasant Creek and, therefore, lies within the corridor zone. The remainder of this

site is situated on the east slope of Pleasant Valley and is outside the potential construction zone.

All cultural resource sites were recorded, evaluated, photographed, sketched and their locations marked on a Scofield, Utah, 15 Minute U.S.G.S. topographic map. Site reports will be provided to all relevant agencies as an appendix to this report.

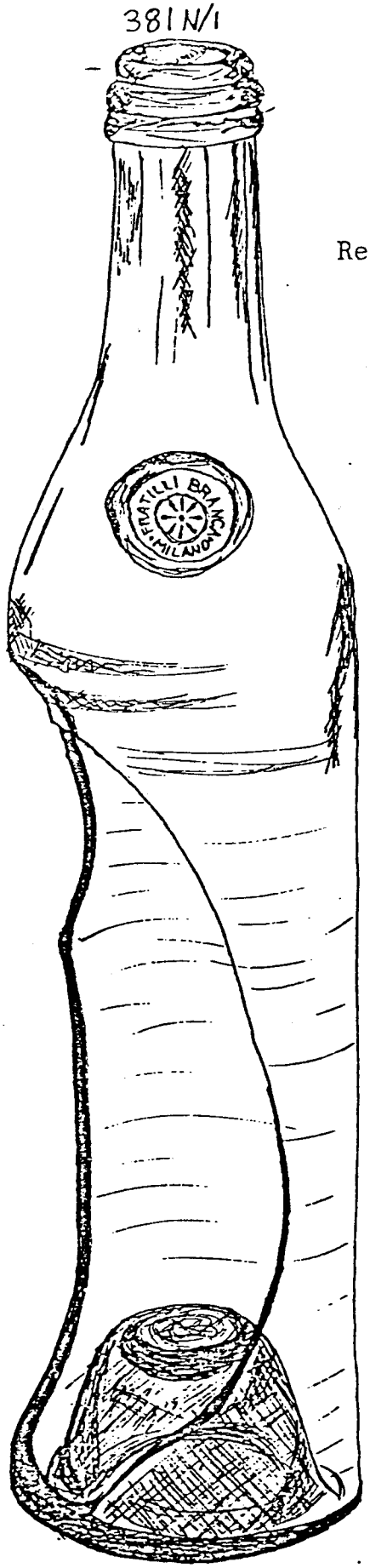
B. Laboratory Research

Laboratory analysis of artifacts was minimal since historic artifacts were minimally collected from only one site (381N/1). No other artifact or ecofact collections were made during the survey or during the 1979 survey when the Eccles Canyon segment of the corridor was evaluated.

C. Artifact Inventory and Analysis

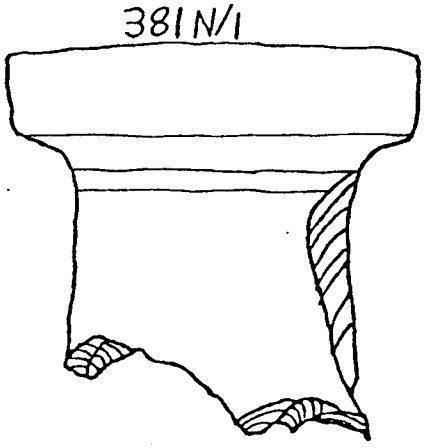
The following historic artifacts were collected at the Utah Mine site (AERC 381N/1):

1. One green wine bottle manufactured in Milan, Italy, by the Fratilli Branca Company. This bottle was manufactured using a three piece mold, a technique used in the United States between 1809 and 1885 A.D. The striations on the body of the bottle indicate a turn mold was used for that portion. Twin molds were in use in the United States between 1880 and 1900 A.D. These factors indicate that this bottle was probably constructed between 1880 and 1915 (c.f. Vienneau 1973:45-46).
2. Two pieces of a historic ceramic were collected in which the trademark show D. MEAKIN Ltd., -----, (E)ngland.



Reduced by 30%

Figure 4



Actual Size

3.- One fragment of a purple, square bottle was collected which carries the trademark --POLEON, Olive Oil.

4. One blue glass insulator was collected which shows the trademark -ingray-42.

5. One brass, portable gas lantern top was collected which has the trademark --OY'S DROPPER, Pat. 5.26.14, 1916.

6. One brown bottle rim was collected.

7. One steel spoon was collected.

8. One square bottle fragment was collected. This fragment contains the trademark --FIC SYRUP CO., __FIC, (PR)ODUCTS (INC.), --(O)R.

9. One wooden mount for an insulator was collected.

Sketches of the wine bottle and the brown bottle rim are shown on Figure 4.

