Mid-Term Permit Review

APPENDICIES - VOLUME 1 OF 2
SECTIONS R645-301-100 thru 600

VALLEY CAMP OF UTAH, INC. February, 1993

SCOFIELD ROUTE * HELPER, UTAH 84526 * PHONE [801] 448-9413

APPENDIX 117.200

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STATE OF UTAH)
ss.
County of Carbon,)

I, Dan Stockburger, on oath, say that I am the Publisher of the The Sun Advocate, a weekly newspaper of general circulation, published at Price, State and County aforesaid, and that a certain notice, a true copy of which is hereto attached, was of published in the full issue of such newspaper for Four (4) consecutive issues, and that the first publication was on the

27th day of March, 1990

and that the last publication of such notice was in the issue of such newspaper dated the

17th day of April, 1990

Dan Stockburger

Subscribed and sworn to before me this

17th day of April, 1990

Holly Jo Crofts
Notary Public.

My Commission expires October 22, 1990

Residing at Price, Utah

Publication fee, $ 141.60

Notary Public
HOLLY JO CROFTS
Route 1, Box 193
Price, Utah 84501
My Commission Expires
October 22, 1990
State of Utah

PUBLIC NOTICE
For Filing Underground Mining Permit Renewal Application

Valley Camp of Utah, Inc., wishes to advise the public that it has filed an Underground Mine Permit Renewal Application with the State of Utah Department of Natural Resources, Division of Oil, Gas, and Mining, and the Office of Surface Mining Reclamation and Enforcement, United States Department of Interior. Valley Camp of Utah, Inc. further advises the public of the following:

1. The full name and business address of the applicant is: Valley Camp of Utah, Inc., Scofield Route, Helper, Utah 84526.

2. The Valley Camp of Utah, Inc. Mine Permit Area is located in Carbon and Emery Counties, Utah, approximately 2 miles south of Scofield, Utah; 20 miles (50 miles by road) northwest of Price, Utah, and 110 miles southeast of Salt Lake City, Utah. Scofield is situated in Pleasant Valley and is accessible by an all-weather road, State Highway 96. This highway connects with U.S. Highway 6 at Colton Junction, approximately 15 miles northeat of Scofield, Utah. From Colton Junction, U.S. Highway 6 extends to the northwest to Interstate 15 at Spanish Fork, Utah. From Colton Junction U.S. Highway 6 extends to the southeast to Price, Utah.

The Valley Camp of Utah, Inc., property extends from Green Canyon on the north to Cox Canyon on the south.

3. The land contained within the Mine Permit Area is described as follows:
T14S R7E SLB&M, Section 7 NW ¼, and NW ¼ of NE ¼, Section 6 W ½, and W ½ of E ½, T14S R6E SLB&M, Section 1 E ½ NE ¼, and NE ¼ of SE ¼, T13S R7E SLB&M, Section 31 SW ¼, and W ½ of NW ¼, Section 30 W ½ W ½, SE ¼ SW ¼, and NE ¼ NW ¼; Section 21 Parts of NW ¼ NW ¼, Section 20 Parts of NE ¼ NE ¼, Section 19 S ½ SW ¼, NE ¼ SW ¼, and parts of W ½ E ½, E ½ NW ½, and NE ¼ NE ¼, Section 17 NE ¼ excluding parts of SW ¼ NE ¼ and NE ¼ NE ¼, N ½ SE ¼, Section 16 W ½ W ½, NE ¼ NW ¼, NW ¼ NE ¼, Section 9 W ½ SW ¼, Section 8 E ½ SE ¼, and a Part of SW ¼ SE ¼, T13S R6E SLB&M, Section 36 All, Section 35 Parts of E ½ E ½, and SW ¼ of SE ¼, Section 25 E ½, and parts of W½, Section 24 SE ¼ and parts of S ½ NE ¼, NW ¼ NE ¼, and E ½ SW ¼

4. A copy of the Mine Permit Renewal Application is available for public inspection at the Carbon and Emery County Recorders' Offices and the Utah Division of Oil, Gas and Mining, 3 Triad Center, Suite 350, S.L.C., Utah 84180-1203 (801)538-5430.

5. Written comments, objections or request for an informal conference concerning the Mine Permit Renewal Application may be submitted to:

State of Utah, Department of Natural Resources, Division of Oil, Gas and Mining, 3 Triad Center, Suite 350, Salt Lake City, Utah 84180-1203

Western Field Operations, Office of Surface Mining, Reclamation & Enforcement, Brooks Tower Second Floor, 1020 15th Street, Denver, Colorado 80202

Published in the Sun Advocate March 27, April 3, 10 and 17, 1990.

APPENDIX 221

Soils Suitability

APPENDIX L

Geotechnical Investigation of Cut Slopes at the Belina Mine Complex and Haul Road Carbon County, Utah

Prepared for

Valley Camp of Utah, Inc.
Helper, Utah

Prepared by

Morrison-Knudsen Co., Inc.
Boise, Idaho

October, 1983

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1.0 INTRODUCTION

1.1 GENERAL: At the request of Valley Camp of Utah, Inc.(Valley Camp), a geotechnical investigation was initiated on September 13, 1983 at the Belina Mine located in Carbon County near Helper, Utah. The purpose of this investigation was to evaluate the stability of cut slopes in the mine facilities area and on the 1.4 mile long haul road leading to the mine from Eccles Canyon.

1.2 SCOPE OF WORK: The geotechnical investigation consisted of a drilling and sampling program, field reconnaissance and mapping, laboratory testing, and computer assisted slope stability analyses. This report presents the data obtained during the course of the investigation, as well as conclusions and recommendations formulated from that data base and other information furnished by Valley Camp.

2.0 FIELD INVESTIGATION

2.1 GENERAL: The field investigation was directed toward evaluating the stability of cut slopes steeper than 2 horizontal:1 vertical. At the mine facilities site, three major cut areas were investigated: the backslope above the upper coal stratum portals; the backslope above the office/changehouse; and, the cut slope near the coal loadout chute. Numerous cut slopes on the haul road were also examined and/or mapped which were steeper than 2H:1V.

2.2 BACKSLOPE DRILLING PROGRAM: Soil and rock samples were required to evaluate the stability of the backslope above the upper portals and the office/changehouse. To obtain these samples, four exploratory borings were drilled to depths ranging from 49 feet to 61 feet below existing grade at location shown on the Geotechnical Investigation Site Plan (Figure 1).

Drilling was performed using a CME-750 drill machine mounted on an all-terrain vehicle and equipped with 6.0 inch diameter continuous flight hollowstem auger and NX-size coring tools. Disturbed samples of soil and soft rock were obtained for laboratory testing and logging purposes using a Standard Penetration Test (SPT) sampler, which is driven into soil or soft rock by a 140 pound hammer with a free-fall of 18 inches. The number of blows required to drive the sampler one foot (known as the "N-Value") is a measure of the relative density of cohesionless soils and the consistency of cohesive materials. Relatively undisturbed soil and soft rock samples for laboratory testing were extracted using a 3-inch o.d. Dames and Moore sampler with inner-liner brass rings, which serve to protect the samples during shipment to the laboratory.

The hollowstem auger was used as casing for NX coring tools. A 10 foot long double tube core barrel with a split inner barrel and carbide or diamond bits was utilized to obtain rock samples for logging and laboratory testing. Water was used as a drilling medium. Excessive water loss into pervious rock strata was experienced at all boring locations. Additives such as bentonite, cellulose, nut shell and DE-7 polymer did not significantly reduce the water loss. Only in borings in the vicinity of a 12,000 gallon

water storage tank, automatically resupplied by pumped water, could sufficient quantities of siphoned water be obtained to allow continuous coring operations.

Soil and soft rock samples were immediately sealed in plastic bags, placed in airtight containers, and stored in special foam-padded aluminum boxes. Rock samples were placed in standard cardboard core boxes; samples selected for laboratory testing were wrapped in plastic, sealed, wrapped in paper, and stored in a padded box.

All borings were thoroughly backfilled with soil after groundwater readings were taken. In the spring, Valley Camp personnel should check the bore holes and refill them if necessary.

2.3 FILL PAD BORING: At the request of Valley Camp an exploratory boring was drilled on the existing earth fill pad to obtain soil samples for later testing, which will determine the suitability of the fill for reclamation purposes. Valley Camp provided burlap bags with plastic inner bags for sample collection at 2.5-foot intervals. Samples were identified for location and depth. It is our understanding that sample shipment and subsequent laboratory testing will be performed under the direction of Valley Camp. The location of this boring is shown in Figure 1. It was backfilled in the same manner as the four backslope borings.

2.4 BORING LOGS: Boring logs were prepared for the four backslope exploratory borings, and are included in the report as boring nos. 1 through 4 (Figures 2 through 5). The fill pad boring was logged and is contained herein as boring no. 5 (Figure 6). Locations and top ground elevations of the borings were determined by Valley Camp personnel and are referenced to Belina Mine survey data points.

The boring logs include: the depths and elevations of major changes in soil and rock stratigraphic units; classification and description of natural soils in accordance with the Unified Soil Classification System; locations of disturbed, undisturbed, and cored soil and(or) rock samples; core sample

data, including the percentage of total core recovered and the percentage of core greater than 4 inches in length (rock quality designation, RQD); pertinent drilling information; and, groundwater data.

2.5 COMPOSITE LOGS OF CUT SLOPES: Two cut slopes in the mine facilities area exposed subsurface stratigraphic rock units and the orientation of fractures within those rock units. These cut slopes were logged in the same manner as an exploratory boring would be logged. The depths were estimated and fracture orientations were inferred from the same stratigraphic unit at several locations in the cut slope.

The composite log for the cut slope behind the office/changehouse building is included in this report as "B-6" (Figure 7), and the log of the cut slope near the coal loadout chute is included as "B-7" (Figure 8).

2.6 DETAIL LINE MAPS: Two detail line maps or detailed mappings of fracture orientations along a measured straight line were made in the cut slope near the loadout chute. The purpose of this mapping was to determine the orientation of primary and secondary joint sets and the nature of any infillings. These detail line maps are shown in Figures 9 and 10. The locations mapped are identified on the Geotechnical Investigation Site Plan (Figure 1), as "D1" and "D2".

Fracture orientations were determined using a hand-held Brunton compass.

2.7 GENERAL RECONNAISSANCE OF MINE FACILITIES AREA: Cut slopes in the mine facilities area were visually examined for evidence of tension cracks related to past and(or) potential slope movements, erosion or ravelling problems, and abnormal vegetation growth above the cut slopes that may indicate slope creep. The results of this reconnaissance are included in site descriptions contained in Section 3.0 of this report, Geology and Site Conditions.

2.8 RECONNAISSANCE OF CUT SLOPES ON THE HAUL ROAD: Detailed descriptions of cut slopes on the haul road were prepared in the field. They are

presented in this report as Figures 11 through 13, which are organized as an odometer mileage log that begins at the beginning of the road in Eccles Canyon. Specific references to these cut slope descriptions are contained in other parts of this report.

Joint and other fracture orientations were measured by Brunton compass, and in most cases, the strikes and dips recorded are actually averages of readings taken on four or more different rock surfaces.

3.0 GEOLOGY AND SITE CONDITIONS

3.1 GEOLOGY OF THE AREA: It is not the purpose of this report to present detailed geologic data of the Belina Mine Complex. However, the following brief overview of the regional geology does provide data pertinent to the geotechnical investigation of the Belina Mine cut slopes.

The Belina Mine lies within the Wasatch Plateau Coal Field, in an area in which all of the coal mined lies within 400 feet of the base of the Blackhawk Formation of Upper Cretaceous geologic age. Other than several coal strata, the lithology is predominately composed of yellow and gray sandstones and siltstones with some interbedded shales.

Structurally the mine lies between two northward striking, vertical displacement faults, on the upthrown block of a horst-like geologic feature. The nearer of the two faults passes less than one-half mile to the west, which may have determined the gentle southwestward dip of stratigraphic rock units at and near the Belina Mine. According to Valley Camp personnel and the observations made for this investigation, the magnitude of the dip is about 4°. Undoubtedly, other less significant faulting has occurred that affects site-specific geology. The approximate location of a possible strike-slip fault passing through the area is indicated in Figure 1 of this report. Mining personnel have indicated that at least one fault with minor vertical displacement has been encountered underground.

Two coal strata are mined at Belina and outcrops of each stratum are located on the enclosed site plan (Figure 1). Separate sets of portals penetrate the two strata.

A generalized backslope lithologic section is presented in this report as Figure 14, which represents data obtained from the four backslope borings.

3.2 BACKSLOPE ABOVE THE UPPER PORTALS: Boring nos. 1 and 2 were drilled in an area in which some slide activity has been experienced. The boring logs indicate that 13.5 to 26.5 feet of colluvium and talus overlie competent bedrock strata, predominately composed of gray siltstones that exhibit

various degrees of differential weathering. Permeability of the bedrock strata is quite high up to the depths penetrated by the borings. However, 20 hours after drilling, a static groundwater level was measured at 12.5 feet below existing grade at the location of boring no. 1. This boring could not be continuously cored because of excessive water loss into the formations at many different depths. Therefore, it is believed that the water level reading is the result of a zone of seepage water, noted on the log at 12.5 feet, filling a hole that was finally sealed with a layer of drilling mud. The sealing occurred after the hollowstem auger was pulled (i.e., rotated up and down to clear the augers) from the bottom of the hole. It does not appear that the backslope above the upper portals has a static phreatic surface within the depths penetrated by boring nos. 1 and 2.

Several tension cracks, approximately one inch wide and 3 to 5 feet long, were observed in an area about 50 feet southwest of boring no. 1. A water seep was trickling from the slope, before drilling began, about 10 to 15 feet below boring no. 1. Evidence of some slope erosion from this seep could be seen. In the vicinity of boring no. 2 there is a distinct lack of tree growth and evidence of recent slide activity, including some erosional scour. No tension cracks or water seeps were noted. An overview of the area suggests that a fault may pass through the natural drainageway in the vicinity of boring no. 2. This conjecture is based only on surface characteristics, the unusual thickness of colluvium and talus in boring no. 2, and conversations with Valley Camp mining personnel. The exploration borings were not deep enough to confirm the fault presence. Vertical displacement of the fault should not be significant, based upon visual observation of the upper coal stratum outcrop.

In general, the backslope above the upper portals appears to be in a nearly natural condition. The slide area seems to be more the result of natural weathering processes on a daylighting fault zone than a condition caused by mining activities.

Sections A-A' and B-B' (Figures 15 and 16) present simplified geologic cross sections through boring nos. 1 and 2, respectively. The sections also show

sample locations and types, as well as the existing slope configurations above and below the borings.

3.3 BACKSLOPE ABOVE THE OFFICE/CHANGEHOUSE: Boring logs 3 and 4 indicate that about 11 feet of colluvium and(or) talus overlie predominately gray siltstones, shales, and sandstones. The bedrock strata are quite pervious, and in some instances a ten foot core run required about 1000 gallons of water to complete. In most cases, core runs were made with water loss of 75 to 100%.

Tension cracks, erosional scour, or seepage zones were not observed in the vicinity of boring nos. 3 and 4. Surface vegetation was lush, and numerous large trees indicated no evidence of slope creep. Except for the steep cut slope behind the office/changehouse, the backslope appears to be virtually natural.

The composite log of the cut slope behind the office/changehouse (Figure 7) shows a section of competent bedrock units. The strike of the slope is approximately parallel to the regional dip direction (to the southwest at 4°±), which is a favorable cut slope orientation. The same cut slope continues to the northeast, and at a point above the waste water treatment plant some potential for ravelling of the upper coal stratum may exist which could precipitate a minor, shallow slide of overlying colluvium. Some ravelling of the coal stratum above the office/changehouse may also occur.

Section C-C' (Figure 17) presents the generalized geologic section of this slope.

3.4 CUT SLOPE NEAR THE COAL LOADOUT CHUTE: The log of this nearly vertical cut slope is referred to herein as "B-7" (Figure 8). Detail line maps (Figures 9 and 10) present further data on fracture orientations. The sandstone exposed in this cut is massive and extremely competent. The overlying coal, however, has been cut quite steeply for about a 3-foot thickness. The coal ravels from this portion of the section even in a light wind. The gentler slope above the coal appears to be nearly natural to the

elevation of the existing tree line, although some evidence of erosional scour can be observed.

3.5 CUT SLOPES ON THE HAUL ROAD: The haul road from Eccles Canyon traverses the east side of the ridge on which the Belina Mine is located. The regional bedding plane dip direction to the southwest presents a favorable orientation for the haul road cuts. Neither cut slopes perpendicular to the dip direction nor cut slopes parallel to the dip directions, have downdip bedding planes daylighting into the slope faces.

Primary and secondary joint sets are prominent in many of the cut slope faces and dips of the joints are generally quite steep, steeper than the inclination of the cut slopes. The steep dip in itself often precludes the possibility of plane shear failure because unfavorable joint planes do not daylight in the slope face.

The primary joint set generally strikes north-south (±10°) and has an average dip of about 80° to the east. The secondary joint set generally strikes east-west (±10°) and has an average dip of 75° to the north.

The descriptions of cut slopes contained in this report (Figures 11 through 13) indicate only four relatively minor areas in which regular maintenance or remedial measures may be required to stabilize cut slopes. These areas will be further discussed in sections 5.0 and 6.0 of this report.

4.0 LABORATORY TESTING

A laboratory testing program was established to determine the engineering properties of soil masses and jointed and intact rock masses. Test results were utilized to properly classify material types and to provide strength parameters for use in slope stability analyses.

4.1 MOISTURE AND DENSITY DETERMINATION: Moisture and density determinations were performed on thirteen specimens. These data, found in Table 1, provide information relative to the degree of saturation, compressibility characteristics, and the mass weight of various stratigraphic soil and rock units. These data are required for slope stability analysis.

4.2 ATTERBERG LIMITS TEST DATA: To properly classify soils in accordance with the Unified Soil Classification System, the liquid and plastic limits (two of the Atterberg limits) of seven representative soil samples were determined. These data also provide indications of the susceptibility of the soils to volume changes with changes in moisture content. Some references (e.g. NAVFAC, DM-7, Department of the Navy, 1972) also correlate these data with the angle of internal friction, ϕ, of a soil, and with certain consolidation characteristics.

Table 2 contains the results of these Atterberg limits tests.

4.3 UNCONFINED COMPRESSION TESTS: Nine specimens of soil and rock were tested in unconfined compression to determine the shear strength parameter, c (unit cohesion), of those materials when ϕ (angle of friction) is assumed to be 0. This is a quick, relatively inexpensive test method for obtaining values of c.

Test results are shown in tabulated form in Table 3. The modulus of elasticity is included, which is a function of the stress-strain curve, dependent on the sample stress history, moisture content, density and other factors. These data are also used in slope stability analyses.

4.4 TRIAXIAL COMPRESSION TESTS: Three samples were subjected to lateral confining pressures before an axial load was applied. These triaxial tests (unconsolidated, undrained) require a high degree of specimen homogeneity before the data points may be combined to provide accurate values for both Ø and c. In this case, the samples did not prove to be sufficiently homogeneous to provide such data, although ranges may be established for Ø and c.

These test data are also found in Table 3.

4.5 DIRECT SHEAR TESTS: Three multi-stage direct shear tests were performed on jointed rock specimens to evaluate the shear strength parameters Ø and c of the rock joints. In a rock slope stability analysis, these data provide parameters for a probable failure surface that would primarily follow existing joint patterns.

Test data are shown in Table 4, and more detailed direct shear test results are contained in Figures 18 through 20 of this report.

5.0 SLOPE STABILITY ANALYSIS

5.1 GENERAL: Recognized potential modes of slope instability consist of plane shear, wedge, circular, and toppling failures. Such failures are dependent upon many factors including the slope configuration, geologic discontinuities, and physical characteristics of the stratigraphic units.

Laboratory data and(or) stratigraphic information from exploratory borings, field reconnaissance, and field mapping were utilized to establish computer models or stereographic projections by which the stability of various cut slopes could be evaluated.

A computer program based on a limiting equilibrium analysis method (STABL, Siegel, 1977) was used to evaluate the two major Belina Mine slopes: the backslope above the upper portals, and the backslope above the office/changehouse. Stereographic projection techniques were used to evaluate the cut slope near the coal loadout chute and the major cuts along the haul road.

For the computer analysis the most important consideration is the selection of correct soil and rock shear strength parameters for each stratigraphic unit. For the backslopes, the worst-case unconfined compression test result of 8.5 psi was utilized for the colluvium/talus. A significant Ø angle was estimated to be 18° from NAVFAC, DM-7. This Ø value was used to calculate the value of c from the unconfined compressive strength test results. For the weathered siltstones, direct shear test results on jointed rock, along with unconfined compression tests of intact rock, were utilized to estimate the shear strength. Since rock joints were noticeably absent in the rock cores extracted in the drilling program, it was assumed that a potential failure surface would have to pass through some intact rock. Therefore, c was estimated to be a midrange value of 34.7 psi and Ø was estimated to be 38°. Groundwater and earthquake factors were not assumed to be significant factors in the analyses. Moist unit weights were used for both soil and rock.

5.2 ANALYSIS OF BACKSLOPE ABOVE UPPER PORTALS: The computer-generated geologic models of the A-A' and B-B' sections are included in this report as Figures 21 and 22. The most critical failure paths passed through the colluvium and(or) talus interface with the underlying bedrock surface. For section A-A', the corresponding factor of safety against slope instability was 1.4. For section B-B' the factor of safety was 1.15 at the steepest portion of the slope, just below boring no. 2. Failure surfaces extending into bedrock materials had very high factors of safety, in excess of 2.5.

5.3 ANALYSIS OF BACKSLOPE ABOVE THE OFFICE/CHANGEHOUSE: Figure 23 presents the computer-generated geologic model of the C-C' section. As in the analysis for the adjacent backslope described above, the most critical failure path passed through the colluvium and(or) talus interface with the bedrock. The lowest factor of safety obtained was 1.9.

5.4 ANALYSIS OF THE CUT SLOPE NEAR THE COAL LOADOUT CHUTE: Stereographic projections are long recognized methods of presenting kinematic tests for various modes of slope instability. Using the cut slope log "B-7" and detail line data, stereographic projections were prepared for potential shear plane, wedge and toppling failures (Figures 24 through 26). The massive sandstone in this cut is extremely competent and joint orientations generally appear to be favorable. Only that portion of the cut slope striking S25°W shows a slight potential for failure in a toppling mode. However, the adjacent portion of the cut confines this potential toppling section, causing the entire slope to be safe.

5.5 ANALYSIS OF THE HAUL ROAD CUT SLOPES: The potential failure plane described between odometer mileage readings 0.14 to 0.17 on Figure 11 does not pass the kinematic test for stability because the slope face is 3° steeper than the 65° dip of the secondary joint set. Relatively minor quantities of rock are found above the daylighting joint set.

