APPLICATION FOR AN UNDERGROUND COAL MINE PERMIT

KAISER STEEL CORPORATION
SUNNYSIDE MINES
CARBON COUNTY, UTAH

BOOK 7

ORGANIZATION OF PERMIT APPLICATION

Book 1	Chapters 1, 2, and 3 through exhibits
Book 2	Chapter 3 (continued) Appendix III-1 through III-3
Book 3	Chapter 3 (continued) Appendix III-4 Plate III-1 through Plate III-4
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CHAPTER VIII

8.1 Scope

The results of the baseline soils study for the Sunnyside Mine permit area is presented in this chapter. Specifically, this chapter contains information concerning the soil characteristics, chemical and textural analyses, and reclamation recommendations. The reclamation information pertains primarily to those currently disturbed areas, or areas which will be disturbed in the future and will require reclamation (Plate III-1, Structures and Facilities Map).

The soil survey on the permit area included an Order 3 survey (SCS) on approximately 14,475 acres. Soil samples were taken for analyses to determine soil suitability for topsoil material. This study was designed to meet the rules and regulations of Utah's DOGM.

8.2 Methodology

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.

In addition to the Order 3 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 14,385 acres was mapped on a topographic map at a scale of approximately 1" = 2,000' (Soil Identification Map, Plate VIII-1). Profiles for selected soil series were sampled in the project area. Physical and chemical properties of the soils were also analyzed. These data were used to test field observations, confirm soil classifications, evaluate topsoil suitability, and to make preliminary soil fertility assessments.

Soil samples were collected and analyzed in two separate series. The first series of soil samples were taken in the permit area as follows:

CHAPTER VIII

Soil Sample Series Number One

Soil Type	Lab No.	Sample Location
PSH	3997	Disturbed slope at the 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. The methods and procedures by which they were analyzed are shown in Table VIII-1. The results of these analyses are indicated in Table VIII-2.

Soil samples and potential borrow materials 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 III-23). The results of these analyses are shown in Table VIII-4. Three test pits were dug within the area that Borrow Area 1 will be expanded. Discussion of these soil materials and laboratory analyses from these test pits are included in Appendix VIII-4. 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 by DOGM (See Figure III-4).

The soil types and sample locations are identified as follows:

CHAPTER VIII

Soil Sample Series Number Two

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

The procedures that were used in the analyses of these soils are shown in Table VIII-3. The results of these analyses are shown in Tables VIII-4 and VIII-5. Results of the analyses indicate that no toxicity problems exist with these materials. The quantity of borrow material presently available is indicated in section 3.5.7.1.

8.3 Soil Resource Information of Mine Plan Area

The information presented in this section has been derived from Jensen et.al (1980). Reference may be made to the Soil Identification Map (Plate VII-1) which covers the permit area.

CHAPTER VIII

8.3.1 Soils Identification

Within the 14,475 acre Sunnyside Mines permit area, 33 soil mapping units were identified; a total of 26 soil series were identified within this same permit area. The soil mapping units and list of soil series are identified in Tables VIII-6 and VIII-7, respectively. The detailed descriptions of the soil mapping units are included in Appendix VIII-1. The descriptions of the soil series found on the permit area are found in Appendix VIII-2.

8.3.2 Soils Description

Information concerning the soil series and mapping unit descriptions are derived from the Carbon County Soil Survey (Jensen, et.al, 1980). The detailed descriptions of the soil mapping units are included in Appendix VIII-1. The descriptions of the soil series found in the permit area are located in Appendix VIII-2.

8.3.3 Present and Potential Productivity of Existing Soils

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 KSC and 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 productivities for unlisted soil mapping units are unavailable from SCS (Cook personal communication). Current productivities are not necessary or required by DOGM (see "Vegetation Guidelines" and Kunzler's letter 09/21/81 to Abbott, Figure VIII-2). Estimated productivities for 1981 are presented in Chapter IX (Figures IX-1 and IX-8, Table VIII-8).

8.4 Prime Farmland Investigation and Determination

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 IV-1) (Jensen et. al, 1980).

8.5 Physical and Chemical Properties of Soils and Results of Analyses, Tests and Trials

Physical and chemical properties of the soils within the project area were analyzed in order to characterize and evaluate their potential as topsoil material. Detailed procedures are included in section 8.2. The results of these analyses are presented in Tables VIII-2, VIII-4, and VIII-5. These data indicate that no toxicity or other problems exist with respect to reclamation of these materials. The refuse pile shows indications of toxicity problems, however, reclamation test plot results are expected to demonstrate appropriate reclamation techniques and procedures.

In May 1980, Kaiser Coal Corporation initiated field trials of several different grass species on various combinations of soils and depths on coarse and fine (slurry) refuse. Figure VIII-1 provides details on this test plot. Results of the trials will be used to aid in revegetation planning. Additional extensive revegetation trials have also been initiated to determine revegetation procedures (Chapter III, section 8.6, Appendix VIII-3).

8.6 Use of Selected Overburden Materials or Substitutes

Because the major 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 disposal site.

Original plans called for mixing coal slurry into the coal refuse pile to aid revegetation efforts. Trial plots were established to test growth on those materials (Chapter 8.5). However, a contract has been let for mining of the slurry material. The quality and amount that will remain at the completion of mining in unknown at this time. Therefore plans to use slurry material in revegetation have been eliminated.

A new series of test plots in addition to the small trial plots described in section 8.5 is under design to evaluate potential methods of revegetating refuse. Plant species evaluation is being done in conjunction with the Upper Colorado Environmental Plant Center. The plot design (Figure VIII-3) and the location (revised Plate VIII-1) are herein included. The plot design was approved by DOGM, 7-26-83, at a meeting in Salt Lake City, Utah. An alternate borrow material is being tested for plant

growth in conjunction with separate lime treatments. Chemical analyses of the borrow material (Table VII-4) show it is apparently suitable for plant growth.

Although White et al. (1982) states that the refuse at Sunnyside has chemical characteristics as good as topsoil for revegetation, Kaiser Steel Corporation has found through additional testing that the refuse turns acid over time (Table III-20). This has been demonstrated in our test plots established in 1980 (Chapter 8.5). Results to date of these evaluation plots have been reported to the DOGM (Wolfe and Abbott 1982) (Appendix VIII-3).

There is a plan in the permit for refuse disposal (Chapter III). The refuse is located in its disposal site. Such refuse piles are state-of-the-art in the United States for disposal of coal refuse. The past few years, some companies have experimented with mining coarse and fine refuses in an attempt to recover additional resources and/or develop used for such materials. If these attempts are perfected, many of the problems of tailings and refuse disposal may be eliminated in the future. A large portion of the refuse pile was constructed prior to 1977 and is therefore not subject to the current reclamation standards (Plate III-23).

An intensive literature review has begun concerning the revegetation of acid refuse. Additional plans for testing the effectiveness of several approaches to refuse revegetation have been approved by DOGM and the plot design is presented in Figure VIII-3. The plan will eventually involve a request for a variance from the four foot cover requirement.

Revegetation of acid refuse has been successful in other parts of the United States without a four foot layer of topsoil (Campion and Benner 1981; Pepperman et al. 1980).

8.7 Plans for Removal, Storage and Protection of Soils

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 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 III-1) 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. Topsoil plans are also discussed in Section 3.5.2.

8.8 Plans for Redistribution of Soils

Grading and soil stabilization will be in accordance with requirements set forth under UMC 817.101 to 817.106 with contours generally matching those shown in the Structures and Facilities Map (Plate III-1).

Topsoil and any necessary borrow material will be handled and protected in accordance with requirements under UMC 817.21 to 817.25.

Disturbance of additional areas is not planned. If any new areas must be disturbed in the future, a topsoil removal, stockpile and redistribution plan will be submitted with the amendment plans for the new area.

8.9 Nutrients and Soil 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 (see Table VIII-2) indicate the soils to be low in nitrogen. The phosphorous content is variable. According to these tests, recommended rates of nutrient application would be a split application of 30 pounds/acre phosphorus (P_2O_5) and 40 pounds/acre nitrogen (ammonium nitrate) which would be tilled into the soil prior to seeding. However, application rates recommended are 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. However at Sunnyside, where no topsoil was stockpiled prior to the initial major disturbances, fertilizer applications may be necessary. Any application will be based on interpretation of samples prior to revegetation. As the soils to be used are presently beneath the facilities, they cannot be sampled. Fertilization may be necessary for

revegetation of refuse. This question is being studied presently. Determination of these requirements will be made at the completion of current studies.

Necessary soil nutrients will be applied based on interpretation of chemical analyses completed prior to the time of revegetation as described in Chapter III.

8.10 Effects of Mining Operations of Soils, Nutrients and Soil Amendments to be Used

In order to revegetate the areas to be disturbed by the surface effects of underground mining, topsoil will be removed and stock piled prior to disturbance. Many of the long-term effects of stockpiling are unknown. Studies concerning the effects of mining and stockpiling on soils have been reported by Power et al, 1978, Miller and Cameron, 1976 and others.

In those areas disturbed prior to the Act, the primary effects of the mining operation on the soils can be expected to be compaction, loss of organic matter, contamination with coal fines, and mixture with subsoil and geologic material during construction events.

These effects will undoubtedly increase the requirements for nutrients in these areas at the time of revegetation. Ripping or other means of loosening the soil will also be necessary at these previously disturbed sites.

CHAPTER VIII

8.11 Mitigation and Control Plans

The extent of surface disturbances will be minimized where possible. The handling of soils will be supervised by the person in charge of reclamation and will follow the plans and procedures discussed in Chapters III and VIII, according to UMC 817.21 through 817.25.

CHAPTER VIII

8.12 Bibliography

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CHAPTER VIII

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CHAPTER VIII

SDD2--BEENOM LOAM, 3 to 15 PERCENT SLOPES, ERODED

This shallow, well drained soil is on gently mountain slopes. It formed in residum 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 VIIs, nonirrigated.

CHAPTER VIII

LIST OF EXHIBITS

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Figure	VIII-2	DOGM statement of productivity requirements
Figure	VIII-3	Sunnyside refuse revegetation test plot design
Table	VIII-1	Soil analysis procedures and references
Table	VIII-2	List of soil identifications
Table	VIII-3	List of soil series
Table	VIII-4	Potential productivity of soils
Table	VIII-5(a) (b)	Results of soil analysis
Table	VIII-6	Results of chemical analyses of topsoil and borrow materials
Table	VIII-7	Methods of chemical analyses used on soil samples
Table	VIII-8	Chemical analysis of soil materials beneath (adjacent) surface facilities
Appendix	VIII-1	Description of soil mapping units
Appendix	VIII-2	Description of soil series
Appendix	VIII-3	1982 revegetation test plot study report
Appendix	VIII-4	Reclamation Soil Borrow Area 1
Plate	VIII-1	Soil identification map

Figure VIII-1 Revegetation Test Plot (As-Built)

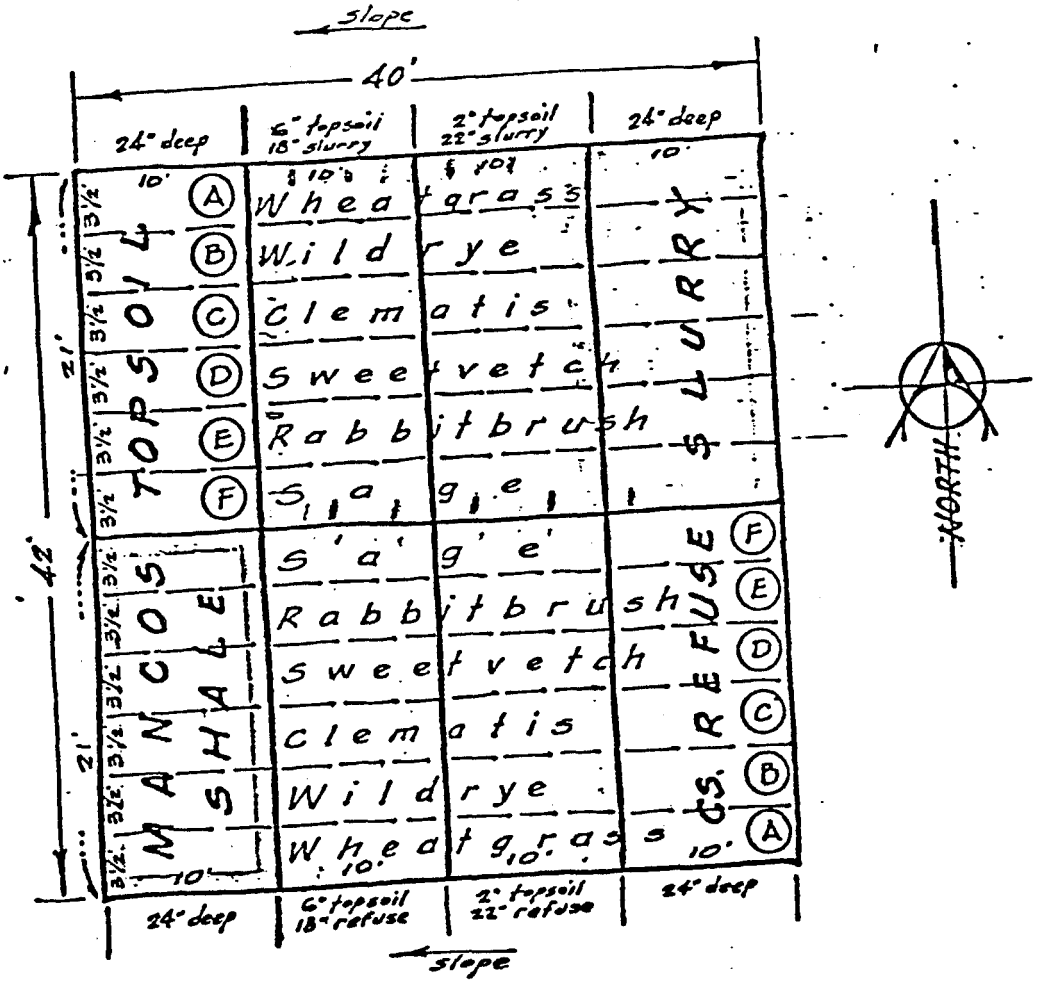
LOCATION: 1200' N & 2150' W of SE Cor. Sect. 29, T14S, R14E, SLB&M; lying in N½, NW¼, SW¼, SE¼ of said Section 29.

Planted: May 14, 1980

Planting Description:

(A)	Streambank Wheatgrass (Agropyron riparium)	4#/ac.(8 oz.)	PLS: 93.9%	Germ: 96%
(B)	Salina Wildrye (Elymus salina)	3#/ac.(4 oz.)	66 %	61%
(C)	Western Clematis (Clematis ligusticifolia)	2#/ac.(4 oz.)	60.7%	58%
(D)	Utah Sweetvetch (Hedysarum boreale)	2#/ac.(4 oz.)	97.2%	85%
(E)	Rubber Rabbitbrush (Chrysothamnus nauseosus)	45 plants	"Tubepak"	
(F)	Prairie Sage (Artemisia ludoviciana)	45 plants	"Tubepak"	

NOTE: Minimum bed preparation (rake only) - no fertilization and no irrigation. Plot to be fenced.



STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS, AND MINING
1588 West North Temple
Salt Lake City, Utah 84116
(801) 533-5771

September 2, 1981

Mr. John Abbott
Kaiser Steel Corporation
P.O. Box D
Sunnyside, Utah 84539

RE: Production Sampling Requirements
Sunnyside Mines
ACT/007/007
Carbon County, Utah

Dear John:

As per your request of August 26, 1981, the following clarification of production sampling requirements should suffice:

1. For baseline data and range sites (when a reference area is not to be used), production measurements for all community types is needed. For woody plants, measure only the current year's growth. Sample adequacy should meet 90% confidence level with a 10% change in the mean (.1d) with the exception of shrublands (where shrubs contribute over 30% of the total cover) when 80% confidence with a 10% change in the mean should be met. It should also be demonstrated that the year of sampling was a "normal" climatological year.

2. For reference areas (or baseline data when a reference area is used), production measurements are not critical until the time of comparison with the revegetated areas and does not need to meet statistical adequacy until that time. However, a statement of productivity should be supplied (preferably the Soil Conservation Service). Reference areas should be in fair range condition or better.

Figure VIII-2
DOGM Statement of productivity requirements.

As mentioned in your letter, the formula is acceptable to the Division of Oil, Gas and Mining.

$$\frac{t^2 s^2}{d^2}$$

where t = the t-value for a 2-tailed t-test,
s = the sample standard deviation,
d = the change in the mean (.1 x sample mean).

(Note: As per the formula used by Wyo., DEQ, the 2 in the numerator has been omitted.)

If you have any other questions, or if further clarification is needed, feel free to contact me.

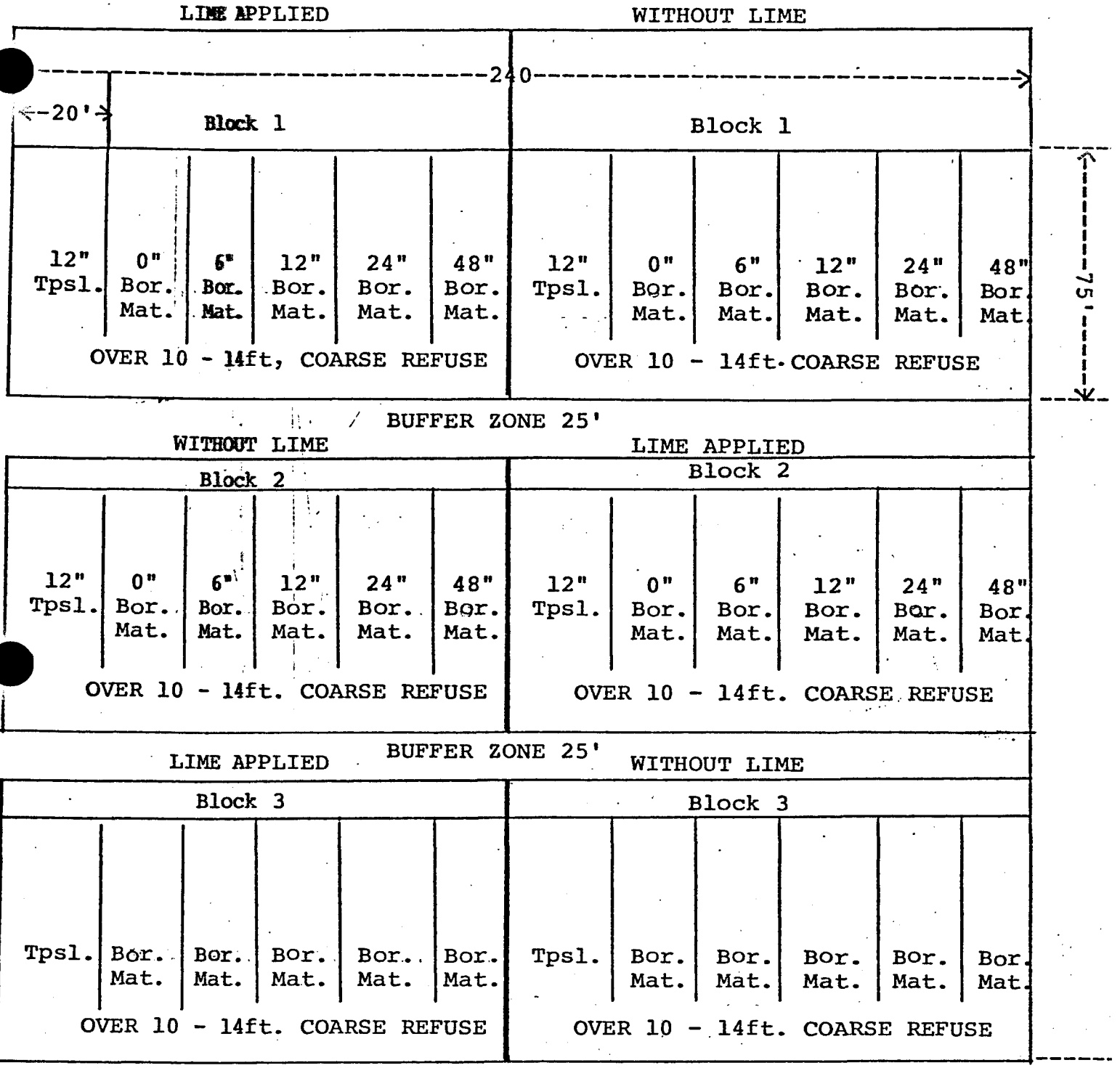
Sincerely,

LYNN M. KUNZLER
RECLAMATION BIOLOGIST

LMK/te

cc: O.S.M., Region V
Susan Linner

Figure VIII-2 Cont.



Exact amount of refuse under a plot can be determined by subtracting the depth of the cover material from 14 ft.

Key:

Bar. Mat. - Borrow Material
Tpsl. - Topsoil

Figure VIII-3. Sunnyside refuse revegetation test plot design.

Table VIII -1 Soil Analysis Procedures and References[1]

Analysis	Reference
Cation Exchange Capacity	USDA Handbook 60 (1954), pp.101, Method 19.
Conductivity of Extract	USDA Handbook 60 (1954), pp.89; Method 4b.
Water - soluable Sodium	USDA Handbook 60 (1954), pp.89, Method 3a
Water-soluable Calcium, Magnesium	USDA Handbook 60 (1954), pp. 94, Method 7.
Sodium Adsorbtion Ratio	USDA Handbook 60 (1954), pp. 18, Ammonium Extractable Cation
Extractable Sodium	USDA Handbook 60 (1954), pp. 100, Method 18
Saturation Percentage	USDA Handbook 60 (1954), pp. 107, Method 27a, Ovendrying.
pH	USDA Handbook 60 (1954), pp. 102, Method 21a.
Texture	Estimated by feel
Lime	Qualitative--Fizz Test
Organic Matter	Agronomy Series No. 9 (1965), pp.90, Method 3.2.
Total Nitrogen	Agronomy Series No. 9 (1965), pp. 83; Method 3.
Phosphorus (Bicarbonate)	Agronomy Series No. 9 (1965), pp. 73, Method 4.4.1.
Potassium	By flame in the bicarbonate extract for Phosphorus.

(1) These procedures were used by the Soils Laboratory of the Utah State University, Logan, Utah 84322, for analyzing soil samples from the Sunnyside Mines Permit Area.

Table VIII-2 Results of Soil Analysis

UTAH STATE UNIVERSITY
Soils Laboratory
Logan, Utah
SOIL ANALYSIS REPORT

COLLECTED BY Kaiser Steel Corp. DATE 10/15/79 LOCATION Sunnyside, Utah

Samples collected 10-10-79 & mailed CSHD — Result received 12-11-79

LABORATORY NUMBER	COLLECTOR'S NUMBER	DEPTH IN INCHES	HORIZON	PARTICLE SIZE DISTRIBUTION (In mm.) (percent) VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY <0.002	0.02-0.002	>2 mm.	TEXTURAL CLASS
4368	1		Undisturbed soil (Grassy Trail Creek floodplain)										sandy loam
4369	2		Road runoff silts										sand

LABORATORY NUMBER	pH SATURATED PASTE	pH 1:5	ORGANIC MATTER: ORGANIC MATTER %	ORGANIC CARBON %	NITROGEN %	C/N	TOTAL SOLUBLE SALTS %	ELECTRICAL CONDUCTIVITY EC x 10³ MILLIMHOS PER CM @ 25°C	CaCO₃ equivalent per cent	GYPSUM me./100g SOIL	GYPSUM %	MOISTURE TENSIONS 1/3 ATMOS. %	MOISTURE TENSIONS 15 ATMOS. %
4368	8.0				.12			.6	++				
4369	6.8				.45			3.5	0				

LABORATORY NUMBER	CATION EXCHANGE CAPACITY meq/100g	Ca	Mg	P ppm	K ppm	SAR Sodium Adsorption Ratio	SATURATION EXTRACT SOLUBLE: Na	K	Ca + Mg milliequivalents per liter	HCO_3	Cl	SO_4	Exchangeable Sodium Percentage
4368	10.2			5.7	214	.1	.6		.52				<.1
4369	6.6			8.5	58	<.1	2.8		4.6				<.1

Table VIII-2 Results of Soil Analysis

UTAH STATE UNIVERSITY
Soils Laboratory
Logan, Utah
SOIL ANALYSIS REPORT

COLLECTED BY Kaiser Steel Corp. DATE 9/28/79 LOCATION Sunnyside, Utah 84539
Samples collected 8-23-79 & mailed (GSH) Result received 10-4-79

LABORATORY NUMBER	COLLECTOR'S NUMBER	DEPTH IN INCHES	HORIZON	PARTICLE SIZE DISTRIBUTION (1= mm.) (percent) VERY COARSE SAND 2-1	COARSE SAND 1-0.5	MEDIUM SAND 0.5-0.25	FINE SAND 0.25-0.10	VERY FINE SAND 0.10-0.05	SILT 0.05-0.002	CLAY <0.002	0.02-0.002	>2 mm.	TEXTURAL CLASS
79-3997	1.slopes			Disturbed slope at the Upper Bathhouse									sandy loam
3998	2.stock-pile			Stockpiled topsoil near slurry ponds									loam

LABORATORY NUMBER	pH SATURATED PASTE	pH 1:5	ORGANIC MATTER: ORGANIC MATTER %	ORGANIC CARBON %	NITROGEN %	C/N	TOTAL SOLUBLE SALTS %	ELECTRICAL CONDUCTIVITY EC x 10³ MILLIMHOS PER CM @25°C	CaCO3 equivalent	GYPSUM me./100g SOIL	GYPSUM %	MOISTURE TENSIONS 1/3 ATMOS. %	MOISTURE TENSIONS 15 ATMOS. %	NaHCO3 P ppm
3997	8.2		-		.05			1.0	++					2.9
3998	8.2		1.21		.06			4.1	++					6.9

LABORATORY NUMBER	CATION EXCHANGE CAPACITY	extractable CATIONS Ca	Mg	Na	K	(SAR) Sodium Ads. Ratio	SATURATION EXTRACT SOLUBLE Na	K	Ca & Mg	HCO_3	Cl	SO_4	PER CENT MOISTURE AT SATURATION	NaHCO3 K ppm
	← milliequivalents per 100g soil →						← milliequivalents per liter →							
3997	10.8			.1		.8	1:7		8.5				29	68
3998	8.7			.4		1.3	7.1		56.4				26	81

CHAPTER VIII

Table VIII-3 Methods of chemical analyses used on soil samples

Parameters	Citation of method
pH and salts	Hergert, G.W. 1971. Soil testing methods. CSU Soil Testing Laboratory, Colorado State University, Ft. Collins, CO
% OM	Allison, L.E. 1965. Organic carbon, pp. 1372-1375. In: Black, C.A. (ed). Methods of soil analysis. AM. Soc. of Agronomy No. 9. Am. Soc. of Agronomy, Madison, WI.
P,K, No_3 - N, Zn, H Fe,CU,Mn	Soltanpour, P.N. and A.P. Schwab. 1977. A new test for simultaneous extraction of macro and micronutrients in alkaline soil. Comm. in Soil Sci. and Plant Anal. 8:195-207.
SAR, Mg, Na	Richards, L.A. et al. 1969. Diagnosis and improvement saline and alkali soil USDA. Handbook No. 60. USDA Washington, D.C.
Texture	Day, P.R. 1965. Particle fractionation and particle size analysis. pp. 562-566. In: Black, C.A. (ed). Methods of Soil analysis. Agronomy No. 9. Am. Soc. of Agronomy. Madison, WI.
Exchangeable Al	Method 16-3.2.2 p. 282-283. Methods of Soil analysis part 2, 1982. Second Ed. Agronomy Monograph Number 9, 1982.
Total Mo, Se, As, Pb	Method 3-5.3, p. 55-57. Methods of Soil Analysis Part 2. page 2. Second Ed. Agronomy Monograph Number 9.
Lime	Colorado State University Soil Testing Laboratory. Updated. Lime test. Colorado State University. Ft. Collins, CO.

