

UNDERGROUND COAL MINE PERMIT

ACT 007/007

Sunnyside Coal Company

SUNNYSIDE MINES
CARBON COUNTY, UTAH

BOOK 1

CHAPTER 1.0 GENERAL
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Chapter 1

General, Legal, and Related Information

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1.00 Introduction

This permit renewal application is submitted by Sunnyside Coal Company, Sunnyside Mines in Carbon County, Utah. The operator is presently operating under Permit No. ACT/007/007.

The Sunnyside Mines are located in the Book Cliffs Coal Field about 120 air miles southeast of Salt Lake City (see Location Map, Plate 1-4). The permit area amounts to 14,520 acres, the bulk of which is owned in fee by Sunnyside Coal with Federal, State of Utah, and Carbon County coal leases making up the balance. It has been in nearly continuous operation since the 1890's and is a major contributor to the socioeconomic well-being of Carbon County.

The Upper and Lower Sunnyside seams of the Blackhawk Formation are mined. Approximately 60 million tons of coal have been produced during the 92 years of operation. Mine workings cover an area approximately 6 1/2 miles by 2 1/2 miles. Projected production ranges from 0.6 to 1.0 million tons of clean coal per year. 1991 will be a transition year for production.

Mine development consists of main slopes driven down the dip from which development entries are driven on the strike extending to bleeder entries to develop the longwall panels. Longwall mining was introduced in 1961 and now accounts for 65 to 80 percent of the coal produced. The balance is derived from development work and limited room and pillar mining. The production exits the mine via a belt conveyor system.

Run-of-mine coal is washed in a preparation plant. The clean coal product is conveyed to the unit train loadout stockpile. Coarse refuse is trucked to the disposal area, and fine refuse is pumped to slurry ponds for disposal and water recovery.

Surface facilities include buildings, portals, shafts, ventilation fans, substations, coarse and fine refuse disposal, sedimentation ponds, and reservoir. They may be located on the Surface Facilities, Hydrology, Disturbed Vegetation Map (Plate 7-4).

Underground mine water, in excess of mine usage, is pumped to the surface for use in coal cleaning and irrigation of city parks, golf course and several alfalfa fields. Any surplus is discharged into Grassy Trail Creek, the only perennial stream within the permit area, under NPDES Discharge Permit UT-0022942.

Grassy Trail Reservoir, formed by the Whitmore Canyon Dam, provides culinary water to the towns of Sunnyside and East Carbon as well as the mine facilities of Sunnyside Coal Company.

The Sunnyside Mines is served by the Denver and Rio Grande Western Railroad. It purchases its power from Utah Power and Light via a 44,000-volt transmission line.

Special activities in progress at Sunnyside Mine presently are:

1. Initiation of reclamation of #2 Mine areas.
2. Planning of a stream enhancement program of Grassy Trail Creek.
3. Preliminary work for a Co-generation plant using the existing refuse and future refuse from the wash plant.
4. The continuing effort to acquire "B" Canyon which will trigger the preparation and submittal of a new permit application.

1.10 Summary of Environmental Impacts

The Sunnyside Mines has been in continuous operation for over ninety years. Nearly all of the disturbance occurred prior to the Federal Act (P.L. 95-87). The total affected area is 314 acres, or 2 percent of the permit area. All environmental impacts are being monitored by regulatory agencies. Contemporaneous reclamation is being performed as needed.

The following summarizes the various environmental impacts:

(a) Land-Use:

Current land-use, other than mining, consists of fish and wildlife habitat, limited grazing, minimal cropland (four acres of alfalfa) oil and gas exploration activities, and recreation. There is no prime farmland within the permit area.

Mining impacts on land-use will be minimal. Mitigation measures are designed to protect the hydrologic balance, soil, vegetative and fish and wildlife resources.

(b) Human Values:

There are no recorded sites in the listing of the National Register of Historic places. A survey indicates some sites

may be eligible for nomination; however, these have coexisted with the mining operation for over 90 years and none are in danger.

(c) Hydrologic Balance:

There is no gravity discharge of water from mine openings. Underground mine water, in excess of consumption by the mine and irrigation of some fields, is discharged into Grassy Trail Creek. Contamination by oil and grease and total suspended solids is controlled with skimmers, sedimentation ponds, soil stabilization, revegetation, and maintenance of roads and berms. Mine water and Grassy Trail Creek water are sampled monthly. The analyses are reported to the regulatory authorities.

(d) Soil Resources:

Most of the areas that have been disturbed by mining activities at the Sunnyside Mines occurred prior to the Surface Mining Control and Reclamation Act of 1977. Consequently, the topsoil materials were not removed and stockpiled prior to construction and other operations activities. Most of these areas are currently active; and as such, many will not be reclaimed until mining activities cease. At that time, the facilities will be abandoned according to the procedures outlined in the permit. The surface materials will be ripped and analyzed for soil nutrients and will then be amended or topsoiled as needed. Revegetation will be completed according to the Utah Rules and Regulations of the Coal Mining and Reclamation Permanent Program.

All areas that have been disturbed since the 1977 Act have been or will be properly prepared prior to mining activities. All suitable topsoil material is appropriately removed and stockpiled for use in future reclamation.

(e) Vegetative Resources:

Approximately 2 percent of the permit area vegetation will be lost during the life of the mine. Future disturbance will be minimized wherever possible. Revegetated and reference areas will be monitored and evaluated to determine the degree of success in revegetation.

(f) Fish and Wildlife:

Mining activities during the past ninety years have had some impact on wildlife resources; however, most affected populations have adjusted to the altered environment. This altered environment will continue until mining is completed and the land reclaimed.

Future surface disturbances will be very small and total impacts on fish and wildlife will be minimal.

(g) Air Quality:

Since this is an underground mining operation and thermal drying of coal is not involved, impacts on air quality are limited to fugitive dust on some unpaved roads and to two small coal-fired boilers.

Calcium chloride, magnesium chloride, and or water is used to control road dust as required. The coal-fired equipment is periodically inspected by the Utah Department of Health, Bureau of Air Quality.

(h) Subsidence:

Minimal, if any, subsidence is expected over much of the permit area as a result of controlled caving during the mining operations. Renewable land resources and structures exist in the permit area and could be affected by mining. Effects of mining are expected to be minimal based on past history and amount of subsidence.

(i) Waste Disposal:

Fine refuse from coal cleaning is sent to slurry ponds from which water is reclaimed for irrigation or discharge into the Icelander drainage system. Coarse refuse is compacted, terraced, and covered with earth fill in the disposal area. The total disturbed area is 334 acres.

At the conclusion of mining, final abandonment and reclamation will begin. All mine openings will be capped or sealed according to MSHA regulations. All surface structures will be dismantled and removed and the disturbed area graded to blend with the surrounding contours, covered with topsoil, and revegetated. Some surface structures may remain for alternate use after mining if approved by the Division at that time. Waste disposal facilities will be scarified, filled if necessary, graded, covered with topsoil, and revegetated.

Some roads will be left for grazing and recreational use. The Grassy Trail Reservoir supplies culinary water to the towns of Sunnyside and East Carbon and is expected to continue serving these communities.

Topsoil will be handled, stored, and redistributed according to performance standards. Revegetation with specific seeds will occur in the first appropriate season, after proper grading and topsoil replacement. Mulching, nutrients, and soil amendments will be applied if needed. Vegetation in reference areas will be used to determine success of revegetation.

The estimated reclamation cost, which is also the performance bond liability, amounts to \$2,674,147.00 for the life of the mine.

1.20 Legal, Financial, Compliance, And Related Information

The applicant is Sunnyside Coal Company and includes information on principal shareholder, directors and officers and surface and coal rights ownership for the Sunnyside Mines and adjacent areas as well as permit term and boundary information.

Permits and licenses issued to the applicant in connection with the operation of coal mines in the United States are provided as well as a listing of Notices of Violation of Federal and State environmental protection laws in connection with such mining activities during the preceding three years.

1.21 Identification of Interest

(1.) The applicant, Sunnyside Coal Company, is a public corporation incorporated under the laws of the State of Colorado.

(2a.) The name, address, and telephone number of the permit applicant:

Sunnyside Coal Company
P. O. Box 99
Sunnyside, Utah 84539
(801) 888-4421

(2b.) The operator and the applicant who will accept service of process is:

Joseph R. Fielder
Mine Manager
Sunnyside Coal Company
Sunnyside Mines
P. O. Box 99
Sunnyside, Utah 84539

(3.) The names and addresses of the officers and directors of Sunnyside Coal Company are as follows:

Officers of Applicant

David B. Corman	President	The Registry 1113 Spruce Street Boulder, CO 80302
William P. Balaz, Jr.	Vice President	P.O. Box 99 Sunnyside, UT 84539
Jeffrey Vigil	Vice President & Treasurer	The Registry 1113 Spruce Street Boulder, CO 80302
Kenneth R. Oldham	Vice President & Secretary	1200 Hudson's Bay Centre 1600 Stout Street Denver, CO 80202

Directors of Applicant

David B. Corman	The Registry 1113 Spruce Street Boulder, CO 80302
(Vacant)	
Jeffrey L. Vigil	The Registry 1113 Spruce Street Boulder, CO 80302
Kenneth R. Oldham	Knutson, Brightwell & Reeves 1200 Hudson's Bay Centre 1600 Stout Street Denver, CO 80202

All common stock of Sunnyside Coal Company is owned and/or controlled by Sunnyside Mines, Inc.

Sunnyside Mines, Inc.
The Registry
1113 Spruce Street
Boulder, CO 80302

(4a.) Applicant has previously conducted mining activities under the name of Sunnyside Reclamation & Salvage, Inc.

Applicant's principal Shareholder, Sunnyside Mines, Inc. conducts mining activities in Pennsylvania through International Anthracite Corporation and in Kentucky through Sunnyside of Kentucky.

(4b.) Current or previous coal mining permits or pending permit applications:

- (1) B Canyon, Carbon County, Utah (May 28, 1985)

Division of Oil, Gas and Mining
Department of Natural Resources
State of Utah

- (2) International Anthracite Corporation, Schuylkill County, Pennsylvania, Permit Nos. 548 413 04, 548 607 01-01

State of Pennsylvania
Department of Environmental Resources
Harrisburg, PA 17120

- (3) Sunnyside of Kentucky, Pike County, Kentucky
Permit Nos. 898-5521, 898-5522, 898-5058, 898-5057,
898-0320, 898-5523, 898-5524, 898-5525, 898-5526, 898-
5527, 898-5528, 898-5531, 898-5530, 898-5529, 898-5059

State of Kentucky
Department for Surface Mining, Reclamation,
and Enforcement
Frankfort, Kentucky 40601

(5a.) The legal identity of equitable owner of record of areas to be affected by surface operations and facilities and of the coal to be mined is:

Sunnyside Coal Company
P. O. Box 99
Sunnyside, Utah 84539

or, since the transfer is still in progress,

Sunnyside Reclamation & Salvage, Inc.
P.O. Box 99
Sunnyside, Utah 84539

United States of America
Department of Interior
Bureau of Land Management
Utah State Offices
University Club Building
136 East South Temple
Salt Lake City, Utah 84111
(801) 524-5433

(5b.) The holder of record of leasehold interest in areas to be affected by surface operations and facilities and of the coal to be mined is:

Sunnyside Coal Company
P. O. Box 99
Sunnyside, Utah 84539

(5c.) No purchaser of record under real estate contract exists in areas to be affected by surface operations and facilities and of the coal to be mined.

(6.) The names and addresses of owners of record of all surface and subsurface areas contiguous to any part of the proposed area are listed below (Also see Plates 1-1 and 1-2):

(i) Surface Owners:

United States of America
Department of the Interior
Bureau of Land Management
324 South State
Salt Lake City, UT 84111-2303

State of Utah
Division of State Lands
355 West North Temple
3 Triad Center
Suite 400
Salt Lake City, UT 84180-1204

Chevron Resources
A Division of Chevron Industries, Inc.
595 Market Street
San Francisco, CA 94120

Dennis, Donald I.
P.O. Box 97
Bullard, TX 75757

East Carbon City
Dale Andrews, Mayor
Columbia Branch
East Carbon City, UT 84520

Hill, Howard L.
23543 Highland Glen Drive
Newhall, CA 91321

Jensen, Glen E.
Elmo, UT 84521

Sunnyside Coal Company
P. O. Box 99
Sunnyside, Utah 84539

Larcher, Ernest
Price, UT 84501

Oliveto, Dominic
P.O. Box 598
Price, UT 84501

Union Steel
P.O. Box 58
Oakland, CA 94604

United States Steel Corporation
1230 Kennecott Building
10 East South Temple
Salt Lake City, UT 84113

(ii) Subsurface Owners:

United States of America
Department of the Interior
Bureau of Land Management
324 South State
Salt Lake City, UT 84111-2303

State of Utah
Division of State Lands
355 West North Temple
3 Triad Center
Suite 400
Salt Lake City, UT 84180-1204

County of Carbon
County Commissioners
County Building
Price, UT 84501

Pagano, Jay
P.O. Box 67
Price, UT 84501

The name of the mine is Sunnyside Mines whose Mine Safety and Health Administration (MSHA) identification numbers are:

<u>Mine No 1</u>	MSHA ID NO. 42-00093
<u>Mine No 2</u>	MSHA ID No. 42-00094
<u>Surface</u>	MSHA ID No. 42-01813

The following is a statement of all lands, interests in land options or pending bids on interests held or made by the applicant for lands which are contiguous to the area to be covered by the permit:

- (i) Sunnyside Coal Company holds surface rights on various parcels of lands contiguous to the permit area (see Surface Ownership Map, Plate 1-1).
- (ii) Sunnyside Coal Company holds coal rights in areas contiguous to the permit area (see Subsurface Ownership Map, Plate 1-2).
- (iii) Currently, there are not any options and pending bids on interests held or made by the applicant for lands contiguous to the permit area.

1.22 Compliance Information

The rules and regulations stated under UMC R614-301-113.100-350--Compliance Information--are presented sequentially in this section. Each subpart is addressed as follows:

(113.100) The applicant, Sunnyside Coal Company, or any subsidiary, affiliate, or persons controlled by or under common control with the applicant:

(113.110) Has not had a Federal or State mining permit suspended or revoked in the last five (5) years;

(113.120) Has not forfeited a mining bond or similar security deposited in lieu of bond.

(113.200) Such a suspension, revocation or forfeiture has not occurred. See (113.100, 113.110, and 113.120) above.

(113.300) A listing of violation notices received by Sunnyside Coal Company in connection with any underground surface coal mining activities during the 3-year period before the application date, for violation of air water environmental protection laws, rules or regulations of the United States and of the State of Utah are provided as follows:

NOTICES OF VIOLATIONS

Sunnyside Mines
Carbon County, Utah

Regulatory Authority:
State of Utah
Department of Natural Resources
Division of Oil, Gas and Mining
Salt Lake City, Utah

NOTICE OF VIOLATION 89-26-1-1 (03/29/89)

Part 1 of 1 UMC 817.97, UMC 817.50

Failure to maintain water quality effluent in accordance with UPDES permit on the Discharge Pond 002, also known as the Whitmore Mine Water Discharge Pond.

Protect fish, wildlife, and related environmental values and maintain water quality effluent by cessation of oil spillage and water sampling.

\$5,000 Penalty Assessed
Terminated 04/12/89

CESSATION ORDER 89-25-1-1 (04/19/89)

Part 1 of 1 UMC 817.97, UMC 843.11 (b)

Failure to protect fish, wildlife, and related environmental values.

Failure to cease deposition of oil and/or flocculated oil into Grassy Trail Creek.

Cessation of deposition of oil and flocculated oil into Grassy Trail Creek.

Vacated 06/20/89

CESSATION ORDER 89-25-2-1 (04/19/89)

Part 1 of 1 S 40-10-9 U.C.A., UMC 817.97, And
UMC 817.42 (a)(1)

Conducting mining activities without a permit (deposit of sediment-laden mine water into Grassy Trail Creek);

Failure to protect fish, wildlife, and related environmental values;

Failure to pass sediment-laden mine water (Sunnyside storage tanks) through a sediment-control structure, pond, or treatment facility prior to leaving the permit area.

Vacated 06/20/89

NOTICE OF VIOLATION 89-30-11-1 (11/08/89)

Part 1 of 1 UMC 817.52 (b)(ii)

Failure to notify appropriate agencies (EPA, State Health, DOGM) of NPDES permit non-compliance within five days of receiving analysis results.

Follow required reporting procedures as outlined in the discharge permit.

\$200 Penalty Assessed

Terminated 11/08/89

NOTICE OF VIOLATION 89-26-24-1 (12/20/89)

Part 1 of 1 UMC 817.181 AND 817.42

Failure to maintain support facilities required or used incidentally for the operation of the underground mine. The specific support facility associated with the "NOV" is the oil emulsion pipeline underground, particularly down the manshaft.

\$1280 Penalty Assessed

Terminated 6/18/90

NOTICE OF VIOLATION 90-20-3-1 (9/21/90)

Failure to submit a permit renewal application at least 120 days prior to expiration of existing permit.

\$380 Penalty Assessed

Termination still open

NOTICES OF VIOLATIONS

International Anthracite
Corporation
Schuylkill County,
Pennsylvania

Regulatory Authority:
State of Pennsylvania
Department of Environmental
Resources
Harrisburg, PA 17120

COMPLIANCE ORDER PERMIT #54841304 (10/13/88)

Paragraph 1 of 1 Special Permit Condition #9 and #25
PA Code 88.49366

Failure to keep backfilling and grading concurrent. Evidenced by an affected area which exceeds the 1,500-foot limit for maximum affected area.

\$1500 Penalty Assessed

Terminated 03/31/89

NOTICES OF VIOLATIONS

Sunnyside Of Kentucky
Pike County, Kentucky

Regulatory Authority:
State of Kentucky
Department for Surface Mining,
Reclamation, and Enforcement
Frankfort, Kentucky 40601

No Violations To Date Since Operator Took Over on April 1990.

1.23 Right of Entry Information

(a) A description of the documents upon which the applicant, Sunnyside Coal Company and its legal predecessor Sunnyside Reclamation and Salvage, Inc., bases its legal right to enter and begin underground coal mining activities in the permit area as follows:

(1) Deed dated 3/9/89 through which Kaiser Coal Corporation, a Nevada corporation, conveyed and warranted to Sunnyside Reclamation and Salvage, Inc., a Colorado corporation, title to tracts of land in Carbon County, Utah. It was recorded by the County Recorder of Carbon County, Utah in Book 287, pages 52-95 inclusive. Fee land included in the deed and within the permit area is described as follows:

T14S, R14E, SLB&M, Utah
Sect. 6: N1/2, S1/2 SW1/4, S1/2 SE1/4, NW1/4 SE1/4
Sect. 7: NW1/4, SW1/4 NE1/4, E1/2 SW1/4, S1/2 SE1/4,
NW1/4 SE1/4
Sect. 17: NE1/4, SE1/4 NW1/4, SW1/4, S1/2S E1/4
Sect. 18: E1/2, S1/2 SW1/4, NE1/4 SW1/4, NW1/4 SW1/4
SW1/4 NW1/4 less the following described area:

Beginning at the NW corner of SW1/4NW1/4 of Section 18,
T14S, R14E:

thence S 45° 05' E, 1,577.42 ft;
thence S 39° 25' W, 1,759.22 ft;
thence N 2,472.87 ft to point of beginning.

Sect. 19 and 20: All
Sect. 21: W1/2
Sect. 28 and 29: All
Sect. 30: NE1/4, NE1/4 NW1/4, NW1/4 SE1/4
Sect. 31: S1/2 NE1/4, NE1/4 NE1/4
Sect. 32 and 33: All
Sect. 34: W1/2

T15S, R14E, SLB&M, Utah
 Sect. 3: W1/2
 Sect. 4: All
 Sect. 5: NE1/4, N1/2 SE1/4, SE1/4 SE1/4
 Sect. 8: NE1/4 NE1/4
 Sect. 9: All
 Sect. 10: W1/2, SE1/4
 Sect. 15: W1/2, N1/2 NE1/4
 Sect. 16: E1/2, NW1/4, E1/2 SW1/4
 Sect. 17: E1/2 NE1/4

(2) Federal Coal Leases numbers Salt Lake 062966-063383-Utah 010140, Utah 32083 and SL-068754. Areas within both the leases and the permit area are described as follows:

T14S, R13E, SLB&M, Utah
 Sect. 1: SE1/4
 Sect. 12: NE1/4, N1/2, NW1/4, SE1/4, NW1/4,
 SE1/4 SE1/4, N1/2 SE1/4, SW1/4 NW1/4
 NE1/4 SW1/4, SW1/4 SE1/4 less the
 following described area:

Beginning at a point which bears South 1320 ft from the NW corner of Section 12:

thence South, 1320 ft;
 thence S 89°55'30" E, 1327.01 ft;
 thence South, 1320 ft;
 thence S89°53'15"E, 1327.22 ft;
 thence South, 1320 ft;
 thence S89°51'E, 1327.43 ft;
 thence N45°05'07"W, 5623.40 ft to the place of beginning.
 Sect. 13: Portions of: NE1/4 NE1/4, E1/2 SE1/4,
 SW1/4 SE1/4, SE1/4 SW1/4, NE1/4 SW1/4,
 NW1/4 SW1/4, SW1/4, NW1/4 which are described
 as follows:

Beginning at a point which bears 2850 ft S89°51'E from the WS corner of Section 13:

thence N42°30'W, 4215 ft;
 thence North 610 ft;
 thence S42°30'E, 3730 ft;
 thence N47°30'E, 100 ft;
 thence S42°30'E, 1450 ft;
 thence N89°50'W, 710 ft to the point of beginning.

Beginning at the SE corner of Section 13:

thence North, 1487.13 ft;
thence S39°25'W, 1920.39 ft;
thence S89°50'E, 1219.36 ft to the point of beginning.

Less the following described area:

Beginning at a point which bears South 1320 ft from the NE corner of Section 13:

thence N89°51'W, 1327.76 ft;
thence North 1320 ft;
thence S 45°05'33"E, 1874 ft to the point of beginning.

Sect. 24: S1/2 SE1/4, Portions of: N1/2 NE1/4, SE1/4 NE1/4, N1/2 SE1/4 and NE1/4 SW1/4 which are described as follows:

Beginning at the NE corner of Section 24:

thence S0°07'W, 1814.87 ft;
thence S57°11'W, 430 ft;
thence N38°23'W, 1165 ft;
thence N42°26'W, 860.51 ft;
thence N39°5'E, 709.31 ft;
thence S89°50'E, 1219.36 ft;
thence South, 45.54 ft to the place of beginning.

Beginning at a point which bears N 0°02'E, 1,294.59 ft from the SE corner of said Section 24:

thence N0°02'E, 1294.59 ft;
thence N0°07'E, 830.41 ft;
thence S57°11'W, 3905.58 ft;
thence S89°E, 3280.00 ft to the place of beginning and containing 80 acres more or less.

Beginning at a point which bears N89°50'W 1720 ft from the EN corner of Section 24:

thence N89°50'W, 750 ft;
thence S42°30'E, 2900 ft;
thence N57°11'E, 100 ft;
thence N38°23'W, 1165 ft;
thence N42°26'W, 860.51 ft;
thence N39°25'E, 350 ft;
thence N42°30'W, 400 ft to the point of beginning.

Sect. 14: Portions of: NW1/4 which is described as follows:

Beginning at a point which bears 1915 ft N89°41'W from the NE corner of Section 14:

thence S42°30'E, 2090 ft;
thence South, 600 ft;
thence N42°30'W, 1400 ft;
thence S48°00'W, 1525 ft;
thence South, 175 ft;
thence N89°41'W, 315 ft;
thence North, 300 ft;
thence N48°00'E, 1775 ft;
thence N42°30'W, 1125 ft;
thence S89°41'E, 500 ft to the point of beginning.

Sect. 11: Portions SW1/4 SE1/4 which is described as follows:

Beginning at a point which bears 1915 ft N89°41'W from the SE corner of Section 11:

thence N40°30'W, 1150 ft;
thence S48°00'W, 380 ft;
thence S42°30'E, 780 ft;
thence S89°41'E, 520 ft to the point of beginning.

Sect. 25: NE1/2 NE1/4

T14S, R14E, SLB&M, Utah:

Sect. 6: NW1/2 SW1/4

Sect. 7: W1/2 SW1/4

Sect. 8: SW1/4, SW1/4 SE1/4

Sect. 17: W1/2 NW1/4, NE1/4 NW1/4, N1/2 SE1/4

Sect. 18: E1/2 NW1/4, NW1/4 NW1/4

Sect. 30: NW1/4 NW1/4, SE1/4 NW1/4, NE1/4 SW1/4
S1/2 SE1/4, NE1/4 SE1/4

Sect. 31: NW1/4 NE1/4

(3) Coal lease, dated November 8, 1989, granted by Carbon County of the State of Utah, the lessor, to Sunnyside Reclamation and Salvage, Inc., the lessee. The lease embraces the following described lands in Carbon County, Utah all of which are within the permit area:

Salt Lake Meridian, Utah
T14S, R14E
Sect. 21: SE 1/4, NE 1/4
Sect. 27: SW 1/4, SW 1/4 of NW 1/4
Sect. 34: E 1/2.
T15S, R14E
Sect. 3: E 1/2
Sect. 10: NE 1/4.

(4) Coal lease agreement, dated February 21, 1990, entered into with Geneva Steel granting a partial sublease of Utah Coal Lease M1-43715. The lease covers the following described lands:

Part of Section 16, T14S, R14E, SLBM described as:

Beginning at a point that is S88°56'36"W 1,251.66 Ft. from the Southwest section corner of said Section 16; running thence N45°00'02"W 1,771.31 Ft; thence N0°03'W 1,704.04 Ft; thence S45°00'02"E 4,218.68 Ft; thence N88°56'35"W 1,724.02 Ft. to the point of beginning, containing 82.81 acres more or less.

(5) The specific land and surface rights for the Sunnyside permit area are included in the deed described in paragraph (1) of this section. Those lands are identified and described as follows:

T14S, R14E, SLB&M, Utah
Sect. 31: SE1/4
T15,S, R14E, SLB&M, Utah
Sect. 5: W1/2, SW1/4 SE1/4
Sect. 6: S1/2S E1/4,SE1/4 SW1/4,
portions of N1/2 SE1/4 and NE1/4 NW1/4 South of
the D&RGW railroad right-of-way.
Sect. 7: N1/2 NE1/4, N3/4 NW1/4
Sect. 8: N1/2 NW1/4, NW1/4 NE1/4

The foregoing documents have been duly assigned and transferred to applicant, and appropriate approvals are being processed and awaited.

The surface operations associated with underground coal mining activities at the Sunnyside Mines does not involve the surface mining of coal.

1.24 Relationship to Areas Designated Unsuitable for Mining

(a) The proposed permit area is not within an area designated unsuitable for surface effects of underground coal mining activities.

(b) Substantial legal and financial commitments were made at Sunnyside Mines before January 4, 1977 and the mines have engaged in underground coal mining in the proposed permit area for more than ninety years.

(c) There are no occupied dwellings within 300 feet of surface operations or facilities.

1.25 Permit Term

Underground coal mining in the permit area began in the late 1890's and has continued to some degree yearly since that time. The termination date is unknown at this time but is estimated to be more than five (5) years. It is conceivable that production will continue beyond that time if the property can remain economically competitive. This estimate is based on a yearly production of approximately one million tons. Plate 1-3 delineates the proposed mining activity for five years. Like all mining plans, this proposal will undoubtedly change numerous times as the property is influenced by physical and economic conditions.

The total permit area encompasses 14,520 acres. Of these, 920 acres are anticipated to be surface lands over the underground workings expected to be mined during the five year period. The proposed mine workings will be under 1,000 feet up to 3,000 feet of overburden. Additional coal leases required for the proposed mine layout are noted on Plate 1-3. These leases will be obtained from Federal, County and private lease holders. Coal in these, as yet unacquired leases, will be lost if not recovered through existing and future access in the Sunnyside Mines. Surface topography in these areas makes it unlikely for another operator to gain access to and mine these areas except through existing workings. Additional coal leases, other than those shown on the map, could be acquired in the future. In such an event, the mine plan would, in all probability, change to take advantage of better conditions, more economical mining costs, easier access and ventilation requirements, or any of a number of benefits that might result from such acquisitions.

The information presented is for the 5 year permit term, although reclamation of most surface areas will not begin at that time.

1.26 Insurance and Proof of Publication

A copy of the certificate of liability insurance is shown in Figure 1-1.

A copy of the newspaper advertisement and publishers affidavit of publication is shown in Figures 1-2 and 1-3.

1.27 Other licenses and Permits

A list of other licenses and permits under applicable State and Federal land-use, air and water quality, water rights and health and safety laws and regulations needed by Sunnyside Coal Company to conduct the underground coal mining activities are as follows:

(1) NPDES Discharge Permit for Sunnyside Coal Company, Sunnyside Mines, UT-0022942.

Issued on September 2, 1977 by:

Enforcement Division
U.S. Environmental Protection Agency
Region VIII
1860 Lincoln Street
Denver, CO 80203

(2) MSHA Identification Number 1211-Ut-09-01813-01 for Sunnyside Preparation Plant Tailings Ponds, Sunnyside Mines, Sunnyside Coal Company.

Issued on March 15, 1976

U.S. Department of the Interior
Mine Safety and Health Administration
P.O. Box 25367, DFC
Denver, CO 80225

(3) MSHA Identification Number 1211-UT-0031 for Grassy Trail Reservoir, Sunnyside Mines, Sunnyside Coal Company.

Issued on August 29, 1978 by:

U.S. Department of Labor
Mine Safety and Health Administration
P.O. Box 25367, DFC
Denver, CO 80225

(4) MSHA Identification Number 1211-UT-09-01813-02 for Sunnyside Coarse Refuse.

(5) Application to Appropriate Water for Miscellaneous Purposes, State of Utah. Application Number 28812 (91-231) by Sunnyside Mines, Sunnyside Coal Company.

Approved on June 14, 1961 by:

State Engineer
Water Rights Division
State of Utah
231 East 400 South
Salt Lake City, UT 84102

(6) Notice of Intent to Mine Coal. Industrial Commission of Utah: Coal was being mined at Sunnyside prior to the establishment of the Industrial Commission; therefore, a Notice of Intent Application was not filed.

(7) Right of Way - USA Salt Lake 064436
expires January 1994.

Right of Way - USA Utah 029686
expires January 1994.

Right of Way - USA Salt Lake 065523
expires January 1998.

Right of Way - USA Utah 016755
expires January 2007.

Right of Way - USA Salt Lake 071198
expires January 2014.

Right of Way - USA Utah 20994
expires January 2014.

Right of Way - USA Salt Lake 069099
expires January 2014.

Right of Way - USA Utah 45898
expires annually in July.

(8) Explosives Permit #9CA00133C1 90026.

ID Number 94-0594733

Issued by Bureau of Alcohol, Tobacco and Firearms, Department of the Treasury. Expires March 31 of each year.

1.28 Location of Public Office for Filing Application

A copy of the application will be simultaneously and concurrently filed for public inspection with the:

Recorder
Carbon County Court House
Price, Utah 84501

1.29 Applicant's Verification and Notarized Signature

STATE OF UTAH)
) ss.
COUNTY OF CARBON)

William P. Balaz, Jr., being first duly sworn, deposes and says:

1. That he is Vice President of Sunnyside Coal Company;

2. That on behalf of said Company, under transmittal letter dated October 8, 1990, he submitted to the State of Utah, Board and Division of Oil, Gas and Mining, an Application for Underground Mining Activities Permit Renewal for Sunnyside Mines, Carbon County, Utah; and

3. That the information contained in said Application is true and correct to the best of his knowledge and belief.

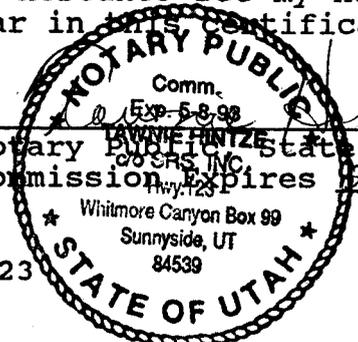


William P. Balaz, Jr.

STATE OF UTAH)
) ss.
CARBON OF COUNTY)

On this 8th day of October, before me, the undersigned, a Notary Public in and for the State of Utah, whose principal place of business is location in Carbon County, Utah, personally appeared WILLIAM P. BALAZ, JR., personally known to me (or proved to me on the basis of satisfactory evidence) to be the VICE PRESIDENT of SUNNYSIDE COAL COMPANY, the Company that executed the instrument and the officer who executed the within instrument on behalf of the Company therein named and acknowledged to me that such Company executed the within instrument pursuant to its bylaws or a resolution of its Board of Directors.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal the day and year in this certificate first above written.



Notary Public, State of Utah
My Commission Expires 5-8-93
Whitmore Canyon Box 99
Sunnyside, UT
84539

List of Exhibits

Figure 1-1	Insurance Certificate
Figure 1-2	Newspaper Advertisement
Figure 1-3	Publication Affidavit
Plate 1-1	Surface Ownership Map
Plate 1-2	Subsurface Ownership Map
Plate 1-3	5 Year Mine Plan
Plate 1-4	Location Map

Original to fireproof safe FEB 15 1996 *Copy to #4* *Print Bonds*

ACORD CERTIFICATE OF LIABILITY INSURANCE

DATE 03/04/96

PRODUCER
PRICE INSURANCE AGENCY
 WEST MAIN ST - P.O. BOX 871
 PRICE, UT 84501-0871
 (801) 637-3351

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW.

INSURED
 KENNETH A. RUSHTON, BANKRUPTCY
 TRUSTEE FOR THE ESTATE OF
SUNNYSIDE COAL COMPANY
 PO BOX 212
 LEHI, UT 84043-0212

COMPANIES AFFORDING COVERAGE
 COMPANY A AGORA SYNDICATE (ILL. INS. EXCH.)
 COMPANY B
 COMPANY C
 COMPANY D

COVERAGES
 THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED, NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

CO LTR	TYPE OF INSURANCE	POLICY NUMBER	POLICY EFFECTIVE DATE (MM/DD/YY)	POLICY EXPIRATION DATE (MM/DD/YY)	LIMITS
A	GENERAL LIABILITY <input checked="" type="checkbox"/> COMMERCIAL GENERAL LIABILITY <input type="checkbox"/> CLAIMS MADE <input checked="" type="checkbox"/> OCCUR <input type="checkbox"/> OWNER'S & CONTRACTOR'S PROT	DAG212228 R-1	02/28/96	02/28/97	GENERAL AGGREGATE \$1,000,000
					PRODUCTS - COMP/OP AGG \$EXCLUDED
					PERSONAL & ADV INJURY \$EXCLUDED
					EACH OCCURRENCE \$1,000,000
					FIRE DAMAGE (Any one fire) \$EXCLUDED
					MED EXP (Any one person) \$EXCLUDED
	AUTOMOBILE LIABILITY <input type="checkbox"/> ANY AUTO <input type="checkbox"/> ALL OWNED AUTOS <input type="checkbox"/> SCHEDULED AUTOS <input type="checkbox"/> HIRED AUTOS <input type="checkbox"/> NON-OWNED AUTOS				COMBINED SINGLE LIMIT \$
					BODILY INJURY (Per person) \$
					BODILY INJURY (Per accident) \$
					PROPERTY DAMAGE \$
	GARAGE LIABILITY <input type="checkbox"/> ANY AUTO				AUTO ONLY - EA ACCIDENT \$
					OTHER THAN AUTO ONLY:
					EACH ACCIDENT \$
					AGGREGATE \$
	EXCESS LIABILITY <input type="checkbox"/> UMBRELLA FORM <input type="checkbox"/> OTHER THAN UMBRELLA FORM				EACH OCCURRENCE \$
					AGGREGATE \$
					\$
	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY THE PROPRIETOR/PARTNERS/EXECUTIVE OFFICERS ARE: <input type="checkbox"/> INCL <input type="checkbox"/> EXCL OTHER				WC STATUTORY LIMITS OTH-ER
					EL EACH ACCIDENT \$
					EL DISEASE - POLICY LIMIT \$
					EL DISEASE - EA EMPLOYEE \$

DESCRIPTION OF OPERATIONS/LOCATIONS/VEHICLES/SPECIAL ITEMS
 LOCATION OF PROPERTY: NEAR SUNNYSIDE, CARBON CUNTY, UT 84539 MINE #ACT-007-007
 GENERAL LIABILITY INCLUDES \$1000 DEDUCTIBLE; XCU COVERAGES INCLUDED IN FORM.

CERTIFICATE HOLDER
 STATE OF UTAH DIVISION OF
 OIL, GAS & MINING
 355 WEST NORTH TEMPLE
 III TRIAD CENTER SUITE 350
 SALT LAKE CITY, UT 84180-1203

CANCELLATION
 SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, THE ISSUING COMPANY WILL ~~EXPIRE UPON~~ ^{SEND BY MAIL} 45 DAYS WRITTEN NOTICE TO THE CERTIFICATE HOLDER NAMED TO THE LEFT. BUT FAILURE TO MAIL SUCH NOTICE SHALL IMPOSE NO OBLIGATION OR LIABILITY OF ANY KIND UPON THE COMPANY, ITS AGENTS OR REPRESENTATIVES.
 AUTHORIZED REPRESENTATIVE *Ray A. Nelson*

ACORD. CERTIFICATE OF INSURANCE

DATE (MM/DD/YY)
03/09/95

PRODUCER

PRICE INSURANCE AGENCY
54 WEST MAIN ST - P.O. BOX 871
PRICE, UT 84501-0871
(801) 637-3351

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW.

COMPANIES AFFORDING COVERAGE

- COMPANY
A AGORA SYNDICATE (ILL. INS. EXCH.)
- COMPANY
B PROGRESSIVE CASUALTY INSURANCE CO.
- COMPANY
C
- COMPANY
D

INSURED

SUNNYSIDE COAL COMPANY
1113 SPRUCE STREET, #300
BOULDER, CO 80302

COVERAGES
THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED, NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

CO LTR	TYPE OF INSURANCE	POLICY NUMBER	POLICY EFFECTIVE DATE (MM/DD/YY)	POLICY EXPIRATION DATE (MM/DD/YY)	LIMITS
A	GENERAL LIABILITY <input checked="" type="checkbox"/> COMMERCIAL GENERAL LIABILITY <input type="checkbox"/> CLAIMS MADE <input checked="" type="checkbox"/> OCCUR <input type="checkbox"/> OWNER'S & CONTRACTOR'S PROT	DAG212228	02/22/95	02/22/96	GENERAL AGGREGATE \$1,000,000
					PRODUCTS - COMP/OP AGG \$EXCLUDED
					PERSONAL & ADV INJURY \$EXCLUDED
					EACH OCCURRENCE \$1,000,000
					FIRE DAMAGE (Any one fire) \$EXCLUDED
					MED EXP (Any one person) \$EXCLUDED
A	AUTOMOBILE LIABILITY <input type="checkbox"/> ANY AUTO <input type="checkbox"/> ALL OWNED AUTOS <input checked="" type="checkbox"/> SCHEDULED AUTOS <input type="checkbox"/> HIRED AUTOS <input type="checkbox"/> NON-OWNED AUTOS	CA53545420	02/22/95	02/22/96	COMBINED SINGLE LIMIT \$500,000
					BODILY INJURY (Per person) \$
					BODILY INJURY (Per accident) \$
					PROPERTY DAMAGE \$
	GARAGE LIABILITY <input type="checkbox"/> ANY AUTO				AUTO ONLY - EA ACCIDENT \$
					OTHER THAN AUTO ONLY:
					EACH ACCIDENT \$
	EXCESS LIABILITY <input type="checkbox"/> UMBRELLA FORM <input type="checkbox"/> OTHER THAN UMBRELLA FORM				AGGREGATE \$
					EACH OCCURRENCE \$
					AGGREGATE \$
	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY THE PROPRIETOR/PARTNERS/EXECUTIVE OFFICERS ARE: <input type="checkbox"/> INCL <input type="checkbox"/> EXCL				STATUTORY LIMITS
					EACH ACCIDENT \$
					DISEASE - POLICY LIMIT \$
					DISEASE - EACH EMPLOYEE \$
	OTHER				

DESCRIPTION OF OPERATIONS/LOCATIONS/VEHICLES/SPECIAL ITEMS
LOCATION OF PROPERTY: SUNNYSIDE MINE, SUNNYSIDE, UT 84539 MINE #ACT-007-007
GENERAL LIABILITY INCLUDES \$1000 DEDUCTIBLE; XCU COVERAGES INCLUDED IN FORM.
ALTERNATIVE UTAH MAILING ADDRESS: 560 PINION ST. PO BOX 99 SUNNYSIDE, UT 84539

CERTIFICATE HOLDER

STATE OF UTAH DIVISION OF
OIL, GAS & MINING
355 WEST NORTH TEMPLE
III TRIAD CENTER SUITE 350
SALT LAKE CITY, UT 84180-1203

CANCELLATION
SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, THE ISSUING COMPANY WILL ~~provide~~ ^{certify} 45 DAYS WRITTEN NOTICE TO THE CERTIFICATE HOLDER NAMED TO THE LEFT.
AUTHORIZED REPRESENTATIVE
Kory A. Nelson

RECEIVED FEB 14 1990

**Alexander
& Alexander**

Alexander & Alexander Inc.
Suite 2300
370 Seventeenth Street
Denver, Colorado 80202
Telephone 303 592-5550

February 12, 1990

Mr. Jeff Vigil
Sunnyside Reclamation & Salvage
c/o BXG, Inc.
1113 Spruce St., Ste. 300
Boulder, CO 80302

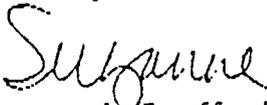
RE: General Liability Policy #35285564
Chubb Insurance Company

Dear Jeff:

I am enclosing the renewal certificate for your Commercial General Liability insurance coverage. This is the policy that covers Sunnyside Reclamation & Salvage, as well as Sunnyside Mines, Inc. Chubb does not issue a new policy, but rather they issue a renewal certificate. Please attach the certificate to your policy.

Jeff, if you have any questions, please feel free to call Joan or me. As always, we sincerely appreciate the opportunity to be of service to you.

Sincerely,



Suzanne L. Swafford, CIC, CPIW
Assistant Vice President

SLS/slp

Enclosure

Commercial Insurance Coverage

Renewal Agreement

ATTACH THIS RENEWAL AGREEMENT TO YOUR POLICY

In return for your payment of the premium, we agree with you that the expiring policy is renewed for the term shown below subject to all the terms and conditions of the policy. We have attached to this agreement changes for coverages and limits of insurance made at this renewal and current editions of forms if the earlier editions were revised during the previous term.

Bill Number: 1
Policy Number: 3528-55-64
Company: Federal Insurance Company
Producer Number: 15015
Renewal Period From: 12-02-89 To: 12-02-90
Named Insured and Mailing Address:
Sunnyside Reclamation and Salvage,
Sunnyside Mines, Inc., c/o BXG, Inc.
1113 Spruce Street, Suite 300, Boulder, CO 80302
Name and Mailing Address of Producer:
Alexander & Alexander, Inc.
370 17th Street, Suite 2300
Denver, Colorado 80202

RATE & PREMIUMS

INSURANCE COVERAGES

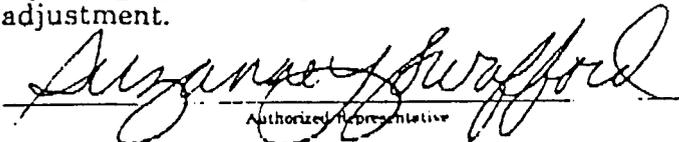
\$26,044.

General Liability

\$26,044.

Total Premium*

*If the Declarations indicate the insurance is subject to audit or a reporting option the premiums stated are estimates and subject to adjustment.


Authorized Representative

vm - 12/28/89

Date

Chubb Group of Insurance Companies

15 Mountain View Road
Warren, New Jersey 07060

Form 40-02-0057 (Ed. 3-86)



CERTIFICATE OF INSURANCE

04/04/89

PRODUCER

Alexander & Alexander Inc.

370 17th Street
Denver, CO
80202-

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW.

COMPANIES AFFORDING COVERAGE

COMPANY LETTER A CHUBB INSURANCE GROUP

COMPANY LETTER B

COMPANY LETTER C

COMPANY LETTER D

COMPANY LETTER E

INSURED

SUNNYSIDE RECLAMATION AND SALVAGE C/O BXG, INC.
2033 11TH STREET
BOULDER, CO
80302-

> COVERAGES <----->
THIS IS TO CERTIFY THAT POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL TERMS, EXCLUSIONS, AND CONDITIONS OF SUCH POLICIES.