The colluvium/talus described between odometer mileage readings 0.69 to 0.72 on Figure 12 indicates that the colluvium/talus is cut in the steepest portion of the slope to an angle of about 65°. The thickness of this

stratum is not known, but a stable slope configuration should be flatter, as evidenced by the results of the Belina Mine Complex backslope analysis.

The potential failure surface described at the 0.86 odometer reading on Figure 12 is located on a "nose", or peninsula-like rock feature. This type of rock mass is the most susceptible to natural weathering processes, and it is likely that the potential failure surface is a naturally occuring phenomenon than a result of "blast damage." In any case, the potential failure surface does not pass the kinematic test for stability.

At odometer reading 0.92 on Figure 12, highly fractured rock may be cut to a slope that is slightly steeper than long-term stability would dictate. There is no laboratory data available to substantiate this possibility.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 GENERAL CONCLUSIONS: Slope stability analyses have indicated that the cut slopes in the area of mine facilities are, in general, stable. The steeper portion of the backslope above the upper portals, represented by section B-B', is the only backslope that does not meet the required 1.3 minimum factor of safety established by the State of Utah for cut slopes steeper than 2 horizontal to 1 vertical. It should be reiterated that this so-called "unstable" condition may not be related to mining operations and may rather be associated with natural geologic discontinuities.

The vertical 3-foot high section of coal above the massive sandstone exposed in the cut slope by the coal loadout chute is too steep, and will probably ravel or weather to an angle of about 34°.

For the most part, the haul road cuts were found to be stable. Four haul road cut slopes described in section 5.5 appear to be too steep for long-term stability, although the cut slope at the 0.86 odometer reading may have had the potential failure surface develop long before the haul road was constructed.

6.2 GENERAL RECOMMENDATIONS

6.2.1 BACKSLOPE ABOVE THE UPPER PORTALS: In the vicinity of boring no. 2 (section B-B') the steep portion of the slope should be excavated to a flatter configuration, perhaps 23°, which is the slope angle of the more stable section A-A'.

Positive surface drainage must be directed away from the slope face, and the slope should be smoothed and revegetated. Seepage water should be controlled, possibly by gravel-lined diversion ditches.

In lieu of the above-mentioned remedial actions, seasonal maintenance of slope or slide debris should be anticipated.

6.2.2 BACKSLOPE ABOVE THE OFFICE/CHANGEHOUSE: Some ravelling may occur from the coal and siltstone strata, and maintenance provisions should be anticipated.

6.2.3 CUT SLOPE NEAR THE COAL LOADOUT CHUTE: The coal stratum above the massive sandstone should be flattened to a slope angle of about 34°. The gentler slope above the coal should be smoothed and revegetated to more properly control surface water runoff. A diversion ditch on the trail above the slope may further reduce the runoff erosion potential.

6.2.4 HAUL ROAD CUT SLOPES: Major cut slope failures on the haul road are not likely. More probably, natural weathering processes will remedy most of the stability problems over a period of years, during which time seasonal maintenance should be anticipated. However, flattening of the slopes identified in section 5.5 should alleviate much of the scheduled road maintenance. In any case, the identified slopes should be carefully observed with monthly regularity, and more often during the spring thaw period.

TABLES

Table 1

Moisture and Density Determinations

Boring No.	Depth (ft.)	Sample No.	Moisture (% of dry wt)	Wet Density (PCF)	Dry Density (PCF)
1	5.0-6.5	1-1*	18.7	146.6	123.5
1	11.5-11.8	1-3*	10.5	136.9	123.9
1	16.0-16.5	CORE	5.7	152.9	144.7
2	4.0-4.5	2-1	17.6	125.0	106.3
2	9.5-10.0	2-2	20.0	130.3	108.6
2	14.3-14.5	2-3	14.5	130.1	113.6
2	29.0-29.5	2-6	5.4	139.6	132.4
3	5.0-5.5	3-1	12.3	126.4	112.6
3	17.0-17.5	3-4	16.1	133.2	114.7
3	21.7-22.3	CORE	7.6	152.8	142.0
3	25.0-25.5	CORE	10.6	156.6	141.6
3	30.5-30.9	CORE	8.2	147.5	136.3
4	9.5-10.0	4-2	15.4	132.6	114.9

*Represents disturbed samples, and wet/dry density results may not be accurate.

Table 2

Atterberg Limits Test Data

Boring No.	Depth (ft.)	Sample No.	Liquid Limit (%)	Plastic Limit (%)	Plasticity* Index (%)	Group Classi-fication
1	5.0-6.5	1-1	38	27	11	ML
2	4.0-4.5	2-1	28	19	9	CL
2	9.5-10.0	2-2	35	19	16	CL
2	14.3-14.5	2-3	35	20	15	CL
3	5.0-5.5	3-1	36	18	18	CL
3	17.0-17.5	3-3	31	19	12	CL
4	9.5-10.0	4-2	29	18	11	CL

*Liquid Limit - Plastic Limit = Plasticity Index

Table 3

Unconfined Compression Tests

Boring No.	Depth (ft.)	Lithology	Density (pcf)	Compressive Strength (psi)	Young's Modulus (psi)
1	16.0-16.5	SILTSTONE	152.9	68*	7.3×10^3
2	4.0-4.5	SANDY CLAY	125.0	8.5	-
2	9.5-10.0	SILTY CLAY	130.3	48	1.3×10^3
2	29.0-29.5	SILTSTONE	139.6	120	5.2×10^3
3	5.0-5.5	SILTY CLAY	126.4	42	2.2×10^3
3	17.0-17.5	SHALE	133.2	90[1]	1.5×10^3
3	21.7-22.3	SHALE	152.8	428[2]	2.3×10^4
3	25.0-25.5	SHALE	156.6	130[3]	2.2×10^3
3	30.5-30.9	SHALE	147.5	61	1.1×10^3
3	59.6-60.0	COAL	76.8	1,540	1.3×10^5
4	9.5-10.0	SANDY CLAY	132.6	37	8.1×10^2
4	57.0-57.5	SANDSTONE	159.2	20,640	-

*Failure across healed fracture

[1]Confining pressure of 20 psi (triaxial test - uu)

[2]Confining pressure of 50 psi (triaxial test - uu)

[3]Confining pressure of 80 psi (triaxial test - uu)

Table 4

Direct Shear Test Results*

Boring No.	Depth (ft.)	Lithology	Type of Joint	Friction Angle, Ø (degrees)	Unit Cohesion c (psi)
3	49.7-50.2	SILTSTONE	70°, OPEN	25.6°	28.3
4	20.5-21.0	SHALE	0°, OPEN	22.3°	30.7
4	37.5-38.0	SILTSTONE	77°, OPEN	38.0°	15.5

*Shear strength parameters for each sample were determined by multi-stage tests, using five different normal stresses.

F I G U R E S

MORRISON KNUDSEN Mining Group

BORING LOG

PROJECT
Valley Camp of Utah, Inc.
Belina Mine, Carbon County

Upper Portal Backslope

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 1
Undisturbed Soil Sampler: 3-in. o.d. DBM sampler	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 3
w=Moisture Content, % / D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 9-13-83

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
9139.6	0	CL	Silty Clay: dark brown; 15-20% fine sand; very wet; medium plasticity; medium stiff. Some organics. (Topsoil zone)			Location - N: 7,226.26 W: 10,102.57
9138.1	1.5	CL	Silty Clay: dark yellowish-brown; 20% fine sand; wet to very wet; medium plasticity; medium stiff.			(on slope above ventilation fan)
9136.1	3.5	CL	As above but mottled with dark grayish-brown and wet.			Hole cased to 13.5' with hollowstem auger.
9134.1	5.5	CL-CH & ML	Silty Clay: dark brownish-gray and dark gray; wet; medium to high plasticity; stiff. Some thin (1/8") coal seams and zones of sandy silt.	SPT 1-1	3, 4, 7	N=11
9132.1	7.5	CH	Silty Clay: dark gray and gray; moist; high plasticity; very stiff.			
9130.1	9.5	CL	Silty and sandy clay: dark gray, yellowish brown, and brown; up to 25% fine sand; moist; low to medium plasticity; hard to very hard. Last 2-3" saturated from groundwater perched on sandstone stringer from 12.5 to 12.7'. (Weathered rock)	D&M 1-2	35, 38	
				SPT 1-3	23, 47	N=70 Groundwater @ 12.3' after 20 hours.
9126.1	13.5		Shale and Siltstone: silty and sandy clay; gray mottled with brownish-yellow; up to 25% fine sand; partings every 8"±; soft rock.	NX core Run #1		94% Recovery (diamond bit; bentonite and D7-E polymer)
9119.6	20					94% RQD (10 pieces)

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Figure 2

MORRISON KNUDSEN **Mining Group**

BORING LOG

PRC CT
Valley Camp of h, nc.
Belina Mine, Ca: C ty

Upper Portal Bac e

Boring Method: 6-in continuous flight auger	Standard Penetration Test		g No. 1
Undisturbed Soil Sampler: 3-in. o.d. D&M sampler	140-lb. Hammer	30-in. Fall	2-in.o.d. Split-barrel S 1 2 of
w = Moisture Content, % D = Dry Density, pcf	Penetration Resistance: N = Blows per foo		9-13-83

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	R
9119.6	20					
9113.3	20.3		As before (shale and siltstone)			56% e (carl ol bento ar 07- lost c atern a 21.5")
			Badly weathered sandstones and shales: brown and brownish yellow; very soft rock.	NX Core Run #2		0% RQD
						Added cellulose, nut shell and mo bentonite to drilling water: began drilling w tricone bit at 2 lost circulation; continued drilli with hollowstem auger; tried trico bit again at 29.0' and lost circula immediately.
				D&M 1-4	72 in 3'	
9107.6	32					
9107.1	32.5		Zone of broken sandstone.			
		CL-ML	Shale and siltstone: silty clay; gray and dark gray; moist; low to medium plasticity; soft rock.			
				SPT 1-5	100	in 3" N=100+
9102.6	37					
9102.1	37.5		Possible sandstone			
		ML	Siltstone: sandy silt; dark brown and grayish brown; dry; slight plasticity; moderately soft rock.			
9099.6	40					

Figure 2a

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MORRISON KNUDSEN Mining Group

BORING LOG

PROJECT

Valley Camp of Utah, Inc.
Belina Mine, Carbon County

Upper Portal Backslope

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 1
Undisturbed Soil Sampler: 3-in. o.d. D&M sampler	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 3 of 3
w = Moisture Content, % / D = Dry Density, pcf	Penetration Resistance: N = Blows per foot		Date: 9-13-83

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
9099.6	40		As before (siltstone) D&M	1-6	100	in 1"
9095.1	44.5		Sandstone (poor recovery with hollowstem auger); soft to moderately hard rock.			
9093.6	46		Siltstone, as before.			
9091.6	48		Sandstone: hard rock.			
9090.6	49		(Refusal of hollowstem auger with carbide teeth, using CME-750 rig)			

Figure 2b

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MORRISON KNUDSEN Mining Group

BORING LOG

PROJECT
Valley Camp of Utah, Inc.
Belina Mine, Carbon County

Upper Portal Backslope

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 2
Undisturbed Soil Sampler: 3-in. o.d. D&M sampler	140-lb. Hammer	30-in. Fall	2-in.o.d. Split-barrel Sampler	Sheet 1 of 3
w=Moisture Content, % / D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 9-14-83

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
9230.1	0	CL	Silty Clay: very dark brown; 15-20% fine sand; moist; medium plasticity; medium stiff.			Location - N: 7,561.28 W: 10,196.59 (Active slide are
9227.6	2.5	CL	Sandy Clay: dark yellowish brown; some pieces of weathered sandstone (¼" diameter).			
9226.6	3.5	CL	Sandy Clay: brownish yellow mottled with brownish gray; 20-25% fine sand; pieces of weathered sandstone; medium plasticity; soft to medium stiff.	D&M 2-1	5, 9, 10	(33% recovered)
9224.1	6	CL& CH	Silty Clay: gray and dark gray becoming dark brownish gray; some pieces of weathered sandstone; medium and high plasticity; very stiff to hard.	D&M 2-2	7, 13, 19	No groundwater 38 hours after drilling.
9218.8	11.3		Weathered sandstone			
9218.1	12	CL& CH	As before but more zones of weathered sandstone.	D&M 2-3	5, 6, 10	
9214.1	16		Weathered sandstone pieces.			
9213.1	17	CL, CH, &SM	Silty and sandy clay: brownish yellow; wet; 5-35% fine sand; low (sandy clay) & high (silty clay) plasticity; stiff. Zones of badly weathered sandstone (SM).	SPT 2-4	3, 11, 8	N=19
9210.1	20					

Figure 3

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MORRISON KNUDSEN Mining Group

BORING LOG

PROJECT
Valley Camp of Utah, Inc.
Belina Mine, Carbon County

Upper Portal Backslope

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 2
Undisturbed Soil Sampler: 3-in. o.d. D&M sampler	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 2 of 3
w=Moisture Content, % / D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 9-14-83

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
9210.1	20	CL, CH, &SM	As before (silty and sandy clay with badly weathered sandstone)			
9206.1	24		Siltstone or sandstone: moderately hard rock; possible talus (no samples).			
9204.6	25.5	CL, CH, SM	As before with thin seams of siltstone	SPT 2-5	9	
9203.6	26.5				10	
					50	in 5" N=60+
			Weathered siltstone: sandy silt; gray; moist; 15-20% fine sand; soft to moderately hard rock.			
				D&M 2-6	16	
					29	
					40	
9197.6	32.5		As above but moderately hard to hard rock (harder than above)			
9194.6	35.5	SM& ML	Badly weathered siltstone & sandstone: brownish yellow and yellowish gray; wet; very soft rock.			
				SPT 2-7	39	
					18	N=64
					46	
9191.1	39		Siltstone or sandstone: moderately hard rock (no recovery).			

Figure 3a

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MORRISON KNUDSEN Mining Group

BORING LOG

PROJECT
Valley Camp of Utah, Inc.
Belina MIne, Carbon County

Upper Portal Backslope

Boring Method: 6-in. continuous flight auger	Standard Penetration Test	Boring No. 2
Undisturbed Soil Sampler: 3-in. o.d. D&M sampler	140-lb. Hammer / 30-in. Fall / 2-in. o.d. Split-barrel Sampler	Sheet 3 of 3
w = Moisture Content, % / D = Dry Density, pcf	Penetration Resistance: N = Blows per foot	Date: 9-14-8

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
9190.1	40		As before.			
9189.6	40.5		Weathered siltstone: sandy silt; gray; moist; soft to moderately hard rock.	D&M 2-8	100 in 2"	Hollowstem auger used as casing at 44.0'; tried to hol water head with bentonite and cellulose to see if coring was possible; lost head of water with 30 seconds.
9182.1	48		Weathered siltstone: as above but mottled with yellowish brown and yellowish gray; somewhat harder.	SPT 2-9	50 in 2"	N=50+
			End of Boring	SPT 2-10	100 in 3.5"	N=100+
9175.8	54.3					

Figure 3b

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MORRISON KNUDSEN Mining Group

BORING LOG

PROJECT
Valley Camp of Utah, Inc.
Belina Mine, Carbon County

Upper Portal Backslope

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 3
Undisturbed Soil Sampler: 3-in. o.d. D&M sampler	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 3
w=Moisture Content, % / D=Dry-Density, pcf	Penetration Resistance: N=Blows per foot		Date: 9-15-83

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
9129.3	0	CL	Silty Clay: dark brown to brown; 15 to 20% fine sand; moist; low to medium plasticity; organics upper 12".			Location - N: 7,786.38 W: 9,745.67 (on slope above changehouse)
9125.8	3.5	CL& CH w/ SM	Silty/sandy clay with sandstone: grayish brown; zones of hard weathered sand compose ≃ 20% of stratum; wet; medium and high plasticity; up to 30% fine sand in zones of sandy clay; very stiff t to hard.	D&M 3-1	14 21 25	Hollowstem auger set as casing at 18.5'
9121.3	8	CL, SM &ML	Badly weathered siltstone&sandstone: sandy clay matrix with pieces of moderately soft rock; brownish yellow and brownish gray.	SPT 3-2	8 23 19	No groundwater data hole plugged at 18' 24 hours after drilling. N=42
9118.8	10.5		Weathered siltstone: gray; moist; moderately soft rock.			
9117.3	12	CL	Silty Clay: brownish yellow; wet; low to medium plasticity; stiff. Zones of claystone ≃ 3-4" thick; hard.	SPT 3-3	7 11 19	N=30
9113.8	15.5	CL-CH	Weathered shale: brownish yellow becoming gray at 17.5'; moist; medium to high plasticity; very soft to soft rock.	D&M 3-4	25 29 23	in 2"
9109.3	20			NX Core Run#1		See following page for core data

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Figure 4

MORRISON KNUDSEN Mining Group

BORING LOG

PROJECT

Valley Camp of Utah, Inc.
Belina Mine, Carbon County

Upper Portal Backslope

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 3
Undisturbed Soil Sampler: 3-in. o.d. D&M sampler	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 2 of 3
w=Moisture Content, % D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 9-15

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
9109.3	20					
9108.8	20.5	CL-CH	As before			
			Weathered shale: gray and brownish yellow; some interbedded sandstone strata ≃ 1-2" thick; partings at 2-3"; soft rock. Joints: 20.5', moderately smooth, open, 10° dip; 21.7-22.3', closed 90° dip; 23.1-23.2' moderately smooth; 30° dip.	Cont. NX Core Run #1		97% Recovery 12% RQD (1 piece (Carbide bit; "unlimited" wate supply by siphon from 12,000 gal. potable water storage tank; wa did not recircula
9105.3	24		Sandstone: brownish yellow; moderately hard rock. Joints: 24.2-24.4' moderately rough, open, 80° dip; 24.6-24.7' moderately smooth, 45&60°; 24.7'24.9', open, moderately smooth, 90° dip.			
9104.4	24.9					
9103.5	25.8		Weathered shale: gray and brownish yellow; moist; soft rock.	NX Core Run #2		52% Recovery 15% RQD (1 piece)
9101.3	28		Badly weathered sandstone & shale: brownish yellow and gray; partings every ½ to 2". Joints: 26.0', open, rough, 75° dip.			
			Lost sample: very soft rock.			
9099.3	30		Weathered shale, siltstone&sandstone: gray and brownish yellow; soft rock partings ½-3".	NX Core Run #3		78% Recovery 14% RQD (2 pieces)
9096.3	33		Sandstone: brownish yellow; hard; thin-bedded (1.5-3").			
9095.3	34		Weathered shale and siltstone: gray and brownish yellow; soft rock; partings ½ to 2". Joints: 39.2', closed, 90°.	NX Core Run #4		87% Recovery 0% RQD
				NX Core Run #5		80% Recovery 23% RQD (2 pieces)
9089.8	39.5		As below			

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Figure 4a

MORRISON KNUDSEN Mining Group

BORING LOG

PROJECT
Valley Camp of Utah, Inc.
Belina Mine, Carbon County

Upper Portal Backslope

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 3
Undisturbed Soil Sampler: 3-in. o.d. DBM sampler	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 3 of 3
w = Moisture Content, %	D = Dry Density, pcf	Penetration Resistance: N = Blows per foot	Date: 9-15-83

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
9089.3	40		Weathered shale: gray and brownish yellow; soft rock. Joints: 40.7 & 41.3', open, rough, 20° dip. Partings every 2 to 12".	Cont. NX Core Run #5		As before
						100% Recovery 46% RQD (8 pieces)
				NX Core Run #6		
9083.8	45.5		Siltstone: gray and brownish yellow; moist; moderately hard rock. Joints: 48.5', open, rough, 0°; 49.5-49.8', 3 pieces, rough, 70°; 50.0', open, moderately smooth, 20°. Partings every 2 to 7".			
9078.3	51		Very soft weathered shale			
9077.3	52		Coal: thin bedded, moderately soft. Partings every 1 to 3"; highly fractured from 55.5' to 56.5'.	NX Core Run #7		82% Recovery 0% RQD
9068.3	61		End of Boring			

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Figure 4b

MORRISON KNUDSEN Mining Group

BORING LOG

PROJECT
Valley Camp of Utah, Inc.
Belina Mine, Carbon County

Upper Portal Backslope

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 4
Undisturbed Soil Sampler: 3-in. o.d. D&M sampler	140-lb. Hammer	30-in. Fall	2-in.o.d. Split-barrel Sampler	Sheet 1 of
w=Moisture Content, % D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 9-16-

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
9176.1	0	CL	Fill: silty and sandy clays; dark gray and dark grayish brown; medium stiff.			Location - N: 8,031.57 W: 9,605.70
9174.6	1.5	CL	Sandy Clay: dark brown to brown; 25-30% fine sand; moist; low plasticity; stiff.			(on jeep trail e of potable water tank)
9171.6	4.5	SM	Sandstone cobble: top 6" badly weathered.	SPT 4-1	32 45	N=50+
9169.6	6.5	CL	Silty Clay: brownish yellow; 15-20% fine sand; wet; medium plasticity; stiff.			No groundwater 24 hrs. after drilling
9168.1	8	SM	Silty Sand: brownish yellow; 40-45% nonplastic fines; moist; dense (badly weathered sandstone cobble).			
9167.1	9	CL, ML, &SM	Silty/sandy clay, sandy silt, and silty sand: hard soil colluvium with pieces of rock.	D&M 4-2	16 25 50	in 2"
9165.6	10.5	ML	Weathered siltstone cobble: brownish gray; moderately soft rock.			
9164.6	11.5		Weathered siltstone with some sandstone: gray mottled with brownish gray and brownish yellow; soft rock.			
				SPT 4-3	34 50	in 5" N=80+
9160.1	16		Weathered shale & sandstone: brownish yellow and gray w/ brownish red; highly fractured; moderately hard rock. Joints(all open): 17.5-17.7', moderately smooth, 80°; 18.3-18.4', moderately rough, 90°, 19.1-19.3', moderately smooth, 20°&90°; (4 pieces).	NX Core Run #1		89% Recovery 34% RQD (4 piece between 19.5' & 25')
9156.6	19.5		As below			

Figure 5

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MORRISON KNUDSEN Mining Group

BORING LOG

PROJECT
Valley Camp of Utah, Inc.
Belina Mine, Carbon County

Upper Portal Backslope

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 4
Undisturbed Soil Sampler: 3-in.o.d. D&M sampler	140-lb. Hammer	30-in. Fall	2-in.o.d. Split-barrel Sampler	Sheet 2 of 3
w=Moisture Content, % D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 9-16-83