Table VIII-4. Results of chemical analyses of topsoil and borrow materials.

Soil Material	Horizon	Text.	pH	Cond.	Lime	%OM	NO_3-N ppm	P ppm	K ppm	Zn ppm	Fe ppm	Mn ppm	Cu ppm	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	31.2
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	47.1
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	35.7
MRG	A	SL	7.7	1.1	H	1.2	23	2	158	.4	6.4	3.4	1.8	.9	32.1
	B	SL	7.8	.7	H	.9	10	1	144	.3	4.6	1.0	1.4	.2	32.1
(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. Borrow areas have been renumbered according to the following: Old borrow areas 1,2,3 have been combined to form borrow area 1; borrow area 4 has been renumbered to 2; and borrow area 5 has been renumbered to borrow area 3. Borrow area 6 is designated as the Grassy Trail borrow area. Reclamation Borrow area 1 (Appendix VIII-4, Plate III-23) is located near the new borrow area 3.

Table VIII-5 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
Shop												
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
Prep. Plant												
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 loam
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
No. 2 Canyon Material Yard												
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

ODD--BEENOM LOAM, 3 TO 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 Beenon 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. 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 VIIs, nonirrigated.

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, juniper, 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 dpeth 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 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, clifforse, 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, nonirrigated; 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 intermittend 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.

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 45 to 47 degrees F, mean annual soil temperature is 47 to 49 F, and the average freeze-free season is 110 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 rangelend and wildlife habitat.

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

This Shingly soil is shallow and well drained. It formed in 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, cliffrose, eriogonum shrub, low sagebrush, pinyon and Utah juniper.

The pinyon and 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. Seedling mortality is also a limitation.

This soil is in Capability Subclass VIIe, nonirrigated; Upland Shallow Shale (Pinyon-Juniper) D34, E47 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 depth of about 19 inches. The horizon over the shale has about 35 percent soft shale fragments.

Permeabilty 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, skelton locoweed, buckwheat, and birchleaf mountainmahogany.

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, cliffrose, eriogonum shrub, low sagebrush, pinyon and Utah juniper.

COMMON PLANT NAME		%
Salina Wildrye	(ELSA)	5
Needleandthread	(STCO4)	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	(CEMO2)	3
Cliffrose	(COME5)	2
Flat 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, nonirrigated; Upland Shallow Shale (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 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 VIIIs, 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.

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 occurence on the landscape. The elevations are 6,200 to 7,200 feet. The soil formed in 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, skelton locoweed, shadscale, 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 clao 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, shadscale, Nuttall saltbush, birchleaf mountainmahogany, eriogonum shrubs, yellowbrush, black sagebrush, and low sagebrush.

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

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 VIIs, nonirrigated

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, mormontea, 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 sandy 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 ranges 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 sandstone, 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.

This unit is used as rangeland and for wildlife habitat.

This unit is in capability subclass VIIe, nonirrigated.

COMMON PLANT NAME		%
Indian Ricegrass	(ORHY)	-
Needleand thread	(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 Shurbs	(SSSS)	5
Birchleaf Mountainmahogany	(CEMO2)	-
Black Sagebrush	(ARARN)	22
Saskatoon Serviceberry	(AMAI2)	8
Utah Snowberry	(SYORU)	8
Big Sagebrush	(ARTR2)	3
Bitterbrush	(PUTR2)	3

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

This map unit is on sides of mountian 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 drainageways and 5 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 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 drianed. 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.

Typcially, the surface is covered with a mat of partially decomposed leaves, twigs, and needles about ½ inch thick. The upper surface layer is grayish brown extremely bouldery loam about 7 inches thick. The underlying surface is pale brown very stony laom about 8 inches thick. The next layer is very pale brown very stony loam about 15 inches thick. 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 sideslopes.

MRG--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 is 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 pale brown extremely bouldery loam about 2 inches thick. Theunderlying layer is pale brown very fine sandy loam about 5 inches thick. The next layer is light olive gray silt loam underlain by silt-stone at a depth of about 9 inches. Depth to siltstone or shale ranges from 9 to 20 inches.

Permeability of the Menefee 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 layer 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 shaly 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. Water supply capacity is 2 to 3 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 range and wildlife habitat.

This Menfee soil is in capability subclass VIII and the Shingle soil is in capability subclass VIIe, nonirrigated.

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 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.

This unit is used for wildlife habitat and rangeland.

The Cabba soil is in capability subclass VIIs, nonirrigated.

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 a 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.

Typcially, 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.

JTG--REPP DONEY 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 mountainmahagony, 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 thoughout the unit; 10 percent Rock outcrop as cliffs and ledges and 5 percent of a soil similar to Firo cobbly fine sandy loam, 3 to 30 percent slopes except under curlleaf mountainmahagony and on slopes of 15 to 50 percent.

The Repp soil 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 stony clay loam about 3 inches thick. The next layer is light gray shaly 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, nonirrigated.

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 49 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 soil 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 mountainmahogany.

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 spps, 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 VIIs, nonirrigated; 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 VIIIs, and is not rated for an ecological site.

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 ary 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 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 soil 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 of 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 squirreltail, Salina wildrye, galleta, Indian ricegrass, eriogonum, globemallow, penstemon, shadscale, sagebrush, Utah juniper and pinyon.

COMMON PLANT NAME		%
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
Globemallow	(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

IEE--ILDEFONSO VERY STONY LOAM, 8 TO30 PERCENT SLOPES

This Idlefonso soil is very 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 Featherlegs 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 light gray very cobbly loam and 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 depth of about 5 inches.

Permeability is moderately rapid. Available water capacity is about 3.75 to 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 mountainmahogany.

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 spps, juniper and pinyon pine.

COMMON PLANT NAME		%
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 Monmontea	(EPTO)	2
Other Shrubs	(SSSS)	14

This soil is in Capability Subclass VIIS, nonirrigated; Upland Stony [illegible]

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 alluvium derived mainly of sedimentary rocks.

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 140 days. Slopes are 3 to 8 percent and on south and east aspects. They are long in length and single to concave-convex in shape.

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, erodod; TA gravelly fine sandy loam, high rainfall, 3 to 8 percent slopes; and LH loam, 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 vobbly loam and very pale brown very cobbly coarse sandy loam to depth of 60 inches or more. A horizon of secondary carbonate accumulation occurs at depth of about 5inches.

Permeability is moderately rapid. Available water capacity is about 3.75 to 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 id greater than 60 inches. Surface runoff is medium and erosion hazard is moderate. The Erosion Condiion Class is slight-32.

The soil is used for rangeland and wildlife habitat.

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

The potential plant community consists of an ocerstory 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, spps, juniper and pinyon pine.

COMMON PLANT NAME		%
Salina Wildrye	(ELSA)	7
Indian Ricegrass	(DRHY)	7
Western Whestgrass	(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, nonirrigated; Upland Stony Loam

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; 30 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 of dark surface; 10 percent Parkay very stony loam, 50 to 70 percent slopes, eroded, 5 percent Comodore 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 the Midfork soil is moderately slow. Available water capacity is about 6.0 inches 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 fir 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 15 inches thick. The substratum is brown very gravelly silt loam about 5 inches thick over hard sandstone.

Permeability of the Ellwood 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, nonirrigated.

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 the 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 of Glenberg 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 needleandthread.

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 squirreltale, 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	(STCO4)	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 Saltbush	(ATCA2)	2
Rabbitbrush	(CHRIS9)	3
Other Shrubs	(SSSS)	8

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 mountainmahogany. 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 degrees 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; 35 percent Podo very stony 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 dominatly 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 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 layer 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, nonirrigated, and the Podo soil is in capability subclass VIIs, nonirrigated.

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

This map unit is on mountain 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 a soil similar to Teton loam, 40 to 70 percent slopes except that there is a bleached horizon below the surface, 15 percent of a 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, Depth to 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 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 in 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 in capability subclass VIIe, nonirrigated.

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; 35 percent Beenom fine sandy loam, 8 to 40 percent slopes and 20 percent other soils. The Beenom very gravelly 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 Benteen 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 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 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 mountainmahogany, 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 VIIs, nonirrigated.

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

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 interminingled.

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 loam. 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 15 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 about 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 as rangeland and for wildlife habitat.

The Rabbitex soil is in capability subclass VIIe, nonirrigated, and Patmos soil is in capability subclass VIIs, nonirrigated.

Description of Soil Mapping Units

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

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 gravelly sandy loam about 9 inches thick. The next layer is yellowish brown very gravelly 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 Glenberg 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 the Rivra soil at higher elevations, 5 percent Glenberg fine sandy loam, 1 to 8 percent slopes intermingled with the Rivra soil at lower elevations, and 5 percent of an Aquic Ustifluvent 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. Water supply capacity is 4 to 6 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 VIIs, nonirrigated.

COMMON PLANT NAME		%
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+)	

APPENDIX VIII-1

Description of Soil Mapping Units

APPENDIX VIII-1

Description of Soil Mapping Units

8.3 Cont.

Table VIII-8 Potential Productivity of Soils

Productivity in lbs./acre (dry weight)

Soil Mapping Unit*	Climate		
	Favorable Year	Normal Year	Unfavorable Year
CIC	900	1025	500
HBC#	1400	900	700
IEC	1500	750	550
IGC#	1000	550	500
JTG	800	1000	300
MTH	1500	450	750
NDH_2	600	550	100
NGG_2	800	900	300
NJFe#	1500	750	550
RWG	1000	1500	300
WAG	2000		1000

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

Table VIII-7 List of Soil Series

BEENOM SERIES
BENTEEN SERIES
CABBA SERIES
DECROSS VARIANT
DETRA VARIANT
DONEY SERIES
ELWOOD SERIES
FD SERIES
FG SERIES
GUBEN SERIES
HAVERSON SERIES
ILDEFONSO SERIES
MENEFEE SERIES
MIDFORK SERIES
PATMOS SERIES
PESO SERIES
PODO SERIES
RABBITEX SERIES
REPP SERIES
RIVRA SERIES
ROCK OUTCROP
SHINGLES SERIES
SUNUP SERIES
TETON SERIES
WIDTSOE SERIES
ZILLION SERIES

Table VIII-6 List of Identification of Soil Mapping Units

CIC---RIVRA LOAM (1%-8% S)
DSG2--RABBITEX-PATMOS COMPLEX (25%-70% S)
DTF---BEENOM COMPLEX (8%-40% S)
FKG---TETON-DECROSS VARIANT COMPLEX (35%-70% S)
FUG---DETRA VARIANT-PODO COMPLEX (40%-70% S)
HBC---HAVERSON LOAM (1%-5% S)
HUG---MIDFORK-ELWOOD COMPLEX (50%-70% S)
IEC---ILDEFONSO LOAM (3%-8% S)
IEE---IDLEFONSO LOAM (8%-30% S)
IGC---IDLEFONSO LOAM/LR. (3%-8% S)
IWG---IDLEFONSO LOAM (50%-70% S)
JTG---REPP-DONEY COMPLEX (40%-70% S)
KXH---PODO-ROCK OUTCROP COMPLEX (50%-80% S)
MIF---CABBA LOAM (20%-40% S)
MRG---MENFEE-ROCK OUTCROP (40%-70% S)
MTH---CABBA-GUBEN-ROCK OUTCROP COMPLEX (40%-70% S)
MUE---CABBA-PODO-PATMOS COMPLEX (3%-30% S)
NDH2--SHINGLE-BADLAND-RUBBLE COMPLEX (50%-80% S)
NGG2--SHINGLE LOAM (50%-70% S)
NJF2--SHINGLE-ILDEFONSO-BADLAND COMPLEX (3%-50% S)
ODD---BEENOM LOAM (3%-15% S)
PJD---BENTEEN LOAM (3%-15% S)
PPH---ZILLION LOAM (55%-80% S)
PSH---ZILLION COMPLEX (55%-80% S)
RFF---BENTEEN LOAM (30%-50% S)
RO----ROCK OUTCROP (see RSH 2)
RR----ROCK OUTCROP-RUBBLE-BADLAND COMPLEX
RSH2--ROCK OUTCROP-RUBBLE-DL COMPLEX (60%-80% S)
RXH2--FD-FG-ROCK OUTCROP COMPLEX (50%-70% S)
RWG---ROCK OUTCROP-RUBBLE-SUNUP COMPLEX (60%-70% S)
SDD2--BEENOM LOAM (3%-15% S)
VOH---PESO-ROCK OUTCROP COMPLEX (50%-60% S)
WAG---WIDTSOE LOAM (50%-70% S)

PJD--BENTEEN LOAM, 3 TO 15 PERCENT SLOPES

This moderately deep, well drained soil is on rolling ridge and mountain tops. It formed residuum and alluvium derived dominantly from sandstone and shale. Slopes are single to slightly convex-concave. The present vegetation is mainly Wyoming big sagebrush, Thurber fescue and melica spp. Elevation is 8,800 to 9,700 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 dark grayish brown loam about 11 inches thick. The upper 12 inches of the subsoil is dary grayish brown silt loam. The lower 12 inches of the subsoil is dark grayish brown silty clay loam. Sandstone is at a depth of 35 inches.

Included in this unit is about 5 percent Beenom gravelly fine sandy loam, 1 to 8 percent slopes intermixed on the landscape; 5 percent of a soil similar to Beenteem loam, 3 to 15 percent except more that 40 inches deep over bedrock also intermixed on the landscape; 5 percent Benteen loam thin surface, 3 to 15 percent slopes and 5 percent Decross loam, 15 to 35 percent slopes.

Permeability of this Benteen soil is moderate. Available water capacity is about 5.5 to 7.0 inches. Water supplying capacity is 14 to 16 inches. The organic matter content of the surface layer is 5 to 10 percent. Effective rooting depth is 20 to 40 inches. Runoff is slow, 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 Benteen soil is in capability subclass, VIe, nonirrigated.

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 other soils. The Zillion very stony fine sandy loam, 55 to 80 percent slopes occurs on narrow sideridges running vertically off the main slope, the Zillion stony loam, 55 to 80 percent slopes occurs near the tops of the sideslopes 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 mountain-mahogany, 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 lower 11 inches is brown very 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 undecomposed 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 sparce salt tolerant vegetation.

This complex is used mainly for esthetic 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 in not place in an ecological site.

Badland

Badland consists of steep and very steep nearly barren beds of actively eroded shale, shale interbedded with gypsum, and occaisonally 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 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 fo an ecological site.

Rubble land

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

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

RXH2--FD-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 hazard 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, Gambel oak and white fir. Important understory plants are elk sedge, slender wheatgrass, Nevada bluegrass, mountain junegrass, nodding bromebrass, bluebunch wheatgrass, Salina wildrye, goldenrod, aster Louisiana sagewort, lupine, showy goldeneye, wild geranium, birchleaf mountainmahogany, serviceberry, Oregon grape, wild currant, dwarf maple, elderberry, and curlleaf mountainmahogany.

Principle use is for wildlife habitat.

This soil Capability Subclass VIIs, nonirrigated; 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 fragements, 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, Gambel oak and white fir. Important understory plants are elk sedge, slender wheatgrass, Nevada blue-grass, 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 curlleaf mountainmahogany.

This soil is in Capability Subclass VIIs, nonirrigated; 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 VIIIs, 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 side slopes. 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

Rockoutcrop 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, nonirrigated; and is not rated for an ecological site.

CHAPTER VIII

SDD2--BEENOM LOAM, 3 to 15 PERCENT SLOPES, ERODED

This shallow, well drained soil is on gently mountain slopes. It formed in residum 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 VIIs, nonirrigated.

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 5,000 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 70 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 ½ 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.

Premeability 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 an occurs as ledges.

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

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

COMMON PLANT NAME		%
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, nonirrigated; Mountain Loam (Shrub) E47 ecological site.

APPENDIX VIII-2

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 10,100 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 nonsticky, nonplastic; 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 subangular 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 subangular blocky structure; very hard, firm, slightly sticky, slightly plastic; few very fine, fine and medium roots; few very fine and fine pores, common moderately thick clay films on ped faces and in 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; weak medium subangular blocky structure; hard, firm, sticky, 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 A11 horizon is noncalcareous or slightly calcareous and is neutral to mildy 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.

BEENOM 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 (7.5YR 3/2) moist; weak medium prismatic parting to moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and plastic; common very few fine and fine, few medium roots; common very fine and fine pores; very few thin clay films, occuring as colloid stains on mineral grains; moderately alakaline (pH 8.4); clear smooth boundary.

C1--9 to 12 inches; pale brown (10YR 6/3) silt loam, yellowish brown (10 YR 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 predominatly 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 mollic 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 moist, and chroma of 1 to 3. It is fine sandy loam through clay loam and very gravelly fine sandy loam through gravelly 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 at 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 and 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; mottles; weak 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 or 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, gravely loam, extremely gravelly loam. The horizon is moderately calcareous or strongly calcareous and is moderately to strongly alakaline.

DECROSS VARIANT

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

The 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.

O--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 subangular blocky structure; soft, very 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 subangular blocky structure; hard, friable, sticky, plastic; common very fine, many medium, few coarse roots; 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 boundary.

B22t--8 to 19 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; slightly 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 (10YR 4/2) gravelly silt loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular 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.

C1ca--24 to 32 inchs; grayish brown (10YR 5/2) gravelly silt loam, dark grayish brown (10YR 4/2) moist; weak fine subangular blocky structure; slightly hard; friable, sticky, plastic; few very fine, few medium roots; 20 percent gravel which slakes in water; strongly calcareous, carbonates are disseminated; 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 channers; strongly calcareous, carbonates are disseminated; strongly alkaline (pH 8.8); diffues 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, 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 of 8,000 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 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 subangular 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 calcareous, carbonates are disseminated; mildly alkaline (pH 7.4); abrupt smooth boundary.

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

C--20 to 34 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate coarse subangular blocky structure; hard, firm, sticky, and plastic; common very fine and fine, few medium roots; moderately calcareous, carbonates are disseminated; mildly alkaline (pH 7.6); abrupt smooth boundary.

R--24inches; 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 or 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 or 5 moist and dry and chroma of 3 or 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 Repp, Firo, and Podo soils, Repp soils have bedrock at depths greater than 40 inches. Firo soils have a dark surface and bedrock at depths of less than 20 inches. Podo soils have 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 very fine and 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) stony clay loam, pale brown (10YR 6/3) 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) shaly clay loam, light brownish gray (10YR 7/2) moist; weak medium subangular blocky structure; very hard, firm, sticky, plastic; few very fine, fine roots; 15 percent soft shale; strongly calcareous, carbonates are disseminated; moderately alkaline (pH 8.4); clear 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 silt-stone; moderately calcareous, carbonates are disseminated; strongly alkaline (pH 8.6); abrupt smooth boundary.

C4r--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 is 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.

O1--1 inch to 0; undecomposed 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; 5 percent gravel, 5 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 subangular blocky parting to weak fine granular structure; hard, friable, slightly sticky, and slightly plastic; common fine and medium, and 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 subangular blocky structure; hard, friable slightly sticky, and slightly plastic; common very fine, and few medium roots; 30 percent gravel, 10 percent cobbles, 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 (10 YR 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 subangular 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 subangular blocky structure; extremely hard, friable, slightly sitcky, 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; masssive; 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 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 pores; 10 percent gravel, 10 percent cobbles and 20 percent stones; moderately alkaline (pH 8.0); clear wavy boundary.

B2T--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 boundry.

C1ca--20 to 60 inches; yellowish brown (10YR 5/4) very cobbly loam, dark yellowish brown (10YR 4/4) when moist; weak medium subangular 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 and residuum derived dominantly 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.

O1--½ inch to 0; litter of 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 subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; common very fine, few fine, medium, coarse roots, few very fine, and 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 subangular blocky structure; slightly hard, firable, 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 thoughout.

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 subangular blocky structure; slightly hard, friable, slightly hard, slightly plastic; common very fine and few fine roots; 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 subangular 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 subangular 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 subangular 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 stongly 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.

Taxonomix classification is loam-skeltal 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 (10YT 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 subangular 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 Maccar 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, and 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 (pH 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 or 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 or 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 and residuum 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 subangular 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 subangular 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; moderatley 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 (10YR 5/3) moist; moderate medium subangular 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 inches; 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, 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 on 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.

O--½ 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 subangular 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, few medium roots; few 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 subangular 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 or 5 dry, chroma 2 or 3 and textures similar to the A horizons.

The C horizon has hue of 5YR to 10YR, value of 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.

RABBITEX 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 subangular 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 subangular 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 subangular 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 in soft 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 20 inches thick.

Depth to bedrock is greater that 40 inches.

Mean annual soil temperature is 41 to 47 degrees F. The control section is commonly 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 rapid 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 subangular 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; 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 subangular 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 subangular 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 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, cabbles, 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 Torrifluvents.

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 alluvial 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 Capacility Subclass VIIs, 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 subangular 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, 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 horzion 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, slity 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 calcareous, carbonates are disseminated; strongly 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.

C3r--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 10YR, 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 classiffication is loamy-skeletal, mixed (calcareous), mesic Lithic Ustic Torriorthents.

Sunup is a very gravelly fine sandy loam, high rainfall, 3 to 15 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 subangular 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, and slightly palstic; 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 subangular 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, non-calcareous, 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, and 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.

APPENDIX VIII-3

1982 Revegetation Test Plot Study Report

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 & 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.

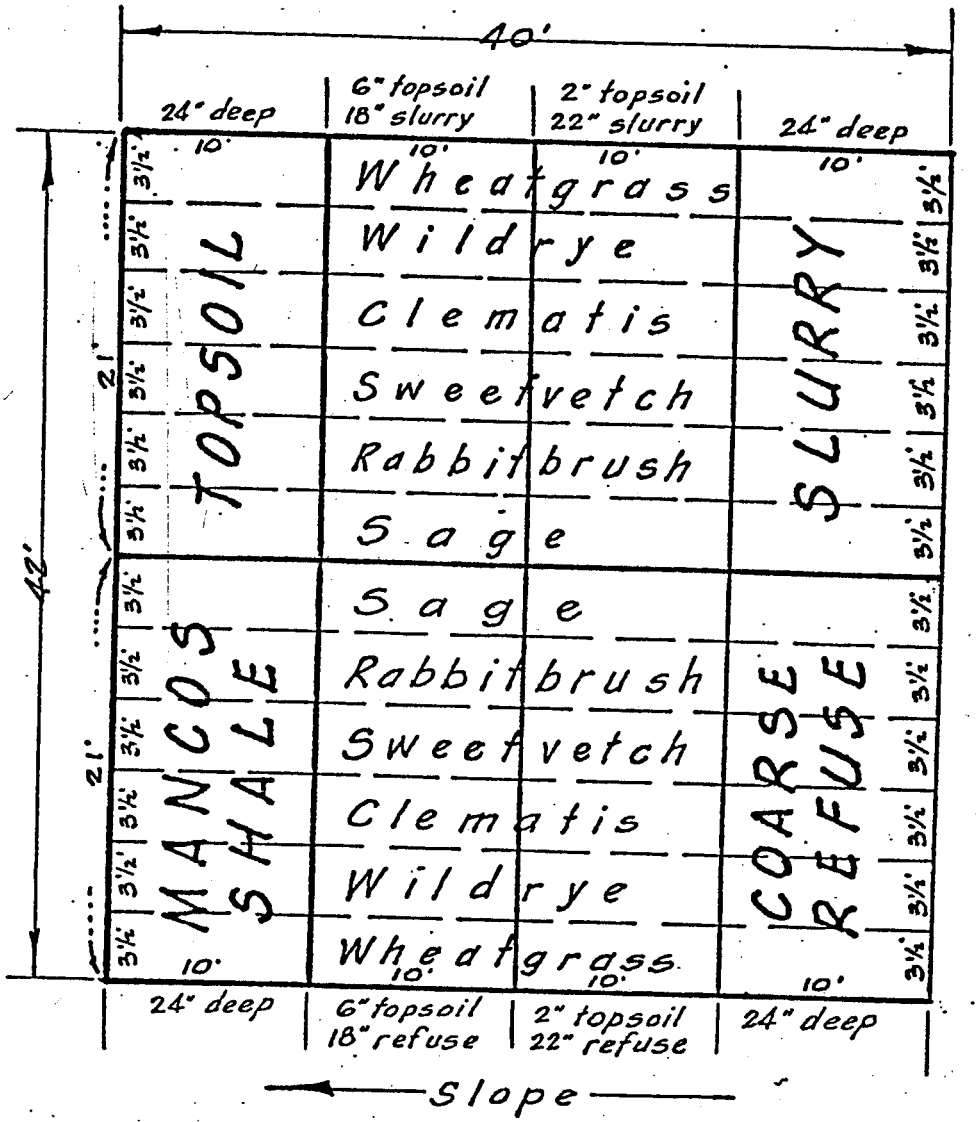
Table 1. Plant Species Used in Sunnyside Mines Revegetation Test Plot.*

Common Name	Scientific Name	Abrev.	Amounts Planted
Streambank Wheatgrass	*Agropyron riparium*	Agri	4 PLS#/A
Salina Wildrye	*Elymus salina*	Elsa	3 "
Western Clematis	*Clematis ligusticifolia*	Clli	2 "
Utah Sweetvetch	*Hedysarum boreale*	Hebo	2 PLS#/A
Rubber Rabbitbrush	*Chrysothamus nauseosus*	Chna	45 plants
Prairie Sage	*Artemisia ludoviciana*	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



Layout of the
Revegetation Test Plot

Figure 1.

Sunnyside Mine

MATERIALS AND METHODS (cont.)

Vegetation sampling was conducted annually for two years on 1 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, streambank 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 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 established plants was slightly

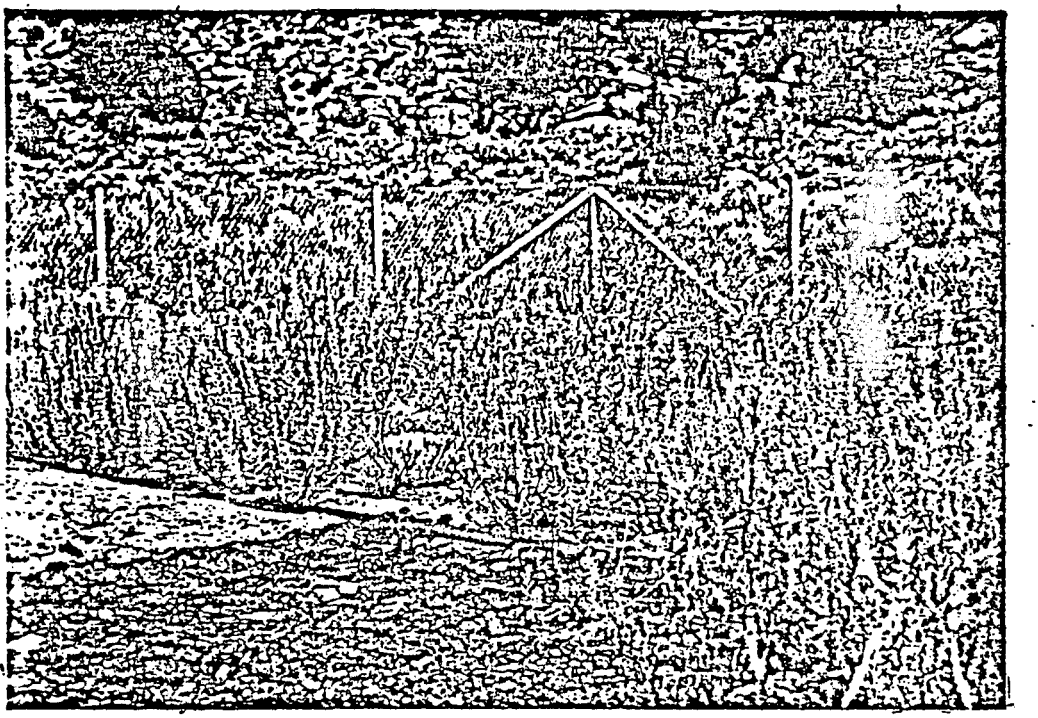


Figure 2. Treatments on far side of pipe illustrate good plant growth. Left to right: 24" topsoil, 6" soil/18" slurry, 2" topsoil/22" slurry, and 24" slurry.