CO LTR	TYPE OF INSURANCE	POLICY NUMBER	POLICY EFF DATE	POLICY EXP DATE	ALL LIMITS IN THOUSANDS	
	GENERAL LIABILITY				GENERAL AGGREGATE	2000
A	<input checked="" type="checkbox"/> COMMERCIAL GEN LIABILITY	3528-55-64	12/02/88	12/02/89	PROD-S-COMP/OPS AGG.	2000
	<input type="checkbox"/> () CLAIMS MADE <input checked="" type="checkbox"/> (X) OCC.		/ /	/ /	PERS. & ADVG. INJURY	1000
	<input type="checkbox"/> OWNER'S & CONTRACTORS PROTECTIVE		/ /	/ /	EACH OCCURRENCE	1000
	<input checked="" type="checkbox"/> \$1, PROPERTY		/ /	/ /	FIRE DAMAGE (ANY ONE FIRE)	100
	<input type="checkbox"/> DAMAGE DEDUCTIBLE		/ /	/ /	MEDICAL EXPENSE (ANY ONE PERSON)	10
	VEHICLE LIAB				CSL	
	<input type="checkbox"/> ANY AUTO		/ /	/ /	BODILY INJURY (PER PERSON)	
	<input type="checkbox"/> ALL OWNED AUTOS		/ /	/ /	BODILY INJURY (PER ACCIDENT)	
	<input type="checkbox"/> SCHEDULED AUTOS		/ /	/ /	PROPERTY	
	<input type="checkbox"/> HIRED AUTOS		/ /	/ /		
	<input type="checkbox"/> NON-OWNED AUTOS		/ /	/ /		
	<input type="checkbox"/> GARAGE LIABILITY		/ /	/ /		
	<input type="checkbox"/> ()		/ /	/ /		
	EXCESS LIABILITY				EACH OCC	AGGREGATE
	<input type="checkbox"/> UMBRELLA FORM		/ /	/ /		
	<input type="checkbox"/> OTHER THAN UMBRELLA FORM		/ /	/ /		
	WORKERS COMP AND EMPLOYERS' LIAB		/ /	/ /	STATUTORY	
			/ /	/ /	EACH ACC	
			/ /	/ /	DISEASE-POLICY LIMIT	
			/ /	/ /	DISEASE-EACH EMPLOYEE	
	OTHER		/ /	/ /		

DESCRIPTION OF OPERATIONS/LOCATIONS/VEHICLES/SPECIAL ITEMS

> CERTIFICATE HOLDER <----->
MR. KEN OLDHAM

CANCELLATION <----->
 * SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, THE ISSUING COMPANY WILL ENDEAVOR TO MAIL 30 DAYS WRITTEN NOTICE TO THE CERTIFICATE HOLDER NAMED TO THE LEFT, BUT FAILURE TO MAIL SUCH NOTICE SHALL IMPOSE NO OBLIGATION OR LIABILITY OF ANY KIND UPON THE COMPANY, ITS AGENTS OR REPRESENTATIVES.

* AUTHORIZED REPRESENTATIVE
Suzanne L. Swafford

Figure 1-2

LEGAL NOTICE

Pursuant to Utah Mining Code R614-301-117.200 notice is hereby given that Sunnyside Coal Company, P.O. Box 99, Sunnyside, Utah 84539, has submitted a Coal Mine Renewal Permit Application for the Sunnyside Mines to the Utah Division of Oil, Gas, and Mining.

The Sunnyside Mines Permit Area is located near the town of Sunnyside, approximately twenty-five miles east of Price, Utah via U.S. Highway 6 and State Highway 123. The following are the legal descriptions of the Permit Area:

1. Fee Land

T14S, R14E, SLB&M, Utah
Sect. 6: N1/2, S1/2 SW1/4, S1/2 SE1/4, NW1/4 SE1/4
Sect. 7: NW1/4, SW1/4 NE1/4, E1/2 SW1/4, S1/2 SE1/4,
NW1/4 SE1/4
Sect. 17: NE1/4, SE1/4 NW1/4, SW1/4, S1/2S E1/4
Sect. 18: E1/2, S1/2 SW1/4, NE1/4 SW1/4, NW1/4 SW1/4
SW1/4 NW1/4 less the following described area:

Beginning at the NW corner of SW1/4NW1/4 of Section 18,
T14S, R14E:

thence S 45° 05' E, 1,577.42 ft;
thence S 39° 25' W, 1,759.22 ft;
thence N 2,472.87 ft to point of beginning.

Sect. 19 and 20: All
Sect. 21: W1/2
Sect. 28 and 29: All
Sect. 30: NE1/4, NE1/4 NW1/4, NW1/4 SE1/4
Sect. 31: S1/2 NE1/4, NE1/4 NE1/4
Sect. 32 and 33: All
Sect. 34: W1/2
T15S, R14E, SLB&M, Utah
Sect. 3: W1/2
Sect. 4: All
Sect. 5: NE1/4, N1/2 SE1/4, SE1/4 SE1/4
Sect. 8: NE1/4 NE1/4
Sect. 9: All
Sect. 10: W1/2, SE1/4
Sect. 15: W1/2, N1/2 NE1/4
Sect. 16: E1/2, NW1/4, E1/2 SW1/4
Sect. 17: E1/2 NE1/4

2. Federal Leases

Federal Coal Leases numbers Salt Lake 062966-063383-Utah 010140, Utah 32083 and SL-068754. Areas within both the leases and the permit area are described as follows:

T14S, R13E, SLB&M, Utah

Sect. 1: SE1/4

Sect. 12: NE1/4, N1/2, NW1/4, SE1/4, NW1/4,
SE1/4 SE1/4, N1/2 SE1/4, SW1/4 NW1/4
NE1/4 SW1/4, SW1/4 SE1/4 less the
following described area:

Beginning at a point which bears South 1320 ft from the NW corner of Section 12:

thence South, 1320 ft;
thence S 89°55'30" E, 1327.01 ft;
thence South, 1320 ft;
thence S89°53'15"E, 1327.22 ft;
thence South, 1320 ft;
thence S89°51'E, 1327.43 ft;
thence N45°05'07"W, 5623.40 ft to the place of beginning.

Sect. 13: Portions of: NE1/4 NE1/4, E1/2 SE1/4,
SW1/4 SE1/4, SE1/4 SW1/4, NE1/4 SW1/4,
NW1/4 SW1/4, SW1/4, NW1/4 which are described as
follows:

Beginning at a point which bears 2850 ft S89°51'E from the WS corner of Section 13:

thence N42°30'W, 4215 ft;
thence North 610 ft;
thence S42°30'E, 3730 ft;
thence N47°30'E, 100 ft;
thence S42°30'E, 1450 ft;
thence N89°50'W, 710 ft to the point of beginning.

Beginning at the SE corner of Section 13:

thence North, 1487.13 ft;
thence S39°25'W, 1920.39 ft;
thence S89°50'E, 1219.36 ft to the point of beginning.

Less the following described area:

Beginning at a point which bears South 1320 ft from the NE corner of Section 13:

thence N89°51'W, 1327.76 ft;
thence North 1320 ft;
thence S 45°05'33"E, 1874 ft to the point of beginning.

Sect. 24: S1/2 SE1/4, Portions of: N1/2 NE1/4, SE1/4 NE1/4, N1/2 SE1/4 and NE1/4 SW1/4 which are described as follows:

Beginning at the NE corner of Section 24:

thence S0°07'W, 1814.87 ft;
thence S57°11'W, 430 ft;
thence N38°23'W, 1165 ft;
thence N42°26'W, 860.51 ft;
thence N39°5'E, 709.31 ft;
thence S89°50'E, 1219.36 ft;
thence South, 45.54 ft to the place of beginning.

Beginning at a point which bears N 0°02'E, 1,294.59 ft from the SE corner of said Section 24:

thence N0°02'E, 1294.59 ft;
thence N0°07'E, 830.41 ft;
thence S57°11'W, 3905.58 ft;
thence S89°E, 3280.00 ft to the place of beginning and containing 80 acres more or less.

Beginning at a point which bears N89°50'W 1720 ft from the NE corner of Section 24:

thence N89°50'W, 750 ft;
thence S42°30'E, 2900 ft;
thence N57°11'E, 100 ft;
thence N38°23'W, 1165 ft;
thence N42°26'W, 860.51 ft;
thence N39°25'E, 350 ft;
thence N42°30'W, 400 ft to the point of beginning.

Sect. 14: Portions of: NW1/4 which is described as follows:

Beginning at a point which bears 1915 ft N89°41'W from the NE corner of Section 14:

thence S42°30'E, 2090 ft;
thence South, 600 ft;
thence N42°30'W, 1400 ft;
thence S48°00'W, 1525 ft;
thence South, 175 ft;
thence N89°41'W, 315 ft;
thence North, 300 ft;
thence N48°00'E, 1775 ft;
thence N42°30'W, 1125 ft;
thence S89°41'E, 500 ft to the point of beginning.

Sect. 11: Portions SW1/4 SE1/4 which is described as follows:

Beginning at a point which bears 1915 ft N89°41'W from the SE corner of Section 11:

thence N40°30'W, 1150 ft;
thence S48°00'W, 380 ft;
thence S42°30'E, 780 ft;
thence S89°41'E, 520 ft to the point of beginning.

Sect. 25: NE1/2 NE1/4

T14S, R14E, SLB&M, Utah:

Sect. 6: NW1/2 SW1/4
Sect. 7: W1/2 SW1/4
Sect. 8: SW1/4, SW1/4 SE1/4
Sect. 17: W1/2 NW1/4, NE1/4 NW1/4, N1/2 SE1/4
Sect. 18: E1/2 NW1/4, NW1/4 NW1/4
Sect. 30: NW1/4 NW1/4, SE1/4 NW1/4, NE1/4 SW1/4
S1/2 SE1/4, NE1/4 SE1/4
Sect. 31: NW1/4 NE1/4

3. Carbon County Leases

Coal lease, dated November 8, 1989, granted by Carbon County of the State of Utah, the lessor, to Sunnyside Reclamation and Salvage, Inc., the lessee. The lease embraces the following described lands in Carbon County, Utah all of which are within the permit area:

Salt Lake Meridian, Utah
T14S, R14E
Sect. 21: SE 1/4, NE 1/4
Sect. 27: SW 1/4, SW 1/4 of NW 1/4
Sect. 34: E 1/2.
T15S, R14E
Sect. 3: E 1/2
Sect. 10: NE 1/4.

4. State Lease

Coal lease agreement, dated February 21, 1990, entered into with Geneva Steel granting a partial sublease of Utah Coal Lease ML-43715. The lease covers the following described lands:

Part of Section 16, T14S, R14E, SLBM described as:

Beginning at a point that is S88°56'36"W 1,251.66 Ft. from the Southwest section corner of said Section 16; running thence N45°00'02"W 1,771.31 Ft; thence N0°03'W 1,704.04 Ft; thence S45°00'02"E 4,218.68 Ft; thence N88°56'35"W 1,724.02 Ft. to the point of beginning, containing 82.81 acres more or less.

Part of Section 16, T14S, R14E, SLBM described as:
Beginning at the Southwest corner of said section,

5. Surface Rights

The specific land and surface rights for the Sunnyside permit area are included in the deed described in paragraph (1) of this section. Those lands are identified and described as follows:

T14S, R14E, SLB&M, Utah
Sect. 31: SE1/4
T15,S, R14E, SLB&M, Utah
Sect. 5: W1/2, SW1/4 SE1/4
Sect. 6: S1/2S E1/4,SE1/4 SW1/4,
portions of N1/2 SE1/4 and NE1/4 NW1/4
South of the D&RGW railroad right-of-way.
Sect. 7: N1/2 NE1/4, N3/4 NW1/4
Sect. 8: N1/2 NW1/4, NW1/4 NE1/4

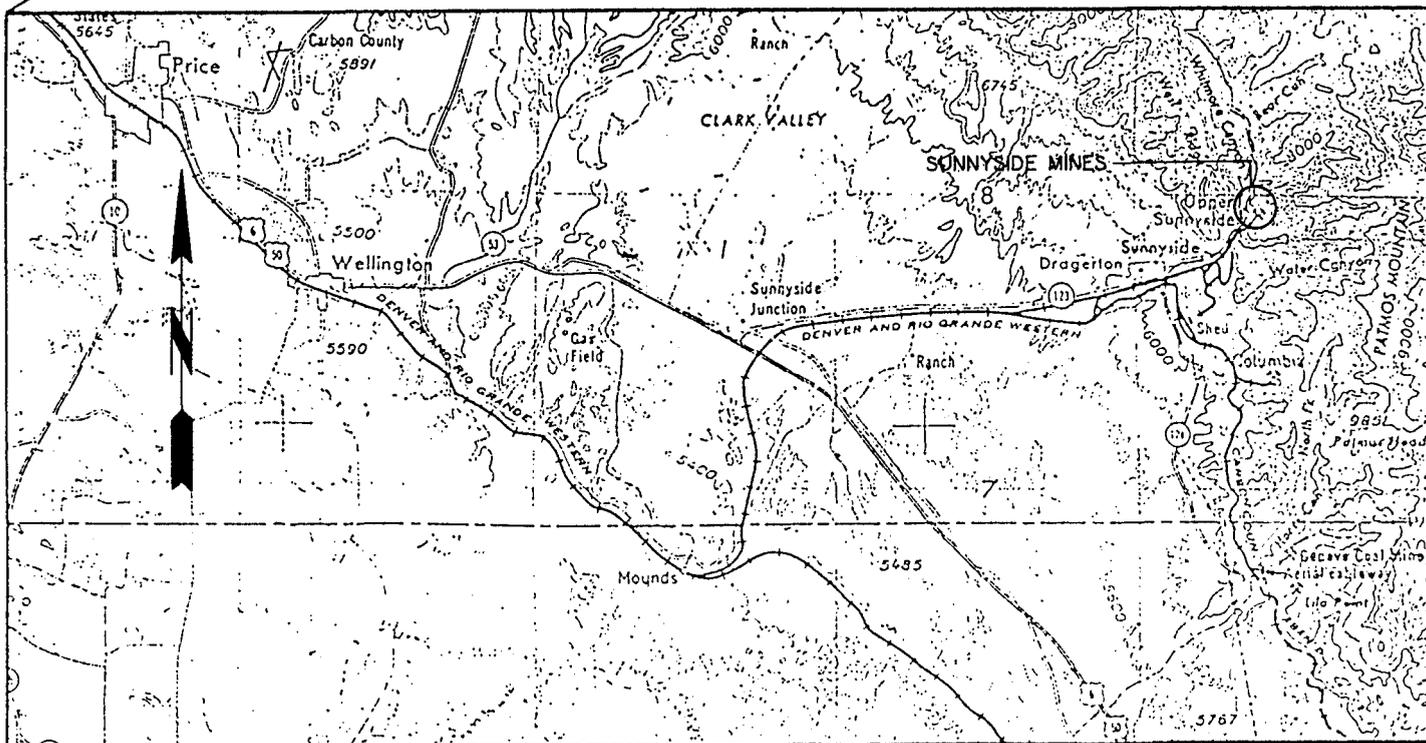
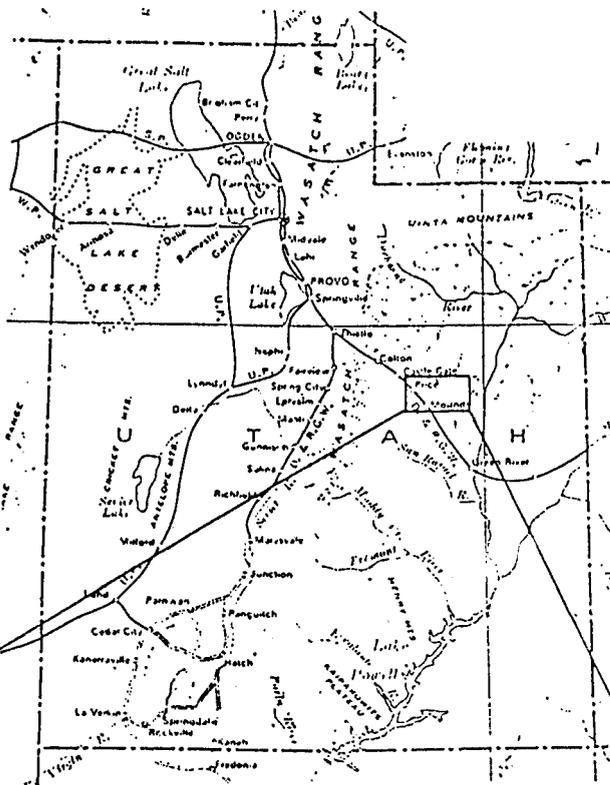
The described areas are contained on the following U.S. Geological Survey 7.5 minute quadrangle maps:

Sunnyside, Patmos Head, Bruin Point, and Mt. Bartles, all in Utah.

A copy of the permit application is available at the office of the County Recorder of Carbon County, Carbon County Courthouse, Price, Utah 84501. Written comments, objections, or requests for

informal conferences may be made to the Utah Division of Oil, Gas and Mining, 355 West North Temple, 3 Triad Center Suite 350, Salt Lake City, Utah, 84180-1203.

(To be published in the Sun Advocate, Price, Utah)



Sunnyside
Coal Company

GENERAL LOCATION MAP

PLATE I-4

Chapter 2

Soils

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2.0 Soils

2.10 Introduction

Information on soil resources, removal, stockpiling, redistribution, and reclamation is presented in this chapter. Since the mine has been in existence for some 95 years, additional information is provided for those areas disturbed prior to 1977.

2.20 Environmental Description

2.21 Prime Farmland Investigation

The land within the Sunnyside Mines permit/mine plan area has not been historically used as cropland due to the mountainous topography, steep slopes, and rocky surface. The Soil Conservation Service study of the mine plan area shows that no soil mapping units or areas have been designated as prime farmland (Figure 2-1) (Jensen et. al, 1980).

2.22 Soil Survey

Information on the soil series, mapping units, and mapping unit descriptions are derived from the Carbon County Soil Survey (Jensen, et. al, 1980) and is presented in Appendix 2-2 and 2-3.

In addition to the soils survey conducted on the permit area, an on-site survey of the major disturbed areas was conducted by Cook (1980). Information from these surveys is presented in this chapter in addition to other pertinent information as cited.

The soils distribution of approximately 14,520 acres was mapped on a topographic map at a scale of approximately 1" = 2,000' (Soil Identification Map, Plate 2-1). Profiles for selected soil series were sampled in the project area. Physical and chemical properties of the soils were also analyzed. This data was used to test field observations, confirm soil classifications, evaluate topsoil suitability, and to make preliminary soil fertility assessments.

Soil samples of pre-1977 disturbed areas were collected and analyzed in two separate series. Test pits were dug around the facilities. Within each soil pit, soil samples were taken at twelve inch increments. A visual examination of soil texture, color, and quality was also made. The first series of soil samples were taken in the permit area as follows:

Soil Sample Series Number One

<u>Soil Type</u>	<u>Lab No.</u>	<u>Sample Location</u>
PSH The	3997	Disturbed Slope At Upper Bathhouse
IGC	3998	Stockpiled Topsoil Near Slurry Pond
CIC	4368	Undisturbed Soil (Grassy Trail Creek Floodplain)
Refuse	4369	Road Runoff Silts

These samples were analyzed by the Soils Laboratory of Utah State University, Logan, Utah. The results of these analyses are indicated in Table 2-1.

Soil samples and potential borrow materials of the Series Number Two were collected and analyzed by the Soils Testing Laboratory at Colorado State University, Ft. Collins. The selected samples from the second series collected from the disturbed sites were sampled to a depth of four feet from several locations directly adjacent to surface facilities and within the disturbed areas excavated for surface facility construction. These disturbed soil samples were collected in order to characterize this material since the construction history of the surface facility is unknown.

Soil samples were collected at all industrial and soil borrow areas (Plate 7-4 (1 of 3)). The results of these analyses are shown in Table 2-2. Three test pits were dug within the area of Reclamation Soil Borrow Area 1. Discussion of these soil materials and laboratory analyses from these test pits are included in Appendix 2-1. Samples were collected from the Grassy Trail Creek Dam Borrow Area at the surface and at 18 inches. Since this is a slide area, normal sampling procedures are inappropriate. This Borrow Area has been approved for use, but is not planned for use unless reclamation needs show up during the actual reclamation activity.

The soil types and sample locations of the second series are identified as follows:

Soil Sample Series Number Two

<u>Soil Type</u>	<u>Sample Location</u>
CIC	South of Rodeo Grounds
IEE	East of Tailings Ponds
MTH	North of Rodeo Grounds
MRG	North of Mouth of Pole Canyon
Borrow (2)	Borrow area No. 1
Borrow (6)	Grassy Trail Dam Borrow Area
Disturbed	Shop
Disturbed	Preparation Plant
Disturbed	No. 2 Canyon Material Yard

The results of these analyses are shown in Tables 2-2 and 2-3. Results of the analyses indicate that no toxicity problems exist with these materials.

A soil investigation of the Reclamation Soil Borrow Area 1 (Appendix 2-1) was conducted to determine its suitability for soil material to reclaim the coarse refuse and slurry disposal area. While not complete the report shows that the area can be used. Additional soil samples will need to be analyzed prior to planning the reclamation of the coarse refuse and slurry disposal area. Concerns about the large rocks affecting the suitability ratings and the removal of the rocks prior to reclamation can be allayed by the use of a temporary grizzly on 2 inch spacing to screen out the rocks during the reclamation activities.

Soil samples were taken at the location of 002B Pond before construction. The results of the chemical analysis of these samples are shown in Tables 2-4a thru 2-4e. The effect of long term stockpiling will be estimated upon the reclamation of the pond.

The results of the analyses of 49 soil samples which were collected at 3 sites for #2 Mine Reclamation is presented in Appendix 2-4. In addition to the standard parameters some samples are also being analyzed for boron and selenium. These will be used to determine material balance for reclamation of the sites at #2 Canyon fan site, Water Canyon Portal site and Fan Canyon site. As other pre-1977 disturbed areas come up for reclamation, soil

samples will be similarly taken, analyzed, and used in the reclamation process.

The present and potential productivity of existing soils is:

Range condition and trend records for the Sunnyside Mines permit area indicate that the current productivity of this area ranges from 600 to 1,300 pounds per acre (air dry weight) under fair range condition. Studies conducted by Jensen and Cook (1980), Kreitler and Barlow (1976), and Cervantez and Kiel (1975) estimated the range condition and trend for the purposes of grazing management under a cooperative agreement between Sunnyside Mines and the SCS. These data can be correlated with precipitation information to aid in determining reclamation success, and to provide an estimate of productivity under generally fair range condition.

Potential productivity for unlisted soil mapping units is unavailable from SCS (Cook personal communication). Estimated productivity for 1981 is presented in Chapter 3 and Table 2-5.

2.23 Soil Characterization

The Carbon County Soil Survey was used for the Order 3 soil survey on the mine permit area and was the primary source of soil information (Jensen et. al, 1980). An Order 3 soils survey is sufficient for the relatively small areas of surface disturbance resulting from the underground mine activities (Sellnow, Jensen personal communications). This survey level will be adequate assuming that no endangered species or toxic soils are present, or that special engineering is required. None of these conditions is expected to occur at the mine.

2.24 Substitute Topsoil

Because the majority of disturbed areas at Sunnyside were created prior to the 1977 Act, little topsoil has been saved. Therefore there may be need for the use of borrow material to aid revegetation of the coarse refuse material to aid revegetation of the coarse refuse material disposal site.

Physical and chemical properties of the soils within the project area were analyzed in order to characterize and evaluate their potential as topsoil material. The results of these analyses indicate that no toxicity or other problems exist with respect to reclamation of these materials.

Test plots of various soils and depths have been made on coarse and fine (slurry) refuse with inconclusive results. This years vegetation study will incorporate a feasibility study for rehabilitation of these plots. Revegetation of refuse has been successful in other places without a four foot layer of topsoil.

It is our goal to determine a plan to justify a request for variance from the four foot cover requirements.

2.30 Operation Plan

All topsoil will be removed prior to further surface disturbances. If insufficient topsoil is available to assure reclamation success, topsoil will be supplemented by suitable subsoil. Topsoil handling is to be accomplished with dozers, scrapers, or front-end loaders and trucks. As most underground disturbances are long-term, the soil will be stockpiled. Subsoil will not be stockpiled separately unless soil tests indicate mixing would not be suitable. Storage areas will be the areas shown on the Structures and Facilities Map (Plate 7-4, (1-3)) and other areas to be approved by the regulatory authority, as needed. Topsoil storage piles will be contoured to minimize soil loss and seeded with quick-growing plants or otherwise protected if the pile will not be redistributed within a reasonable time.

The permit area is comprised of several types of disturbances. First, approximately 136.64 acres of land were disturbed prior to the 1977 Act that required topsoil removal before commencement of mining operations. The status of these lands is varied, and includes active and inactive areas as well as reclaimed and non-reclaimed sites. Second, the area encompassed by the refuse and slurry piles includes 83 acres of land that will remain active until cessation of mining activities, although some reclamation of this area is occurring and will continue to occur. The third type of disturbance includes any future surface disturbances that may occur within the permit area. The soil removal and storage procedures for each of these disturbance types are discussed in the following sections.

2.31 Soil Removal

Future surface disturbances within the permit area are not currently identified, consequently site specific plans concerning topsoil removal and storage are not possible at this time. An amendment will be submitted to DOGM containing details of the site specific plans for topsoil removal, testing, stockpiling, and redistribution. Generally, however, the soil removal procedure is as follows:

Handling of topsoil during mining operations involves several different activities. These activities include the removal of vegetation, topsoil stripping, stockpiling, and replacement of the topsoil onto the areas to be ultimately reclaimed. Trees and large shrubs will be removed prior to topsoil removal. Small shrubs, grasses, and forbs will be collected with the topsoil material since these materials increase both the available organic matter in the soil and the available seed stock. This procedure will be especially beneficial if the soils are stockpiled for a relatively

short period of time. Topsoil will then be removed to the extent possible by front-end loaders and trucks, or by other standard equipment and methods such as scrapers and dozers. The stripping depth for the Reclamation Soil Borrow Area 2 will be determined prior to removal based on information contained in Appendix 2-1. This information will be confirmed in the field prior to disturbance. Samples of topsoil material will be taken for chemical analyses. Suitable soil materials will be scraped from the areas to be disturbed and then stockpiled.

2.32 Soil Substitutes

Because very little topsoil was saved from lands disturbed prior to 1977 substitute material will be needed. Some soil may be salvaged around the distributed areas and samples indicate that this material is usable.

Some areas can be revegetated without topsoil placement. Most of the volume of soil needed for reclamation will come from borrow areas.

The quantity of borrow material that will be required to cover the portals, coarse refuse and fine coal slurry is identified by reclamation area in Table 2-6. The quantity of borrow material that is available for both industrial and reclamation purposes is identified by Borrow Area in Table 2-7. The total amount of borrow material that will be required is about 229,174 cu yd; the amount of material available is about 638,650 cu yd. It is anticipated that all of the borrow material will be taken from Reclamation Borrow Area 1 (Appendix 2-1). Grassy Trail Dam Borrow Area will be used only if conditions at the end of mining warrant.

Three test pits were dug to identify and evaluate the soil materials in the borrow area. Information concerning the test methods, laboratory procedures, and results are discussed in Appendix 2-1. It should be noted that the extent and quantity of these borrow soil materials is limited, and the material available may not adequately cover all areas that have been disturbed.

Because the practice of borrowing topsoil material requires the area be disturbed, this ultimately results in more acres being disturbed and reduces the total productivity. Therefore, borrow area materials use will be limited. These soils will only be used on areas where vegetation is not successful, or in other required circumstances such as covering the coal seams (or portals), coarse refuse and slurry material.

As a consequence of these factors, many of the disturbed areas will need to be revegetated without the topsoil without the topsoil amendment. Revegetation test plots have shown some revegetation success under several soil depth, amendment, and seeding regimes. However, the test plots will be re-evaluated in September-October 1990.

The results of these tests should provide information concerning the most appropriate reclamation techniques and procedures to insure revegetation success.

Several areas in particular will, of necessity, be revegetated without additional topsoil. In particular, the supply materials yard may be reseeded without the addition of topsoil materials. Topsoil is not expected to be required in areas where suitable soil material may remain in place, such as the engineering office. Test pits dug around existing facilities indicated that no toxic materials are present, and furthermore, none are anticipated at the time of reclamation. Reclamation test plots will assess topsoiling and revegetation methods and techniques for the refuse pile.

Any areas contaminated with oil or other petroleum products will be excavated and the material disposed in the refuse pile. These areas are expected to be few and small in extent, and will be covered with soil material and then revegetated.

2.33 Soil Storage

Stockpiles will be contoured, stabilized, and protected from wind and water erosion by seeding with rapidly establishing grass and forb species. Seedbed preparation will consist of contouring; fertilizer will not be required for stockpiles. Stockpiles will be seeded with the approved temporary seed mix. Because contractors are frequently used at the Mines for reclamation efforts, the precise equipment that will be used cannot be predicted. However, standard reclamation equipment and techniques will be employed in order to insure stabilization and vegetation success.

Prior to re-disturbance of some areas, five stockpiles of soil materials were saved from several sites. The histories of these soils are unknown. The location of each soil material stockpile is indicated on Plate 7-1, and the quantity of material contained within each stockpile is indicated as follows:

QUANTITIES OF STOCKPILED TOPSOIL

<u>Stockpile Location</u>	<u>Quantity</u>
East Borrow Pit (Industrial Borrow Pit 1)	36,600 cu ft
No. 3 Hoisthouse Pond (Industrial Pit 1)	4,200 cu ft
Slurry Pond Pile (Near Slurry Cell I)	127,900 cu ft
Haul Road Pile (NE corner of Refuse Pile)	102,200 cu ft
Rail Cut Pile (Rail Cut Pond)	15,800 cu ft
Reclamation Test Plot (At Test Plot)	67,500 cu ft
Twinshaft Pond	<u>32,600 cu ft</u>
Total	386,600 cu ft

The soils contained in these stockpiles are currently committed for use in topsoiling the sites from where the soils were removed, i.e. the sedimentation ponds and the reclamation test plots.

2.40 Reclamation Plan

2.41 Soil Redistribution

Before placement of topsoil from whatever source the area to be reclaimed will have been recontoured and regraded. Recontouring and regrading will be accomplished with the use of equipment such as a bulldozer, scraper, maintainer, backhoe, or front-end loader. The work will be done prior to replacement of any soil material and after removal of any facilities. The extent of surface disturbances at an underground mine are small compared to a surface mine, and a minimal amount of regrading will be necessary prior to revegetation. Each site to be disturbed will be contoured to blend with adjacent undisturbed areas. They may not be returned to original contours, as those are unknown in several instances, but will be approximate.

Small areas will be restored with a maintainer or front-end loader. A backhoe will be used when practicable for restoring cuts and fills to an approximate original contour such as was accomplished in Slaughter Canyon. Other road bases, will be regraded to blend with rugged topography. Berms will be removed and the road bed ripped to blend with rugged topography.

The coarse refuse pile is contoured throughout its construction and covered with four feet of non-toxic material. Any coal seam exposed because of a portal opening will be covered with four feet of non-toxic material. The post-mine contours will remain approximately the same as the current contours. Final leveling and regarding changes will typically be very small, and they will not appear on the map. The final contours will approximate those shown on Plate 7-4.

The handling of soils will be supervised by the person in charge of reclamation and will follow approved plans and procedures.

The common depth of topsoil for the mapping units described from the disturbed sites is three inches. Most soil mapping units have only a thin A horizon situated directly over the C horizon. The HBC mapping unit is described to have had a six inch A horizon. All of this mapping unit located within the permit area has been previously disturbed. As almost all pre-mine topsoils were very thin, changes of any remaining undisturbed topsoil are small.

Any borrow material to be used will remain in place (Plate 7-4) until the material is needed. For placement on large areas the material will be loaded, moved and spread with scrapers to an even depth as determined to be required by revegetation studies. For purposes of bond estimation a four foot depth has been assumed necessary to cover the coarse refuse disposal area and portals. Other areas, such as the slurry ponds will be covered with one foot of borrow material. The surface will be left rough to enhance rainfall retention and vegetation growth.

After facility removal and regrading, the soil material placed on each site and replaced for seeding will be tested for productivity, fertility, and potential toxicities according to the following plan. An average of three samples per acre will probably be needed to determine soil quality and fertility. Each of the three samples will be analyzed for fertility. Each of the three samples will be analyzed for fertility, texture, pH, conductivity, lime, manganese, and copper. In addition, analyses for metal toxicities will also be run if the material has not yet been evaluated, or if field conditions warrant. The results of the soil testing will be used to establish recommendations for fertilizer or other soil amendments.

Any necessary soil nutrients will be spread prior to revegetation according to interpretation of the test results and the species to be planted. If needed, phosphorus ($P^{2}O^{5}$) will be disked into the soil prior to planting. Nitrogen fertilizer (ammonium nitrate) will also be added if soil testing and interpretations indicate it is necessary.

Soil material will be worked on the contour whenever possible, unless there are steep slope limitations. Soil will be placed as evenly as possible, with deeper depth on bottom habitat types and more shallow depths on slopes. After facility removal on areas where no soil material will be replaced, the ground will be ripped with a bulldozer to a depth of eighteen to twenty inches to loosen the surface material and increase infiltration. The site will then be graded to its final contour and sampled for chemical analysis prior to planting.

2.42 Soil Nutrients and Amendments

Tests indicate no particular soil amendments should be necessary at the Sunnyside Mines when topsoil and native plants are used. It is planned to use hay or straw as a mulch which would provide additional organic matter as well as erosion protection and improved seed establishment. Wood fiber or other material such as Terra Tac or J-Tac may be used as tackifiers.

Results of initial soil analyses indicate the soils to be low in nitrogen. The phosphorous content is variable. Application rates from soil tests are recommended based on agronomic crops under irrigation for the purpose of maximum production; typically

when topsoil and native plants are used, fertilization is generally not necessary. Irrigation is not planned at this time.

Where no topsoil was stockpiled prior to the initial major disturbances, fertilizer applications may be necessary; fertilizer may be necessary for revegetation of refuse. Necessary soil nutrients will be applied based on interpretation of chemical analyses completed prior to the time of revegetation.

2.43 Soil Stabilization

Terracing for erosion control is being done on the coarse refuse disposal area. The up-slope above the upper bathhouse and hoisthouse are were previously hand terraced.

Regrading will be done on the contour when possible for erosion control purposes. The large acreages of pre-law revegetation also aid in erosion control. A diversion ditch (Plate 5-12) has been installed to surround part of the surface facilities to minimize erosion across the disturbed area.

This ditch will be removed after approval of revegetation.

The preparation of the soil bed will be rough to allow better retention of rainfall. Where necessary use of mulch and tackifier will be used. Rills and gullies of reclaimed areas will be monitored and repaired when not meeting performance standards.

List of Exhibits

Figure 2-1	SCS Letter on Prime Farmland Determination
Table 2-1	Series 1 Soil Analysis
Table 2-2	Series 2 Soil Analysis (Borrow Areas)
Table 2-3	Series 2 Soil Analysis (Facilities)
Table 2-4(a-e)	Pond 002B Area Soil Analysis
Table 2-5	Potential Productivity of Soils
Table 2-6	Required Borrow Material
Table 2-7	Available Borrow Material
Appendix 2-1	Reclamation Soil Borrow 1 Area Investigation
Appendix 2-2	Description of Soil Mapping Units
Appendix 2-3	Description of Soil Series
Appendix 2-4	No. 2 Mine Reclamation Soil Analyses
Appendix 2-5	1982 Test Plot Study
Plate 2-1	Soil Identification Map



United States
Department of
Agriculture

Soil
Conservation
Service

4012 Federal Building
125 South State Street
Salt Lake City, UT 84138

March 16, 1981

Marcia Wolfe
Kaiser Steel Corporation
P. O. Box 1107
Raton, New Mexico 87740

Dear Ms. Wolfe:

A review of the soils on your company's Sunnyside properties as described on maps provided by John Huefner, March 6, 1981, indicates no prime farmland within the permit area.

These maps will remain on file in the SCS State Office for future reference.

Sincerely,

THERON B. HUTCHINGS
State Soil Scientist

cc:
Gary D. Moreau; DC, Price

Figure 2-1 Prime Farmland Determination



TABLE 2-1

SOIL ANALYSIS REPORT

ANALYSIS DONE BY UTAH STATE UNIVERSITY SOILS LABORATORY; LOGAN, UTAH
 SAMPLES COLLECTED 10/10/79, REC'D 10/15/79, RESULTS REC'D 12/11/79

	UNITS	LAB NUMBER			
		4368	4369	3997	3998
TEXTURAL CLASS		SANDY LOAM	SAND	SANDY LOAM	LOAM
PASTE pH		8.0	6.8	8.2	8.2
ORGANIC MATTER	%			0.00	1.21
NITROGEN	%	0.12	0.45	0.05	0.06
ELECT CONDUCT'Y	mmho/cm	0.6	3.5	1.0	4.1
CaCO3 Equiv.		0.0	0.0	0.0	0.0
CATION EXCH CPY		10.2	6.6	10.8	8.7
P	ppm	5.7	8.5		
K	ppm	214	58		
Extract. Na CATION	milli-eq/100 g			0.1	0.4
SAR		0.1	0.1	0.8	1.3
Na	milli-eq/l	0.6	2.8	1.7	7.1
Ca & Mg		0.52	4.6	8.5	56.4
EXCHANG Na %		0.1	0.1		
NaHCO3 -- K				68	81
NaHCO3 -- P				2.9	6.9

LAB NO. 4368 SAMPLED UNDISTURBED SOIL IN GRASSY TRAIL FLOODPLAIN
 LAB NO. 4369 SAMPLED ROAD RUNOFF SILTS
 LAB NO. 3997 SAMPLED DISTURBED SLOPE AT THE UPPER BATHHOUSE
 LAB NO. 3998 SAMPLED STOCKPILED TOPSOIL NEAR SLURRY PONDS

Table 2-2

Results of chemical analyses of topsoil and borrow materials.

Soil Material	Horizon	Text.	pH	Cond.	Lime	%OM	PARAMETER									
							NO ₃ -N	ppm P	ppm K	ppm Zn	ppm Fe	ppm Mn	ppm Cu	SAR	%Sat	
CIC	A	SL	6.8	1.3	H	1.7	31	4	234	1.1	7.4	1.5	1.9	.1	26.9	
	B	SL	7.6	.7	H	1.3	9	1	277	.3	5.3	.7	2.3	.7	31.3	
IEE	A	SL	7.4	1.5	H	1.8	48	13	103	.8	18.0	3.3	1.5	.1	30.5	
	B	SL	7.5	.7	H	2.8	12	2	71	.2	15.2	4.4	2.0	.2	47.3	
MTH	A	SL	7.0	1.2	L	1.9	33	8	259	1.1	24.0	4.4	2.1	.2	34.0	
	B	SL	7.0	1.6	L	2.0	53	5	212	1.0	18.8	1.4	2.0	.2	35.0	
MRG	A	SL	7.7	1.1	H	1.2	23	2	158	.4	6.4	3.4	1.8	.9	32.0	
	B	SL	7.8	.7	H	.9	10	1	144	.3	4.6	1.0	1.4	.2	32.0	
(1) Borrow*	-	SCL	7.9	.4	H	2.4	38	3	60	.28	3.1	1.3	1.6	-	-	
(2) Borrow*	-	SCL	8.45	.3	H	.8	1.5	3	40	0	1.9	1.7	.4	.55	-	
(3) Borrow*	-	SL	7.9	.3	H	2.7	18	3	173	.25	10.6	2.1	1.1	-	-	
(4) Borrow*	-	SL	8.1	.7	H	1.7	1.7	1	156	.7	6.9	2.6	4.4	-	-	
(5) Borrow*	-	SL	8.5	.6	H	.5	2.3	2	38	.5	3.4	1.2	1.9	.6	-	
(6) Borrow*	-															
Grassy Trail Dam	-	sc,cl	8.0	0.6	H	0.25	7.0	1	105	0.9	8.7	1.9	3.9	0.4	-	

*BORROW data averaged from several samples at each potential site.

Samples 1, 2, and 3 are located in Borrow Area 1
 Sample 4 is located in Borrow Area 2
 Sample 5 is located in Reclamation Soil Borrow Area 1
 Sample 6 is Grassy Trail Dam Borrow Area

Table 2-3 Chemical analyses of soil materials beneath (adjacent) surface facilities

Location and Depth	PARAMETER											
	pH	ec (mohm/cm)	%OM	N (ppm)	P (ppm)	K (ppm)	Zn (ppm)	Fe (ppm)	%Lime	Mn (ppm)	Cu (ppm)	Texture
<u>Shop</u>												
0-12"	7.0	.4	.9	1	1.0	141	.4	12.1	low	2.8	2.7	clay
12-24"	7.0	.3	2.6	.6	3.0	171	1.3	21.2	low	3.2	2.7	clay
24-36"	6.7	.3	2.0	1	1.0	145	.5	11.7	low	2.6	2.2	clay
36-48"	6.9	.3	1.7	1	1.0	209	.4	10.2	low	2.1	2.6	clay
<u>Prep. Plant</u>												
0-12"	7.4	.3	.8	2	1.0	110	.5	7.9	low	.6	4.2	clay
12-24"	6.4	.3	4.8	3	1.0	290	1.5	20.9	low	10.6	1.7	clay lo
24-36"	7.7	.3	1.0	7	1.0	91	.4	9.3	low	.7	3.3	clay
36-48"	6.6	.4	3.2	4	1.0	145	.7	20.7	low	1.1	3.4	clay
<u>No. 2 Canyon Material Yard</u>												
0-12"	8.0	.8	.4	1	1.0	97	.4	8.0	low	.1	1.3	clay
12-24"	7.6	.4	1.2	2	1.0	121	.2	9.2	low	1.8	2.0	clay
14-36"	8.0	.6	.9	1	1.0	177	.5	17.2	high	.8	5.5	clay
36-48"	6.8	.5	2.2	1	1.0	236	.6	12.9	low	2.8	3.4	clay

Tables 2-4 (a-e)
Pond 002B Area Soil Analyses



1633 Terra Avenue
 Sheridan, Wyoming 82801
 Tel. (307) 672-8945

1714 Phillips Circle
 Gillette, Wyoming 82716
 Tel. (307) 682-8945

Sunnyside Reclamation and Salvage, Inc.
 Sunnyside Mine
 P.O. Box 99
 Sunnyside, Utah 84539

Lab No	Location/	Depth	Munsell	Soil Color
31594	1A	0-6	10YR 4/2	Dark Grayish Brown
31595	1B	6-12	5YR 5/2	Reddish Gray
31596	2A	0-6	10YR 4/3	Brown/Dark Brown
31597	2B	6-12	10YR 5/3	Brown
31598	3A	0-6	10YR 4/2	Dark Grayish Brown
31599	3B	6-12	10YR 5/3	Brown

Table 2-4a



Inter-Mountain Laboratories, Inc.
 Sheridan, Wyoming 82801

1633 Terra Avenue

Tel. (307) 672-8945

SRS, INC.
 SUNNYSIDE, UTAH
 MINE: SUNNYSIDE

September 13, 1989

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Lab No.	Location	Depths	pH	EC mmhos/cm @ 25°C	Satur- ation %	Calcium meq/l	Magnesium meq/l	Sodium meq/l	SAR	Coarse Fragments %	Sand %	Silt %	Clay %	Texture
31597	2B	6-12	7.4	0.42	33.4	3.51	0.86	0.50	0.34	11.7	54.7	35.1	10.2	SANDY LOAM
31601	31597(DUP)	6-12	7.4	0.43	32.8	3.17	0.81	0.63	0.45		54.7	36.9	8.4	SANDY LOAM

Table 2-4b



Inter-Mountain Laboratories, Inc.

Sheridan, Wyoming 82801

Tel. (307) 672-8945

1633 Terra Avenue

SRS, INC.
SUNNYSIDE, UTAH
MINE: SUNNYSIDE

September 13, 1989

Page 2 of 2

Lab No.	Location	Depths	Organic Matter %	Carbonate %	P ppm	Nitrate-Nitrogen ppm	K PE meq/l	Total Kjeldahl Nitrogen %	1/3 bar	CO3 meq/l	HCO3 meq/l
31597	2B	6-12	1.2	13.9	4.48	1.49	0.31	0.09	15.8	0.00	4.32
31601	31597(DUP)	6-12	1.1	14.0	4.86	1.69	0.42	0.09			

Table 2-4c



Inter-Mountain Laboratories, Inc.

1633 Terra Avenue

Sheridan, Wyoming 82801

Tel. (307) 672-8945

SRS, INC.
SUNNYSIDE, UTAH
MINE: SUNNYSIDE

September 13, 1989

Page 1 of 2

Lab No.	Location	Depths	pH	EC mmhos/cm @ 25°C	Satur- ation %	Calcium meq/l	Magnesium meq/l	Sodium meq/l	SAR	Coarse Fragments %	Sand %	Silt %	Clay %	Texture
31594	1A	0-6	7.4	0.47	30.5	4.20	0.78	0.42	0.27	14.3	67.5	24.1	8.4	SANDY LOAM
31595	1B	6-12	7.4	0.37	31.6	2.96	0.69	0.47	0.35	33.6	62.9	27.8	9.3	SANDY LOAM
31596	2A	0-6	7.3	0.45	35.9	3.75	0.75	0.41	0.27	1.0	42.9	45.1	12.0	LOAM
31597	2B	6-12	7.4	0.42	33.4	3.51	0.86	0.50	0.34	11.7	54.7	35.1	10.2	SANDY LOAM
31598	3A	0-6	7.4	0.37	32.5	2.84	0.82	0.54	0.40	7.0	48.4	41.4	10.2	LOAM
31599	3B	6-12	7.4	0.40	32.4	2.79	0.94	0.57	0.42	8.3	49.3	24.2	26.5	SANDY CLAY LOAM

Table 2-4d



Inter-Mountain Laboratories, Inc.