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
9156.1	20		Weathered shale: gray, brownish gray, very dark gray and very dark grayish brown; moist; medium and high plasticity; zones of siltstone; soft rock. 2" thick highly fractured sandstone at 20.8'. Partings every 2 to 9".	Cont. NX Core Run #1		As before
9151.9	24.2		Siltstone: gray; moderately hard rock.			
9151.1	25		Sandstone: brownish yellow, gray and yellowish red; thin shale seams (1/8"); highly fractured in part; parts moderately hard.	NX Core Run #2		96% Recovery 9% RQD (1 piece, below 27')
9149.7	26.4		Badly weathered shale & siltstone: gray mottled with brownish yellow; highly fractured in part; very soft rock. Partings every ½ to 3" (some coal in partings). Joint: 29.6-29.8', open, smooth, 90°.			
				NX Core Run #3		100% Recovery 39% RQD (8 pieces, between 33 & 38')
9143.9	32.2		Siltstone: yellowish gray mottled with brownish yellow; up to 35% fine sand; moderately hard rock. Partings every 2-8" with leaf fossils. Parting with slickensides at 34': variable dip of partings above 34', 20° dip below 34'.			
9138.1	38		Weathered siltstone: dark gray and gray mottled with brownish yellow; many multi-piece irregular joints; cont....			
9136.1	40					

Figure 5a

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MORRISON KNUDSEN Mining Group

BORING LOG

PROJECT
Valley Camp of Utah, Inc.
Belina Mine, Carbon County

Upper Portal Backslope

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 4
Undisturbed Soil Sampler: 3-in. o.d. D&M sampler	140-lb. Hammer / 30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 3 of 3
w=Moisture Content, % / D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 9-16-83

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
9136.1	40		Weathered siltstone, cont.. soft rock with zones of very soft rock. Partings every ½ to 3". Joints: 39.5-39.6', open, irregular, moderately smooth, 70-90° dip, 4 pieces.			
9133.1	43		Siltstone: yellowish gray; moderately hard rock. Partings every 2 to 5".	NX Core Run #4		95% Recovery 32% RQD (7 pieces between 43-44' & 45-50')
9132.1	44	ML				
9131.1	45		Badly weathered siltstone: yellowish brown; weathered to soil in part; very soft rock. Partings every ½ to 2".			
			Weathered siltstone: yellowish brown and gray; badly fractured from 47.5 to 48.0 and 49.0-49.4'. Partings every 2-10".			
9126.7	49.4		Claystone: dark gray; hard rock.			
9124.4	51.7			NX Core Run #5		100% Recovery 50% RQD (5 pieces)
9124.3	51.8		Weathered clay parting			
			Siltstone: gray and brownish yellow; moderately hard rock becoming softer. Partings generally every 2-3".			
9120.4	55.7		Siltstone: brownish yellow; zones of fine sandstone, badly fractured from 59.5 to 60.0'. Partings every 2-12". Joint: 57.5-57.8', open, rough, 60°, 4 pieces.			
911.61	60		End of Boring			

Figure 5b

MORRISON KNUDSEN Mining Group

BORING LOG

PROJECT

Valley Camp of Utah, Inc.
Belina Mine, Carbon County
Boring to Sample Fill on Pad

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 5
Undisturbed Soil Sampler: 3-in. o.d. D&M sampler	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 2
w=Moisture Content, % / D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 9-17-83

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
8923.3	0	CL w/ coal	Fill: silty clay with coal; very dark grayish brown.	1		Location - N: 7526.24 W: 9092.96
8921.3	2	SM w/ CL	Fill: silty sand with silty clay; brownish yellow.	2		Purpose of hole was to obtain bag samples at 2.5' intervals for testing by Valley Camp to determine potential use of the fill for reclamation. Borin log is necessarily rough because of variations within the fill.
8917.3	6	CL	Fill: sandy clay; dark yellowish brown.	3		
8916.3	7	SM& CL	Fill: pieces of sandstone and sandy clay; brownish yellow.	4		No groundwater 24 hours after drilling.
8912.3	11	CL	Fill: silty clay; dark yellowish brown.	5		
				6		
8908.3	15	CL	Fill: silty and sandy clay with pieces of wood and roots; very dark grayish brown.	7		
				8		
8903.3	20					

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Figure 6

MORRISON KNUDSEN Mining Group

BORING LOG

PROJECT

Valley Camp of Utah, Inc.
Belina Mine, Carbon County
Boring to Sample Fill on Pad

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 5
Undisturbed Soil Sampler: 3-in. o.d. D&M sampler	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 2 of 2
w=Moisture Content, % D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 9-17-8

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
8903.3	20		As before	9		
8901.3	22	CL w/ coal	Fill: silty clay with coal and coal tailings; very dark grayish brown.	10		
8897.3	26	CL	Fill: sandy clay; very dark grayish brown.	11		
				12		
8893.3	30					

Figure 6a

601

MORRISON KNUDSEN Mining Group

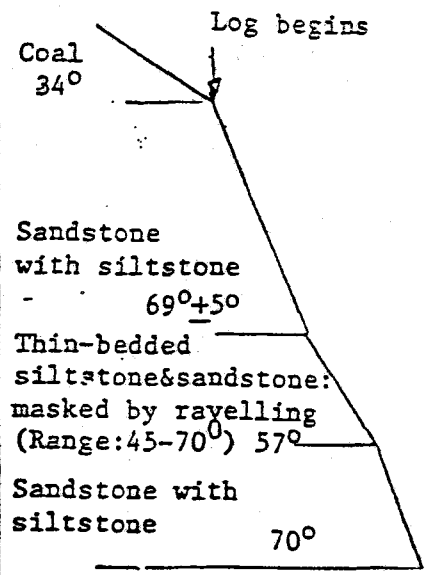
LOG OF CUT SLOPE

PROJECT

Valley Camp of Utah, Inc.
Belina Mine, Carbon County
Composite Log of Cut Slope
Behind Changehouse

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 6
Undisturbed Soil Sampler: 3-in. o.d. DBM sampler	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 2
w=Moisture Content, % / D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 9-17-83

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
9042*	0		Sandstone: hard; fractured in part.			Composite log of cut slope behind the changehouse, at the center of the building. Depths shown in log are estimated only, from the base of the coal stratum.
9040.5	1.5		Siltstone			
9039.5	2.5		Sandstone: hard; joints strike N80W with dip 70-90°N.			
9038	4		Siltstone			
9037.5	4.5		Sandstone: hard, as before.			
9036	6		Shale and siltstone: hard.			
9034.5	7.5		Sandstone: as before, but secondary joint system strikes N20E and dips 80°E.			
9033	9		Alternating zones of sandstone and siltstone.			
9030	12		Coal			
9029.5	12.5		Sandstone: hard, as before.			
9028.5	13.5		Siltstone: thin-bedded (½ to 2"); soft rock. Source of erosion, ravelling, and undercut.			
9025	17		Sandstone and siltstone: 1-6" thick bedding; joints strike N10E, dipping 85°E.			
9022	20					



Generalized section

*Elevation estimated from topographic map

601

Figure 7

MORRISON KNUDSEN Mining Group

LOG OF CUT SLOPE

PROJECT

Valley Camp of Utah, Inc.
Belina Mine, Carbon County
Composite Log of Cut Slope
Behind Changehouse

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 6
Undisturbed Soil Sampler: 3-in. o.d. D&M sampler	140-lb. Hammer / 30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 2 of 2
w=Moisture Content, % / D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 9-17-83

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
9022	20		Sandstone with some siltstone: massive in part (bedding 1-3" thick, and up to 24" thick); primary joints strike N10E, dipping 85°E; secondary joints strike E-W with dip 85°N. The 24" thick bedding is actually very tight thin-bedded sandstone.			
9016	26		Bottom of slope cut			

Figure 7a

601

MORRISON KNUDSEN Mining Group

LOG OF CUT SLOPE

PROJECT
Valley Camp of Utah, Inc.
Belina Mine, Carbon County
Composite Log of Cut Slope
East of Loadout Chute

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 7
Undisturbed Soil Sampler: 3-in. o.d. D&M sampler	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 1
w=Moisture Content, % D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 9-17-83

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
8949*	0		Coal: cut almost vertically, ravels in light wind.			Composite log of vertical cut slope (at the center of the cut) near the coal loadout chute. Depths shown in log are estimated only, from the top of the "vertical" section.
8947	2		Weathered shale: dark yellowish brown.			
8945.5	3.5		Sandstone: massive; hard rock; yellowish brown.			Log of cut was made at point D1 of the first detail line (see boring location plan).
8938	11					
8937.8	11.2		Bedding plane filled with weathered sandstone.			
			Sandstone: massive, as before.			
			Base of cut			
8924	25					

*Elevation estimated from topographic map

Figure 8

DATA SHEET FOR DETAIL LINE MAPPING

PROJECT Valley Camp BY B. Gale

LINE NO. D1 TREND S55°W PLUNGE 0° ELEV. 8929 LOCATION Bellna DATE 9-17-83

LINE INTERCEPT (ft.)	ROCK TYPE	STRUCTURE TYPE	STK	DIP	GEOMETRY MD	P	LENGTH	± OVERLAP	T_L	T_U	R	WIDTH ( )	FILLING	W	REMARKS
D1 (NE end)															
0		SJ	S60W	90		PL	5'		R	N	SM				
5		SJ	S25W	84E		PL	4'		N	R	SM	1.5"	Clay		
9	MASSIVE SANDSTONE (OVERLAIN BY LOWER COAL STRATUM)	SJ	W	75N		WV	2"		R	N	RH				
11		SJ	S65W	80E		PL	14'		N	N	SM				
25		SJ	S	90		PL	3'		N	R	SM				
28		SJ	W	83N		PL	16'		N	N	SM	becoming RH			
39		SJ	-	58E		--	--		R	R	--	"			
44		SJ	S15W	87W		PL	1'		N	R	SM				
45			BLAST DAMAGED JOINT												
45.5		SJ	S35W	86E		WV	1.5'		N	R	RH				
47			BLAST DAMAGED MASSIVE ROCK TO 62'												
62		SJ	S75W	54S		PL	2'		R	N	SM				
63			BLAST DAMAGED MASSIVE ROCK TO 83'												
83		SJ	S	84E		PL	2'		N	R	SM				
85			BLAST DAMAGED MASSIVE ROCK TO 90'												
90 (D1', SW End: at a point 14' NE of ℄ of loadout chute drive, perpendicular to ℄)															

ROCK TYPE ABBREVIATIONS		STRUCTURE TYPE		GEOMETRY	
		SJ	SINGLE JOINT	MD = MINIMUM DIP	
		FT	FAULT	P = PLANARITY: PL, WV	R = ROUGHNESS: SM, RH
		CT	CONTACT		
				T_L, T_U = TERMINATIONS	
WATER: D = DRY, W = WET, F = FLOWING				H >20°	R IN ROCK
FILLING ABBREVIATIONS				L <20°	N NONE
N	NONE				E ENECHELON

Figure 9

[redacted] PROJECT [redacted] BY [redacted]

LINE NO. D2 TREND S25°W PLUNGE 0° ELEV. 8929 LOCATION Belina DATE 9-17-83

LINE INTERCEPT (ft.)	ROCK TYPE	STRUCTURE TYPE	STRUCTURE STK	STRUCTURE DIP	GEOMETRY MD	GEOMETRY P	GEOMETRY LENGTH	GEOMETRY ± OVERLAP	GEOMETRY T_L	GEOMETRY T_U	GEOMETRY R	WIDTH ( )	FILLING	W	REMARKS
D2 (N end)															
0	SANDSTONE, AS BEFORE ON D1	SJ	--	70N		PL	--		N	R	SM				
0		SJ	S25W	76W		PL	21'		N	N	SM				
21		SJ	N85E	73S		PL	--		N	R	SM	1.5"	Open		
21		SJ	S20W	80W		PL	7'		N	N	SM				
28		SJ	E	78S		WV	1'		N	R	SM	12"	Clay		
29		SJ	S15W	83E		PL	23'		N	R	SM				
51		BLAST DAMAGED FACE 2'LONG													
52		SJ	S15W	75E		PL	8'		N	R	SM				
60 (D2', S End; at a point 10' from D1 on the same slope)															

ROCK TYPE ABBREVIATIONS			

STRUCTURE TYPE			
SJ	SINGLE JOINT		
FT	FAULT		
CT	CONTACT		

GEOMETRY

MD = MINIMUM DIP

P = PLANARITY: PL, WV R = ROUGHNESS: SM, RH

T_L, T_U = TERMINATIONS

H	>20°	R	IN ROCK
L	<20°	N	NONE
		E	ENECHELON

WATER: D = DRY, W = WET, F = FLOWING

FILLING ABBREVIATIONS

N	NONE				

Figure10

Geotechnical Mileage Log of Cut Slopes

Valley Camp of Utah, Inc.
Belina Mine Haul Road
Section 19, R7E, T13S, Carbon County, Utah

Odometer Mileage	Description
0.0	Road begins on north side of Eccles Canyon.
0.14-0.17	*Evidence of movement along secondary joint set on 20-25' high 68° cut slope. Secondary set strikes E-W with dip to N @ 65° (Primary N-S ± 10°, dip to E @ 75-90°) Strike of slope S53°E at this point. Bedding dips into slope (SW dip direction & 4° dip)
0.21	40' high cut (above slide area) with 65° slope angle. Upper portion has some overhanging rock, and cobble zone at top will produce some rockfall. Primary joints strike N-S ± 10°, dip to E 75-90° Secondary joints strike E-W ± 10°, dip to N 70-90° Bedding dips into slope
0.32	Same cut as above, but 30' high "nose" with weathered sandstone and siltstone cut at 45° to depth of 10', and competent sandstone cut to 60°. Primary joints of competent sandstone strike N10°W to N20°E, dip 72-78°E Secondary joints strike E-W ± 10°, dip N 60-65°. Bedding dips into slope
0.37	Center of 20' high 45-50° cut in competent sandstones.
0.42	10' high "nose" (with same joint sets as described below at mile 0.52) will weather/ravel to smoother slope.
0.44	Beginning of cut described at mile 0.52.
0.52	Center of 70°, 25' high (500' ± long) cut with 6' weathered rock on top of competent sandstone and siltstone. Parts of weathered rock section may be cut too steep, but natural weathering will remedy. Primary joints of sandstone strike N3°W, dip 84°E Secondary joints strike N80°W with dip 90° ± 5° Bedding dip is into the slope.

*Indicates areas that may require regular maintenance and (or) remedial work.

Figure 11

Geotechnical Mileage Log of Cut Slopes, cont.

Odometer Mileage	Description
0.57	Drainageway
0.61	65°, 12' high cut in competent rock with dip into the slope.
0.69-0.72	*25' high cut in possible colluvium/talus on 65° slope with concave face. May be a potential slide area: top of slope could be flattened but revegetation would be essential.
0.74	Major drainageway
0.86	*Possible blast damaged "nose" rock section. 15' high that may creep on an open, potential failure surface (which might continue beneath the road section) with a strike of $S60^{\circ}W$ and a dip of $42^{\circ}E$.
0.87	20' high cut in very competent sandstone. Strike of cut parallels primary joint set (N-S $\pm 5^{\circ}$ with dip of $82^{\circ}E$). Secondary set strikes E-W with 90° dip.
0.92	*Possible fault? Rock is highly fractured in $40-45^{\circ}$, 20' high cut. Evidence of soil creep and erosion. Soil cover will continue moving (perhaps 3-4' thickness)
0.97	Heavy soil cover on slope described at mile 1.02, but some competent rock strata still visible. Cut is 48°.
1.02	20' high, 60° cut in rock composed of sandstones and siltstones with 1-8" thick bedding. Most of cut is perpendicular to SW dip direction.
1.06	Drainageway
1.07	15' high, 55° cut in competent rock.
1.12	15' cut with weathered rock (top 5') over competent rock with dip into the slope.
1.23	Some ravelling evident at beginning of slope described at mile 1.32.

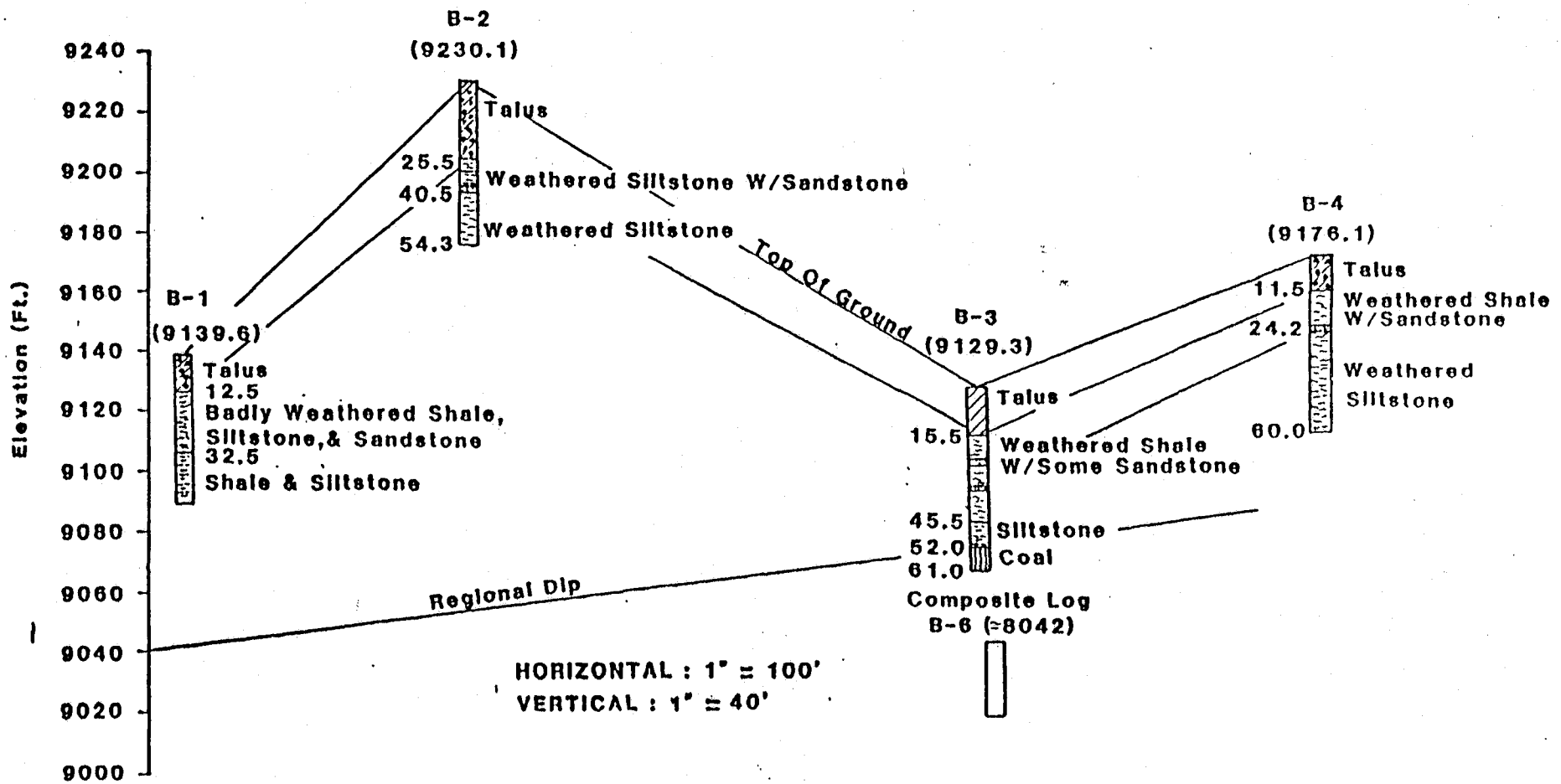
*Indicates areas that may require maintenance and (or) remedial work.

Figure 12

Geotechnical Mileage Log of Cut Slopes, cont.

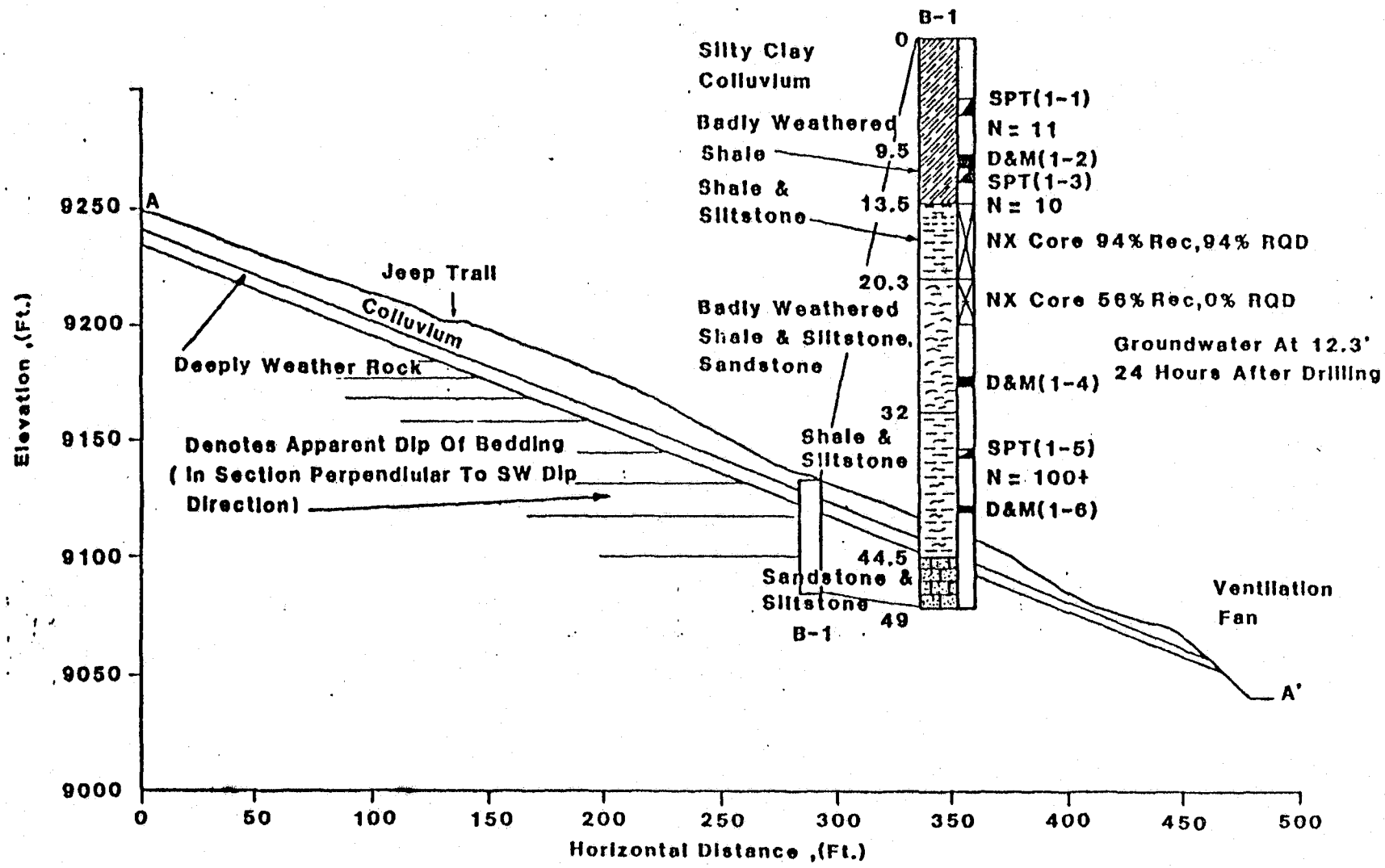
Odometer Mileage	Description
1.32	15' cut, 42° in weathered rock (top 6') and competent rock with dip into slope. Some ravelling will occur from the top of the cut. At mile 1.28, primary joint set strikes N10°E with dip of 85°E.
1.40	20' high cut, 35° in weathered rock, 55° in competent rock (sandstone/siltstone) with primary joint set striking parallel to the haul road (≈N-S) dipping at 85°E.
1.42	Fork in haul road leading to upper and lower portals of the Belina mine.