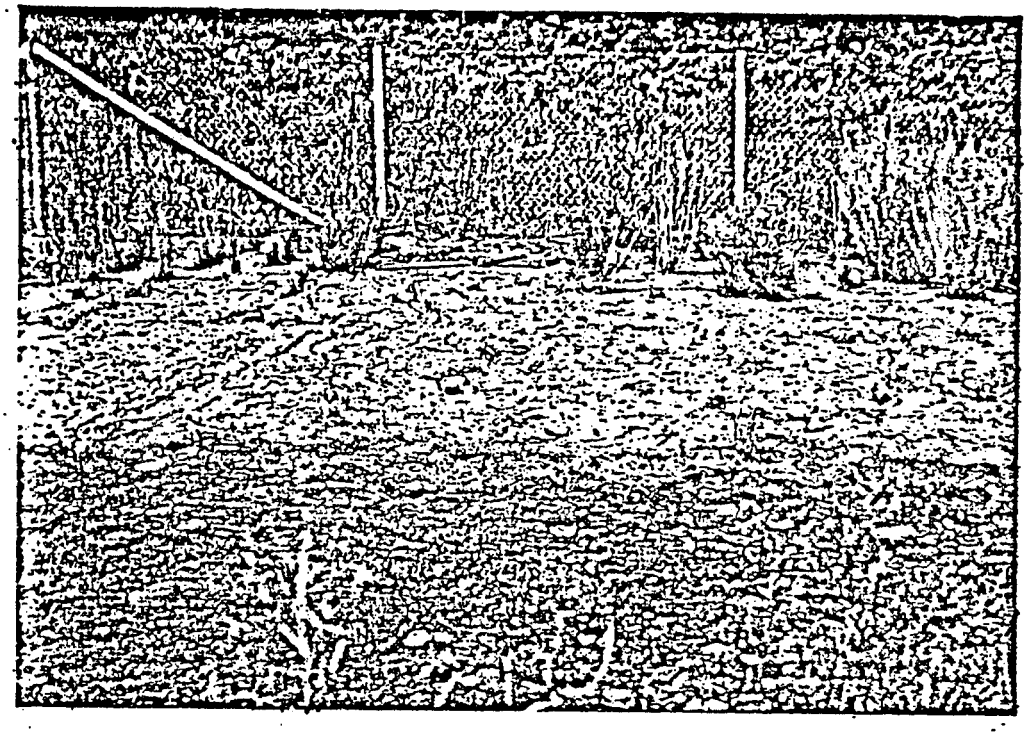


Figure 3. Coarse refuse treatments illustrate almost no plant growth. Front to back they are coarse refuse, 24", 2" topsoil/22" refuse and 6" topsoil/ 18" refuse. The good growth on the farthest plot is on 24" Mancos shale.

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
Clii	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.

SPECIES VIGOR (cont.)

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[1].

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 rhizomateously.

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.

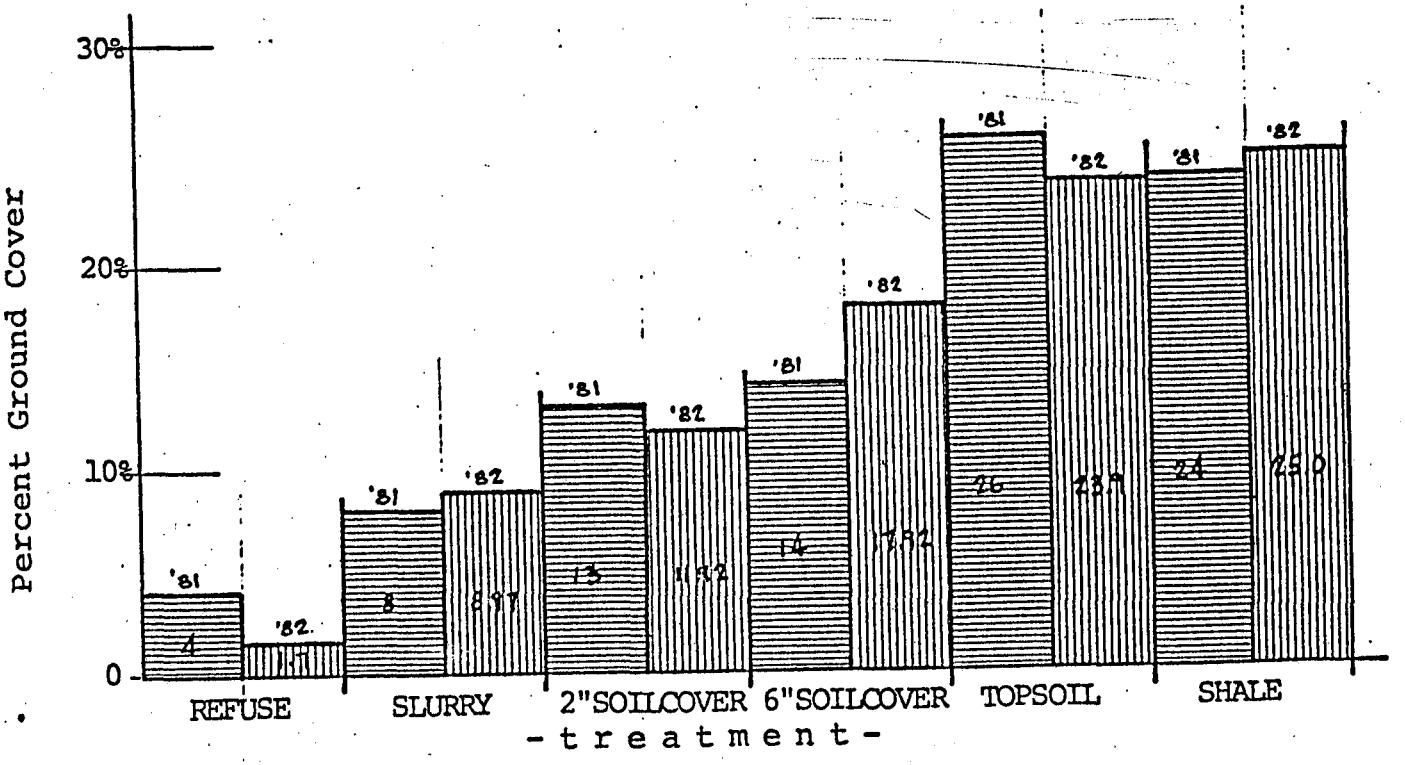
Average cover of all species, both test and invaded, ranged from 21% to 30% across all treatments, except the coarse refuse plots (Table 6). Total plant cover on each of the latter plots was less than 13% (refuse).

1. See footnote on Table 4.

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



(note: topsoil over refuse & topsoil over slurry average figures combined together.)

Figure 4. Percent Ground Cover of Trial Species as determined by line intercept.

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
Clli	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

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

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

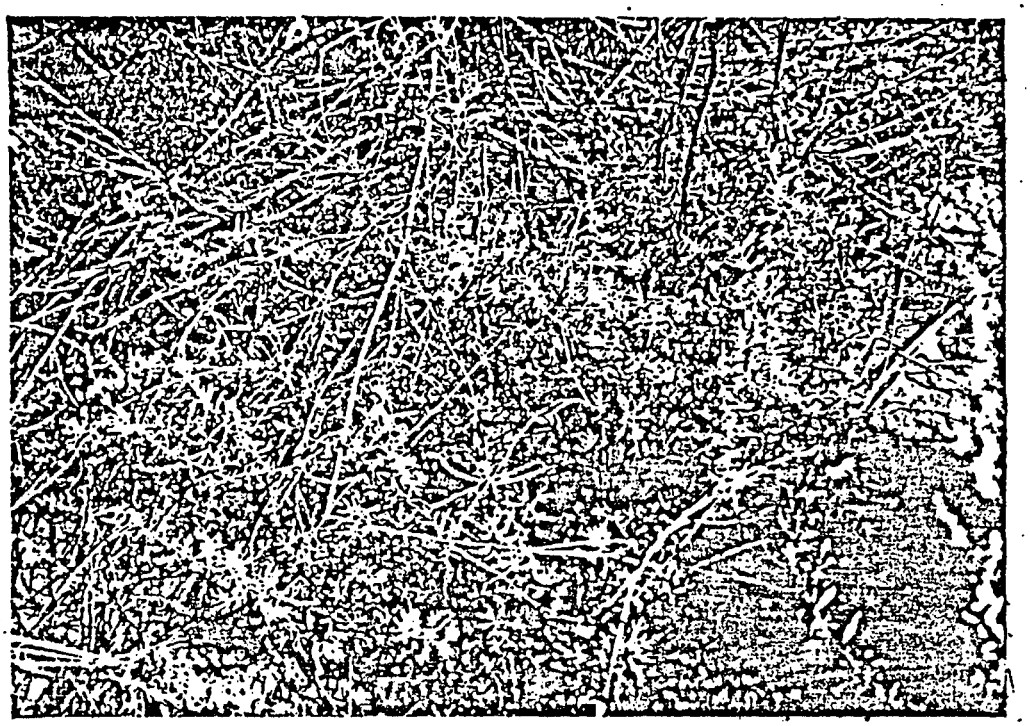


Figure 5. Louisiana sage, an excellent reclamation species, is seen here spreading vigorously from rhizomes.

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 pervent 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.

DISCUSSION (cont.)

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 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 unusually 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 revealed by soil analysis are toxic to the trial species. 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).

DISCUSSION (cont.)

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 globemallow, 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 tops[illegible]htly improved plant cover.

[illegible] in total cover of pio[illegible]ecies 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, Campion & 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).

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Appen VIII-4 ?

RECLAMATION SOIL BORROW AREA 1

A soils 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 rip-rap, 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 alluvial fans and fan terraces. They are formed in alluvium and glacial outwash derived dominately 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 dominate 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 suitability rating with depths are in Table 2.

Table 1

SUNNYSIDE RECLAMATION SOIL BORROW AREA NO. 1 LABORATORY ANALYSIS - Part 1

Sample I.D.	Sample Footage	Sample Date	Saturated Paste Extraction: Saturation %	pH (units)	E.C. mmhos/ cm @ 25°C	Calcium meq/l	Magnesium meq/l	Sodium meq/l	SAR
ST1 A1	0" - 6"	Unknown	32	7.5	0.55	5.31	1.60	0.22	0.12
ST1 C1CA	6" - 18"	Unknown	32	7.6	0.43	4.23	1.53	0.16	0.09
ST1 C2CA	18" - 30"	Unknown	33	7.6	0.41	3.43	1.68	0.27	0.17
ST1 C3	30" - 44"	Unknown	36	8.2	0.35	2.14	2.78	0.23	0.15
ST1 C4	44" - 60"	Unknown	37	8.2	0.45	1.74	3.96	0.84	0.50
ST1 C5	60" - 75"	Unknown	36	8.2	0.44	1.80	3.47	0.83	0.51
ST2 A1	0" - 6"	Unknown	41	7.4	0.65	7.45	1.91	0.19	0.09
ST2 C1CA	6" - 18"	Unknown	37	8.1	1.48	7.61	13.1	1.85	0.57
ST2 C2CA	18" - 34"	Unknown	34	8.0	1.78	10.7	12.5	2.88	0.85
ST2 C3	34" - 46"	Unknown	33	8.3	3.62	6.34	20.2	21.4	5.87
ST2 C4	46" - 58"	Unknown	33	8.1	3.82	7.72	23.8	20.6	5.19
ST2 C5	58" - 70"	Unknown	36	8.4	0.67	1.53	1.79	5.05	3.92
ST2 C6	70" - 82"	Unknown	36	8.5	0.49	1.07	1.52	3.84	3.37
ST2C7	82" - 94"	Unknown	35	8.1	5.98	20.1	44.9	23.6	4.14
ST2 C8	94" - 106"	Unknown	32	8.1	6.88	24.8	52.2	26.4	4.25
ST2 C9	106" - 118"	Unknown	33	8.1	6.92	25.1	51.1	25.2	4.08
ST2 C10	118" - 130"	Unknown	35	8.2	5.38	17.2	40.3	19.7	3.67
ST2 C11	130" - 142"	Unknown	34	8.1	6.55	27.8	50.0	23.0	3.69
ST2 C12	142" - 157"	Unknown	32	8.1	5.98	21.9	46.5	24.7	4.22

Table 1

SUNNYSIDE RECLAMATION SOIL BORROW AREA NO. 1 LABORATORY ANALYSIS - Part 2

Sample I.D.	Sample Footage	Sample Date	Saturated Paste Extraction						
			Saturation %	pH (units)	E.C. mmhos/ cm @ 25°C	Calcium meq/l	Magnesium meq/l	Sodium meq/l	SAR
ST3 A1	0" - 5"	Unknown	46	7.4	0.83	10.1	2.58	0.22	0.09
ST3 C1CA	5" - 17"	Unknown	31	8.2	3.39	11.9	22.7	14.7	3.53
ST3 C2CA	17" - 29"	Unknown	27	8.7	0.82	1.83	2.23	5.80	4.07
ST3 C3CA	29" - 43"	Unknown	27	8.7	0.71	1.48	1.75	5.78	4.55
ST3 C4	43" - 55"	Unknown	31	8.6	0.64	1.78	3.54	2.90	1.78
ST3 C5	55" - 62"	Unknown	31	8.6	0.55	1.63	3.73	1.48	0.90
ST3 C6	67" - 78"	Unknown	30	8.5	0.52	1.80	3.90	1.02	0.60
ST3 C7	78" - 91"	Unknown	31	8.4	0.49	2.04	3.79	0.61	0.36
ST3 C8	91" - 103"	Unknown	32	7.8	0.32	2.43	1.54	0.25	0.18
ST3 C9	103" - 115"	Unknown	38	7.4	0.41	3.13	1.72	0.28	0.18
ST3 C10	115" - 131"	Unknown	32	8.2	1.65	3.32	7.10	9.14	4.00
ST4 A1	0" - 5"	Unknown	43	6.9	0.89	10.2	2.21	0.25	0.10
ST4 C1CA	5" - 17"	Unknown	46	7.3	0.41	4.07	1.46	0.28	0.17
ST4 C2CA	17" - 29"	Unknown	39	7.5	0.39	3.46	1.73	0.35	0.22
ST4 C3CA	29" - 41"	Unknown	34	8.0	0.34	3.13	1.78	0.42	0.27
ST4 C4CA	41" - 53"	Unknown	34	8.1	0.38	2.50	2.27	0.59	0.38
ST4 C5	53" - 65"	Unknown	34	8.5	0.67	2.32	2.75	3.49	2.19
ST4 C6	65" - 77"	Unknown	34	8.7	0.74	2.19	3.10	4.42	2.72

Table 1

SUNNYSIDE RECLAMATION SOIL BORROW AREA NO. 1 LABORATORY ANALYSIS - Part 3

Sample I.D.	Sample Footage	Sample Date	Saturated Paste Extraction						
			Saturation %	pH (units)	E.C. mmhos/ cm @ 25°C	Calcium meq/l	Magnesium meq/l	Sodium meq/l	SAR
ST4 C7	77" - 89"	Unknown	35	8.6	0.58	1.83	2.47	3.20	2.18
ST4 C8	89" - 101"	Unknown	31	8.5	0.65	1.72	1.95	4.64	3.43
ST4 C9	101" - 113"	Unknown	31	8.4	0.72	1.76	2.35	5.18	3.61
ST4 C10	113" - 125"	Unknown	30	8.5	0.70	1.70	1.70	5.45	4.18
ST4 C11	125" - 137"	Unknown	30	8.3	1.38	3.30	4.88	9.24	4.57
ST4 C12	137" - 149"	Unknown	32	7.9	4.19	22.5	31.1	15.9	3.07

Table 1

SUNNYSIDE RECLAMATION SOIL BORROW AREA NO. 1 LABORATORY ANALYSIS - Part 4

Sample I.D.	Sample Footage	Boron (Hot Water Extract) ppm	Selenium (Hot Water Extract) ppm	Organic Matter %	Sand %	Silt %	Clay %	Texture	Neutralization Potential as $CACO_3$	CEC (meg/100 gm)
ST1 A1	0" - 6"	0.4	0.01	0.9	64	23	13	SL	5.1	6.00
ST1 C1CA	6" - 18"	0.2	-0.01	0.8	66	20	14	SL	6.1	6.28
ST1 C2CA	18" - 30"	0.4	-0.01	0.7	54	30	16	SL	8.7	5.53
ST1 C3	30" - 44"	0.6	-0.01		48	28	24	SCL L	15.2	6.28
ST1 C4	44" - 60"	1.3	-0.01		58	21	21	SCL	4.6	7.98
ST1 C5	60" - 75"	1.7	-0.01		58	19	23	SCL	3.8	8.98
ST2 A1	0" - 6"	1.0	0.01	3.0	61	21	18	SL	13.9	11.5
ST2 C1CA	6" - 18"	1.8	-0.01	0.9	63	18	19	SL	19.1	5.73
ST2 C2CA	18" - 34"	0.6	0.01	0.7	69	15	16	SL	15.0	4.48
ST2 C3	34" - 46"	0.9	-0.01		58	23	19	SL	13.7	3.58
ST2 C4	46" - 58"	0.9	-0.01		59	25	16	SL	11.5	3.60
ST2 C5	58" - 70"	1.9	-0.01		51	25	24	SCL	9.1	6.45
ST2 C6	70" - 82"	1.3	-0.01		49	26	25	SCL	13.2	6.30
ST2C7	82" - 94"	0.3	-0.01		58	29	13	SL	9.6	3.60
ST2 C8	94" - 106"	0.3	-0.01		58	29	13	SL	10.5	4.18
ST2 C9	106" - 118"	0.2	-0.01		56	31	13	SL	10.1	4.68
ST2 C10	118" - 130"	0.1	-0.01		64	26	10	SL	9.6	2.95
ST2 C11	130" - 142"	0.3	-0.01		58	28	14	SL	9.9	4.05
ST2 C12	142" - 157"	0.3	-0.01		58	28	14	SL	9.8	4.33

Table 1

SUNNYSIDE RECLAMATION SOIL BORROW AREA NO. 1 LABORATORY ANALYSIS - Part 5

Sample I.D.	Sample Footage	Boron (Hot Water Extract) ppm	Selenium (Hot Water Extract) ppm	Organic Matter %	Sand %	Silt %	Clay %	Texture	Neutralization Potential as $CACO_3$	CEC (meg/100 gm)
ST3 A1	0" - 5"	0.9	0.01	4.1	66	21	13	SL	13.0	11.2
ST3 C1CA	5" - 17"	0.8	-0.01	0.1	57	30	13	SL	7.8	3.05
ST3 C2CA	17" - 29"	0.6	-0.01	0.1	66	23	11	SL	7.1	2.10
ST3 C3CA	29" - 43"	0.5	-0.01		61	26	13	SL	9.1	2.50
ST3 C4	43" - 55"	0.6	-0.01		61	25	14	SL	8.3	2.48
ST3 C5	55" - 62"	0.6	-0.01		59	26	15	SL	8.1	2.95
ST3 C6	67" - 78"	0.4	-0.01		64	25	11	SL	7.9	2.60
ST3 C7	78" - 91"	0.6	-0.01		71	19	10	SL	9.2	4.53
ST3 C8	91" - 103"	0.4	-0.01		71	19	10	SL	10.9	4.98
ST3 C9	103" - 115"	0.4	-0.01		61	25	14	SL	16.7	8.35
ST3 C10	115" - 131"	0.1	-0.01		63	26	11	SL	7.5	4.48
ST4 A1	0" - 5"	0.8	0.01	3.2	68	21	11	SL	8.9	15.9
ST4 C1CA	5" - 17"	0.5	-0.01	1.5	46	34	20	L	21.2	12.2
ST4 C2CA	17" - 29"	0.2	-0.01	0.8	51	30	19	L	19.0	9.75
ST4 C3CA	29" - 41"	0.2	-0.01		53	29	18	SL	16.6	7.53
ST4 C4CA	41" - 53"	0.3	-0.01		59	26	15	SL	15.0	6.03
ST4 C5	53" - 65"	0.9	-0.01		57	29	14	SL	11.3	5.75
ST4 C6	65" - 77"	1.0	-0.01		57	28	15	SL	12.8	6.43

Table 1

SUNNYSIDE RECLAMATION SOIL BORROW AREA NO. 1 LABORATORY ANALYSIS - Part 6

Sample I.D.	Sample Footage	Boron (Hot Water Extract) ppm	Selenium (Hot Water Extract) ppm	Organic Matter %	Sand %	Silt %	Clay %	Texture	Neutralization Potential as $CACO_3$	CEC (meg/100 gm)
ST4 C7	77" - 89"	0.9	-0.01		56	29	15	SL	11.7	6.38
ST4 C8	89" - 101"	0.5	-0.01		60	26	14	SL	7.5	6.73
ST4 C9	101" - 113"	0.5	-0.01		67	23	10	SL	6.2	4.93
ST4 C10	113" - 125"	0.6	-0.01		64	23	13	SL	7.2	5.38
ST4 C11	125" - 137"	0.7	-0.01		63	23	14	SL	8.7	5.55
ST4 C12	137" - 149"	0.7	-0.01		64	23	13	SL	6.9	5.60

KAISER COAL COMPANY
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102 S. TEJON
COLORADO SPRINGS, CO 80903

ATTN: MS. SUSAN HASENJAGER

BOOKCLIFFS COMMERCIAL LABORATORIES
OVERBURDEN ANALYSIS

Report Date: NOVEMBER 21,1985
Date Received SEPTEMBER 12, 1985

LAB. NO.	SAMPLE I.D.	SAMPLE FOOTAGE	SAMPLE DATE	SATURATED PASTE EXTRACTION: SATURATION %	pH (Units)	E.C. mmhos/cm @	CALCIUM meq/l	MAGNESIUM meq/l	SODIUM meq/l	SAR
85-0086-OB	HE1 A1	0" - 8"	UNKNOWN	31	7.5	0.54	2.93	1.01	1.24	0.88
85-0087-OB	HE1 C1CA	8" - 20"	UNKNOWN	33	7.3	0.36	2.96	1.14	0.38	0.27
85-0088-OB	HE1 C2CA	20" - 32"	UNKNOWN	36	7.5	0.34	2.89	1.37	0.28	0.19
85-0089-OB	HE1 C3CA	32" - 46"	UNKNOWN	34	7.7	0.42	2.90	1.81	0.63	0.41
85-0090-OB	HE1 C4CA	46" - 60"	UNKNOWN	32	7.8	0.37	2.62	1.52	0.75	0.52
85-0091-OB	HA2 A1	0" - 3"	UNKNOWN	33	7.8	0.94	4.19	1.47	4.10	2.44
85-0092-OB	HA2 C1	3" - 14"	UNKNOWN	37	8.3	8.23	12.9	5.99	80.7	26.3
85-0093-OB	HA2 C2	14" - 26"	UNKNOWN	30	8.9	10.55	6.97	7.47	127	47.3
85-0094-OB	HA2 C3	26" - 38"	UNKNOWN	35	8.5	16.30	10.0	11.9	181	54.7
85-0095-OB	HA2 C4	38" - 49"	UNKNOWN	35	8.6	23.10	33.6	71.4	262	36.2
85-0096-OB	HA2 C5	49" - 60"	UNKNOWN	35	8.6	14.70	30.6	34.8	153	26.8
85-0097-OB	GL3 A1	0" - 4"	UNKNOWN	33	7.9	0.86	6.43	2.63	1.25	0.59
85-0098-OB	GL3 C1	4" - 16"	UNKNOWN	30	8.0	0.63	4.47	2.24	1.16	0.63
85-0099-OB	GL3 C2	16" - 28"	UNKNOWN	31	8.1	0.39	3.76	1.46	0.40	0.25
85-0100-OB	GL3 C3	28" - 40"	UNKNOWN	30	8.2	0.31	2.68	1.34	0.42	0.30
85-0101-OB	GL3 C4	40" - 52"	UNKNOWN	30	8.1	0.33	2.97	1.34	0.35	0.24
85-0102-OB	GL3 C5	52" - 60"	UNKNOWN	30	8.1	0.34	2.49	1.31	0.38	0.28
85-0103-OB	DA4 A11	0" - 4"	UNKNOWN	49	6.5	0.92	7.47	2.19	0.92	0.42
85-0104-OB	DA4 A12	4" - 10"	UNKNOWN	39	6.3	0.55	4.20	1.75	0.43	0.25
85-0105-OB	DA4 B	10" - 24"	UNKNOWN	35	6.4	0.39	3.23	1.49	0.32	0.21

Ralph V. Poulsen

Ralph V. Poulsen, Director

BOOKCLIFFS COMMERCIAL LABORATORIES
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KAISER COAL COMPANY
P.O. BOX 2679
102 S. TEJON
COLORADO SPRINGS, CO 80903

ATTN: MS. SUSAN HASENJAGER

LAB. NO.	SAMPLE I.D.	SAMPLE FOOTAGE	BORON (Hot Wate Extract) ppm	SELENIUM (Hot Water Extract) ppm	ORGANIC MATTER %	SAND %	SILT %	CLAY %	TEXTURE	NEUTRALIZATION POTENTIAL (as CaCO3) %	CEC (meq/100g)
85-0086-OB	HE1 A1	0" - 8"	0.6	-0.01	0.8	63	26	11	SL	6.4	10.2
85-0087-OB	HE1 C1CA	8"- 20"	0.5	0.01	0.6	55	25	20	SCL SL	17.2	9.75
85-0088-OB	HE1 C2CA	20" - 32"	0.4	-0.01	0.6	49	28	23	SCL L	18.0	9.25
85-0089-OB	HE1 C3CA	32" - 46"	0.5	-0.01	0.6	54	28	18	SL	17.5	9.23
85-0090-OB	HE1 C4CA	46" - 60"	0.5	-0.01	0.7	54	28	18	SL	16.4	8.45
85-0091-OB	HA2 A1	0" - 3"	1.0	-0.01	1.7	52	35	13	SL L	10.8	8.05
85-0092-OB	HA2 C1	3" - 14"	1.1	-0.01	1.4	47	43	10	L	11.6	7.83
85-0093-OB	HA2 C2	14" - 26"	1.5	-0.01	0.5	66	24	10	SL	10.0	4.18
85-0094-OB	HA2 C3	26" - 38"	1.2	0.02	0.4	72	18	10	SL	10.0	3.70
85-0095-OB	HA2 C4	38" - 49"	3.0	-0.01	0.9	51	33	16	L	12.2	7.50
85-0096-OB	HA2 C5	49" - 60"	0.9	-0.01	0.4	60	30	10	SL	10.9	4.05
85-0097-OB	GL3 A1	0" - 4"	0.5	0.01	0.7	69	23	8	SL	8.4	4.08
85-0098-OB	GL3 C1	4" - 16"	0.5	-0.01	0.4	63	26	11	SL	11.5	4.45
85-0099-OB	GL3 C2	16" - 28"	0.4	-0.01	0.4	63	26	11	SL	12.4	5.03
85-0100-OB	GL3 C3	28" - 40"	0.4	-0.01	0.3	62	28	10	SL	12.4	3.93
85-0101-OB	GL3 C4	40" - 52"	0.5	-0.01	0.4	67	24	9	SL	10.9	3.93
85-0102-OB	GL3 C5	52" - 60"	0.4	-0.01	0.3	72	19	9	SL	10.5	3.73
85-0103-OB	DA4 A11	0" - 4"	0.7	-0.01	5.7	50	40	10	L	0.3	20.2
85-0104-OB	DA4 A12	4" - 10"	0.5	-0.01	3.0	48	39	13	L	0.2	13.7
85-0105-OB	DA4 B	10" - 24"	0.4	-0.01	1.3	44	38	18	L	0.3	11.2