1633 Terra Avenue

Sheridan, Wyoming 82801

Tel. (307) 672-8945

SRS, INC.
SUNNYSIDE, UTAH
MINE: SUNNYSIDE

September 13, 1989

Page 2 of 2

Lab No.	Location	Depths	Organic Matter %	Carbonate %	P ppm	K PE meq/l	Alkalinity PE meq/l	Total Kjeldahl Nitrogen %	1/3 bar	15 bar	CO3 meq/l	HCO3 meq/l
31594	1A	0-6	1.0	8.2	4.67	0.10	4.92	0.09	12.2	5.3	0.00	4.92
31595	1B	6-12	1.0	12.3	5.05	0.21	3.73	0.09	15.4	5.6	0.00	3.73
31596	2A	0-6	1.5	11.9	4.09	0.38	5.13	0.12	17.2	7.6	0.00	5.13
31597	2B	6-12	1.2	13.9	4.48	0.31	4.32	0.09	15.8	5.7	0.00	4.32
31598	3A	0-6	1.5	4.8	4.48	0.26	4.22	0.13	14.7	6.6	0.00	4.22
31599	3B	6-12	1.0	13.8	2.75	0.63	4.60	0.09	18.1	8.0	0.00	4.60

Table 2-4e

Table 2-5 Potential Productivity of Soils

Productivity in lbs./acre (dry weight)

Soil Mapping Unit*	C l i m a t e		
	Favorable Year	Normal Year	Unfavorable Year
CIC	900	-	500
HBC#	1400	1025	700
IEC	1500	900	550
IGC#	1000	750	500
JTG	800	550	300
MTH	1500	1000	750
NDH ₂	600	450	100
NGG ₂	800	550	300
NJFe#	1500	900	550
RWG	1000	750	300
WAG	2000	1500	1000

*Information is unavailable for those soil mapping units not listed.
 #Soils of major disturbed sites.

TABLE 2-6

Borrow Material Required for Reclamation

Area	Type of Disturbance	Borrow Material Required (cu yd)
Area 1	4 Portals ¹	920
Area 2	3 Portals	690
Area 3	None	0
Area 4	2 Portals ¹	460
Area 5	6 Portals, Refuse	25,451
Area 6	None	0
Area 7	Refuse, Slurry, etc., 3 Portals	419,592
Area 8	9 Portals	2,070
Area 9	1 Portal	230
Area 10	1 Portal	230
Total		449,643

1 Portals will be sealed and covered with four feet of borrow material.

2 Coarse refuse material will be covered with four feet of borrow material; fine coal slurry material will be covered with one foot of borrow material.

Table 2-7

Available Industrial and Reclamation Borrow Material

<u>Borrow Area</u>	<u>Acres</u>	<u>Depth (ft)</u>	<u>Cu. Yds. Available</u>
Industrial 1	3.42	8.5'	46,899
Industrial 2	3.25(1)	0.0'	0
Industrial 3	3.36(2)	12.0	32,525
Reclamation 1	30.14	12.0	550,726
Grassy Trail Borrow(3)	-----	-----	8,500
Total			638,650

1. Borrow area 2 has been used for industrial purposes; e.g., roads, etc. and is substantially gone.
2. Approximately 10 ft of this material has been used, however, about 6 ft. of material remains in place.
3. Grassy Trail Dam Borrow Area is a slide area, and acres and depth have not been determined.

Appendix 2-1

Reclamation Soil Borrow Area 1 Investigation

RECLAMATION SOIL BORROW AREA 1

A soil investigation was conducted on the Sunnyside Mines area to locate additional suitable borrow material for use in final reclamation at the Sunnyside Mines. This investigation included a soil survey and soil sampling using test pits. A determination was made on the soil physical and chemical properties, its susceptibility to erosion, suitability for topsoil, and the soils feasibility for reclamation. The results of that investigation are included in this Appendix.

An intensive Order 2 soil survey was conducted to conform with the Utah Division of Oil, Gas and Mining guidelines and with the Soil Conservation Service recommendations. Distribution of the soil mapping units were identified and a number of soil profiles were sampled to determine the nature and extent of the soils within the mapping unit. The genetic horizons were examined for color, texture, structure, and other characteristics in hand-dug holes, along road cuts, and within four - 10 to 13 feet deep - test pits dug with heavy equipment.

Within each profile, continuous, representative one quart samples were dug by a backhoe or by a shovel and hand auger. When possible, the samples were taken in the major genetic horizons. However in the subsurface, the horizons were separated for laboratory analyses and not because of morphological differences. The layers were identified by numbering each subdivision consecutively, starting at the top. Generally the layers were split so most samples did not represent a layer greater than 12 inches thick.

The Utah Division of Oil, Gas and Mining Guidelines were used to rank suitability of topsoils. Three suitability ratings (good, fair, poor, and unsuited) were used to determine the salvage depths of each mapping unit. Limiting factors were noted for each component soil series phase. Soils with more than 35 percent coarse fragments have an unsuitable rating but can be improved by removing the stones and boulders during reclamation efforts. It should be noted that Kaiser will remove the large stones and boulders from the borrow material prior to applying it on areas to be reclaimed. These rocks will be used in drainage areas, for riprap, and other mine related purposes. Since boulders are the only limiting factor, the volume of total soil suitable for use as topsoil in reclamation was obtained by multiplying the acreage of each soils mapping unit within the boundaries of the soil borrow area by the depth of suitable material.

The soils that are found within the Reclamation Soil Borrow Area 1 are very bouldery or are very stony Strych soils (formerly designated as IEE soils, Plate VIII-1). In the vicinity of the Sunnyside Mines, these soils are very deep, well drained soils on dissected alluvium fans and fan terraces. They are formed in alluvium and glacial derived dominantly from sandstone and shale.

Typically, the Strych soil has a brown very bouldery or stony sandy loam surface. The underlying layer is a pale brown, calcareous very stony sandy loam. Deeper in the soil profile, the soil becomes stratified with sandy loam and sandy clay loam layers. There are also some very thin lenses of sand and gravel that may occur in the profile.

The coarse fragments are the limiting soil characteristic for revegetation. Boulders, stones and the calcareous horizon occur in the surface 2 to 3 feet. The soil quality improves deeper in the soil profile. Below 36 inches there is a decrease in coarse fragment and calcium carbonates. There is some increase in salts below 100 inches depth, as indicated by a higher sodium adsorption ratio (SAR) and electrical conductivity. However, the soil is rated fair for use as borrow material and should be suitable for vegetation establishment.

No chemical constituents were found in sufficient concentrations that would pose a potential hazard to plants or animals. All tested soil samples contained low concentrations of selenium and boron. Soils indicated a higher accumulation of salts whenever shale had a dominant influence on the parent material, or when the soil was overlying shale.

Table 1 shows the Reclamation Soil Borrow Area 1 Laboratory Analyses for soil samples collected within the test pits and augered holes. The topsoil material stability rating with depths are in Table 2.

Table 1.

Physical and Chemical Properties of Borrow Area Soils

Soil Unit	Depth (in)	Permeability (in/hr)	Water Cap.	pH	Salinity (mmhos/cm)	Erosion Factor	
						K	T
Strych very stony, sandy loam, 3-8%	0-6	2.5-7.5	1.2	7.4	0.65	.32	4
	6-18	2.5-7.5	1.2	8.1	1.48	.28	
	18-34	2.5-7.5	1.2	8.0	1.78	.32	
	34-60	2.5-7.5	1.2	8.3	3.62	.32	
Strych very stony, sandy loam, 9-15%	0-5	2.5-7.5	1.2	7.4	0.83	.32	4
	5-17	2.5-7.5	1.2	8.2	3.39	.28	
	17-29	2.5-7.5	1.2	8.7	0.82	.28	
	29-43	2.5-7.5	1.2	8.7	0.71	.28	
	43-60	2.5-7.5	1.2	8.6	0.64	.28	

TABLE 2 TOPSOIL MATERIAL SUITABILITY RATINGS

SOIL SERIES	TOPSOIL RATING AND DEPTH				
	Good	Fair	Poor	Unsuited	Limitation
Strych(1) very stony sandy loam, 3 - 8% slopes				0 - 34"	Stones and cobbles, remove 15% coarse fragments(2)
		34-157"			
Strych(1) very stony sandy loam, 9 - 15% slopes				0 - 43"	Stones and cobbles, remove 15% coarse fragments(2)
		43-131"			

(1) Strych soils were formerly classified as IEE soils by the SCS (Plate).

(2) When the stones are removed, they will be used for rip-rap. Soils will then be rated as fair.

Appendix 2-2

Description of Soil Mapping Units

DTF--BEENOM COMPLEX, 8 TO 40 PERCENT SLOPES

This map unit is on ridgetops and on the steeper sideslopes of the Book Cliffs. Slopes are single to slightly convex and long. Elevation is 8,000 to 8,700 feet. The average temperature is 30 to 45 degrees F, and the average freeze-free season is 60 to 120 days.

This unit is 45 percent Beenom very gravelly fine sandy loam, 8 to 40 percent slopes; and 20 percent other soils. The Beenom very fine sandy loam is on the broad ridge lines and the Beenom fine sandy loam is in areas throughout the unit.

Included in this unit are about 10 percent a soil similar to Podo gravelly loam, 50 to 70 percent slopes, except slopes are 8 to 40 percent; 7 percent Pino silty clay loam, 3 to 30 percent slopes; and 3 percent of a soil similar to benten loam thin surface loam, 30 to 50 percent slopes except at a lower elevation (scrubby aspen). The soils are extermingled on the landscape.

The Beenom very gravelly fine sandy loam is shallow and well drained. It formed in residuum derived dominantly from sandstone and shale. The present vegetation is mainly black sagebrush, Salina Wildrye, rabbitbrush, and larkspur.

Typically, the surface layer is brown very gravelly fine sandy loam about 2 inches thick. The subsoil is brown loam about 8 inches thick over sandstone. Depth to sandstone ranges from 10 to 20 inches.

Permeability of the Beenom very gravelly fine sandy loam is moderate. Available water capacity is less than 2 inches. Water supplying capacity is 3 to 5 inches. The organic matter content of the surface layer is 3 to 5 percent. Effective rooting is 10 to 20 inches. Runoff is medium and the hazard of erosion is moderate. The hazard of soil blowing is slight.

The Beenom fine sandy loam is shallow and well drained. It formed in residuum derived dominantly from sandstone and shale. The present vegetation is mainly serviceberry, birchleaf mountain mahogany, Salina wildrye, big sagebrush, snowberry, chokecherry, and needleandthread.

Typically, the surface layer is dark yellowish brown fine sandy loam about 2 inches thick. The upper 6 inches of the subsoil is dark yellowish brown fine sandy loam. The lower 4 inches is dark yellowish brown very cobbly sandy clay loam. Sandstone is at a depth of 12 inches. Depth to sandstone ranges from 10 to 20 inches.

Permeability of the Beenom fine sandy loam is moderate. Available water capacity, to a depth of 12 inches, is less than 2 inches. Water supplying capacity is 3 to 6 inches. The organic

matter content of the surface layer is 3 to 5 percent. Effective rooting depth is 10 to 20 inches. Runoff is medium and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for rangeland and wildlife habitat.

This unit is in capability subclass VIIIs, non-irrigated.

DSG2--RABBITEX-PATMOS COMPLEX, 25 TO 70 PERCENT SLOPES, EROSED.

This map unit is on mountainsides. Slopes are concave to convex and long. Elevation is 7,200 to 8,400 feet. The average annual precipitation is about 16 to 20 inches, the mean annual air temperature is 38 to 45 degrees F and the average freeze-free season is 60 to 120 days.

This unit is 35 percent Rabbitex loam, 25 to 70 percent slopes, eroded; 35 percent Patmos channery loam, 27 to 70 percent slopes, eroded, and 30 percent other soils. The components of this unit are intermingled.

Included in this unit are about 15 percent of a soil similar to Guben extremely bouldery loam, 40 to 75 percent slopes, except bedrock is within 20 inches, 10 percent Moreno extremely bouldery loam, 30 to 60 percent slopes in concave positions, 5 percent Rock outcrop.

The Rabbitex soil is deep and well drained. It formed in alluvium and colluvium derived dominantly from sandstone and shale. The present vegetation is mainly Salina wildrye, western wheatgrass, and birchleaf mountainmahogany.

Typically, the surface layer is dark brown loam and channery loam about 12 inches thick. The upper 18 inches of the next layer is yellowish brown and pale brown channery loam and gravelly. The lower part to a depth of 53 inches or more is very pale brown loam. A layer of secondary carbonate accumulation is at a depth of about 30 to 50 inches.

Permeability of the Rabbitex soil is moderate. Available water capacity is about 7.5 to 8.5 inches. Water supplying capacity is 9 to 12 inches. The organic matter content of the surface layer is 3 to 5 percent. Effective rooting depth is 60 inches or more. Runoff is rapid and the hazard of water erosion is high. The hazard of soil blowing is slight.

The Patmos soil is moderately deep and well drained. It formed in alluvium and colluvium derived dominantly from sandstone and shale. The present vegetation is mainly Salina wildrye, bluegrass, larkspur, black sagebrush, and little yellow rabbitbrush.

Typically, the surface layer is light brownish gray channery loam about 2 inches thick. The underlying material to a depth of 24 inches is pale brown and very pale brown very gravelly and very cobbly fine sandy loam. Sandstone is at a depth of 24 inches. A layer of secondary carbonate accumulation is at a depth of 2 to 24 inches.

Permeability of the Patmos soil is moderate. Available water capacity is about 2 to 4 inches. Water supplying capacity is 5 to

7 inches. The organic matter content of the surface layer is 1 to 3 percent. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high. The hazard of soil blowing is slight.

This unit is used at rangeland and for wildlife habitat.

The Rabbitex soil is in capability subclass VIIe, non-irrigated, and Patmos soil is in capability subclass VIIs, non-irrigated.

Description of Soil Mapping Units

CIC--RIVRA EXTREMELY BOULDERY SANDY LOAM, 1 TO 8 PERCENT

This very deep and well drained soil is on valley and canyon floors. It formed in alluvium derived dominantly from sandstone and shale. Slopes are short to medium in length and single in shape. The present vegetation is mainly basin big sagebrush, rabbitbrush, wheatgrass, needleandthread, and dropseed. Elevation is 4,600 to 7,200 feet. The average annual precipitation is about 12 to 16 inches, the mean annual air temperature is 43 to 45 degrees F, and the average freeze-free season is 110 to 145 days.

Typically the surface layer is dark grayish brown, extremely bouldery sandy loam about 3 inches thick. The underlying layer to a depth of 12 inches is brown and yellowish brown gravely sandy loam about 9 inches thick. The next layer is yellowish brown very gravely sandy loam and extremely stony loamy sand about 28 inches thick. The next layer is brown extremely gravely sandy loam to a depth of 60 inches.

Included in this unit is about 15 percent Glenburg fine sandy loam, high rainfall, 1 to 3 percent slopes intermingles on the landscape; 10 percent Havre loam, 3 to 8 percent slopes intermingled with the Rivra soil at higher elevations, 5 percent Glenburg fine sandy loam, 1 to 8 percent slopes intermingled with the Rivra soil at lower elevations, and 5 percent of an Aquic Ustifluent along the stream channels with riparian habitats.

Permeability of this Rivra soil is moderately rapid. Available water capacity, to a depth of 60 inches, is about 3.5 to 4.0 inches. The organic matter content of the surface layer is 1 to 3 percent. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight. The hazard of soil blowing is slight.

This unit is used for rangeland, wildlife habitat, and recreation.

The Rivra soil is in capability subclass VIIIs, non-irrigated.

<u>COMMON PLANT NAME</u>	<u>%</u>
Bluebunch Wheatgrass (AGSP)	35
Western Wheatgrass (AGSM)	25
Needleandthread (STCO4)	20
Blue Grama (BCGR2)	5
Other Annual Forbs (AAFF)	5
Other Annual Grasses (AAGG)	5
Other Shrubs (SSSS)	5
Rose (ROSA+)	

FKG--TETON DECROSS VARIANT COMPLEX, 35 TO 70 PERCENT SLOPES

This map unit is on sideslopes. Slopes are medium to long in length and are convex to single in shape. The present vegetation is mainly sub alpine fir, aspen, and Douglas fir. Elevation is 7,800 to 9,600 feet. The average annual precipitation is about 20 to 30 inches, the mean annual air temperature is less than 38 degrees F, and the average freeze-free season is less than 60 days.

This unit is 35 percent Teton loam, 40 to 70 percent slopes, 30 percent Decross Variant fine sandy loam, 35 to 70 percent slopes; and 35 percent inclusions of other soils. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit is about 15 percent of soil similar to Teton loam, 40 to 70 percent slopes except that there is a bleached horizon below the surface, 15 percent of the soil similar to Teton loam, 40 to 70 percent slopes except less than 20 inches deep; and 5 percent Midfork bouldery loam, 50 to 70 percent slopes.

The Teton soil is moderately deep and well drained. If formed in colluvium derived dominantly from sandstone, siltstone and shale. Slope is 40 to 70 percent.

Typically, the surface is covered with a mat of leaves, twigs, and needles about 2 inches thick. The surface layer is brown loam about 8 inches thick. The substratum is brown cobbly fine sandy loam about 12 inches thick over siltstone ranges from 20 to 40 inches.

Permeability of the Teton Soil is moderate to a depth of 4 inches and moderately rapid below this depth. Available water capacity, to a depth of 24 inches, is about 2.0 to 3.5 inches. Water supplying capacity is 6 to 10 inches. The organic matter of the content of the surface layer is 5 to 10 percent. Effective rooting depth is 20 to 40 inches. Runoff is rapid and the hazard of water erosion is high. The hazard of soil blowing is slight.

The Decross Variant is deep and well drained. It formed in colluvium derived dominantly from sandstone, siltstone and shale. Slope is 35 to 70 percent.

Typically, the surface is covered with a mat of leaves, twigs and needles about one inch thick. The surface layer is dark grayish brown fine sandy loam about 3 inches thick. The upper 16 inches of the subsoil is dark grayish brown or silt loam. The lower 5 inches is dark grayish brown gravelly silt loam. The upper 8 inches of the substratum is grayish brown gravelly silt loam. The lower part to a depth of 55 inches is pale brown very gravelly fine sandy loam. A layer of carbonates is at a depth of about 24 inches. Depth to shale ranges from 40 to 60 inches.

Permeability of the Decross Variant soil is moderate.

Available water capacity, to a depth of 55 inches, is about 6.0 to 8.0 inches. Water supplying capacity is 11 to 18 inches. The organic matter content of the surface layer is 5 to 10 percent. Effective rooting depth is 40 to 60 inches. Runoff is rapid, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for wildlife habitat and woodland.

This is a capability subclass VIIe, non-irrigated.

FUG--DETRA VARIANT-PODO COMPLEX, 40 TO 70 PERCENT SLOPES

This map unit is on mountain sideslopes. Slopes are medium in length and concave in shape. The present vegetation is mainly big sagebrush, Salina wildrye, serviceberry and birchleaf mountain mahogany. Elevation is 8,000 to 9,000 feet. The average annual precipitation is about 16 to 20 inches, the mean annual air temperature is 38 to 45 F, and the average freeze-free season is 60 to 120 days.

This unit is 40 percent Detra Variant loam, 40 to 70 percent slopes; and 25 percent other soils. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit is about 15 percent Doney gravelly loam, 50 to 70 percent slopes on ridge crests; 3 percent Midfork bouldery loam, 50 to 70 percent slopes on drainages; 2 percent Benteen loam, thin surface, 30 to 50 percent slopes; 5 percent rock outcrop. The Detra Variant soil is moderately deep and well drained. It formed in residuum derived dominantly from sandstone.

Typically, the surface layer is brown loam about 5 inches thick. The subsoil is brown clay loam about 15 inches thick. The substratum is brown clay loam is about 14 inches thick over sandstone.

Permeability of the Detra Variant soil is moderately slow. Available water capacity, to a depth of 34 inches is about 5.0 to 6.5 inches. Water supply capacity is 9 to 12 inches. The organic matter content of the surface is 3 to 5 percent. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high. The hazard of soil blowing is slight.

The Podo soil is shallow and well drained. It formed in residuum derived dominantly from sandstone and shale.

Typically, the surface layer is grayish brown very stony loam about 5 inches thick. The underlying material to a depth of 10 inches is light brownish gray clay loam. The subsoil is light brownish gray clay loam about 6 inches thick. Shale is at a depth of 16 inches.

Permeability of the Podo soil is moderate. Available water capacity, to a depth of 16 inches is about 2.5 to 3.0 inches. Water supplying capacity is 5 to 7 inches. The organic matter content of the surface layer is 1 to 3 percent. Effective rooting depth is 10 to 20 inches. Runoff is rapid, and the hazard of water erosion is high. The hazard of soil blowing is slight.

This unit is used for rangeland and wildlife habitat.

The Detra Variant soil is in capability subclass VIIe, non-

irrigated, and the podo soil is in capability subclass VIIIs, non-irrigated.

HBC--HAVERSON FINE SANDY LOAM, HIGH RAINFALL, 1 TO 5 PERCENT SLOPES

This Haverson soil is very deep and well drained. It occurs on alluvial fans and drainage ways at elevations of 6,300 to 6,850 feet. This soil formed in mixed, calcareous alluvium derived mainly from sandstone and shale.

The average annual precipitation is 12 to 14 inches. Mean annual air temperature is 47 to 49 degrees F, mean annual soil temperature is 49 to 51 degrees F, and average freeze-free season is 100 to 120 days. Slopes are 1 to 5 percent and occur on all aspects. They are long in length and single in shape.

Included in mapping are small areas in Glenburg fine sandy loam, high rainfall, 1 to 3 percent slopes; and Haverson fine sandy loam, high rainfall, 5 to 15 percent slopes, eroded.

In a representative profile the surface layer is brown fine sandy loam about 6 inches thick. The underlying layer is pale brown loam and silt loam about 30 inches thick. The next layer is pale brown fine sandy loam to depth of 60 inches or more.

Permeability is moderately slow. Available water capacity is about 7.5 to 11 inches to a depth of 60 inches. Water supplying capacity is about 6.5 to 8 inches. Organic matter content in the surface layer is low. Effective rooting depth is greater than 60 inches. Surface runoff is slow and erosion hazard is moderate. The Erosion Condition Class is slight-27.

This soil is used for rangeland, wildlife habitat and recreation.

Present vegetation is dominantly big sagebrush, black sagebrush, greasewood, blue grama, indian ricegrass and needle-andthread.

The potential plant community is about 60 percent grass, 10 percent forbs and 30 percent shrubs. Important plants are native bluegrass, western wheatgrass, needleandthread, prairie junegrass, bluebunch wheatgrass, bottlebrush squirreltail, Salina wildrye, blue grama, scarlet gobemallow, aster, meadow milkvetch, peavine, big sagebrush, Wyoming sagebrush, black sagebrush, yellowbrush and winterfat.

COMMON PLANT NAME%

Blue Grama	(BOGR2)	5
Western Wheatgrass	(AGSM)	5
Needleandthread	(STC04)	10
Blue Grass	(POA++)	15
Salina Wildrye	(ELSA)	5
Other Perennial Grasses	(PPGG)	20
Scarley gobemallow	(SPCD)	2
Meadow Milkvetch	(ASOI5)	1
Aster	(ASTER)	1
Other Perennial Grasses	(PPFF)	6
Sagebrush	(ARTEM)	15
Winterfat	(EULAS)	2
Flowering Saltbrush	(ATCA2)	2
Rabbitbrush	(CHRIS9)	3
Other Shrubs	(SSSS)	8

HUG--MIDFORK-ELWOOD COMPLEX, 50 TO 70 PERCENT SLOPES

This map unit is on steep mountain sideslopes. Slopes are single to convex in shape and long in length. The present vegetation is mainly Douglas fir, snowberry, and quaking aspen. Elevation is 7,900 to 9,500 feet. The average annual precipitation is about 20 to 30 inches, the mean annual air temperature is less than 38 degrees F., and the average freeze-free season is less than 60 days.

This unit is 40 percent Midfork bouldery loam, 50 to 70 percent slope; 3 percent Elwood extremely bouldery loam 50 to 70 percent, and 30 percent inclusions of other minor soils. These soils are intermixed on the landscape.

Included in this unit is about 15 percent of a soil similar Midfork bouldery loam, 50 to 70 percent slopes except with less than 6 inches dark surface; 10 percent Parkway very stony loam, 50 to 70 percent slopes, eroded, 5 percent commodore very stony, very fine sandy loam, 50 to 60 percent slopes.

The Midfork soil is very deep and well drained. It formed in colluvium derived dominantly from sandstone and shale.

Typically, the surface is covered with a mat of partially decomposed twigs, leaves and needles about 2 inches thick. The surface layer is dark yellowish brown bouldery loam and clay loam about 7 inches thick. The underlying material to a depth of 30 inches is yellowish brown very channery loam. The next layer to a depth of 60 inches or more is yellowish brown gravelly loam.

Permeability of a Midfork soil is moderately slow. Available water capacity is about 6.0 to 7.5 inches. Water supplying capacity is 15 to 19 inches. The organic matter content of the surface layer is 5 to 10 percent. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is high. The hazard of soil blowing is slight.

The Elwood soil is moderately deep and well drained. It formed in colluvium and alluvium derived dominantly from sandstone, siltstone and shale.

Typically, the surface is covered with a mat of fur needles and twigs about 1 inch thick. The surface layer is brown extremely bouldery loam about 4 inches thick. The subsoil is brown very gravelly silt loam about 5 inches thick over hard sandstone.

Permeability of the Elwood soil is moderate. Available water capacity is about 2.5 to 3.5 inches. Water supplying capacity is 7 to 10 inches.

The organic matter content of the surface layer is 5 to 10 percent. Effective rooting depth is 20 to 40 inches. Runoff is

rapid, and the hazard of water erosion is high. The hazard of soil blowing is slight.

This unit is used for wildlife habitat. This unit is in capability subclass VIIe, non-irrigated.

IEC--ILDEFONSO VERY STONY LOAM, 3 TO 8 PERCENT SLOPES

This Ildefonso soil is very deep and well drained. It occurs on benches, mesas, and outwash plains at elevations of 5,600 to 7,400 feet. This soil formed in glacial outwash and in alluvium derived mainly of sedimentary rocks.

This average annual precipitation is 12 to 14 inches. Mean annual air temperature is 45 to 47 degrees F. mean annual soil temperature is 47 to 49 degrees F, and the average freeze-free season is 100 to 140 days. Slopes are 3 to 8 percent slopes, eroded; TA gravelly fine sandy loam, high rainfall, 3 to 8 percent slopes; and LH loam 3 to 8 percent slopes.

Included in mapping are small areas of featherlegs stony loam, 3 to 8 percent slopes; Sedillo very stony fine sandy loam, 3 to 8 percent slopes, eroded; TA gravelly fine sandy loam, high rainfall 3 to 8 percent slopes; and LH loams 3 to 8 percent slopes.

In a representative profile the surface layer is pinkish gray very stony loam about 5 inches thick. The underlying layer is light gray very cobbly loam and very pale brown very cobbly coarse sandy loam to a depth of 60 inches or more. A horizon of secondary carbonate accumulation occurs at depth of 5 inches.

Permeability is moderately rapid. Available water capacity is about 3.75 to 5.0 inches to depth of 60 inches or more. Water supplying capacity is about 5 to 6 inches. Organic matter content in the surface is low. Effective rooting depth is greater than 60 inches. Surface runoff is medium and erosion hazard is moderate. The Erosion Condition Class is slight-32.

The soil is used for rangeland and wildlife habitat.

Present vegetation is dominantly pinyon, juniper, Salina wildrye, Indian ricegrass, black sagebrush, and birchleaf mountain mahogany.

The potential plant community consists of an overstory of pinyon pine and Utah juniper with a canopy cover of 30 percent. The natural vegetation consists of about 35 percent grasses, 5 percent forbs, 30 percent shrubs and 30 percent trees. Important plants are Salina wildrye, Indian ricegrass, western wheatgrass, needleandthread, penstemon, owl clover, globemallow, birchleaf mountain mahogany, cliffrose, Torrey mormontea, sagebrush, spps, juniper and piñon pine.

<u>COMMON PLANT NAME</u>		<u>%</u>
Salina Wildrye	(ELSA)	7
Indian Ricegrass	(DRHY)	7
Western Wheatgrass	(AGSM)	7
Needleandthread	(STCO)	3
Blue Grama	(BOGR2)	3
Other Perennial Grasses	(PPGG)	8
Globemallow	(SPHAE)	1
Penstemon	(PENST)	1
Other Perennial Forbs	(PPFF)	3
Birchleaf Mountain Mahogany	(CEMO2)	7
Black Sagebrush	(ARARN)	7
Pinyon	(PIED)	15
Utah Juniper	(JUOS)	15
Torrey Mormontea	(EPTO)	2
Other Shrubs	(SSSS)	14

This soil is in capability Subclass VIIs, non-irrigated; Upland Stony loam.

IEE--ILDEFONSO VERY STONY LOAM, 8 TO 30 PERCENT SLOPES

This ildefonso soil is deep and well drained. It occurs on benches, dissected outwash plains and toe slopes at elevations of 6,200 to 7,300 feet. This soil formed in glacial outwash and alluvium derived mainly from sedimentary rocks.

The average annual precipitation is 12 to 14 inches. Mean annual air temperature is 40 to 47 degrees F, mean annual soil temperature is 47 to 49 degrees F, and the average freeze-free season is 100 to 140 days. Slopes are 8 to 30 percent and occur on all aspects. They are medium in length and convex-concave in shape.

Included in mapping are small areas of Shingle extremely stony loam, 20 to 50 percent slopes, eroded; a soil similar to feather-legs stony loam, 3 to 8 percent slopes except the slopes are 8 to 30 percent; and a soil similar to Sedillo very stony fine sandy loam, 3 to 8 percent slopes, eroded except the slopes are 8 to 30 percent.

In a representative profile the surface layer is pinkish gray very stony loam about 5 inches thick. The underlying layer is very pale brown very cobbly very stony loam about 42 inches thick. The next layer is very pale brown very cobbly coarse sandy loam to a depth of 60 inches or more. A horizon of secondary carbonate accumulation occurs at depth of about 5 inches.

Permeability is moderately rapid. Available water capacity is about 3.75 to about 5.0 inches to depth of 60 inches. Water supplying capacity is about 5 to 6 inches. Organic matter content in the surface layer is low. Effective rooting depth is greater than 60 inches. Surface runoff is medium and erosion hazard is moderate. The Erosion Condition Class is slight-32.

The soil is used for rangeland and wildlife habitat.

Present vegetation is dominantly pinyon, juniper, Salina wildrye, Indian ricegrass, black sagebrush, and birchleaf mountain-mahogany.

The potential plant community consists of an overstory of pinyon pine and Utah juniper with a canopy cover of about 30 percent. The natural vegetation consists of about 35 percent grasses, 5 percent forbs, 30 percent shrubs and 30 percent trees. Important plants are Salina wildrye, Indian ricegrass, western wheatgrass, needleandthread, penstemon, owl clover, globemallow, birchleaf, mountain mahogany, cliffrose, Torrey mormontea, sagebrush spps, juniper and pinyon pine.

<u>COMMON PLANT NAME</u>		<u>%</u>
Salina wildrye	(ELSA)	7
Indian ricegrass	(DRHY)	7
Western Wheatgrass	(AGSM)	7
Needleandthread	(STCO)	3
Blue Grama	(BOGR2)	3
Other Perennial Grasses	(PPGG)	8
Globemallow	(SPHAE)	1
Penstemon	(PENST)	1
Other Perennial Forbs	(PPFF)	3
Birchleaf Mountain Mahogany	(CEMO2)	7
Black Sagebrush	(ARARN)	7
Pinyon	(PIED)	15
Utah Juniper	(JUOS)	15
Torrey Mormontea	(EPTO)	2
Other Shrubs	(SSSS)	14

This soil is in capability Subclass VIIS, non-irrigated;
Upland stony loam.

IGC--ILDEFONSO VERY STONY LOAM, LOW RAINFALL, 3 TO 8 PERCENT SLOPES

This Ildefonso soil is very deep and well drained. It occurs on alluvial fans and terraces at elevations of 5,400 to 6,400 feet. This soil formed in alluvium and glacial outwash derived mainly from sandstone and shale.

The average annual precipitation is 8 to 12 inches. Mean annual air temperature is 45 to 47 degrees F, mean annual soil temperature is 47 to 49 degrees F, and the average freeze-free season is 115 to 140 days. Slopes are 3 to 8 percent and occur on south and east aspects. They are long in length and single to concave-convex in shape.

Included in mapping are small areas of Harvey loam, 3 to 6 percent slopes; Chilton very stony fine sandy loam, low rainfall, 5 to 15 percent slopes; and Harvey fine sandy loam, gravelly substratum, 1 to 3 percent slopes.

In a representative profile, the surface layer is pinkish gray very stony loam about 5 inches thick. The underlying layer is light gray very cobbly loam and very pale brown very stony loam about 42 inches thick. The next layer is a very pale brown very cobbly coarse sandy loam to a depth of 60 inches or more. A horizon of secondary carbonate accumulation occurs at a depth of about 5 inches.

Permeability is moderately rapid. Available water capacity is about 3.75 to 5.0 inches to a depth of 60 inches. Water supplying capacity is about 5 to 6 inches. Organic matter content in the surface layer is low. Effective rooting depth is greater than 60 inches. Surface runoff is medium and erosion hazard is moderate. The Erosion Condition Class is slight-32.

This is used for wildlife habitat and rangeland.

Present vegetation is dominantly juniper, pinyon, Salina wildrye, Indian ricegrass, and mormon-tea.

The potential plant community is Utah juniper and pinyon with a canopy cover about 10 percent. The natural vegetation is about 45 percent grasses, 10 percent forbs, 15 percent shrubs and 30 percent trees. Important plants are bottlebrush, squirrel-tail, Salina wildrye, galleta, Indian ricegrass, eriogonum, globemallow, penstemon, sagebrush, Utah juniper and pinyon.

<u>COMMON PLANT NAME</u>		<u>%</u>
Bottlebrush Squirreltail	(SIHY)	5
Salina Wildrye	(ELSA)	5
Galleta	(MIJA)	10
Indian Ricegrass	(OPYH)	7
Bluebunch Wheatgrass	(AGSP)	10
Other Perennial Grasses	(PPGG)	8
Eriogonum	(ERIOG)	2
Gobemallow	(SPHAE)	2
Other Perennial Forbs	(PPFF)	3
Other Annual Forbs	(AAFF)	3
Utah Juniper	(JUOS)	20
Pinyon	(PIED)	12
Shadescale	(ATCO)	3
Sagebrush	(ARTEM)	3
Other shrubs	(SSSS)	7

IWG--ILDEFONSO- ROCK OUTCROP COMPLEX, 50 TO 70 PERCENT SLOPES

This complex consists of about 50 percent Ildefonso very stony loam, 50 to 70 percent slopes; 30 percent Rock outcrop; and 20 percent other soils.

This complex occurs on mountain slopes. The soils are intermixed in the complex. The elevations are 7,000 to 7,500 feet. The Ildefonso soil formed in alluvium and colluvium derived mainly from sandstone and shale.

The average annual precipitation is 12 to 14 inches. Mean annual air temperature is 45 to 47 degrees F, mean annual soil temperature is 47 to 40 degrees F, and the average freeze-free season is 100 to 120 days. Slopes are 50 to 70 percent and occur on south and southeast aspects. They are short to medium in length and convex-concave in shape.

Included in mapping are small areas of Lazear sandy clay loam, high rainfall, 8 to 30 percent slopes; Pinon loam, 8 to 30 percent slopes; and Rubble land.

This complex is used for wildlife habitat and rangeland.

The Ildefonso soli is very deep and well drained.

In a representative profile the surface layer is pinkish gray very stony loam about 5 inches thick. The underlying layer is light gray very cobbly loam and very pale brown very cobbly coarse sandy loam to a depth of 60 inches or more. A horizon of secondary carbonate accumulation occurs at a depth of about 5 inches.

Permeability is moderately rapid. Available water capacity is about 3.75 to 5.0 inches to a depth of 60 inches or more. Water supplying capacity is about 5 to 6 inches. Organic matter content in the surface layer is low. Effective rooting depth is greater than inches. Surface runoff is rapid and erosion hazard is high. The Erosion Condition Class is slight-32.

Present vegetation is dominantly pinyon, juniper, Salina wildrye, Indian ricegrass, black sagebrush, and Birchleaf mountain mahogany.

The potential plant community consists of an overstory of Pinyon pine and Utah juniper with a canopy cover of about 30 percent. The natural vegetation consists of about 35 percent grasses, 5 percent forbs, 30 percent shrubs and 30 percent trees. Important plants are Salina wildrye, Indian ricegrass, western wheatgrass, needleandthread, penstemon, mormontea, sagebrush spp, juniper and pinyon pine.

The pinyon pine and Utah juniper are in site class III, the site index is 20+5 and Woodland Suitability Group is 3r.

This soil is in Capability Subclass VIIIs, non-irrigated; Upland Stony Loam (Pinyon-Juniper) D34, E47 ecology site.

Rock outcrop - Rock outcrop is exposed bedrock consisting of sandstone, conglomerate sandstone, and limestone.

Rock outcrop is in Capability Subclass VIIIIs, and is not rated for an ecological site.

JTG--REPP COMPLEX, 40 TO 70 PERCENT SLOPES

This map unit is on south facing steep mountain and canyon sideslopes, and narrow ridge tops. Slopes are short to medium in length and single in shape. The present vegetation is mainly curlleaf mountainmahogany, pinyon pine, juniper, and mountain shrubs. Elevation is 7,500 to 9,000 feet. The average annual precipitation is about 16 to 20 inches, the mean annual air temperature is 38 to 45 degrees F, and the average freeze-free season is 60 to 120 days.

This unit is 45 percent Repp extremely bouldery fine sandy loam, 40 to 70 percent slopes, 25 percent Doney very stony loam, 40 to 70 percent slopes, and 30 percent inclusions of other soils. The Repp soil is on lower sideslopes and fans, the Doney soil is on ridge tops, the upper sideslopes, and convex ridge lines.

Included in this unit is about 10 percent Podo very bouldery loam, 50 to 70 percent slopes on sideslopes, 5 percent Podo very stony loam, 40 to 70 percent scattered throughout the unit; 10 percent Rock outcrop as cliffs and ledges and 5 percent of soil is similar to Firo cobbly fine sandy loam, 3 to 30 percent slopes except under curlleaf mountainmahogany and on slopes of 15 to 50 percent.

The Repp is very deep and well drained. It formed in colluvium derived dominantly from sandstone. Typically, the surface layer is brown extremely bouldery fine sandy loam about 2 inches thick. The subsoil is reddish brown very cobbly fine sandy loam about 22 inches thick. The upper 8 inches of the substratum is brown extremely cobbly fine sandy loam. The lower part to a depth of 60 inches is reddish brown very stony fine sandy loam. A layer of carbonates is at a depth of about 24 inches.

Permeability of the Repp soil is moderately rapid. Available water capacity, to a depth of 60 inches, is about 4.0 to 5.0 inches. Water supplying capacity is 7 to 8 inches. The organic matter content of the surface layer is 1 to 3 percent. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Doney soil is moderately deep and well drained. It formed in colluvium derived dominantly from sandstone and siltstone. Typically, the surface layer is light brownish gray very stony loam about 6 inches thick. The underlying layer is light brownish gray very stony clay loam about 3 inches thick. The next layer is light gray shaley clay loam. Fractured soft sandstone siltstone is at a depth of about 29 inches. Depth to soft sandstone ranges from 20 to 40 inches.

Permeability of the Doney Soil is moderate to a depth of 6 inches and moderately slow below this depth. Available water capacity to a depth of 29 inches, is about 3 to 4 inches. Water supplying capacity is 6 to 8 inches. The organic matter content of the surface layer is 1 to 3 percent. Effective rooting is 20 to 40 inches. Runoff is rapid and the hazard of water erosion is high. The hazard of soil blowing is slight.

This unit is used for rangeland, wildlife habitat, and recreation.

The Repp and Doney soils are in capability subclass VIIe, non-irrigated.

KXH--PODO-ROCK OUTCROP COMPLEX, 50 TO 80 PERCENT SLOPES

This map unit is on very steep mountain side slopes. Slopes are single to slightly convex in shape and long in length. The present vegetation is mainly pinyon pine, Utah juniper, Salina wildrye, mormon tea, and Douglas fir. Elevation is 5,200 to 8,900 feet. The average annual precipitation is about 12 to 16 inches. The mean annual air temperature is 42 to 45 degrees F, and the average freeze-free season is 100 to 120 days.

This unit is 50 percent Podo very bouldery loam, 50 to 70 percent slopes; 30 percent rock outcrop, and 20 percent other soils. The Podo soil is on steep mountain sideslopes, and the rock outcrop is on nearly vertical ledges and cliffs.

Included in this unit is about 10 percent soil similar to Falcon loam, 1 to 8 percent slopes except on 40 to 70 percent slopes; 5 percent Firo cobbly fine sandy loam, 3 to 30 percent slopes, 5 percent Guben extremely bouldery loam, 50 to 75 percent slopes. These soils are intermixed on the landscape.

The Podo soil is shallow and well drained. It formed in colluvium and residuum derived dominantly from sandstone and shale.

Typically, the surface layer is brown very bouldery sandy loam about 5 inches thick. The underlying material is strong brown gravelly sandy loam. Sandstone is at a depth of 12 inches. Depth to sandstone ranges from 10 to 20 inches.

Permeability of the Podo soil is moderate. Available water capacity, to a depth of 12 inches, is less than 2 inches. Water supplying capacity is less than 2 inches. The organic matter content of the surface layer is 1 to 3 percent. Effective rooting depth is 10 to 20 inches. Runoff is rapid, and the hazard of water erosion is high. The hazard of soil blowing is slight.

Rock outcrop consists of areas of exposed sandstone, limestone and hard shale. It dominantly consists of sandstone.

This unit is used for wildlife habitat.

The Podo soil is in capability subclass VIIIe.

MIF--CABBA BOULDERY LOAM, 20 TO 40 PERCENT SLOPES

This shallow and well drained soil is found on bench and mesa sideslopes. It formed in residuum and local alluvium derived dominantly from shale and siltstone. Slopes are short to medium in length and slightly concave in shape. The present vegetation is mainly pinyon, juniper, birchleaf mountainmahogany, and Salina wildrye. Elevation is 6,400 to 7,600 feet. The average annual precipitation is about 12 to 16 inches, the mean annual air temperature is 42 to 45 degrees F, and the average freeze-free season is 60 to 120 days.

Typically, the surface layer is pale brown bouldery loam about 3 inches thick. The underlying material is brown and light yellowish brown loam. Rippable shale is at a depth of 15 inches. Depth to shale ranges from 10 to 20 inches.

Included in this unit is about 5 percent of a soil similar to Cabba extremely bouldery loam, 20 to 40 percent slopes except moderately deep; 5 percent Ildefonso very stony loam, 8 to 30 percent slopes on the toeslopes; and 5 percent Rock outcrop on sandstone and shale ledges.

Permeability of this cabba soil is moderate. Available water capacity, to a depth of 15 inches, is about 2.0 to 4.0 inches. Water supplying capacity is 4 to 7 inches. The organic matter content of this surface layer is 1 to 3 percent. Affective rooting depth is 10 to 20 inches. Runoff in medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for wildlife habitat and rangeland.

The Cabba soil is in capability subclass VIIIs, non-irrigated.

AMRG--MENFEE-ROCK OUTCROP COMPLEX, 40 TO 70 PERCENT SLOPES

This map unit is on south facing canyon sideslopes. Slopes are short in length and concave-convex in shape. The present vegetation is mainly pinyon, Salina wildrye, mormontea, and a few scattered Douglas fir. Elevation is 5,000 to 8,000 feet. The average annual precipitation is about 12 to 16 inches, the mean annual air temperature 45 to 47 degrees F, and the average freeze-free season is 110 to 145 days.

This unit is 40 percent Menfee extremely bouldery loam, low rainfall, 40 to 70 percent slopes; 30 percent Rock outcrop, and 20 percent slopes, eroded. The menfee soil is on steep and very steep canyon sideslopes, the Rock outcrop is on canyon rims and ledges, and the Shingle soil is on steep and very steep canyon sideslopes.

Included in this unit is about 5 percent Lazear sandy clay loam, 8 to 30 percent slopes on benches, 5 percent Guben extremely bouldery loam, 45 to 75 percent slopes on steep and very steep sideslopes.

The Menfee soil is shallow and well drained. It formed in residuum and colluvium derived dominantly from sandstone and shale from the Green River Formation.

Typically, the surface layer is brown extremely bouldery loam about 2 inches thick. The underlying layer is pale brown very fine sandy loam about 5 inches thick. The next layer is light olive gray siltloam underlain by siltstone at a depth of about 9 inches. Depth of siltstone or shale ranges from 9 to 20 inches.

Permeability of the Menfee soil is moderate. Available water capacity, to a depth of 9 inches, is less than 2 inches. Water supplying capacity is 2 to 4 inches. The organic matter content of the surface is 1 to 3 percent. Effective rooting depth is 9 to 20 inches. Runoff is rapid, and the hazard of water erosion is high. The hazard of soil blowing is slight.

Rock outcrop consists of areas of exposed sandstone, siltstone, and shale. It dominantly occurs on canyon rims and ledges.

The Shingly soil is shallow and well drained. It formed in residuum derived dominantly from shale.

Typically, the surface layer is pinkish gray very shaley loam about 3 inches thick. The underlying layer is pinkish gray loam about 4 inches thick. The next layer is very soft shale fragments to a depth of 14 inches over weathered shale.