Figure 13



VALLEY CAMP OF UTAH, INC.
BELINA MINE, CARBON COUNTY
GENERALIZED BACKSLOPE SECTION

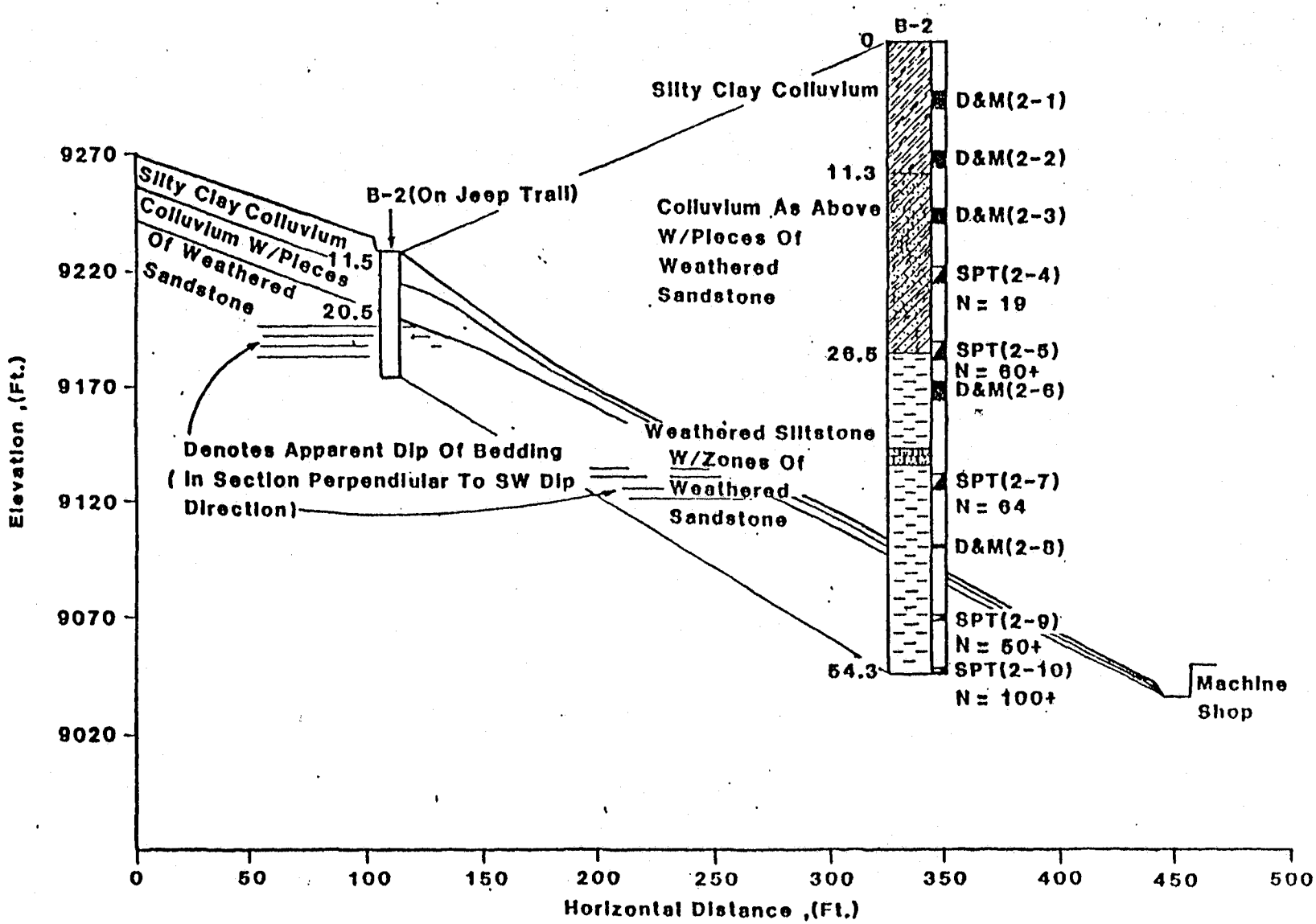
FIGURE 14



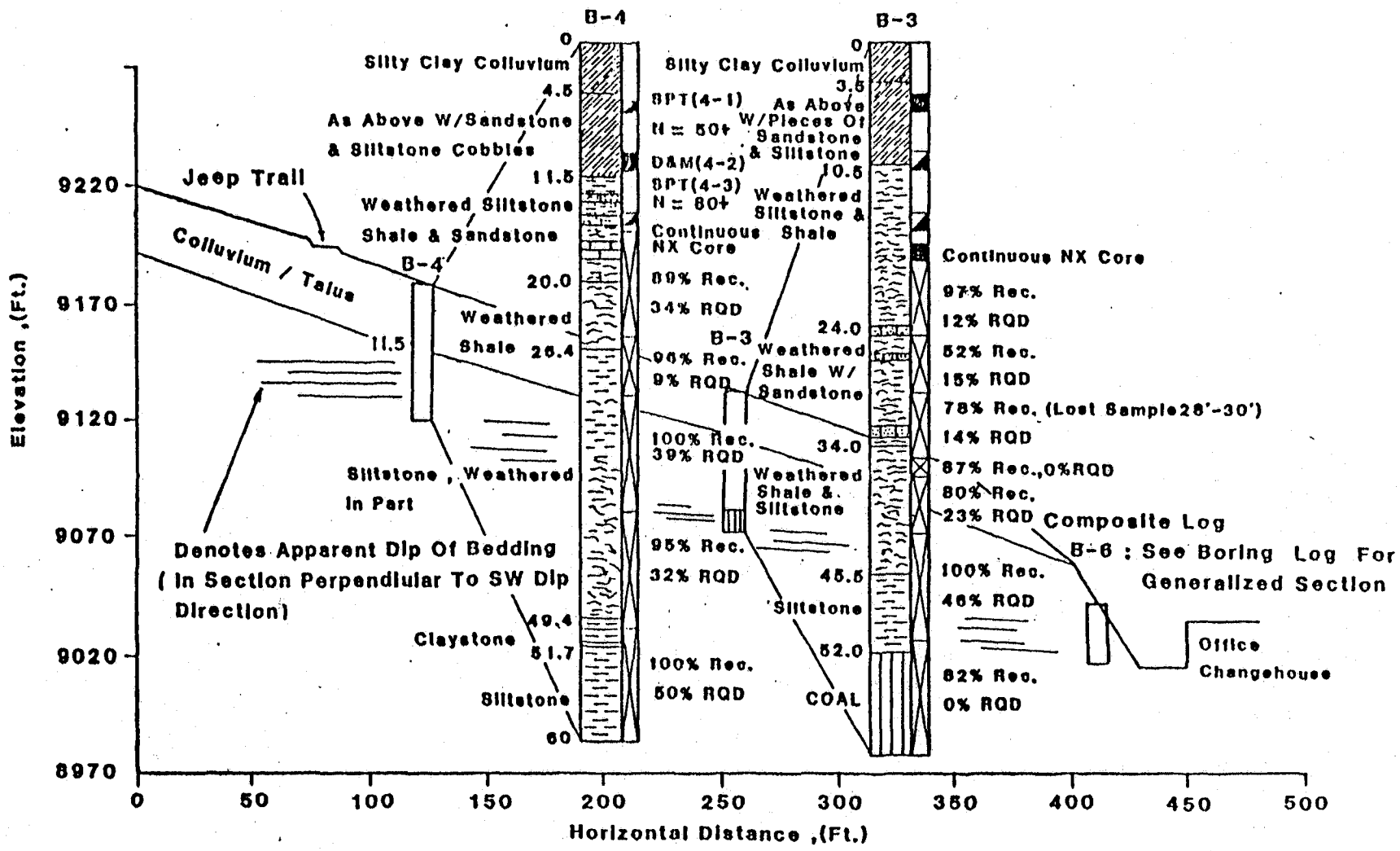
VALLEY CAMP OF UTAH , INC.
BELINA MINE , CARBON COUNTY

UPPER PORTAL BACKSLOPE SECTION A - A'

FIGURE 15



VALLEY CAMP OF UTAH , INC.
BELINA MINE , CARBON COUNTY
UPPER PORTAL BACKSLOPE SECTION B - B'
(ACTIVE SLIDE AREA)
FIGURE 16



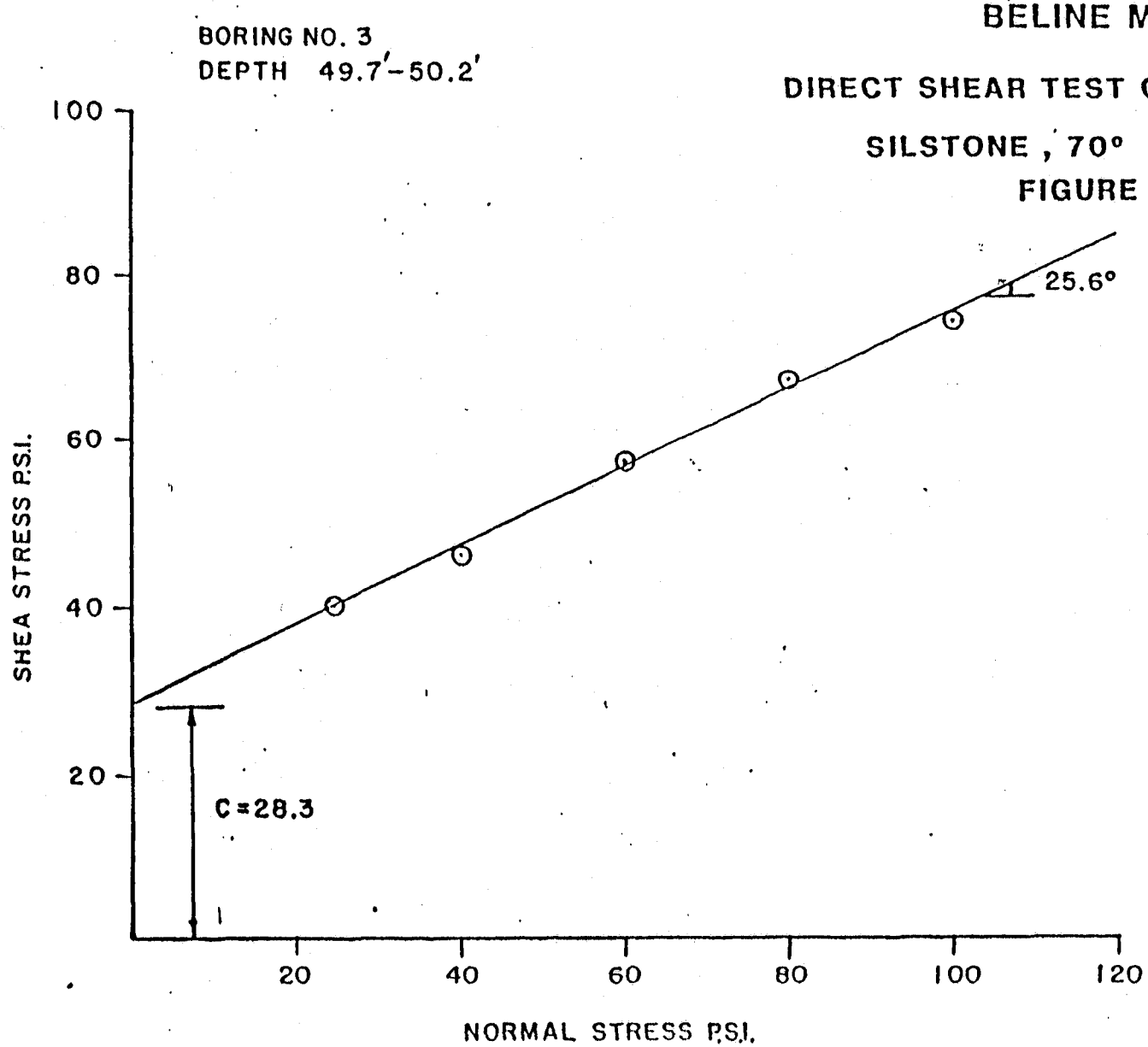
VALLEY CAMP OF UTAH ; INC.
BELINA MINE , CARBON COUNTY
UPPER PORTAL BACKSLOPE SECTION C - C'
FIGURE 17

VALLEY CAMP OF UTAH , INC.
BELINE MINE

DIRECT SHEAR TEST ON DISCONTIUITY :

SILSTONE , 70° OPEN JOINT

FIGURE 18

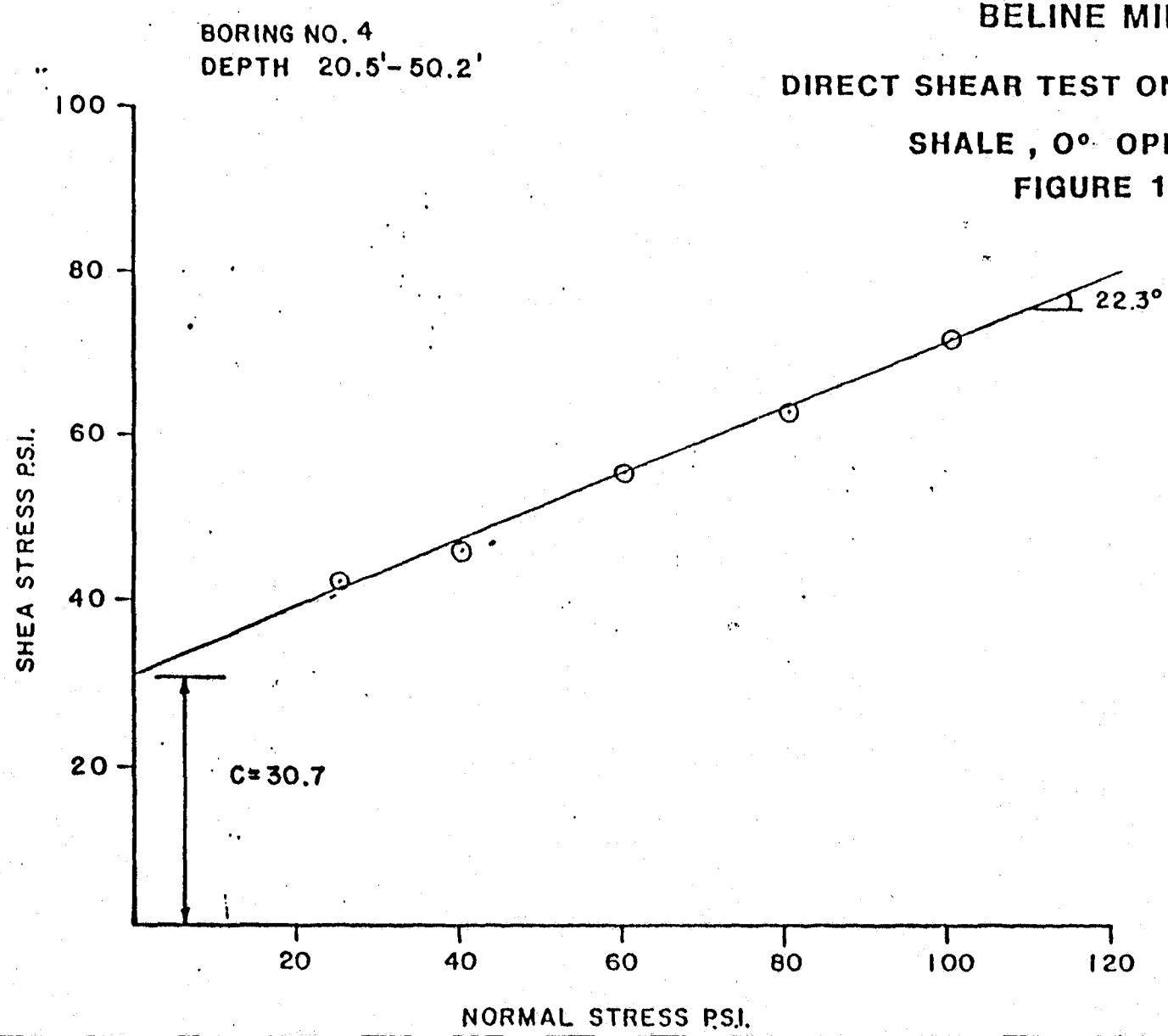


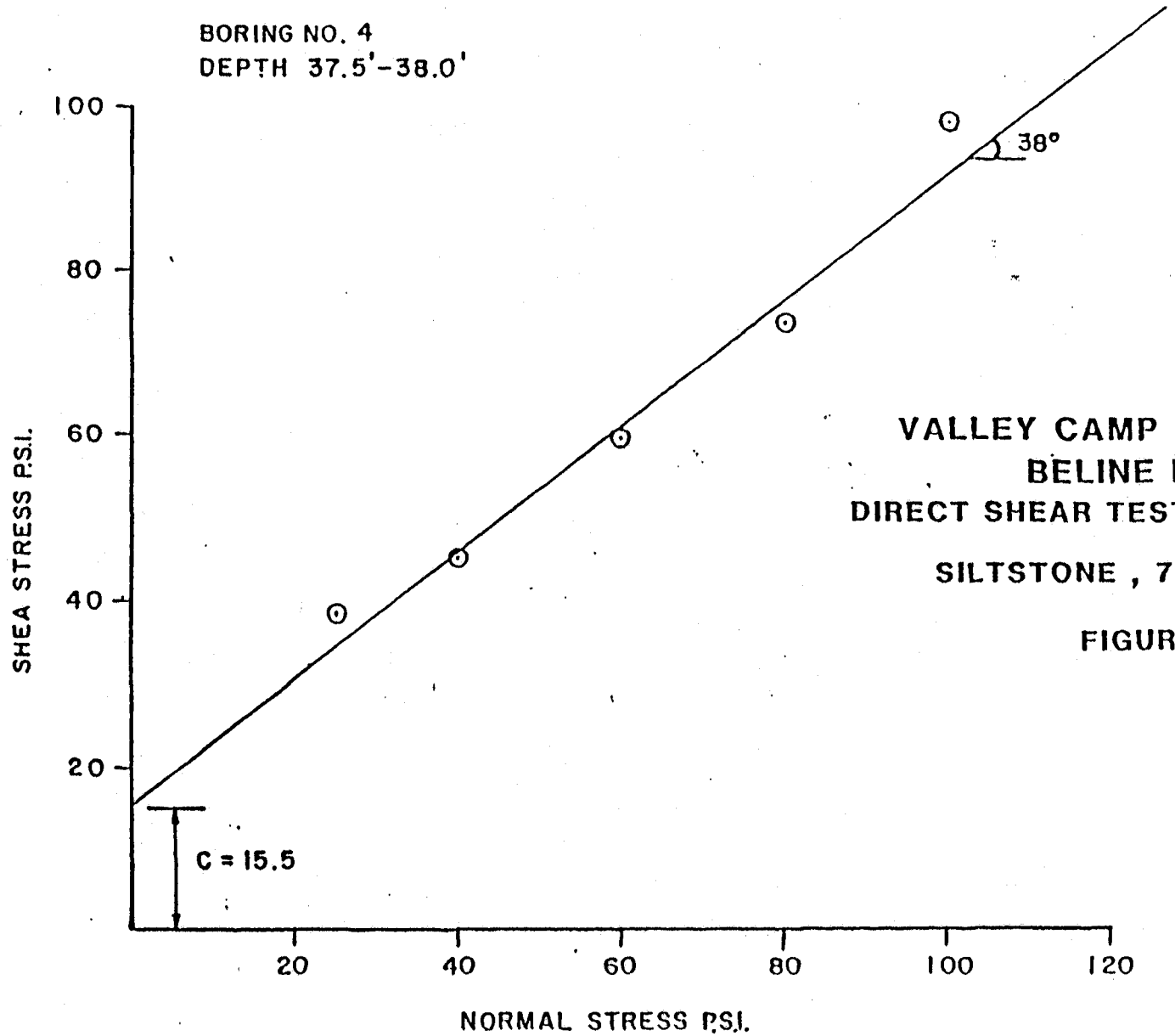
VALLEY CAMP OF UTAH , INC.
BELINE MINE

DIRECT SHEAR TEST ON DISCONTIUITY :