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BOOKCLIFFS COMMERCIAL LABORATORIES
OVERBURDEN ANALYSIS

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Date Received SEPTEMBER 12, 1985

LAB. NO.	SAMPLE I.D.	SAMPLE FOOTAGE	SAMPLE DATE	SATURATED PASTE EXTRACTION: SATURATION %	pH (Units)	E.C. mmhos/cm @	CALCIUM meq/l	MAGNESIUM meq/l	SODIUM meq/l	SAR
85-0106-OB	DA4 C1CA	24" - 36"	UNKNOWN	44	7.7	0.36	3.03	1.58	0.28	0.18
85-0107-OB	DA3 C2	36" - 48"	UNKNOWN	32	8.0	8.02	23.0	92.9	20.1	2.64
85-0108-OB	DA4 C3	48" - 60"	UNKNOWN	32	8.2	15.80	27.4	197	55.4	5.23
85-0109-OB	C05 A1	0" - 7"	UNKNOWN	38	7.7	0.98	7.41	4.28	0.44	0.18
85-0110-OB	C05 C1	7" - 12"	UNKNOWN	36	7.5	2.03	15.1	7.81	1.26	0.37
85-0111-OB	MI6 A11	0" - 5"	UNKNOWN	47	7.7	0.65	7.15	2.00	0.28	0.13
85-0112-OB	MI6 A12	5" - 12"	UNKNOWN	37	7.6	0.76	6.67	2.44	0.34	0.16
85-0113-OB	MI6 C1	12" - 24"	UNKNOWN	38	7.3	0.51	4.33	1.86	0.42	0.24
85-0114-OB	MI6 C2	24" - 38"	UNKNOWN	36	7.4	0.96	7.94	2.91	1.39	0.60
85-0115-OB	MI6 C3	38" - 49"	UNKNOWN	34	7.7	0.60	5.47	1.86	0.47	0.25
85-0116-OB	MI6 C4	49" - 60"	UNKNOWN	31	7.9	0.38	3.21	1.39	0.40	0.26
85-0117-OB	ST7 A1	0" - 6"	UNKNOWN	37	7.2	0.58	4.86	1.74	0.44	0.24
85-0118-OB	ST7 C1CA	6" - 18"	UNKNOWN	42	7.5	0.78	8.68	2.35	0.96	0.41
85-0119-OB	ST7 C2CA	18" - 31"	UNKNOWN	34	7.8	0.41	3.97	1.57	0.40	0.24
85-0120-OB	ST7 C3	31" - 43"	UNKNOWN	32	8.3	0.34	2.02	2.46	0.33	0.22
85-0121-OB	ST7 C4	43" - 55"	UNKNOWN	36	8.6	0.39	1.37	3.39	0.54	0.35
85-0122-OB	ST7 C5	55" - 60"	UNKNOWN	34	8.4	0.57	2.16	3.69	0.63	0.37
85-0123-OB	GE8 A1	0" - 6"	UNKNOWN	38	7.6	0.72	6.49	2.53	0.33	0.16
85-0124-OB	GE8 C1	6" - 10"	UNKNOWN	43	7.8	0.58	4.35	2.48	0.45	0.24
85-0125-OB	GE8 C2	10" - 16"	UNKNOWN	46	8.0	0.39	2.49	1.69	0.43	0.30

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102 S. TEJON
COLORADO SPRINGS, CO 80903

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LAB. NO.	SAMPLE I.D.	SAMPLE FOOTAGE	BORON (Hot Wate Extract) ppm	SELENIUM (Hot Water Extract) ppm	ORGANIC MATTER %	SAND %	SILT %	CLAY %	TEXTURE	NEUTRALIZATION POTENTIAL % CACO3%	CEC (meq/100 gm)
85-0106-OB	DA4 C1CA	24" - 36"	0.5	-0.01	1.6	40	40	20	L	12.3	15.0
85-0107-OB	DA3 C2	36" - 48"	0.7	0.01	0.9	46	34	20	L	18.0	8.60
85-0108-OB	DA4 C3	48" - 60"	0.8	0.02	0.8	47	33	20	L	17.8	7.60
85-0109-OB	C05 A1	0" - 7"	0.8	-0.01	4.5	34	46	20	L	5.8	18.0
85-0110-OB	C05 C1	7" - 12"	1.0	-0.01	3.1	29	47	24	L	3.7	18.0
85-0111-OB	MI6 A11	0" - 5"	1.0	-0.01	4.3	51	38	11	L	0.5	19.5
85-0112-OB	MI6 A12	5" - 12"	0.6	-0.01	3.0	47	40	13	L	0.3	12.9
85-0113-OB	MI6 C1	12" - 24"	0.3	-0.01	1.3	40	41	19	L	0.1	11.6
85-0114-OB	MI6 C2	24" - 38"	0.3	-0.01		44	38	18	L	0.9	10.0
85-0115-OB	MI6 C3	38" - 49"	0.6	0.01		61	21	18	SL	14.1	11.1
85-0116-OB	MI6 C4	49" - 60"	0.3	-0.01		65	20	15	SL	15.4	7.63
85-0117-OB	ST7 A1	0" - 6"	0.4	-0.01	1.5	53	24	23	SL	0.5	15.2
85-0118-OB	ST7 C1CA	6" - 18"	0.6	-0.01	2.0	64	25	11	SL	17.5	11.6
85-0119-OB	ST7 C2CA	18" - 31"	0.2	-0.01	0.8	68	21	11	SL	14.0	7.23
85-0120-OB	ST7 C3	31" - 43"	0.3	-0.01		57	30	13	SL	6.3	7.30
85-0121-OB	ST7 C4	43" - 55"	1.6	-0.01		54	28	18	SL	5.6	7.78
85-0122-OB	ST7 C5	55" - 60"	1.3	-0.01		59	25	16	SL	10.8	6.98
85-0123-OB	GE8 A1	0" - 6"	0.7	-0.01	2.0	53	34	13	SL	17.6	11.4
85-0124-OB	GE8 C1	6" - 10"	0.4	-0.01	1.5	28	46	26	L	13.6	13.8
85-0125-OB	GE8 C2	10" - 16"	0.4	-0.01		16	58	26	SiL	12.7	16.4

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LAB. NO.	SAMPLE I.D.	SAMPLE FOOTAGE	SAMPLE DATE	SATURATED PASTE EXTRACTION: SATURATION %	pH (Units)	E.C. mmhos/cm @	CALCIUM meq/l	MAGNESIUM meq/l	SODIUM meq/l	SAR
85-0126-OB	GL9 A1	0" - 4"	UNKNOWN	31	7.9	0.65	4.34	1.64	1.14	0.66
85-0127-OB	GL9 C1	4" - 17"	UNKNOWN	29	7.9	1.73	8.56	3.99	5.24	2.09
85-0128-OB	GL9 C2	17" - 29"	UNKNOWN	27	8.2	3.08	5.71	6.37	24.0	9.77
85-0129-OB	GL9 C3	29" - 44"	UNKNOWN	31	8.2	1.93	4.62	6.64	13.3	5.61
85-0130-OB	GL9 C4	44" - 60"	UNKNOWN	27	8.5	1.02	2.30	1.63	8.11	5.79
85-0131-OB	GE10 A1	0" - 8"	UNKNOWN	34	7.8	0.66	5.67	1.93	0.56	0.29
85-0132-OB	GE10 C1	8" - 14"	UNKNOWN	31	7.9	0.63	4.90	2.31	0.59	0.31
85-0133-OB	GE10 C2	14" - 18"	UNKNOWN	31	8.1	0.71	4.33	3.12	1.22	0.63
85-0134-OB	ST11 A1	0" - 5"	UNKNOWN	36	7.3	0.58	4.92	1.55	0.79	0.44
85-0135-OB	ST11 C1	5" - 18"	UNKNOWN	36	7.6	0.40	3.44	1.59	0.87	0.55
85-0136-OB	ST11 C2	18" - 30"	UNKNOWN	30	8.0	0.40	2.44	2.36	0.67	0.43
85-0137-OB	ST11 C3	30" - 42"	UNKNOWN	28	8.1	0.44	1.39	2.96	0.91	0.62
85-0138-OB	ST11 C4	42" - 54"	UNKNOWN	33	8.1	0.46	1.68	2.97	1.04	0.68
85-0139-OB	ST11 C5	54" - 60"	UNKNOWN	32	7.8	1.35	12.1	5.68	1.12	0.38
85-0140-OB	ST1 A1	0" - 6"	UNKNOWN	32	7.5	0.55	5.31	1.60	0.22	0.12
85-0141-OB	ST1 C1CA	6" - 18"	UNKNOWN	32	7.6	0.43	4.23	1.53	0.16	0.09
85-0142-OB	ST1 C2CA	18" - 30"	UNKNOWN	33	7.6	0.41	3.43	1.68	0.27	0.17
85-0143-OB	ST1 C3	30" - 44"	UNKNOWN	36	8.2	0.35	2.14	2.78	0.23	0.15
85-0144-OB	ST1 C4	44" - 60"	UNKNOWN	37	8.2	0.45	1.74	3.96	0.84	0.50
85-0145-OB	ST1 C5	60" - 75"	UNKNOWN	36	8.2	0.44	1.88	3.47	0.83	0.51

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LAB. NO.	SAMPLE I.D.	SAMPLE FOOTAGE	BORON (Hot Water Extract) ppm	SELENIUM (Hot Water Extract) ppm	ORGANIC MATTER %	SAND %	SILT %	CLAY %	TEXTURE	NEUTRALIZATION POTENTIAL AS CACO3 %	CEC (meq/100 gm)
85-0126-OB	GL9 A1	0" - 4"	0.7	-0.01	2.9	72	20	8	SL	8.8	7.35
85-0127-OB	GL9 C1	4" - 17"	1.0	-0.01	1.0	69	21	10	SL	9.6	9.15
85-0128-OB	GL9 C2	17" - 29"	0.7	-0.01	0.4	78	14	8	LS SL	10.1	9.35
85-0129-OB	GL9 C3	29" - 44"	0.6	-0.01		69	20	11	SL	11.8	8.38
85-0130-OB	GL9 C4	44" - 60"	0.6	-0.01		71	19	10	SL	11.2	7.28
85-0131-OB	GE10 A1	0" - 8"	1.0	0.01	1.4	48	33	19	L	12.0	8.68
85-0132-OB	GE10 C1	8" - 14"	0.6	0.01	0.6	56	30	14	SL	13.6	5.45
85-0133-OB	GE10 C2	14" - 18"	0.4	-0.01	0.4	46	43	11	L	17.4	5.03
85-0134-OB	ST11 A1	0" - 5"	0.5	-0.01	1.1	51	28	21	SCL L	11.3	7.68
85-0135-OB	ST11 C1	5" - 18"	0.3	-0.01	1.2	49	31	20	L	12.6	6.98
85-0136-OB	ST11 C2	18" - 30"	0.2	-0.01	0.5	64	20	16	SL	10.2	4.30
85-0137-OB	ST11 C3	30" - 42"	0.3	-0.01		84	6	10	LS	6.0	2.63
85-0138-OB	ST11 C4	42" - 54"	0.8	-0.01		56	25	19	SL	7.1	5.55
85-0139-OB	ST11 C5	54" - 60"	0.8	0.01		59	25	16	SL	1.1	7.83
85-0140-OB	ST1 A1	0" - 6"	0.4	0.01	0.9	64	23	13	SL	5.1	6.00
85-0141-OB	ST1 C1CA	6" - 18"	0.2	-0.01	0.8	66	20	14	SL	6.1	6.28
85-0142-OB	ST1 C2CA	18" - 30"	0.4	-0.01	0.7	54	30	16	SL	8.7	5.53
85-0143-OB	ST1 C3	30" - 44"	0.6	-0.01		48	28	24	SCL L	15.2	6.28
85-0144-OB	ST1 C4	44" - 60"	1.3	-0.01		58	21	21	SCL	4.6	7.98
85-0145-OB	ST1 C5	60" - 75"	1.7	-0.01		58	19	23	SCL	3.8	8.98

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LAB. NO.	SAMPLE I.D.	SAMPLE FOOTAGE	SAMPLE DATE	SATURATED PASTE EXTRACTION SATURATION %	pH (Units)	E.C. mmhos/cm @	CALCIUM meq/l	MAGNESIUM meq/l	SODIUM meq/l	SAR
85-0146-OB	ST2 A1	0" - 6"	UNKNOWN	41	7.4	0.65	7.45	1.91	0.19	0.09
85-0147-OB	ST2 C1CA	6" - 18"	UNKNOWN	37	8.1	1.48	7.61	13.1	1.85	0.57
85-0148-OB	ST2 C2CA	18" - 34"	UNKNOWN	34	8.0	1.78	10.7	12.5	2.88	0.85
85-0149-OB	ST2 C3	34" - 46"	UNKNOWN	33	8.3	3.62	6.34	20.2	21.4	5.87
85-0150-OB	ST2 C4	46" - 58"	UNKNOWN	33	8.1	3.82	7.72	23.8	20.6	5.19
85-0151-OB	ST2 C5	58" - 70"	UNKNOWN	36	8.4	0.67	1.53	1.79	5.05	3.92
85-0152-OB	ST2 C6	70" - 82"	UNKNOWN	36	8.5	0.49	1.07	1.52	3.84	3.37
85-0153-OB	ST2 C7	82" - 94"	UNKNOWN	35	8.1	5.98	20.1	44.9	23.6	4.14
85-0154-OB	ST2 C8	94" - 106"	UNKNOWN	32	8.1	6.88	24.8	52.2	26.4	4.25
85-0155-OB	ST2 C9	106" - 118"	UNKNOWN	33	8.1	6.92	25.1	51.1	25.2	4.08
85-0156-OB	ST2 C10	118" - 130"	UNKNOWN	35	8.2	5.38	17.2	40.3	19.7	3.67
85-0157-OB	ST2 C11	130" - 142"	UNKNOWN	34	8.1	6.55	27.8	50.0	23.0	3.69
85-0158-OB	ST2 C12	142" - 157"	UNKNOWN	32	8.1	5.98	21.9	46.5	24.7	4.22
85-0159-OB	ST3 A1	0" - 5"	UNKNOWN	46	7.4	0.83	10.1	2.58	0.22	0.09
85-0160-OB	ST3 C1CA	5" - 17"	UNKNOWN	31	8.2	3.39	11.9	22.7	14.7	3.53
85-0161-OB	ST3 C2CA	17" - 29"	UNKNOWN	27	8.7	0.82	1.83	2.23	5.80	4.07
85-0162-OB	ST3 C3CA	29" - 43"	UNKNOWN	27	8.7	0.71	1.48	1.75	5.78	4.55
85-0163-OB	ST3 C4	43" - 55"	UNKNOWN	31	8.6	0.64	1.78	3.54	2.90	1.78
85-0164-OB	ST3 C5	55" - 67"	UNKNOWN	31	8.6	0.55	1.63	3.73	1.48	0.90
85-0165-OB	ST3 C6	67" - 78"	UNKNOWN	30	8.5	0.52	1.80	3.90	1.02	0.60

Ralph V. Poulsen

Ralph V. Poulsen, Director

BOOKCLIFFS COMMERCIAL LABORATORIES
OVERBURDEN ANALYSIS

Report Date: NOVEMBER 21, 1985
Date Received SEPTEMBER 12, 1985

KAISER COAL COMPANY
P.O. BOX 2679
102 S. TEJON
COLORADO SPRINGS, CO 80903

ATTN: MS. SUSAN HASENJAGER

LAB. NO.	SAMPLE I.D.	SAMPLE FOOTAGE	BORON (Hot Water Extract) ppm	SELENIUM (Hot Water Extract) ppm	ORGANIC MATTER %	SAND %	SILT %	CLAY %	TEXTURE	NEUTRALIZATION POTENTIAL AS CACO3 %	CEC (meq/100 gm)
85-0146-OB	ST2 A1	0" - 6"	1.0	0.01	3.0	61	21	18	SL	13.9	11.5
85-0147-OB	ST2 C1CA	6" - 18"	1.8	-0.01	0.9	63	18	19	SL	19.1	5.73
85-0148-OB	ST2 C2CA	18" - 34"	0.6	0.01	0.7	69	15	16	SL	15.8	4.48
85-0149-OB	ST2 C3	34" - 46"	0.9	-0.01		58	23	19	SL	13.7	3.58
85-0150-OB	ST2 C4	46" - 58"	0.9	-0.01		59	25	16	SL	11.5	3.60
85-0151-OB	ST2 C5	58" - 70"	1.9	-0.01		51	25	24	SCL	9.1	6.45
85-0152-OB	ST2 C6	70" - 82"	1.3	-0.01		49	26	25	SCL	13.2	6.30
85-0153-OB	ST2 C7	82" - 94"	0.3	-0.01		58	29	13	SL	9.6	3.60
85-0154-OB	ST2 C8	94" - 106"	0.3	-0.01		58	29	13	SL	10.5	4.18
85-0155-OB	ST2 C9	106" - 118"	0.2	-0.01		56	31	13	SL	10.1	4.68
85-0156-OB	ST2 C10	118" - 130"	0.1	-0.01		64	26	10	SL	9.6	2.95
85-0157-OB	ST2 C11	130" - 142"	0.3	-0.01		58	28	14	SL	9.9	4.05
85-0158-OB	ST2 C12	142" - 157"	0.3	-0.01		58	28	14	SL	9.8	4.33
85-0159-OB	ST3 A1	0" - 5"	0.9	0.01	4.1	66	21	13	SL	13.0	11.2
85-0160-OB	ST3 C1CA	5" - 17"	0.8	-0.01	0.1	57	30	13	SL	7.8	3.85
85-0161-OB	ST3 C2CA	17" - 29"	0.6	-0.01	0.1	66	23	11	SL	7.1	2.10
85-0162-OB	ST3 C3CA	29" - 43"	0.5	-0.01		61	26	13	SL	9.1	2.58
85-0163-OB	ST3 C4	43" - 55"	0.6	-0.01		61	25	14	SL	8.3	2.48
85-0164-OB	ST3 C5	55" - 67"	0.6	-0.01		59	26	15	SL	8.1	2.95
85-0165-OB	ST3 C6	67" - 78"	0.4	-0.01		64	25	11	SL	7.9	2.60

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Report Date: NOVEMBER 21, 1985
Date Received SEPTEMBER 12, 1985

				SATURATED PASTE EXTRACTION						
LAB. NO.	SAMPLE I.D.	SAMPLE FOOTAGE	SAMPLE DATE	SATURATION %	pH (Units)	E.C. mmhos/cm @	CALCIUM meq/l	MAGNESIUM meq/l	SODIUM meq/l	SAR
85-0166-OB	ST3 C7	78" - 91"	UNKNOWN	31	8.4	0.49	2.04	3.79	0.61	0.36
85-0167-OB	ST3 C8	91" - 103"	UNKNOWN	32	7.8	0.32	2.43	1.54	0.25	0.18
85-0168-OB	ST3 C9	103" - 115"	UNKNOWN	38	7.4	0.41	3.13	1.72	0.28	0.18
85-0169-OB	ST3 C10	115" - 131"	UNKNOWN	32	8.2	1.65	3.32	7.10	9.14	4.00
85-0170-OB	ST4 A1	0" - 5"	UNKNOWN	43	6.9	0.89	10.2	2.21	0.25	0.10
85-0171-OB	ST4 C1CA	5" - 17"	UNKNOWN	46	7.3	0.41	4.07	1.46	0.28	0.17
85-0172-OB	ST4 C2CA	17" - 29"	UNKNOWN	39	7.5	0.39	3.46	1.73	0.35	0.22
85-0173-OB	ST4 C3CA	29" - 41"	UNKNOWN	34	8.0	0.34	3.13	1.78	0.42	0.27
85-0174-OB	ST4 C4CA	41" - 53"	UNKNOWN	34	8.1	0.38	2.50	2.27	0.59	0.38
85-0175-OB	ST4 C5	53" - 65"	UNKNOWN	34	8.5	0.67	2.32	2.75	3.49	2.19
85-0176-OB	ST4 C6	65" - 77"	UNKNOWN	34	8.7	0.74	2.19	3.10	4.42	2.72
85-0177-OB	ST4 C7	77" - 89"	UNKNOWN	35	8.6	0.58	1.83	2.47	3.20	2.18
85-0178-OB	ST4 C8	89" - 101"	UNKNOWN	31	8.5	0.65	1.72	1.95	4.64	3.43
85-0179-OB	ST4 C9	101" - 113"	UNKNOWN	31	8.4	0.72	1.76	2.35	5.18	3.61
85-0180-OB	ST4 C10	113" - 125"	UNKNOWN	30	8.5	0.70	1.70	1.70	5.45	4.18
85-0181-OB	ST4 C11	125" - 137"	UNKNOWN	30	8.3	1.38	3.30	4.88	9.24	4.57
85-0182-OB	ST4 C12	137" - 149"	UNKNOWN	32	7.9	4.19	22.5	31.1	15.9	3.07

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LAB. NO.	SAMPLE I.D.	SAMPLE FOOTAGE	BORON (Hot Water Extract) ppm	SELENIUM (Hot Water Extract) ppm	ORGANIC MATTER %	SAND %	SILT %	CLAY %	TEXTURE	NEUTRALIZATION POTENTIAL AS CACO3 %	CEC (meq/100 gm)
85-0166-OB	ST3 C7	78" - 91"	0.6	-0.01		71	19	10	SL	9.2	4.53
85-0167-OB	ST3 C8	91" - 103"	0.4	-0.01		71	19	10	SL	10.9	4.98
85-0168-OB	ST3 C9	103" - 115"	0.4	-0.01		61	25	14	SL	16.7	8.35
85-0169-OB	ST3 C10	115" - 131"	0.1	-0.01		63	26	11	SL	7.5	4.48
85-0170-OB	ST4 A1	0" - 5"	0.8	0.01	3.2	68	21	11	SL	8.9	15.9
85-0171-OB	ST4 C1CA	5" - 17"	0.5	-0.01	1.5	46	34	20	L	21.2	12.2
85-0172-OB	ST4 C2CA	17" - 29"	0.2	-0.01	0.8	51	30	19	L	19.0	9.75
85-0173-OB	ST4 C3CA	29" - 41"	0.2	-0.01		53	29	18	SL	16.6	7.53
85-0174-OB	ST4 C4CA	41" - 53"	0.3	-0.01		59	26	15	SL	15.0	6.03
85-0175-OB	ST4 C5	53" - 65"	0.9	-0.01		57	29	14	SL	11.3	5.75
85-0176-OB	ST4 C6	65" - 77"	1.0	-0.01		57	28	15	SL	12.8	6.43
85-0177-OB	ST4 C7	77" - 89"	0.9	-0.01		56	29	15	SL	11.7	6.38
85-0178-OB	ST4 C8	89" - 101"	0.5	-0.01		60	26	14	SL	7.5	6.73
85-0179-OB	ST4 C9	101" - 113"	0.5	-0.01		67	23	10	SL	6.2	4.93
85-0180-OB	ST4 C10	113" - 125"	0.6	-0.01		64	23	13	SL	7.2	5.38
85-0181-OB	ST4 C11	125" - 137"	0.7	-0.01		63	23	14	SL	8.7	5.55
85-0182-OB	ST4 C12	137" - 149"	0.7	-0.01		64	23	13	SL	6.9	5.60

Ralph V. Poulsen

Ralph V. Poulsen, Director

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		34-157"		0 - 34"	Stones and cobbles, remove 15% coarse fragments(2)
Strych(1) very stony sandy loam, 9 - 15% slopes		43-131"		0 - 43"	Stones and cobbles, remove 15% coarse fragments(2)

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

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

CHAPTER IX

VEGETATION RESOURCES

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CHAPTER IX

9.1 Scope

The objective of this study was to map and quantify the vegetation communities of the Sunnyside Mines coal permit area which were disturbed. The information is presented to satisfy the Utah Division of Oil, Gas and Mining (DOGM) and the U.S. Office of Surface Mining requirments.

The vegetation of Sunnyside permit area has been mapped and five 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

Vegetation sampling was conducted from late June into September 1981 by qualified Kaiser Coal Corporation personnel (Section 1.4). 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.

9.2 Methodology

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 IX-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 III-1).

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 complied 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 structures needed for complete identification and were designated as unknowns. The collected plants are retained in the Kaiser Coal Corporation Herbarium, Raton, New Mexico. 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 IX-5). The quadrat method estimated the herbaceous understory layer, while line intercept estimated only tree and shrub canopy cover. The DOGM later requested a method that would combine understory and canopy cover as one value, so the point line method was used. This method was approved by Lynn Kunzler of DOGM (personal communication, 1981).

Point line transects, which measured total first hit cover, were laid out 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 (12.5m) 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.

CHAPTER IX

Tree density in the Pinyon-Juniper types was estimated using 0.02 ha macroplots. These macroplots were in the shape of an elbow (Figure IX-5) 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 variablities found within the Pinyon-Juniper zone. Tree seedlings (less that 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 Ellenberg, 1974). The shrubs less than 12 inches tall were counted as seedlings and were not included 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 IX-1.

The range conditions at the time of the productivity estimations by the SCS were fair and good (Figure IX-3). Precipitation records are maintained onsite at Sunnyside, Utah (Table IX-39) and the 1981 precipitation was well above average. Data recorded since submission of the permit application has been amended to Chapter XI. Effective precipitation has been graphed against precipitation for comparison (Figure IX-4).

A recent 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 (Figure VIII-2).

$$n_{min} = \frac{(t)^2(s)^2}{[(.1)(x)]^2}$$

Where ^{n} min = the 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 IX-1.

All sampling techniques were reviewed and discussed with DOGM personnel, and were found to be appropriate and acceptable (Figure IX-5) (Mary Ann Wright, Lynn Kunzler, personal communications).

Copies of all raw vegetation data is maintained on file at Kaiser Coal Corporation at the Sunnyside Mines. It is available for inspection and verification. One copy has been provided to the DOGM for filing as requested.

9.3 Existing Resources

9.3.1 General Site Description

The Sunnyside Mines permit area is located in the Book Cliffs area. This is 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 2,896 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 (see Sections 7.1.5 and 7.2.2.2). 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. Research on the fire history of the area is underway. A small town was once located at the mine site in Whitmore Canyon and, thus, the area has a long history of pertubation which has affected most of the vegetation.

An old pre-law portal in B Canyon will be activated by

future mining activities. However, no additional surface disturbances of B Canyon are anticipated at this time. 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 chained in the late 1960s, 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.