Permeability of the shingle soil is moderately slow. Available water capacity, to a depth of 14 inches, is about 2 to 3 inches. The organic matter content of the surface layer is 1 to 3 percent. Effective rooting depth is 10 to 12 inches. Runoff is

rapid, and the hazard of water erosion is high. The hazard of soil blowing is slight.

This unit is used for range and wildlife habitat.

This Menfee soil is capability subclass VIII and the Shingle soil is in capability subclass VIIe, non-irrigated.

MTH--CABBA-GUBEN-ROCK OUTCROP COMPLEX, 40 TO 75 PERCENT SLOPES

This map unit is on sides of mountain canyons. Slopes are medium to long and convex. Elevation is 5,000 to 8,200 feet. The average annual precipitation is about 14 to 20 inches, the mean annual air temperature is 42 to 45 degrees F, and the average freeze-free season is 60 to 120 days.

This unit is 45 percent Cabba bouldery loam, 40 to 70 percent slopes, 20 percent Guben extremely bouldery loam, 40 to 75 percent slopes, and 15 percent Rock outcrop ledges, the Guben soil is on steep foot slopes and Rock outcrop is on canyon rims, ledges, and very steep sideslopes.

Included in this unit are about 8 percent Peso extremely bouldery fine sandy loam, 50 to 80 percent slopes on colluvial foot slopes and toe slopes, 5 percent of a soil similar to Lazear sandy clay loam, high rainfall, 1 to 8 percent slopes, except it has slopes of 40 to 50 percent and is between Rock outcrop ledges; 2 percent Rivra Variant extremely bouldery loam, 1 to 8 percent slopes, on bottoms of drainage ways and five percent of a soil similar to Guben extremely bouldery loam, 40 to 75 percent slopes except that it is very cobbly fine sandy loam, 30 to 50 percent slopes.

The Cabba soil is shallow and well drained. It formed in residuum and in colluvium derived dominantly from sandstone and shale of the Green River Formation. Slopes are 40 to 70 percent. The present vegetation is mainly Pinyon, Juniper, Salina wildrye, and mormontea.

Typically, the surface layer is pale brown bouldery loam about 3 inches thick. The next layer is brown loam about 4 inches thick. Below this layer is light yellowish brown loam that is underlain by rippable shale at a depth of about 15 inches. Depth to shale ranges from 3 to 20 inches.

Permeability of the Cabba soil is moderate. Available water capacity, to a depth of 9 inches, is about 1 to 3 inches. Water supplying capacity is 2 to 5 inches. The organic matter content of the surface layer is 1 to 3 percent. Effective rooting depth is 3 to 20 inches. Runoff is rapid, and the hazard of water erosion is high. The hazard of soil blowing is slight.

The Guben soil is deep and well drained. It formed in colluvium and residuum derived dominantly from sandstone and shale of the Green River Formation. Slopes are 40 to 75 percent. The present vegetation is mainly Douglas fir, pinyon, juniper, Salina wildrye, birchleaf mountainmahogany, and serviceberry.

Typically, the surface is covered with a mat of partially decomposed leaves, twigs, and needles about a 1/2 inch thick. The upper surface layer is grayish brown extremely bouldery loam about

7 inches thick. The underlying surface is pale brown very stony loam about 8 inches thick. The next layer is very pale brown very stony loam about 15 inches. The next layer to a depth of 60 inches or more is light yellowish brown extremely stony loam. A layer of carbonates is at a depth of about 15 inches.

Permeability of the Guben soil is moderate. Available water capacity to a depth of 60 inches, is about 6.0 to 7.5 inches. Water supplying capacity is 7 to 10 inches. The organic matter content of the surface layer is 3 to 5 percent. Effective rooting depth is 60 inches or more. Runoff is rapid and the hazard of water erosion is high. The hazard of soil blowing is slight. Rock outcrop consists of areas of exposed sandstone and shale. It dominantly occurs on canyon rims, ledges, and very steep side-slopes.

This unit is used as rangeland and for wildlife habitat.

This unit is in capability subclass VIIe, non-irrigated.

<u>COMMON PLANT NAME</u>		<u>%</u>
Indian Ricegrass	(ORHY)	-
Needleandthread	(STCO4)	-
Bluebunch Wheatgrass	(AGSP)	6
Western Wheatgrass	(AGSM)	5
Bluegrass	(POA++)	16
Slender Wheatgrass	(AGTR)	5
Other Perennial Grasses	(PPGG)	10
Other Perennial Forbs	(PPFF)	9
Other Shrubs	(SSSS)	5
Birchleaf Mountainmahogany	(CEM02)	-
Black Sagebrush	(ARARN)	22
Saskatoon Serviceberry	(AMAI2)	8
Utah Snowberry	(SYORU)	8
Big Sagebrush	(ARTR2)	3
Bitterbrush	(PUTR2)	3

MUE--CABBA-PODO COMPLEX, 3 TO 30 PERCENT SLOPES

This map unit is on bedrock controlled benches, canyon rims, and toe slopes. Slopes are short in length and concave-convex in shape. The present vegetation is mainly pinyon, juniper, mormon-tea, blacksage and shadescale. Elevation is 5,900 to 8,200 feet. The average annual precipitation is about 12 to 16 inches the mean annual air temperature is 42 to 45 degrees F, and the average freeze-free season is 60 to 120 days.

This unit is 30 percent Cabba gravelly loam, 3 to 30 percent slopes, 30 percent Podo gravelly loam, 3 to 30 percent slopes, and 20 percent Patmos very gravelly loam, low rainfall, 3 to 30 percent slopes. The Cabba Podo soils are intermixed on the landscape while the Patmos soil is found on toe slopes and small ridge slopes.

Included in this unit is about 10 percent Macar Variant fine sandy loam, 3 to 8 percent slopes on toe slopes and bench interiors; 5 percent Macar Variant silt loam, 3 to 5 percent slopes on toe slopes and some bench interiors; 5 percent Rock outcrop on canyon rims and on benches as sandstone outcrops.

Typically, the surface layer is pale brown gravelly loam about 2 inches thick. The underlying layer is brown gravelly loam underlain by weathered shale at a depth of 13 inches. Depth to shale ranges from 10 to 20 inches.

Permeability of the Cabba soil is moderate. Available water capacity to a depth of 7 inches, is about 1 to 3 inches. Water supply capacity is 2 to 5 inches. The organic matter content of the surface layer is 1 to 3 percent. Effective rooting depth is 7 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Podo soil is shallow and well drained. It formed in residuum and colluvium derived dominantly from sandstone.

Typically, the surface layer is brown sandy loam about 2 inches thick. The underlying layer is brown loam about 6 inches thick. The next layer is brown gravelly sandy loam underlain by fractured sandstone at a depth of about 11 inches. Depth to fractured sandstone from 10 to 20 inches.

Permeability of the Podo soil is moderate. Available water capacity to a depth of 11 inches, is about 1 to 3 inches. Water supply capacity is 2 to 4 inches. The organic matter content of the surface layer is 1 to 3 percent. Effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Patmos soil is moderately deep and well drained. It formed in colluvium and residuum derived dominantly from sand-

stone, siltstone, and shale.

Typically, the surface layer is brown very gravelly loam about 3 inches thick. The upper 10 inches of the underlying layer is brown or pale brown gravelly loam, very gravelly loam. The lower part to a depth of 12 inches is pale olive very gravelly loam. Hard siltstone or shale is at a depth of 23 inches.

Permeability of the Patmos soil is moderate. Available water capacity, to a depth of 23 inches, is about 2 to 3.5 inches. Water supplying capacity is 5 to 7 inches. The organic matter content of the surface layer is 1 to 3 percent. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for wildlife habitat and rangeland.

This unit is in capability subclass VIIIs, non-irrigated

NDH2--SHINGLE-BADLAND-RUBBLE-LAND COMPLEX, 50 TO 80 PERCENT

This complex consists of about 40 percent Shingle very stony clay loam, 50 to 80 percent slopes, 25 percent Badland; 20 percent Rubble land; and 15 percent other soils.

This complex occurs on benches and mountain side slopes. There is no definite pattern of soil occurrence on the landscape. The elevations are 6,200 to 7,200 feet. The soil formed from colluvium derived mainly from sandstone and shale.

The average annual precipitation is 12 to 14 inches. Mean annual air temperature is 45 to 47 degrees F, mean annual soil temperature is 47 to 49 degrees F, and the average freeze-free season is 100 to 120 days. Slopes are 50 to 80 percent and occur on east and northeast aspects. They are short in length and concave-convex in shape.

Present vegetation is dominantly Salina wildrye, Indian ricegrass, daisy, skeleton locoweed, shadescale, black sagebrush, and birchleaf mountainmahogany.

Included in mapping are small areas of Shingly extremely stony loam, 50 to 70 percent slopes, eroded; Ildefonso very stony loam, 8 to 30 percent slopes; and Rock outcrop.

This Complex is used for wildlife habitat.

Shingle very stony clay loam, 50 to 80 percent slopes eroded

The Shingle soil is shallow and well drained.

In a representative profile the surface layer is grayish brown very stony clay loam about 3 inches thick. The underlying layer is grayish brown cobbly silty clay loam about 13 inches thick. The next layer is grayish brown silty clay loam over weathered shale at a depth of about 20 inches.

Permeability is moderately slow. Available water capacity is about 2.0 to 3.0 inches above shale. Water supplying capacity is about 3 to 5 inches. Organic matter content in the surface layer is low. Effective rooting depth is about 10 to 20 inches. Surface runoff is rapid and erosion hazard is high. The Erosion Condition Class is moderate- 50. Soil movement occurs principally as numerous small flow patterns although some sheet erosion is also evident.

The potential plant community is about 40 percent grasses, 10 percent forbs, and 50 percent shrubs. Important plants are Salina wildrye, Indian ricegrass, galleta, squirreltail, aster, locoweed, Indian tea, pestemon, princesplume, shadescale, Nuttall saltbush, birchleaf mountainmahogany, eriogonum shrubs, yellow-brush, black sagebrush, and low sagebrush.

This soil is in Capability Subclass VIIe, non-irrigated; Upland Shallow Shale D34, E47 ecological site.

Badland

Badland consists of steep and very steep nearly barren beds actively eroding shale. Shale interbedded with sandstone, shale interbedded with gypsum, and occasionally small areas of shale capped by sandstone. The landscape is dissected by numerous intermittent drainage channels.

Runoff is very rapid. The sediment potential is high during intense summer thunderstorm.

Badland supports only very sparse salt tolerant vegetation.

Badland is in Capability Subclass VIIs, and is not placed in an ecological site.

Rubble land

Rubble land consists of areas covered by stones and boulders to the point that practically no soil is exposed. Rubble land supports only sparse vegetation except for lichens.

Rubble land is in Capability Subclass VIIIs, and is not placed in an ecological site.

NGG2--SHINGLE EXTREMELY STONY LOAM, 50 TO 70 PERCENT SLOPES, ERODED

This Shingle soil is shallow and well drained. It occurs on bench and fan terrace side slopes at elevations of 5,800 to 8,000 feet. This soil formed in colluvium mainly from sandstone and shale.

The average annual precipitation is 12 to 14 inches. Mean annual air temperature is 45 to 47 degrees F. Mean annual soil temperature is 47 to 49 degrees F, and the average freeze-free season is 100 to 130 days. Slopes are 50 to 70 percent and occur on all aspect. They are short in length and concave-convex in shape.

Included in mapping are small areas of Ildefonso very stony loam, 8 to 30 percent slopes, a soil similar to Shingle extremely stony loam, 50 to 70 percent slopes, eroded, except the soil has more than 35 percent rock fragments throughout; Badland; and Rubble land.

In a representative profile the surface layer is light grayish brown extremely stony loam about 7 inches thick. The underlying layer is gray and light brownish gray silt loam overlying weathered shale at a depth of about 19 inches. The horizon over the shale has about 35 percent soft shale fragments.

Permeability is moderately slow. Available water capacity is about 2.0 to 3.0 inches above the shale. Water supplying capacity is about 3 to 6 inches. Organic matter content in the surface layer is low. Effective rooting depth is about 15 to 20 inches. Surface runoff is rapid and erosion hazard is high. The Erosion Condition Class is moderate-54. The erosion occurs as numerous small flow patterns and pedestals.

This soil is used for wildlife habitat.

Present vegetation is dominantly Pinyon, juniper, Salina wildrye, skeleton locoweed, buckwheat, and birchleaf mountain-mahogany.

The potential plant community consists of an overstory of pinyon and juniper with canopy cover of about 15 percent. The natural vegetation is about 40 percent grasses, 10 percent forbs, 20 percent shrubs, and 30 percent trees. Important plants are Salina wildrye, needleandthread, Indian ricegrass, galleta, northern milkvetch, locoweed, birchleaf mountainmahogany, cliff-rose, eriogonum shrub, low sagebrush, pinyon and utah juniper.

<u>COMMON PLANT NAME</u>		<u>%</u>
Salina Wildrye	(ELSA)	5
Needleandthread	(STC04)	5
Indian Ricegrass	(ORHY)	10
Galleta	(HIJA)	10
Other Perennial Grasses	(PPGG)	10
Whitehaired Crazyweed	(OXLA3)	1
Locoweed	(ASTRA)	1
Other Annual Forbs	(AAFF)	8
Birchleaf Mountainmahogany	(CEM02)	3
Cliffrose	(COME5)	2
Mat Eriogonum	(ERCA8)	1
Low Sagebrush	(ARAR8)	11
Pinyon	(PIED)	8
Utah Juniper	(JUDS)	20
Other Shrubs	(SSSS)	5

This soil is in Capability Subclass VIIe, non-irrigated;
Upland Shallow Shale (Pinyon-Juniper) D34, E47 ecological site.

NJF2--SHINGLE-ILDEFONSO-BADLAND COMPLEX, 3 TO 50 PERCENT SLOPES, ERODED

This complex consists of about 40 percent Shingle extremely stony loam, 20 to 50 percent slopes, eroded; 30 percent Ildefonso very stony loam, 3 to 8 percent slopes; 20 percent Badland; and 10 percent other soils.

These soils occur on mountain foot slopes and toe slopes. The Shingle soil and Badland occur on the foot slope erosional surfaces. The Ildefonso soil occurs on the toe slope. The elevations are 6,100 to 6,700 feet.

The average annual precipitation is 12 to 14 inches. Mean annual air temperature is 47 to 49 degrees F, and the average freeze-free season is 10 to 120 days.

Included in mapping are small areas of Lazear sandy clay loam, high rainfall, 1 to 8 percent slopes on small remnant tops and Haverson loam, high rainfall, 1 to 5 percent slopes along the drainages.

This complex is used for rangeland and wildlife habitat.

Shingle extremely stony loam, 20 to 50 percent slopes, eroded

This Shingly soil is shallow and well drained. It formed residuum derived mainly from shale.

Slopes are 20 to 50 percent and occur on all aspects. They are short in length and concave-convex in shape.

Present vegetation is dominantly pinyon, juniper, Salina wildrye, locoweed, buckwheat, and birchleaf mountainmahogany.

In a representative profile the surface layer is light grayish brown extremely stony loam about 7 inches thick. The underlying layer is gray and light brownish gray silt loam overlying weathered shale at depth of about 19 inches. The horizon over the shale has about 35 percent soft shale fragments.

Permeability is moderately slow. Available water capacity is about 2.0 to 3.0 inches above the shale. Water supplying capacity is about 3 to 6 inches. Organic matter content in the surface layer is low. Effective rooting depth is about 15 to 20 inches. Surface runoff is rapid and erosion hazard is high. The Erosion Condition Class is moderate-54. The erosion occurs as numerous small flow patterns and pedestals.

The potential plant community consists of an overstory of pinyon and juniper with canopy cover of about 15 percent. The natural vegetation is about 40 percent grasses, 10 percent forbs, 20 percent shrubs, and 30 percent trees. Important plants are

Salina wildrye, needleandthread, Indian ricegrass, galleta, northern milkvetch, locoweed, birchleaf mountainmahogany, cliff-rose, eriogonum shrub, low sagebrush, pinyon and Utah juniper.

The pinyon and the juniper are Site Class III, the site index is 20+6, and the Woodland Suitability Group is 3d. The average production 1 to 2 cords of wood per acre. The potential for posts of Christmas tree production is very poor. The dominant soil limitation is shallow soil over shale. Seeding mortality is also a limitation.

This soil Capability Subclass VIIe, non-irrigated; Upland Shallow Shale (Pinyon-Juniper) D34, E47 ecological site.

ILDEFONSO VERY STONY LOAM, 3 TO 8 PERCENT SLOPES

The Ildefonso soil is very deep and well drained. It formed in alluvium derived mainly from sandstone and shale.

Slopes are 3 to 8 percent and occur on south and east aspects. They are medium to long in length and single in shape.

Present vegetation is dominantly pinyon, Salina wildrye, Indian ricegrass, black sagebrush and birchleaf mountainmahogany.

In a representative profile the surface layer is pinkish gray very stony loam about 5 inches thick. The underlying layer is very pale brown very stony loam about 42 inches thick. The next layer is very pale brown very cobbly coarse sandy loam to a depth of 60 inches or more. A horizon of secondary carbonate accumulation occurs at a depth of about 5 inches.

Permeability is moderately rapid. Available water capacity is about 3.75 to 5.0 inches to a depth of 60 inches. Water supplying capacity is about 5 to 6 inches. Organic matter content in the surface layer is low. Effective rooting depth is greater than 60 inches. Surface runoff is medium and erosion hazard is high. The Erosion Condition Class is slight-32.

The potential plant community consists of an overstory of pinyon pine and Utah juniper with a canopy cover of about 30 percent. The natural vegetation consists of about 35 percent grasses, 5 percent forbs, 30 percent shrubs and 30 percent trees. Important plants are Salina wildrye, Indian ricegrass, western wheatgrass, needleandthread, penstemon, owl clover, globemallow, birchleaf mountainmahogany, cliffrose, Torrey mormontea, sagebrush ssps, juniper and pinyon pine.

The pinyon pine and Utah juniper are in Site class III, the site index is 38 ± 8 and Woodland Suitability Group is 3x. The average production is less than 4 cords of wood per acre. The potential for fence posts and Christmas trees is poor.

This soil is in Capability Subclass VIIs, non-irrigated; Upland Stony Loam (Pinyon-Juniper) D34, E47 ecological site.

Badland

Badland consists of steep and very steep nearly barren beds of actively eroding shale, shale interbedded with sandstone, shale interbedded with gypsum, and occasionally small areas of shale capped by sandstone. The landscape is dissected by numerous intermitted drainage channels.

Runoff is very rapid. The sediment potential is high during intense summer thunderstorms.

Badland supports only very sparse salt tolerant vegetation.

This is in capability Subclass VIIIs, and is not placed in an ecological site.

ODD--BEENOM LOAM, 3 TP 5 PERCENT SLOPES

This shallow and well drained soil is on broad ridge lines and ridge tops. It formed in residuum derived dominantly from calcareous sandstone. Slopes are short in length and convex-concave in shape. The present vegetation is mainly Wyoming big sagebrush, snowberry, lupine, Salina wildrye, and western wheatgrass. Elevation is 8,000 to 9,700 feet. The average annual precipitation is about 16 to 20 inches, the mean annual air temperature is 38 to 45 degrees F, and the average freeze-free season is 60 to 120 days.

Typically, the surface layer is dark brown loam about 2 inches thick. The subsoil is dark brown silt loam and loam about 13 inches thick. Sandstone is at a depth of 15 inches. Depth to bedrock ranges from 10 to 20 inches.

Included in this unit is about 20 percent of a soil similar to Pino silty clay loam, 3 to 30 percent slopes except the vegetation is mountain big sagebrush; 10 percent Beenom very gravely fine sandy loam 8 to 40 percent slopes on slope breaks and sideslopes; 5 percent Benteen loam, thin surface, 3 to 15 percent slopes on concave slope positions.

Permeability of the Beenom soil is moderate. Available water capacity, to a depth of 15 inches, is about 1.5 to 2.0 inches. Water supplying capacity is 4 to 5 inches. The organic matter content of the surface layer is 3 to 5 percent. Effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The unit is used for rangeland, wildlife habitat, and recreation.

The Beenom soil is in capability subclass VIIIs, non-irrigated.

PPH--ZILLION VERY STONY LOAM, 55 TO 80 PERCENT SLOPES

This deep, well drained soil is on steep mountain sideslopes. It formed in colluvium derived dominantly from sandstone and shale. Slopes are single to slightly convex in shape and long in length. (The present vegetation is mainly Gambel oak, serviceberry, and birchleaf mountainmahogany). Elevation is 6,000 to 8,700 feet. The average annual precipitation is about 16 to 20 inches, the mean annual air temperature is 38 to 45 degrees F, and the average freeze-free season is 60 to 120 days.

Typically, the surface layer is very dark grayish brown very stony loam about 4 inches thick. The upper 10 inches of the subsoil is very dark grayish brown gravelly loam. The lower 8 inches is grayish brown very gravelly loam. The substratum to a depth of 60 inches or more is brown and grayish brown extremely stony and very stony fine sandy loam.

Included in this unit is about 10 percent of a soil similar to Zillion very stony fine sandy loam, 55 to 80 percent slopes except without a layer of clay accumulation. This soil is intermixed with Zillion very stony loam, 55 to 80 percent slopes on the landscape.

Permeability of this Zillion soil is moderate. Available water capacity, to a depth of 60 inches, is about 6 to 7.5 inches. Water supplying capacity is 9 to 12 inches. The organic matter content of the surface layer is 5 to 10 percent. Effective rooting depth is 60 inches or more. Runoff is rapid and the hazard of water erosion is high. The hazard of soil blowing is slight or none.

This unit is used for wildlife habitat.

The Zillion soil is in capability subclass VIIIe.

PSH--ZILLION COMPLEX, 55 TO 80 PERCENT SLOPES

This map unit is on mountain and canyon sideslopes. Elevation is 7,200 to 8,800 feet. The average annual precipitation is about 16 to 20 inches, the mean annual air temperature is 38 to 45 degrees F, and the average freeze-free season is 60 to 120 days.

This unit is 40 percent Zillion very stony fine sandy loam, 55 to 80 percent slopes; 35 percent Zillion stony loam, 55 to 80 percent slopes; and 25 percent inclusions of the soils. The Zillion very stony fine sandy loam, 55 to 80 percent slopes occurs on narrow side ridges running vertically off the main slope, the Zillion stony loam, 55 to 80 percent slopes occurs near the tops of the side slopes and in shallow alluvial drainages running down the slopes.

Included in this unit is about 10 percent of a soil similar to Doney gravelly loam, 50 to 70 percent slopes except with bedrock greater than 60 inches deep, 5 percent of a soil similar to Zillion, very stony fine sandy loam, 55 to 80 percent slopes except with an extremely bouldery surface, 5 percent of a soil similar to Guben very stony loam, high rainfall, 30 to 50 percent slopes except on slopes of 50 to 80 percent and 5 percent Rock outcrop. These soils are intermixed on the landscape.

The Zillion very stony fine sandy loam, 55 to 80 percent slopes is very deep and well drained. It formed in colluvium and residuum derived dominantly from sandstone and shale. Slopes are single to convex in shape, medium to long in length. The present vegetation is mainly serviceberry, birchleaf mountainmahogany, big sagebrush, curlleaf mountainmahogany, and Douglas fir.

Typically, the surface layer is dark brown very stony fine sandy loam and cobbly fine sandy loam about 16 inches thick. The upper 7 inches of the subsoil is dark brown cobbly fine sandy loam. The substratum to a depth of 60 inches or more is brown very stony fine sandy loam.

Permeability of the Zillion very stony fine sandy loam, 55 to 80 percent slopes, soil is moderate. Available water capacity, to a depth of 60 inches, is about 6 to 7 inches. Water supplying capacity is 9 to 12 inches. The organic matter content of the surface layer is 5 to 10 percent. Effective rooting depth is 60 inches or more. Runoff is rapid and the hazard of water erosion is high. The hazard of soil blowing is slight.

The Zillion stony loam, 55 to 80 percent slopes is very deep and well drained. It formed in colluvium derived dominantly from sandstone and shale. Slopes are single to convex in shape and medium to long in length. The present vegetation is mainly birchleaf mountainmahogany, serviceberry, Douglas fir, Wasatch penstemon, big sagebrush, snowberry, pinegrass, and Salina wildrye.

Typically, the surface is covered with a mat of un-decomposed leaves and twigs about 1 inch thick. The surface layer is dark grayish brown stony loam about 3 inches thick. The subsoil is dark grayish brown stony loam about 7 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown very stony loam.

Permeability of the Zillion stony loam, 55 to 80 percent soil is moderate. Available water capacity, to a depth of 60 inches, is about 6 to 7.5 inches. Water supplying capacity is 9 to 12 inches. The organic matter content of the surface layer is 5 to 10 percent. Effective rooting erosion is high. The hazard of soil blowing is none.

This unit is used for wildlife habitat.

This unit is in capability subclass VIIIe.

RFF--BENTEEN LOAM, THIN SURFACE, 30 TO 50 PERCENT SLOPES

This moderately deep, well drained soil is on sideslopes of canyons. It formed in alluvium derived dominantly from sandstone, and shale. Slopes are single to slightly convex-concave. The present vegetation is mainly aspen, snowberry and perennial grasses. Elevation is 8,600 to 9,400 feet. The average annual precipitation is about 20 to 30 inches, the mean annual air temperature is less than 38 degrees F, and the average freeze-free season is less than 60 days.

Typically, the surface layer is very dark grayish brown loam about 4 inches thick. The upper subsoil is brown silt loam about 12 inches thick. The lower subsoil is dark grayish brown clay loam about 19 inches thick over calcareous sandstone. Depth to sandstone ranges from 20 to 40 inches.

Included in this unit is about 10 percent Benteen loam, clayey substratum, 15 to 40 percent slopes; 5 percent of a soil like Doney gravelly loam 50 to 70 percent slopes except 5 percent slopes are on 30 to 50 percent, slopes; 5 percent of a soil similar to Adel loam, 30 to 50 percent slopes; and 3 percent of a soil similar to Benteen loam but at a lower elevation (scrubby aspen) in the mapping unit, and 5 percent Benteen loam, 3 to 5 percent slopes.

Permeability of this Benteen soil is moderate. Available water capacity is about 3.5 to 6.5 inches. Water supplying capacity is 12 to 15 inches. The organic matter content of the surface layer is 5 to 10 percent. Effective rooting depth is 20 to 40 inches. Runoff is medium and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for rangeland, wildlife habitat, recreation, and watershed.

The Benteen soil is in capability subclass, VIIe, nonirrigated.

RR--ROCK OUTCROP-RUBBLE LAND-BADLAND COMPLEX

This complex consists of about 40 percent Rock outcrop; 35 percent Rubble land; and 25 percent Badland. It is on canyon and mesa escarpments. The Rock outcrop and Badland occur as alternating strata. The Rubble land occurs as narrow bands of rock debris that are fan shaped and originate from exposed and fractured sandstone lenses.

The Badland may support only very scarce salt tolerant vegetation.

This concept is used mainly for asthenic purposes.

Rock outcrop

Rock outcrop is exposed bedrock consisting of sandstone, conglomerate sandstone and limestone.

Rock outcrop is in Capability Subclass VIIIs and is not rated for an ecological site.

Rubble land

Rubble land consists of areas covered by stones and boulders to the point that practically no soil is exposed.

Rubble land is in Capability Subclass VIIIs, and is not placed in an ecological site.

Badland

Badland consists of steep and very steep nearly barren beds of actively eroded shale, shale interbedded with gypsum, and occasionally small areas of shale capped by sandstone. The landscape is dissected by numerous intermitted drainage channels.

Runoff is very rapid. The sediment potential is high during intense summer thunderstorms.

Badland is in Capability Subclass VIIs, and is not placed in an ecological site.

RSH2--ROCK OUTCROP-RUBBLE LAND-DL COMPLEX, 60 TO 80 PERCENT SLOPES,
ERODED

This complex consists of about 40 percent Rock outcrop; 25 percent Rubble land; 25 percent DL cobbly fine sandy loam, 60 to 80 percent slopes, eroded; and 15 percent other soils.

It occurs on very steep mountain slopes. The DL soil is mixed with the Rubble land and Rock outcrop in no identifiable pattern. Elevations are 7,900 to 8,100 feet. The DL soil formed in residuum and colluvium derived mainly from sandstone and shale.

The average annual precipitation is 14 to 18 inches. Mean annual air temperature is 43 to 45 degrees F, mean annual soil temperature is 45 to 47 degrees F, and the average freeze-free season is 60 to 80 days.

Included are small areas of Datino extremely stony fine sandy loam, 40 to 60 percent slopes, eroded; and Comodore very stony very fine sandy loam, 50 to 60 percent slopes, eroded.

This complex is used for wildlife habitat.

Rock outcrop

Rock outcrop is exposed bedrock consisting of sandstone, conglomerate sandstone, and limestone.

Rock outcrop is in Capability Subclass VIIIs, and is not rated for an ecological site.

Rubble land

Rubble land is areas of stones and boulders virtually free of vegetation except for lichens.

Rubble land is in Capability Subclass VIIIs, and is not placed in an ecological site.

RXH2--FG-ROCK OUTCROP COMPLEX 50 TO 70 PERCENT SLOPES

This complex consists of about 35 percent FD extremely stony clay loam, 50 to 70 percent slopes, eroded; 20 percent FG very stony loam, 50 to 70 percent slopes, eroded; 25 percent Rock outcrop, and 20 percent other soils.

It occurs on mountain slopes. The FD and FG soils show no definite pattern of occurrence on the landscape. Elevations are 6,750 to 8,750 feet. The soils formed in colluvium derived mainly from sandstone.

The average annual precipitation is 14 to 18 inches. Mean annual air temperature is 43 to 45 degrees F, mean annual soil temperature is 45 to 47 degrees F, and the average freeze-free season is 80 to 100 days. Slopes are 50 to 70 percent and occur on north and northwest aspects. They are long in length and convex and concave in shape.

Present vegetation is dominantly Douglas fir, snowberry, native bluegrass and Rocky Mountain juniper.

Included in mapping are small areas of Comodore very stony very fine sandy loam, 50 to 60 percent slopes, eroded; and a shallow soil over sandstone with light colors.

The soils in this complex are used for wildlife habitat.

FD extremely stony clay loam, 50 to 70 percent slopes, eroded

This soil is very deep and well drained.

In a representative profile the A horizon has been eroded away. The present surface, the upper subsoil is brown extremely stony clay loam about 5 inches thick. The lower subsoil is light yellowish brown cobbly sandy clay loam about 11 inches thick. The substratum is light yellowish brown and very pale brown, cobbly loam to a depth of 60 inches or more. The soil surface is covered by a mantle of decomposing organic material 1 inch thick.

Permeability is moderate. Available water capacity is about 7 to 8.5 inches above a depth of 60 inches. The water supplying capacity is about 8 inches to 10 inches. Surface runoff is medium and erosion runoff is high. The Erosion Condition Class is moderate-48. Flow patterns are small and readily noticeable. Water flow has moved coarse fragments, soil and surface litter.

The potential plant community is about 20 percent grasses, 5 percent forbs, 20 percent shrubs and 55 percent trees. About 85 percent of the trees are inland Douglas fir. Other trees of the sight are Utah juniper, Rocky Mountain juniper, pinyon pine, bigtooth maple, Gamble oak and white fir. Important understory plants are elk sedge, slender wheatgrass, Nevada bluegrass,

mountain junegrass, nodding bromegrass, bluebunch wheatgrass, Salina wildrye, goldenrod, mountainmahogany, serviceberry, Oregon grape, wild currant, dwarf maple, elderberry, and curleaf mountainmahogany.

Principle use is for wildlife habitat.

This soil Capability Subclass VIIIs, non-irrigated; Woodland Douglas Fir ecological site.

FG very stony loam, 50 to 70 percent slopes, eroded

This soil is very deep and well drained.

In a representative profile the surface layer is dark grayish brown, very stony loam about 7 inches thick. The subsoil is dark yellowish brown, very cobbly loam about 13 inches thick. The substratum is yellowish brown very cobbly loam to a depth of 60 inches or more. The soil has a duff layer one inch thick.

Permeability is moderate. Available water capacity is about 5 to 7.5 inches above a depth of 60 inches. Water supplying capacity is about 6 to 10 inches. Organic matter content in the surface layer is moderate. Effective rooting depth is greater than 60 inches. Surface runoff is medium and erosion hazard is high. The Erosion Condition Class is moderate-48. Flow patterns are small and readily noticeable. Water flow has moved coarse fragments, soil and surface litter.

The potential plant community is about 20 percent grasses, 5 percent forbs, 20 percent shrubs and 55 percent trees. About 85 percent of the trees are inland Douglas fir. Other trees of the site are Utah juniper, Rocky mountain juniper, pinyon pine, bigtooth maple, Gamble oak and White fir. Important understory plants are elk sedge, slender wheatgrass, Nevada bluegrass, mountain junegrass, nodding bromegrass, bluebunch wheatgrass, Salina wildrye, goldenrod, aster Louisiana sagewort, lupine, showy goldeneye, wild geranium, birchleaf mountainmahogany, serviceberry, snowberry, Oregon grape, wild currant, dwarf maple, elderberry, and curleaf mountainmahogany.

This soil is in Capability Subclass VIIIs, non-irrigated; Woodland Douglas fir ecological site.

Rock outcrop

Rock outcrop is exposed bedrock consisting of sandstone, conglomerate sandstone and limestone.

Rock outcrop is in Capability Subclass VIIIIs, and is not rated for an ecological site.

RWG--ROCK OUTCROP-RUBBLE LAND-SUNUP COMPLEX 60 TO 70 PERCENT SLOPES

This complex consists of about 25 percent Rock outcrop; 30 percent Rubble land; 25 percent sunup very gravelly fine sandy loam, high rainfall, 60 to 70 percent slopes; and 10 percent other soils.

It occurs on canyon walls, escarpments from mesas, and on mountain sideslopes. The sunup soil is intermixed with the Rock outcrop and Rubble land on these landscapes. Elevations are 4,350 to 8,700 feet. The soils formed in colluvium derived from sandstone.

The average annual precipitation is 12 to 40 inches. Mean annual air temperature is 45 to 50 degrees F, mean annual soil temperature is 47 to 52 degrees F, and the average freeze-free season is 100 to 150 days. Slopes are 50 to 70 percent and occur on all aspects.

Present vegetation is dominantly Utah juniper, pinyon pine, Salina wildrye and galleta.

Included in mapping are small areas of Ildefonso very stony loam, 50 to 70 percent slopes, on colluvial slopes; Shingle extremely stony loam, 50 to 70 percent slopes, eroded; and areas where this sunup soil has an extremely stony surface.

This complex is used for wildlife habitat.

Rock outcrop

Rock outcrop is exposed bedrock consisting of sandstone, conglomerate sandstone, and limestone.

Rock outcrop is in Capability Subclass VIIIs, and is not rated for an ecological site.

Rubble land

Rubble land is areas of stones and boulders virtually free of vegetation except for lichens.

Rubble land is in Capability Subclass VIIIs, and is not placed in an ecological site.

Sunup very gravelly fine sandy loam 60 to 70 percent slopes

This soil is shallow and excessively drained.

In a representative profile the surface layer is brown very gravelly fine sandy loam about 2 inches thick. The underlying layer is brown gravelly fine sandy loam over conglomerate at a depth of about 6 inches.

Permeability is moderately rapid. Available water capacity is about 1.0 inch. Water supplying capacity is about 2.0 inches. Organic matter content in the surface layer is very low. Effective rooting depth is about 5 to 20 inches. Surface runoff is very rapid and erosion hazard is high. The Erosion Condition Class is slight-37.

This soil is in Capability Subclass VIIIs, non-irrigated; and is not rated for an ecological site.

SDDS--BEENOM LOAM, 3 TO 15 PERCENT SLOPES, ERODED

This shallow, well drained soil is on gently mountain slopes. It formed in residuum derived dominantly from sandstone. Slopes are medium in length and convex in shape. The present vegetation is mainly Salina wildrye, Mountain big sagebrush, serviceberry and snowberry. Elevation is 7,000 to 8,100 feet. The average annual precipitation is about 16 to 18 inches, the mean annual temperature is 43 to 45 degrees F, and the average freeze-free season is 50 to 70 days.

Typically the surface layer is brown loam about 6 inches thick. The subsoil is brown clam loam about 8 inches thick. Sandstone is at a depth of 14 inches. Depth to sandstone ranges from 10 to 20 inches.

Included in this unit are small areas of a similar soil to Beenom loam, 3 to 15 percent slope, eroded except 20 to 40 inches deep and a shallow soil lacking layer of clay accumulation.

Permeability of this Beenom soil is moderately slow. Available water capacity, to a depth of 14 inches is about 3.0 inches. water supplying capacity is 4 to 6.5 inches. The organic matter content of the surface layer is 3 to 5 percent. Effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for rangeland and wildlife habitat.

The Beenom soil is in capability subclass VIIIs, non-irrigated.

VOH--PESO-ROCK OUTCROP COMPLEX, 50 TO 80 PERCENT SLOPES

This map unit is on steep to very steep mountain sideslopes. Slopes are short in length and single to convex in shape. The present vegetation is mainly Douglas fir, serviceberry, birchleaf mountainmahogany, mockorange, and western wheatgrass. Elevation is 5,00 to 9,500 feet. The average annual precipitation is about 16 to 20 inches, the mean annual air temperature is 38 to 45 degrees F, and the average freeze-free season is 60 to 120 days.

This unit is 55 percent Peso extremely bouldery fine sandy loam, 50 to 80 percent slopes; 20 percent Rock outcrop, and 25 percent other soils. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit is about 12 percent Midfork bouldery loam, 50 to 80 percent slopes on concave slope positions in drainages, 10 percent Comodore very stony fine sandy loam, 50 to 60 percent slopes, intermixed on the landscape and 3 percent Zillion very stony fine sandy loam, 55 to 80 percent slopes.

The Peso soil is moderately deep and well drained. It formed in colluvium derived dominantly from sandstone and shale.

Typically, the surface is covered with a mat of partially decomposed needles, twigs, and leaves about a 1/2 inch thick. The surface layer is yellowish brown extremely bouldery fine sandy loam about 3 inches thick. The subsoil is yellowish brown very gravelly fine sandy loam about 11 inches thick. The substratum is a yellowish brown extremely cobbly fine sandy loam about 8 inches thick over sandstone. Depth to sandstone ranges from 20 to 40 inches.

Permeability of the Peso soil is moderately rapid. Available water capacity, to a depth of 22 inches, is about 1.0 to 2.0 inches. Water supplying capacity is 3 to 5 inches. The organic matter content of the surface layer is 3 to 50 percent. Effective rooting depth is 20 to 40 inches. Runoff is moderate, and the hazard of water erosion is slight. The hazard of soil blowing is slight.

Rock outcrop consists of areas of exposed sandstone and shale. It is dominantly interbedded and occurs as ledges.

This unit is used for rangeland, wildlife habitat, and recreation.

The Peso soil is in capability subclass VIIe, non-irrigated, and Rock outcrop is in capability subclass VIII.

WAG--WIDTSOE VERY STONY LOAM, HIGH RAINFALL, 50 TO 70 PERCENT SLOPES

This Widtsoe soil is very deep and well drained. It occurs on very steep mountain slopes at elevations of 7,200 to 8,700 feet. This soil formed in colluvium derived mainly from sandstone and shale.

The average annual precipitation is 14 to 17 inches. Mean annual air temperature is 42 to 45 degrees F, mean annual soil temperature is 44 to 47 degrees F, and the average freeze-free season is 50 to 90 days. Slopes are 50 to 70 percent and occur on the north aspects. They are short in length and concave convex in shape.

Included in mapping are small areas of similar soil except 20 to 40 inches deep; and UH extremely stony loam, 30 to 50 percent slopes.

In a representative profile the surface layer is dark grayish brown and grayish brown very stony loam about 9 inches thick. The subsoil is brownish yellow very cobbly clay loam about 15 inches thick. The substratum is light brownish gray very cobbly loam to a depth of 60 inches or more. There is a horizon of carbonate accumulation at a depth of 24 inches.

Permeability is moderately slow. Available water capacity is about 5.0 to 7.0 inches above a depth of 60 inches. Water supplying capacity is 7 to 10 inches. Organic matter content in the surface layer is moderate. Effective rooting depth is greater than 60 inches. Surface runoff is medium and erosion hazard is moderate. The Erosion Condition Class is slight-37.

This soil is used for wildlife habitat.

Present vegetation is dominantly serviceberry, bluegrass, slender wheatgrass, birchleaf mountainmahogany, snowberry and black sagebrush.

The potential plant community is about 40 percent grasses, 5 percent forbs, and 55 percent shrubs. Important plants bluegrass, Salina wildrye, bluebunch wheatgrass, muttongrass, Nevada bluegrass, slender wheatgrass, prairie junegrass, western wheatgrass, hawksbeard, locoweed, penstemon, sego lily, birchleaf mountainmahogany, Wyoming big sagebrush, black sagebrush, yellowbrush, serviceberry and snowberry.

<u>COMMON PLANT NAME</u>		<u>%</u>
Salina wildrye	(ELSA)	8
Bluebunch wheatgrass	(AGSP)	9
Muttongrass	(POEE)	6
Nevada Bluegrass	(POHE3)	6
Other Perennial Grasses	(PPGG)	8
Other Perennial Forbs	(PPFF)	4
Other Annual forbs	(AAFF)	1
Birchleaf Mountainmahogany	(CEMO2)	20
Sagebrush	(ARTEM)	10
Serviceberry	(AMELA)	15
Snowberry	(SYMPH)	5
Other Shrubs	(SSSS)	5

This soil is in capability Subclass VIIIx, non-irrigated;
Mountain Loam (Shrub) E47 ecological site.

BLUE

Appendix 2-3

Description of Soil Series

Description of Soil Series

BENTEEN SERIES

These soils are classified as fine-loamy, mixed Argic Pachic Cryoborolls.

The Benteen series consists of moderately deep, well drained, and moderately permeable soils that formed in residuum derived dominantly from limestone or sandstone.

These soils are on mountain and ridge sideslopes and benches at elevations of 7,200 to 10,000 feet. Slope ranges from 1 to 50 percent. The average annual precipitation ranges from 20 to 30 inches, and the mean annual air temperature is less than 38 degrees F.

O1--3 inches to 0; somewhat decomposed leaves and twigs.

A1--0 to 4 inches; very dark grayish brown (10YR 3/2) loam, black (10YR 2/1) moist; moderate medium granular structure; soft, very friable non sticky, non plastic; few fine and very fine roots; neutral reaction (pH 7.2), abrupt smooth boundary.

B21t--4 to 9 inches; brown (10YR 4/3) silt loam, very dark grayish brown (10YR 3/2) moist; moderate, medium sub-angular blocky structure; hard firm, slightly sticky, slightly plastic, few fine medium and coarse roots, few very fine and fine pores; few thin clay films on ped faces and in pores; neutral reaction (pH 7.2); clear smooth boundary.

B22t--9 to 16 inches; brown (10YR 5/3) silt loam, very grayish brown (10YR 3/2) moist; moderate, medium sub-angular blocky structure; very hard, firm, slightly sticky, slightly plastic; few very fine, fine and medium and roots, few very fine and fine pores, common moderately thick clay films on ped faces and on pores; mildly alkaline (pH 7.6); clear smooth boundary.

B23t--16 to 35 inches; brown (10YR 5/3) clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium sub-angular blocky structure; very hard, firm, slightly sticky, slightly plastic; few very fine, fine and medium roots; few very fine and fine pores; few thin clay films on ped faces and in pores; mildly alkaline (pH 7.6); abrupt smooth boundary.

R--35 inches; calcareous sandstone.

The mollic epipedon is 16 to 35 inches thick. Depth to bedrock is 20 to 40 inches. Mean annual soil temperature is 40 to 44 degrees F. Mean summer soil temperature is 45 to 52 degrees F,

The A horizon has hue of 10YR or 2.5YR, value of 3 to 5 dry, 2 or 3 moist, and chroma of 1 to 3. It is dominantly loam, silt

loam, and fine sandy loam with less than 27 percent clay.

The All horizon is noncalcareous or slightly calcareous and is neutral to mildly alkaline.

The B2t horizon has hue of 10YR or 2.5YR, value of 3 to 5 dry, 2 or 3 moist, and chroma of 2 to 4. It is loam, clay loam, and silty clay loam, and silt loam with gravel, cobbles, and channery fragment content ranging from 0 to 25 percent. Clay content is 24 to 35 percent.

Some pedons have a thin C horizon. The C horizon has hue of 10YR or 2.5y, value of 5 to 7 dry, 4 or 5 moist, and chroma of 2 to 4. It is loam, clay loam to silty clay with cobbles, pebbles, and channery fragments ranging from 10 to 40 percent in volume.

BEEBOM SERIES

These soils are classified as loamy, mixed Lithic Argiborolls.

The Beenom series consists of shallow, well drained, and moderately permeable soils that formed in residuum derived dominantly from sandstone. These soils are on broad ridgelines, cuesta dipslopes, and gently mountain sideslopes at elevations of 6,800 to 9,700 feet. Slope ranges from 1 to 50 percent. The average annual precipitation ranges from 16 to 20 inches, and the mean annual air temperature ranges from 38 to 45 degrees F.

They are near the Podo, Pino, Benteen, Corpening, Firo and Kiev soils. Podo, Corpening, Firo, and Kiev soils all lack a layer of clay accumulation. Pino and Benteen soils are deeper than 60 inches.