SHALE , 0° OPEN JOINT

FIGURE 19

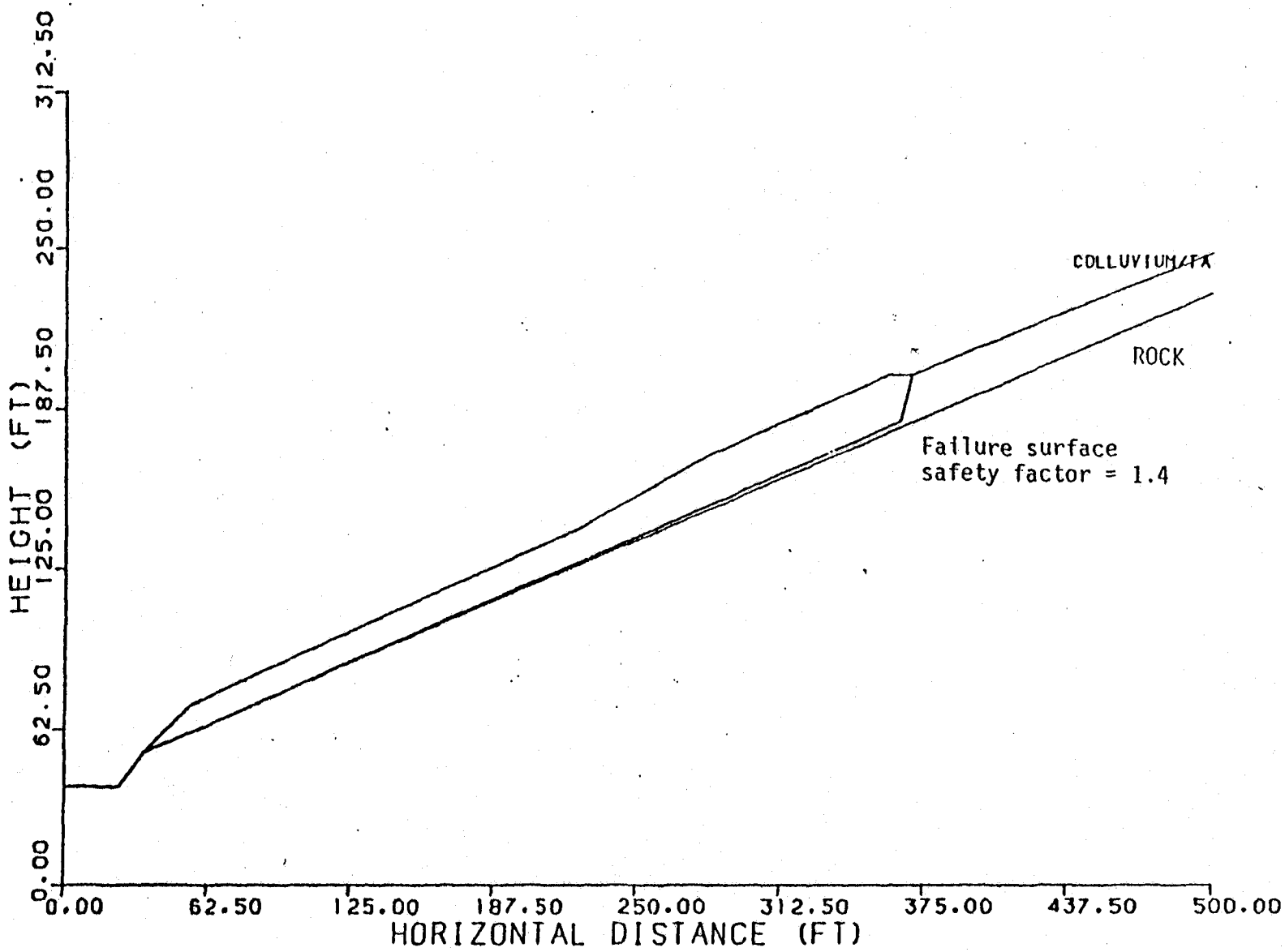




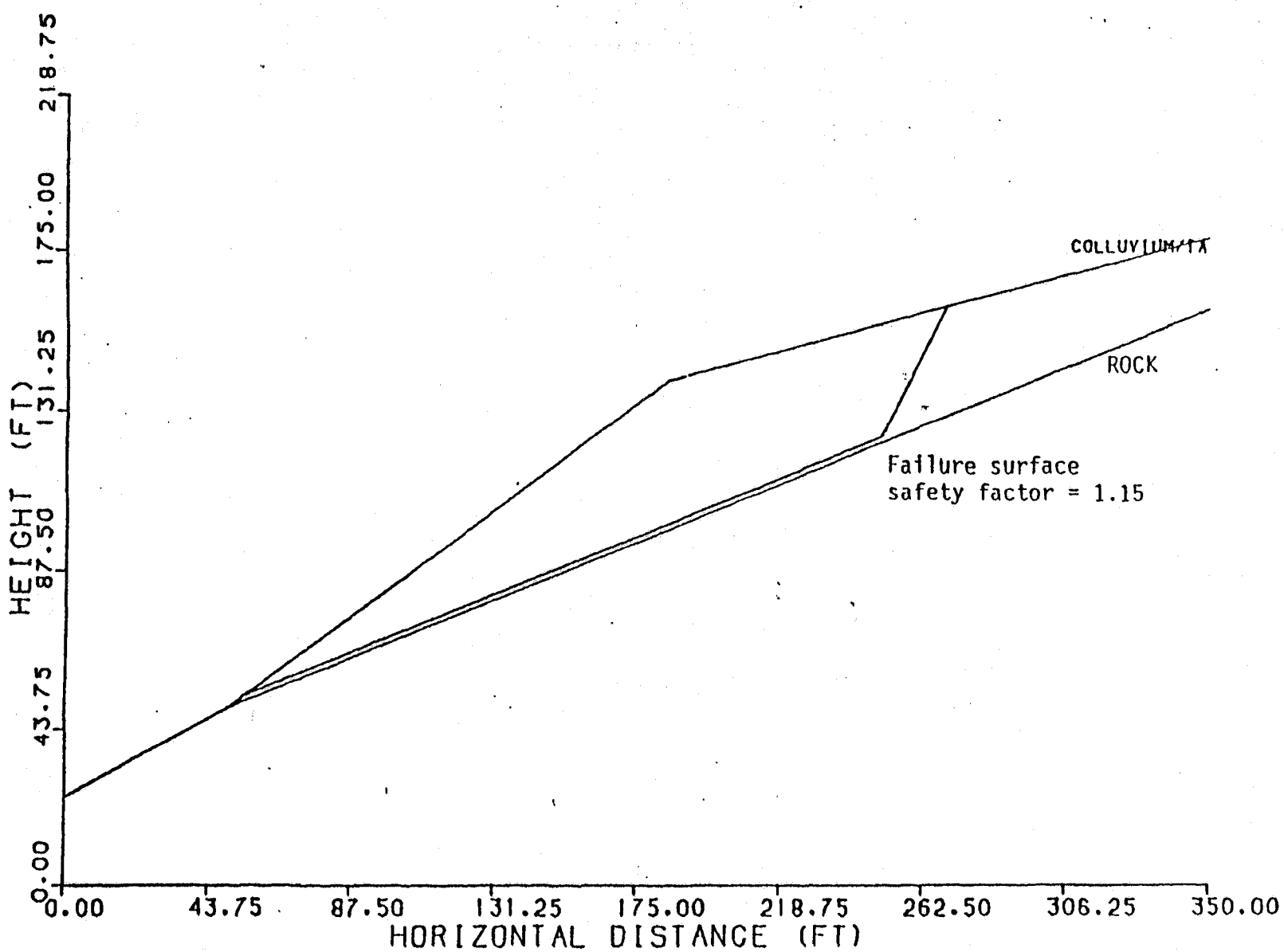
VALLEY CAMP OF UTAH , INC.
BELINE MINE
DIRECT SHEAR TEST ON DISCONTIUITY :

SILTSTONE , 77° OPEN JOINT

FIGURE 20

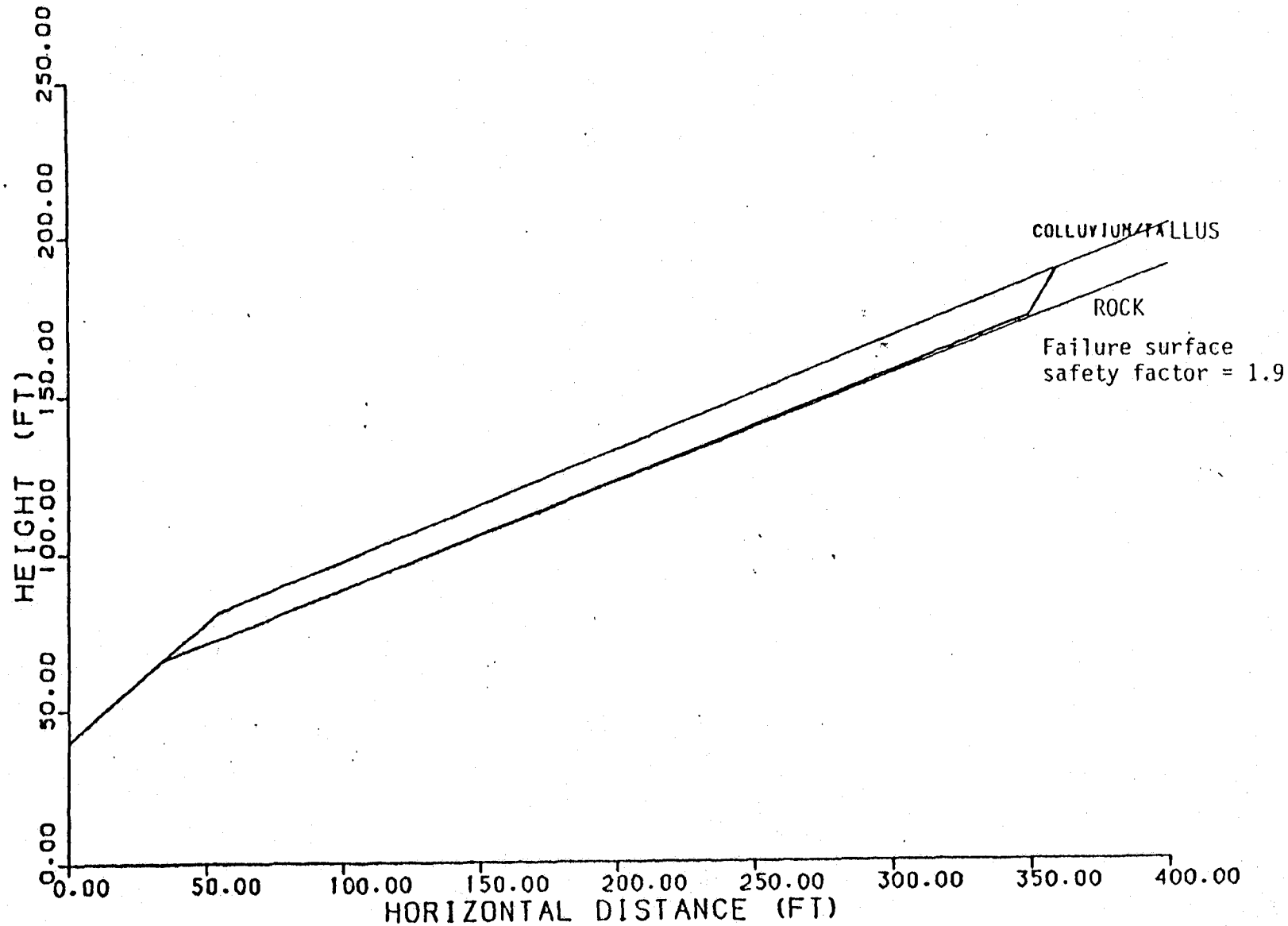


Valley Camp of Utah, Inc.
Belina Mine
Computer Generated Geologic
Model of Section A-A



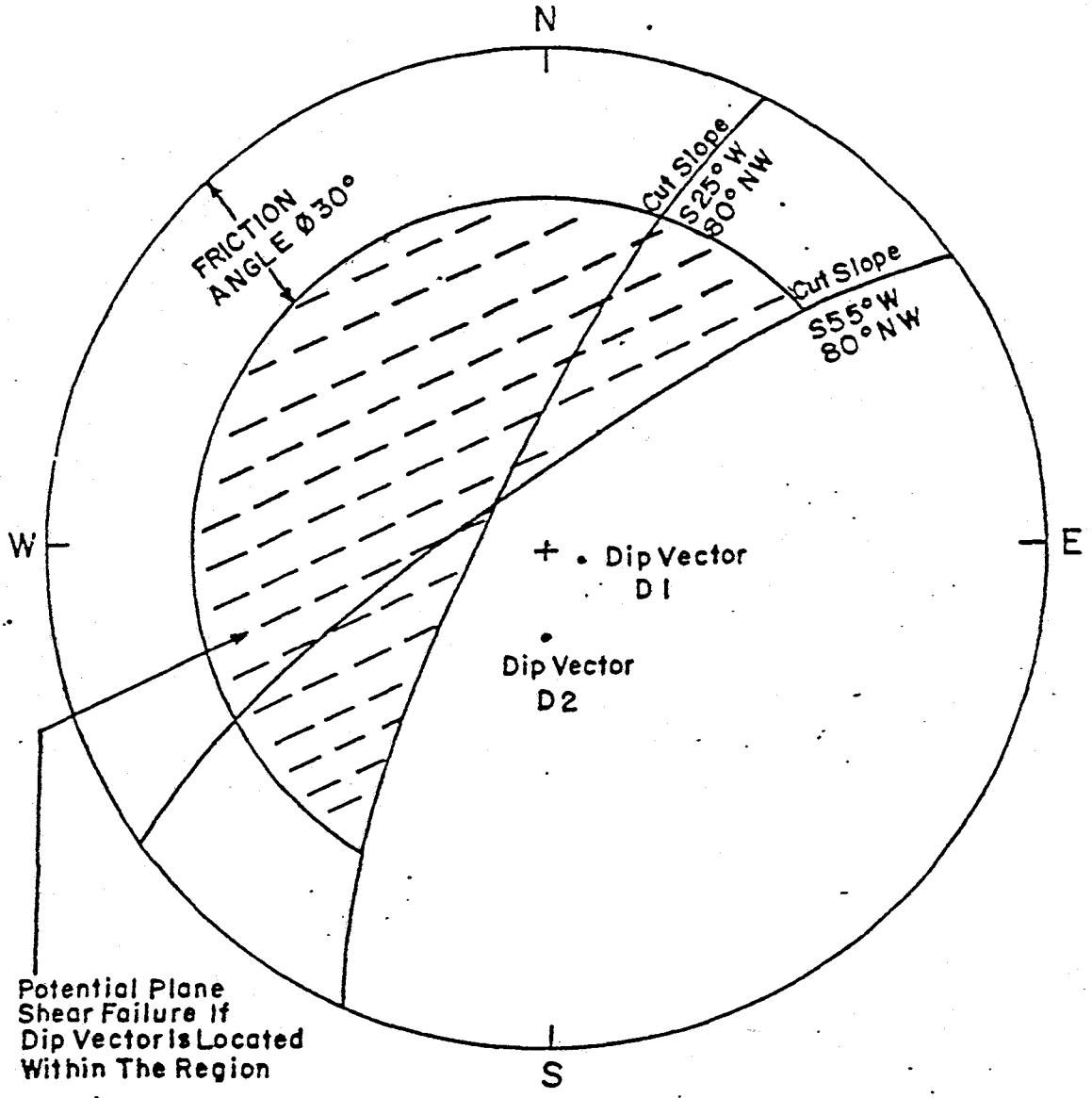
Valley Camp of Utah, Inc.
Belina Mine
Computer Generated Geologic
Model of Section B-B (most critical portion)

Figure 22



Valley Camp of Utah, Inc.
Belina Mine
Computer Generated Geologic
Model of Section C-C

Figure 22

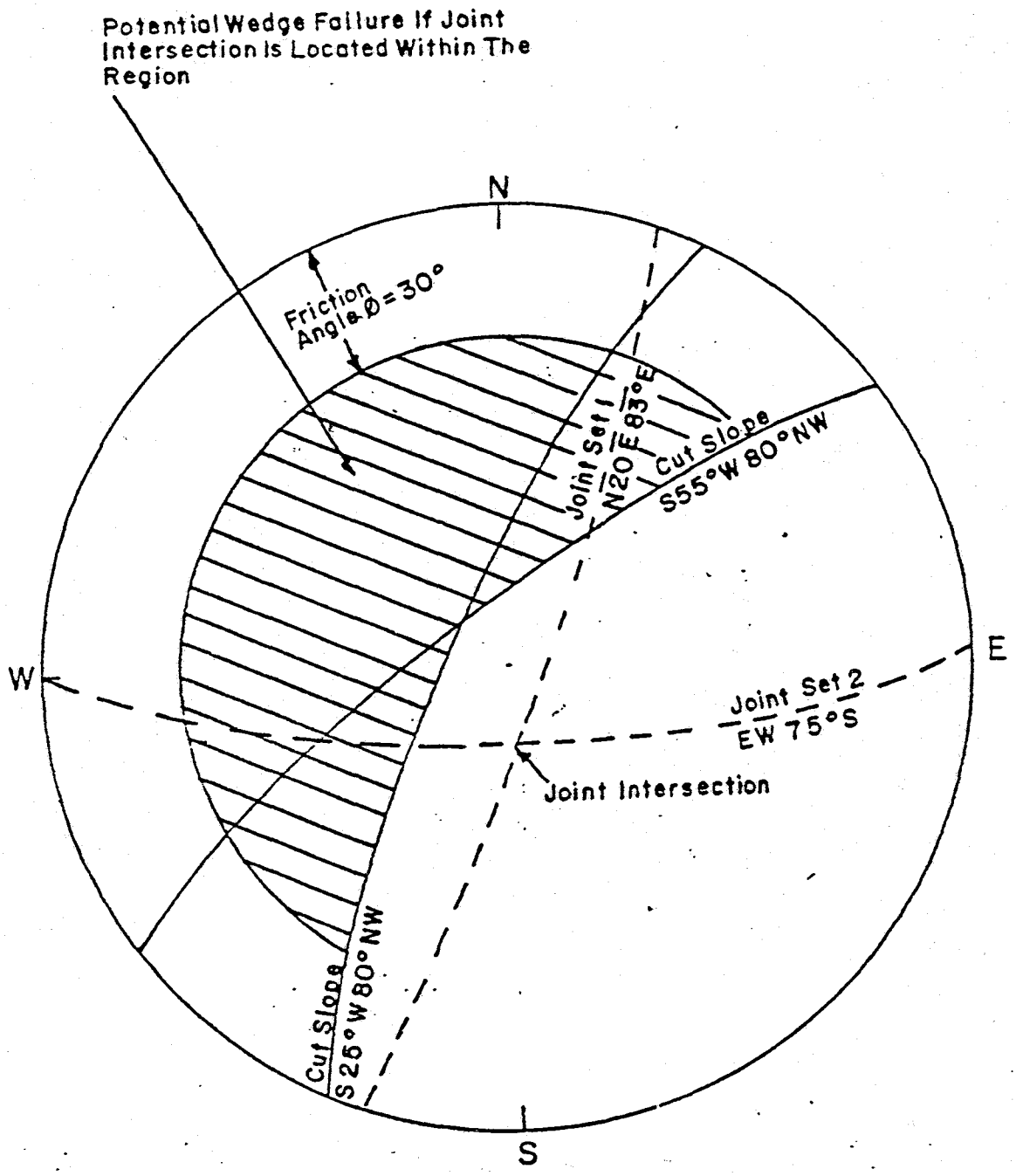


VALLEY CAMP OF UTAH , INC.

BELINA MINE

STEREOPLOT FOR PLANE SHEAR ANALYSIS FOR CUT SLOPE NEAR COAL LOADOUT CHUTE

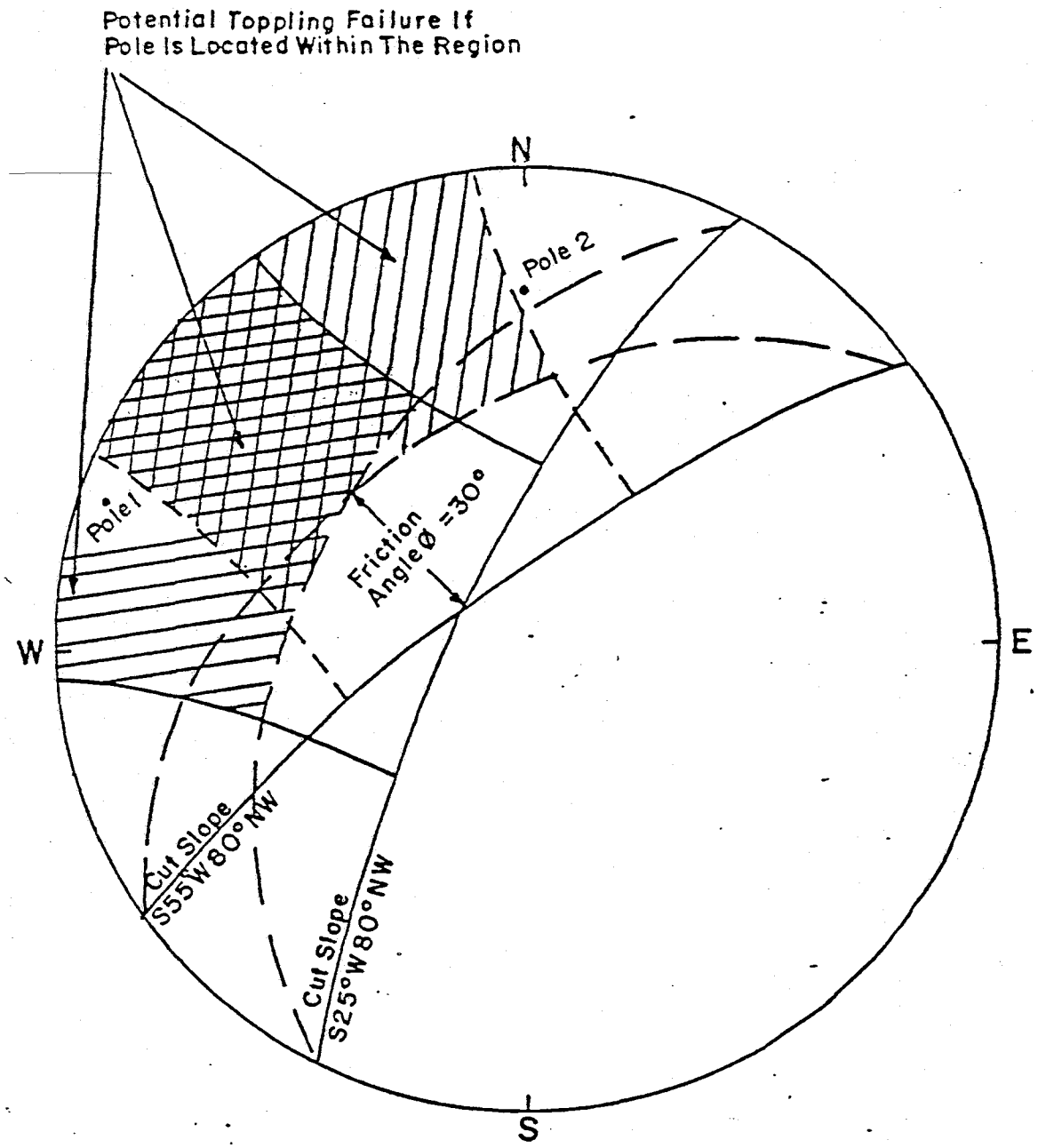
FIGURE 24 --



VALLEY CAMP OF UTAH , INC.
BELINA MINE

STEREOPLOT FOR WEDGE FAILURE ANALYSIS FOR CUT SLOPE NEAR COAL LOADOUT CHUTE

FIGURE 25



VALLEY CAMP OF UTAH , INC.
BELINA MINE

STEREOPLOT FOR POTENTIAL TOPPLING FAILURE FOR CUT SLOPE NEAR COAL LOADOUT CHUTE

FIGURE 26

FORD CHEMICAL LABORATORY, INC.
Bacteriological and Chemical Analysis
40 West Louise Avenue
Salt Lake City, Utah 84115
Phone: 466-8761