Chapter III - CULTURAL RESOURCE DESCRIPTIONS

A. Site Analyses

A total of seven historic cultural resource sites is situated in the general project area. Four of these sites are either in the potential construction corridor (AERC 270U/1 and 2) or are partially within the corridor (AERC 381N/1 and 3). These four endangered sites are indicated on Table 1.

Based upon the definitions of cultural resource significance (see Chapter IV), none of the seven historic sites listed in Table 1 are considered eligible for nomination to the National Register of Historic Places (NRHP) based upon an archeological evaluation. The significance of these sites is provided on Table 2. Site 381N/1, the Utah Mine, is a potential candidate for nomination to the NRHP, based upon the available historic information on the Mine. This site has been given a CRRS:S-2 rating (see Chapter IV). The other three sites are not considered as having NRHP potential. The Nicolitus Mine has been rated a CRRS:S-3 while the two cabin foundations were originally rated at the equivalent of CRRS:S-4. Should additional historic data upon these four sites provide information indicating that any site has a greater cultural value than presently assigned, the site rating will be adjusted accordingly.

Site locations are shown on Figure 3. This map can be coordinated with Figure 2 to demonstrate the spatial relationship of these sites to the corridor zone. Additional information on these sites is provided in the site reports which are being provided to all relevant government agencies as an appendix to this report.

Table 1

Cultural Resource Site Summary

AERC Site No.	Permanent Site No.	Site Type	Culture	Land Ownership
270N/1	----	Mine	Euro-American	Private
270U/1*	----	Cabin, Stone foundation	Euro-American	Private
270U/2*	----	Cabin, Stone foundation	Euro-American	Private
381N/1*	----	Mine	Euro-American	Private
381N/2	----	Saw mill, corral	Euro-American	Private
381N/3*	----	Mine	Euro-American	Private
381N/4	----	Mine	Euro-American	Private

*Sites situated in the corridor zone which could be directly affected by transportation corridor development.

B. Comparative Resource Analysis

Of the four sites situated in the transmission corridor zone, and therefore susceptible to adverse affect during the construction period, site 381N/1, the Utah Mine, is the most important. The Utah Mine was originally begun between 1875 and 1880 when it was known as the Mud Creek Mine. This mine "opened on the Castlegate 'A' coal bed. The mouth of the mine is at tipple height above the railroad, and in 1923 the coal, which was then being mined for railroad use, was dumped from the mine cars without screening into railroad cars. This mine was idle for many years after it was opened and the workings are less extensive than those of the other old mines of the district" (Speaker 1931:96). The Utah Mine is still producing under the present ownership of Valley Camp of Utah. Extensive surface modification in the site area conducted during the past 100 years has altered much of the historic nature of the site. Some historic foundation rubble and depressions are presently discernable as are limited trash and rubble accumulations situated between the railroad track and the paved highway.

The Nicolitus Mine site (381N/3) includes two portals situated on both the east and west slopes of Pleasant Valley. This site is situated at the mouth of Eccles Canyon and is visible from the highway. The mine portals were opened in the early 1920s by John Nicolitus and were worked for about five years. Joe Williams obtained the lease from Nicolitus and worked the portals in 1931 and 1932 but without success. Williams subsequently sold the lease to John Stone for $1100, who unsuccessfully solicited John Staley and Joe Podbevsek to reopen the mine. The mine was never again worked because the veins were too thin to be profitable. No coal was ever sold from the mine (personal interviews conducted with Tom Biggs and John Staley in Scofield on August 29, 1980 by V. Garth Norman).

Sites AERC 270U/1 and 2 include two historic cabin foundations situated on the north ridge at the mouth of Eccles Canyon. These sites were originally recorded in 1979 by AERC while consulting for Coastal States Energy Company (CSEC-79-2). Both sites are limited, consisting of stone alignments and minimal construction materials. No trash area was discernible. Both sites may have been temporary campsites utilized during the construction of the west portal of the Nicolitus Mine (381N/3).

No prehistoric cultural resource sites or isolated artifacts have been observed or recorded in the general project locality.