A1--0 to 3 inches; brown (7.5YR 4/4) gravelly fine sandy loam, dark brown (7.5YR 3/2) moist; weak medium platy structure; soft, very friable, nonsticky, and slightly plastic; common very fine and few fine and medium roots; common very fine and fine pores; noncalcareous, lime is disseminated; moderately alkaline (pH 8.4); abrupt smooth boundary.

B2t--3 to 9 inches brown (7.5 YR 4/4) loam, dark brown (7.5 YR 3/2) moist; weak medium prismatic sub-angular blocky structure; slightly hard, firm, slightly sticky and plastic; common very fine and few fine, few medium roots; common very fine and fine pores; very few thin clay films, occurring as colloid stains on mineral grains; moderately alkaline (pH 8.4); clear smooth boundary.

C1--9 to 12 inches; pale brown (10YR 6/3) silt loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, firm, nonsticky, and slightly plastic; few fine roots; few fine pores; moderately calcareous, carbonates are disseminated; moderately alkaline (pH 8.4).

R--12+ inches, calcareous sandstone.

Depth to sandstone is 8 to 20 inches. Rock fragments range from fine gravel to stone but are predominately sandstone cobbles in some horizons. Rock fragments range from 0 to 50 percent but averages less than 35 percent in the central section. Mean annual soil temperature is 41 to 47 degrees F. The nollic epipedon is 8 to 18 inches thick.

The A horizon has hue of 7.5YR and 10YR, value of 3 to 5 dry, 1 to 3. It is fine sandy loam through clay loam and very gravelly fine sandy loam through clay loam.

The B2t horizon has hue of 7.5YR and 10YR, value of 3 to 5, 2 to 4 moist, and chroma of 1 to 3. It is typically loam or clay loam but may also be silt loam or sandy clay loam with this strata

of very cobbly sandy clay loam, fine sandy loam, or very gravelly sandy clay loam. Clay content is 18 to 35 percent.

Some pedons have a thin C horizon. The C horizon has hue of 7.5YR or 10YR, value of 5 to 7 dry, 4 moist, and chroma of 3 or 4.

CABBA SERIES

These soils are classified as loamy, mixed (calcareous), frigid, shallow, Typic Ustorrhents. The Cabba series consists of shallow, well drained, moderately permeable soils that formed in residuum and colluvium derived dominantly from shale or siltstone of the Green River Foundation.

These soils are on benches, canyon rims, and steep canyon sideslopes at elevations of 5,000 to 8,200 feet. Slope ranges from 3 to 70 percent. The average annual precipitation ranges from 12 to 16 inches, and the mean annual air temperature ranges from 42 to 45 degrees F.

They are near the Podo, Guben, and Patmos soils.

Podo soils have hard sedimentary rock and depths of less than 20 inches. Guben and Patmos soils have depths greater than 20 inches.

A1--0 to 3 inches; pale brown (10YR 6/3) bouldery loam, brown (10YR 4/3) moist; moderate medium granular that parts to fine granular structure; loose, slightly sticky, slightly plastic, common very fine roots; 5 percent fine gravels, 10 percent cobbles; 15 percent boulders; slightly calcareous, carbonates are disseminated; strongly alkaline (pH 8.6) abrupt smooth boundary.

C1--3 to 7 inches; brown (10YR 5/3) loam, brown (10YR 4/3) moist; moderate medium granular that parts to fine granular structure; loose, slightly sticky, slightly plastic, common very fine roots; slightly calcareous, moderately alkaline (pH 8.4); abrupt smooth boundary.

C2--7 to 15 inches; light yellowish brown (10YR 6/4) loam, yellowish brown (10YR 5/4) moist; massive; soft, friable, slightly sticky, slightly plastic; common very fine, fine roots; 5 percent shale fragments which slake in water; slightly calcareous, strongly alkaline (pH 8.8); abrupt smooth boundary.

C3r--15 inches; rippable shale; soft carbonate coatings on the surface of rocks.

Depth to soft shale or siltstone is 8 to 20 inches. Rock fragments are soft shale, siltstone with some sandstone fragments and range in size from fine gravel to large sandstone flags and boulders. The surface contains from 0 to 10 percent coarse fragments, but the control section contains less than 35 percent. These soils are commonly calcareous throughout.

The A horizon has hue of 2.5YR or 10YR, value of 5 to 7 dry, 3 to 5 moist, and chroma of 2 to 3. It is loam, bouldery loam, or gravelly loam.

The C horizon has hue of 2.5YR or 10YR, value of 5 or 6 dry, 4 or 5 moist, and chroma of 2 to 4. It is loam, silty clay loam, clay loam, gravelly loam, extremely gravelly loam. The horizon is moderately calcareous or strongly calcareous and is moderately to strongly alkaline.

DECROSS VARIANT

These soils are classified as fine-loamy, mixed Argic Pachic Cryoborolls.

These Decross Variant consists of deep, well drained, moderately permeable soils that formed in colluvium derived dominantly from colluvium sandstone, siltstone and shale.

These soils are on mountain sideslopes at elevations of 7,500 to 9,600 feet. Slope ranges from 15 to 70 percent. The average annual precipitation ranges from 20 to 30 inches, and the mean annual air temperature is less than 38 degrees F.

They are near the Benteen, Teton, and Midfork soils. Benteen soils have a mollic epipedon which is less than 16 inches thick. Teton soils have a lithic contact within 40 inches and a mollic epipedon less than 16 inches thick and no argillic horizon.

0---1 inch to 0; duff of needles, twigs and leaves.

A1--0 to 3 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; moderate medium sub-angular blocky structure; soft, friable, slightly sticky, slightly plastic, common very fine, medium few coarse roots; moderately calcareous, carbonates are disseminated; strongly alkaline (pH 8.6); abrupt smooth boundary.

B21t--3 to 8 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate coarse sub-angular blocky structure; hard, friable, sticky, plastic; common very fine, few fine pores; few thin clay films on ped faces and pores; moderately calcareous, carbonates are disseminated; strongly alkaline (pH 8.6); clear smooth bouldery.

B22t--8 to 19 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium, sub-angular blocky structure; hard, friable, sticky, plastic; common very fine, few medium and coarse roots; few very fine pores; few thin clay films on ped faces and lining pores; 10 percent gravel; moderately calcareous, carbonates are disseminated; strongly alkaline (pH 8.6); clear wavy boundary.

B3-- 19 to 24 inches; dark grayish brown, gravelly silt loam, very dark grayish brown (10YR 3/2) moist, weak medium sub-angular blocky structure; slightly hard; friable, sticky, plastic; few very fine and fine roots; few very fine pores; 20 percent gravels; strongly calcareous, carbonates are disseminated; strongly alkaline (Ph 8.6); clear smooth boundary.

Clay--24 to 32 inches; grayish brown (10YR 5/2) gravelly silt loam, dark grayish brown (10YR 4/2) moist; weak fine sub-angular blocky structure; slightly hard; friable, sticky, plastic; few very

fine, few medium roots; 20 percent gravel which slakes in water; strongly alkaline (pH 8.6); clear smooth boundary.

C2ca--32 to 55 inches; pale brown (10YR 6/3) very channery fine sandy loam, dark brown (10YR 3/3) moist; single grain; soft, very friable, slightly sticky, slightly plastic; few very fine roots; 40 percent gravel, 20 percent channery; strongly calcareous, carbonates are disseminated; strongly alkaline (pH 8.8); diffuse wavy boundary.

C3r--55 inches, calcareous shale.

Depth to bedrock is greater than 40 inches. The control section is commonly loam, and silt loam, but ranges to include clay loam in some pedons. Clay content is 18 to 35 percent. Rock fragments are less than 10 percent in the control section.

The A horizon has hue of 2.5Y or 10YR, value of 4 or 5 dry, 2 or 3 moist, and chroma of 2 or 3. It is loam and fine sandy loam.

The B2t horizon has hue of 2.5Y or 10YR, value of 4 or 5 dry and 3 or 4 moist. It is loam and silt loam, or clay loam with 18 to 35 percent clay and 0 to 10 percent gravel.

The Cca horizon is moderately calcareous or strongly calcareous and is mildly to strongly alkaline.

Vegetation on Decross Variant is white fir, subalpine fir, Douglas fir and snowberry.

DETRA VARIANT

These soils are classified as fine-loamy, mixed Pachic Argiborolls.

The Detra Variant consists of moderately deep, well drained, and moderately slow permeable soils that formed in residuum derived dominantly from calcareous sandstone.

These soils are on mountains, benches, or ridge sideslopes at elevation 8,000 to 9,000. Slope ranges from 40 to 70 percent. The average annual precipitation ranges from 16 to 20 inches, and the mean annual air temperature ranges from 38 to 42 degrees F.

They are near the Podo, Cabba, Guben, Zillion and Doney soils. Zillion and Guben soils have a greater than 35 percent rock fragments, Podo and Cabba soils lack a dark surface layer and are less than 20 inches deep. Doney soils lack a dark surface layer and a layer of clay accumulation.

A1--0 to 5 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak medium sub-angular blocky structure; very hard, firm, sticky, and plastic; common very fine and fine, few coarse roots; few very fine, fine and medium pores; 10 percent gravel; moderately gravel; moderately calcareous, carbonates are disseminated; mildly alkaline (pH 7.4); abrupt smooth boundary.

B2t--5 to 20 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; moderate medium sub-angular blocky structure; very hard, firm, sticky, and plastic; common very fine and fine pores; moderately calcareous, carbonates are disseminated; mildly alkaline (pH 7.6); clear smooth boundary.

R--24 inches; calcareous sandstone.

Thickness of the solum ranges from 23 to 40 inches.

Depth to calcareous sandstone is 20 to 40 inches. The control section is commonly loam or clay loam, but ranges to include silt loam, silty clay loam, and cobbly silty clay loam in some pedons.

Reactions range from mildly to moderately alkaline.

The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 dry; 2 or 3 moist, and chroma of 2 or 3.

The B2t horizon has hue of 7.5YR or 10YR, value of 3 to 5 dry; 2 to 3 moist, and chroma of 2 or 3. Thickness of the solum ranges from 18 to 35 inches.

The C horizon where present has hue of 2.5Y or 10YR, value of 4 to 5 moist and dry and chroma of 3 to 4.

Detra Variant differs from Detra series because it is moderately deep. hue of 10YR in the B2t horizon, and dry value ranges up to 5 dry in the A horizon.

DONEY SERIES

These soils are classified as fine-loamy, mixed (calcareous), frigid Typic Ustorthents.

The Doney series consists of moderately deep, well drained, moderate to moderately slow permeable soils that formed in colluvium and residuum derived dominantly from sandstone, siltstone, and shale.

These soils are on south facing steep mountain and canyon sideslopes at elevations of 7,500 to 9,500 feet. Slope ranges from 40 to 70 percent. The average annual precipitation ranges from 16 to 20 inches, and the mean annual air temperature ranges from 38 to 45 degrees F.

They are near the Rep, Firo, and Podo soils, Repp soils have bedrock at depths greater than 40 inches. Firo soils have a dark surface and bedrock at depths less than 20 inches.

A1--0 to 6 inches; light brownish gray (10YR 6/2) very stony loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; slightly hard, firm, nonsticky, slightly plastic; common fine and very fine, few medium roots; 15 percent gravel, 10 percent cobbles, 15 percent stones, 1 percent boulders; moderately calcareous, carbonates are disseminated; moderately alkaline (pH 8.2); abrupt smooth boundary.

C1ca--6 to 9 inches; light brownish gray (10YR 6/2) very stony loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure hard, firm, sticky, plastic; common very fine, few medium roots; 10 percent gravel, 5 percent stones; moderately calcareous, carbonates are disseminated; moderately alkaline (pH 8.2); clear smooth boundary.

C2ca--9 to 19 inches; light gray (10YR 7/2) shaley clay loam, pale loam, light brownish gray (10YR 7/2) moist; weak medium sub-angular blocky structure; very hard, firm, sticky, plastic, few very fine, fine roots; 15 percent soft shale; strongly calcareous, carbonates are disseminated; strongly alkaline (pH 8.6); abrupt smooth boundary.

C3--19 to 29 inches; white (10YR 8/2) shaley silty clay loam, very pale brown (10YR 7/3) moist; rock structure; few very fine roots; 25 percent siltstone; moderately calcareous, carbonates are disseminated; moderately alkaline (pH 8.6); abrupt smooth boundary.

C4--29 inches; soft sandstone.

Depth to sandstone or siltstone is 20 to 40 inches. The control section is commonly clay loam but ranges to include loam, sandy loam, and silty clay loam in some pedons. Clay content is 18 to 35 percent. Rock fragments are gravel, channers, and flags

of sandstone, siltstone and shale and range from 0 to 25 percent in the control section. These soils are commonly calcareous throughout.

The A horizon has hue of 10YR, value of 4 to 6 dry, and chroma of 2 or 3. It is gravelly loam, very stony loam, fine sandy loam.

The C horizon is strongly calcareous or very strongly calcareous and is moderately or strongly alkaline.

ELWOOD SERIES

These soils are classified as loamy-skeletal, mixed Argic Cryoborolls.

The Elwood series consist of moderately deep, well drained, and moderately permeable soils that formed in residuum and colluvium derived dominantly from sandstone and shale.

These soils are on moderately steep to very steep mountain slopes at elevations of 7,900 to 9,500 feet. Slope ranges from 50 to 70 percent. The average annual precipitation ranges from 20 to 30 inches, and the mean annual air temperature ranges from 32 to 38 degrees F.

They are near the Decross, Adel, Benteen, Teton, Midfork and Zillion soils. Decross, Adel, Teton and Benteen soils have fine-loamy control sections. Zillion, Decross, Adle, and Benteen soils have thick dark colored surface horizons. Midfork soils is a very deep soil.

01--1 inch to 0; un-decomposed twigs, needles and leaves.

A1--0 to 4 inches; brown (10YR 4/3) extremely bouldery loam, dark brown (10YR 3/3) moist; moderate fine granular structure; hard friable, slightly sticky, and slightly plastic; few fine, medium and coarse roots; five percent gravel, five percent cobble, 15 percent stones, 5 percent boulders; mildly alkaline (pH 7.6); abrupt smooth boundary.

B21t--4 to 13 inches; brown (10YR 4/3) very gravelly silt loam, dark brown (10YR 3/3) moist; weak fine sub-angular blocky parting to weak fine granular structure; hard, friable, slightly sticky, slightly plastic; common fine and medium, a few coarse roots; 30 percent gravel, 10 percent cobbles, and 5 percent stones; mildly alkaline (pH 7.6); clear wavy boundary.

B22t--13 to 19 inches; brown (10YR 5/3) very gravelly silt loam, brown (10YR 4/3) moist; weak medium sub-angular blocky structure; hard, friable, slightly sticky, and slightly plastic; common very fine, and few medium roots; 30 percent gravel, 10 percent cobbles, and 5 percent stones; mildly alkaline (pH 7.8); abrupt wavy boundary.

B23t--19 to 24 inches; brown (10YR 5/3) very gravelly silt loam, brown (10YR 4/3) moist; rock structure; hard, friable, slightly sticky, and slightly plastic; few very fine, fine and medium roots; 40 percent gravel, 10 percent cobbles, and 5 percent stones; slightly calcareous, carbonates are disseminated; moderately alkaline (pH 8.0); abrupt wavy, boundary.

R--24 inches; sandstone.

FD SERIES

Taxonomic classification is loamy-skeletal, mixed Typic Cryoboralfs.

O1--1 to 0 inches; duff, partly needles, twigs and grass.

B21t--0 to 5 inches; brown (10YR 5/3) extremely stony clay loam, dark grayish brown (10YR 4/2) when moist; moderate medium sub-angular blocky structure; extremely hard, firm, sticky, plastic, common very fine and fine, few coarse roots; many very fine and common fine pores; few thin clay films on faces of peds; 5 percent gravel, 10 percent cobbles, and 30 percent stones; mildly alkaline (pH 7.6); clear wavy boundary.

B22t--5 to 16 inches; light yellowish brown (10YR 6/4) cobbly sandy clay loam, brown (10YR 5/3) when moist, moderate medium angular blocky structure; extremely hard, firm sticky, plastic; few very fine, medium, and coarse roots; common very fine and fine, few medium pores; few thin clay films on faces of peds; 15 percent gravel and 15 percent cobbles; mildly alkaline (PH 7.6); clear smooth boundary.

C1-16 to 30 inches; light yellowish brown (10YR 5/4) cobbly loam, yellowish brown (10YR 5/4) when moist; moderate medium sub-angular blocky structure; extremely hard, friable, slightly sticky, slightly plastic; few very fine, fine, medium and coarse roots; common fine and few medium pores; 5 percent gravel and 10 percent cobbles; mildly alkaline (pH 7.6); clear wavy boundary.

C2--30 to 60 inches; very pale brown (10YR 7/3) cobbly loam, brown (10YR 5/3) when moist; massive; very hard friable, slightly sticky, slightly plastic; few very fine, fine medium and coarse roots; few fine and medium pores; 10 percent gravel and 10 percent cobbles, slightly calcareous, strongly alkaline (pH 8.6).

The range in characteristics of this soil has not yet been determined.

FG SERIES

Taxonomic classification is loamy-skeletal, mixed Argic Pachic Cryoborolls.

01--1 inch to 0; partly decomposed needles, twigs and grass.

A1--0 to 7 inches; dark grayish brown (10YR 4/2) very stony loam, dark brown (10YR 3/3) when moist; moderate medium granular structure; hard, friable, slightly sticky, slightly plastic, common fine, medium and coarse roots; common fine and medium coarse roots; common fine and medium pores; 10 percent gravel, 10 percent cobbles and 20 percent stones; moderately alkaline (pH 8.0); clear wavy boundary.

Bet--7 to 20 inches; dark yellowish brown (10YR 4/4) very cobbly loam, dark brown (10YR 3/3) when moist; moderate medium angular blocky structure; extremely hard, firm, sticky, plastic; many fine and medium common coarse roots; few fine and medium pores; few thin clay films on faces of peds; 10 percent gravel, 20 percent cobbles and 10 percent stones; moderately alkaline (pH 8.2); very wavy boundary.

Clca--20 to 60 inches; yellowish brown (10YR 5/4) very cobbly loam, dark yellowish brown (10YR 4/4) when moist; weak medium sub-angular blocky structure; hard, friable, slightly sticky, slightly plastic, common fine, medium and coarse roots; common fine and few medium pores; 10 percent gravel; 30 percent cobbles and 10 percent stones; strongly calcareous, carbonates are in veins and as coatings on the undersides of coarse fragments; moderately alkaline (pH 8.4).

GUBMEN SERIES

These soils are classified as loamy-skeletal Typic Calciborolls.

The Guben series consists of deep, well drained, moderately permeable soils that formed in colluvium derived dominately from sandstone and shale of the Green River Formation.

These soils are on steep and very steep canyon sideslopes at elevations of 5,000 to 8,400 feet. Slope ranges from 30 to 75 percent. The average annual precipitation ranges from 16 to 20 inches, and the mean annual air temperature ranges from 42 to 45 degrees.

They are near the Cabba, Peso, and Lazear soils. Cabba and Lazear soils are shallow. Peso soils are moderately deep.

01--1/2 inch to 0; litter partially decayed pine needles and grasses.

A11--0 to 7 inches; grayish brown (10YR 5/2) extremely bouldery loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable, slightly sticky, slightly plastic; common very fine, fine medium and coarse roots; 15 percent gravel, 10 percent cobbles, 5 percent stones, 10 percent boulders; moderately calcareous, carbonates are disseminated; moderately alkaline (pH 8.2); clear wavy boundary.

A12--7 to 15 inches; pale brown (10YR 6/3) very stony loam, dark brown (10YR 3/3) moist; weak fine granular structure; soft, very friable, slightly sticky, slightly plastic, common very fine, fine, medium coarse roots; 10 percent gravel, 15 percent cobbles, 20 percent stones, moderately calcareous, carbonates are disseminated; moderately alkaline (pH 8.4); clear broken boundary.

C1ca--15 to 30 inches; very pale brown (10YR 7/3) very stony loam, pale brown (10YR 6/3) moist; moderate medium sub-angular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; common very fine, few fine, medium, coarse roots, few very fine, medium common fine pores; 10 percent gravel, 10 percent cobbles, 20 percent stones, 5 percent boulders; strongly calcareous, carbonates are disseminated; strongly alkaline (pH 8.6); clear smooth boundary.

C2--30 to 60 inches; light yellowish brown (10YR 6/4) extremely stony loam, brown (10YR 5/3) moist; moderate medium sub-angular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; few very fine, fine and medium roots; few very fine, medium common fine pores; 10 percent gravel, 20 percent cobbles, 25 percent stones, 5 percent boulders; moderately calcareous, carbonates are disseminated; strongly alkaline (pH

9.0).

The mollic epipedon is 7 to 16 inches thick. Depth to bedrock is greater than 40 inches. The control section is commonly very stony loam but ranges to include fine sandy loam, very stony fine sandy loam in some pedons. Rock fragments are 35 to 60 percent in the control section and consist of gravel, cobbles, stones and boulders. These soils are commonly calcareous throughout.

The A horizon has hue of 10YR, value of 4 or 5 dry, 2 or 3 moist, and chroma of 1,2 or 3. It is very stony loam, extremely bouldery loam.

The C horizon has hue of 10YR, value of 5 to 7 dry, 4 to 6 moist, and chroma of 3 or 4. The C horizon is moderately calcareous of strongly calcareous and is moderately to strongly alkaline.

HAVERSON SERIES

A1--0 to 6 inches; brown (10YR 5/3) fine sandy loam, grayish brown (10YR 5/2) moderate coarse sub-angular blocky structure; slightly hard, friable, slightly hard, slightly plastic; common very fine and fine pores; moderately calcareous, carbonates are disseminated; strongly alkaline (pH 8.6); abrupt smooth boundary.

C1--6 to 16 inches; pale brown (10YR 6/3) loam, grayish brown (10YR 5/2) when moist; moderate coarse sub-angular blocky structure; hard friable; slightly sticky, slightly plastic; few very fine roots; many very fine, few fine and medium pores; moderately calcareous, carbonates are disseminated; strongly alkaline (pH 8.8); clear wavy boundary.

C2--16 to 24 inches; pale brown (10YR 6/3) silt loam, grayish brown (10YR 5/2) when moist; moderate medium sub-angular blocky structure; hard, friable, sticky, plastic; few very fine roots; common very fine, few fine and medium pores; moderately calcareous, carbonates are disseminated; strongly alkaline (pH 8.8); abrupt smooth boundary.

C3--24 to 36 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) when moist; moderate medium sub-angular blocky structure; very hard, friable, slightly sticky, slightly plastic, few very fine and fine pores; moderately calcareous, carbonates are disseminated; strongly alkaline (pH 8.8); clear smooth boundary.

C4--36 to 45 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; massive; very hard, firm, slightly sticky, slightly plastic; common very fine pores, cicada casts present; moderately calcareous, carbonates are disseminated; strongly alkaline (pH 8.8); clear smooth boundary.

C5--45 to 60 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; massive; very hard, firm, slightly sticky, slightly plastic, common very fine pores; cicada casts present; moderately calcareous, carbonates are disseminated; strongly alkaline (pH 9.0).

ILDEFONSO SERIES

A1--0 to 5 inches; pinkish gray (7.5YR 6/2) very stony loam, dark grayish brown (7.5YR 4/2) when moist; weak fine granular structure; slightly hard, friable, slightly sticky, slightly plastic; common fine and many coarse roots; common very fine and few fine pores; 20 percent gravel, 10 percent cobbles, 15 percent stones and boulders; strongly calcareous, carbonates are disseminated; strongly alkaline (pH 8.6); gradual wavy boundary.

C1ca--5 to 17 inches; light gray (10YR 7/2) very cobbly loam, grayish brown (10YR 5/2) when moist; massive, hard, friable, slightly sticky, slightly plastic; common fine and many coarse roots; few very fine pores; 10 percent gravel, 20 percent cobbles and 10 percent stones; strongly calcareous, carbonates are veined; strongly alkaline (pH 8.6); gradual wavy boundary.

C2ca--17 to 47 inches; very pale brown (10YR 7/3) very stony loam, brown (10YR 5/3) when moist; massive; hard, friable, slightly sticky, slightly plastic; few fine and medium roots; many very fine and few fine pores; 15 percent gravel, 25 percent cobbles and 20 percent stones; strongly calcareous, carbonates occur as powdery soft masses; strongly alkaline (pH 8.8); gradual wavy boundary.

C3--47 to 60 inches; very pale brown (10YR 8/4) very cobbly coarse sandy loam, light yellowish brown (10YR 6/4) when moist; massive; slightly hard, very friable; few fine roots; few fine pores; 20 percent gravel, 20 percent cobbles and 5 percent stones; strongly calcareous, carbonates are disseminated; strongly alkaline (pH 8.8).

The A horizon has hue of 7.5YR or 10YR value of 5 or 6 dry, and chroma of 2 or 3. It ranges from very stony loam to very stony fine sandy loam. The A horizon is moderately or strongly calcareous and ranges from 3 to 10 inches thick.

The Cca horizon has hue of 10YR or 7.5YR value of 6 or 7 dry and chroma of 2 to 4. It ranges from very stony loam or very cobble loam to very stony fine sandy loam. Rock fragments in the Cca horizon range from 35 to 60 percent of which, 15 to 45 percent are stones and cobbles, and 10 to 30 percent are gravel. The Cca horizon is 11 to 42 inches thick.

The C horizon has value of 7 or 8 dry and chroma of 3 or 4. It ranges from very cobbly coarse sandy loam to very stony fine sandy loam. The C horizon has 10 to 20 percent gravel and 25 to 30 percent stones and cobbles.

Taxonomixclassification is loam-skeletal mixed, mesic Ustollic Calciorthids.

MENEFEE SERIES

These soils are classified as loamy, mixed (calcareous), mesic, shallow, Typic Ustorthents.

The Menefee series consists of shallow, well drained, and moderately permeable soils that formed in residuum and colluvium derived dominantly from shale, siltstone, and sandstone of the Green River Formation.

These soils are on canyon sideslopes and escarpments at elevations of 5,000 to 8,000 feet. Slope ranges from 40 to 70 percent. The average annual precipitation ranges from 12 to 16 inches, and the mean annual air temperature ranges from 45 to 47 degrees F.

They are near the Lazear, Shingle, and Guben soils. Lazear soils are shallow over hard sandstone, siltstone, or shale. Guben soils are over 40 inches in depth, and Shingle soils are drier three quarters of the time.

A1--0 to 2 inches; pale brown 10YR 6/3) extremely bouldery loam, brown (10YR 4/3) moist; moderate coarse granular structure; soft, very friable, slightly sticky, slightly plastic, few very fine, and fine roots; moderately calcareous, carbonates are disseminated; strongly alkaline (pH 8.8) abrupt smooth boundary,

C1--2 to 7 inches; pale brown (10YR 6/3) loam, brown (10 4/3) moist; weak medium sub-angular blocky structure; soft very friable, slightly sticky, slightly plastic; few very fine and fine roots; moderately calcareous, carbonates are disseminated; strongly alkaline (pH 8.6); abrupt smooth boundary.

C2--7 to 9 inches; light olive gray (5YR 6/2) silt loam, olive gray (5YR 5/2) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; few very fine and fine roots; few very fine pores; moderately calcareous, carbonates are disseminated; strongly alkaline (pH 8.8); abrupt smooth boundary.

C3r--9 inches; siltstone which is rippable and slakes in water.

The range in characteristics has not been determined for this series.

MIDFORK SERIES

These soils are classified as loamy-skeletal, mixed Typic Cryoborolls.

The Midfork series consists of deep, well drained, moderately slow permeable soils that formed in calcareous sedimentary rocks.

These soils are on gently sloping to very steep fans and mountainsides at elevations of 7,500 to 9,500 feet.

Slope ranges from 50 to 70 percent.

The average annual precipitation ranges from 20 to 30 inches, and the mean annual air temperature ranges from 34 to 38 degrees F.

They are near the Elwood, Macar, Quigley, and Podo soils. Elwood and Macar soils have bedrock within 40 inches. Podo soils have shallow control sections over sandstone and are neutral or slightly acid throughout. Quigley soils have fine-loamy control sections.

02--2 inches to 0; partially decomposed twigs, leaves, and needles.

A11--0 to 1 inch; dark yellowish brown (10YR 4/4) bouldery loam, dark brown (7.5YR 3/2) moist; weak fine granular structure; soft, very friable, nonsticky, and nonplastic; few very fine and fine roots; neutral (pH 7.2); abrupt smooth boundary.

A12--1 to 7 inches; dark yellowish brown (10Yr 4/4) clay loam, dark brown (10YR 3/3) moist; weak medium prismatic structure that parts to weak medium granular; slightly hard, firm, slightly sticky, slightly plastic; common fine and few medium roots; few very fine and fine pores; 10 percent fine gravel; mildly alkaline (pH 7.8); clear smooth boundary.

C1--7 to 30 inches; yellowish brown (10YR 5/4) very channery loam, brown (10YR 4/3) moist; massive; slightly hard, firm; slightly sticky and slightly plastic; common fine and few medium roots; 30 percent channers, 10 percent gravel, and 5 percent cobbles; slightly calcareous, carbonates are disseminated; mildly alkaline p 7.8); gradual smooth boundary.

C2--30 to 60 inches; yellowish brown (10YR 5/4) gravelly loam, brown (10YR 4/3) moist; massive; soft, friable, slightly sticky, and slightly plastic; few fine roots; 10 percent channers and 25 percent gravel; slightly calcareous, carbonates are disseminated; moderately alkaline (pH 8.4).

The mollic epipedon is 7 to 15 inches thick. Depth to free

carbonates range from 4 to 15 inches. Mean annual soil temperature is 36 to 40 degrees F. The control section is commonly gravelly loam or gravelly clay loam but ranges to include very channery loam in some pedons. Clay content is 18 to 35 percent. Rock fragments are 35 to 60 percent of the control section.

The A horizon has hue of 10YR or 7.5YR, value of 4 to 5 dry, 2 or 3 moist, and chroma of 2 to 4. The A horizon is neutral to moderately alkaline.

The C horizon has hue of 10YR or 7.5YR, value of 4 to 6 dry, 4 to 5 moist, and chroma of 2 through 4. The C horizon is mildly alkaline to strongly alkaline.

PATMOS SERIES

These soils are classified as loamy-skeletal, mixed (calcareous), frigid Typic Ustorthents.

The Patmos series consists of moderately deep, well drained, and moderately permeable soils that formed in colluvium derived dominantly from sandstone and shale.

These soils are on canyon rims and mountain sideslopes at elevations of 5,900 to 9,000 feet. Slope ranges from 3 to 70 percent. The average annual precipitation ranges from 12 to 20 inches, and the mean annual air temperature ranges from 38 to 45 degrees F.

Doney, Frandsen, and Zahill soils are similar to the Patmos soils. Frandsen and Zahill soils have rock fragments less than 10 percent; Doney soils have soft sandstone or limestone at 20 to 40 inches.

They are near the Cabba, Podo, Gappmayer Variant, Repp and Rabbitex soils. Cabba and Podo soils have depths less than 20 inches. Gappmayer Variant, Repp, and Rabbitex soils have depths of 60 inches. Gappmayer Variant soils have a dark surface layer, and Rabbitex soils have clay content greater than 18 percent.

A1--0 to 3 inches; pale brown (10YR 6/3) extremely stony loam, brown (10YR 5/3) moist; moderate medium sub-angular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; few very fine pores; 40 percent cobbles and 5 percent stones; moderately calcareous, carbonates are disseminated; strongly alkaline (pH 8.6); abrupt smooth boundary.

C1--3 to 14 inches; pale brown (10YR 6/3) gravelly loam, brown (10YR 5/3) moist; moderate medium sub-angular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine, few fine and medium roots; many very fine pores; 20 percent gravel and 5 percent cobbles; moderately calcareous, carbonates are disseminated; strongly alkaline (pH 8.8); clear smooth boundary,

C2--14 to 21 inches; pale brown (10YR 6/3) very cobbly loam, brown (10YR5/3) moist; moderate medium sub-angular blocky structure; soft, friable, slightly sticky, and slightly plastic; common very fine, few fine roots; few very fine pores; 20 percent gravel, 25 percent cobbles, and 5 percent stones; moderately calcareous, carbonates are disseminated; strongly alkaline (pH 8.8); clear smooth boundary.

Cr--21 to 26 inches; fractured sandstone, common very fine roots; moderately calcareous, gradual smooth boundary.

R--26; sandstone.

Mean summer soil temperature is 41 to 47 degrees F. These

soils are commonly calcareous throughout. Depth to sandstone, siltstone, or shale is 20 to 40 inches. Rock fragments are gravel, cobbles and stones ranging from 35 to 60 percent. Clay content is 15 to 25 percent.

The A horizon has hue of 5 or 6 dry, value of 4 or 5 moist, and chroma of 2 or 3. It is very gravelly to extremely stony loam.

The C horizon has hue of 10YR to 2.5YR , value of 5 to 7 dry and 4 to 6 moist, and chroma of 2 to 4. It is predominantly very gravelly, very cobble fine sandy loam or loam.

PESO SOILS

These soils are classified as loamy-skeletal, mixed Typic Haploborolls.

The Peso series consists of moderately deep, well drained, moderately rapid permeable soils that formed in colluvium and derived dominantly from sandstone and shale of the Green River Formation.

These soils are steep to very steep mountain sideslopes at elevations of 5,000 to 9,500 feet. Slope ranges from 50 to 80 percent. The average annual precipitation ranges from 16 to 20 inches, and the mean annual air temperature ranges from 38 to 45 degrees F.

They are near the Midfork and Comodore soils. Midfork soils are over 40 inches deep. Comodore soils are shallow.

0--1/2 inch to 0; litter layer of fir needles.

A1--0 to 3 inches; yellowish brown (10YR 5/4) extremely bouldery fine sandy loam, dark brown (10YR 3/3) moist; moderate coarse granular structure; slightly hard, very friable, slightly sticky, slightly plastic; many very fine, few very coarse roots; common very fine pores; 15 percent gravel; strongly calcareous, carbonates are disseminated; moderately alkaline (pH 8.4); abrupt smooth boundary.

B2--3 to 14 inches; yellowish brown (10YR 5/4) very gravelly fine sandy loam, dark brown (10YR 3/3) moist; weak medium sub-angular blocky structure; soft, very friable, slightly sticky, slightly plastic, common very fine few very coarse roots; common very fine pores; 50 percent gravel 10 percent cobbles; strongly calcareous, carbonates are disseminated; strongly alkaline (pH 8.6); abrupt smooth boundary.

C1--14 to 22 inches; yellowish brown (10YR 5/4) extremely cobbly fine sandy loam, brown (10YR 4/3) moist; massive; soft, very friable, slightly sticky, non plastic; few very fine, few very coarse roots; 20 percent gravel, 50 percent cobbles; moderately calcareous, carbonates are disseminated; strongly alkaline (pH 8.8); gradual smooth boundary.

R--22 inches; very hard sandstone.

Depth to bedrock is 20 to 40 inches.

The control section is commonly very gravelly fine sandy loam but ranges to include very cobbly fine sandy loam, and cobble loam in some pedons. Rock fragments are 35 to 60 percent and consist of gravel, cobbles, and stones. These soils are commonly calcareous throughout.

The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 dry; 2 or 3 moist, and chroma of 2 or 3. It is extremely bouldery fine sandy loam and bouldery loam.

The C horizon has hue of 7.5YR or 10YR, value of 5 or 6 dry, 3 through 5 moist, and chroma of 3 or 4. The C horizon is moderately calcareous or strongly calcareous and is moderately or strongly alkaline.

This soil is a taxajunct and differs from Peso by having less than 18 percent clay in the control section.

PODO SERIES

These soils are classified as loamy, mixed (calcareous), frigid Lithic Ustorthents.

The Podo series consists of shallow, well drained and moderately rapid permeable soils that formed in residuum and local colluvium derived dominantly from sandstone with some soils derived from limestone and shale.

These soils are on gently sloping benches, ridge tops, and sideslopes of moderately steep to very steep hills and mountains at elevations of 5,200 to 8,400 feet. Slope ranges from 1 to 70 percent. The average annual precipitation ranges from 12 to 20 inches, and the mean annual air temperature ranges from 42 to 45 degrees F.

They are near the Detra Variant and Doney soils. Detra Variant and Doney soils have pedons deeper than 40 inches. Detra Variant soils have mollic epipedons.

A11--0 to 5 inches; grayish brown (10YR 5/2) very stony loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; hard, friable, slightly sticky, and slightly plastic; common very fine, fine, and medium roots; slightly calcareous, carbonates are disseminated; moderately alkaline (pH 8.2); abrupt smooth boundary.

A12--5 to 10 inches; light brownish gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; hard, firm, sticky, and plastic; common very fine, and fine pores; 5 percent gravel; slightly calcareous, carbonates are disseminated; moderately alkaline (pH 8.0); Abrupt smooth boundary.

C1--10 to 16 inches; light brownish gray (10YR 6/2) clay loam, brown (10YR 4/3) moist; moderate medium sub-angular blocky structure; very hard, firm, sticky, and plastic; common very fine and fine, few medium roots; few very fine and fine pores; 5 percent gravel; moderately calcareous; carbonates are disseminated; moderately alkaline (pH 8.0); abrupt wavy boundary.

R--16 inches; sandstone.

Depth to lithic contact is 8 to 10 inches. Rock fragments are in individual horizons and range from 0 to 70 percent but average less than 35 percent in the control section. Mean annual soil temperature is 44 to 47 degrees F and the mean summer soil temperature is 59 to 64 degrees F.

The A horizon has hue of 7.5YR or 10YR, value of 5 to 7 dry, 3 to 5 moist, and chroma of 2 to 4. Textures are loam, very stony loam, very bouldery sandy loam, stony sandy loam, sandy loam, gravelly loam, fine sandy loam, cobbly loam and very channery silt

loam.

Some Pedons have a thin B horizon with hue 10YR, value 4 to 5 dry, chroma 2 or 3 and textures similar to the A horizons.

The C horizon has hue of 5YR to 10YR, value 5 to 7 dry, 4 to 6 moist, and chroma of 2 to 8. It is sandy loam, fine sandy loam, loam and gravelly loam, silt loam, channery silt loam, gravelly and sandy loam or light clay loam. The C horizon is slightly to strongly calcareous.

RABBITEK SERIES

These soils are classified as fine-loamy, mixed Typic Calciborolls.

The Rabbitex series consists of deep, well drained, and moderately permeable soils that formed in residuum and local colluvium derived dominantly from sandstone and shale.

These soils are on mountain sideslopes and ridge tops at elevations of 6,500 to 9,000 feet. Slope ranges from 25 to 70 percent. The average annual precipitation ranges from 16 to 20 inches, and the mean annual air temperature ranges from 38 to 45 degrees F.

Rabbitex soils are similar to the Ipano, Kiev, and Quigley soils. Ipano soils have bedrock between 20 and 40 inches. Kiev soils have less than 10 percent rock fragments coarser than 2mm. Quigley soils have a noncalcareous B horizon extending to depths of 15 inches overlying a layer of carbonate accumulation.

They are near the Patmos and Zillion soils. Patmos soils lack a dark surface layer; Zillion soils have greater than 35 percent coarse fragments and have a layer of clay accumulation.

A11--0 to 5 inches; dark brown (10YR 3/3) loam, very dark brown (10YR 2/2) dry; moderate, medium prismatic that parts to moderate medium granular structure; slightly hard, firm, slightly sticky, nonplastic; common very fine and fine roots; few very fine and fine pores; 10 percent gravel; mildly alkaline (pH 7.8); clear smooth boundary.

A12--5 to 12 inches; dark brown (10YR 3/3) channery loam, dark brown (10YR 3/3) dry, mottles; moderate, medium sub-angular blocky structure; soft, friable, slightly sticky, slightly plastic; common very fine and fine roots; few very fine and fine pores; 20 percent channers and 10 percent gravel; slightly calcareous, moderately alkaline (pH 8.2); clear smooth boundary.

B2ca--12 to 22 inches; yellowish brown (10YR 5/4) channery loam, brown (10YR 5/4) channery loam, brown (10YR 4/3) dry, weak medium sub-angular blocky structure; soft, friable, slightly sticky, slightly plastic; few very fine and medium, common fine roots; few very fine and fine pores; 20 percent channers and 5 percent gravel; slightly calcareous; moderately alkaline (pH 8.2); clear smooth boundary.

C1ca--22 to 30 inches; pale brown (10YR 6/3) gravelly loam, yellowish brown (10YR 5/4) dry; weak medium sub-angular blocky structure; soft, friable, slightly sticky, slightly plastic, few very fine and fine roots; few very fine and fine pores; 25 percent gravel; strongly calcareous, carbonates are disseminated and soft in masses; moderately alkaline (pH 8.4); clear smooth boundary.

C2ca--30 to 40 inches; pale brown (10YR 6/3) gravelly loam, yellowish brown (10YR 5/4) moist massive; soft, friable, slightly sticky, slightly plastic; few very fine and fine roots; 15 percent gravel; strongly calcareous, carbonates are disseminated and in soft masses; moderately alkaline (pH 8.4); gradual smooth boundary.

C3ca--40 to 53 inches; pale brown (10YR 6/3) gravelly loam, yellowish brown (10YR 5/4) moist; massive; soft, friable, slightly sticky, slightly plastic; 20 percent gravel; strongly calcareous, carbonates are disseminated and in soft masses; moderately alkaline (pH 8.4); gradual smooth boundary.

C4--53 to 60 inches; very pale brown (10YR 7/3) loam, yellowish brown (10YR 5/4) moist; massive; soft, friable, slightly sticky, slightly plastic; 10 percent gravel sized shale fragments; moderately calcareous, carbonates are soft masses; strongly alkaline (pH 8.6).

The mollic epipedon is 10 to 12 inches thick.

Depth to bedrock is greater than 40 inches.

Mean annual soil temperature is 41 to 47 degrees F. The control section is commonly loam to cobbly loam to cobbly loam but ranges to include sandy clay loam to silt loam in some pedons. Thickness of the solum ranges from 10 to 30 inches.

Rock fragments coarser than 2mm range from 10 to 35 percent by volume in the control section.

The A horizon has hue of 3 to 5 dry, value of 1 to 3 moist, and chroma of 1 to 3. Clay content is 16 to 25 percent. It is dominantly loam through stony loam but ranges from fine sandy loam to clay loam in some profiles.

The B horizon has hue of 4 to 6, value of 4 and 5 moist, and chroma of 3 to 5. Clay content is 20 to 30 percent. The B layer ranges from 0 to 15 inches thick. It is sandy clay loam, through silt loam and cobbly clay loam.

The Cca horizon has hue of 10YR and 2.5YR, value of 6 to 8 dry, 5 and 6 moist, and chroma of 2 to 4. It is gravelly sandy clay loam, gravelly and very cobbly loam.

Some pedons have a C horizon. The C layer ranges from 0 to 10 inches thick. The C horizon has hue of 10YR and 2.5Y, value of 6 to 8 dry, 5 to 7 moist, and chroma of 2 to 4. It is loam to silt loam.

The A, B, Cca and horizons are neutral to strongly alkaline.

REPP SERIES

These soils are classified as loamy-skeletal, mixed, frigid, Typic Ustochrepts.

The Repp series consists of very deep, well drained, moderately permeable soils that formed in colluvium derived dominantly from sandstone, siltstone, and shale.

These soils are on steep and very steep canyon and mountain sideslopes at elevations of 7,000 to 9,000 feet. Slope ranges from 40 to 70 percent. The average annual precipitation ranges from 16 to 20 inches, and the mean annual air temperature ranges from 38 to 45 degrees F.

They are near the Patmos, Doney, and Gappmayer Variant soils.

Patmos soils have bedrock at 20 to 40 inches. Doney soils have bedrock at 20 to 40 inches. Gappmayer Variants have a dark surface and an argillic horizon.

A1--0 to 3 inches; brown (10YR 5/3) bouldery fine sandy loam, dark brown (10YR 3/3) moist; moderate medium sub-angular blocky structure; soft, very friable, slightly sticky, slightly plastic, many very fine, few fine roots; common very fine pores; 5 percent gravel; strongly gravel; strongly calcareous, carbonates are disseminated; moderately alkaline (pH 8.4); abrupt smooth boundary.

B1--3 to 7 inches; brown (10YR 5/3) fine sandy loam, brown (10YR 4/3) moist; moderate medium sub-angular blocky structure; soft, very friable, slightly sticky, slightly plastic; many very fine, few fine roots, common very fine pores; 5 percent gravel; strongly calcareous, carbonates are disseminated; strongly alkaline (pH 8.8); abrupt smooth boundary.

B2--7 to 14 inches; light yellowish brown (10YR 6/4) gravelly fine sandy loam, yellowish brown (10YR 5/4) moist; moderate medium sub-angular blocky structure; hard, friable, slightly sticky, slightly plastic; common very fine, few fine roots, common very fine pores; 15 percent gravel; strongly calcareous, carbonates are disseminated and in soft masses on the underside of gravel; strongly alkaline (pH 8.8); gradual wavy boundary.

C1ca--14 to 30 inches; very pale brown (10YR 7/4) very cobble fine sandy loam, yellowish brown (10YR 5/4) moist; massive; very hard, friable, slightly sticky, slightly plastic; few fine roots, common very fine pores; 20 percent gravel, 15 percent cobbles, strongly calcareous, carbonates are disseminated and on the underside of gravel and cobbles as soft as masses; strongly alkaline (pH 8.8); distinct wavy boundary.