RECEIVED
FEB 27 1990
DIVISION OF
OIL, GAS & MINING

METHODS OF ANALYSIS FOR SOIL & OVERBURDEN SAMPLES

Parameter	Units	Method of Extraction & Analysis
Texture Analysis		
Sand	%	Sieve Analysis; USDA, 1952; #18
Silt	%	Hydrometer; USDA, 1952; #18
Clay	%	Hydrometer; USDA, 1952; #18
Total Combustible Solids	%	Dry Ash: ASTM D 3174
Total Noncombustible Solids	%	Dry Ash; ASTM D 3174
pH - Paste	Units	Saturated Paste; USDA, 1969; #60
Iron - Total Fe	ppm	AB DTPA 1
Manganese Mn	ppm	AB DTPA 1
Sulfur		
Phyritic Sulfur	%	ASTM D 2492; #26
Sulfate Sulfur	%	ASTM D 2492; #26
Organic Sulfur	%	ASTM D 2492; #26
Total Sulfur	%	ASTM D 3177; #26
Major Ions (Salinity-Alkalinity)		
Calcium as Ca	ppm	Saturated Paste Extract, USDA #60
Chloride as Cl^{-1}	ppm	Saturated Paste Extract, USDA #60
Fluoride as F^{-1}	ppm	Saturated Paste Extract, USDA #60
Magnesium as Mg	ppm	Saturated Paste Extract, USDA #60
Nitrogen: Nitrate as NO_3^{-1}	ppm	Saturated Paste Extract, USDA #60
Phosphate as PO_4^{-3}	ppm	AB-DTPA 1
Potassium as K	ppm	Saturated Paste Extract, USDA #60
Sodium as Na	ppm	Saturated Paste Extract, USDA #60
Sulfate as SO_4^{-2}	ppm	ASTM D 2492; #26
Conductivity	um/hos/cm	Saturated Paste Extract, USDA #60
Sodium Adsorption Ratio (SAR)		Saturated Paste Extract, USDA #60
Total Carbonate as CO_3^{-2}	%	Acid Titration, (23c), USDA #60
Toxic Heavy Metals		
Arsenic as As	ppm	AB DTPA 1
Barium as Ba	ppm	AB DTPA 1
Boron as B	ppm	Saturated Paste Extract, USDA #60
Cadmium as Cd	ppm	AB DTPA 1
Chromium as Cr	ppm	AB DTPA 1
Copper as Cu	ppm	AB DTPA 1
Lead as Pb	ppm	AB DTPA 1
Mercury as Hg	ppm	Acid Extract; U.S. EPA, 1979; 245.5
Molybdenum as Mo	ppm	AB DPTA 1
Nickel as Ni	ppm	AB DPTA 1
Selenium as Se	ppm	AB DPTA 1
Zinc as Zn	ppm	AB DPTA 1
Radioactive		
Gross Alpha	ppbU	USGS, 1977
Gross Beta	piC/kg	USGS, 1977

Ford Chemical
LABORATORY, INC.
Bacteriological and Chemical Analysis
40 WEST LOUISE AVENUE
SALT LAKE CITY, UTAH 84115
PHONE 466-8761

Test Hole No. 1

CERTIFICATE OF ANALYSIS
83-006765

	0 - 2 FT.	2 - 4 FT.	4 - 6 FT.	6 - 8 FT.
Moisture %	19.80	22.50	36.40	33.20
Molybdenum ppm AB DTPA 1	.075	.036	.055	.028
Neut./Potential Tons/1000Tons	4.07	3.04	2.48	3.14
Nitrate NO3-N ppm USDA 60	3.30	4.20	5.40	6.70
Organic Material % (WB)	4.70	3.90	4.50	3.36
pH USDA 60	7.50	7.40	7.45	7.80
Phosphorus ppm AB DTPA 1	20.60	31.40	4.50	16.20
Potassium ppm USDA 60	114.00	95.00	81.00	110.00
Pyritic Sulfur % ASTM D2492	.0140	.0133	.0125	.0150
Saturation %	22.50	21.90	19.30	24.60
Selenium ppm AB DTPA 1	.015	.010	.006	.002
Sodium Absorption Ratio	.047	.064	.087	.100
Sodium Sol.Meq/l USDA 60	.42	.51	.72	.85
Zinc ppm AB DTPA 1	1.650	2.400	1.900	2.300

FORD CHEMICAL LABORATORY, INC.

All reports are submitted as the confidential property of clients. Authorization for publication of our reports, conclusions, or, extracts from or regarding them, is reserved pending our written aporoval as a mutual protection to clients, the public and ourselves.

Ford Chemical
LABORATORY, INC.
Bacteriological and Chemical Analysis
40 WEST LOUISE AVENUE
SALT LAKE CITY, UTAH 84115
PHONE 466-8761

Test Hole No. 1

DATE: 12/29/83

CERTIFICATE OF ANALYSIS

VALLEY CAMP OF UTAH
SCOFIELD ROUTE
HELPER, UTAH
84526

83-006765

SAMPLE: SOIL SAMPLES FROM BELINA PAD #1 COLLECTED 9-23-83 RECEIVED 9-23-83 FOR ANALYSIS UNDER P.O. #30-83-10-007831.

	0 - 2 FT.	2 - 4 FT.	4 - 6 FT.	6 - 8 FT.
1-Clay % USDA 18	12.80	28.20	85.50	60.20
Sand % USDA 18	65.80	53.50	27.50	27.30
1-Silt % USDA 18	21.40	18.30	14.00	12.50
Acid/Base Pot.Tons/1000 Tons	.43	.41	.39	.46
Boron Sol.ppm USDA 60	.057	.119	.089	.008
Ca.Carbonate Tons/1000Tons	4.50	3.45	2.87	3.60
Calcium Carbonate ppm USDA 60	4,500.00	3,450.00	2,870.00	3,600.00
Calcium Sol. Meq/l USDA 60	130.73	108.78	117.26	122.00
Conductivity mmhos/cm @ 25	.80	.77	.85	.95
Copper ppm AB DTPA 1	.250	.100	.300	.050
Iron ppm AB DTPA 1	66.500	68.300	59.200	77.500
Magnesium Sol. Meq/l USDA 60	15.81	15.33	14.26	17.26
Manganese ppm AB DTPA 1	14.500	12.600	10.500	6.650

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Ford Chemical
LABORATORY, INC.
Bacteriological and Chemical Analysis
40 WEST LOUISE AVENUE
SALT LAKE CITY, UTAH 84115
PHONE 466-8761

Test Hole No. 2

DATE: 12/29/83

CERTIFICATE OF ANALYSIS

ALLEY CAMP OF UTAH
COFIELD ROUTE
HELPER, UTAH
84526

83-006766

SAMPLE: SOIL SAMPLES FROM BELINA PAD #2 COLLECTED 9-23-83
RECEIVED 9-23-83 FOR ANALYSIS UNDER P.O. 30-83-10-007831.

	0 - 2 FT.	2 - 4 FT.	4 - 8 FT.
1-Clay % USDA 18	10.50	19.50	30.80
Sand % USDA 18	20.00	50.00	37.70
Silt % USDA 18	69.50	30.50	31.50
Acid/Base Pot.Tons/1000 Tons	.38	.37	.36
Iron Sol.ppm USDA 60	.058	.013	.112
Ca.Carbonate Tons/1000Tons	2.07	3.87	4.39
Calcium Carbonate ppm USDA 60	2,700.00	3,870.00	4,390.00
Calcium Sol. Meq/l USDA 60	95.30	117.26	127.64
Conductivity mmhos/cm @ 25	.90	.75	.69
Copper ppm AB DTPA 1	.200	.270	.300
Iron ppm AB DTPA 1	51.500	45.600	44.900
Magnesium Sol. Meq/l USDA 60	21.41	15.65	17.28
Manganese ppm AB DTPA 1	4.900	8.600	9.300

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Test Hole No. 2

CERTIFICATE OF ANALYSIS
83-006766

	0 - 2 FT.	2 - 4 FT.	4 - 8 FT.
Moisture %	23.00	34.60	40.20
Molybdenum ppm AB DTPA 1	.008	.010	.009
Neut./Potential Tons/1000Tons	2.32	3.50	4.03
Nitrate NO3-N ppm USDA 60	2.40	4.60	5.10
Organic Material % (WB)	3.60	5.40	4.80
pH USDA 60	7.20	7.30	7.50
Phosphorus ppm AB DTPA 1	16.50	26.40	25.40
Potassium ppm USDA 60	110.00	86.00	79.00
Pyritic Sulfur % ASTM D2492	.0123	.0120	.0115
Saturation %	23.40	18.70	25.10
Selenium ppm AB DTPA 1	.025	.017	<.001
Sodium Absorption Ratio	.039	.062	.063
Sodium Sol.Meq/l USDA 60	.30	.51	.54
Zinc ppm AB DTPA 1	.950	1.850	1.990

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Bacteriological and Chemical Analysis
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SALT LAKE CITY, UTAH 84115
PHONE 466-8761

Test Hole No. B-5

DATE: 12/29/83

CERTIFICATE OF ANALYSIS

LLEY CAMP OF UTAH
OFIELD ROUTE
ELPER, UTAH
4526

83-006763

AMPLE: SOIL SAMPLES FROM BELINA PAD COLLECTED 9-15-83 RECEIVED 9-23-83 FOR ANALYSIS UNDER P.O. 30-83-10-007831.

	0 - 2.5	2.5 - 5	5 - 7.5	7.5 - 10	10 - 12.5
-Clay % USDA 18	54.50	38.60	51.90	22.50	48.90
Sand % USDA 18	33.50	39.80	31.50	56.50	25.50
Silt % USDA 18	12.00	21.60	16.60	21.00	25.60
cid/Base Pot.Tons/1000 Tons	.39	.42	.34	.37	.57
on Sol.ppm USDA 60	.258	.168	.241	.165	.117
Carbonate Tons/1000Tons	4.60	4.20	3.77	3.92	3.70
cium Carbonate ppm USDA 60	4,600.00	4,200.00	3,770.00	3,920.00	3,700.00
cium Sol. Meq/l USDA 60	127.74	123.75	115.26	118.26	128.74
nductivity mmhos/cm @ 25	.75	.80	.84	.90	.78
per ppm AB DTPA 1	.020	.090	.100	.150	.280
n ppm AB DTPA 1	56.500	54.200	63.500	74.100	58.900
gnesium Sol. Meq/l USDA 60	14.79	14.40	13.76	13.57	13.11
ganese ppm AB DTPA 1	9.200	6.800	4.900	8.300	9.500

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40 WEST LOUISE AVENUE
SALT LAKE CITY, UTAH 84115
PHONE 466-8761

Test Hole No. B-5

CERTIFICATE OF ANALYSIS
83-006763

	0 - 2.5	2.5 - 5	5 - 7.5	7.5 - 10	10 - 1
Moisture %	19.80	21.50	22.40	22.50	34.
Molybdenum ppm AB DTPA 1	.166	.175	.116	.150	.
Neut./Potential Tons/1000Tons	4.21	3.78	3.43	3.55	3.
Nitrate NO3-N ppm USDA 60	2.10	4.60	1.80	2.50	1
Organic Material % (WB)	3.30	4.60	8.20	5.90	7
pH USDA 60	7.20	7.40	7.80	7.30	7.
Phosphorus ppm AB DTPA 1	12.90	15.60	8.70	16.20	11
Potassium ppm USDA 60	112.00	95.00	86.00	69.00	72.
Pyritic Sulfur % ASTM D2492	.0125	.0136	.0110	.0120	.
Saturation %	24.50	21.80	24.60	23.80	3
Selenium ppm AB DTPA 1	.005	.001	.001	<.001	<.0
Sodium Absorption Ratio	.081	.062	.080	.096	
Sodium Sol.Meq/l USDA 60	.69	.52	.65	.78	
Zinc ppm AB DTPA 1	1.770	1.950	1.800	7.100	7.

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SALT LAKE CITY, UTAH 84115
PHONE 466-8761

Test Hole No. B-5

CERTIFICATE OF ANALYSIS
83-006763

	12.5 - 15	15 - 17.5	17.5 - 20	20 - 22.5	22.5 -25
Organic Material % (WB)	5.50	6.80	4.85	10.50	6.80
pH USDA 60	7.80	7.44	7.90	7.50	7.45
Phosphorus ppm AB DTPA 1	10.50	14.50	21.60	15.50	11.50
Potassium ppm USDA 60	105.00	120.00	119.00	88.00	79.00
Pyritic Sulfur % ASTM D2492	.0122	.0165	.0180	.0135	.0124
Saturation %	27.10	20.70	21.50	28.20	20.40
Selenium ppm AB DTPA 1	<.001	<.001	<.001	<.001	<.001
Sodium Absorption Ratio	.060	.050	.060	.064	.084
Sodium Sol.Meq/l USDA 60	.47	.38	.50	.52	.65
Zinc ppm AB DTPA 1	2.200	1.300	1.450	1.220	2.100

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LABORATORY, INC.
Bacteriological and Chemical Analysis
40 WEST LOUISE AVENUE
SALT LAKE CITY, UTAH 84115
PHONE 466-8761

Test Hole No. B-5

CERTIFICATE OF ANALYSIS
83-006763

	12.5 - 15	15 - 17.5	17.5 - 20	20 - 22.5	22.5 - 2
1-Clay % USDA 18	15.30	14.00	20.00	24.20	31.5
1-Sand % USDA 18	60.20	54.50	33.50	24.50	58.
1-Silt % USDA 18	24.50	31.50	46.50	51.30	9.9
Acid/Base Pot.Tons/1000 Tons	.38	.51	.56	.42	.
Boron Sol.ppm USDA 60	.098	.258	.410	.165	.
Ca.Carbonate Tons/1000Tons	3.49	2.96	4.13	3.59	3.1
Calcium Carbonate ppm USDA 60	3,490.00	2,960.00	4,130.00	3,590.00	3,150.
Calcium Sol. Meq/l USDA 60	109.73	99.10	122.50	114.42	102.7
Conductivity mmhos/cm @ 25	.88	.92	.88	.76	.
Copper ppm AB DTPA 1	.030	.050	.100	.240	.
Iron ppm AB DTPA 1	66.900	71.400	75.200	61.500	59.50
Magnesium Sol. Meq/l USDA 60	10.52	13.57	15.24	13.68	14
Manganese ppm AB DTPA 1	11.600	9.500	8.500	6.750	8.5
Moisture %	18.50	23.50	21.50	24.60	20.
Molybdenum ppm AB DTPA 1	.085	.025	.016	.025	.
Neut./Potential Tons/1000Tons	3.11	2.45	3.57	3.17	2.7
Nitrate NO3-N ppm USDA 60	2.80	4.40	3.50	1.80	2.

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SALT LAKE CITY, UTAH 84115
PHONE 466-8761

Test Hole No. B-5

CERTIFICATE OF ANALYSIS
83-006764

	25 - 27.5	27.5 - 30
Moisture %	31.40	29.50
Molybdenum ppm AB DTPA 1	.118	.037
leut./Potential Tons/1000Tons	3.65	3.62
Nitrate NO3-N ppm USDA 60	6.40	5.30
rganic Material % (WB)	4.85	4.91
H USDA 60	7.35	7.40
hosphorus ppm AB DTPA 1	30.70	29.20
otassium ppm USDA 60	96.00	91.00
yritic Sulfur % ASTM D2492	.0119	.0110
aturation %	25.10	19.70
elenium ppm AB DTPA 1	<.001	<.001
Sodium Absorption Ratio	.056	.061
odium Sol.Meq/l USDA 60	.45	.50
inc ppm AB DTPA 1	1.700	1.800

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LABORATORY, INC.
Bacteriological and Chemical Analysis
40 WEST LOUISE AVENUE
SALT LAKE CITY, UTAH 84115
PHONE 466-8761

Test Hole No. B-5

DATE: 12/29/83

CERTIFICATE OF ANALYSIS

VALLEY CAMP OF UTAH
SCOFIELD ROUTE
HELPER, UTAH
84526

83-006764

SAMPLE: SOIL SAMPLES FROM BELINA PAD COLLECTED 9-15-83 RECEIVED 9-23-83 FOR ANALYSIS UNDER P.O. 30-83-10-007831.

	25 - 27.5	27.5 - 30
1-Clay % USDA 18	22.00	17.10
-Sand % USDA 18	49.50	53.50
1-Silt % USDA 18	28.50	29.40
Acid/Base Pot.Tons/1000 Tons	.37	.34
Boron Sol.ppm USDA 60	.066	.098
Ca.Carbonate Tons/1000Tons	4.02	3.96
Calcium Carbonate ppm USDA 60	4,025.00	3,960.00
Calcium Sol. Meq/l USDA 60	120.25	119.01
Conductivity mmhos/cm @ 25	.74	.75
Copper ppm AB DTPA 1	.420	.460
Iron ppm AB DTPA 1	45.500	43.800
Magnesium Sol. Meq/l USDA 60	14.58	15.24
Manganese ppm AB DTPA 1	11.200	10.850

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Valley Camp of Utah, Inc.
Belina Mine Site
Clear Creek, Utah 84526

MINE: UTAH NO. 2

ANALYSIS BY: INTER-MOUNTAIN LABORATORIES, INC.

DATE: September 24, 1983

Lab No.	Hole No.	Depth Interval Ft.	pH	Cond. mmhos/ cm @ 25°C	Saturation %	Particle Size Sand %	Silt %	Clay %	Texture	Soluble Cations Ca	Mg Meq/l	Na	SAR (1)
22093	1	10 Ft. - 2 Ft.	7.3	0.79	34.3	50.4	38.9	10.7	Loam	5.29	1.71	1.22	0.6
22094	2	8 Ft. - 2 Ft.	7.4	1.08	30.5	59.5	30.7	9.8	Sandy Loam	7.75	2.35	1.32	0.5
22095	3	6 Ft. - 2 Ft.	5.5	0.31	32.2	44.0	42.5	13.5	Loam	1.81	0.41	0.97	0.9

Fc .iotes: (1) Sodium Adsorption Ratio

Valley Camp of Utah, Inc.
Belina Mine Site
Clear Creek, Utah 84526

MINE: UTAH NO. 2 ANALYSIS BY: INTER-MOUNTAIN LABORATORIES, INC. DATE: September 24, 1983

Lab No.	Hole No.	OM% (13)	K+ (14)	PO4 (15)	Fe ppm (2)	Zn ppm (3)	B ppm (4)	N ppm (5)	Mo ppm (6)	Cu ppm (7)	Mn ppm (8)	TS % (9)	AB (10)	NP (11)	ABP (12)
2093	1	1.9	123.	17.4	15.1	1.09	0.84	7.13	0.09	0.51	9.35	0.05	1.56	22.3	20.7
2094	2	2.5	69.	13.7	16.6	1.12	0.85	5.71	0.08	0.41	13.3	0.05	1.56	57.1	55.5
2095	3	4.5	68.	8.74	59.3	0.66	0.76	4.30	0.05	0.80	7.52	0.05	1.56	11.9	10.3

Footnotes:
(13) Organic Matter
(14) Potassium
(15) Phosphate as P
(2) Iron DTPA
(3) Zinc DTPA
(4) Boron
(5) Nitrate Nitrogen
(6) Ammonium Extractable Molybdenum
(7) Copper DTPA
(8) Manganese DTPA
(9) Total Sulfur Per Cent
(10) Acid Base
(11) Neutralization Potential
(12) Acid Base Potential in Tons Calcium Carbonate per 1000 Tons of Soil

United States
Department of
Agriculture

Soil
Conservation
Service

P. O. Box 11350
Salt Lake City, UT 84147

May 28, 1982

Valley Camp of Utah, Inc.
Scofield Route
Helper, UT 84526

Dear Sir:

In response to your request we have made an examination of the soil survey data available. On the basis of this information the soils in this area do not meet the requirements for prime farmland because no irrigation water is available and the growing season is too short.

Without irrigation water the moisture requirement for prime farmland cannot be met.

Sincerely,

Harold J. Brown, acting

GEORGE D. MCMILLAN
State Conservationist

The Soil Conservation Service
is an agency of the
Department of Agriculture

September 16, 1986

TO: Technical File

FROM: James S. Leatherwood, Reclamation Soils Specialist JSL

RE: Substitute Topsoil Suitability, Belina Complex, Valley Camp of Utah, Inc., ACT/007/001, Folder #2, Carbon County, Utah

Pursuant to Conditions #5 and #6, the operator has submitted analytical data for the Utah No. 2 and Belina Pad materials. This information has been presented to determine the suitability of these materials as substitute topsoils. The following delineates the submitted data with a corresponding topsoil substitute suitability rating as defined in Table 2 of the Draft Topsoil and Overburden Guideline (enclosed).