9.3.2 Vegetation Types

The vegetation within the permit area varies from sagebrush/grass habitat type at the lower elevations, to the Douglas fir/aspen habitat type at higher elevations. Only six vegetation types have been disturbed by the actively used surface facilities of the mines. The disturbed vegetation types are comprised of the following communities:

Community	Acres
Mountain brush (serviceberry)	2,675
Pinyon-juniper	4,306
Pinyon-juniper/grass	676
Pinyon-juniper/sagebrush	76
Riparian/cottonwood	136
Sagebrush/grass	1,948

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 occured pre-1977 law. This disturbed area was probably within the Pinyon-Juniper/-sagebrush vegetation type, and data have been collected in this area to aid in revegetation planning and reclamation success determinations.

Other vegetation types found within the permit area include:

Aspen	179
Douglas fir	2,222
Douglas fir/aspen	532
Douglas fir/mountain brush	1,166
Douglas fir/aspen/mountain brush	189
Douglas fir/pinyon-juniper	3,451
Douglas fir/sage	1,179
Pinyon/juniper-mountain brush	3,999
Riparian-bullrush/sedge	1
Riparian-willow	74
Sagebrush/mountain brush	1,223
Total	14,215

9.3.2.1 Cover data
9.3.2.2 Production data
9.3.2.3 Tree data
9.3.2.4 General description
9.3.2.5 Species list

The general descriptions of each vegetation type to be disturbed are presented in Appendix IX-1. Cover data, production data, species lists, and tree data are given, when appropriate, in Tables or text within each description.

9.3.2.6 Total Acres in Mine Plan Area

The total mine permit area includes 14,475 acres.

9.3.2.7 Total Acres of Vegetation Types to be Disturbed

Vegetation Type	Acreage	Relative % of Permit Area
Mountain Brush	13.88	4.83
Pinyon-Juniper	13.16	4.58
Pinyon-Juniper/Grass	175.42	61.05
Sagebrush-Grass	84.90	29.54
Total	287.36	100.00

9.3.2.8 Reference Area Supporting Data

Reference areas were selected for each vegetation type that has been disturbed within the permit area. Because the begetation was disturbed or removed prior to enactment of the 1977 law, baseline vegetation data cannot be collected on these areas. Consequently, the potential vegetation of these disturbed sites has been deduced from the soils, slop, aspect, and adjacent communities. Reference areas were selected based on these potential begetation types. Comparisons cannot, therefore, be made between the refercnce areas and the disturbed site original vegetation; however, the reference areas are compared to the corresponding disturbed areas within the permit area based on site charactestics (Tables IX-40 through IX-46). These reference areas (and the backup data) will serve as the standard to determine the success of reclamation.

The locations of the reference areas are illustrated on Plate IX-1. These sites were inspected and approved by Tonia Torrence, DOGM, on February 19, 1981 (Figure IX-6). As noted by Tonia Torrence, there is no way to statistically compare the plant cover and productivity of the reference areas with the disturbed sites. (This is because the disturbances are very old and no baseline vegetation data for the disturbed sites is available).

One reference area - Pinyon-Juniper/Grass - has been relocated within the Sunnyside permit area in order to allow for the expansion of Reclamation Borrow Area 1. The location of this new reference area and associated data to justify the relocation of this area will be submitted to the Division along with the additional soils data within 30 days of permit approval.

In B Canyon, the portal occurs within the Pinyon-Juniper/sage-brush vegetation type. This portal facility is within a stand that was sampled according to the methods discussed in Section 9.2. A reference area was established for this vegetation type

All of the reference areas have been permanently marked in the field (Plate IX-1). These areas will not be disturbed during the life of the mine, or at any time during the performance bond responsibility period. After revegetation is completed, the comparison reference area and the reclaimed areas will be sampled and statistically compared. The reference area will serve as the standard to determine the reclamation success.

Reclamation will be considered successful when the ground cover, and tree and shrub density within the revegetated areas are equivalent to the cover and density in the comparison reference area. This data comparison will be at the statistical levels stated in the DOGM regulations. Reclamation may also be deemed successful when the reclamation is equivalent to local and regional recommendations set for fish and wildlife land use, and when the ground cover is determined by DOGM to be adequate to control soil erosion.

9.4 Threatened and Endangered Species

None of the species on the official federal threatened and endangered plant list were found in the permit area. However, during a field search a rare plant, Hedysarum occidentale canoe, was found in a side canyon adjacent to Whitmore Canyon and in B Canyon. This species is considered a Class High Priority 2 species by the Utah Native Plant Society. This species was identified and verified by Dr. Stanley Welsh, Brigham Young University (BYU) and the voucher specimen is contained in the BYU herbarium. The location is given on the specimen there. Placement of the exact locations of threatened and endangered plants in public documents is not an appropriate procedure (USFWS 1980)(John Hubbard, personal communication 1983). The exact location of this rare plant is considered sensitive biological information since the species is not protected.

The populations will not be affected by any currently planned coal mining disturbance. The area is foraged by both wildlife and livestock. Asphalt mining activities do occur adjacent to its site. However, these other mining activities are not under the control of Kaiser Steel Corporation. Since no new surface disturbances are anticipated in B Canyon, the plants found in this area will not be disturbed.

9.5 Effects of Mining Operations on Vegetation

The Sunnyside Mines have been in operation for over eighty years. Most disturbed areas have been in existence for long

periods.

Disturbed land surfaces will be largely lost from vegetation use during the life of the mine. Disturbed ground immediately surrounding all facilities and construction sites will be revegetated during the life of the mine.

9.6 Mitigation and Management Plans

9.6.1 Mitigation

Areas adjacent to construction sites which have been disturbed during the life of the mine will be seeded during the first appropriate season. All disturbed areas will be minimized.

If feasible, the Sagebrush-grass vegetation type will be interseeded with perennial grasses found adjacent to the disturbed area. Use of specially designed seed mistures (Chapter III) should improve the range condition for wintering deer. Agropyron smithii and Agropyron spicatum are excellent spring forage species, and Bouteloua gracilis is a good forage and winter supplement. The livestock allotments should be slightly reduced to adjust for the decrease in available acreage for grazing, however, this is the responsibility of the land management agencies.

Dust control plans (Chapter III) should minimize any effect of increased dust and the potential for a reduction of the photosynthetic process.

Management of wildlife, grazing and recreation by the appropriate agencies will continue for the life of the mine. Kaiser Steel Corporation will appropriately manage revegetated areas for establishment until bond release. Any necessary management practices, including accepted or experimental techniques, may be used to assure the establishment and development of revegetated areas. At the time of bond release it will be the responsibility of the land owner or managment agency to properly implement the post-mine land uses.

Plant species used for revegetation which are adapted to the permit area soils will help mitigate vegetation losses during the period of post-mine succession. The use of species important for support of natural wildlife populations (Section 9.7) and others suitable for secondary plant succession will temper habitat losses and enhance the natural successional process.

9.7 Revegetation Methods and Justification

Areas disturbed by mining operations will be prepared for revegetation as particular sites are withdrawn from active service. Experience and site conditions may occasionally modify these methods.

Methods for revegetation at the Sunnyside Mines follow established and proven techniques for critical area stabilization (Currier 1973). The basic considerations are:

Use adapted species considering the post-mine land use

Reduce plant competition and prepare a good seedbed

Cover seed to proper depth

Provide sufficient plant nutrients

Modify moisture regimen to supply adequate water

(a) Use of Adapted Species

Lack of availability, economics and practicality makes replacement of all plant species virtually impossible. It is not realistic to expect to be able to plant climax plant communities on soils which are not in an equivalent state of development (Curry 1975).

The seed mixtures have been designed to provide a diverse, permanent and effective cover of vegetation for stabilization, range and wildlife use. Seed mixtures are included in Tables III-5 through III-9. The wildlife value of each species is contained in Table IX-46 and cultural characteristics in Table III-19.

All but two of the species included in the mixtures are natives. Non-natives include Kentucky Bluegrass (Poa pratensis) and Redtop (Agrostis alba). These species are widely naturalized in the western United States (USFS 1937) and are a common component of the present vegetation at Sunnyside. Although Poa pratensis is frequently considered an introduced species, it is comprised of apomictic races, one of which is a far ranging native of the western United States (Boivin and Love 1960). Since it is so widely naturalized and a common component of the Sunnyside flora, it is not considered by Kaiser to be an introduced species.

Although redtop is an introduced species, it is also widely naturalized. Use of introduced species is not planned at this time, except perhaps in the revegetation test plots.

The amount of seed mixture to be applied will range from 15 to 30 pounds pure live seed (PLS) per acre, depending upon aspect and method of application (Cook et al. 1974). When possible seed will be drilled otherwise it will be broadcast at double the drill rate.

(b) Reduce Plant Competition and Prepare a Good Seedbed

Areas to be seeded will be cultivated on the countour when possible by disc plowing or other means, to turn under competitive species present before seeding (Cook et al 1974). The cultivation will present the seed with a loose, friable surface, optimal for successful seeding (Vallentine 1971).

(c) Cover Seed to Proper Depth

Seed has little chance of survival in an arid climate unless covered by mineral soil (Currier 1973). Following seeding areas otherwise covered will be dragged with a section of chainlink or chain to cover the seed.

(d) Seed at Proper Time

Late fall seeding is best in the mountains and valleys of the intermountain region, where 45 to 65 percent of the precipitation comes in the winter months (Vallentine 1971, Cook et al. 1974). Seeding at the Sunnyside Mines will generally be performed in late fall, as also recommended by the SCS. However, because of the precipitation regime, grasses and forbs may also be successfully seeded in the spring.

(e) Provide Sufficient Plant Avaliable Nutrients

Most soils are enhanced for plant production by application of chemical fertilizer (EPA 1975, Vallentine 1971, Cook et al. 1974, Bauer et al. 1978). Although soil tests performed at the Utah State Soil Testing Laboratory indicated the need for an application of nitrogen and phosphorus, these recommendations are based on agronomic crops. Phosphorus is important for seed establishment (Berg 1979). The phosphorus and ammonium nitrate will be applied and disked into the soil before seeding because it does not leach into the soil. Any necessary nitrogen fertilization will be based on interpretation of the analyses in site specific teems considering species and soil materials to be seeded and the results of revegetation testing.

(f) Modify Soil Moisture Regimen to Supply Adequate Water

The Sunnyside area is characterized by hot summers, cool winters and an average annual precipitation of sixteen inches. At this site, available moisture is often deficient due to excessively high evapotranspiration rates, well-drained soils, and erratic precipitation. The lack of plentiful, dependable moisture is the principal impediment to plant establishment in this region (Cook et al. 1974).

All revegetated areas will be mulched with hay at a rate of 2 tons/acre. Tackified woodfiber at a rate of 105 pounds/acre will be applied over the hay. Mulch will decrease moisture loss, increase site stabilization, moderate soil surface temperature and reduce wind velocity at the soil surface.

(g) Transplants

Shrubs and trees shown on Table IX-12, except rabbitbrush, will be transplanted on revegetated areas to provide food and cover for wildlife. In the arid west, nursery-grown transplants provide a much higher degree of success than attempts to grow similar species from seed (Packer and Aldon, 1978). Hardened seedling stock will be utilized and will be planted during the spring or summer rainy season.

9.8 Revegetation Monitoring

Reclaimed areas not subject to future disturbance will be monitored at intervals recommended by DOGM during the bond period. Ground cover, i.e. vegetation, litter, rock and bare ground will be estimated. The sampling will be consistent and comparable across the years.

During the last two years of the responsibility period the reclaimed sites and the reference areas will be sampled to help determine revegetation success. The sampling will be comparable and statistically adequate. Parameters to be sampled include vegetation cover, productivity, and shrub density.

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9.9 Bibliography

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United States Department of Agriculture
Soil Conservation Service
350 N. 400 E.
Price, UT 84501

November 4, 1981

John Abbott
Kaiser Steel Corporation
Sunnyside, UT 84539

Dear John;

This letter confirms the findings of George Cook when he visited your Sunnyside operation on September 30, 1981. The rangeland productivity estimates by site are listed below:

Site #1 (upper portal) - Mountain brush community
800 lbs/acre air dry

Site #2 (Bear Canyon bottom) - Sagebrush/grass community
1000 lbs/acre air dry

Site #3 (cottonwood area) - Riparian community
understory production 2500 lbs/acre air dry
(willow area) - 3000 lbs/acre air dry

Site #4 - Pinyon-juniper grass community
understory - 300 lbs/acre air dry
Pinyon/juniper - 400 lbs/acre

Site #5 - (Fan Canyon) - Pinyon-juniper /Rock community
understory - 200 lbs/acre

If we can be of further assistance, please contact us in Price.

Sincerely,

Gary D. Moreau

Gary D. Moreau
District Conservationist
Price/Castle Dale Field Office

GDM/lhb

Figure IX-1, Rangeland Productivity Estimations

KAISER STEEL CORPORATION
SUNNYSIDE COAL MINES
SUNNYSIDE, UTAH 84539
TELEPHONE 801-888-4421

November 21, 1980

Mary Ann Wright
Reclamation Biologist
Division of Oil, Gas & Mining
1588 West North Temple
Salt Lake City, Utah 84116

Dear Ms. Wright:

This letter is a formal request for a determination from the Division of the adjacent areas which may be required for a vegetation survey concerning the proposed underground mine on the "South Lease" owned by Kaiser Steel Corporation.

Enclosed for your study are two maps of the area. Exhibit I illustrates the entire mine plan area (green and purple lines) and proposed right of ways (blue, orange and yellow lines). Exhibit II shows a close-up of the general area of typical surface disturbances.

If you have any questions, please feel free to call me at York Canyon - 505-445-5531, extension 274. My mailing address is P. O. Box 1107, Raton, New Mexico 87740.

Thank you for your assistance.

Sincerely,

KAISER STEEL CORPORATION

Marcia J. Wolfe
Reclamation Engineer

MJW:dm

Enclosures - 2

Figure IX - 2 Request for determination of adjacent areas

United States Department of Agriculture
Soil Conservation Service
350 North 4th East
Price, Utah 84501

August 8, 1983

Marcia H. Wolfe
Reclamation Engineer
Kaiser Coal Properties
P. O. Box 1107
Raton, New Mexico 87740

Dear Marcia:

I went to East Carbon and checked the condition of the sites that were listed in the letter dated November 4, 1981, from Gary.

Sites #1, 2, and 3 are in fair condition. Sites #4 and 5 are in good condition.

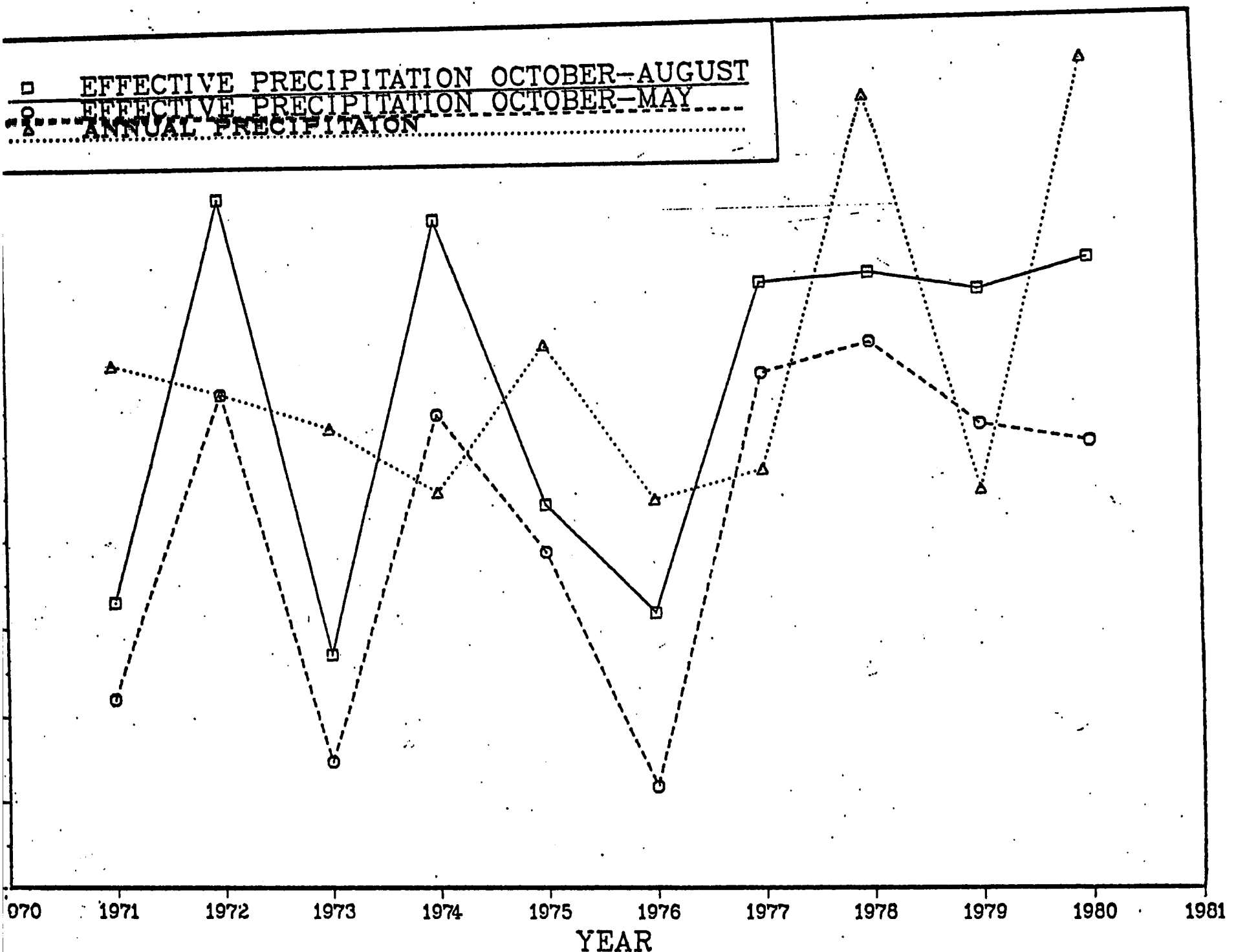
The potential soil productivities are still not available. We will get the draft copy of the information sometime this fall. When it comes, I will send it to you.

George S. Cook

George S. Cook
Range Conservationist

Figure IX-3
Range conditions at time of SCS productivity estimations.

FIGURE IX-4. EFFECTIVE 10 YEAR SUNNYSIDE PRECIPITATION



KAISER STEEL
KAISER STEEL CORPORATION
WESTERN COAL OPERATIONS
SUNNYSIDE, UTAH 84539
TELEPHONE 801-888-4421

13 July 1981

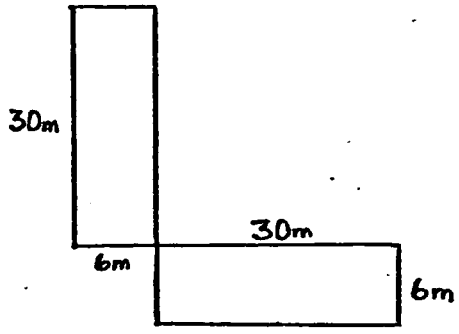
Ms. Mary Ann Wright
Dept. of Natural Resources
Division of Oil, Gas and Mining
1588 West North Temple
Salt Lake City, UT 84116

Dear Mary Ann:

I am writing to confirm our conversation in your office on Wednesday, June 10, 1981. The vegetation sampling plan we agreed upon for Kaiser's Sunnyside and South Lease permits is described in the following:

Type: Pinyon-Juniper

Modified Lindsey's Elbow



Parameters Collected:

1. Herbaceous cover in 1% increments from 40 randomly located 20 x 50 cm quadrats.
2. Shrub cover from two (2) 30 meter line intercepts.
3. Tree cover from two (2) 30 meter line Intercepts.
4. Tree basal diameter for each tree in the elbow.
5. Tree density from no. 4.
6. Frequency (generated from cover data).
7. Species list

Figure IX - 5
Confirmation of DOGM approval of vegetation survey methods.

Type: Shrub and Grass Communities

Line transects with randomly located quadrats.

Parameters collected:
1. Herbaceous cover in 1% increments from 20 randomly located quadrats along a 50 meter line.
2. Frequency generated from cover data.
3. Species list.

Type: Grass dominated communities (cover less than 30% shrubs or trees).

Line transects with randomly located quadrats.

Parameters collected:
1. Herbaceous cover in 1% increments from 20 randomly located quadrats along a 50 meter line.
2. Frequency generated from cover data.
3. Species list.
4. Production will be double sampled (1 quadrat clipped to 5 quadrats estimated).

Type: Riparian areas

Line transects with randomly located quadrats.

Parameters collected:
1. Herbaceous cover in 1% increments from 20 randomly located quadrats along a 10 meter line.
2. Frequency generated from cover data
3. Shrub cover from 10m line intercept.
4. Species list.

Sample Adequacy as per cook and Bonham (1977) formulat

$$\frac{(\text{t-value})^2 (2) (s^2)}{\left[(\%\text{change})(\bar{x})\right]^2} = n_{min}$$

with the t-value being two tailed and the % change in accord with the Regulations Pertaining to Surface Effects of Underground Coal Mining Activities.

Figure IX-5 Cont.

These methods cover the types of vegetation present in the disturbed areas of the Sunnyside Mine and the potential disturbed area of the South Lease.

Thanks for your help and clarification.

Yours truly,

John P. Abbott

John Abbott
Range Scientist

JA:sp

Figure IX-5 Cont.

April 16, 1981

Memo to Coal File:

RE: Sunnyside Complex
Kaiser Steel Corporation
ACT/007/007
Carbon County, Utah

On February 19, 1981, Tonia Torrence accompanied Sandy Pruitt and Tom Portle, inspectors for DOGM to the Sunnyside Mine. Tom and Sandy conducted an inspection; see Kaiser memo dated March 3, 1981.

Tonia Torrence was accompanied by Marcia Wolfe the environmental engineer for Kaiser Steel Corporation on a tour of proposed reference areas for the permit area. All reference areas seemed to be valid representations of disturbed areas. As the area is already disturbed, there is no way to verify the similarities between areas statistically.

TONIA TORRENCE
RECLAMATION BIOLOGIST

TT/btb

Statistics:

See Blazon memo dated March 2, 1981.

Figure IX-6
Approval of reference area

STATE OF UTAH
NATURAL RESOURCES
Oil, Gas & Mining

Scott M. Matheson, Governor
Temple A. Reynolds, Executive Director
Dianne R. Nielson, Ph.D., Division Director

424 [redacted]ate Office Building • Salt Lake City, UT 84114 • 801-533-5771

August 20, 1984

Ms. Marcia H. Wolfe
Reclamation Engineer
Kaiser Steel Corporation
P. O. Box 1107
Raton, New Mexico 87740

Dear Ms. Wolfe:

RE: Approval Given for the B Canyon Reference Area, Kaiser Steel Corporation, Sunnyside Mines, ACT/007/007, #2, Carbon County, Utah

Approval is given for the establishment and use of the reference area immediately adjacent to the existing ventilation portal in B Canyon. The reference area was observed during my site visit of August 17, 1984.

The reference area is located in a sagebrush-grass vegetation community type and will be used to evaluate revegetation success when the ventilation portal is reclaimed. It should be permanently marked and a map submitted showing its location in relation to the portal area.

If you have any questions, please contact me.

Sincerely,

Steve Cox
Reclamation Biologist

SC/btb
cc: Allen Klein, OSM
Lou Hamm, OSM
Mary Boucek, DOGM
Bart Kale, DOGM
89740-12

Figure IX - 7 - Approval of B Canyon Reference Area by DOGM

United States Department of Agriculture
Soil Conservation Service
350 North 4th East
Price, Utah 84501

September 10, 1984

Marcia H. Wolfe
Reclamation Engineer & Ecologist
Kaiser Steel Corporation
Raton Coal Properties
P. O. Box 1107
Raton, New Mexico 87740

Dear Marcia:

The site we looked at above the old portal in "C" Canyon was Pinyon-Juniper sagebrush, Mormon Tea site. The site is in excellent condition. The production is about 800 lbs. per acre.

George S. Cook

George S. Cook
Range Conservationist

Figure IX - 8 - Rangeland Productivity and Condition for B Canyon Site.

Table IX-1. Sampling intensities for measured vegetation parameters. Sunnyside Mines, Utah. August through September 1981.

Vegetation Type	Parameter	$n_{sampled}$	$n_{minimum}$
Mountain Brush	Cover quadrats	220	202
	Point-lines	12	9
	Shrub density	20	13
	Line intercept	13	12
Pinyon-Juniper	Cover quadrats	240	914
	Point-lines	26	26
	Shrub density	30	28
	Line intercept	20	19
	Tree density	22	19
Pinyon-Juniper/Grass	Cover quadrats	360	168
	Point-lines	28	19
	Shrub density	19	222
	Line intercept	19	19
	Tree density	17	11
Pinyon-Juniper/Sagebrush	Cover quadrats	13	13
	Point-lines	11	10
	Shrub density	10	9
	Tree density	10	8
	Line intercept	21	16
Riparian	Point-lines	10	1
	Shrub density	7	5
Sagebrush-Grass	Cover quadrats	120	100
	Point-lines	6	1
	Shrub density	15	10
	Line intercept	14	8

Table IX-2. Shrub stem density by species. Mountain Brush vegetation type. Sunnyside Mines, Utah. August 1981.

Species	Common Name	Stem Density per acre	Stem Density per hectare
Amelanchier alnifolia	Serviceberry	265	654
Artemisia tridentata	Big sagebrush	35	86
Cercocarpus montanus	True mountain mahogany	520	1284
Chrysothamnus nauseosus	Rubber rabbitbrush	20	49
Pachistima myrsinites	Box leaf	40	99
Philadelphus microphyllus	Mock orange	50	123
Rosa woodsii	Woods rose	20	49
Symphoricarpus spp.	Snowberry	50	123
Symphoricarpus vaccinoides	Snowberry	40	99
Tetradymia canescens	Gray horsebrush	5	12
Xanthocephlum sarothrae	Broom snakeweed	35	86
Total		1080	2664

Table IX-3. Shrub cover by species from a 50 m line-intercept. Mountain Brush vegetation type. Sunnyside Mines, Utah. August 1981.

Species	Common Name	Cover (%)
Amelanchier alnifolia	Serviceberry	13.90
Artemisia tridentata	Big sagebrush	.10
Cercocarpus montanus	True mountain mahogany	11.20
Chysothamnus depressus	Dwarf rabbitbrush	.001
Chysothamnus nauseosus	Rubber rabbitbrush	.11
Philadelphus microphyllus	Mock orange	.23
Rhus trilobata	Skunkbush sumac	.02
Rosa woodsii	Woods rose	.02
Xanthocephalum sarothrae	Broom snakeweed	.20
Total Shrub Cover		25.60

Table IX-4. Vegetation cover from 0.10 m^2 quadrats. Mountain Brush vegetation type. Sunnyside Mines, Utah. August 1981.

Parameter	Cover (%)	Relative Vegetation Cover (%)
Forb	1.9	19
Grass	6.7	68
Shrub	1.3	13
Vegetation Cover	9.90	
Bare ground	38.6	
Litter	19.6	
Rock	31.9	
Total	100.0	100

TABLE IX-5. PERCENT COVER AND CONSTANCY BY SPECIES

FOR MOUNTAIN BRUSH VEGETATION TYPE.

SUNNYSIDE MINES, UTAH. JULY-AUGUST, 1981.