C2ca--30 to 60 inches; pale yellow (2.5YR 7/4) very stony fine sandy loam, light olive brown (2.5YR 5/4) moist; massive hard,

friable, slightly sticky, slightly plastic, few fine roots, common very fine pores; 30 percent gravel; 10 percent cobbles; 20 percent stones; strongly calcareous, carbonates are disseminated and on the underside of coarse fragments as soft masses; strongly alkaline (pH 8.8).

Depth to bedrock is greater than 60 inches. The control section is commonly very gravelly fine sandy loam but ranges to include gravelly and very gravelly silt loam in some pedons. Clay content is 18 to 35 percent. Rock fragments are gravels, cobbles, and stones and range from 35 to 60 percent in the control section.

The A horizon has hue of 10YR, 7.5YR, value of 4 or 5 dry, 3 or 4 moist, and chroma of 2 to 4. It is cobbly silty clay loam, extremely bouldery fine sandy loam, bouldery fine sandy loam.

The B horizon has hue of 5YR, 10YR, 7.5YR, value of 4 to 6 dry, 4 or 5 moist, and chroma of 2 to 4. It is commonly fine sandy loam or gravelly fine sandy loam but ranges to cobbly fine sandy loam. The B horizon is moderately calcareous or strongly calcareous and is moderately to strongly alkaline.

The Cca horizon has hue of 2.5YR, 10YR, 7.5YR, value of 5 to 7 dry, 4 to 6 moist, and chroma of 2 to 4. The Cca horizon is moderately calcareous or strongly calcareous and is moderately to strongly alkaline.

This soil is a taxajunct and varies from the Repp series because it is calcareous throughout and differs in value from the A and B horizons.

RIVRA SERIES

These soils are classified as sandy-skeletal, mixed, frigid Ustic Torrifuvents.

The Rivra series consists of very deep, well drained, rapidly permeable soils that formed in alluvium derived dominantly from sandstone and shale. These soils are on alluvium bottoms at elevation of 4,600 to 7,200 feet. Slope ranges from 0 to 8 percent. The average annual precipitation ranges from 12 to 16 inches, and the mean annual air temperature ranges from 43 to 45 degrees F.

They are near the Havre and Glenberg soils. Havre and Glenberg soils have a control section finer than sandy loam, and Glenberg is mesic.

A1--0 to 3 inches; dark grayish brown (10YR 4/2) extremely bouldery sandy loam, very dark grayish brown (10YR 3/2) moist; moderate very coarse platy structure; soft, very friable, slightly sticky, and slightly plastic; common very fine and few fine roots; common very fine pores; 25 percent gravel; moderately calcareous, carbonates are disseminated; moderately alkaline (pH 8.0); abrupt smooth boundary.

C1--3 to 6 inches; yellowish brown (10YR 5/4) gravelly sandy loam, brown (10YR 4/3) moist; moderate very coarse platy structure; soft, very friable, nonsticky, and nonplastic; common very fine and few fine roots; few very fine pores; 25 percent gravel; strongly calcareous, carbonates are disseminated; strongly calcareous (pH 8.6); abrupt broken boundary.

C2--6 to 12 inches; brown (10YR 5/3) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; massive; soft, very friable, nonsticky, and nonplastic; few very fine and few medium roots; common very fine and few fine pores; 15 percent gravel and 5 percent cobbles; strongly calcareous, carbonated are disseminated; strongly alkaline (pH 8.6); abrupt smooth boundary.

C3--12 to 17 inches; yellowish brown (10YR 5/4) very gravelly sandy loam, dark yellowish brown (10YR 4/4) moist; massive; loose, nonsticky, and nonplastic, common very fine and few fine roots; 45 percent very fine gravel and 10 percent gravel; strongly calcareous, carbonates are disseminated; moderately alkaline (pH 8.4); abrupt broken boundary.

IIC4--17 to 40 inches; yellowish brown (10YR 5/4) extremely stony loamy sand, dark yellowish brown (10YR 3/4) moist; massive; loose, nonsticky, and nonplastic; few very fine and medium roots; 30 percent gravel, 15 percent cobbles, and 25 percent stones; strongly calcareous, carbonates are disseminated; moderately alkaline (pH 8.4); abrupt smooth boundary.

IIIC5--40 to 60 inches; brown (10YR 5/3) extremely gravelly

sandy loam, dark brown (10YR 3/3) moist; massive, loose, nonsticky, and nonplastic; few very fine, fine, and medium roots; 60 percent gravel and 5 percent boulders; strongly calcareous, carbonates are disseminated; moderately alkaline (pH 8.4).

ROCK OUTCROP

Rock outcrop is exposed bedrock consisting of sandstone, conglomerate sandstone and limestone.

Sparse vegetation may occur in cracks and fissures in the Rock outcrop. This vegetation is dominantly juniper, pinyon, and mountainmahogany.

Rock outcrop is in Capability Subclass VIIIs, and is not rated for an ecological site.

SHINGLE SERIES

Taxonomic classification is loamy, mixed (calcareous), mesic, shallow Ustic Torriorthents.

A1--0 to 7 inches; light brownish gray (10YR 6/2) extremely stony loam, dark brown (10YR 4/3) when moist; weak medium sub-angular blocky structure; slightly hard,, friable, slightly sticky, slightly plastic; common very fine, few fine, and many coarse roots; many fine and few medium pores; 30 percent gravel, 10 percent cobbles, 30 percent stones and boulders; strongly calcareous, carbonates are disseminated; moderately alkaline (pH 8.2); clear smooth boundary.

C1--7 to 16 inches; gray (10YR 6/1) silt loam, dark grayish brown (10YR 4/2) when moist; massive; hard, friable, sticky, plastic; common very fine, few medium and coarse roots; 35 percent very soft shale fragments; strongly calcareous, carbonates are disseminated; strongly alkaline (pH 8.6); clear smooth boundary.

C2--16 to 19 inches; light brownish gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) when moist; massive; hard, friable, slightly sticky, slightly plastic; few very fine and fine roots; 40 percent very soft shale fragments; strongly calcareous, carbonates are disseminated; strongly alkaline (pH 8.6); clear smooth boundary.

C3r--19 inches; partly weathered shale.

Depth to weathered shale ranges from 15 to 20 inches.

The A horizon has hue of 10YR or 7.5YR, value of 5 or 6 dry, and chroma of 2 to 4. It is extremely stony loam or very stony silt loam. Rock fragments range from 50 to 70 percent. The A horizon ranges from 2 to 8 inches thick.

The C horizon has hue of 10YR, 2.5Y or 5Y, value of 5 to 7 dry, and chroma of 1 to 4. It is silt loam, silty clay loam, and loam. Some pedons have a small amount of gravel (less than 10 percent). The C horizon is slightly to strongly calcareous.

A1--0 to 3 inches; grayish brown (2.5Y 5/2) very stony clay loam, very dark grayish brown (2.5Y 3/2) when moist; weak fine granular structure; slightly hard, firm, sticky, plastic; common fine and medium roots; common fine and few medium pores; 15 percent gravel, 10 percent cobbles and 20 percent stones; slightly calcareous, carbonates are disseminated; moderately alkaline (pH 8.2); abrupt smooth boundary.

C1--3 to 16 inches; grayish brown (2.5Y 5/2) cobbly silty clay loam very dark grayish brown (2.5Y 3/2) when moist; massive; hard, firm sticky, plastic; few very fine, fine, and medium roots; 10 percent gravel, 10 percent cobbles and 5 percent stones; moderately

alkaline (pH 8.6); clear smooth boundary.

C2--16 to 20 inches; grayish brown (1.5Y 5/2) silty clay loam very dark grayish brown (2.5y 3/2) when moist; massive, hard, firm, sticky, plastic; few very fine and fine roots; 10 percent gravel; moderately calcareous, carbonates are disseminated; strongly alkaline (pH 8.6); clear smooth boundary.

C3--20 inches; weathered shale.

Depth to weathered shale ranges from 10 to 20 inches.

The A horizon has hue of 2.5Y or 10YR and value of 5 or 6 dry. The horizon ranges from 3 to 7 inches.

The C horizon has hue of 2.5Y or 10 YR, value of 5 or 6 dry, and chroma of 1 or 2. It is silty clay loam, cobbly silty clay loam or silt loam.

SUNUP SERIES

Taxonomic classification is loamy-skeletal, mixed (calcareous), mesic Lithic Ustic Torriorthents.

Sunup is a very gravelly fine sandy loam, high rainfall, 3 to 125 percent slopes represent this soil.

A1--0 to 2 inches; brown (7.5YR 5/4) very gravelly fine sandy loam, dark brown (7.5YR 4/4) when moist; weak fine granular structure; soft, very friable, slightly sticky, slightly plastic; few very fine roots; few very fine pores; 60 percent gravel; moderately calcareous, carbonates are disseminated; moderately alkaline (pH 8.4); abrupt smooth boundary.

C1--2 to 6 inches; brown (7.5YR 5/4) gravelly very fine sandy loam, dark brown (7.5YR 4/4) when moist; weak fine sub-angular blocky structure; soft very friable, slightly sticky, slightly plastic, few very fine roots; few very fine pores; 30 percent gravel; moderately calcareous, carbonates are disseminated; moderately alkaline (pH 8.2).

R--6 inches; conglomerate.

Depth to conglomerate ranges from 5 to 20 inches.

TETON SERIES

These soils are classified as fine-loam, mixed Typic ryoborolls. The Teton series consists of moderately deep, well drained, and moderately permeable soils that formed in local collubium and residuum derived dominantly from siltstone and sandstone.

These soils are on mountain sideslopes at elevations of 7,800 to 9,600 feet. Slope ranges from 40 to 70 percent.

The average annual precipitation ranges from 20 to 30 inches, and the mean annual air temperature is less than 38 degrees F.

They are near the Adel, Podo, Decross, and Benteen soils. Adel soils have a mollic epipedon deeper than 16 inches. Podo soils have a lithic contact less than 20 inches deep. Decross and Benteen soils have an argillic horizon.

O1--2 inches to 0; decomposed organic matter.

A1-0 to 4 inches; brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; weak fine platy structure; soft, very friable, slightly sticky, slightly plastic; few very fine, fine and medium roots; few very fine and fine pores; noncalcareous carbonates are disseminated; slightly acid (pH 6.4); abrupt smooth boundary.

B2--4 to 12 inches; brown (10YR 4/3) cobbly fine sandy loam, dark brown (10YR 3/3) moist; weak medium sub-angular blocky structure; soft, very friable, slightly sticky, and slightly plastic; few very fine, fine and medium roots; few very fine and fine pores; 15 percent cobbles and 10 percent gravel, noncalcareous, carbonates are disseminated; slightly acid (pH 6.4); abrupt smooth boundary.

C1--12 to 23 inches; brown (10YR 5/3) cobbly fine sandy loam, brown (10YR 4/3) moist; massive; soft, very friable, slightly sticky, slightly plastic; 20 percent cobbles and 10 percent gravel; noncalcareous, carbonates are disseminated; slightly acid (pH 6.4); abrupt smooth boundary.

R--24+ inches; siltstone.

This soil is a taxadjunct and differs from the Teton series by the thickness of the solum being less than 17 inches, and chroma greater than 2.

WAG--WIDTSOE VERY STONY LOAM, HIGH RAINFALL, 50 TO 70 PERCENT SLOPES

This widtsoe soil is very deep and well drained. It occurs on very steep mountain slopes at elevations of 7,200 to 8,600 feet. This soil formed in colluvium derived mainly from sandstone and shale.

The average annual precipitation is 14 to 17 inches. Mean annual air temperature is 42 to 45 degrees F, mean annual soil temperature is 44 to 47 degrees F,, and the average freeze-free season is 50 to 90 days. Slopes are 50 to 70 percent and occur on north aspects. They are short in length and concave convex in shape.

Included in mapping are small areas similar soil except 20 to 40 inches deep; and UH extremely stony loam, 30 to 50 percent slopes.

In a representative profile the surface layer is dark grayish brown and grayish brown very stony loam about 9 inches thick. The subsoil is brownish yellow very cobbly clay loam about 15 inches thick. The substratum is light brownish gray very cobbly loam to a depth of 60 inches or more. There is a light horizon of carbonate accumulation at a depth of 24 inches.

Permeability is moderately slow. Available water capacity is about 5.0 to 7.0 inches above a depth of 60 inches. Water supplying capacity is 7 to 10 inches. Organic matter content in the surface layer is moderate. Effective rooting depth is greater than 60 inches. Surface runoff is medium and erosion hazard is moderate. The Erosion Condition Class is slight-37.

This soil is used for wildlife habitat.

Present vegetation is dominantly serviceberry, bluegrass, slender wheatgrass, birchleaf mountainmahogany, snowberry and black sagebrush.

The potential plant community is about 40 percent grasses, 5 percent forbs, and 55 percent shrubs. Important plants bullgrass, Salina wildrye, bluebunch wheatgrass, muttongrass, Nevada bluegrass, slender wheatgrass, prairie junegrass, western wheatgrass, hawksbeard, locoweed, penstemon, sego lilly, birchleaf mountainmahogany, Wyoming big sagebrush, black sagebrush, yellowbrush, serviceberry, and snowberry.

<u>COMMON PLANT NAME</u>		<u>%</u>
Salina Wildrye	(ELSA)	8
Bluebunch Wheatgrass	(AGSP)	9
Muttongrass	(POEE)	6
Nevada Bluegrass	(POHE3)	6
Other Perennial Grasses	(PPGG)	8
Other Perennial Forbs	(PPFF)	4
Other Annual Forbs	(AAFF)	1
Birchleaf Mountainmahogany	(CEMO2)	20
Sagebrush	(ARTEM)	10
Serviceberry	(AMELA)	15
Snowberry	(SYMPH)	5
Other shrubs	(SSSS)	5

This soil is in Capability Subclass VIIIx, non-irrigated;
Mountain Loam (Shrub) E47 ecological site.

Appendix 2-4

No. 2 Mine Reclamation Soil Analyses



Inter-Mountain Laboratories, Inc.

1633 Terra Avenue

Sheridan, Wyoming 82801

Tel. (307) 672-8945

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Lab No.	Location	Depths	pH	EC mmhos/cm @ 25°C	Satur- ation %	Calcium meq/l	Magnesium meq/l	Sodium meq/l	SAR	Coarse Fragments %	Sand %	Silt %	Clay %	Texture
41665	FC-2A	0.0-24.0	6.4	2.98	45.5	20.0	14.3	2.74	0.66	36.6	73.1	20.2	6.7	SANDY LOAM
41666	NO.2-1 B	6.0-12.0	7.0	2.44	35.6	22.9	5.95	1.00	0.26	39.4	61.3	25.8	12.9	SANDY LOAM
41667	NO.2-2 B	6.0-12.0	6.7	2.64	42.0	26.8	5.42	0.67	0.17	63.0	60.5	25.5	14.0	SANDY LOAM
41668	NO.2-3 A	0.0-16.0	6.6	2.57	35.3	28.3	3.15	0.54	0.14	50.3	58.5	27.7	13.8	SANDY LOAM



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Lab No.	Location	Depths	Organic Matter %	Total Sulfur %	T.S. AB t/1000t	Neut. Pot. t/1000t	T.S. ABP t/1000t	Sulfate Sulfur %	Pyritic Sulfur %	Organic Sulfur %	PyrS AB t/1000t	PyrS ABP t/1000t
41665	FC-2A	0.0-24.0	62.6	1.19	37.2	9.24	-27.9	0.50	0.05	0.64	1.56	7.68
41666	NO.2-1 B	6.0-12.0	15.3	0.83	25.9	85.6	59.7	0.61	0.06	0.16	1.87	83.7
41667	NO.2-2 B	6.0-12.0	21.2	0.90	28.1	34.7	6.61	0.53	0.10	0.27	3.12	31.6
41668	NO.2-3 A	0.0-16.0	21.4	0.80	25.0	31.5	6.54	0.53	0.04	0.23	1.25	30.3

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neut. Pot.= Neutralization Potential



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Lab No.	Location	Depths	P ppm	Nitrate- Nitrogen ppm	Boron ppm	Selenium ppm	Bulk Density	Total Kjeldahl Nitrogen %	1/3 bar	15 bar	Available Water Capacity in/in
41665	FC-2A	0.0-24.0	4.03	3.06	1.66	<0.02	1.13	0.77	25.5	10.5	0.150
41666	NO.2-1 B	6.0-12.0	5.61	1.64	0.42	<0.02	1.92	0.20	18.7	8.9	0.098
41667	NO.2-2 B	6.0-12.0	4.03	1.22	0.20	<0.02	1.87	0.26	18.2	9.0	0.092
41668	NO.2-3 A	0.0-16.0	5.23	2.48	0.18	<0.02	2.34	0.25	19.1	8.9	0.102



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Lab No.	Location	Depths	pH	EC mmhos/cm @ 25°C	Satur- ation %	Calcium meq/l	Magnesium meq/l	Sodium meq/l	SAR	Coarse Fragments %	Sand %	Silt %	Clay %	Texture
41602	WC-1A	0.0-6.0	7.2	0.94	38.8	6.05	2.42	1.12	0.55	55.4	54.0	32.0	14.0	SANDY LOAM
41603	WC-1B	6.0-12.0	7.7	0.40	32.6	2.31	1.02	1.26	0.98	56.8	52.9	30.4	16.7	SANDY LOAM
41604	WC-1C	12.0-24.0	7.8	0.46	29.8	2.28	1.49	1.26	0.92	53.0	52.0	31.3	16.7	SANDY LOAM
41605	WC-1D	24.0-36.0	7.8	0.57	28.6	2.87	1.57	1.33	0.90	45.2	54.7	29.5	15.8	SANDY LOAM
41606	WC-1E	36.0-72.0	7.5	4.43	31.1	24.5	38.2	4.01	0.72	51.4	55.6	27.7	16.7	SANDY LOAM
41607	WC-2A	0.0-24.0	7.5	3.66	31.1	24.3	23.2	3.23	0.66	34.8	45.6	34.9	19.5	LOAM
41608	WC-2B	24.0-48.0	7.7	5.95	34.1	21.3	65.6	7.17	1.09	44.6	48.4	32.1	19.5	LOAM
41609	WC-3A	0.0-6.0	7.7	0.77	29.4	4.96	1.89	1.22	0.66	60.0	54.7	29.5	15.8	SANDY LOAM
41610	WC-3B	6.0-12.0	7.8	0.60	30.2	3.88	1.51	1.31	0.80	62.8	56.5	25.5	18.0	SANDY LOAM
41611	WC-3C	12.0-24.0	7.9	0.62	29.9	3.51	1.58	1.15	0.72	56.9	54.5	29.7	15.8	SANDY LOAM
41612	WC-3D	24.0-36.0	7.8	0.64	26.7	2.92	2.40	1.47	0.90	24.2	61.8	26.0	12.2	SANDY LOAM
41613	#2-1A	0.0-6.0	7.5	1.22	30.1	9.10	3.25	1.30	0.52	16.3	50.9	31.8	17.3	LOAM
41614	#2-1C	12.0-24.0	7.4	3.17	37.0	23.4	21.2	1.46	0.31	27.3	41.6	34.8	23.6	LOAM
41615	#2-1D	24.0-36.0	7.5	3.51	39.9	22.6	29.2	1.42	0.28	37.5	40.7	34.8	24.5	LOAM
41616	#2-1E	36.0-84.0	7.6	3.02	39.7	20.6	21.6	1.89	0.41	23.2	39.8	35.7	24.5	LOAM
41617	#2-2A	0.0-6.0	7.1	2.57	49.8	25.2	6.55	1.13	0.28	15.4	32.5	41.1	26.4	LOAM
41618	#2-2C	12.0-24.0	7.5	2.76	38.7	23.5	13.0	1.42	0.33	29.1	38.9	36.6	24.5	LOAM
41619	#2-2D	24.0-36.0	7.6	1.77	37.5	12.6	8.14	1.19	0.37	29.8	38.7	36.8	24.5	LOAM
41620	#2-2E	36.0-84.0	7.8	1.26	35.7	5.07	7.79	1.74	0.68	33.5	39.8	36.6	23.6	LOAM
41621	#2-3B	16.0-22.0	7.0	2.88	45.9	26.8	12.8	0.99	0.22	3.4	48.7	34.0	17.3	LOAM



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Lab No.	Location	Depths	Organic Matter %	Carbonate %	P ppm	Boron ppm	Selenium ppm	K PE meq/l	Alkalinity PE meq/l	Total Kjeldahl Nitrogen %	1/3 bar	15 bar	Available Water Capacity in/in
41602	WC-1A	0.0-6.0	7.5	6.3	10.1	0.78	<0.02	1.59	7.47	0.16	18.1	8.6	0.095
41603	WC-1B	6.0-12.0	7.2	6.9	1.68	0.47	<0.02	1.49	2.93	0.13	16.9	7.5	0.094
41604	WC-1C	12.0-24.0	4.9	8.3	0.88	0.89	<0.02	1.50	3.30	0.11	15.9	6.8	0.091
41605	WC-1D	24.0-36.0	4.0	9.8	1.61	0.69	<0.02	0.75	2.86	0.10	14.3	6.0	0.083
41606	WC-1E	36.0-72.0	4.0	9.1	1.40	0.78	<0.02	0.67	2.54	0.09	14.6	6.2	0.084
41607	WC-2A	0.0-24.0	6.7	9.1	0.88	0.60	<0.02	0.24	1.97	0.11	14.9	7.6	0.073
41608	WC-2B	24.0-48.0	7.1	9.3	0.54	0.79	<0.02	0.32	1.65	0.11	15.4	7.9	0.075
41609	WC-3A	0.0-6.0	0.7	13.1	1.16	0.82	<0.02	0.59	2.45	0.07	14.8	6.3	0.085
41610	WC-3B	6.0-12.0	1.5	14.8	1.06	0.53	<0.02	0.49	2.46	0.07	14.2	5.1	0.091
41611	WC-3C	12.0-24.0	0.9	15.5	0.74	0.57	<0.02	0.38	2.16	0.06	16.6	6.2	0.104
41612	WC-3D	24.0-36.0	1.2	12.3	1.16	0.63	<0.02	0.21	2.31	0.07	11.4	4.4	0.070
41613	#2-1A	0.0-6.0	4.7	11.3	5.72	0.75	<0.02	0.23	3.18	0.10	16.4	6.2	0.102
41614	#2-1C	12.0-24.0	3.0	20.9	1.88	0.52	<0.02	0.76	2.25	0.10	16.4	8.6	0.078
41615	#2-1D	24.0-36.0	1.7	22.1	0.68	0.50	<0.02	0.63	2.12	0.09	15.7	8.5	0.072
41616	#2-1E	36.0-84.0	0.7	10.9	0.47	0.69	<0.02	0.86	1.91	0.08	16.4	9.7	0.067
41617	#2-2A	0.0-6.0	8.6	13.2	4.85	1.41	<0.02	0.85	3.68	0.20	20.0	10.5	0.095
41618	#2-2C	12.0-24.0	1.3	26.8	5.93	0.49	<0.02	1.30	1.40	0.06	16.4	7.9	0.085
41619	#2-2D	24.0-36.0	0.8	14.2	0.19	0.49	<0.02	0.77	1.30	0.06	15.3	7.9	0.074
41620	#2-2E	36.0-84.0	0.7	28.1	0.19	0.47	<0.02	0.04	1.82	0.04	14.6	7.8	0.068
41621	#2-3B	16.0-22.0	4.2	1.4	0.95	0.69	<0.02	0.51	3.03	0.21	19.6	10.1	0.095



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Lab No.	Location	Depths	pH	EC mmhos/cm @ 25°C	Satur- ation %	Calcium meq/l	Magnesium meq/l	Sodium meq/l	SAR	Coarse Fragments %	Sand %	Silt %	Clay %	Texture
41623	#2-3C	22.0-28.0	6.9	3.07	47.4	26.6	17.1	1.09	0.23	4.8	46.0	31.3	22.7	LOAM
41624	#2-3D	28.0-40.0	7.5	3.30	42.5	23.7	25.7	1.13	0.23	5.4	40.5	38.6	20.9	LOAM
41625	#2-3E	40.0-52.0	7.5	3.68	38.5	21.2	35.2	1.40	0.26	16.9	46.2	32.9	20.9	LOAM
41626	#2-3F	52.0-91.0	7.7	6.69	43.1	17.9	30.8	2.73	0.55	5.4	44.4	32.9	22.7	LOAM
41627	FC-1A	0.0-6.0	7.6	0.98	35.1	6.16	2.95	1.20	0.56	62.6	42.7	37.3	20.0	LOAM
41628	FC-1B	6.0-12.0	7.7	0.68	30.1	4.29	1.51	1.12	0.66	46.5	40.2	39.8	20.0	LOAM
41629	FC-1C	12.0-24.0	7.7	0.93	31.4	7.03	1.00	1.22	0.61	44.0	33.8	44.4	21.8	LOAM
41630	FC-1D	24.0-36.0	7.5	2.48	32.9	25.5	6.80	1.33	0.33	53.6	35.6	45.3	19.1	LOAM
41631	FC-1E	36.0-84.0	7.5	5.23	31.5	24.1	56.9	3.90	0.61	65.9	46.9	37.6	15.5	LOAM
41632	FC-2B	24.0-30.0	7.8	5.28	28.8	21.7	55.7	8.96	1.44	65.0	51.5	33.0	15.5	LOAM
41633	FC-2C	30.0-36.0	7.8	5.51	30.6	20.7	58.0	10.2	1.62	62.5	52.5	32.0	15.5	SANDY LOAM
41634	FC-2D	36.0-48.0	7.7	5.85	31.8	19.7	63.8	11.8	1.82	60.1	48.9	35.6	15.5	LOAM
41635	FC-2E	48.0-60.0	7.8	6.66	31.6	22.0	79.4	13.6	1.91	62.3	64.5	23.7	11.8	SANDY LOAM
41636	FC-2F	60.0-84.0	7.7	7.14	30.1	22.1	79.5	13.2	1.85	48.5	49.3	36.2	14.5	LOAM
41637	FC-3A	0.0-6.0	7.6	1.09	35.8	6.70	3.11	1.37	0.62	27.3	42.9	41.6	15.5	LOAM
41638	FC-3B	6.0-12.0	7.8	0.61	31.5	3.43	1.59	1.24	0.79	34.1	33.8	45.3	20.9	LOAM
41639	FC-3C	12.0-24.0	7.8	0.54	31.5	2.58	1.51	1.31	0.92	47.1	32.9	45.3	21.8	LOAM
41640	FC-3D	24.0-36.0	7.9	0.55	32.1	2.44	1.88	1.38	0.94	42.0	32.9	46.2	20.9	LOAM
41641	FC-3E	36.0-48.0	7.1	0.95	33.6	4.70	4.38	1.60	0.75	49.3	35.6	43.5	20.9	LOAM
41642	FC-3F	48.0-84.0	7.7	4.19	34.5	21.1	41.5	3.02	0.54	35.1	37.5	43.4	19.1	LOAM



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September 6, 1990

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Lab No.	Location	Depths	Organic Matter %	Carbonate %	P ppm	Boron ppm	Selenium ppm	K PE meq/l	Alkalinity PE meq/l	Total Kjeldahl Nitrogen %	1/3 bar	15 bar	Available Water Capacity in/in
41623	#2-3C	22.0-28.0	2.9	1.0	0.50	0.70	<0.02	0.43	2.41	0.14	19.2	12.7	0.065
41624	#2-3D	28.0-40.0	1.4	17.9	0.30	0.85	<0.02	0.35	1.53	0.09	19.8	9.2	0.106
41625	#2-3E	40.0-52.0	0.9	19.8	0.02	0.63	<0.02	0.27	1.43	0.06	18.4	7.8	0.106
41626	#2-3F	52.0-91.0	0.6	12.3	0.26	0.53	<0.02	0.21	1.68	0.03	19.3	8.6	0.107
41627	FC-1A	0.0-6.0	3.7	13.2	3.06	0.54	<0.02	0.76	4.35	0.10	15.4	6.4	0.090
41628	FC-1B	6.0-12.0	4.2	14.1	1.44	0.45	<0.02	0.61	2.75	0.10	15.6	6.4	0.092
41629	FC-1C	12.0-24.0	3.8	17.9	1.99	0.75	<0.02	1.38	2.49	0.09	16.0	6.8	0.092
41630	FC-1D	24.0-36.0	3.6	18.9	0.95	0.98	<0.02	0.34	1.83	0.10	16.4	6.8	0.096
41631	FC-1E	36.0-84.0	4.0	18.1	0.78	1.11	0.03	0.34	3.75	0.09	15.2	6.9	0.083
41632	FC-2B	24.0-30.0	1.5	15.1	1.02	1.28	<0.02	0.67	1.34	0.07	14.8	6.4	0.084
41633	FC-2C	30.0-36.0	1.7	14.5	1.12	0.99	<0.02	1.47	1.39	0.07	14.7	6.2	0.085
41634	FC-2D	36.0-48.0	1.6	15.4	0.88	0.88	0.03	0.89	1.57	0.07	15.1	6.3	0.088
41635	FC-2E	48.0-60.0	2.6	13.2	1.02	0.88	0.05	1.14	1.70	0.09	15.0	6.6	0.084
41636	FC-2F	60.0-84.0	1.9	16.5	0.74	1.04	0.17	1.10	1.40	0.07	15.1	6.2	0.089
41637	FC-3A	0.0-6.0	6.8	11.8	3.92	1.00	<0.02	1.93	4.55	0.17	16.5	7.1	0.094
41638	FC-3B	6.0-12.0	5.3	13.9	1.40	1.16	<0.02	1.00	2.92	0.12	18.1	6.5	0.116
41639	FC-3C	12.0-24.0	5.0	15.3	0.81	1.12	<0.02	0.30	2.96	0.11	18.8	9.8	0.090
41640	FC-3D	24.0-36.0	5.0	14.9	0.57	1.18	<0.02	0.68	2.46	0.11	18.0	9.6	0.084
41641	FC-3E	36.0-48.0	5.8	14.6	1.40	1.17	0.02	1.07	2.36	0.11	18.0	9.9	0.081
41642	FC-3F	48.0-84.0	4.8	15.4	0.47	0.86	0.04	0.79	1.77	0.10	18.5	9.4	0.091



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Lab No.	Location	Depths	pH	EC mmhos/cm @ 25°C	Satur- ation %	Calcium meq/l	Magnesium meq/l	Sodium meq/l	SAR	Coarse Fragments %	Sand %	Silt %	Clay %	Texture
41643	WCFCR-1A	0.0-2.0	7.7	1.38	26.5	8.34	2.74	2.44	1.04	41.9	59.3	28.0	12.7	SANDY LOAM
41644	WCFCR-1B	2.0-4.0	7.7	0.87	28.1	5.20	1.72	1.58	0.85	40.0	56.5	30.8	12.7	SANDY LOAM
41645	WCFCR-1C	12.0-24.0	7.5	2.43	29.4	24.9	3.69	1.95	0.52	48.0	59.3	27.1	13.6	SANDY LOAM
41646	WCFCR-1D	24.0-36.0	7.6	3.39	28.8	24.4	15.9	4.58	1.02	57.2	62.2	25.1	12.7	SANDY LOAM
41647	WCFCR-1E	36.0-72.0	7.7	5.32	29.6	21.3	36.4	16.8	3.13	54.0	41.3	44.7	14.0	LOAM



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Lab No.	Location	Depths	Organic Matter %	Carbonate %	P ppm	Boron ppm	Selenium ppm	K PE meq/l	Alkalinity PE meq/l	Total Kjeldahl Nitrogen %	1/3 bar	15 bar	Available Water Capacity in/in
41643	WCFCR-1A	0.0-2.0	1.0	12.5	3.20	0.51	<0.02	1.03	2.71	0.09	13.4	6.5	0.069
41644	WCFCR-1B	2.0-4.0	0.8	13.6	1.61	0.46	<0.02	0.36	1.85	0.05	12.8	6.6	0.062
41645	WCFCR-1C	12.0-24.0	1.0	13.1	1.75	0.50	<0.02	0.73	1.61	0.04	12.8	6.6	0.062
41646	WCFCR-1D	24.0-36.0	1.3	12.5	1.23	0.56	0.03	0.41	1.90	0.08	13.8	7.3	0.065
41647	WCFCR-1E	36.0-72.0	1.2	12.5	1.16	0.59	0.03	0.19	2.78	0.06	14.7	7.8	0.069



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Lab No.	Location	Depths	pH	EC mmhos/cm @ 25°C	Satur- ation %	Calcium meq/l	Magnesium meq/l	Sodium meq/l	SAR	Coarse Fragments %	Sand %	Silt %	Clay %	Texture
41647	WCFCR-1E	36.0-72.0	7.7	5.32	29.6	21.3	36.4	16.8	3.13	54.0	41.3	44.7	14.0	LOAM
41649	41647(DUP)	36.0-72.0	7.7	5.28	30.1	21.0	35.9	16.7	3.12		42.2	43.8	14.0	LOAM
41642	FC-3F	48.0-84.0	7.7	4.19	34.5	21.1	41.5	3.02	0.54	35.1	37.5	43.4	19.1	LOAM
41650	41642(DUP)	48.0-84.0	7.7	4.06	36.9	20.9	40.3	2.98	0.54		37.6	44.8	17.6	LOAM
41620	#2-2E	36.0-84.0	7.8	1.26	35.7	5.07	7.79	1.74	0.68	33.5	39.8	36.6	23.6	LOAM
41651	41620(DUP)	36.0-84.0	7.8	1.18	36.2	4.83	7.13	1.93	0.79		39.5	38.3	22.2	LOAM
41613	#2-1A	0.0-6.0	7.5	1.22	30.1	9.10	3.25	1.30	0.52	16.3	50.9	31.8	17.3	LOAM
41652	41613(DUP)	0.0-6.0	7.5	1.16	31.2	8.53	3.07	1.35	0.56		48.5	35.7	15.8	LOAM
41603	WC-1B	6.0-12.0	7.7	0.40	32.6	2.31	1.02	1.26	0.98	56.8	52.9	30.4	16.7	SANDY LOAM
41653	41603(DUP)	6.0-12.0	7.7	0.40	32.6						50.4	34.7	14.9	LOAM



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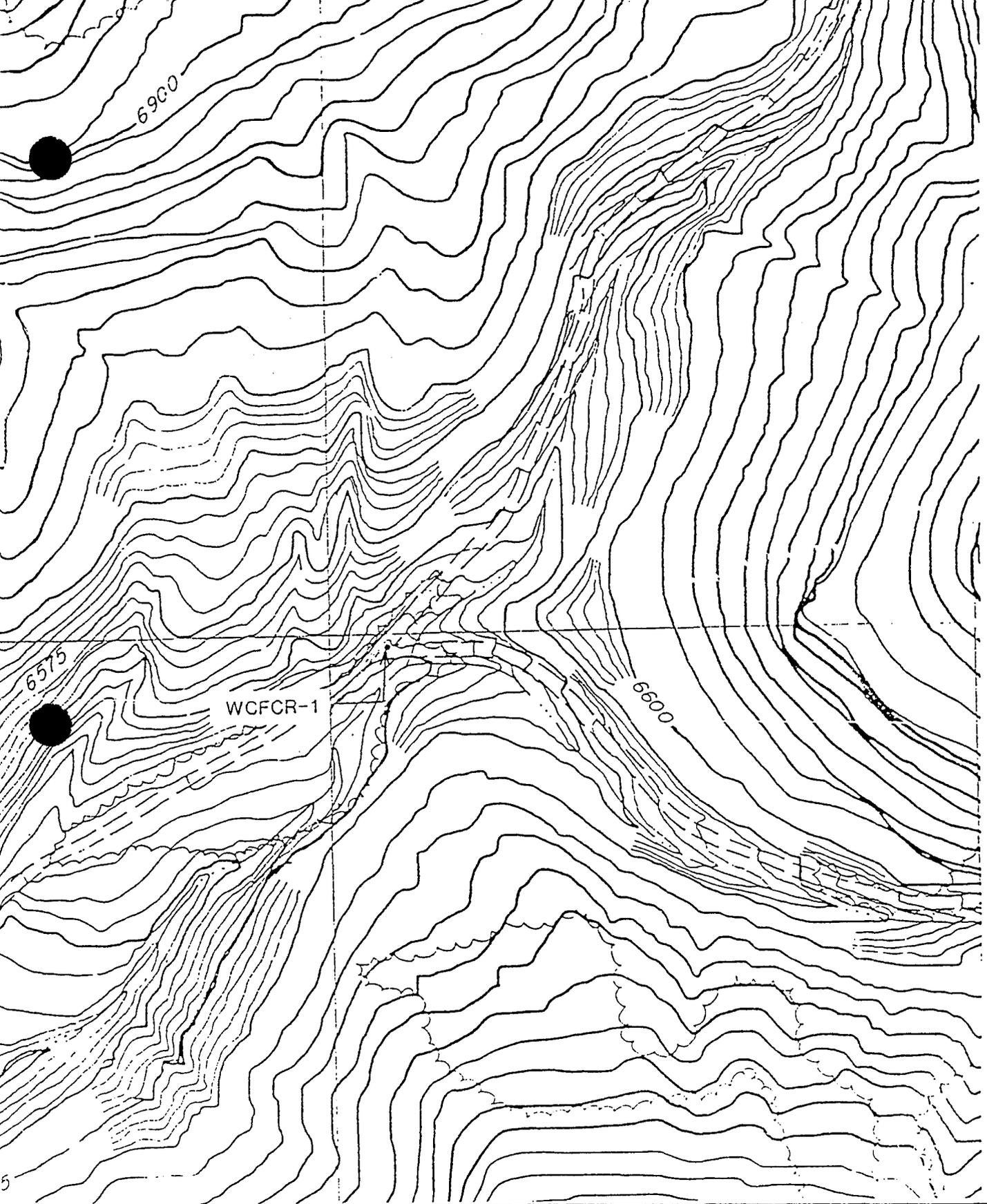
September 6, 1990

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Lab No.	Location	Depths	Organic Matter %	Carbonate %	P ppm	Boron ppm	Selenium ppm	K PE meq/l	Alkalinity PE meq/l	Total Kjeldahl Nitrogen %	1/3 bar	15 bar	Available Water Capacity in/in
41647	WCFCR-1E	36.0-72.0	1.2	12.5	1.16	0.59	0.03	0.19	2.78	0.06	14.7	7.8	0.069
41649	41647(DUP)	36.0-72.0	1.3	13.2	1.47	0.70	0.04	0.19	2.42	0.06	14.4	8.1	0.063
41642	FC-3F	48.0-84.0	4.8	15.4	0.47	0.86	0.04	0.79	1.77	0.10	18.5	9.4	0.091
41650	41642(DUP)	48.0-84.0	5.3	15.8	0.61	1.03	0.06	0.69	1.69	0.09	19.5	9.4	0.101
41620	#2-2E	36.0-84.0	0.7	28.1	0.19	0.47	<0.02	0.04	1.82	0.04	14.6	7.8	0.068
41651	41620(DUP)	36.0-84.0	0.7	27.8	0.50	0.42	0.04	0.07	2.75	0.03	16.0	8.5	0.075
41613	#2-1A	0.0-6.0	4.7	11.3	5.72	0.75	<0.02	0.23	3.18	0.10	16.4	6.2	0.102
41652	41613(DUP)	0.0-6.0	5.0	11.1	4.51	0.65	0.05	0.20	2.92	0.10	15.7	7.0	0.087
41603	WC-1B	6.0-12.0	7.2	6.9	1.68	0.47	<0.02	1.49	2.93	0.13	16.9	7.5	0.094
41653	41603(DUP)	6.0-12.0	7.7	7.1	1.85	0.40	<0.02	1.97		0.13	15.5	7.8	0.077

Lab No.	Location	Depths	Hue Value/Chroma	Munsell Soil Color
41602	WC-1A	0.0-6.0	10YR 5/2	Grayish Brown
41603	WC-1B	6.0-12.0	10YR 5/2	Grayish Brown
41604	WC-1C	12.0-24.0	10YR 5/2	Grayish Brown
41605	WC-1D	24.0-36.0	10YR 5/2	Grayish Brown
41606	WC-1E	36.0-72.0	10YR 5/2	Grayish Brown
41607	WC-2A	0.0-24.0	10YR 5/2	Grayish Brown
41608	WC-2B	24.0-48.0	10YR 5/2	Grayish Brown
41609	WC-3A	0.0-6.0	10YR 6/2	Light Brownish Gray
41610	WC-3B	6.0-12.0	2.5Y 6/2	Light Brownish Gray
41611	WC-3C	12.0-24.0	10YR 6/3	Pale Brown
41612	WC-3D	24.0-36.0	10YR 6/3	Pale Brown
41613	#2-1A	0.0-6.0	10YR 6/2	Light Brownish Gray
41614	#2-1C	12.0-24.0	10YR 6/3	Pale Brown
41615	#2-1D	24.0-36.0	2.5Y 7/2	Light Gray
41616	#2-1E	36.0-84.0	2.5Y 7/2	Light Gray
41617	#2-2A	0.0-6.0	10YR 6/2	Light Brownish Gray
41618	#2-2C	12.0-24.0	2.5Y 7/2	Light Gray
41619	#2-2D	24.0-36.0	2.5Y 7/2	Light Gray
41620	#2-2E	36.0-84.0	2.5Y 7/2	Light Gray
41621	#2-3B	16.0-22.0	10YR 5/2	Grayish Brown
41623	#2-3C	22.0-28.0	2.5Y 5/2	Grayish Brown
41624	#2-3D	28.0-40.0	10YR 7/3	Very Pale Brown
41625	#2-3E	40.0-52.0	10YR 7/3	Very Pale Brown
41626	#2-3F	52.0-91.0	10YR 7/3	Very Pale Brown
41627	FC-1A	0.0-6.0	10YR 6/2	Light Brownish Gray
41628	FC-1B	6.0-12.0	10YR 5/2	Grayish Brown
41629	FC-1C	12.0-24.0	10YR 5/2	Grayish Brown
41630	FC-1D	24.0-36.0	10YR 5/3	Brown
41631	FC-1E	36.0-84.0	10YR 5/3	Brown
41632	FC-2B	24.0-30.0	10YR 5/3	Brown
41633	FC-2C	30.0-36.0	10YR 5/3	Brown
41634	FC-2D	36.0-48.0	10YR 5/2	Grayish Brown
41635	FC-2E	48.0-60.0	10YR 5/2	Grayish Brown
41636	FC-2F	60.0-84.0	10YR 5/2	Grayish Brown
41637	FC-3A	0.0-6.0	10YR 5/2	Grayish Brown
41638	FC-3B	6.0-12.0	10YR 5/2	Grayish Brown
41639	FC-3C	12.0-24.0	2.5YR 5/2	Grayish Brown
41640	FC-3D	24.0-36.0	2.5YR 5/2	Grayish Brown
41641	FC-3E	36.0-48.0	2.5YR 5/2	Grayish Brown
41642	FC-3F	48.0-84.0	2.5YR 5/2	Grayish Brown

Lab No.	Location	Depths	Hue Value/Chroma	Munsell Soil Color
41643	WCFCR-1A	0.0-2.0	10YR 6/3	Pale Brown
41644	WCFCR-1B	2.0-4.0	10YR 6/3	Pale Brown
41645	WCFCR-1C	12.0-24.0	10YR 6/3	Pale Brown
41646	WCFCR-1D	24.0-36.0	10YR 6/3	Pale Brown
41647	WCFCR-1E	36.0-72.0	10YR 6/3	Pale Brown
41665	FC-2A	0.0-24.0	7.5YR 2/0	Black
41666	#2-1B	6.0-12.0	2.5YR 4/2	Dark Grayish Brown
41667	#2-2B	6.0-12.0	10YR 4/2	Dark Grayish Brown
41668	#2-3A	0.0-16.0	10YR 4/1	Dark Gray



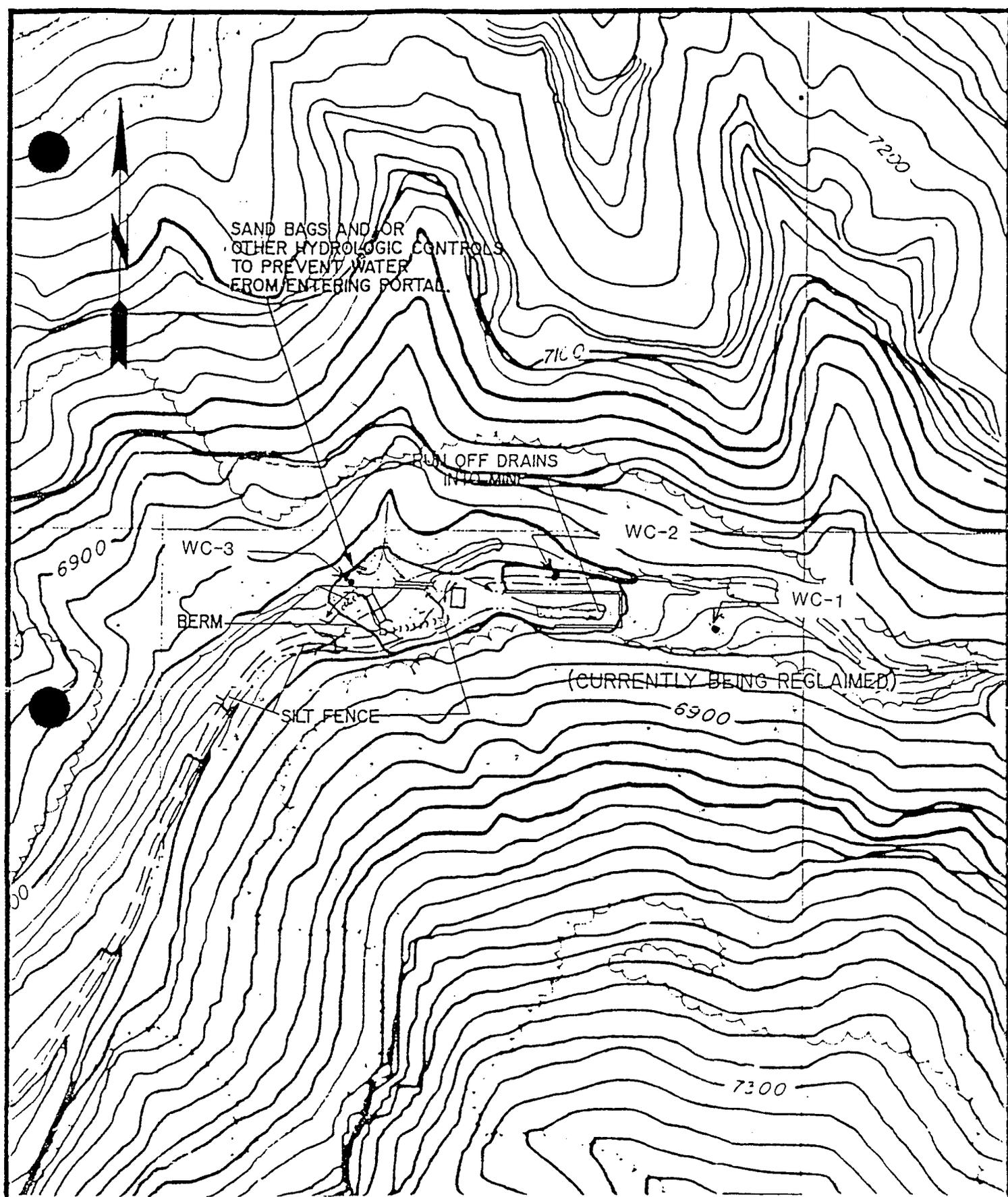
Sunnyside
Coal Company

SUNNYSIDE MINES

REVISIONS		
NO	DATE	BY
1		
2		
3		
4		

MOUTH OF FAN & WATER CANYONS	
DRAWN BY	DATE
CHECKED BY	DATE
APPROVED	DATE

DRAWING NO.