Chapter IV - EVALUATIONS AND RECOMMENDATIONS

A. Resource Significance Evaluations:

An evaluation of site significance for the four sites situated within the mine plan permit area is presented in Table 2. Here the site quality indicators are presented with a statement on site condition. The field assessment of significance utilizing the CRRS system is provided in the fourth column. The CRRS system is best explained by quoting from the BLM definition sheet:

> Cultural Resource Rating System
>
> The following criteria are established as guidelines. The Bureau recognizes that the assignment of a particular rating is a professional judgment; however, the rationale of these judgments will be explicitly documented as part of the evaluation process.
>
> Assign an evaluation rating (S1, S2, S3, S4) to each site according to the following guidelines and record on the BLM form 6400-3:
>
> S1. S1 sites are those sites which are worthy of preservation *in situ*. In general, they are sites in relatively good condition with integrity (both internal and external); and are unique or representative; and/or have associations with important events or personages; and/or have yielded, or have a clear potential for yielding, highly significant scientific or educational information.
>
> S2. S2 sites are those sites which contain important scientific or educational data but yet are not worthy of preservation *in situ*. They are generally not particularly unique, representative, nor do they have important associations. Many contemporary sites may be S2 sites because, although they cannot be clearly and immediately assessed as such, they may become highly significant when evaluated from a future historical perspective.
>
> S3. S3 sites are those sites whose main worth are their potential for contributing data in regards to solving larger problems, such as reconstruction of

Table 2

Site Significance

Site	Quality	Condition	CRRS Value Rating
270N/1	a, g	Poor	3
270U/1*	----	Poor	4
270U/2*	----	Poor	4
381N/1* (First mine in area)	a, c, g, h	Poor	2
381N/2 (Saw mill for 381N/1)	g, h	Poor	3
381N/3*	g	Poor	3
381N/4	g	Poor	3

*Sites situated in the corridor zone which could be directly affected by transporation corridor development.

AERC Quality indicators are:

a) size or layout is unique;

b) quantity and/or quality of artifacts is unique;

c) indication of depth;

d) environmental location is unique;

e) existence of unique artifacts, architecture, art or structure;

f) condition is excellent for preservation of materials or data;

g) site contains specific cultural data revelant to temporal and spatial identifications;

h) site is scene of an important event; and

i) site is associated with an important person.

paleo-environments and human use patterns. These kinds of sites generally show little concentration of artifacts, few features, no important associations, and little or no uniqueness or representativeness.

S4. S4 sites are those sites which have minimal information retrieval possibilities, or which have no integrity, uniqueness, representativeness, or no important associations.

No sites were accorded CRRS:S-1 significance.

Only one site is rated as CRRS:S-2 while one site is of CRRS:S-3 value. The remaining two sites have been given a CRRS:S-4 rating.

The site (AERC 381N/1) has been given an S-2 value based on the potential for additional information through archeological excavation. Should future research on any one of these sites provide new data relative to significance, the CRRS rating will be appropriately upgraded.

B. National Register Criteria of Eligibility:

Application of the National Register Criteria of Eligibility, defined under 36 CFR 60.6, to each of the four sites that are situated in the mine plan permit area provides the following information:

a) None of the four sites are associated with events that have made a significant contribution to the broad patterns of our history; or

b) none of the four sites are associated with the lives of persons significant in our past; or

c) none of the four sites embody the distinctive characteristics of a type, period or method of construction, or represent the work of a master, or possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction; and

d) site 381N/1 could yield information of value to the history of the region. Extensive surface modification of this site, however, precludes the Utah Mine from consideration as an important and intact historic site. Any information of value to the history of the region would have to be obtained through oral history research and through archeological excavation.

C. Discussion of Impact Potential on Cultural Resource Sites

Direct impact, i.e., project-related disturbance of the four cultural resource sites located in the potential disturbance zone could result during surface modification for road and conveyor belt line development. Activities on the Utah Mine site (381N/1) will have marginal affect on the historic value of the site because of the extensive modifications which have earlier occurred at the site. The other three sites (270U/1, 2 and 381N/3) are of lesser importance although more intact. The cabin foundations (270U/1 and 2) can probably be easily avoided during the construction period. The endangered west portal of the Nicolitus Mine (381N/3) is of marginal historic value and disturbance could occur without causing a loss of valuable information or historic materials.

Indirect impact of these four sites through vandalism can be considered a minimal threat to their historic value. Any valuable or useful lumber or construction materials which provide an identity to these sites has already been removed, discarded or destroyed on site.

Table 3 provides a summary of the basic adverse affect potential for all seven historic sites situated in the general project area.

Table 3

Cultural Resource Impact Potential

Site	CRRS Status	Direct Impact	Indirect Impact	Impact Agent	Figure Reference
270N/1	3	No	No	-----	2
270U/1*	4	Not probable	Possible	Vandalism	2
270U/2*	4	Not probable	Possible	Vandalism	2
381N/1*	2	Yes	Possible	Coal Mine Development	2
381N/2	3	No	Possible	Vandalism	2
381N/3*	3	Yes	Possible	Transmission Corridor Development & Vandalism	2
381N/4	3	No	Possible	Vandalism	2

*sites situated in the corridor zone

D. Recommendations

AERC recommends that whenever possible, site avoidance procedures be implemented as a means of preserving the historic resources of the general area (see Table 3). Should total destruction of any one of these sites become necessary, a complete photographic documentation of the site should be conducted prior to disturbance.