STAND NUMBER	1	2	3	4	5	6	7	8	9	10	11	CONSTANC
GRID NUMBER	13	13	13	13	13	13	13	13	13	13	13	
ELEVATION IN FEET	7350	7300	7325	7300	7350	7300	7375	7400	7400	7325	7425	
ASPECT	E	E	E	E	NE	NE	NE	E	E	E	E	
SLOPE IN PERCENT	44	62	62	44	54	55	64	48	49	60	58	
SOIL MAPPING UNIT	PSH	PSH	PSH	PSH	PSH	PSH	PSH	PSH	PSH	PSH	PSH	
GRASSES:												
Elymus salina	4.3	10.0	5.2	2.1	1.6	1.5	2.0	7.4	9.3	7.9	18.4	100
Koeleria cristata	•	•	•	0.3	0.3	0.1	0.5	•	•	•	•	36
Poa pratensis	•	•	•	0.7	•	0.4	•	•	•	•	•	18
Unknown grass	•	•	•	•	0.2	2.1	•	•	•	•	•	18
FORBS:												
Artemisia ludoviciana	•	•	•	.75	.2	•	1.2	•	•	•	•	27
Aster spp.	•	•	•	•	•	1.5	.1	•	•	•	0.4	27
Astragalus tenellus	•	•	1.4	1.1	0.2	1.0	•	•	•	•	•	36
Balsamorhiza sagittata	•	•	•	•	•	•	0.8	•	•	•	•	9
Castilleja flava	•	•	•	.1	•	•	•	•	•	•	•	9
Cirsium sp.	•	•	•	•	•	0.1	•	•	•	•	•	9
Collardia spathulata	•	•	•	•	+	•	•	•	•	•	•	9
Gilia aggregata	•	•	•	•	•	+	•	•	•	•	•	9
Hedysarum boreale	•	•	0.1	1.0	•	0.3	•	0.1	0.1	•	1.5	55
Hymenoxys richardsonii	•	•	0.8	+	0.5	0.2	0.2	•	0.4	0.2	•	64
Machaeranthera grindelioides	+	0.3	0.6	.9	+	•	0.1	+	0.3	0.6	•	82
Physaria acutifolia	•	0.1	0.5	0.3	•	0.4	•	+	0.2	0.4	+	73
Senecio sp.	•	•	•	•	0.2	•	•	•	•	•	•	9
Solidago sparsifolia	•	•	0.4	•	0.4	0.2	•	•	•	•	•	27
Stipa comata	•	•	+	•	0.1	•	•	•	•	•	•	18
Tragopogon dubius	•	•	•	•	•	0.1	•	•	•	•	•	9
Vicia americana	•	•	•	0.3	0.3	•	0.3	0.1	•	0.2	•	45
Unknown forb	•	•	•	•	•	•	•	•	•	•	•	18
SHRUBS:												
Amelanchier alnifolia	•	•	0.3	•	•	•	•	•	•	0.1	•	9
Artemisia tridentata	•	•	•	•	•	•	0.1	•	•	•	•	36
Cercocarpus montanus	•	0.1	0.2	•	•	•	•	•	0.4	+	•	27
Chrysothamnus depressus	•	0.9	•	•	•	0.5	•	•	0.6	•	•	9
C. nauseosus	•	•	•	•	•	•	+	•	•	•	•	18
Mahonia repens	•	•	•	•	•	1.1	•	•	0.1	•	•	9
Pachystima myrsinites	•	•	•	•	•	1.8	•	•	•	•	•	27
Tetradymia canescens	•	0.3	•	•	•	1.6	•	•	0.1	•	•	9
Xanthocephlum sarothrae	•	•	•	0.3	•	•	•	•	•	•	•	

Table IX-6. Vegetation cover from 30 m point-line transect. Mountain Brush vegetation type. Sunnyside Mines, Utah. August 1981.

Parameter	Cover (%)	Relative Vegetation Cover (%)
Forb	1.2	3
Grass	11.7	25
Shrub	33.3	72
Vegetation Cover	46.2	
Bare ground	19.6	
Litter	19.0	
Rock	15.2	
Total	100.0	100

Table IX-7. Comprehensive species list for the Mountain Brush vegetation type. Sunnyside Mines, Utah. June through September 1981.

Scientific Name	Abbreviation	Common Name
Forbs		
Achillea millefolium	ACMI	Western yarrow
Artemisia ludoviciana	ARLU	Louisiana sagebrush
Aster spp.	ASTER	Aster
Astragalus spp.	ASTRA	Milkvetch
Astragalus tenellus	ASTE	Looseflower milkvetch
Balsamorhiza sagittata	BASA	Arrowleaf balsamroot
Castilleja chromosa	CACH	Desert Indian paintbrush
Castilleja flava	CAFL	Yellow Indian paintbrush
Caulanthus crassicalis	CACR	Thickstem wildcabbage
Cirsium spp.	CIRSI	Thistle
Eriogonum spp.	ERIOG	Wild buckwheat
Gaillardia spathulata	GASP	Blanket flower
Gilia aggregata	GIAG	Skyrocket gilia
Hedysarum boreale	HEBO	Northern sweetvetch
Hedysarum occidentale canone	HEOCC	Western sweetvetch
Hymenoxys richardsonii	HYRI	Pinque hymenoxys
Leucelene ericoides	LEER	Heath aster
Lupinus concinnus	LUCO	Bajada lupine
Machaeranthera grindelioides	MAGR	Aster (var.)
Opuntia spp.	OPUNT	Pricklypear
Penstemon comarrhenus	PECO	Dusty penstemon
Penstemon watsonii	PEWA	Watson penstemon
Physaria acutifolia	PHAC	Common twinpod
Senecio multilobatus	SEMU	Lobeleaf groundsel
Senecio spp.	SENEC	Groundsel
Solidago sparsiflora	SOSP	Goldenrod
Tragopogon dubius	TRDU	Yellow salsify

Table IX-7 Cont.

Scientific Name	Abbreviation	Common Name
Grasses		
Agropyron spicatum	AGSP	Bluebunch wheatgrass
Bouteloua gracilis	BOGR	Blue grama
Elymus salina	ELSA	Salina wildrye
Koeleria cristata	KOCR	Prairie junegrass
Oryzopsis hymenoides	ORHY	Indian ricegrass
Phleum pratense	PHPR	Timothy
Poa pratensis	POPR	Kentucky bluegrass
Grasslike		
Carex spp.	CAREX	Sedge
Shrubs		
Amelanchier alnifolia	AMAL	Serviceberry (var.)
Amelanchier utahensis	AMUT	Utah serviceberry
Artemisia tridentata	ARTR	Big sagebrush
Cercocarpus ledifolius	CELE	Curlleaf mountain mahogany
Cercocarpus montanus	CEMO	Mountain mahogany
Chrysothamnus depressus	CHDE	Dwarf rabbitbrush
Chrysothamnus nauseosus	CHNA	Rubber rabbitbrush
Chrysothamnus vaseyi	CHVA	Vasey rabbitbrush
Chrysothamnus viscidiflorus	CHVI	Low rabbitbrush
Holodiscus microphyllus	HOMI	Ocean-spray
Mahonia repens	MARE	Creeping barberry
Pachistima myrsinites	PAMY	Myrtle pachistima
Philadelphus microphyllus	PHMI	Littleleaf mockorange
Potentilla fruticosa	POFR	Shrubby cinquefoil
Rhus trilobata	RHTR	Skunkbush sumac
Rosa woodsii	ROWO	Woods rose
Symphoricarpos vaccinioides	SYVA	Snowberry

Table IX-7 Cont.

Scientific Name	Abbreviation	Common Name
Shrubs		
Tetradymia canescens	TECA	Grey horsebrush
Xanthocerphalum sarothrae	XASA	Broom snakeweed
Trees		
Juniperus communis	JUCO	Common juniper
Populus tremuloides	POTR	Quaking aspen
Pseudotsuga menziesii	PSME	Douglas fir

Table IX-8. Tree and shrub cover from 30 m line-intercept transects. Pinyon-Juniper vegetation type. Sunnyside Mines, Utah. August 1981.

Species	Common Name	Cover (%)
Cercocarpus ledifolius	Curlleaf mountain mahogany	0.90
Cercocarpus montanus	True mountain mahogany	3.40
Chrysothamnus nauseosus	Rubber rabbitbrush	.03
Coxania mexicana	Stansbury cliffrose	1.00
Ephedra viridis	Green Mormon tea	.50
Juniper osteosperma	Utah juniper	13.00
Pinus edulis	Pinyon Pine	15.00
Total		33.83

Table IX-9. Tree density by species. Pinyon-Juniper vegetation type. Sunnyside Mines, Utah. August 1981.

Species	Common Name	Stem Density	
		per acre	per hectare
Juniperus osteosperma	Utah juniper	125	309
Pinus edulis	Pinyon pine	132	325
Total		257	634

Table IX-10. Tree basal areas by species. Pinyon-Juniper vegetation type. Sunnyside Mines, Utah. August 1981.

Species	Common Name	Basal Area ft^2/A	Basal Area m^2/ha
Juniperus osteosperma	Utah juniper	61	14
Pinus edulis	Pinyon pine	29	7
Total		90	21

TABLE II-11. PERCENT COVER AND CONSTANCY BY SPECIES

FOR PINYON-JUNIPER VEGETATION TYPE.

SUNNYSIDE MINES, UTAH. JULY-AUGUST, 1981.

STAND NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	CONSTANCY
GRID NUMBER	14	14	14	14	14	14	14	14	14	14	14	14	
ELEVATION IN FEET	7225	7250	7380	7400	7380	7225	7200	7240	7280	7360	7380	7400	
ASPECT	E	E	E	E	E	E	E	E	E	E	E	E	
SLOPE IN PERCENT	61	61	61	61	41	41	41	41	41	52	71	71	
SOIL MAPPING UNIT	RWG	RWG	RWG	RWG	RWG	RWG	RWG	RWG	RWG	RWG	RWG	RWG	
GRASSES:													
Agropyron sp.	•	•	•	•	•	•	0.1	•	•	•	•	•	8
Bromus tectorum	•	•	•	•	•	•	+	•	•	•	•	•	8
Elymus salina	•	•	•	•	•	•	•	•	•	•	•	•	17
Oryzopsis hymenoides	0.7	0.4	1.4	9.5	0.8	•	0.2	•	0.2	0.2	0.2	0.4	83
Poa sp.	•	0.2	0.3	•	•	•	0.4	+	•	•	•	•	33
Unknown grass	0.1	•	0.2	0.1	•	•	•	•	•	•	•	•	25
FORBS:													
Aster sp.	•	•	•	•	•	•	•	•	0.2	•	•	•	8
Brassicaceae spp.	0.2	+	0.2	+	•	0.1	•	•	•	•	+	•	50
Conringa orientalis	•	•	•	•	•	0.1	•	0.1	•	•	•	•	17
Cryptantha spp.	+	0.2	0.3	0.1	•	0.1	•	•	•	•	•	•	50
Hedysarum boreale	2.9	0.3	0.8	0.1	•	•	•	•	•	•	•	•	33
Lesquerella ericoides	•	•	•	•	•	•	•	•	•	0.2	•	•	8
Malva neglecta	•	•	•	0.1	•	•	•	•	•	•	•	•	8
Opuntia sp.	•	•	•	•	•	•	1.6	•	•	0.6	•	0.2	25
Penstemon subglaber	•	0.8	•	•	•	•	•	•	•	•	•	•	8
Physaria acutifolia	•	•	0.1	0.1	0.1	+	+	•	0.1	0.4	0.1	•	67
Senecio multilobatus	•	•	0.1	•	•	•	•	•	•	•	•	+	17
Vicia americana	•	+	•	•	•	•	•	•	•	•	•	•	8
Unknown forb	+	•	•	•	•	•	0.1	0.1	•	•	•	•	25
SHRUBS:													
Ceratocarpus ledifolius	•	•	•	+	•	•	•	•	•	•	0.5	•	17
C. montanus	•	•	•	•	+	•	•	•	•	+	•	+	25
Chrysothamnus nauseosus	•	•	•	•	•	0.1	•	•	•	•	•	•	8
Coleogyne ramosissima	•	•	•	•	+	•	•	•	+	•	•	•	17
Ephedra viridis	•	•	•	•	0.1	•	•	•	•	•	•	•	8
TREES:													
Juniperus osteosperma	•	+	•	•	•	•	•	•	•	•	•	•	8
Pinus edulis	0.2	•	•	•	•	•	•	•	•	•	•	0.3	17

Table IX-12. Comprehensive species list for Pinyon-Juniper vegetation type. Sunnyside Mines, Utah. June through September 1981.

Scientific Name	Abbreviation	Common Name
Forbs		
Aster spp.	ASTER	Aster
Brassica spp.	BRASS	Mustard
Conringia orientalis	COOR	Treacle haresear
Cryptantha mensana	CRME	Cryptantha (var.)
Cryptantha spp.	CRYPT	Cryptantha
Hedysarum boreale	HEBO	Northern sweetvetch
Leucelene ericoides	LEER	Heath aster
Malva spp.	MALVA	Mallow
Opuntia spp.	OPUNT	Pricklypear
Penstemon spp.	PENST	Beardstongue
Physaria acutifolia	PHAC	Common twinpod
Senecio multilobatus	SEMU	Lobeleaf groundsel
Vicia americana	VIAM	American vetch
Grasses		
Agropyron spp.	AGROP	Wheatgrass
Bromus tectorum	BRTE	Cheatgrass brome
Elymus salina	ELSA	Salina wildrye
Oryzopsis hymenoides	ORHY	Indian ricegrass
Poa spp.	POA	Bluegrass
Sitanion hystrix	SIHY	Bottlebrush squirreltail
Shrubs		
Amelanchier spp.	AMELA	Serviceberry
Artemisia nova	ARNO	Black sagebrush
Cercocarpus ledifolius	CELE	Curlleaf mountain mahogany
Chrysothamnus nauseosus	CHNA	Rubber rabbitbrush
Coleania mexicana	COMES	Stansbury cliffrose

Table IX-12 Cont.

Scientific Name	Abbreviation	Common Name
Shrubs		
Ephedra torreyana	EPTO	Torrey ephedra
Xanthocephalum sarothrae	XASA	Broom snakeweed
Trees		
Juniperus osteosperma	JUOS	Utah juniper
Juniperus scopulorum	JUSC	Rocky Mountain juniper
Pinus edulis	PIED	Pinyon pine

Table IX-13. Shrub stem density by species. Pinyon-Juniper vegetation type. Sunnyside Mines, Utah. August 1981.

Species	Common Name	Stem Density per acre	Stem Density per hectare
Amelanchier alnifolia	Saskatoon serviceberry	2	5
Artemisia nova	Black sage	2	5
Cercocarpus ledifolius	Curlleaf mountain mahogany	59	145
Cercocarpus montanus	True mountain mahogany	78	193
Chrysothamnus nauseosus	Rubber rabbitbrush	32	78
Cowania mexicana	Stansbury cliffrose	84	207
Ephedra viridis	Green ephedra	57	142
Xanthocephalum sarothrae	Broom snakeweed	19	47
Total		333	822

Table IX-14. Vegetation cover by life form from 0.25 m^2 quadrats. Pinyon-Juniper vegetation type. Sunnyside Mines, Utah. August 1981.

Parameter	Cover (%)	Relative Vegetation Cover (%)
Cryptogam	0.12	7.5
Forb	0.79	49
Grass	0.54	34
Shrub	0.04	2
Tree	0.12	7.5
Vegetation Total	1.61	
Bare ground	48.55	
Litter	14.05	
Rock	31.96	
Total	100.17	100.0

Table IX-15. Vegetation cover by life form from 30 m point-line transects. Pinyon-Juniper vegetation type. Sunnyside Mines, Utah. August 1981.

Parameter	Absolute Cover (%)	Relative Vegetation Cover (%)
Forb	0.6	2
Grass	0.4	1
Shrub	5.5	19
Tree	22.2	78
Vegetation Total	28.7	
Bare ground	12.3	
Litter	19.6	
Rock	39.4	
Total	100.0	100

Table IX-16. Vegetation cover by species from 30 m line-intercept transects. Pinyon-Juniper/Grass vegetation type. Sunnyside Mines, Utah. August 1981.

Species	Common Name	Total Cover (%)
Shrubs:		
Cercocarpus montanus	True mountain mahogany	.59
Trees:		
Juniperus osteosperma	Utah juniper	17.93
Pinus edulis	Pinyon pine	13.47
Total		31.99

Table IX-17. Shrub stem and tree density by species. Pinyon-Juniper/Grass vegetation type. Sunnyside Mines, Utah. August 1981.

Species	Common Name	Stem Density per acre	Stem Density per hectare
Shrub:			
Artemisia nova	Black sagebrush	20	50
Cercocarpus montanus	True mountain mahogany	520	1300
Chrysothamnus nauseosus	Rubber rabbitbrush	61	150
Xanthocephalum sarothrae	Broom snakeweed	951	2350
Shrub Total		1558	3850
Tree:			
Juniperus osteosperma	Utah juniper	149	368
Pinus edulis	Pinyon pine	102	253
Tree Total		241	621

Table IX-18. Tree basal area by species. Pinyon-Juniper/Grass vegetation type. Sunnyside Mines, Utah. August 1981.

Species	Common Name	Basal Area ft^2/A	Basal Area m^2/ha
Juniperus osteosperma	Utah juniper	6325	1451
Pinus edulis	Pinyon pine	2423	556
Total		8748	2007

Table IX-19. Tree seedling density by species. Pinyon-Juniper/Grass vegetation type. Sunnyside Mines, Utah. August 1981.

Species	Common Name	Seedling Density per acre	Seedling Density per hectare
Juniperus osteosperma	Utah juniper	107	265
Pinus edulis	Pinyon pine	210	519
Total		317	784

Table IX-20. Vegetation cover from 0.25 m^2 quadrats. Pinyon-Juniper/Grass vegetation type. Sunnyside Mines, Utah. August 1981.

Parameter	Cover (%)	Relative Vegetation Cover (%)
Forb	4.77	53.72
Grass	3.73	42.00
Shrub	0.0*	0.0
Tree	.39*	4.28
Vegetation Cover	8.89	
Bare ground	24.60	
Litter	55.04	
Rock	20.54	
Total	100.00	100.00

* Only individuals <12 inches in height (33 cm) are included in herbaceous data.

TABLE II-21. PERCENT COVER AND CONSTANCY BY SPECIES FOR PINYON-JUNIPER/GRASS VEGETATION TYPE. SUNNYSIDE MINES, UTAH. JULY-AUGUST, 1981.

STAND NUMBER	1	2	3	4	5	6	7	8	9	10
GRID NUMBER	19	19	19	19	19	19	19	19	19	19
ELEVATION IN FEET	6380	6390	6400	6380	6390	6380	6360	6390	6400	6400
ASPECT	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
SLOPE IN PERCENT	1	1	1	1	1	1	1	1	1	1
SOIL MAPPING UNIT	IEE	IEE	IEE	IEE	IEE	IEE	IEE	IEE	IEE	IEE
GRASSES:										
Agropyron smithii	•	•	•	•	•	•	•	+	•	•
Aristida spp.	0.4	+	•	0.2	•	•	•	+	4.2	•
A. wrightii	•	•	•	•	•	•	•	•	•	0.1
Bromus tectorum	•	•	0.1	•	•	•	•	•	+	•
Oryzopsis hymenoides	9.6	2.4	5.9	4.7	6.4	2.1	2.4	4.6	1.1	2.0
Sitanion hystrix	0.2	•	0.3	+	0.2	•	+	•	•	0.1
Stipa comata	•	•	•	0.2	•	•	•	•	•	•
Unknown grass	•	•	•	•	•	•	•	•	•	•
FORBS:										
Brassicaceae spp.	0.1	0.2	0.5	•	0.1	•	+	•	•	•
Caulanthus crassicaulis	0.3	•	•	•	0.1	0.2	0.2	0.2	0.2	0.1
Chenopodium album	•	•	0.1	+	•	•	•	+	•	+
Cryptantha spp.	0.7	0.1	1.4	0.2	0.2	0.2	0.3	0.1	0.9	0.6
Eriogonum spp.	0.3	0.2	0.1	+	•	+	0.1	0.1	0.4	0.1
Euphorbia fendleri	0.4	0.1	0.1	•	•	•	0.1	+	0.3	+
Hedysarum boreale	•	•	•	•	•	0.3	•	•	•	•
Hymenoxys richardsonii	0.5	•	0.8	0.3	0.1	0.3	0.2	0.1	0.2	0.1
Opuntia sp.	•	0.5	1.5	•	•	•	0.3	•	0.4	•
[illegible] *subglaber*	2.6	1.0	2.4	1.0	2.4	2.1	3.3	1.7	4.0	2.7
[illegible] *nemoraiana*	•	•	•	+	•	•	•	•	•	•
[illegible] *acutifolia*	•	•	•	•	•	•	•	•	0.6	•
Senecio multilobatus	0.7	1.0	1.0	0.4	0.7	0.7	1.8	0.7	1.0	0.8
Townsendia incana	0.3	0.1	0.3	0.1	0.1	0.3	0.1	1.1	0.1	0.2
Xanthocephalum sarothrae	•	•	•	•	•	•	•	•	0.1	•
Unknown forb	•	+	•	•	+	+	•	•	•	•
TREES:										
Pinus edulis	•	•	•	•	•	0.1	0.4	•	0.3	•
Juniper osteosperma	•	•	•	0.4	0.3	+	1.4	•	•	•
Cryptogam	0.5	0.1	•	•	•	0.2	•	•	•	0.3

TABLE II-21 (CONT.)

STAND NUMBER	11	12	13	14	15	16	17	18	CONSTANCY
GRID NUMBER	19	19	19	19	19	19	19	19	
[illegible] IN FEET	6380	6380	6380	6380	6360	6360	6400	6490	
ASPECT	SW	SW	SW	SW	SW	SW	SW	SW	
SLOPE IN PERCENT	1	1	1	1	1	1	1	1	
SOIL MAPPING UNIT	IEE	IEE	IEE	IEE	IEE	IEE	IEE	IEE	
GRASSES:									
Agropyron smithii	•	0.1	•	•	•	+	•	•	17
Aristida spp.	•	+	•	•	0.3	+	•	•	44
A. wrightii	•	•	•	+	•	0.2	•	•	17
Bromus tectorum	•	•	•	•	•	•	•	•	11
Oryzopsis hymenoides	2.2	2.0	4.7	3.6	0.8	0.7	2.3	2.2	100
Sitanion hystrix	0.1	•	0.1	•	0.1	+	0.4	•	61
Stipa comata	•	•	•	•	•	•	•	•	6
Unknown grass	+	•	•	•	•	•	+	•	11
FORBS:									
Brassicaceae spp.	•	•	0.1	•	0.1	•	•	•	39
Caulanthus crassicaulis	0.2	+	0.1	0.1	0.1	0.2	•	0.1	78
Chenopodium album	•	+	•	•	•	•	0.1	•	33
Cryptantha spp.	1.2	0.6	0.6	0.3	0.9	0.6	0.7	0.8	100
Eriogonum spp.	•	0.3	0.1	0.1	0.1	0.1	0.1	•	83
Euphorbia fendleri	0.1	+	+	0.2	0.1	•	+	+	78
Hedysarum boreale	•	•	•	•	•	•	•	•	6
Hymenoxys richardsonii	•	0.5	+	•	•	•	•	•	61
Opuntia sp.	0.6	0.1	0.2	+	•	•	•	0.5	50
Penstemon subglaber	4.1	1.9	2.5	0.8	3.4	1.2	2.6	2.9	100
Phacelia nemoralis	•	0.1	•	•	0.1	0.1	•	0.6	28
Physaria acutifolia	•	•	•	•	•	•	•	•	6
Senecio multilobatus	0.9	0.3	0.9	0.3	1.1	0.3	1.3	0.9	100
[illegible]*endia inoana*	0.2	•	0.5	0.1	+	+	•	•	83
[illegible]*cephalum sarothrae*	•	•	•	•	•	•	•	•	6
Unknown forb	•	•	0.1	•	+	+	+	•	39
TREES:									
Pinus edulis	0.5	+	1.0	0.3	0.1	•	1.0	•	50
Juniper osteosperma	0.3	0.1	•	0.1	•	•	+	•	44
Cryptogam	•	+	•	+	•	+	•	•	39

Table IX-22. Comprehensive species list for the Pinyon-Juniper/Grass vegetation type. Sunnyside Mines, Utah. June through September 1981.

Scientific Name	Abbreviation	Common Name
Forbs		
Astragalus mollissimus	ASMO	Woolly milkvetch
Astragalus spp.	ASTRA	Milkvetch
Caulanthus crassicalis	CACR	Thickstem wildcabbage
Chorispora tenella	CHTE	Blue mustard
Cryptantha fulvocanescens	CRFU	Beggarlice hiddenflower
Cryptantha spp.	CRYPT	Cryptantha
Erigeron pumilus	ERPU	Low fleabane
Erysimum asperum	ERAS	Plains erysimum
Euphorbia fendleri	EUFE	Fendler euphorbia
Gilia aggregata	GIAG	Skyrocket gilia
Haplopappus armerioides	HAAR	Thrifty goldenweed
Hedysarum boreale	HEBO	Northern sweetvetch
Hymenoxys acaulis	HYAC	Stemless hymenoxys
Hymenoxys richardsonii	HYRI	Pinque hymenoxys
Lappula echinata	LAEC	European stickseed
Lathyrus lanzwertii	LALA	Thickleaf peavine
Lepidium montanum	LEMO	Mountain pepperweed
Leptodactylon pungens	LEPU	Prickly phlox
Lesquerella intermedia	LEIN	Bladderpod (var.)
Lesquerella ludoviciana	LELU	Silver bladderpod
Lygodesmia spp.	LYGOD	Skeletonweed
Machaeranthera grindelioides	MAGR	Aster (var.)
Opuntia spp.	OPUNT	Pricklypear
Penstemon spp.	PENST	Beardtongue
Penstemon subglaber	PESU	Penstemon (var.)
Physaria australis	PHAU	Twinpod (var.)
Physaria spp.	PHYSA	Twinpod

Table IX-22 Cont.

Scientific Name	Abbreviation	Common Name
Forbs		
Senecio multilobatus	SEMU	Lobeleaf groundsel
Sisymbrium altissimum	SIAL	Tumblemustard
Stanleya viridiflora	STVI	Princesplume
Tragopogon dubius	TRDU	Yellow salsify
Grasses		
Aristida spp.	ARIST	Three-awn
Aristida wrightii	ARWR	Wright three-awn
Bromus tectorum	BRTE	Cheatgrass brome
Elymus salina	ELSA	Salina wildrye
Oryzopsis hymenoides	ORHY	Indian ricegrass
Sitanion hystrix	SIHY	Bottlebrush squirreltail
Stipa comata	STCO	Needle-and-thread
Shrubs		
Cercocarpus montanus	CEMO	Mountain mahogany
Chrysothamnus nauseosus	CHNA	Rubber rabbitbrush
Chrysothamnus spp.	CHRYS	Rabbitbrush
Eurotia lanata	EULA	Winterfat
Xanthocephalum sarothrae	XASA	Broom snakeweed
Trees		
Juniperus osteosperma	JUOS	Utah juniper
Juniperus scopulorum	JUSC	Rocky Mountain juniper
Pinus edulis	PIED	Pinyon pine

Table IX-23. Vegetation cover from 30 m point-line transect. Pinyon-Juniper/Grass vegetation type. Sunnyside Mines, Utah. August 1981.

Parameter	Cover (%)	Relative Vegetation Cover (%)
Forb	3.58	10.22
Grass	4.00	11.42
Shrub	.50	1.43
Tree	26.95	76.93
Vegetation Cover	35.03	
Bare ground	25.09	
Litter	20.16	
Rock	19.72	
Total	100.00	100.00

Table IX-24. Comprehensive species list for Riparian vegetation type. Sunnyside Mines, Utah. June through September 1981.