Sunnyside Coal Company

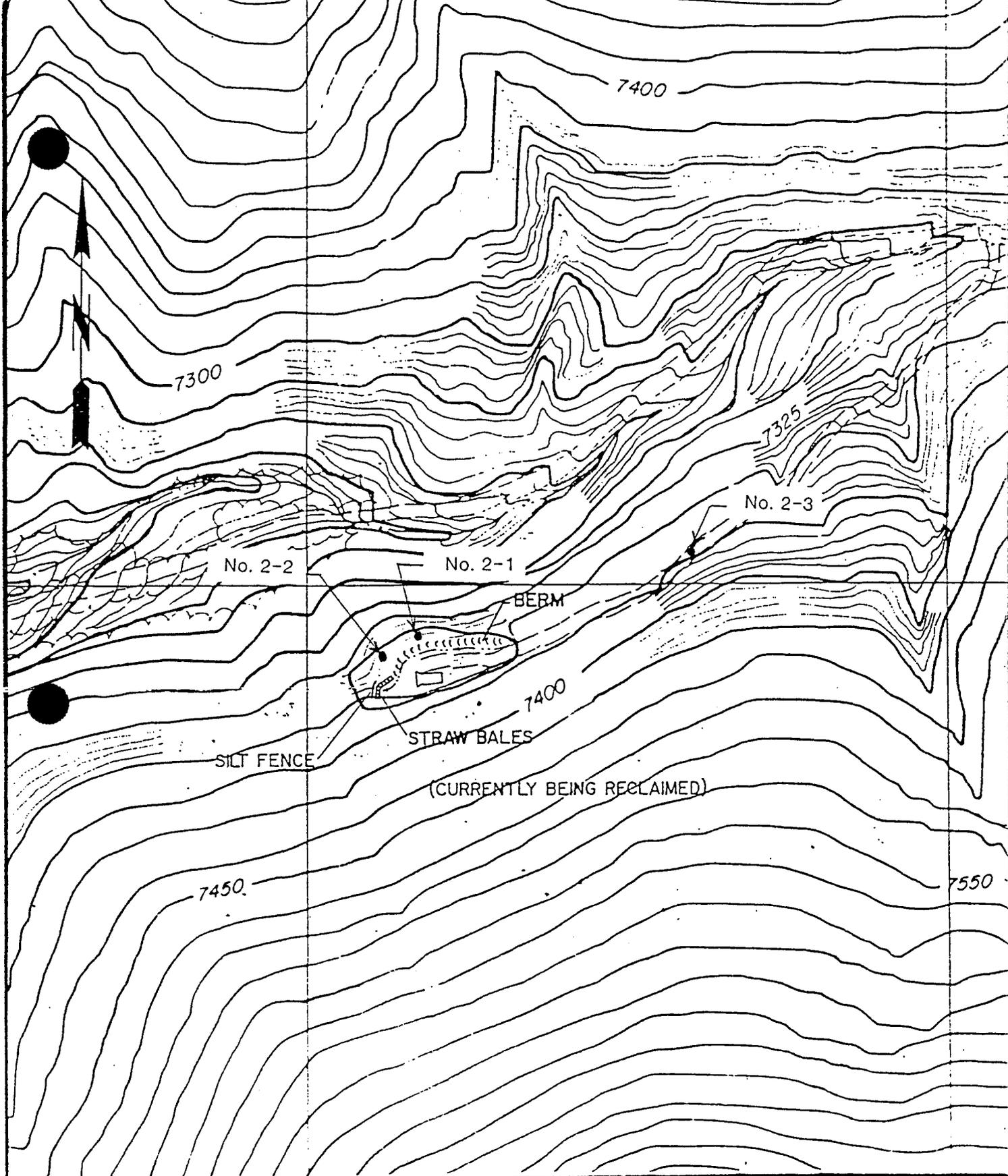
SUNNYSIDE MINES

REVISIONS		
NO	DATE	BY
1	11/4/84	BCP
2	7/11/88	B.F.A.
3		
4		

WATER CANYON PORTALS	
B.T.C.A. AREA	0.99 ACRES
Drawn by	DCP
Checked by	
Approved	
DATE	11-21-83
DATE	
SCALE	1" = 200'

PLATE 5-5

DRAWING NO. AS-0107



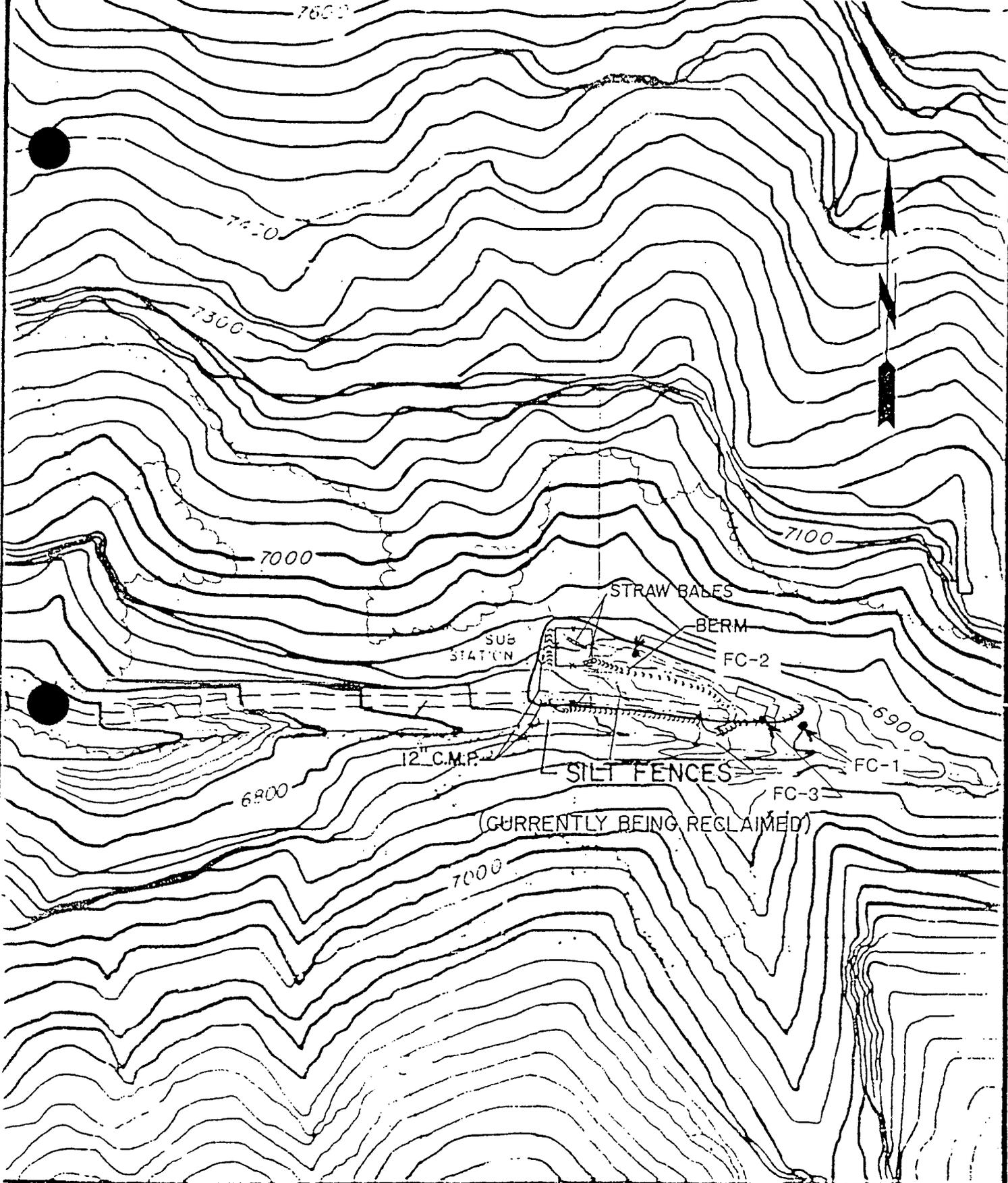
Sunnyside Coal Company

SUNNYSIDE MINES

REVISIONS		
NO	DATE	BY
1	11/14/84	DCP
2	7/11/88	B.F.A.
3		
4		

NO. 2 CANYON FAN		
B.T.C.A. AREA		
0.50 ACRES		PLATE 5-5
DRAWN BY	DCP	DATE 11-21-83
CHECKED BY		DATE
APPROVED		SCALE 200'

DRAWING NO. A5-0106



Sunnyside Coal Company

SUNNYSIDE MINES

REVISIONS		
NO.	DATE	BY
1	11/14/84	DCP
2	7/1/88	B.F.A.
3		
4		

NO. 2 MINE FAN	
B.T.C.A. AREA	
0.95 ACRES	
DRAWN BY	DATE
DCP	11-21-83
CHECKED BY	DATE
APPROVED	SCALE
	200'

LEARNING CO.
 AS-0110

Appendix 2-5

1982 Test Plot Study

REVEGETATION TEST PLOT STUDY REPORT, 1982

SUNNYSIDE UNDERGROUND MINES, SUNNYSIDE, UTAH

By: Marcia J. Wolfe and John P. Abbott
Reclamation Engineers

OBJECTIVE

To determine establishment of selected plant species on coarse coal refuse, coal slurry, Mancos shale, topsoil over refuse, topsoil over slurry, and topsoil alone as a control.

MATERIALS and METHODS

The plots are situated in a valley bottom adjacent to Grassy Trail Creek and has a slope ranging from 0-1%. A 42' x 40' area was excavated in 1980 with a front-end loader to a depth of two feet. The following eight plant growth media were installed:

1. 24" coarse refuse
2. 24" slurry
3. 24" Mancos shale
4. 2" topsoil over 22" of coarse refuse
5. 6" topsoil over 18" of coarse refuse
6. 2" topsoil over 22" of slurry
7. 6" topsoil over 18" of slurry
8. 24" of topsoil

Plant species and seeding rates used are listed in Table 1. These species were recommended by Mary Ann Wright, Utah Division of Oil, Gas and Mining. The plot arrangement is presented in Figure 1. Seeded species were planted in furrows and lightly raked to cover. Containerized stock was planted in offset rows.

All planting was performed on 14 May 1980. Furrow irrigation was applied during the 1980 summer at a rate of one inch of water per week until late August. No fertilization and no further irrigation were applied. The plot was fenced with a six foot chain-link fence.

Vegetation sampling was conducted annually for two years on 21 June 1981, and 11 August 1982. Line intercept was used to measure ground cover of each species along a 2.5m transect. A buffer zone was maintained to minimize edge effects between plots. Vigor was qualitatively evaluated on a 0-5 scale (Table 2). In August, 1982, soil samples were taken of the slurry, coarse refuse and Mancos shale treatments, from both the surface layer and a 6" depth. The samples were sent to the Colorado State University Soils Laboratory for chemical analysis. Additional samples were taken from all refuse plots in November, 1982, to verify earlier results and expand data from refuse material.

RESULTS

Generally, plant growth on all treatments, except coarse refuse, was satisfactory (Figure 2 & Figure 3).

SPECIES VIGOR

As in 1981, stream bank wheatgrass and Louisiana sage maintained the most vigorous performance across all treatments (Table 3). Salina wildrye performed fairly to satisfactorily on all treatments except slurry. Clematis failed to emerge in any treatment. Neither sweetvetch nor rubber rabbitbrush became established on coarse refuse or on refuse covered with 2" of topsoil. However, they performed fairly vigorously on all the other treatments. The vigor values for all species were the lowest on the three coarse refuse treatments. Two inches of topsoil on refuse did not improve vigor. However, growth of establishment plants was slightly increased on plots with 6" of topsoil over coarse refuse. Vigors were highest on the topsoil control and Mancos shale. Plant growth on the slurry treatment was improved with the addition of any amount of topsoil.

Compared to 1981 (Table 4), vigors as measured in 1982 were essentially the same, with the exception of some erratic changes by sweetvetch. Sweetvetch became established for the first time in slurry. Vigor values for sweetvetch dropped on all other treatments except with 24" of topsoil on which vigor improved slightly.

PLANT COVER

Total average plant cover of trial species did not change significantly between 1981 and 1982, with the exception of a decrease in cover on coarse refuse (Figure 4). A small decrease in cover on the 2" topsoil over refuse treatment was also deduced.

With the exception of good plant cover on the 6" soil over refuse by Louisiana sage, cover of test species was low on all coarse refuse treatments (Table 5). Although several of the sage plants have died, the survivors are spreading rhizomately.

Cover of surviving test species was good on topsoil, with the exception of sweetvetch. Rabbitbrush, streambank wheatgrass and Louisiana sage had the greatest cover on both shale and 24" topsoil. As stated before, clematis did not become established on any treatment.

Average cover of all species, both test and invaded, ranged from 21% to 30% across all treatments, except the coarse refuse plots (Table 6). Total plant cover on each of the latter plots was less than 13% (refuse).

1. See footnote on Table 4.

SOILS

Results of some chemical analyses of four plot materials are shown in Table 7. The coarse refuse exhibited an unexpected low pH (average of 6.2) with corresponding high values for iron, manganese and copper. The other three materials had a low basic pH (7.4 to 8.2). Slurry was high in sodium at the 6" depth (16.6 meq/l).

DISCUSSION

The revegetation test plot at the Sunnyside Mine demonstrates the potential of selected trial species to become established on various media with establishment irrigation, and without the addition of soil amendments. Streambank wheatgrass and Louisiana sage had the best vigor across all treatments. These are native species. Streambank wheatgrass is adapted to moderately alkaline, sandy to clay textured soils (Thornberg 1981). Louisiana sage is a highly complex species which has been divided into seven subdivisions by Keck. It apparently has quite a wide ecologic amplitude. It was the only trial species which did well on one of the coarse refuse treatments (Table 5). Louisiana sage was spreading vigorously in several plots by rhizomatous growth (Figure 5).

Apparent reasons for the failure of clematis to become established on any media were either poor seed (PLS was only 36%) or special germination requirements. Clematis is native to the canyons and valleys of the Sunnyside permit area and was expected to do well on the 24" topsoil treatment.

Rubber rabbitbrush did best on slurry and topsoil. These materials were higher in SAR than the other media. Rubber rabbitbrush is adapted to similar alkaline and salty soils (EPA 1975).

Salina wildrye only did well on Mancos shale and topsoil. Although it failed to establish on slurry, it should be noted that a non-seeded species, Indian ricegrass, accounted for 10% cover on the slurry treatment. This species is adapted to sandy loam soils (EPA 1975).

Sweetvetch performed erratically. It did not establish at all on coarse refuse without a 6" soil covering. Redente (1982) found temperatures above 30°C detrimental to germination of sweetvetch. Although it can germinate at low osmotic potentials, high temperatures such as would occur on the black coarse refuse may also be limiting germination of this and other species. However, if high temperature was the primary limitation, it should have been ameliorated by the topsoil overlays. It was not.

Performance of sweetvetch on slurry was poor to excellent with topsoil covering. It did less well on 24" of topsoil perhaps because of competition from yellow sweetclover. Extra scarification or fall seeding is recommended for sweetvetch (Redente 1982), as even when adequate water is available, the hard seed coat can prevent imbibition. Therefore, spring planting may also have minimized establishment of sweetvetch.

Quality of vigor and establishment was reflected by the amount of plant cover exhibited by each trial species. Generally, the slurry plots, Mancos shale and topsoil demonstrated much more vigorous growth than any coarse refuse treatment. Some 11 non seeded species have invaded these plots while only 3 species have invaded the refuse plots.

Poor response to the refuse material in all species is grossly evident (Figure 3). Additionally, cover and vigor of species previously established on refuse declined.

A soil sample was taken from the coarse material in all species previously established on refuse declined.

A soil sample was taken from the coarse refuse test plot in 1982. Contrary to the results of analysis made of refuse elsewhere in the Colorado Plateau (White, et al. 1982), refuse at Sunnyside had low pH in both the surface and subsurface, 6" depth, (Table 7). The surface was expected to have a lower pH than at the 6" depth. However, the surface layer had a medium quantity of lime whereas the deeper layers reflected a low quantity. As the surface layer weathered, the lime apparently raised the pH slightly. This change, however, was insufficient to improve plant establishment by the trial species.

As is common in soils of low pH, the tests indicated an increased presence of metals in the refuse. Levels of plant available iron, manganese and copper present in the refuse were usually high.

Native soils of the Sunnyside region tend to be alkaline. Therefore, germination and establishment of the native species on refuse may be adversely affected by low pH. Little information concerning toxicities to native plants is available from the literature. However, soil test research is currently underway to define such information for native plants (Berg 1978). But probability is high that the plant available levels of iron and manganese depresses growth in general (Black 1968). Soil acidity is known to inhibit root growth and concomitantly affects both uptake of water and nutrients (Black 1968). Soil acidity is known to inhibit root growth and concomitantly affects both uptake of water and nutrients (Black 1968). Copper toxicity of agronomic species also increases with soil acidity. Reuther, et al. (1953) found even spray residues of copper to be toxic to vegetation on soils of low pH.

In addition to apparent toxicity, the coarse texture and potential high temperature created by the dark color of the refuse may affect soil water retention and germination. However, micronutrient toxicities apparently overshadowed these effects as cover of the material with topsoil only allowed small increases in plant cover. Total cover on all refuse treatments was half that on Mancos shale, topsoil or topsoil on slurry treatments.

The trial plots also reflected the potential for natural plant succession by the invasion of non-seeded species. Invading species on all coarse refuse and 24" shale treatments accounted for only a small addition of ground cover (1%) (Table 6). On the other hand, additional cover created by invading species in the slurry plots and 24" topsoil treatment ranged from 6% to 13%. Invading species which contributed considerable amounts of cover were Indian ricegrass, yellow sweetclover, bigbract verbena, scarlet globe-mallow, and curlycup gumweed.

CONCLUSIONS

Plant growth on Mancos shale, topsoil and slurry were far superior to growth on any refuse treatment. Mancos shale and topsoil are two commonly occurring substrata in the Sunnyside region to which the native species are adapted.

Covering slurry with topsoil slightly improved plant cover. An increase in total cover of pioneer species which invaded the slurry plots indicated some are more adapted to the material than those species tested. Revegetation with species more specifically adapted to the physical and chemical characteristics of slurry (i.e. species more adapted to salinity and less sensitive to conductivities greater than 4 mmhos/l) would undoubtedly be as successful as use of a soil cover.

Generally, a topsoil cover was insufficient in treating coarse refuse. Improved growth on refuse may be obtained by liming or the use of a deeper cover of soil material. However, selection of plant species adapted to growth on low pH growth media would probably be a more economical approach. Direct seeding of acid mine spoil has been successful in the eastern United States (Pepperman, et al. 1980, Champion & Benner 1981). Additional study of coarse refuse to determine the physical and chemical characteristics of the material over time is necessary to better plan revegetation of this material.

Use of a high profile mulch with tackifier could be expected to improve germination and establishment on all sites in general (Wolfe 1981) and on coal refuse (Abbott 1981). Phosphorus fertilizer has also been found to increase biomass and density of native species seeded on coal refuse (Abbott 1981).

LITERATURE CITED:

- Abbott, John Parsons. 1981. Revegetation of three disturbed sites in Colorado. Master thesis. Colorado State University, Fort Collins, Colorado.
- Aldon, Earl F., David G. Scholl & Charles P. Pase. 1979. Establishing cool season grasses on coal mine spoils in northeastern New Mexico.
- Berg, W.A. 1978. Limitations in the use of soil tests on drastically disturbed lands. In: Reclamation of drastically disturbed lands. Eds, Schaler, Frank W. & Paul Sutton, ASA, CSSA, SSSA. Madison, Wisconsin.
- Campion, Peter S.A. & David K. Benner. 1981. Establishing permanent vegetation on coal refuse without a four foot layer of topsoil. In: Symposium on surface mine hydrology, sedimentology and reclamation. University of Kentucky, Lexington Kentucky.
- Pepperman, R.E., J.C. Draper & R.J. Houston. 1980. Experimental direct vegetation of a deep coal mine spoil bank in Green County, Pennsylvania. In: Proceedings of the fifth annual meeting, Canadian Land Reclamation Assn, Timmons, Ontario.
- Redente, Edward F. 1982. Sweetvetch seed germination. J. range manage. 35(4) :469-472.
- White, Susan M., Kent Oslter & Cyrus McKell. 1982. Coal refuse - an increasingly serious problem for Colorado Plateau coal production. DOE, Division of Coal Mining. FE-24, Washington, DC. by Plant Resources Institute, Salt Lake City, Utah.
- Wolfe, Marcia Hamann. 1981. Reclamation in the mountains of Northeastern New Mexico. In: Reclamation in mountainous areas. Proceedings of the Sixth Annual meeting of the Canadian Land Reclamation Association and the fifth annual British Columbia Mine Reclamation Symposium. Cranbrook, BC. August 24-27, 1981.

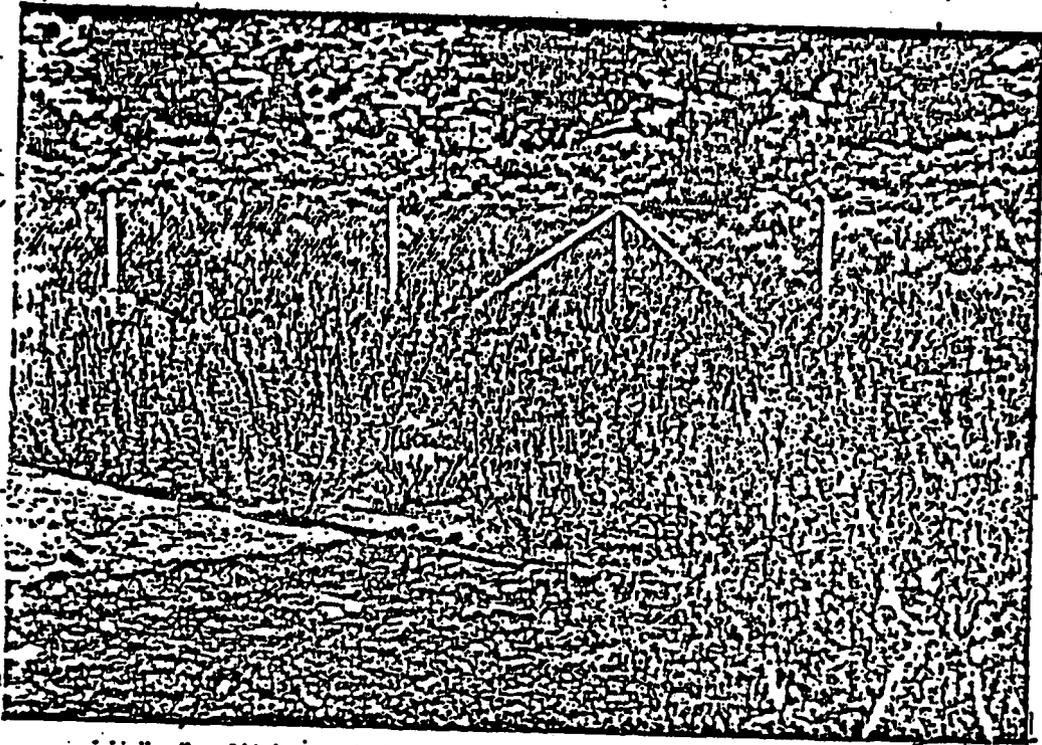


Figure 2. Treatments on far side of pipe illustrate good plant growth. Left to right: 24" topsoil, 6" soil/18" slurry, 2" topsoil/22" slurry, and 24" slurry.

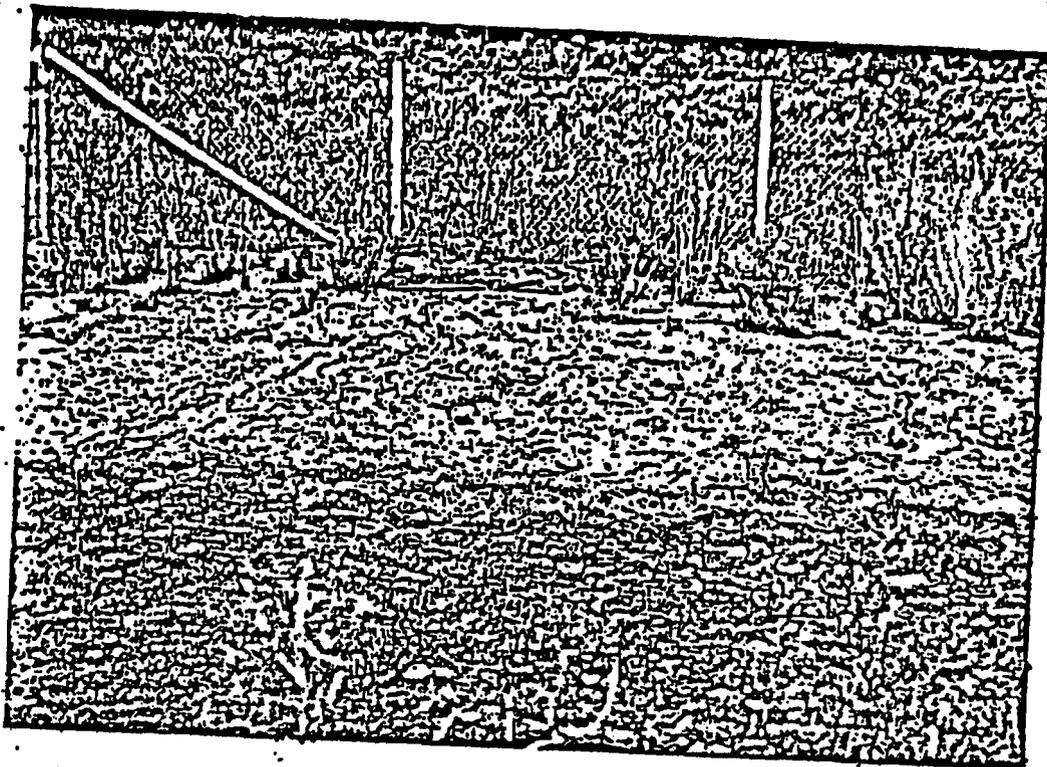
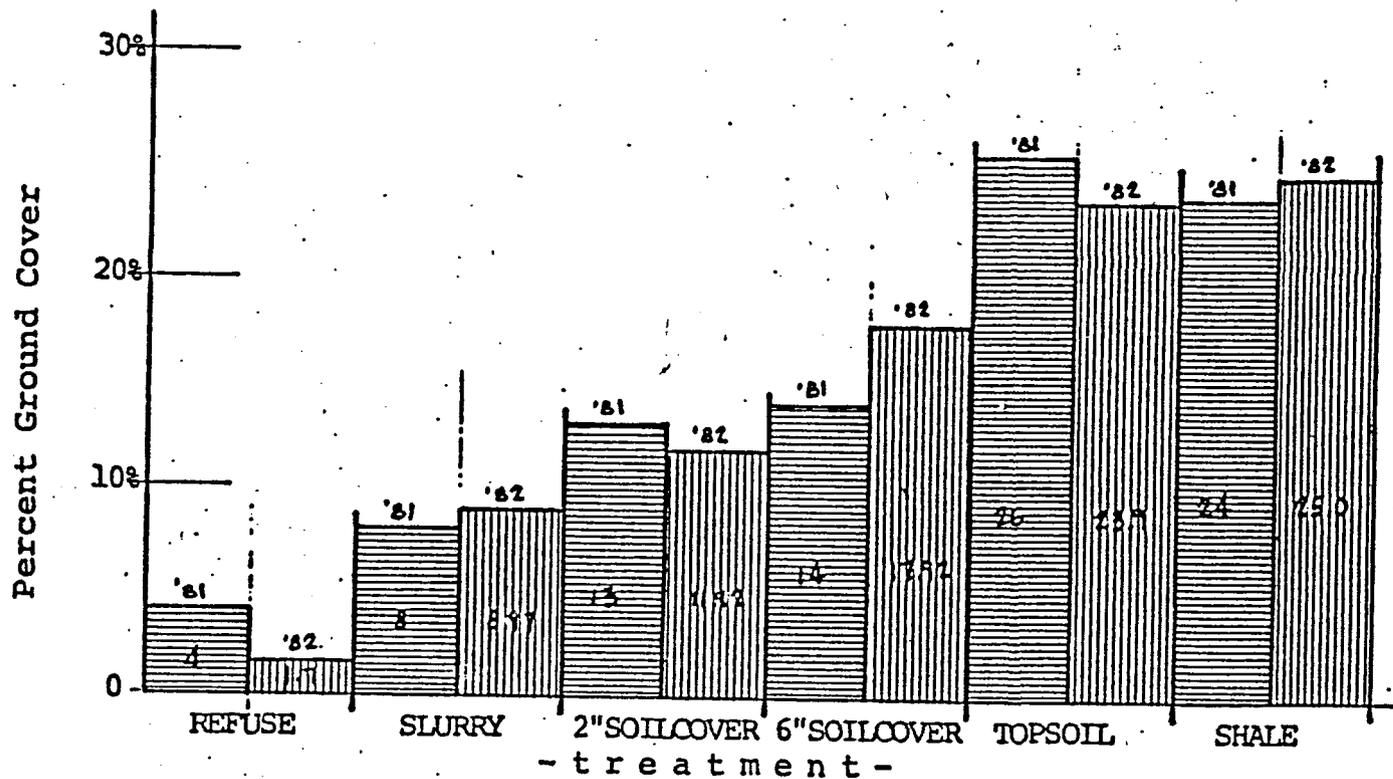


Figure 3. Coarse refuse treatments illustrate almost no plant growth. Front to back they are coarse refuse, 24", 2" topsoil/22" refuse and 6" topsoil/18" refuse. The good growth on the farthest plot is on 24" Mancos shale.



(note: topsoil over refuse & topsoil over slurry average figures combined together.)

▨ 1981

▤ 1982

Figure 4. Percent Ground Cover of Trial Species as determined by line intercept.

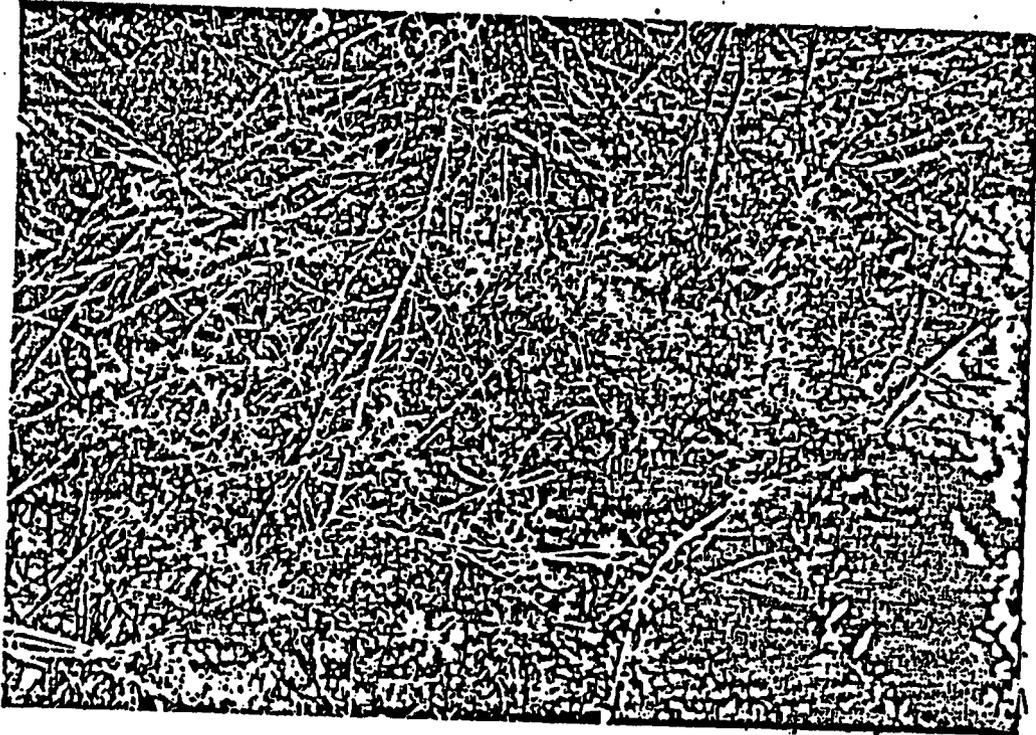


Figure 5. Louisiana sage, an excellent reclamation species, is seen here spreading vigorously from rhizomes.

Table 1. Plant Species Used in Sunnyside Mines
Revegetation Test Plot.*

Common Name	Scientific Name	Abrev.	Amounts Planted
Streambank Wheatgrass	<i>Agropyron riparium</i>	Agri	4 PLS#/A
Salina Wildrye	<i>Elymus salina</i>	Elsa	3 "
Western Clematis	<i>Clematis ligusticifolia</i>	Clli	2 "
Utah Sweetvetch	<i>Hedysarum boreale</i>	Hebo	2 PLS#/A
Rubber Rabbitbrush	<i>Chrysothamus nauseosus</i>	Chna	45 plants
Prairie Sage	<i>Artemisia ludoviciana</i>	Arlu	45 plants

* All plant material from Native Plants, Salt Lake City, Utah

Table 2. Scale of Plant Vigor

rating	description
0	dead or not present
1	dying
2	poor
3	fair
4	good
5	excellent growth

Table 3. 1982 Vigor Measurements of Species Seeded and Transplanted in Sunnyside Mines Revegetation Test Plot.+

species	treatment							
	coarse refuse	2"soil over refuse	6"soil over refuse	Mancos shale	slurry	2"soil over slurry	6"soil over slurry	topsoil
Agri	3	2	2	2	3	3	5	3
Elsa	2	2	1	0	3	2	4	4
Clli	0	0	0	0	0	0	0	0
Hebo	0	0	2	3	3	3	3	3
Chna.	0	0	2	3	4	4	5	2
Arlu	2	1	2	3	4	4	3	5

+ See Table 1 for complete names of abbreviations.

Table 4. Comparison of 1981 and 1982 Vigor Measurements

species	treatment											
	coarse refuse		slurry		Mancos shale		2" topsoil		6" topsoil		24" topsoil	
	81	82	81	82	81	82	81	82	81	82	81	82
Agri	3	3	3	2	3	3	3	2.5	2	2.5	5	5
Elsa	1	2	0	0	3	4	2	2.5	1.5	1.5	4	4
Clli	0	0	0	0	0	0	0	0	0	0	0	0
Hebo	0	0	0	3	4	3	4	1.5	4	2.5	2.5	3
Chna	0	0	4	3	2	2	2	2	3	3	4	5
Arlu	2	2	3	3	5	5	3.5	2.5	2	3	3	3

Note: Data from topsoil over slurry and topsoil over refuse combined as evaluated in 1981. Averaging these two treatments masks the results of the coarse refuse treatment; however, field data for 1981 is lost and figures cannot be separated

Table 5. Percent Plant Cover of Seeded Species in 1982

species	treatment							
	coarse refuse	2"soil over refuse	6"soil over refuse	Mancos shale	slurry	2"soil over slurry	6"soil over slurry	topsoil
Agri	2.0	1.6	.8	12.8	11.2	18.8	9.2	23.2
Elsa	1.0	22	13	12.8	0	5.2	18.8	15.6
C111	0	0	0	0	0	0	0	0
Hebo	0	0	13	5.2	3	17	24	4.8
Chna	0	0	.2	55.2	11.6	44.8	48	56
Arlu	7.2	1.2	44	64	28	32.4	44	43.6

Table 6. Average Percent Cover of Two Plant Species Groups by Treatment in 1982

species group	treatment							
	coarse refuse	2"soil over refuse	6"soil over refuse	Mancos shale	slurry	2"soil over slurry	6"soil over slurry	topsoil
6 trial species	1.7	4.13	11.83	25.0	8.97	19.7	24.0	23.9
all species	2.7	5.08	12.6	26.4	22.17	30.85	35	30.2

Table 7. Some Chemical Analysis of Slurry, Mancos Shale and Coarse Refuse.

material & sampling depth	parameter										
	pH +	cond.	meq/l Na *	SAR *	lime	ppm Zn #	ppm Fe #	ppm Mn #	ppm Cu #	texture @	
coarse Refuse	2"	6.6	3.6	.3	.1	med	7.0	156.0	28.9	2.1	S
	6"	5.8	3.4	.2	.1	lo	10.3	273	22.5	2.7	S
slurry	1"	7.5	2.7	.5	.2	hi	1.4	15.9	5.6	1.2	LS
	6"	7.4	4.5	16.6	3.2	med	2.8	17.8	2.0	1.1	LS
Mancos shale	1"	7.5	2.7	.7	.2	hi	1.0	16.9	2.1	.9	SCL
	6"	7.9	3.8	4.8	.9	hi	.9	7.0	.3	.6	SCL
topsoil		8.2	1.9	2.6	1.6						CL

+ saturated paste
 * saturated extract (Na in meq/l)
 # AB-DPTA extractable (ppm)
 @ estimated

Chapter 3

Biology

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3.10 Introduction

The focus of this chapter is the vegetation and wildlife resources within the permit boundary, vegetation and wildlife affected or potentially affected by mining operations, and mitigation/management plans.

3.20 Resource Information

3.21 Vegetation Information

The objective of this study was to map and quantify the vegetation communities of the Sunnyside Mines coal permit area.

The vegetation of Sunnyside permit area has been mapped and six of these vegetation types have been disturbed by mining operations. The disturbed communities include:

1. Mountain Brush
2. Pinyon-Juniper
3. Pinyon-Juniper/Grass
4. Riparian
5. Sagebrush/Grass
6. Pinyon-Juniper/Sagebrush

Of these disturbed communities, only four are in areas actively used or disturbed since 1977; these are Pinyon-Juniper, Mountain Brush, Pinyon-Juniper/Grass, and Sagebrush/Grass.

Vegetation sampling was conducted from late June into September 1981 by qualified personnel. All vegetation types previously disturbed or scheduled for future disturbance during the permit period were sampled. This sampling analysis and reference areas will be used to help evaluate reclamation success.

Vegetation types were determined in the field from reconnaissance, and plotted on a 1:12000 topographic map. Vegetation types were finalized on a 1:24000 topographic map (Plate 3-1) and include all areas within the permit area and contiguous areas within 1 km of the disturbed sites. The assumed vegetation of previously disturbed areas was mapped on a 1:6000 topographic map (Plate 7-4, (1-3)).

Vegetation mapping units may contain inclusions of other vegetation types. The number of inclusions within any mapped area depends upon the local variations in topography. Drainage and aspect changes are common in this region, and several changes may occur on a single slope. This region is generally dominated by rock outcrop and rubbleland; these areas are included within the appropriate vegetation dominated mapping unit and not delineated separately.

The species list for each vegetation type was compiled from plants collected during reconnaissance and collected during field measurements. All species were collected according to Harrington and Durrell (1957) and identified according to Welsh and Moore (1973) and Harrington (1964). Botanical nomenclature generally follows Welsh and Moore (1973). Difficult specimens were annotated by Dr. Stanley Welsh, Brigham Young University Herbarium, Provo Utah. Some Plants lacked structure needed for complete identification and were designated as unknowns. All vegetation types were physically examined for threatened and endangered species. Welsh (1977) and the USFWS (1980) were consulted to determine which critical habitats to examine.

Vegetation cover was estimated using two different and independent sampling techniques. Initially, the quadrat and line intercept method was used after being approved in a meeting with Mary Ann Wright of DOGM (Figure 3-4). The quadrat method estimated the herbaceous understory layer, while line intercept estimated only tree and shrub canopy cover.

Point line transects, which measured total first hit cover, were laid in all vegetation types. Transects were sampled at 0.5 meter intervals for the species first encountered by a descending point. All point transects were 25 meters long, and 50 points were taken on each transect at every 1/2 meter except on Pinyon-Juniper vegetation. In the Pinyon-Juniper types, half of the transect (12.5m) was parallel to the contour and the other half (12.5) was perpendicular to the contour. Fifty points were split between the two sides.

The quadrat method was used to estimate herbaceous cover, by species, for all types. A 0.25m^2 (79cm x 32cm) quadrat was used in the three Pinyon-Juniper types. In the Mountain Brush and Sagebrush/Grass a 0.10m^2 (20cm x 50cm) quadrat was used because of the high density of the shrubs. Quadrats in all types were located randomly along 30 m line transects.

The tree and shrub canopy cover over 12 inches tall was estimated along a line-intercept transect. When less than 12 inches tall, trees and shrubs were considered part of the herbaceous layer. The 12 inch delineation is an arbitrary one selected to avoid duplication of shrub and tree cover values. Thirty meter lines were appropriate in all types except Mountain Brush, where a 50 meter transect was necessary because of the large openings between shrub clumps.

Tree density in the Pinyon-Juniper types was estimated using 0.02 ha macroplots. These macroplots were in the shape of an elbow (Figure 3-4) with two 3 x 30 meter plots at a right angle to each other (H.E. Woodin and Lindsey 1954). This shape helps to account

for the great variabilities found within the Pinyon-Juniper zone. Tree seedlings (less than 4 1/2 feet tall, ie. dbh) were counted to help determine population trends but were not included in the tree density estimates.

Shrub density for each species was estimated by counting each shrub stem greater than 12 inches tall within either a 0.004 ha ((33' x 13.2') or 0.02 ha area (two 3 x 30m). The 0.004 ha area was used in Sagebrush/Grass and Mountain Brush; and the same 0.02 ha area as for tree densities was used in all Pinyon-Juniper types. The different plot sizes were selected on the basis of what was most appropriate for the vegetation type being sampled (Mueller-Dombois and Ellenburg, 1974). The shrubs less than 12 inches tall were counted as seedlings and were not used in the shrub stems per unit area estimates.

Annual primary productivity estimates were made by Mr. George Cook, District Range Conservationist, USDA Soil Conservation Service according to Standard SCS procedures. This information is contained in Figure 3-1.

The range conditions at the time of the productivity estimations by the SCS were fair and good (Figure 3-2). The 1981 precipitation was well above average. Effective precipitation has been graphed against precipitation for comparison (Figure 3-3)

A study relating standing crop and precipitation demonstrated that all the significant regression equations across a number of sites throughout the Intermountain Region, as well as the Northern Great Plains, illustrated similar vegetation precipitation relationships (Joyce 1981). If precipitation was greater than average, but within one standard deviation, standing crop averaged 117 percent of the long term mean and if it was greater than one standard deviation above, standing crop averaged 160 percent of the mean. Therefore it may be deduced the productivities estimated in 1981 averaged about 160 percent of the mean standing crops.

The sampling intensity was determined by using the following sample adequacy formula (Cook and Bonham 1977). This formula was recommended by the DOGM (Mary Ann Wright) and approved by Lynn Kunzler.

$$n_{\min} = \frac{(t)^2(s)^2}{[(.1)(x)]^2}$$

where n_{\min} = minimum number of samples needed,
t = two-tailed t-value with appropriate alpha level and
degrees of freedom,
s = sample variance, and
x = sample mean.

Sampling intensity information is contained in Table 3-1.

All sampling techniques were received and discussed with DOGM personnel, and were found to be appropriate and acceptable (Figure 3-4) (Mary Ann Wright, Lynn Kunzler, personal communications).

Copies of all raw vegetation data are maintained on file at the Sunnyside Mines.