BELINA PAD

Sample Site No. 1
Overall Rating = Good-Fair

Parameter	Depth	Data	Rating(5)	Parameter	Depth	Data	Rating
pH				Texture			
	0-2	7.5	G		0-2	sl	G
	2-4	7.4	G		2-4	scl	G
	4-6	7.5	G		4-6	c	P
	6-8	7.8	G		6-8	c	P
$CaCO_3$%				EC(1)			
	0-2	0.45	G		0-2	0.80	G
	2-4	0.35	G		2-4	0.77	G
	4-6	0.29	G		4-6	0.85	G
	6-8	0.36	G		6-8	0.95	G

BELINA PAD

Sample Site No. 1 (Cont'd.)
Overall Rating = Good-Fair

Parameter	Depth	Data	Rating(5)	Parameter	Depth	Data	Rating
SAR(2)				OM%(3)			
	0-2	0.047	G		0-2	4.7	
	2-4	0.064	G		2-4	3.9	
	4-6	0.087	G		4-6	4.5	
	6-8	0.100	G		6-8	3.4	
SAT%(4)							
	0-2	22.5	P				
	2-4	21.9	P				
	4-6	19.3	P				
	6-8	24.6	P				

BELINA PAD

Sample Site No. 2
Overall Rating = Good-Fair

Parameter	Depth	Data	Rating(5)	Parameter	Depth	Data	Rating
pH				EC(1)			
	0-2	7.2	G		0-2	0.90	G
	2-4	7.3	G		2-4	0.75	G
	4-8	7.5	G		4-8	0.69	G
$CaCO_3$%				SAR(2)			
	0-2	0.21	G		0-2	0.039	G
	2-4	0.39	G		2-4	0.062	G
	4-8	0.44	G		4-8	0.063	G
Texture				OM%(3)			
	0-2	sil	G		0-2	3.6	
	2-4	l	G		2-4	5.4	
	4-8	cl	F		4-8	4.8	
Sat%(4)							
	0-2	23.4	P				
	2-4	18.7	P				
	4-8	25.7	F				

BELINA PAD

Sample Site No. B-5
Overall Rating = Good-Fair

Parameter	Depth	Data	Rating(5)
pH			
	0-2.5	7.2	G
	2.5-5.0	7.4	G
	5.0-7.5	7.8	G
	7.5-10.0	7.3	G
	10.0-12.5	7.5	G
	12.5-15.0	7.8	G
	15.0-17.5	7.4	G
	17.5-20.0	7.9	F
	20.0-22.5	7.5	G
	22.5-25.0	7.5	G
	25.0-27.5	7.4	G
	27.5-30.0	7.4	G
CaCO%			
	0-2.5	0.46	G
	2.5-5.0	0.42	G
	5.0-7.5	0.38	G
	7.5-10.0	0.39	G
	10.0-12.5	0.37	G
	12.5-15.0	0.35	G
	15.0-17.5	0.30	G
	17.5-20.0	0.41	G
	20.0-22.5	0.36	G
	22.5-25.0	0.32	G
	25.0-27.5	0.40	G
	27.5-30.0	0.40	G
Texture			
	0-2.5	c	P
	2.5-5.0	cl	F
	5.0-7.5	c	P
	7.5-10.0	scl	G
	10.0-12.5	c	P
	12.5-15.0	sl	G
	15.0-17.5	sl	G
	17.5-20.0	l	G
	20.0-22.5	sl	G
	22.5-25.0	scl	G
	25.0-27.5	scl	G
	27.5-30.0	sl	G

Parameter	Depth	Data	Rating
EC(1)			
	0-25	0.75	G
	2.5-5.0	0.80	G
	5.0-7.5	0.84	G
	7.5-10.0	0.90	G
	10.0-12.5	0.78	G
	12.5-15.0	0.88	G
	15.0-17.5	0.92	G
	17.5-20.0	0.88	G
	20.0-22.5	0.76	G
	22.5-25.0	0.80	G
	25.0-27.5	0.74	G
	27.5-30.0	0.75	G
SAR(2)			
	0-2.5	0.08	G
	2.5-5.0	0.06	G
	5.0-7.5	0.08	G
	7.5-10.0	0.10	G
	10.0-12.5	0.05	G
	12.5-15.0	0.06	G
	15.0-17.5	0.05	G
	17.5-20.0	0.06	G
	20.0-22.5	0.06	G
	22.5-25.0	0.08	G
	25.0-27.5	0.06	G
	27.5-30.0	0.06	G
OM%(3)			
	0-2.5	3.3	
	2.5-5.0	4.6	
	5.0-7.5	8.2	
	7.5-10.0	5.9	
	10.0-12.5	7.7	
	12.5-15.0	5.5	
	15.0-17.5	6.8	
	17.5-20.0	4.9	
	20.0-22.5	10.5	
	22.5-25.0	6.8	
	25.0-17.5	4.9	
	27.5-30.0	4.9	

Parameter	Depth	Data	Rating(5)	Parameter	Depth	Data	Rating
Sat%(1)							
	0-2.5	24.5	P				
	2.5-5.0	21.8	P				
	5.0-7.5	24.6	P				
	7.5-10.0	23.8	P				
	10.0-12.5	31.5	G-F				
	12.5-15.0	27.1	F				
	15.0-17.5	20.7	P				
	17.5-20.0	21.5	P				
	20.0-22.5	28.2	F				
	22.5-25.0	20.4	P				
	25.0-27.0	25.1	F				
	27.5-30.0	19.7	P				

UTAH NO. 2 PAD

Sample Site No. 1
10-ft. Depth
Overall Rating = Good

Parameter	Data	Rating(5)	Parameter	Data	Rating
pH	7.3	G	Texture	1	G
Sat%(4)	34.3	G-F	EC(1)	0.79	G
SAR(2)	0.65	G	OM%(3)	1.9	

UTAH NO. 2 PAD

Sample Site No. 2
8-ft. Depth
Overall Rating = Good

Parameter	Data	Rating(5)	Parameter	Data	Rating
pH	7.4	G	Texture	sl	G
Sat%(4)	30.5	G-F	EC(1)	1.08	G
SAR(2)	0.59	G	OM%(3)	2.5	

Sample Site No. 3
6-ft. Depth
Overall Rating = Good-Fair

Parameter	Data	Rating(5)	Parameter	Data	Rating
pH	5.5	F	Texture	1	G
Sat%(4)	32.2	G-F	EC(1)	0.31	G
SAR(2)	0.92	G	OM%(3)	4.5	

(1) Electrical Conductivity (mmhos/cm @ 25°C)

(2) Sodium Adsorption Rates

(3) Organic matter percent (Organic matter suitability ratings are undetermined at this time. Data is presented for information purposes only.

(4) Saturation Percent (Data on the Belina Pad materials is misleading. In some cases there is a high clay content and low saturation percentage- See Sample Site No. 1, 4-6 and 6-8 feet samples).

(5) Ratings:

Good = G
Fair = F
Poor = P
Unsuitable = U

Enclosure(s)
JSL/djh
cc: S. Linner
L. Kunzler
0798R/6

Table 2. Suitability Limits for Rating Topsoil Substitutes*

	Good	Fair	Poor	Unsuitable
Available water capacity	>0.10	0.05-0.10	<0.05	
pH	6.1-7.8	5.1-6.1 7.9-8.4	4.5-5.0 8.5-9.0	<4.5 >9.0
USDA Textural Class	SL L, SiL SCL VFSL FSL	CL,SICL, SC,LS LFS	SIC S, SC, C COS, FS, VFS	G, VCOS
Slope (%)	<8	8-15	>15	
Electrical Conductivity	0-4	5-8	9-15	>16
Sodium Adsorption Ratio (SAR)	5	6-10	10-12 Fine Texture 10-15 Coarse Texture	>12 Fine Texture >15 Coarse Texture
Boron	<5.0			>5.0
Selenium	<0.1	>0.1		
Rock Fragments (% Volume)				
3 inches	0-15	15-25	25-30	30
3-10 inches	0-15	15-25	25-30	30
More than 10 inches	0-3	3-7	7-10	10
Alkalinity as Calcium Carbonate %	0-15	15-25	25-40	>40
Saturation Percentage (%)			<25 >80	

* Many native species have their roots in soils that are determined poor to unsuitable by these values. Therefore, plant growth trials may be needed where re-establishment of native species is desired.

APPENDIX 411.140

AERC Archeological Investigation

Copy to Mary

SCOTT M. MATHESON
GOVERNOR

STATE OF UTAH
DEPARTMENT OF COMMUNITY AND ECONOMIC DEVELOPMENT

Division of State History
(UTAH STATE HISTORICAL SOCIETY)

MELVIN T. SMITH, DIRECTOR
307 WEST 2ND SOUTH
SALT LAKE CITY, UTAH 84101
TELEPHONE 801/533-5755

[illegible]
[illegible]IL, GAS & [illegible]ING

January 7, 1981

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

RE: Skyline Mine - Coastal State's Energy Company, Carbon County, Utah

Dear Mr. Smith:

The staff of the Utah State Historic Preservation Officer has received your letter of October 24, 1980. The staff, having reviewed the submitted report by Archeological Environmental Research Corporation, entitled "Archeological Surface Evaluations in the Skyline Project in Carbon and Emery Counties," has determined that the report is adequate to determine mitigation of impacts of the proposed operations on historic and cultural resources. Because of the limited number of resources and the described no adverse effect upon them in the Skyline Mine project, it is felt that this report could satisfactorily be submitted as part of a mining program as outlined by the Memorandum of Agreement between the Division of State History and the Division of Oil, Gas and Mining.

The Preservation Office is aware of the December 22, 1980 letter submitted to Coastal States Energy by the Office of Surface Mining concerning the adequacy of the report for submission. Our office agrees that there are many technical errors in the report. However, since the cultural resources are not eligible and there is no adverse effect, the mine plan should be approved.

The Office of Surface Mining has pointed out some serious problems with this report and others. The Preservation Office of Utah would like to suggest to Oil Gas & Mining and the Office of Surface Mining that a meeting be set up to determine some specific guidelines that can be dealt with on a systems basis rather than individual cases.

State History Board: Milton C. Abrams, Chairman • Theron H. Luke • Ted J. Warner • Elizabeth Montague • Thomas G. Alexander
Dee G. Dayton • Walter K. [illegible] • Helen Z. [illegible] • [illegible]

Should you need assistance or clarification, please call or write James L. Dykman, Cultural Resource Advisor, or Wilson G. Martin, Preservation Development Coordinator, Utah State Historical Society, Preservation Development, 300 Rio Grande, Salt Lake City, Utah 84101.

Sincerely,

Melvin T. Smith
Director and
State Historic Preservation Officer

JLD:jr:C942CB

cc: Office of Surface Mining, Attn: Bill Killiam, Brooks Towers, 1020 15th Street, Denver, Colorado 80202

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 No. 2 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. One of the seven sites is considered to meet the minimal criteria of eligibility under 36 CFR 60.6.

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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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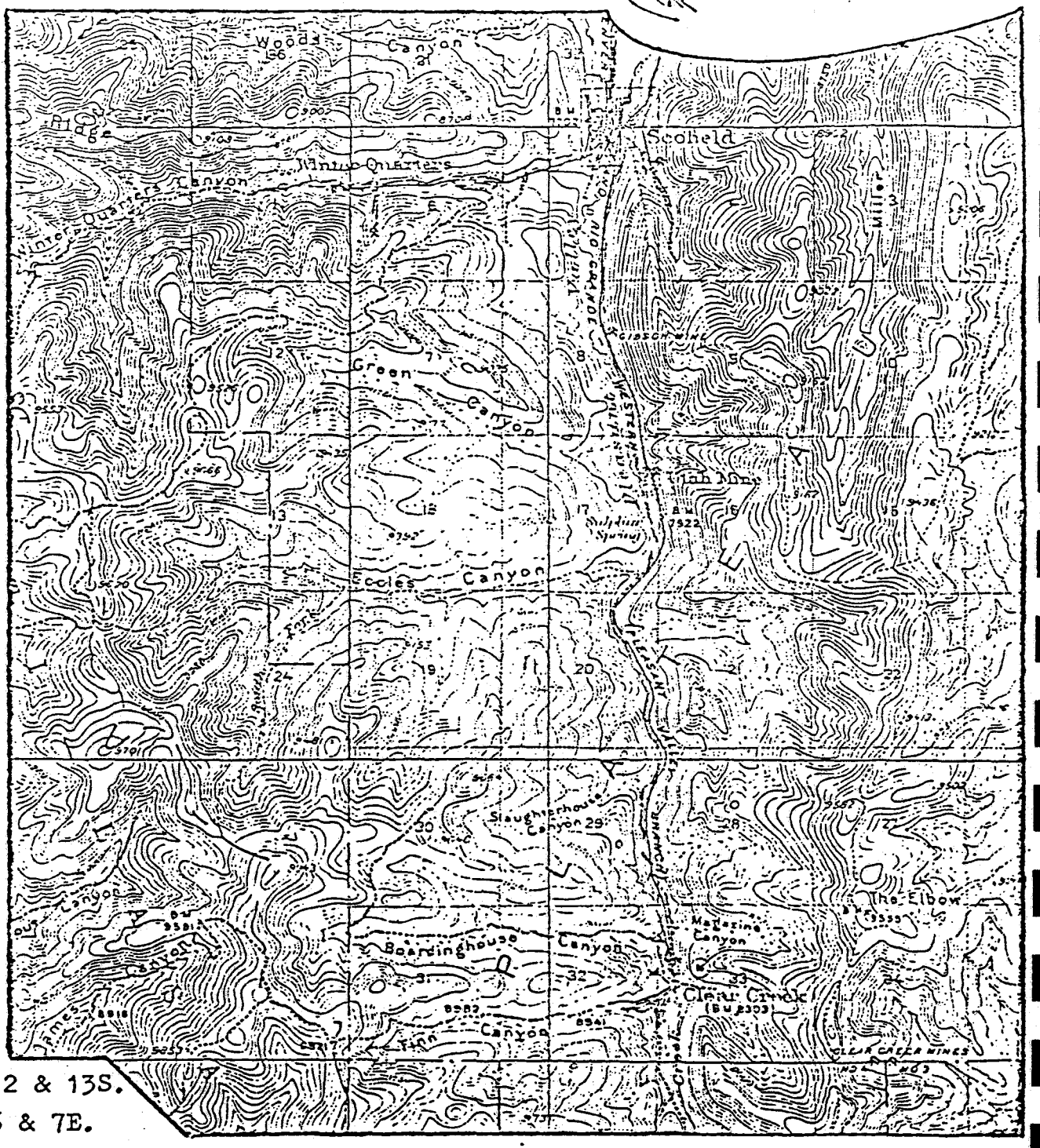


T. 12 & 13S.

R. 6 & 7E.

Meridian: Salt Lake B. & M.

Quad:

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

Scofield, Utah
15 Minute USGS

Legend:

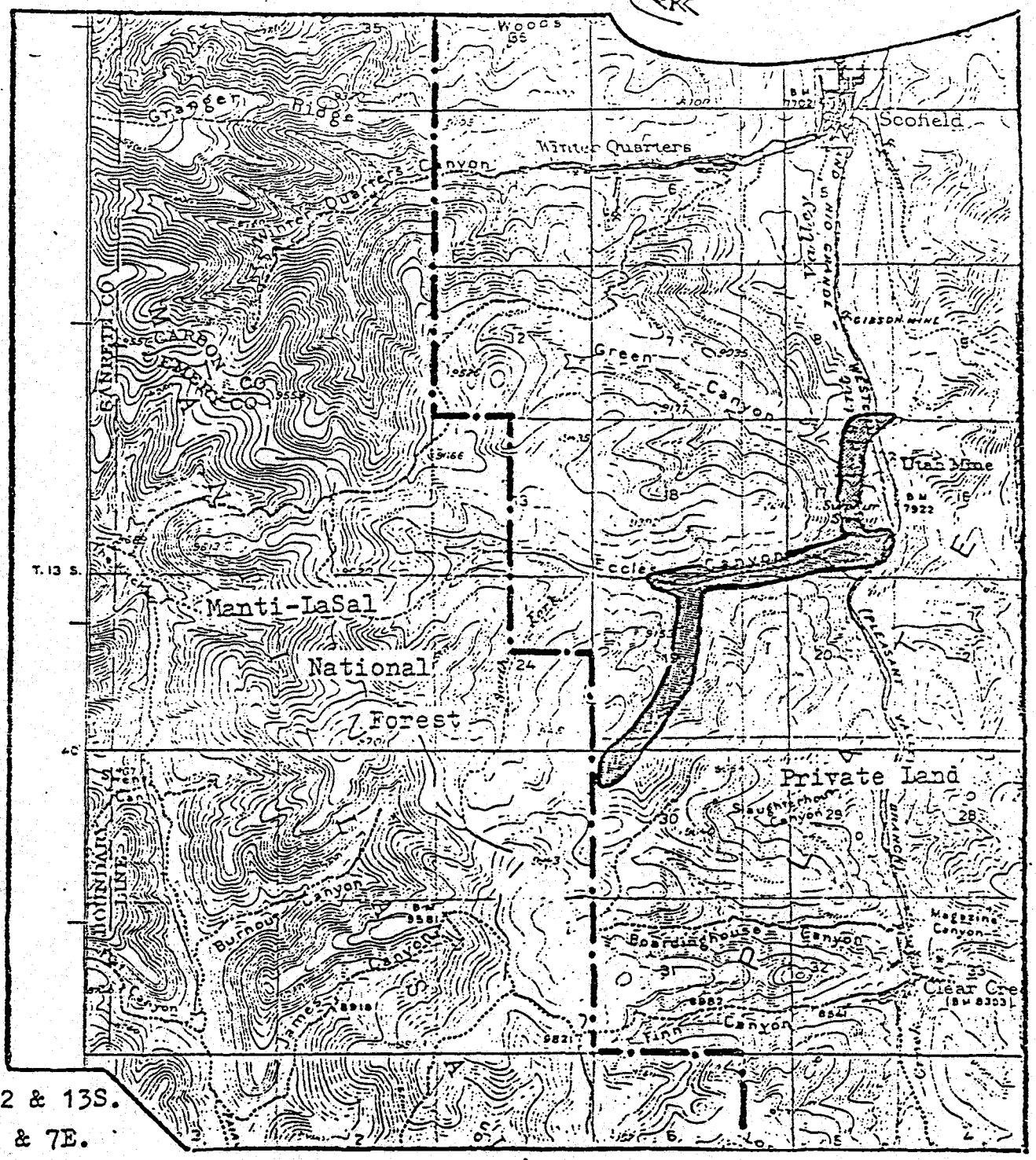
N

1 0 1 2 M.

1 0 1 2K.

Scale

ARCHEOLOGICAL-ENVIRONMENTAL RESEARCH CORPORATION



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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

N

1 0 1 2 M.

1 0 1 2 K.

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 Section 8 and then east to the Utah No. 2 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 Peoples and Cultures 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 in 1979 (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 Bison antiquus.

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 effectivel 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 Chateau-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, Green-river (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 what 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 habitation 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.

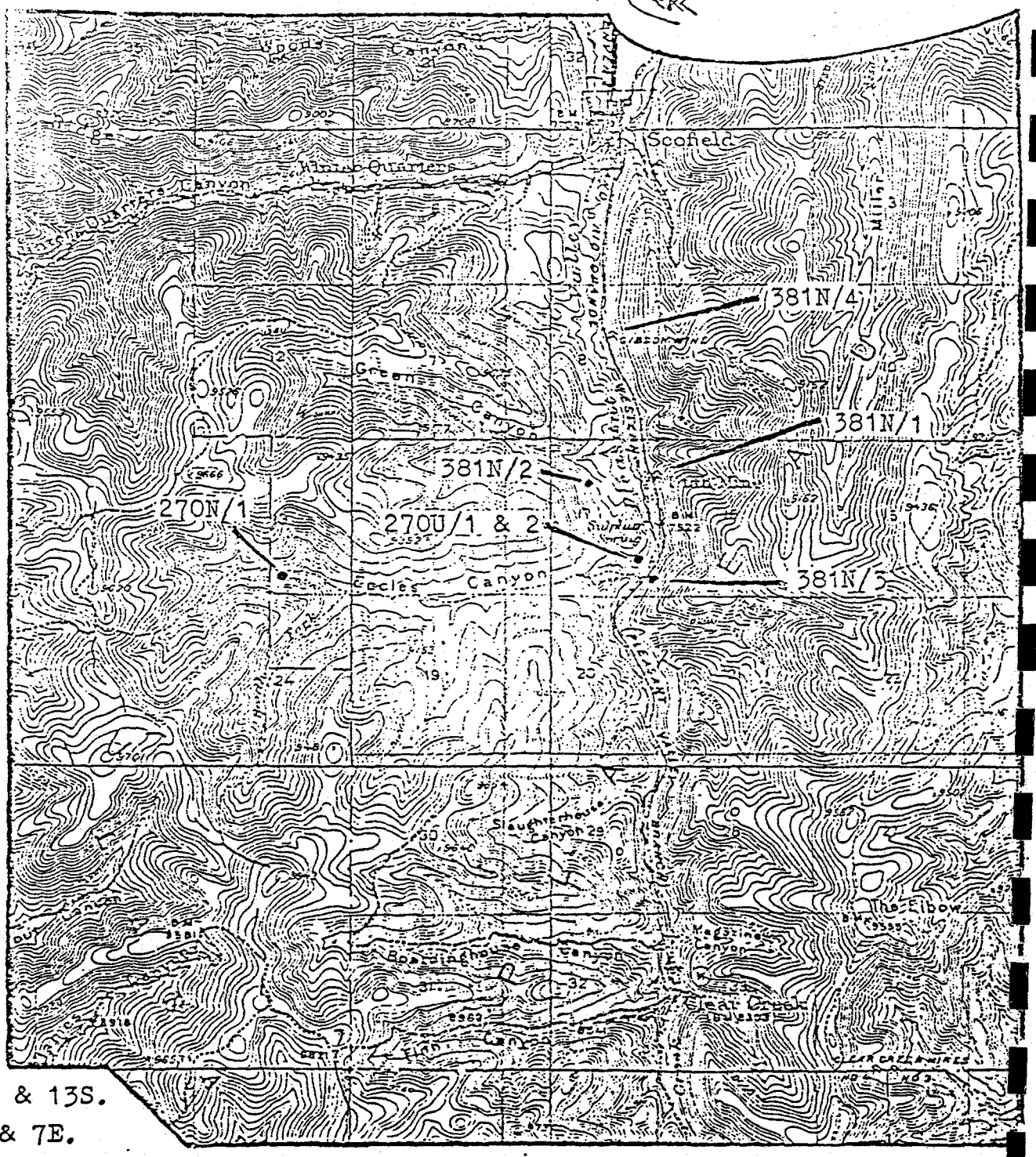
V. Garth Norman, a staff archeologist with AERC, was in charge of the field crew which included Monika Williams and Bunny Melendez. F. R. Hauck, president of AERC was principal investigator.

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 two sites, the Nicolitus Mine portals (AERC 381N/3), and the Gibson Mine (AERC 381 N/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

0 1 2 M.
0 1 2 K.
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 four 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 OSEC-79-2 dated 7/23/79). Site AERC 381N/1 is the historic Utah No. 1 Mine site which is situated at the northern end of the corridor zone. The Green Canyon Sawmill site (AERC 381N/2) is located near the mouth of Green Canyon.

Three 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; 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

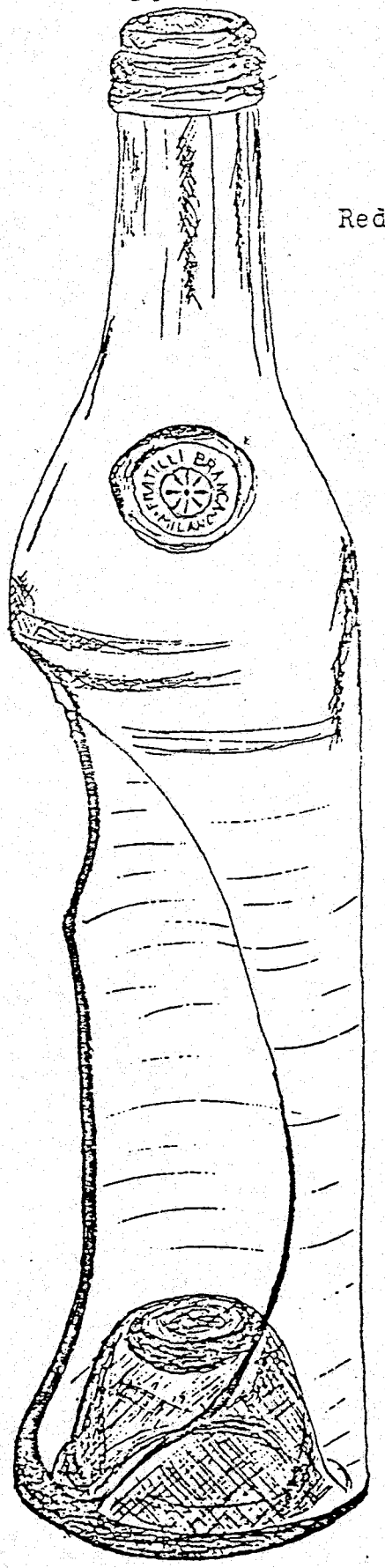
Laboratory analysis of artifacts was minimal since historic artifacts were minimally collected from only one site (381N/1). No other artifact or ecofact collections were made during the survey or during the 1979 survey when the Eccles Canyon segment of the corridor was evaluated.