AERC would also recommend that an archeologist be present to monitor the disturbance of any large trash areas or midden accumulations since such localities could contain historically diagnostic artifacts.

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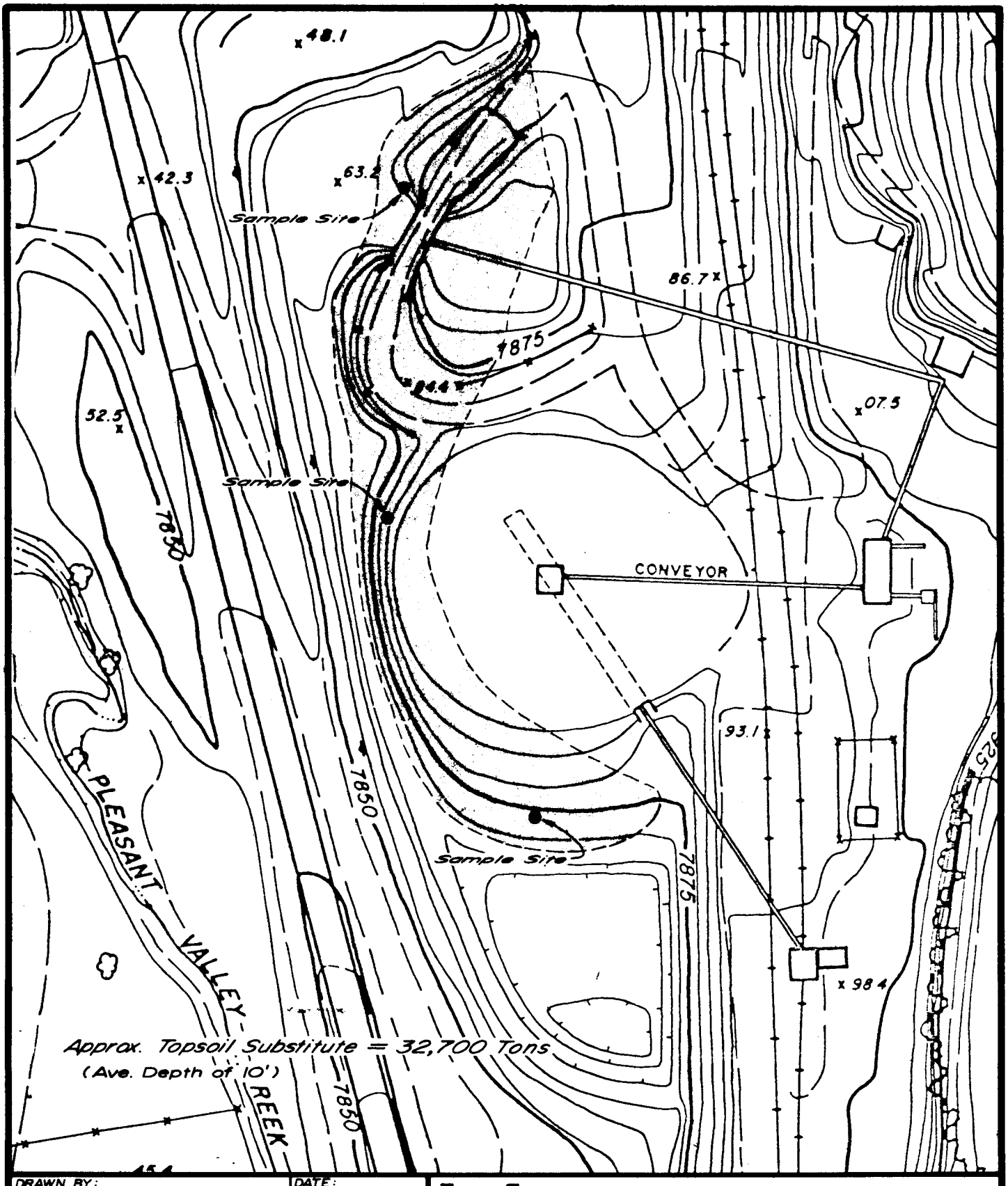
APPENDIX

Site Reports Under Separate Cover
Provided to Relevant Agencies
Upon Authorized Request



DRAWN BY: Ed Sanderson	DATE: Oct. 13, 1983	VALLEY CAMP of UTAH SCOFIELD ROUTE HELPER, UTAH 84526
CHECKED BY:	DATE:	
REVISED BY:	SCALE: 1" = 100'	
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APPROVAL SAFETY:	TITLE: UT. #2 SUBSTITUTE TOPSOIL	DRAWING NO. A5-0076 / REV. NO. 0
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