General Site Description

The Sunnyside Mines permit area is located in the Book Cliffs area. This is a rugged mountainous region, deeply dissected by narrow valleys and box canyons cut by intermittent or ephemeral streams. Rock outcrop, mesas, cliffs and pediments arise from the canyons. Altitude ranges from 5,900 to 9,500 feet (1,798 to 2896 m) in elevation.

Whitmore Canyon is the primary valley affected by mine facilities. The canyon is headed by Grassy Trail Reservoir. The section of Grassy Trail Creek below the dam has an intermittent flow. Further downstream a small, perennial flow is created by mine water discharge. The drainage is narrowly lined with fragmented riparian vegetation.

The mines have been in operation since the 1890's. The area has been extensively grazed by sheep, goats, horses and cattle (Cook, personal communication). The vegetation of some areas indicated previous forest fires and tree removal. A small town was once located at the mine site in Whitmore Canyon and, thus the area has a long history of perturbation which has affected most of the vegetation.

An old pre-law portal in B Canyon exists presently; no additional surface disturbances of B Canyon are anticipated for this permit. The two canyons in this area, A Canyon and B Canyon, are rugged box canyons cut by ephemeral streams. A few elements of riparian vegetation are found scattered along the edge of the drainage in moist micro-sites. The narrow canyon floors are strewn with recent rockfall. There is a strong north-south slope effect because of these narrow canyons. Pinyon-Juniper dominated vegetation is typically found on south facing slopes; vegetation on north facing slopes is dominated by Douglas fir or mountain brush.

Some of the Pinyon-Juniper adjacent to the mouth of B Canyon was cleared in the late 1960's however trees are presently reinvading these sites. The rugged topography within these narrow side canyons is generally unsuitable for livestock grazing and is used as wildlife habitat.

Vegetation Types

The vegetation within the permit area varies from sagebrush/grass habitat type at the lower elevations, to the Douglas fir/aspens habitat at higher elevations. Only four vegetation types have been disturbed by the actively used surface facilities of the mines. The disturbed vegetation types are comprised of the following communities:

<u>Community</u>	<u>Acres</u>
Mountain Brush (serviceberry)	13.6
Pinyon-Juniper/Grass	204.7
Sagebrush/Grass	87.5
Pinyon-Juniper	8.3
Total	314.1

It should be noted that all Riparian vegetation disturbances were made prior to 1977 and were also revegetated prior to that date. Because no future redisturbances are planned along Grassy Trail Creek, riparian data are not required and have not been included. Disturbances of the B Canyon portal occurred pre-1977 law. This disturbance area was probably within the Pinyon-Juniper/sagebrush vegetation type, and have been collected in this area to aid in revegetation planning and reclamation success determinations.

Other vegetations types found within the permit area include:

- Aspen
- Douglas Fir
- Douglas Fir/Aspen
- Douglas Fir/Mountain Brush
- Douglas Fir/Aspen/Mountain Brush
- Douglas Fir/Pinyon-Juniper
- Douglas Fir/Sage
- Pinyon/Juniper-Mountain Brush
- Riparian-Bulrush/Sedge
- Riparian-Willow
- Sagebrush/Mountain Brush

The general description of each vegetation type to be disturbed are presented. Cover data, production data, species lists, and tree data are given, when appropriate, in Tables or text within each description.

Pinyon-Juniper/Sagebrush

The Pinyon-Juniper/sagebrush habitat type that is currently disturbed is generally located on south-east facing slopes above and to the north of the portal in B Canyon. The elevation within this vegetation type ranges from 7,100 to 7,300 feet (2,164 to 2,225 m) and the slope ranges from 55 to 80 percent.

This habitat type is generally found within the rock outcrop (RO) and rock outcrop-rubbleland-DL (RSH2) soils complex mapping units. The rock outcrop consists of exposed sandstone bedrock, conglomerate sandstone, and limestone. The rock outcrop-rubbleland-DL complex is comprised of 40 percent rock outcrop, 25 percent rubbleland, and 25 percent DL cobbly fine sandy loam. This complex occurs on 60 to 80 percent slopes. The DL soil is mixed with rubbleland and rock outcrop and occurs with no identifiable pattern. The DL soil formed in residuum and colluvium derived mainly from sandstone and shale. The DL soil is shallow and somewhat excessively drained; permeability is moderately rapid and effective rooting depth is about 10 to 20 inches. Surface runoff is rapid and the erosion hazard is high.

The Pinyon-Juniper/sagebrush habitat type is dominated by a relatively uniform mixture of pinyon-juniper and sagebrush, with very little understory. The sparse vegetation typically grows in cracks, fissures, and between rocks where soil and moisture collect. This vegetation type is commonly found on the soil bearing portion of the soil mapping unit complex, and less commonly on the rock outcrop or rubbleland portion.

The total understory cover (4.40 percent) as measured by quadrats, is dominated by grass (3.85 percent), with bluebunch wheatgrass (Agropyron spicatum, 1.70 percent) and salina wildrye (Elymus salina, 1.73 percent) being the important grasses (Table 3-33). The point line cover, which measures canopy and understory cover simultaneously, estimated cover from trees at 16 percent, shrubs at 14.7 percent, and grasses with 11.27 percent (Table 3-36). With both quadrats and point line, rock had the highest cover with 53.12 percent and 32.91 percent, respectively (Table 3-37 and 3-36). Table 3-38 presents a comprehensive species list for the Pinyon-Juniper/sagebrush habitat type.

Stand characteristics are delineated in association Table 3-33. Pinyon pine (Pinus edulis) and Utah juniper (Juniperus osteosperma) are about equally prevalent with 144 and 153 trees per hectare, respectively (Table 3-34). Tree canopy cover, as determined by the line intercept method, is 8.7 percent for Utah juniper, 7.4 percent for pinyon pine and 11.2 percent for big sagebrush (Tables 3-34 and 3-35). The most common shrub is big sagebrush (Artemisia tridentata) with 3,478 stems per hectare (Table 3-35). A single portal opening with pre-law disturbance of less than one acre occurs within this habitat type. No additional

surface disturbance is planned as the result of including this facility in the mine plan. However, some surface re-disturbance may occur at the time of reclamation.

Riparian

The Riparian vegetation type is located along Grassy Trail Creek through the permit area. This type is comprised of several different communities depending upon the location along the stream. Dr. Larry Larson, U.S. Office of Surface Mining (personal communication, 1981), recommended sampling of the riparian community most disturbed and most likely to be vegetated. Using photographs taken near the early Sunnyside town-site in the late nineteenth century, it was determined that a willow (*Salix* spp.) community existed along the creek in the location of the current surface facilities at the mouth of Whitmore Canyon. The Riparian vegetation sampling was focused on the willow community currently upstream from the surface facilities. Attempting to reestablish a willow community along Grassy Trail Creek will provide rapid bank stabilization, reduced sediment loads and decrease the velocity of flow. Willow is a valuable cover and food for small game and bird species (Martin et al, 1974), and offers a mechanical barrier to livestock movement and consequently slows degradation of the banks.

The Riparian vegetation type described for the Sunnyside permit area is located between 6600 and 7400 feet (2010 to 2225 m) in elevation. The slope of the creek channel is 0 to 2 percent. The creek bank slopes away from the stream at 0 to 75 percent. Aspect is generally southern.

This vegetation type occurs in the Rivra extremely bouldery sandy loam. Little horizon development is present in the stream flood plain due to the young age and recent depositions of sediment. Texture varies from fine to coarse and is finer than loamy sand at depths greater than one foot (30 cm). Willows dominate this Riparian vegetation type, with 64 percent of the total vegetation cover, and 78 percent of the relative vegetation cover (Table 3-23). Willow stem densities average 18,124 stems per acre (48,950 stems/ha). Big sagebrush is the second most prevalent shrub with a density of 1013 stems per acre (2500 stems/ha). Complete shrub stem density information is contained in Table 3-24. A comprehensive species list is included in Table 3-25.

Tree overstory consists of narrowleaf cottonwood (*Populus angustifolia* and box elder (*Acer neugundo*). With few exceptions, these trees are small in size. Average basal diameter is 5.4 inches (13.7cm) for the cottonwoods and 2.4 inches (6.1 cm) for the box elder. Tree densities are 41 cottonwoods per acre (102/ha) and 36 box elder per acre (89/ha). The box elders appear to have greater seedling success, with 403 seedlings per acre (995/ha) compared

with 290 cottonwood seedlings per acre (716/ha).

The understory, except at the stream edge, is sparse. Kentucky bluegrass (*Poa pratensis*), wheatgrass (*Agropyron* spp.) and virginbower (*Clematis columbia*) are the most common species. Cover and constancy by species are given in Table 3-26. Total forb and grass cover is 4.4 percent (Table 3-23).

Annual primary production is estimated by the U.S. Soil Conservation Service as 3000 pounds air dry per acre (3360 kg/ha). The area is disturbed by a county road, culverts and concrete lined channel. The permanent area occupies approximately 4.0 acres (1.6/ha).

Artemisia-Bromus
(Sagebrush-Grass)

The Sagebrush-Grass vegetation type occurs at elevations of 6800 to 7400 feet (2072 to 2255m). Slopes vary from 1 to 7 percent. Aspect is typically south facing.

This vegetation type occurs on the Rivra extremely bouldery sandy loam soil mapping unit. Average surface layer (A1) thickness is 3 inches (7.5 cm) of sandy loam, over 57 inches (145cm) of very gravelly sandy loam in five C horizons. Runoff is very slow and water erosion potential is slight.

The Sagebrush-Grass vegetation type lies in the bottoms of Whitmore Canyon and its tributaries. These areas have been subject to heavy grazing pressure and presently represents a grazing disclimax with perennial grasses and forb greatly altered as a result. Big sagebrush (*Artemisia tridentata*) dominates the vegetation type (Table 3-27). Rubber rabbit brush (*Chrysothamnus nauseosus*) and snowberry (*Symphoricarpos oreophilus*) are common but less frequent components of the shrub stratum. Common forbs are Utah sweetvetch (*Hedysarum boreale*), pingue (*Hymenoxys richardsonii*), annual crypthanths (*Cryptantha* spp.), and pepperweeds (*Lepidium* spp.). Salina wildrye (*Elymus salina*), Indian ricegrass (*Oryzopsis hymenoides*), and Western wheatgrass (*Agropyron smithii*) are also present. Cover and constancy by species is presented in Table 3-27. The comprehensive species list for Sagebrush-Grass is contained in Table 3-28.

Herbaceous vegetation cover from quadrats (Table 3-29) averages more than 36 percent. Grasses, annual and perennial, account for 93 percent of the relative herbaceous cover.

Typical of many sagebrush areas in the intermountain region, most of the typical perennial bunch grasses have been replaced by increasing amounts of sagebrush (Christensen and Johnson 1964,

Cottam 1961, Driscoll 1964, Pearson 1965). At Sunnyside, the bunchgrasses have mostly been replaced by Bromus tectorum. Competition by this species prevents seedling establishment of many other species and has displaced Agropyron spicatum over large areas (Harris 1967).

Shrub cover from line-intercept measurements averages 21 percent (Table 3-30). Total first-hit vegetation cover from point-line transects averages 77 percent (Table 3-31). Annual primary production was estimated by the U.S. Soil Conservation as 1000 air dry per acre (1120 kg/ha).

This vegetation type has been disturbed by several mine facilities, including a power substation, sediment control structures, and major mine offices and shops. Approximately 87.5 acres (35.4 ha) are disturbed in this.

Mountain Brush

The mountain brush vegetation type occurs from elevations of 7000 to 8600 feet (2133 to 2620m). Slopes range from 44 to 64 percent. Aspect is typically eastern.

The vegetation type is found on Zillion Complex soils. The proportions of the complex given by the SCS (1980) are: 40 percent Zillion very stony fine sandy loam, 35 percent Zillion stony loam, both with 55 to 80 percent slopes, and 25 percent inclusions of other soils. Soils of the Zillion series are described as deep, well-drained, moderately permeable soils formed from sandstone and shale colluvium. Runoff is rapid and water erosion potential is high.

The Mountain Brush vegetation type is characterized by shrub thickets interspersed with clearings of grasses, forbs and solitary shrubs. True mountain mahogany (*Cercocarpus montanus*) and Saskatoon serviceberry (*Amelanchier alnifolia*) are the dominant shrubs, with stem densities of 520 stems per acre (1284/ha) and 265 stems per acre (654/ha), respectively (Table 3-2). Shrub cover, estimated by line-intercept transects, is 26 percent (Table 3-3).

Understory cover, from quadrats, is estimated to be 10 percent (Table 3-4). Grasses, particularly Salina wildrye (*Elymus salina*), account for almost 70 percent of the relative understory cover. Complete understory cover and constancy by species are included in Table 3-5. Point-line transect data indicates a total vegetation cover of 46 percent (Table 3-6). The comprehensive species list for the Mountain Brush vegetation type is presented in Table 3-7. Annual primary production is estimated by the SCS (1981) to be 800 pounds air dry per acre (896 kg/ha).

Existing disturbances in this type are the upper bathhouse/manshaft and ventilation fans. The disturbed acreage approximately equals 13.6 acres (5.5 ha).

Pinyon-Juniper (Pinus-Juniperus)

The Pinyon-Juniper (PJ) vegetation type is found from an elevation of 6900 to 7600 feet (2102-2315m). Slopes range from 41 to 71 percent. Aspects are typically south-facing.

The PJ vegetation type occurs on steep, rocky colluvial slopes. Bedrock is often exposed and is surrounded by bouldery areas largely barren of vegetation. Soil is present on small level areas and in rock cliffs. The soil is classified as the Rock Outcrop-Rubbleland-Sun-up Complex. The complex is estimated by the U.S. SCS to be comprised of 35 percent rock 30 percent Rubble, 25 percent Sun-up and 10 percent other soils. The Rock and Rubbleland series exhibits minimal soil development. The thin Sun-up soil has a typical surface horizon (A1) of very gravelly fine sandy loam, two inches thick, over 4 inches (10cm) of gravelly fine sandy loam (C1). Runoff is very rapid and the erosion hazard potential is high.

Utah Juniper and Pinyon pine are the dominant species and account for 78 percent of the relative vegetation cover (Table 3-8). Tree densities and basal areas are included in Table 3-9 and 3-10. Numerous grasses and forbs are present in the understory. Indian ricegrass (*Oryzopsis hymenoides*) is the most common grass, with cryptantha (*Cryptantha* spp.), twinpod (*Physaria acutifolia*) and mustards (*Brassicacea* spp.) the most common forbs. Complete understory cover and constancy data is presented in Table 3-11. A comprehensive species list is contained in Table 3-12.

Shrubs are numerous in this vegetation type, with densities over 300 shrubs per acre (822 per ha). True and curleaff mountain mahogany (*Cercocarpus montanus* and *C. ledifolius*) and Stansbury cliffrose (*Cowania mexicana*) are the most frequently encountered members of the shrub strata (Table 3-13).

Understory vegetation cover from quadrats (Table 3-14) averages less than two percent. Shrub and tree cover (Table 3-8) from line intercept measurements averages 34 percent. Total first-hit cover from point-line transects (Table 3-15) averages 29 percent for all vegetation. Annual primary production is estimated by the SCS to be 200 pounds per acre (244 kh/ha).

Existing disturbances are an electrical substation, ventilation fans, and old portals. The disturbed acreage approximately equals 8.3 acres (3.4 ha).

Pinyon-Juniper/Grass

The Pinyon-Juniper/Grass vegetation type is found at elevations of 6400 to 6500 feet (1949 to 1980m) in the Sunnyside Mines permit area. The land is largely level and rarely exceeds 3 percent

slope. The aspect is southwestern.

The Ildefonso very stony loam soil lies beneath this vegetation type. The surface horizon (A1) is very stony loam, 5 inches (12.5cm) deep. The C horizons beneath the A1 are very cobbly coarse sandy loam to very stony loam and extend to a depth of more than 60 inches (150 cm). Runoff is medium and erosion hazard potential is moderate.

The Pinyon-Juniper/Grass vegetation type lies on the dissected outwash plains and shallow toe slopes of the Book Cliffs. The vegetation is dominated by pinyon pine and Utah juniper. These two species contribute 31 percent of the line-intercept transect cover (Table 3-16). Tree densities are 102 pinyon pine per acre (252/ha) and 149 Utah junipers per acre (368/ha). Complete tree and shrub densities are given in Table 3-17. Utah juniper has the greater amount of basal area per acre (Table 3-18), while pinyon pine produced far more seedlings per acre than the juniper (Table 3-19).

The dominant shrub component is true mountain mahogany (*Cercocarpus montanus*) while the dominant understory components are Indian ricegrass (*Oryzopsis hymenoides*), penstemon (*Pinstemon subglaber*) and lobeleaf groundsel (*Senecio multilobatus*). Understory vegetation cover, estimated from quadrat data, is 9 percent (Table 3-20). Complete cover and constancy information for understory vegetation is included in Table 3-21. A comprehensive species list is contained in Table 3-22.

Vegetation measurements from point-line transects indicated a first-hit total vegetation cover of 35 percent (Table 3-23). Annual primary production was estimated by the SCS to be 300 pounds per acre (336 kg/ha) for understory and 400 pounds per acre (448 kg/ha) for the tree overstory.

This vegetation type has been disturbed by haul roads and preparation plant refuse disposal areas. Approximately 204.7 acres (82.9 ha) are disturbed in the Pinyon-Juniper/Grass Vegetation Type.

3.22 Fish and Wildlife Information

The mine plan area encompasses a portion of the West Tavaputs Plateau in Carbon County, Utah. This area drains into Grassy Trail Creek and on to the Price River, which flows into the Green River and ultimately into the Colorado River at a point upstream from Lake Powell. Generally speaking, the West Tavaputs Plateau is encompassed by cold desert (upper Sonoran life zone), submontane (Transition life zone) and montane (Canadian life zone) ecological associations. These life zones could be inhabited on occasion and during different seasons of the year by about 363 species of

vertebrate wildlife--20 fish species, 5 amphibian species, 14 reptile species, 244 bird species and 80 mammal species. It is interesting to note that 84 percent of these species are protected.

The mine plan area itself is represented by the Transition and Canadian life zones and probably provides habitat for approximately 296 species of wildlife--4 fish species, 5 amphibian species, 14 reptile species, 196 bird species and 77 mammal species. Ninety-five of these species are of high interest to the State of Utah. A listing of the high interest species potentially in the mine permit area is presented in Table 3-46.

High interest wildlife are defined as all game species; any economically important species; and any species of special aesthetic, scientific or educational significance. This definition would include all federally listed, threatened and endangered species of wildlife.

A ranking and display of wildlife habitats and use areas relative to high interest species of vertebrate wildlife has been developed (Table 3-49). Critical wildlife use areas followed in respective importance by high-priority, substantial value and limited value wildlife use areas require various levels of protection from man's activities and developments.

For purposes of clarification, the classification of waters in Utah that will be referenced in the following narrative represents a Division of Wildlife Resources system developed and applied to all the State's waters in 1970. The classification system determined a numerical rating for each of the stream sections or lakes within Utah. (Insofar as possible, each stream section represents an ecologically and physically uniform stream segments.) The numerical values were developed through an evaluation at each water of esthetics, availability of the water to sportsmen and production of fish. Class 1 waters are the best and Class 6 are the poorest.

Critical wildlife use areas are "sensitive use areas" necessary to sustain the existence and perpetuation of one or more species of wildlife during crucial periods in their life cycles. These areas are restricted in area and lie within high-priority wildlife use areas. All stream sections, reservoirs, lakes and ponds identified by Utah Division of Wildlife Resources as Class 1 or 2 are classified as being critical. Biological intricacies dictate that significant disturbances cannot be tolerated by the members of an ecological assemblage on critical sites. Professional opinion is that disturbance to critical use areas or habitats will result in irreversible changes in the species composition and/or biological productivity of an area.

High-priority wildlife use areas are "Intensive use areas" for one or more species of wildlife. "Intensive use areas" are not restricted in area and in conjunction with limited value use

areas form the substantial value distribution for a wildlife species. All stream sections, reservoirs, lakes and ponds identified by Utah Division of Wildlife Resources as Class 3 are classified as being of high-priority. In addition, wildlife use areas where surface disturbance or underground activities may result in subsidence that could interrupt underground aquifers and result in a potential for local loss of ground water and decreased flows in seeps and springs should be considered as being of high-priority to wildlife.

Substantial value wildlife use areas are "existence areas" for one or more species of wildlife. "Existence areas" represent a herd of population distribution and are formed by the merging of high-priority and limited value wildlife use areas for a species. All stream sections, reservoirs, lakes and ponds identified by Utah Division of Wildlife Resources as Class 4 are classified as being of substantial value.

Limited value wildlife use areas are "occasional use areas" for one or more species of wildlife. "Existence areas" represent a herd or population distribution and are formed by the merging of high-priority and limited value wildlife use areas for a species. All stream sections, reservoirs, lakes and ponds identified by Utah Division of Wildlife Resources as Class 5 or 6 are classified as being of limited value.

Vegetation and Wildlife Habitats

It is believed that if satisfactory reclamation is achieved and man's disturbance does not continue or become a factor, that most species of wildlife displaced from the mine plan area will return. Without doubt, the key to success for enhancing or restoring wildlands will be development of habitats so that the postmining condition as compared to the premining condition will have similar species, frequency and distribution of permanent plants in each vegetative type. This will allow for natural plant succession. Additionally, other habitat features that represent the various life requirements for local wildlife must be provided.

FISH AND WILDLIFE INVENTORY

Aquatic Use Areas

Macrophytes

From a position of the aquatic wildlife resource it is believed that there is no practicality for information relative to macrophytes to be addressed by the mine permit application; such information is not generally available.

Macroinvertebrates

Since the permit application does not identify any plans to impact the local salmonid fishery or discharge of polluting effluents into local waters, no data relative to macroinvertebrates as a pollution index or a forage base for fishes or other predators dependent upon the aquatic resource need be presented.

Note, impact avoidance procedures that will protect the integrity of the aquatic resource are included with the mine permit application. Of importance are facility designs that preclude impacts on streams or lakes and identification of procedures that will be utilized to keep any form of coal sediments or other pollution from entering Grassy Trail Creek and Grassy Trail Reservoir. Snow removal and road maintenance is designed to avoid being a significant contributor of sediments to local riverine systems. Deposition of coal particles in the aquatic system will be avoided.

Fish--Species Occurrence and Use Areas

Aquatic habitats associated with the mine plan area support two species of game and two species of non-game fish; all of which are protected. Of these fish, the two game species have been determined to be of high interest to Utah.

The rainbow trout is an exotic species. Within Utah there are several different strains of these species. Generally speaking, they spawn from mid-March through June; hatching is normally completed by late June. It is important to note that natural reproduction by this species is almost non-existent, since it is managed as a stocked population. This management scheme has resulted since their catchability is higher than other trout and the life expectancy of hatchery fish is short.

The brown trout is an exotic species. Its spawning period begins as early as mid-October and is normally completed by late December; hatching of eggs begins in spring and is usually completed by late May. Most populations are sustained through natural reproduction and supplemental plantings of fingerling brown trout.

The spawning period represents a crucial period for maintenance of trout populations spawning areas are ranked as being of critical value. Such areas are characterized by clean, gravel zones that are at least six inches deep. These zones must also be covered by a minimum of six inch deep water flowing at a velocity of not less than one foot per second. These physical parameters are necessary for optimum spawning success.

Once the rainbow trout have spawned their eggs incubate in the reeds approximately 30 to 50 days--water temperatures

ranging from 45 to 50 degrees F. Brown trout eggs incubate throughout the winter which lasts approximately 100 to 150 days--water temperatures ranging from 35 to 40 degrees F. During this crucial period water temperature affects the rate of embryonic develop--the warmer the water the more quickly incubation is completed. It is also during this period that ongoing sedimentation can result in suffocation of the eggs. Fluctuations in stream flow also negatively affects incubation; wherever practicable, maintenance of a constant flow of water during the spawning period enhances reproductive success.

Grassy Trail Reservoir, which lies on the mine plan area, has been ranked as being of substantial value to Utah's cold water fishery management program; it is a class 4 fishery. Use of the lake by sportsmen is prohibited since the water is used for culinary purposes. The reservoir supports brown trout. The trout were introduced as a biological control for salamanders, since the amphibians have represented a nuisance by plugging water lines.

Brown trout from Grassy Trail Reservoir do not utilize the left and right forks of Grassy Trail Creek for spawning and nursery activities. Flows from these two tributary waters are not suitable for the fall spawning activities of the brown trout. Possibly, speckled dace and redbreast shiner inhabit this stream section.

Grassy Trail Creek below the reservoir (stream section 2) is ranked as being of high-priority to Utah's cold water fishery management program and is a Class 3 fishery. It can support a catchable sized rainbow trout population. It may also be inhabited by speckled dace and redbreast shiner. Note, that the trout population results from a "put and take" management scheme and is only practicable during the best of water years.

It is important to note that no species of fish having relative abundances so low as to have caused them to be federally listed as threatened or endangered inhabit the mine plan or adjacent areas. The endangered humpback chub, bonytail chub and Colorado squawfish inhabit the Green and Colorado Rivers. Additionally, the humpback (razorback) sucker also inhabits those rivers; it is likely that this species will one day be federally listed as threatened. It is not believed that mining and reclamation activities in the permit area will impact any of these species.

Terrestrial Use Areas

Wildlife Habitat Types

Of the eleven wildlife habitat types present on the mine plan area wetlands and riparian habitats are ranked as being of critical value to all wildlife. They are normally associated with drainage bottoms (ephemeral or intermittent), or perennial streams, seeps

and springs within the upper Sonoran, Transition and Canadian life zones. Cliffs and their associated tallus areas that lie within the upper Sonoran, Transition life zones are ranked as being of high-priority value to all wildlife. When compared to all other wildlife habitats the aforementioned situations are considered to represent unique habitat associations.

Riparian and wetland areas are highly productive in terms of herbage produced and use by wildlife as compared to surrounding areas. Experience has shown that as much as 70 percent of a local wildlife population or dependant upon riparian zones. Cliffs and tallus are of special importance to many high interest wildlife.

Qualitative (condition, successional stage and trend) data concerning the wildlife habitats in each ecological association is included as part of the mine permit application. It is important to note that each legal section of land represented by the mine plan and adjacent areas has been ranked as to its value for the total wildlife resource. Section 33 of Township 14 South Range 14 East has been ranked as being of critical value to wildlife. Sections 1, 12, 13, 24, 25 and 36 of Township 14 South Range 13 East have each been ranked as being the high-priority value to wildlife. This is also true for sections 4 through 9, 16 through 21 and 28 through 32 of Township 14 South Range 14 East, and sections 4 through 9 of Township 15 South Range 14 East. These rankings were developed through an analysis of cumulative values for use areas of individual wildlife species inhabiting each legal section of land.

Amphibians--Species Occurrence and Use Areas

Five species of amphibians, all of which are protected, are known to inhabit the biogeographic area in which the mine plan and adjacent areas. Only one species of the amphibians inhabiting the project area has been determined to be of high interest to the State of Utah.

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

spring for breeding and may remain there during much of the summer. Such an intensive use area would be ranked as being of high-priority value to the animal. In September the newly transformed animals leave the water to find suitable places to spend the winter.

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

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

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

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

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

Reptiles--Species Occurrence and Use Areas

Fourteen species of reptiles, all of which are protected, are known to inhabit the biogeographic area in which the mine plan and adjacent areas located. It is probable that all of these species inhabit the project area. Only one species of the reptiles inhabiting the project area has been determined to be of high interest to the State of Utah.

The Utah milk snake is a yearlong resident animal of the project area. Its substantial value use area encompasses all wildlife habitats extending from the upper Sonoran (cold desert life zone) through the submontane (Transition life zone) and into the montane (Canadian and possibly Hudsonian life zone) ecological associations. Although its use area spans a multitude of habitats, the animal is extremely secretive, mostly nocturnal and is often found inside or under rotten logs, stumps, boards, rocks or within

other hiding places. At night they can be found in the open where they hunt for small rodents, lizards and other small snakes. Occasionally, the milk snake may take small birds or bird eggs.

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

To date snake dens, which are protected and of critical value to snake populations, have not been identified on or adjacent to the project area. It is important to note that inventory for such has not been attempted. If, at some later time, a den is discovered it will be reported to the Utah Division of Wildlife Resources.

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

Birds-Species Occurrence and Use Areas

Two hundred forty-four species of birds, all of which are protected, are known to inhabit the biogeographic area in which the mine plan and adjacent areas are located. It is probable that one hundred ninety-six of these species inhabit the project area. Sixty-four species of the birds inhabiting the project area have been determined to be of high interest to the State of Utah.

The western grebe is a summer resident of the environs associated with the project. Its substantial valued use area is always associated with large lakes or ponds where it feeds on fish. This bird builds a floating nest which is usually located in emergent vegetation at some backwater where wind-wave action is not severe. Usually the western grebe nests in a colony. The nest is a critical site while occupied for several of the grebe population.

The double-crested cormorant is a summer resident of the environs associated with the project. Its substantial valued use area is always associated with large lakes or ponds where it feeds on fish. This bird may nest on the ground at islands or other features that are nearly surrounded by water such as dikes. They also nest in trees along the waterways where they fish. They normally nest in colonies and the nest is a critical site while occupied for survival of the cormorant population.

The great blue heron is a yearlong resident of the environs associated with the project. The bird's substantial valued use area is always associated with open water where it feeds on aquatic

wildlife. The great blue heron normally nests in rookeries that are often co-inhabited by snowy egrets and black-crowned night herons. The nest may be placed high in a tree along a lake or stream edge, however, they will nest on the ground. The rookery, none of which are known to be located on the project area, is ranked as being of critical value to herons; it is normally a traditional site and utilized year after year by a nesting colony. It is important to note that rookeries are abandoned if they become vulnerable to predation or experience continual disturbance.

Swans, geese and ducks commonly known as waterfowl are represented by twenty-three species that may on occasion or during different seasons of the year inhabit the mine plan area. All of these species are of high interest to the State of Utah (Appendix A). Generally speaking, the riparian and wetland habitats encompassed by the project and adjacent areas provide substantial valued habitats for waterfowl. Each species has different life requirements and makes various uses of the riparian and wetland environs associated with the project.

For those waterfowl that nest locally, the period March 15 through July 15 is ranked as being of crucial value to maintenance of the population. Following incubation, which dependent upon the species may vary between 20 and 28 days and extend up until mid-August, the riparian and wetland habitats represent a high-priority brooding area. Additionally, the wetland habitat (large open water areas or dense marshland) is of high-priority for seclusion and protection of adult waterfowl during their flightless period when they moult. Males may began the moult in early June and both sexes and the young are capable of flight by mid-August.

It is important to note that agricultural lands producing corn or other small grain crops are of critical value to geese and dabbling duck species on a yearlong basis. All wetlands and open water areas can become locally important as high-priority use areas for waterfowl during peak migration periods in the spring (March 15 through May 15) and fall (August 15 through October 15).

The project and adjacent areas provides substantial valued habitat for a multitude of raptors--turkey vulture, bald and golden eagles, five species of falcons (prairie, American peregrine and arctic peregrine falcons; Merlin and American kestrel), seven species of hawks (goshawk, sharp-shinned, Cooper's, red-tailed, Swainson's, rough-legged and marsh hawks), osprey and eight species of owls (barn, screech, flammulated, great horned, pygmy, long-eared, short-eared and saw-whet owls). Many of these species are of high federal interest pursuant to 43 CFR, 3461.1 (n-1). All of these species are of high interest to the State of Utah.

Realistically, nesting habitat does not exist on the project or adjacent areas for many of these species. However, if a species were to nest on or adjacent to the project area it would have a

specific crucial period during which the aerie would need protection from disturbance; this period of time lies between February 1 and August 15. Generally speaking, aeries represent a critical valued site and need protection from significant or continual disturbance within a one-half kilometer radius of the nest. This consideration need only be implemented during the period of time that the nest is occupied.

Golden eagles are a common yearlong resident of the mine plan area. To date there are no known active aerie territories associated with the project area. (Note, an aerie territory is utilized by one pair of eagles but may contain several nest sites.) It is believed that golden eagle aerie territories may exist on the project area. This believe is based upon the fact that suitable nesting habitat is widespread on the mine plan area and throughout the local area. It is important to note that the regularity of golden eagle observations and the fact that status is common has resulted in documentation of mostly opportunistic observations of aerie territories.

An active golden eagle nest site is extremely sensitive to disturbance within a one-half kilometer radius. This buffer zone is ranked as being of critical value to maintenance of the eagle population when the bird is actually utilizing the aerie; that period of time is normally between April 15 and June 15. The radius for a buffer zone may need to be increased by one kilometer if a disturbance were to originate from above and within direct line of sight to the eagle aerie.

To date there are no known high-priority concentration areas or critical roost trees for golden eagles on the project area. The mine plan and adjacent areas have been ranked as being of substantial value to golden eagles.

The northern bald eagle is an endangered winter resident (November 15 to March 15) of the local area. To date there are no known high-priority concentration areas or critical roost trees for this species on or adjacent to the project. The mine plan area has been ranked as being of substantial value to wintering bald eagles. Note that bald eagles are known to nest in Utah; historic data documents nesting activity by these birds in the State. There is no known historic evidence of the northern bald eagle nesting on the mine plan or adjacent areas.

The American peregrine falcon (status is endangered) and the prairie falcon (status is common) are yearlong residents of the mine plan and adjacent areas. Each of these species utilized cliff nesting sites. To date there are no known aerie sites for cliff nesting falcons on the project area. However, suitable nesting habitat for the prairie falcon is widespread. Suitable nesting habitat for the American peregrine falcon cannot be found on the mine plan and adjacent areas. The project area has been ranked as

being of substantial value to the prairie falcon but only of limited value to the peregrine falcon.

For each falcon their aerie site while being utilized and one-half kilometer radius would be ranked as being of critical value to maintenance of their populations. The falcon's period of use at the aerie site spans the spring and early summer period--prairie falcon, April 15 to June 30; peregrine falcon, March 1 to June 30.

The level of data relative to site specific use of the project area by cliff nesting falcons (not including the kestrel) is low and there could be aeries that have not been identified.

The endangered arctic peregrine falcon is a winter resident (November 15 through March 15) of the local area. This species has not been observed to utilize the environs on or adjacent to the mine plan area, however, its occasional presence would not be likely. Therefore, the project area is ranked as being of limited value to this species.

The blue grouse is a yearlong resident of the project area. Adult birds prefer open stands of conifers. During winter the blue grouse feeds exclusively upon needles and buds of douglas-fir and spruce trees. Thus, this wildlife habitat (spruce-fir forest) is ranked as being of critical value to over-winter survival of the population during the crucial period of December through February.

Blue grouse annually exhibit what has been termed a reverse vertical migration. That is, during the spring months, they migrate from the high elevation spruce-fir habitat to lower elevation sagebrush, pinion-juniper or shrubland habitats. This movement is caused by a need of the birds to feed on early developing vegetation. Such movement also facilitates successful breeding, nesting and brooding of their young. Then as the year progresses, they move to the higher elevations.

The males are polygamous and will set up and defend territories for booming and breeding activities against other breeding males. Such territories are critical to maintenance of the population during the crucial period of mid-March through mid-June.

After breeding the female develops the nest site which is secreted on the ground; the nest is of critical value to maintenance of the blue grouse population. Upon hatching, which occurs in late May and early June, the young accompanied by the hen immediately leave the nest. The young blue grouse while being brooded rely heavily on insects for their protein needs during their first several months of development. The adult bird also shifts its diet during this period to include a high proportion of insects. Brooding areas are ranked as being of high-priority value to blue grouse. The crucial period extends from hatching into mid-August.

As summer progresses into the fall season the grouse consumes large quantities of berries.

The ruffed grouse is a yearlong resident of the project area. These grouse are usually found in the continuum of habitats extending from aspen to shrubland types. But, during winter they often roost in dense stands of conifers. Generally speaking ruffed grouse prefer habitats lying within 0.25 mile of a stream course; such areas are ranked as being of high-priority value to their population. During winter the ruffed grouse feeds exclusively upon staminate aspen buds. Thus, this wildlife habitat (aspen forest) is ranked as being of critical value to over-winter survival of the population during the crucial period of December through February. During the remainder of the year their diet shifts to include a wide variety of plant and insect material.

Ruffed grouse do not exhibit any type of seasonal migration.

The males are polygamous and will set up and defend territories against other breeding males. The focal point for breeding activity is the drumming log; all such logs are ranked as being of critical value to grouse since they represent sites of historical use. Such territories are critical to maintenance of the population during the crucial period of early March through May.

After breeding the female develops a nest site which is secreted on the ground and deep within the aspen grove; the nest is of critical value to maintenance of the ruffed grouse population. Upon hatching, which occurs in late May and early June, the young accompanied by the hen immediately leave the nest. The young ruffed grouse while being brooded rely heavily on insects for their protein needs during the first several months of development. The adult bird also shifts its diet during this period to include a high proportion of insects. Brooding areas are ranked as being of high-priority value to ruffed grouse. The crucial period of brooding extends from hatching into mid-August.

Agricultural areas for adjoining wildlands associated with the project and adjacent areas may provide yearlong, substantial valued habitats for ringnecked pheasants. Due to the pheasants complete dependency on agricultural systems, all cultivated fields are ranked as being of critical importance to this species. Pheasants depend primarily on waste grain, corn and other crops for food. They utilize wild grains and insects to a lesser extent. Croplands can provide for all the life requirements of pheasants. High quality habitat must retain adequate cover and food for the birds use throughout the year.

Pheasants initiate nesting as early as mid-April and continue as early as mid-July. This period of time and successful nesting activities is of crucial importance to the maintenance of the

pheasant population.

Pheasants have not been found in the mine permit area.

The chukar is a yearlong resident of the project area. It is important to note that they are an exotic species introduced from Asia during the 1950's. These birds prefer open rocky areas in the cold desert and submontane ecological associations. During summer chukars feed on grass shoots and insects, but during winter their diet is primarily seeds. Their substantial valued habitats are the cliff and tallus type and the associated desert scrub or shrubland types.

The winter season is a crucial period (early December through mid-February) for chukars; the birds concentrate on selected areas. Winter range has been ranked as being of critical value to over-winter survival of the chukar populations. Disturbance on winter range must be avoided when chukars are present.

Chukars are monogamous; the pairs nest between early April and late May. Nest sites are critical to maintenance of the population during the crucial nesting period.

It is important to note that all sources of water within the substantial valued use area for chukars are critical to maintenance of their populations on a yearlong basis.

The american coot may be a summer resident of the project area. Transient individuals are also present during spring and fall migration. The discussions earlier provided for waterfowl also apply to this specie.

The snowy plover is only a transient in the project area during spring and fall migration periods. Since the environs associated with the project would be inhabited only on occasion, they have been ranked as being of only limited value to the snowy plover.

The common snipe is a summer resident of the project area. It may inhabit the project area on a yearlong basis by utilizing wetland habitats along running streams or at seeps that do not freeze over. This specie breeds in late May and early June and nests on the ground in wetland areas. The nest while being utilized is of critical value to maintenance of the snipe populations.

Mourning doves normally inhabit the project and adjacent areas. which represents a substantial valued use area for these birds between May 1 and September 15 each year. They nest throughout most of this period and each pair produces two clutches. The pinion-juniper and riparian habitats are ranked as being of high-priority value for nesting. Locally, mourning doves show

two peaks in nesting activity--early July and August. Successful nesting activities and any water sources are critical to maintenance of the mourning dove population.

The yellow-billed cuckoo is a summer resident of the project area. This bird only nests in the riparian wildlife habitat, therefore, such areas are of critical value to maintenance of the species. Little is known concerning the yellow-billed cuckoo. Its nest is represented by a frail, saucer shaped structure of twigs and is always placed in bush or tree.

The black swift is a summer resident of the West Tavaputs Plateau. The montane ecological association represents the swift's substantial valued use area. Normally, the bird is associated with a small flock that represents a colony. Black swifts are usually observed soaring as pairs and they feed upon flying insects. A colony's nests are scattered along precipitous terrain where the nest is often secreted behind a waterfall. Such a moist habitat is not known to exist on the project area. Cliff and tallus wildlife habitats are ranked as being of high-priority value to the black swift. There is evidence that pair bonds are long lasting and that a nest may be utilized in successive years.

The belted kingfisher is a yearlong resident of the project area. It is found only along riverine systems and its substantial value use area extends from the cold desert through the submontane and into the montane ecological associations. Therefore, the riparian wildlife habitat represents a high-priority valued use area for this bird. It feeds exclusively upon fish. The kingfisher's nest is always secreted within a burrow along stream banks, thus, dirt bank habitats along riparian areas are critical value to this bird.

The pileated woodpecker is a species having high federal interest pursuant to 43 CFR 3461.1 (n-1). The spruce-fir and aspen wildlife habitats of the montane ecological association represent this bird's substantial valued use area. It is important to note that the pileated woodpecker has never been documented to utilize the environs of the biogeographic area that surrounds the project site. In areas of the State where the bird is known to exist, it is a yearlong resident with a relative abundance considered to be rare.

The Williamson's sapsucker is another species having high federal interest pursuant to 43 CFR 2461.1 (n-1). Typically, the substantial valued use area for this species is the spruce-fir habitat of the Canadian life zone on the project site would only represent the substantial valued use area for the yellow-bellied sapsucker. The yellowed-belled sapsucker is a yearlong resident of the environs associated with the project area and it has a relative abundance considered to be common. Whereas the Williamson's sapsucker has never been documented to utilize the environs of the biogeographic area that surrounds the project site. In

areas of the State where the Williamson's sapsucker is known to exist, it is a summer resident with a relative abundance considered to be uncommon.

The Lewis woodpecker is also another species having high federal interest pursuant to 43 CFR 3461.1 (n-1). Its substantial valued use area is represented by riparian habitats characterized by cottonwood stands and ponderosa forests. These habitats do not exist on the project site. It is important to note that the Lewis woodpecker has never been documented to utilize the environs of the biogeographic area that surrounds the project site. In areas of the State where the bird is known to exist, it is a summer resident or only a transient. Its relative abundance is unknown.

The purple martin is a summer resident known to inhabit the environs of biogeographic area that surrounds the project site. In Utah its substantial valued use area is represented by open spruce-fir, aspen or ponderosa forest habitats of the montane ecological association. The purple martin feeds on flying insects and may secret its nest within any suitable above-ground cavity.

The western bluebird is an uncommon summer resident known to inhabit the environs of the biogeographic area that surrounds the project site. Where as the mountain bluebird is a common yearlong resident of the area. Both birds are cavity nesting species. The western bluebird nests from the pinion-juniper habitat of the submontane ecological association up into the lower forest habitats within the Canadian life zone of the montane ecological association. The mountain bluebird utilizes the same continuum of habitats for nesting, but also extends its nesting use across the Canadian and Hudsonian life zones and into the Alpine life zone. During winter both species show elevational and longitudinal migrations; they then utilize all habitats associated with the cold desert ecological association. Therefore, the substantial valued use area for each species spans a broad continuum of habitats. It is important to note that trees with cavities located on the project area can be of critical value to bluebirds.

Grace's warbler is a species having high federal interest pursuant to 43 CFR 3461.1 (n-1). Its substantial valued use area is shrublands and associated ponderosa forest habitats of the submontane and montane ecological associations. This bird's nest is built twenty or more feet above ground in a ponderosa tree. It is important to note that the Grace's warbler has never been documented to utilize the environs of the biogeographic area that surrounds the project site. In areas of the State where it is known to exist, it is a summer resident with a relative abundance considered to be uncommon.

Scott's oriole is also a species having high federal interest pursuant to 43 CFR 3461.1 (n-1). Its substantial valued use areas are riparian habitats characterized by cottonwood stands and the

continuum of habitats extending from the pinion-juniper forest into shrublands of the submontane ecological association. The oriole's nest is characterized as a grassy pouch and is hung in a tree. It is important to note that the Scott's oriole has never been documented to utilize the environs of the biogeographic area that surrounds the project site. In areas of the State where it is known to exist, it is a summer resident with a relative abundance considered to be uncommon.

The grasshopper sparrow is a rare transient species known to inhabit the environs of the biogeographic area that surrounds the project site. It normally frequents dry grassland areas in the desert scrub habitat of the cold desert ecological association during spring and fall migration periods. The project area borders sites that could attract this specie. Since its use for such sites is best described as "occasional", those habitats in the region are only ranked as being of limited value to the bird.

Mammals--Species Occurrence and Use Areas

Eighty species of mammals, of which 22 percent are protected, are known to potentially inhabit the biogeographic area in which the project and adjacent areas are located. It is probable that seventy-seven of these species inhabit the project area. Twenty-seven species of the mammals inhabiting the project area have been determined to be of high interest to the State of Utah.

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

The red bat is a summer resident of the biogeographic area that surrounds the project site. The animal roosts in wooded areas (riparian woods and pinion-juniper forests) of the submontane ecological associations. Such areas represent this animals substantial use area. An occasional individual has been known to utilize caves; those individuals could hibernate and remain over winter.

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

The spotted bat may inhabit the environs of the project area. To date, little else is known of this specie.

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

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

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

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

The red fox and kit fox are yearlong inhabitants of the biogeographic area that surrounds the project site. The substantial valued use area for the red fox would include all wildlife habitats extending from the cold desert through the montane (Canadian life zone) ecological associations. The substantial valued use area for the kit fox is restricted to all of the habitats of the cold desert ecological association and extends into the sagebrush and pinion-juniper habitats of the submontane ecological association. Almost nothing is known of their population dynamics. Without doubt a crucial period for both species is when they are caring for young in the den. Dens while being inhabited are a critical use area.

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

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

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

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