Scientific Name	Abbreviation	Common Name
Forbs		
Abronia fragrans	ABFR	Snowball sandverbena
Artemisia ludoviciana	ARLU	Louisiana sagebrush
Aster fendlerii	ASFE	Aster (var.)
Clematis columbiana	CLCO	Virginsbower
Dalea flavescens	DAFL	Yellow prairie clover
Eriogonum shockleyi	ERSH	Shockley wild buckwheat
Gilia aggregata	GIAC	Skyrocket gilia
Lappula occidentalis	LOAC	Annual stickseed
Lupinus masculatus	LUMA	Lupine
Mentha arvensis	MEAR	Field mint
Myosotis verne	MYVE	Forget-me-not
Vicia americana	VIAM	American vetch
Grasses		
Agropyron spp.	AGROP	Wheatgrass
Agrostis alba	AGAL	Redtop
Aristida fendleriana	ARFE	Fendler three-awn
Oryzopsis hymenoides	ORHY	Indian ricegrass
Poa pratensis	POPR	Kentucky bluegrass
Poa secunda	POSE	Sandburg bluegrass
Stipa lettermani	STLE	Letterman needlegrass
Grasslike		
Juncus balticus	JUBA	Baltic rush
Juncus ensifolius	JUEN	Swordleaf rush
Shrubs		
Alnus tenuifolia	ALTE	Thinleaf alder

Table IX-24 Cont.

Scientific Name	Abbreviation	Common Name
Shrubs		
Amelanchier spp.	AMELA	Serviceberry
Artemisia tridentata	ARTR	Big sagebrush
Cercocarpus montanus	CEMO	Mountain mahogany
Chrysothamnus nauseosus	CHNA	Rubber rabbitbrush
Chrysothamnus viscidiflorus	CHVI	Low rabbitbrush
Philadelphus microphyllus	PHMI	Littleleaf mockorange
Rhus trilobata	RHTR	Skunkbush sumac
Ribes aureum	RIAU	Golden current
Salix spp.	SALIX	Willow
Symphoricarpos vaccinoides	SYVA	Snowberry
Trees		
Acer glabrum	ACGL	Rocky Mountain maple
Acer negundo	ACNE	Box Elder
Juniperus communis	JUCO	Common juniper
Juniperus scopulorum	JUSC	Rocky Mountain juniper
Populus angustifolia	POAN	Narrowleaf cottonwood
Ulmus parvifolia	ULPA	Chinese elm

TABLE 33-25. PERCENT COVER AND CONSTANCY BY SPECIES

FOR RIPARIAN VEGETATION TYPE.

SUNNYSIDE MINES, UTAH. JULY-AUGUST, 1981.

STAND NUMBER	1	2	3	4	5	6	7	8	9	10	CONSTANCY
GRID NUMBER	15	15	15	15	15	15	15	15	15	15	
ELEVATION IN FEET	6900	6900	6900	6900	6900	6900	6900	6900	6900	6900	
ASPECT	S	S	S	S	S	S	S	S	S	S	
SLOPE IN PERCENT	2	3	2	2	2	3	3	3	3	3	
SOIL MAPPING UNIT	CIC	CIC	CIC	CIC	CIC	CIC	CIC	CIC	CIC	CIC	
GRASSES:											
Agropyron spp.	16	20		16						4	40
Bromus tectorum	4			12	4						30
Elymus salina		8									10
Oryzopsis hymenoides							4		4		20
Poa pratensis		16	16	4	40	8	8	4	4	12	80
GRASSLIKE:											
Juncus balticus											10
J. mexifolius	+				+						10
FORBS:											
Artemisia ludoviciana			4	4			16		4	4	50
A. tridentata		20									10
Asclepias sp.	+			4							20
Aster fendleri					12				+		20
A. sp.		4					4		12		30
Clematis columbiana	+				12						20
Melilotus officinalis	4										10
Salsola kali	4								4		10
Solidago sparsiflora											10
SHR											
Chrysothamnus nauseosus					12						10
Salix exigua	84	68	48	84	80	92	52	48	56	32	100
TREES:											
Acer negundo			16				36	36			30
Populus angustifolia									20	48	20
Ulmus americana			12								10

Table IX-26. Vegetation cover from 10 m point-line transects. Riparian vegetation type. Sunnyside Mines, Utah. August 1981.

Parameter	Cover (%)	Relative Vegetation Cover (%)
Forb	2.4	3
Grass	2.0	2
Shrub	68.4	78
Tree	14.4	17
Vegetation Total	87.2	
Bare ground	2.8	
Litter	7.2	
Rock	2.8	
Total	100.0	100

TABLE II-27. PERCENT COVER AND CONSTANCY BY SPECIES

FOR SAGEBRUSH-GRASS VEGETATION TYPE.

SUNNYSIDE MINES, UTAH. JULY-AUGUST, 1981.

	1	2	3	4	5	6	CONSTANCY
STAND NUMBER	12	12	12	12	12	12	
GRID NUMBER	7100	7100	7100	7100	7100	7100	
ELEVATION IN FEET	357	357	357	357	357	357	
ASPECT	7	7	7	7	7	7	
SLOPE IN PERCENT	CIC	CIC	CIC	CIC	CIC	CIC	
SOIL MAPPING UNIT							
GRASSES:							
Agropyron cristatum	.6	.8	.5	1.0	.2	1.0	100
A. smithii	2.2	•	•	12.5	8.5	5.1	50
A. spicatum	•	•	•	.3	•	.3	33
Bouteloua gracilis	.2	•	•	•	•	•	17
Bromus tectorum	.9	22.00	24.00	11.2	15.8	16.3	100
Calamagrostis sp.	•	.3	•	•	•	•	17
Elymus salina	4.0	.2	16.6	•	.1	4.3	83
Oryzopsis hymenoides	2.9	6.2	5.8	4.3	12.0	11.5	100
Sitanion hystrix	.6	1.5	.9	.3	•	3.5	83
Sporobolus cryptandrus	•	•	•	•	•	.4	17
Stipa comata	1.1	.3	.9	•	•	•	50
S. sp.	1.2	•	•	•	•	•	17
FORBS:							
Artemesia ludoviciana	.1	•	•	•	•	•	17
Brassicaceae spp.	•	.1	•	•	•	•	17
Cirsium sp.	1.3	•	2.0	•	•	•	33
Crytantha spp.	.5	•	.1	•	•	1.8	50
Grindelia squarrosa	•	.1	•	•	•	•	17
Hedysarum sp.	2.0	•	•	•	•	•	17
Hymenoxys richardsonii	.7	•	•	•	•	•	17
Lappula spp.	•	.1	.3	•	.1	.8	67
native spp.	•	.1	.1	•	•	•	33
Machaeranthera grindelioides	.2	•	•	•	•	•	17
Opuntia sp.	•	•	•	1.3	•	•	17
Sphaeralcea coccinea	•	.6	•	•	•	1.0	33
S. sp.	•	•	•	.1	.3	1.0	50
Unknown forbs	.4	.1	.4	.6	.1	.2	100

Table IX-28. Shrub stem density by species for Sagebrush-Grass vegetation type. Sunnyside Mines, Utah. August 1981.

Species	Common Name	Stem Density per acre	Stem Density per hectare
Artemisia tridentata	Big sagebrush	3477	8576
Amelanchier alnifolia	Serviceberry	13	34
Chrysothamnus nauseosus	Rubber rabbitbrush	220	543
Xanthocephalum sarothrae	Broom snakeweed	20	49
Unknown shrub		7	16
Total		3733	9218

Table IX-29. Comprehensive species for Sagebrush-Grass. Sunnyside, Utah. June through September 1981.

Scientific Name	Abbreviation	Common Name
Forbs		
Achillea lanulosa	ACMIL	Western yarrow
Artemisia ludoviciana	ARLU	Louisiana sagebrush
Asclepias spp.	ASCLE	Milkweed
Cirsium spp.	CIRSI	Thistle
Cryptantha spp.	CRYPT	Cryptantha
Grindelia squarrosa	GRSQ	Curlycup gumweed
Hedysarum boreale	HEBO	Northern sweetvetch
Hymenoxys richardsonii	HYRI	Pinque hymenoxys
Lappula spp.	LAPPU	Stickseed
Lepidium spp.	LEPID	Pepperweed
Machaeranthera grindelioides	MAGR	Aster (var.)
Opuntia spp.	OPUNT	Pricklypear
Solidago spp.	SOLID	Goldenrod
Sphaeralcea coccinea	SPCO	Scarlet globemallow
Sphaeralcea spp.	SPHAE	Globemallow
Grasses		
Agropyron cristatum	AGCR	Fairway wheatgrass
Agropyron smithii	AGSM	Western wheatgrass
Agropyron spicatum	AGSP	bluebunch wheatgrass
Bouteloua gracilis	BOGR	Blue grama
Bouteloua hirsuta	BOHI	Hairy grama
Bromus tectorum	BRTE	Cheatgrass brome
Calamagrostis spp.	CALAM	Reedgrass
Elymus cinereus	ELCI	Great Basin wildrye
Elymus salina	ELSA	Salina wildrye
Oryzopsis hymenoides	ORHY	Indian ricegrass
Sitanion hystrix	SIHY	Bottlebrush squirreltail

Table IX-29 Cont.

Scientific Name	Abbreviation	Common Name
Grasses		
Sporobolus spp.	SPORO	Dropseed
Stipa comata	STCO	Needle-and-thread
Stipa spp.	STIPA	Needlegrass
Shrubs		
Amelanchier alnifolia	AMAL	Serviceberry
Artemisia tridentata	ARTR	Big sagebrush
Chrysothamnus nauseosus	CHNA	Rubber rabbitbrush
Eurotia lanata	EULA	Winterfat
Symphoricarpos spp.	SYMPH	Snowberry
Xanthocephalum sarothrae	XASA	Broom snakeweed

Table IX-30. Vegetation cover for the Sagebrush-Grass vegetation type from 0.25 m^2 quadrats. Sunnyside Mines, Utah. July 1981.

Parameter	Cover (%)	Relative Vegetation Cover (%)
Forb	2.61	7.00
Grass	33.40	93.00
Shrub	+	
Tree	*	
Vegetation Cover	35.01	
Bare ground	25.43	
Litter	34.11	
Rock	4.39	
Total	100.00	100.00

* No trees present

+ Only shrubs <12 inches (33 cm) were measured in quadrats. Line-intercept data for shrubs is included in Table IX-26.

Table IX-31. Shrub cover from 30 m line-intercept. Sagebrush-Grass vegetation type. Sunnyside Mines, Utah. August 1981.

Species	Common Name	Cover (%)
Artemisia frigida	Fringed sage	.24
Artemisia tridentata	Big sagebrush	19.34
Chrysothamnus nauseosus	Rubber rabbitbrush	.79
Symphoricarpus spp.	Snowberry	.13
Total		20.60

Table IX-32. Vegetation cover for the Sagebrush-Grass vegetation type from 50 m point-line transect. Sunnyside Mines, Utah. July 1981.

Parameter	Cover (%)	Relative Vegetation Cover (%)
Forb	3.33	4.22
Grass	49.34	33.33
Shrub	26.33	62.45
Tree	*	
Vegetation Cover	79.00	
Bare ground	4.33	
Litter	15.00	
Rock	1.67	
Total	100.00	100.00

* No trees present

Table IX-33. Percent cover, frequency and constancy by species for pinyon-juniper/sagebrush habitat type. Sunnyside Mines, E-Canyon, Utah. Summer 1983.

Stand number	1	2	3	4	5	6	7	8	9	10	11	12	13		
State and county	Carbon County, Utah														
Grid number	41	41	41	41	41	41	41	41	41	41	41	41	41		
Elevation in feet	7120	7120	7120	7120	7120	7120	7120	7120	7120	7120	7120	7120	7120		
Aspect	117°	117°	126°	125°	128°	126°	117°	119°	117°	123°	123°	125°	140°		
Slope in percent	76%	66%	58%	58%	70%	65%	67%	68%	53%	76%	76%	50%	63%		
Soil mapping unit	RSH_2	RSH_2	RSH_2	RSH_2	RSH_2	RSH_2	RSH_2	RSH_2	RSH_2	RSH_2	RSH_2	RSH_2	RSH_2		
	Average Cover and Frequency													Cover (%)	
Species	AC-F	AC-F	AC-F	AC-F	AC-F	AC-F	AC-F	AC-F	AC-F	AC-F	AC-F	AC-F	AC-F	$\bar{x}$	s	Constancy (%)
Grasses																
Agropyron spicatum	+	0.40-15	0.20-5	1.70-65	1.70-35	0.45-15	2.95-40	2.20-55	1.10-30	1.90-35	3.85-50	2.35-55	3.25-60	1.70	1.23	92
Bouteloua gracilis	-	-	-	+	+	-	-	-	+	-	-	-	-	+	-	0
Bromus tectorum	-	+	-	0.35-20	0.35-10	-	0.75-25	0.05-5	0.05-5	0.30-5	0.20-10	0.60-10	0.35-10	0.23	0.25	62
Elymus salina	3.05-55	4.70-85	5.50-70	0.95-25	0.30-20	1.10-25	0.55-20	1.20-30	1.40-35	1.15-45	1.50-15	0.15-5	0.95-10	1.73	1.66	100
Oryzopsis hymenoides	+	0.05-5	+	+	+	+	-	-	0.15-10	0.65-10	0.10-5	-	+	0.07	0.18	31
Oryzopsis micrantha	-	-	-	-	0.25-10	-	-	-	-	-	-	-	+	0.02	0.07	8
Poa spp.	-	-	-	-	-	0.05-5	0.05-5	+	0.45-15	-	-	-	0.10-5	0.05	0.12	31
Sporobolus cryptandrus	-	-	-	+	-	-	-	-	-	-	-	0.65-15	-	0.05	0.18	8
Total	3.05	5.15	5.70	3.00	2.60	1.60	4.30	3.45	3.15	4.00	5.65	3.75	4.65	3.85	1.22	
Grass-like																
Carex spp.	-	-	-	-	0.05-5	0.05-5	-	-	-	-	-	-	-	0.01	0.02	15
Forbs																
Artemisia ludoviciana	-	-	-	-	-	-	-	-	-	-	-	0.10-5	-	0.01	0.03	8
Chryptantha spp.	+	-	-	-	-	-	-	-	+	-	-	-	-	+	-	0
Descurainia spp.	-	-	-	-	-	0.05-5	-	-	-	-	-	-	-	T	-	8
Erigeron spp.	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	0
Erigeron divergens	-	-	-	-	-	-	-	-	-	-	-	0.05-5	-	T	-	8
Erigeron flagellaris	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	0
Machaeranthera spp.	+	-	-	+	+	-	-	0.05-5	-	-	0.05-5	-	+	0.01	0.02	15
Oxybaphus linearis	-	-	-	-	-	-	-	-	-	-	0.15-10	-	-	0.01	0.04	8
Senecio multilobatus	-	+	-	-	+	+	-	-	0.05-5	-	-	-	-	T	-	8
Sisymbrium altissimum	-	-	-	-	-	-	-	-	-	-	-	0.05-5	-	T	-	8
Tragopogon dubius	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-	0
Unknown forbs	-	-	-	0.05-5	-	-	-	-	+	-	-	-	-	T	-	8
Total	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.05	0.05	0.00	0.05	0.35	0.00	0.04	0.10	
Shrubs																
Amelanchier alnifolia	+	+	-	-	-	-	-	-	+	+	-	-	+	+	-	0
Amelanchier tridentata	+	+	+	0.25-5	0.05-5	+	+	0.70-10	+	+	+	0.30-10	+	0.08	0.10	31
Atriplex canescens	+	+	+	+	-	-	+	+	+	+	-	-	-	+	-	0
Atriplex confertifolia	-	+	+	-	-	-	-	-	-	-	-	-	-	+	-	0
Brickellia microphylla	-	-	-	-	-	+	-	-	-	-	-	-	-	+	-	0
Cercocarpus montanus	-	-	-	-	-	+	-	-	-	-	-	-	-	+	-	0
Chrysothamnus nauseosus	+	+	-	-	-	-	-	-	+	-	-	-	-	+	-	0
Cowania mexicana	+	-	-	-	+	-	-	-	-	-	-	-	-	+	-	0
Echinocereus spp.	-	+	-	-	+	0.25-5	-	-	+	-	-	-	+	0.02	0.07	8
Ephedra viridis	+	+	+	+	+	+	+	+	+	0.10-5	+	+	+	0.01	0.03	8
Gutierrezia sarothrae	-	0.10-5	0.15-5	+	+	0.25-10	0.25-5	0.05-5	+	-	-	-	-	0.14	0.34	38
Opuntia polyacantha	-	0.10-5	+	+	+	+	-	-	-	-	-	-	+	0.01	0.03	8
Philadelphus microphyllus	-	-	+	-	-	+	-	-	+	-	-	-	-	+	-	0
Symphoricarpos oreophilus	+	-	+	-	+	+	-	+	-	-	-	-	+	+	-	0
Total	0.00	0.20	0.15	0.25	0.05	0.50	1.25	0.75	0.00	0.10	0.00	0.10	0.00	0.26	0.37	
Trees																
Juniperus osteosperma	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	0
Juniperus scopulorum	+	-	+	+	-	-	-	-	-	-	-	+	-	+	-	0
Pinus edulis	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	0
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Others																
Moss	-	-	-	-	-	0.75-15	-	0.15-5	-	-	-	-	-	0.07	0.21	15
Total vegetation	3.05	5.35	5.85	3.25	2.70	2.95	5.55	4.40	3.20	4.10	5.70	4.20	4.65	4.23	1.18	
Rock	56.35	45.25	58.55	33.65	62.40	62.70	48.70	50.85	55.30	45.45	65.85	51.10	54.40	53.12	8.73	
Litter	9.20	12.65	10.25	3.00	1.70	16.15	1.95	2.45	1.50	6.90	10.05	6.80	1.50	6.47	4.90	
Bareground	31.40	36.75	25.35	60.10	33.20	18.20	43.80	42.30	40.00	43.55	18.40	37.90	39.45	36.18	11.32	

The + indicates that the species was observed but not in the plot.

The T represents mean cover values which are less than 0.005 percent.

Table IX-34. Tree population analyses for pinyon-juniper/sagebrush habitat type. Sunnyside Mines, B-Canyon, Utah. Summer 1983.

Plant Community	Species	Cover %	Basal Area m^2ha	Basal Area ft^2/ac	Density Trees/ha	Density Trees/ac	Timber Volume (Board ft/ac)	Site Index
Pinyon-juniper/sagebrush	Juniperus osteosperma	8.7	7.09	30.87	153	62	N/A	N/A
	Juniperus scopulorum	0.5			11	4	N/A	N/A
	Pinus edulis	7.4	1.75	7.62	144	58	N/A	N/A
Total		16.6	8.84	38.49	308	124		

Table IX-35. Shrub population characteristics in 1983 of the pinyon-juniper/sagebrush habitat type. Sunnyside Mines, B-Canyon, Utah.

Species	Canopy Cover (%)	Density	
		Stems/ha	Stems/acre
Amelanchier alnifolia	0.2	36	15
Atriplex canescens	0.5	150	61
Atriplex confertifolia	0.1	11	4
Artemisia nova	0.1		
Artemisia tridentata	11.2	3478	1409
Cercocarpus montanus		6	2
Chrysothamnus nauseosus		17	7
Cowania mexicana		3	1
Ephedra viridus	1.9	896	363
Philadelphus microphyllus		72	29
Symphoricarpos oreophilus		8	3
Total	14.0	4677	1894

Table IX-36. Vegetation cover from 30 meter point line transects. Pinyon-juniper/sagebrush habitat type. Sunnyside Mines, B-Canyon, Utah. Summer 1983.

Parameter	Cover (%)	Relative Vegetation Cover (%)
Grass	11.27	26.83
Shrub	14.73	35.07
Trees	16.00	38.10
Total Vegetation Cover	42.00	
Bareground	6.18	
Rock	32.91	
Litter	18.91	

Table IX-37. Vegetation cover estimated from 0.10 m^2 quadrats. Pinyon-juniper/sagebrush habitat type. Sunnyside Mines, B-Canyon, Utah. Summer 1983.

Parameter	Cover (%)	Relative Vegetation Cover (%)
Grass	3.85	91.00
Grasslike	0.01	0.24
Forb	0.04	0.95
Shrub	0.26	6.15
Moss	0.07	1.66
Total Vegetation Cover	4.23	
Bareground	6.47	
Rock	53.12	
Litter	36.18	

Table IX-38. Comprehensive species list for pinyon-juniper/sagebrush habitat type. Sunnyside Mines, B-Canyon, Utah. Summer 1983.

Trees	
Juniperus osteosperma	Utah juniper
Juniperus scopulorum	Rocky Mountain juniper
Pinus edulis	pinyon pine
Shrubs	
Amelanchier alnifolia	Saskatoon serviceberry
Artemisia nova	black sagebrush
Artemisia tridentata	big sagebrush
Atriplex canescens	four-wing saltbush
Atriplex confertifolia	shadscale saltbush
Brickellia microphylla	brickellia
Cercocarpus montanus	true mountain mahogany
Chrysothamnus nauseosus	rubber rabbitbrush
Cowania mexicana	cliffrose
Echinocereus spp.	echinocereus
Ephedra viridis	green ephedra
Gutierrezia sarothrae	broom snakeweed
Opuntia polyacantha	plains prickly pear
Philadelphus microphyllus	littleleaf mockorange
Symphoricarpus oreophilos	mountain serviceberry
Forbs	
Artemisia ludoviciana	Louisiana sagebrush
Cryptantha spp.	cryptantha
Descurainia spp.	tansy mustard
Erigeron spp.	fleabane
Erigeron divergens	spreading fleabane
Erigeron flagellaris	trailing fleabane
Machaeranthera spp.	aster
Oxybaphus linearis	

Table IX-38. Continued.

Forbs	
Senecio multilobatus	groundsel
Sisymbrium altissimum	garlic mustard
Tragopogon dubius	salsify
Grasses	
Agropyron spicatum	bluebunch wheatgrass
Bouteloua gracilis	blue grama
Bromus tectorum	cheatgrass brome
Elymus salina	salina wildrye
Oryzopsis hymenoides	indian ricegrass
Oryzopsis micrantha	littleseed ricegrass
Sporobolus cryptandrus	sand dropseed
Poa spp.	bluegrass
Others	
Moss	moss

Table IX - 39. Annual precipitation records (in inches) for Sunnyside.

Sunnyside	
Year	Amount
1959	13.54
1560	10.74
1961	13.56
1962	11.12
1966	9.59
1967	11.95
1968	14.96
1969	19.16
1970	10.23
1971	12.1
1972	11.36
1973	10.62
1974	9.09
1975	12.46
1976	8.86
1977	9.62
1978	18.16
1979	9.1
1980	19.02
1981	17.64
$\bar{x}$ =	12.64
s =	3.42
Range =	9.09 - 19.16

Table IX-40 Comparison of Actively Disturbed Site to Proposed Reference Site

Parameter	Disturbed Site	Proposed Reference Site (1)
Vegetation Type	Mountain Brush	Mountain Brush
Location	Whitmore Canyon	Whitmore Canyon
Section	SW¼SW¼, Section 17, T14S, R14E	SW¼NW¼, Section 20 T14S, R14E
Elevation, Ft./M	7280/2219	7290/2222
Geologic formation	North Horn Flagstaff Formation	North Horn Flagstaff Formation
Soils mapping unit	Zillion Complex	Zillion Complex
Slope (percent)	40	42.5
Aspect (degrees)	102	96
Species composition	Assumed to be similar*	Amelanchier/Elymus dominants
Plant Cover		
Quadrat data (Herbaceous only)	**	10.0%
Point Line Data	**	45.8%
Productivity	**	800lb/acre

*This disturbed site is adjacent to the mountain brush community. The probable potential of the disturbed site is determined to be mountain brush. Species composition, plant cover and productivity undoubtedly would fall within the normal variation expected in this type.

**No vegetation data is presented because the sites are already disturbed, therefore no statistical comparisons can be made.

Table IX-41 Comparison of Actively Disturbed Site to Proposed Reference Site

Parameter	Disturbed Site	Proposed Reference Site (2)
Vegetation type	Pinyon/Juniper	Pinyon/Juniper
Location	Slaughter Canyon	Fan Canyon
Section	SW¼SW¼, Section 30 T14S, R14E	NE¼SW¼, Section 30, T14S, R14E
Elevation, Ft./M	7020/2139	7280/2210
Geologic Formation	Mesa Verde and Mancos Shale	Mesa Verde and Mancos Shale
Soils Mapping Unit	Ildefonso - Rock uptcrop complex. Menefee Rock outcrop complex. Rock-Rubble-Sunup complex.	Rock-Rubble-Sunup Complex
Slope (percent)	Streambed - 14 Canyon walls -59	62
Aspect (degrees	275° and 95°	112
Species composition	Assumed to be similar	Pinus/Ephedra
Plant cover		
Quadrat data (Herbaceous only)	**	1.44%
Point Line data	**	28.5%
Productivity	**	200lb/acre

*This previously disturbed site is in the pinyon/juniper habitat type. Species composition, cover and productivity are assumed to fall within the normal variation expected in this vegetation type.

**No vegetation data is presented because sites are already disturbed therefore no statistical comparisons can be made.

Table IX- 42 Comparison of Actively Disturbed Site to Proposed Reference Site

Parameter	Disturbed Site	Proposed Reference Site (2)
Vegetation type	Pinyon/Juniper	Pinyon/Juniper
Location	Fan Canyon	Fan Canyon
Section	NW¼SW¼, Section 30, T14S, R14E	NW¼SW¼, Section 30, T14S, R14E
Elevation, Ft./M	7120/2172	7280/2210
Geologic Formation	Mesa Verde and Mancos Shale	Mesa Verde and Mancos Shale
Soils Mapping Unit	Ildefonso Rock outcrop complex. Minfre Rock outcrop complex.	Rock-Rubble-Sunup Complex
Slope (percent)	68	62
Aspect (degrees)	92	112
Species composition	Assumed to be similar	Pinus/Ephedra
Plant cover		
Quadrat date (Herbaceous only)	**	1.44%
Point Line data	**	28.5%
Productivity	**	200lb/acre

*This previously distrubed site is in the pinyon/juniper habitat type. Species composition, cover and productivity are assumed to fall within the normal variation expected in this vegetation type.

**No vegetation is presented because the sites are already disturbed, therefore no statistical comparisons can be made.

Table IX-43 Comparison of Actively Disturbed Site to Proposed Reference Site

Parameter	Disturbed Site	Proposed Reference Site (3)
Vegetation type	Pinyon/Juniper/Grass	Pinyon/Juniper/grass
Location	Mouth of Whitmore Canyon	Mouth of Whitmore Canyon
Secetion	NE¼SE¼, Section 6, T15S, R14E	NE¼NW¼, Section 7, T15S, R14E
Elevation, Ft./M	6525/1989	6480/1975
Geologic Formation	Mesa Verde and Mancos Shale	Mesa Verda and Mancos Shale
Soils Mapping Unit	Ildefonso Very Stony Loam Shingle-Ildelfonso-Badland complex	Ildefonso Very Stony Loam
Slope (percent)	0-5	0-5
Aspect (degrees)	260	247
Species composition	Assumed to be similar*	Juniperus/Oryzopsis
Plant cover		
Quadrat data (Herbaceous only)	**	3.49
Point Line data	**	8.89
Productivity	**	300lb/acre

*This actively disturbed site appears to be in the pinyon/juniper/grass habitat type as deduced from old aerial photographs.