C. Artifact Inventory and Analysis

The following historic artifacts were collected at the Utah No. 1 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.

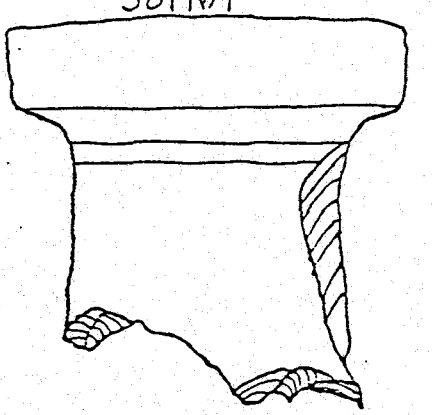
381 N/1



Reduced by 30%

Figure 4

381 N/1



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. Five of these sites are either in the potential construction corridor (AERC 270U/1 and 2) or are partially within the corridor (AERC 381N/1, 2, and 3). These five 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 No. 1 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 five sites situated in the transmission corridor zone, and therefore susceptible to adverse affect during the construction period, site 381N/1, the Utah No. 1 Mine, is the most important. The Utah No. 1 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 south 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" (Spieker 1931:96). 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 Green Canyon Sawmill site (AERC 381N/2) includes a cement foundation and wooden rails for the log track. A corral and an abandoned roadbed are associated with this site which lies behind the Valley Camp of Utah offices.

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 is associated with events that have made a significant contribution to the broad patterns of our history; or

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

c) none of the four sites embodies the distinctive characteristics of a type, period, or method of construction, or represents the work of a master, or possesses high artistic values, or represents 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. This site should, therefore, be considered as meeting the standards of criteria "d" of 36 CFR 60.6. The other three sites (270U/1, 2, and 381N/3) are not eligible under the criteria outlined above.

C. Discussion of Impact Potential on Cultural Resource Sites

Direct impact, i.e., project-related disturbance of the four cultural resource sites located adjacent to the potential disturbance zone could result during surface modification for road and conveyor belt line development. The cabin foundations (270U/1 and 2), the Utah No. 1 Mine site (381N/1), and the sawmill site (381N/2) can 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	Not probable	No	Coal Mine Development	2
381N/2	3	No	Possible	Vandalism	2
381N/3	3	Not probable	Possible	Transmission Corridor Development & Vandalism	2
381N/4	3	No	No	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 412.200

Land Owner Comments

Valley Camp Attorneys are currently working on providing information to be included within this appendix.

APPENDIX 420

Air Quality Approval

Scott M. Matheson
Governor

STATE OF UTAH
DEPARTMENT OF HEALTH
DIVISION OF ENVIRONMENTAL HEALTH
150 West North Temple, P.O. Box 2500, Salt Lake City, Utah 84110

Alvin E. Rickers, Director
Room 425 801-533-6121

James O. Mason, M.D., Dr.P.H.
Executive Director
801-533-6111

DIVISIONS
Community Health Services
Environmental Health
Family Health Services
Health Care Financing and Standards

OFFICES
Administrative Services
Health Planning and Policy Development
Medical Examiner
State Health Laboratory

533-6108
August 17, 1981

RECEIVED
AUG 21 1981
By

Trevor G. Whiteside
Valley Camp of Utah, Inc.
Scofield Route
Helper, UT 84526

RE: Air Quality Approval Order for Increase of Coal Production

Dear Mr. Whiteside:

On April 30, 1981, the Executive Secretary published a notice of intent to approve your increase in coal production from 1.2×10^6 tons/year to 2.25×10^6 tons/year. The 30-day public comment period expired on May 30, 1981 and no comments were received.

This air quality approval order authorizes the increase in production as proposed in your notice of intent dated March 26, 1981 with the following conditions:

1. The conveyor hood sections shall be securely positioned when transporting coal and be maintained in good operating condition.

2. The conveyor head chutes, reclaim tunnel feeder chutes and vibrator feeder discharge chutes shall be totally enclosed and maintained in good operating condition.

3. The conveyor skirtboards shall be properly positioned when transporting coal and be replaced as needed.

4. Stacker tube dust flaps shall be replaced as needed.

5. The 2.2 miles of haul road shared with other companies shall be paved no later than September 1, 1982. In the interim, the road shall be chemically stabilized to minimize fugitive emissions. A record/log of all treatments including date, amount and location shall be kept and made available to the Executive Secretary upon request.

6. The unpaved sections of haul roads not covered in condition #5 shall be chemically stabilized as necessary with dust suppressive material. A record/log of all treatments including date, amount and location shall be kept and made available to the Executive Secretary upon request.

7. All conveyor transfer points shall be equipped with water sprays.

8. The opacity of the crushing plant baghouse shall not exceed 20%. The baghouse shall be maintained in good operating condition.

9. No visible emissions, except from internal combustion engines, shall exceed 20% opacity as per Section 4.1.2, Utah Air Conservation Regulations (UACR). Visible emissions from diesel engines shall not exceed 20% opacity except for starting motion no farther than 100 yards or for stationary operation not exceeding three minutes in any hour according to Section 4.1.4, UACR.

10. All surge bins for loading of trucks or railroad cars shall be equipped with a telescoping chute to minimize the fall distance of the coal.

11. Total annual production of coal from the two mines and crushing plant throughput shall not exceed 2.25×10^6 tons without prior approval from the Executive Secretary according to Section 3.1, UACR.

12. The Executive Secretary shall be notified when monthly production reaches full capacity as a compliance inspection is required.

You are considered a minor source for purposes of the PSD regulations and will not require a permit from EPA/Region VIII. However, for State purposes you are a major source.

According to Section 3.9, UACR, a fee for the cost associated with processing this permit is required to be paid to the State of Utah upon receipt of this approval order. The final costs are attached.

Sincerely,

Brent C. Bradford
Executive Secretary
Utah Air Conservation Committee

DR:jw
cc: Southeastern District Health Dept.
EPA Region VIII (D. Kircher)
enclosure

APPENDIX 222

Soils/Vegetation/ Wildlife Studies

APPENDIX 341.300

Vegetation-Supporting Materials Studies

Cedar Creek
(1986)

COVER AND PRODUCTIVITY ANALYSIS OF TEMPORARY REVEGETATION SITES AT VALLEY CAMP OF UTAH, INC.'S UTAH #2 AND BELINA OPERATIONS

Prepared For:
VALLEY CAMP OF UTAH, INC.
Scofield, UT

Prepared by:
CEDAR CREEK ASSOCIATES, INC.
Fort Collins, CO

August, 1986

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1.0 INTRODUCTION AND PROJECT HISTORY

The following report details the results of cover and productivity data collection and analysis completed on temporary revegetation sites at Valley Camp of Utah, Inc's (Valley Camp) Utah #2 and Belina permit areas. The temporary revegetation site evaluated at the Utah #2 disturbance was the west-facing slope below the operating truck dump. Field analysis took place on July 11, 1986. The three temporary revegetation sites analyzed at the Belina disturbance included the southeast-facing slope northeast of the operating conveyor (Area A), the north-facing slope above the existing sediment pond (Area B), and the southeast-facing slope to the southwest of the operating conveyor (Area G). Field data were collected from all three Belina sites on July 12, 1986.

The impetus to conduct this study resulted from a stipulation associated with the permit issued for the Utah #2 and Belina operations. The stipulation required Valley Camp to construct revegetation test plots. The purpose of these plots would be to determine whether substitute topsoil material stockpiled at the disturbed sites is suitable plant growth media for final revegetation. This stockpiled substitute topsoil is necessary for use since the current disturbed area was affected prior to the effective date of current mining regulations. No soil had been salvaged on the Utah #2 and Belina disturbances during pre-law years.

Following a June 6, 1986 meeting between Valley Camp, Cedar Creek Associates, Inc. (Cedar Creek), and UDOGM personnel, UDOGM representatives contacted the OSM. The contact was made to determine whether the test plot stipulation could be waived on the basis of the condition of existing vegetation planted on stockpiled substitute topsoil material. The interim revegetation acreage was overlain with varying amounts of substitute topsoil and shows impressive plant cover. Mr. Dwight Kimsey of the OSM proposed that a properly conducted evaluation of interim revegetation acreage could result in a waiver of the test plot stipulation if the interim revegetation met unspecified cover and production levels. Subsequently, Valley Camp contracted with Cedar Creek to conduct the cover and production analyses on the temporarily reclaimed areas.

On July 11, 1986, representatives of Valley Camp, Cedar Creek, and UDOGM met to select temporarily revegetated areas from which cover and production data would be gathered. The objective was to select four sites (one at Utah #2 and three at the Belina complex) which would accurately reflect final revegetation acreage, slope, and aspect considerations. It was also believed necessary to evaluate areas which had been revegetated using techniques (appendices 1 and 2) that paralleled those proposed for final revegetation.

During this field survey, the slope below the truck dump was selected for analysis at the Utah #2 disturbance. It is most representative of the proposed final graded slope and aspect and was planted over five years ago. A sediment pond slope was rejected since it was composed solely of

topsoil material. One other site adjacent to the Utah #2 entrance was rejected since it had been planted in 1985 and had not completed one growing season.

At the Belina complex, three acceptable sites were selected. These sites accurately reflect what is believed to be the dominant aspects to which the presently disturbed area will be graded. The degree of slope for each site is within the range of proposed final graded slopes though they are somewhat steeper than the average of proposed slopes. Techniques used to revegetate these slopes essentially parallel proposed final revegetation techniques. Areas A and B on the Belina disturbance were planted in 1980. The fact that these areas have existed through over five growing seasons added to their suitability as evaluation sites. Area G, planted in 1985, was selected to represent a site where planted species were nearing the end of one growing season. Locations of all sites analyzed are depictd on maps included with this document.

By concensus, it was agreed to limit evaluations on Area B to the upper 25% of the site. The lower 75% of the site apparently had been negatively affected by an overly heavy maintenance fertilizer application which "burned" significant areas of grass. It was felt that the inclusion of this burned area would not result in data representative of the growth potential of the substitute topsoil material.

Few other areas were considered for analysis at the Belina site. One area to the west of Area G was briefly considered. This area showed excellent plant cover, density, and diversity. It was rejected, however, due to the comparatively intense labor effort expended to complete the revegetation process.

At the conclusion of this field review, Cedar Creek began data collection on the selected site at the Utah #2 disturbed site.

2.0 METHODOLOGY

2.1 Cover Data Collection

The procedure for measuring cover on Belina areas A, B, and G consisted of extending ten meter transects from randomly selected points (areas of recent dozer work were avoided). Along each transect a one-meter long ten-point optical frame (0.1 meter between points) was placed at one-meter intervals. Each point on the frame consisted of an optical scope with fine cross-hairs. The observer viewed the revegetated surface through each scope and recorded first hits, by cross-hairs on vegetation by species, rock, litter, and bare ground below the instrument. In this manner, 100 readings per transect were recorded. The hits were then tallied by category resulting in percentages recorded for total cover, total vegetative cover, percent cover by species, percent litter and percent bare ground exposure for each transect.

Each transect served as one sample for sample adequacy calculations. Sample adequacy was reached and exceeded for each temporarily reclaimed area analyzed by completing ten transects per area. Ten transects are the equivalent of 1,000 point-intercepts on the sampled area.

The method used for measuring cover at the Utah #2 site was identical to that used for the Belina sites with one exception. Transects at the Utah #2 site were systematically not randomly located. The temporarily revegetated area was of insufficient size to permit randomization. Therefore, transects were aligned from the near top to the near bottom of the slope at approximately two meter intervals. This spacing allowed for complete linear coverage along the north-south axis of the site.

2.2 Productivity Data Collection

Productivity was measured by clipping all current year's plant growth from randomly located 0.5 meter quadrats. Each quadrat served as one sample for sample adequacy calculations. Clipped plant material was bagged by life form (grasses vs. forbes vs. shrubs), transported to Fort Collins, Colorado, oven-dried at 100°C for 24 hours, and then weighed to the nearest 0.1 gram. To determine sample adequacy in the field, "wet" weights were used to complete sample adequacy calculations. Sample adequacy was also calculated on oven-dry samples to ensure that adequate samples were taken. Field data sheets used to record data are on file at Valley Camp's mine office.

Prior to clipping each temporarily reclaimed area, photos (Appendix 3) were taken of the area as a whole and of four randomly selected quadrats to depict site conditions.

2.3 Sample Adequacy Determination

Sample adequacy was determined for both cover and production on all temporarily revegetated areas using the following equation:

$$nm = (ts^2)/(d\bar{x})^2$$

where:

- nm = minimum number of samples needed,
- $\bar{x}$ = estimated sample mean,
- s = estimated sample standard deviation,
- t = value from t-table for a given probability level (1.645 for 90% confidence), and
- d = percent change in the sample mean desired to be detected (0.1 for 10%)

3.0 COVER MEASUREMENTS

Percentages given in the following discussion are averages for the ten transects completed at each sampled site unless otherwise noted. Cover percentages for individual species are given as a percent of total floral cover.

3.1 Utah #2 Disturbance

Seven species were encountered along the ten transects completed for this temporary revegetation site. The dominant specie was Poa pratensis at 47.7% cover followed by Dactylis glomerata at 12.0%, Elymus junceus at 3.7%, and Agropyron smithii at 3.4% cover. A. trachycaulum, Circium vulgare and an unknown forb each had less than 1.0% cover. The average total floral cover for the ten transects equaled 67.5%. Litter and rock accounted for 11.9% and 4.7% cover, respectively. The total ground cover, including the floral, litter, and rock catagories, was 84.1%.

The plants encountered appeared vigorous with no signs of chlorosis evident. Mature seedheads were common for all species found along the transect. Individual plants of Elymus junceus found near the bottom of the slope were exceptionally vigorous specimens. Numerous seedlings were noted during the analysis indicating that reproduction was occuring throughout the site.

Ten transects were evaluated for this site. Using the statistical adequacy calculation, the minimum number of transects necessary for this site would have been approximately 1.5 ($n = 10$; $\bar{x} = 67.5$; $s = 5.017$).

3.2 Belina Disturbances

The average total floral cover for site A was 67.2%. Litter and rock accounted for 14.3% and 10.5% cover, respectively, resulting in a total average ground cover of 92.0%. Eleven species were encountered along the ten transect lines. D. glomerata was the dominant specie on this site providing 35.6% cover. P. pratensis had 15.4% cover followed by A. smithii, A. trachycaulum, Medicago sativa, and Salsola kali with 9.3%, 1.0%, 1.9% and 1.1% cover, respectively. Species having less than 1.0% cover included Bromus inermis, E. junceus, Astragalus sp., and C. vulgare. Artemisia tridentata, the only shrub species encountered on the transects, provided 1.4% cover. A variety of other species, not hit on any transect, were observed on the site. These species included Symphoricarpos oreophilus, Hordeum jubatum, populus tremuloides, Prunus virginiana, Carex sp. and several invading forbs.

Overall, this site appears to be the most vigorous with fully mature grasses, forbs, and shrubs covering the site. A. tridentata is very common on site despite the relatively low cover percentage shown by the data. Fully developed seedheads were common for all grass species encountered. No stressed or chlorotic plants were observed during the field analysis.

Ten transects were extended on this site and the sample adequacy calculation completed for the data. The number of transects required was 3.4 ($n = 10$; $\bar{x} = 67.2$; $s = 7.554$).

D. glomerata was, by far, the dominant specie on site B with an average of 50.2% cover. Of the eight other species encountered along the transects, only P. pratensis at 3.9% and Phlem sp. (believed to be Phlem alpinum) at 3.1% produced notable cover. Of the remaining five species encountered, moss accounted for 2.1% cover while B. inermis, E. junceus, M. sativa, A. tridentata and Picea engelmannii each accounted for less than 1.0% cover. Total floral cover equaled 61.2 percent. Together with floral cover, litter at 26.2% and rock at 8.3% resulted in a total ground cover of 95.7%, the highest of all areas sampled. Other species observed on site included A. tridentata, Carex sp., Festuca sp., Picea pungens, and several invading forbs.

Few seedheads were observed on this site though the species present appeared very vigorous. The high level of litter, primarily year-old grass blades, appears to further confirm the overall vigor of this population. The absence of mature seedheads is believed to be a function of the northerly aspect of the site resulting in a later maturing plant population.

Ten transects were extended on this site and the data was used to calculate sample adequacy. Approximately 1.3 transects would have been necessary. The sample mean was 61.1% and the sample standard deviation equaled 4.122.

The total ground cover on Area G, planted in 1985, was 68.7%. Total floral cover, litter, and rock accounted for 28.9%, 21.2%, and 18.6%, respectively. The dominant species on site was Festuca rubra with 19.0% cover. This species is believed to be a volunteer from the mulch application. Eleven other species were encountered along the transects. D. glomerata (4.6%), A. smithii (1.5%), and P. pratensis (1.0%) were the most notable of these species. The remaining eight species (Agropyron dasystachyum, A. trachycaulum, B. inermis, E. junceus, Achillea millifolium, M. sativa, M. officinalis and an unknown forb) each had less than 1.0% cover.

Planted in the fall of 1985, the individual plants on this site appeared healthy. No evidence of chlorosis and little evidence of stress was noted. Developing seedheads were observed for all grasses found along the transects with the exception of E. junceus. Flowers for both planted legumes were observed on site.

Statistical adequacy calculations conducted on the data from ten transects ($\bar{x}$ = 28.9, s = 4.840) showed that sample adequacy could have been attained with 7.6 transects.

4.0 PRODUCTIVITY MEASUREMENTS

All weights reported in this section are oven-dry weights unless otherwise noted.

4.1 Utah #2 Disturbance

The average productivity for a 0.5 meter quadrat was 66.44 grams or the equivalent of approximately 1,182 pounds per acre. Forb production was relatively low at 0.59 grams per 0.5 meter quadrat.

Fifteen quadrats were sampled to meet initial sample adequacy calculations. Calculations completed on the dry weights of the 15 samples showed seven quadrats required sampling for adequacy ($\bar{x}$ = 66.5; s = 10.757).

4.2 Belina Disturbances

At site A, the average production per 0.5 meter quadrat was 123.17 grams. This equates to 2192 pounds of oven-dry forage per acre. Forbs and shrubs averaged 17.69 and 12.93 grams per 0.5 meter quadrat, respectively.

Adequacy calculations completed on dry weights of the ten collected samples showed that four quadrats would have been sufficient for sampling ($\bar{x}$ = 123.2; s = 15.040).

The average production at site B was 49.24 grams per 0.5 meter quadrat or 877 pounds per acre. No forbs or shrubs were collected from any quadrat.

Calculations completed for the ten samples collected ($\bar{x}$ = 49.2; s = 7.611) showed that sampling approximately six and one-half quadrats would have achieved sample adequacy.

The average quadrat at site G yielded 47.18 grams of plant material which equals a per acre production of 840 pounds. Forbs averaged 2.17 grams per quadrat and were present on seven of the twelve quadrats clipped.

Calculations completed on the data from the twelve quadrats indicated that approximately eight quadrats sampled would have fullfilled sample adequacy ($\bar{x}$ = 47.2; s = 8.105) requirements.

5.0 CONCLUSIONS

Average total floral cover percentages for the sites sampled ranged from 67.5% to 28.9%. The Utah #2 and Belina sites A and B, all planted in 1980, had roughly identical percentages at 67.5%, 67.2% and 61.2%, respectively. Belina site G, planted in the fall of 1985, had significantly less cover at 28.9%. It is believed that the latter percent cover should increase through subsequent growing seasons.

Species dominance varied from site to site. Dactylis glomerata was the dominant specie on Belina sites A and B and a major component on the other site sampled. Poa pratensis was the dominant specie on the Utah #2 site and showed excellent performance on Belina sites A and B. Agropyron smithii, though never a truely dominant species, performed comparatively well on all areas with the exception of Belina Area B. A. dasystachyum is believed to be a stronger performer than the sample data would indicate. Some difficulty was encountered in separating this species from A. smithii in the field due to physiognomy. Elymus junceus was a notable component on the Utah #2 site but was a minor species on all sites sampled at the Belina complex. Artemisia tridentata, present on all areas sampled, was a stong performer only on Belina site A.

Species diversity ranged from seven to twelve species over the four areas sampled. Belina Area G, which had the lowest total floral cover, showed the highest diversity. Belina Area B, with nine species counted within transects, appeared to be supporting a significant number of invading species. Most notable of these are Phlem sp. (3.1 % cover) and Picea englemannii (1.0% cover). Numerous other species not counted on transects were present on this area which is the closest in proximity to a non-disturbed area of any temporary revegetation site sampled. Invasion of non-planted species appears to be a viable mechanism on this and other sites sampled. Though present on all sites, Medicago sativa and Melilotus officinalis were not overly impressive performers. This may, in large part, be due to the fact that fall seedings were completed for all temporary revegetation sites. Fall seeding is generally thought to suppress the establishment of these legume species.

Vegetation at all sites sampled appeared healthy. No signs of chlorosis or other nutrient deficiencies were observed. Mature seedheads were found on all sites sampled with the exception of Belina site B. The absence of seedheads at site B was believed to be due to site physical conditions. This cold, north-facing site retains snow much later into the spring than does other sampled sites delaying the maturity of indigenous vegetation. It is believed that seedheads will develop and mature as the season progresses.

Productivity ranged from 840 to 2,192 pounds per acre oven-dry weight. Site A, containing notable forb and shrub components as compared to other sites sampled, had the highest recorded production. Belina site B and Belina site G had production rates of 877 and 840 pounds per acre,

respectively. It is believed that site B production is depressed due to the physical site conditions described above but will continue to increase through this growing season as seedheads develop. The comparatively low production rate of site G is due to the fact that this site has experienced less than one full growing season. As the age of this stand increases, productivity should increase as well.

The data presented in this report suggest that acceptable cover and productivity values and notable diversity can be produced on all substitute topsoil material stockpiled at the Utah #2 and Belina disturbances. Existing cover and productivity data for all sites compare favorably with general revegetation and native "range" levels considering the length of time since these areas were planted and the aspect factor affecting Belina site B. There appears to be no reason, based on these data, why the material stockpiled should not be considered acceptable seedbed material for use during revegetation of the Utah #2 and Belina disturbances.