**No vegetation data is presented because the sites are already disturbed, therefore no statistical comparisons can be made.

Table IX- 43 Comparison of Actively Disturbed Site to Proposed Reference Site

Parameter	Sagebrush/Grass Disturbed Site	Proposed Reference Site (5)
Vegetation type	Sagebrush/Grass	Sagebrush/Grass
Location	Whitmore Canyon	Whitmore Canyon
Section	S½. Section 32, T14S, R14E	NW¼NW¼, Section 29, T14S, R14E
Elevation, Ft./M	7080/2158	7000/2106
Geologic Formation	Price River	Price River
Soils Mapping Unit	Haverson Loam, Rivra Loam	Rivra Loam
Slope (percent)	0-5	0-3
Aspect (degrees)	227	187
Species Composition	Assumed to be similar*	Artemisia/Elymus
Plant Cover		
Quadrat data (herbaceous only)	**	36%
Point Line data	**	79%
Productivity	**	1,000lb/acre

*This previously disturbed site is in the sagebrush/grass habitat type. Species, composition, cover and productivity are assumed to fall within the normal variation expected in this vegetation type.

**No vegetation data is presented because the sites are already disturbed, therefore no statistical comparisons can be made.

Table IX-45 Comparison of Actively Disturbed Site to Proposed Reference Site
Pinyon-Juniper/Sagebrush

Parameter	Disturbed Area	Proposed Reference Site (5)
Vegetation Type	Pinyon-Juniper/Sagebrush	Pinyon-Juniper/Sagebrush
Location	B Canyon	B Canyon
Section	14	14
Elevation, Ft./M		
Geologic Formation	Mesa Verde/Mancos Shale Groups	Mesa Verde/Mancos Shale Groups
Soils Mapping Unit	RSH_2/RO	RO
Slope (percent)	66%	70%
Aspect (degrees)	120	117
Species Composition	*	PJ/Elymus and Agropyron
Plant Cover		
Quadrat data (herbaceous only)	**	4.23
Point Line Data	*	42.00
Productivity	*	800 lb/acre

* This site is previously disturbed and falls within the same vegetation mapping unit as the reference area. Therefore, species composition, cover, and productivity undoubtedly would fall within the normal variation for this site.

** No vegetation data is presented because the site is already disturbed; therefore, no statistical comparisons can be made.

Table IX- 45 . Value of revegetation species to deer and elk for the Sunnyside mine, Utah.

Plant Species	Animal Species	Usage[1,2]	Comments[2,3]
TREES			
Juniperus spp.	Deer Elk	****Su **W,Sp,Su	
Pseudotsuga menziesii	Deer Elk	****W ****W	
Populus augustifolia	Deer Elk	*F *W,Sp	
SHRUBS			
Acer glabrum	Deer Elk	** *W	Leaves, twigs, sprouts are fair in palatability
Amelanchier spp.	Deer Elk	***Su,F ##W,Sp,Su,F	1) Good cover 2) L-M elk forage value
Artemisia spp.		---	Fair to good winter browse
Cercocarpus spp.	Deer Elk	***F,W,Sp ##F,W,Sp	1) Good cover 2) M-H elk forage value
Chrysothamnus nauseosus	Deer ELK	*F,W ##W #Sp	L-M elk forage value
Cowania mexicana		---	Good winter browse
Ephedra viridis		---	1) Exc. Su & W browse 2) Good Sp browse
Eurotia lanata	Deer Elk	--- ##W	1) Good Sp, Su, W browse 2) Low elk forage value
Potentilla fruticosa	Deer Elk	--- #W	L-M deer & elk forage
Rhus trilobata	Deer Elk	+ ---	Poor to fair deer and elk forage

(Continued on Next Page)

Table IX- 46 . (Continued).

Plant Species	Animal Species	Usage[1,2]	Comments[2,3]
Rosa woodsii	Deer	---	1) Sp, Su & F browse
	Elk	##Su,F #Sp	2) Med. elk forage value
Salix spp.	Deer	+	L-M elk forage value
	Elk	**W,Sp ###W,Su,F	
Symphoricarpos spp.	Deer	---	1) Important deer Su forage
	Elk	#S,F,W	2) L-M elk forage value
GRASSES			
Agropyron spp.	Deer	**Sp,Su	Fair winter forage
	Elk	*W,Sp	
Agropyron spicatum	Deer	---	
	Elk	##W,Sp,Su,F	L-M elk forage value
Agrostis alba		---	1) Poor deer forage 2) Good elk forage
Bouteloua gracilis	Deer	---	1) Poor to fair deer forage
	Elk	##Su,F #W	2) Low elk forage value
Elymus spp.	Deer	---	1) Fair Sp,F,W forage
	Elk	+	2) Good Su forage
Hilaria jamesii	---	---	---
Koeleria cristata	Deer	**Sp,Su	Fair deer and elk forage
	Elk	+	
Oryzopsis hymensides	Deer	**Sp,Su	
	Elk	###F ##W	L-M elk forage value
Poa pratensis	Deer	---	1) Good Sp,F,W forage
	Elk	---	2) Poor Su forage

(Continued on Next Page)

Table IX-46 . (Continued).

Plant Species	Animal Species	Usage[1,2]	Comments[2,3]
Sitanion hystrix	Deer Elk	--- #Su	1) Good Sp forage 2) Poor Su,F,W forage 3) Low elk forage value
Sporobolus cryptandrus		---	1) Exc. Su forage 2) Poor F,W,Sp forage
Stipa comata	Deer Elk	--- ###F ##S #W	1) Fair deer forage 2) L-H elk forage value
FORBS			
Achillea lanulosa		---	poor for deer and elk
Artemisia ludoviciana		---	1) Fair F,W forage 2) Good Sp,Su forage
Balsamorhiza sagittata		---	Exc. Sp forage
Castilleja spp.		---	Fair deer and elk forage
Gaillardia aristata	Deer Elk	--- #Su	1) Low deer Su usage 2) Low elk forage value
Gilia aggregata		---	Low deer usage all year
Hedysarum boreale		---	1) Good Sp, Su forage 2) Fair F,W forage
Medicago sativa	Deer Elk	+ ---	1) Good Sp,Su forage 2) Poor F,W forage
Melilotus officinalis		---	1) F-G forage 2) winter hardy
Oenothera pallida		---	Poor forage value
Penstemon spp.		---	1) Fair summer forage 2) Occassional winter use
Petalostemon purpureum		---	---

(Continued on Next Page)

Table IX- 46 . (Continued).

Plant Species	Animal Species	Usage[1,2]	Comments[2,3]
Solidago canadensis		---	1) Poor F,W forage 2) Good Sp,Su forage
Sphaeralcea coccinea		---	Moderate deer fall usage

1 From Martin et al (1951).
- = Use to an undertermined extent
+ = 1/2 to 2% of diet
* = 2 to 5% of diet
** = 5 to 10% of diet
*** = 10 to 25% of diet
**** = 25 to 50% of diet
W = Winter; Sp = Spring; Su = Summer; F = Fall

2 From Thomas and Toweill (1982).
# = light use; ## = moderate use; ### = heavy use
L = low forage value; M = moderate; H = high

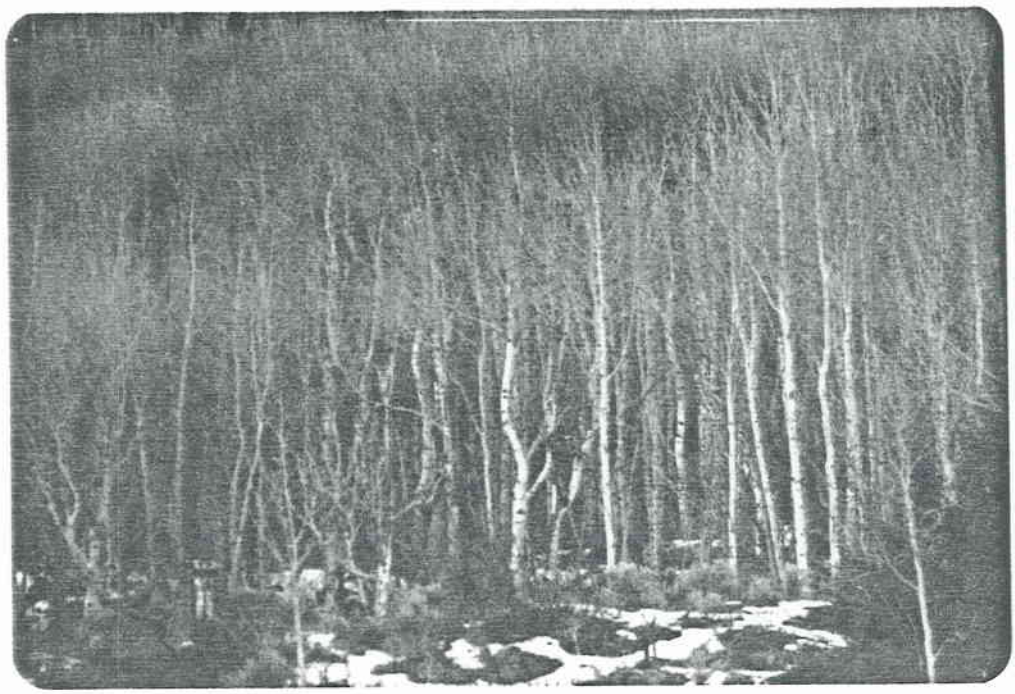
3 Other information obtained from: Dittberner (1978), Johnson and Nichols (1970), Kufeld (1973), Plant Information Network, Plummer et al (1968), Taylor (1956) and Martin (1951).

Photographs and Plates

Photographs

Photo No.	Vegetation Type
1	Aspen
2	Douglas fir
3	Douglas fir/aspen
4	Douglas fir/mountain brush
5	Douglas fir/pinyon juniper
6	Mountain brush (serviceberry)
7	Pinyon/juniper
8	Pinyon/juniper-grass
9	Pinyon/juniper-mountain brush
10	Pinyon/juniper-sagebrush
11	Riparian-bullrush-sedge
12	Riparian-cottonwood grove
13	Riparian-willow
14	Sagebrush-grass
15	Sagebrush/mountain brush*
16	Douglas fir/aspen/mountain brush*
17	Douglas fir/sage*

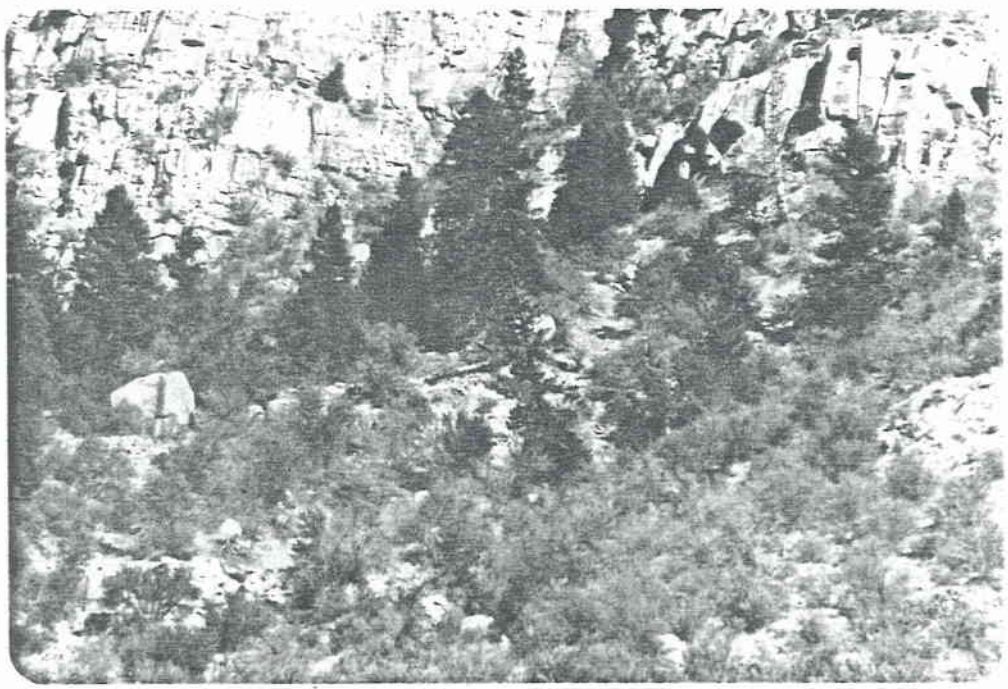
* Photograph unavailable at this time.



1 Aspen

2 Douglas Fir

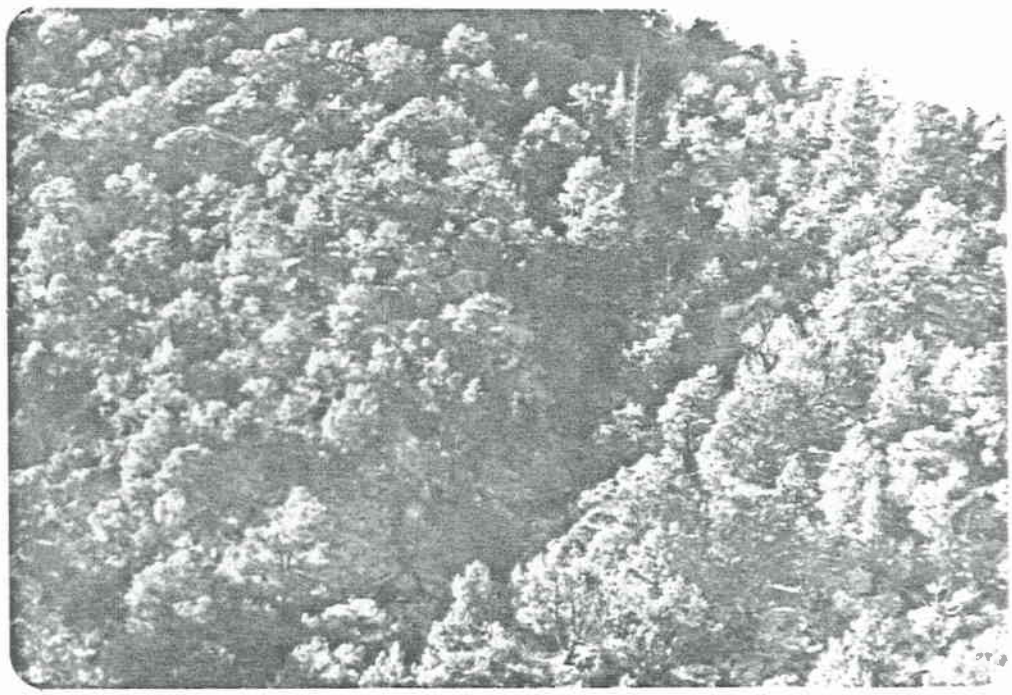
3 Douglas Fir/Aspen



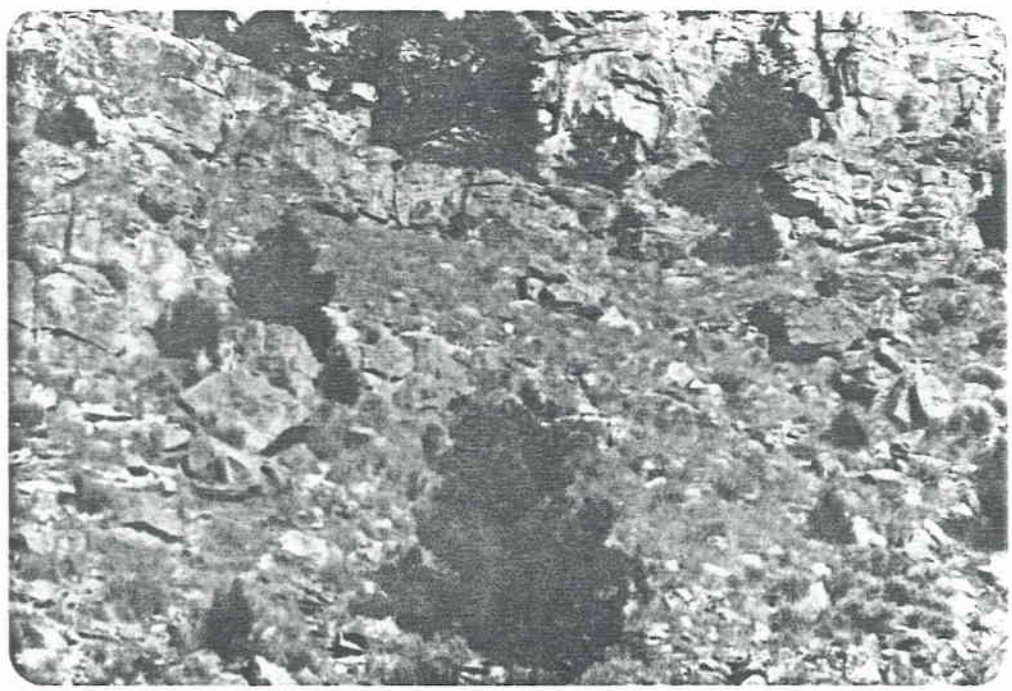
4 Douglas Fir/Mountain Brush

5 Douglas Fir/Pinyon-Juniper

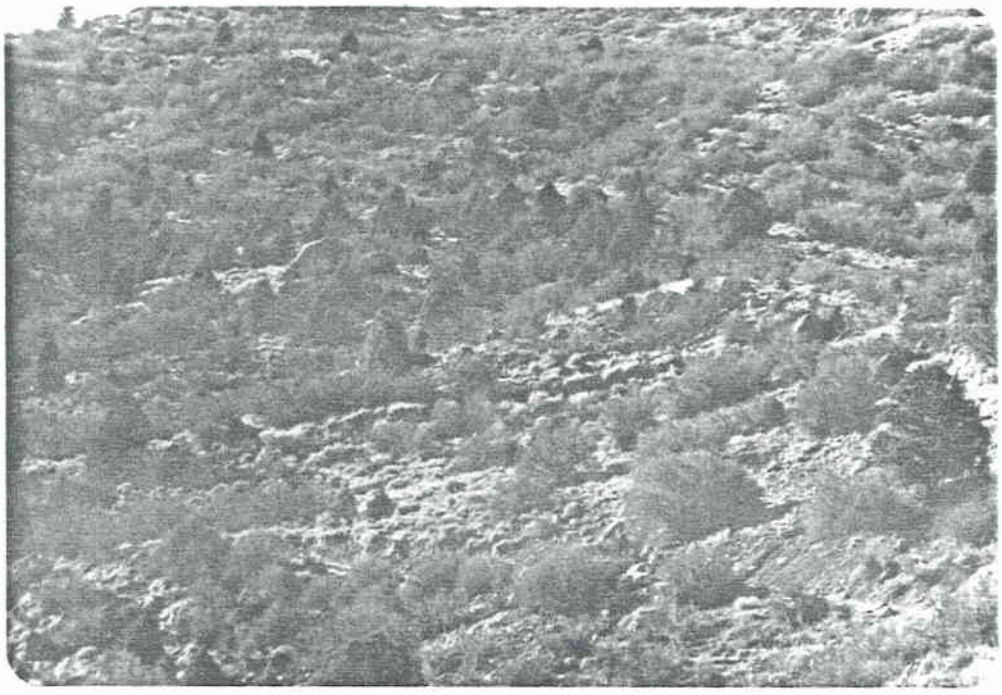
6 Mountain Brush



7 Pinyon/Juniper

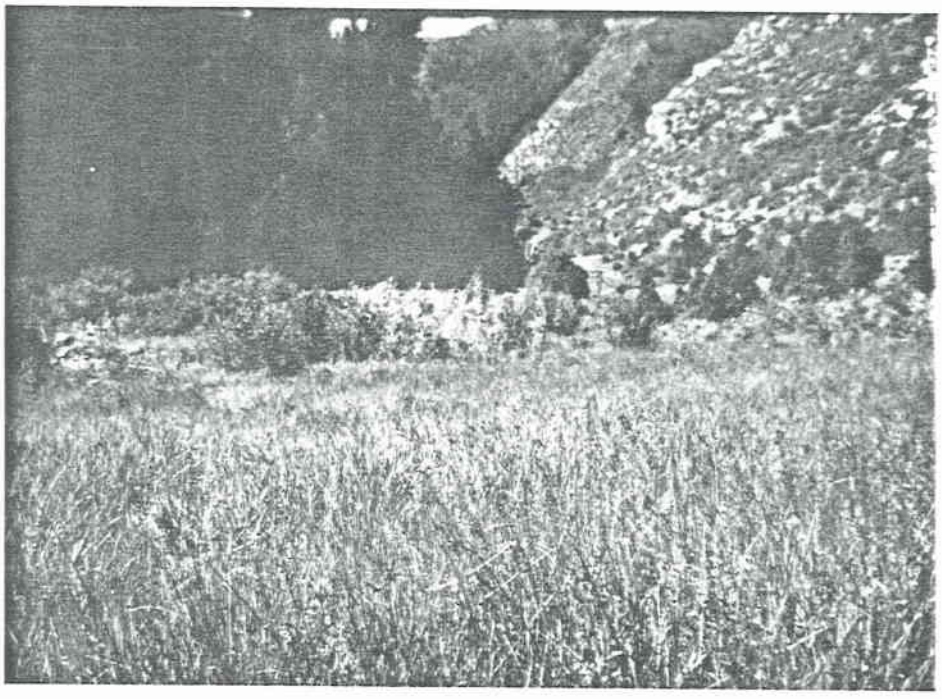


8 Pinyon/Juniper-Grass

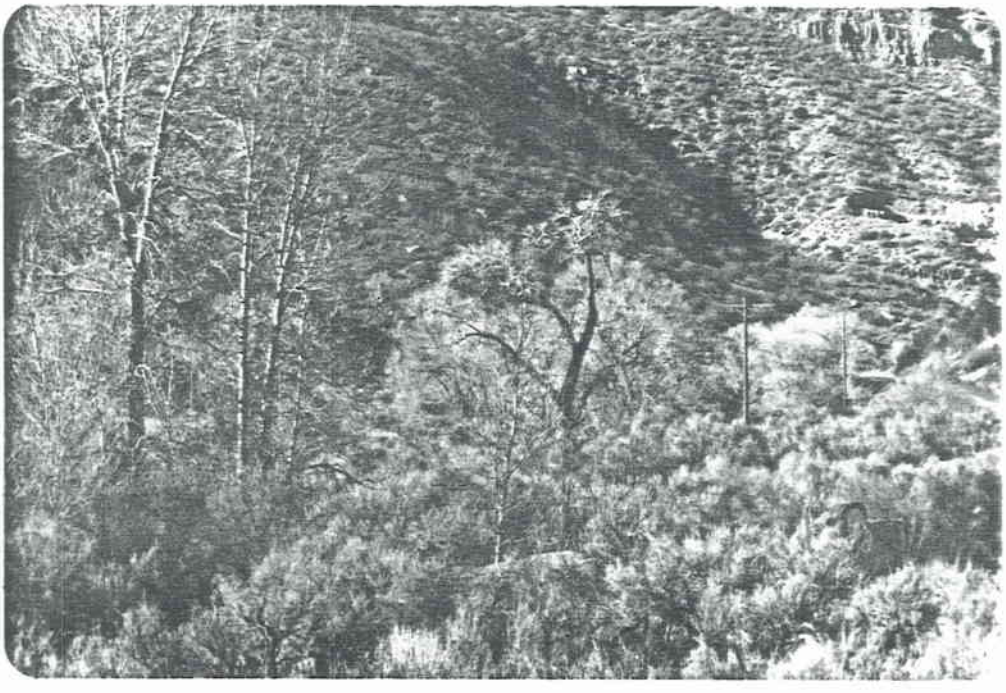


9 Pinyon/Juniper-Mountain Brush

10 Pinyon/Juniper-Sagebrush

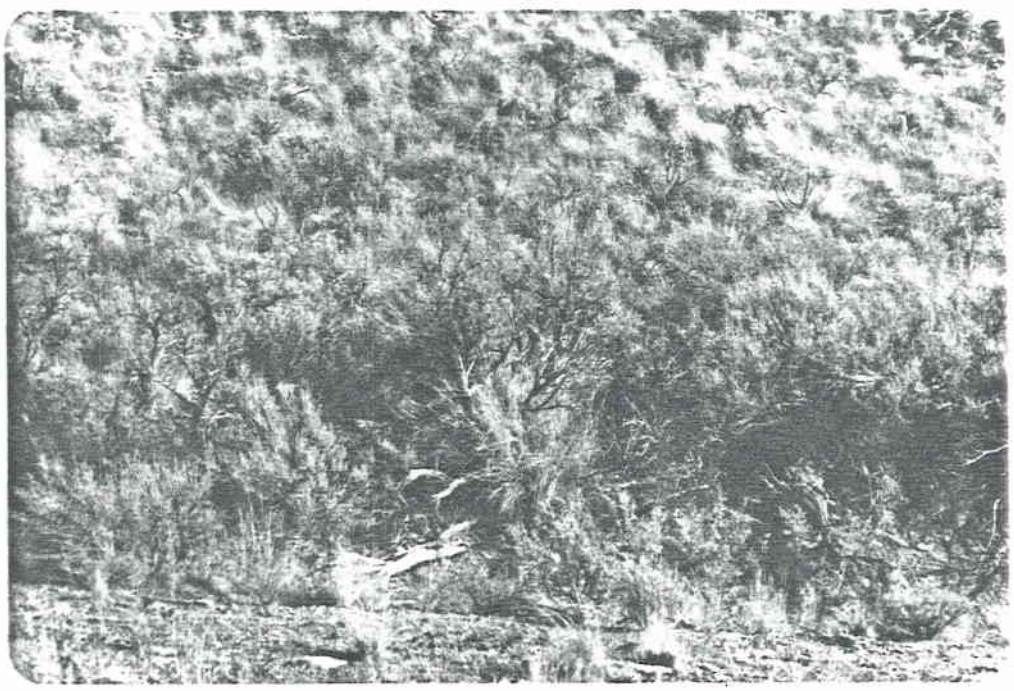


11 Riparian-Bulrush-Sedge



12 Riparian-Cottonwood Grove

13 Riparian-Willow



14 Sagebrush-Grass

CHAPTER IX

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 IX-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 IX-36). With both quadrats and point line, rock had the highest cover with 53.12 percent and 32.91 percent, respectively (Table IX-37 and IX-36). Table IX-38 presents a comprehensive species list for the Pinyon-Juniper/sagebrush habitat type.

Stand characteristics are delineated in the association table, Table IX-33. Pinyon pine (Pinus edulis) and Utah juniper (Juniperus osteosperma) are about equally prevalent with 144 and 153 trees per hectare, respectively (Table IX-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 IX -34 and IX-35). The

most common shrub is big sagebrush (Artemisia tridentata) with 3,478 stems per hectare (Table IX-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), recommends that Kaiser only sample the riparian community most disturbed and most likely to be revegetated. Using photographs taken near the early Sunnyside townsite 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 IX-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 IX-24. A comprehensive species list is included in Table IX-25.

Tree overstory consists of narrowleaf cottonwood (*Populus angustifolia*) and box elder (*Acer negundo*). With few exceptions, these trees are small in size. Average basal diameter is 5.4 inches (13.7 cm) for the cottonwood and 2.4 inches (6.1 cm) for the box elder. Tree densities are 41 cottonwoods per acre (102/ha) and 36 box elders 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 virginsbower (*Clematis columbiana*) are the most common species. Cover and constancy by species are given in Table IX-26. Total forb and grass cover is 4.4 percent (Table IX-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 disturbance 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 2255 m). Slopes vary from 1 to 7 percent. Aspect is typically south-facing.

This vegation 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 (145 cm) 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 IX-27). Rubber rabbitbrush (Chrysothamnus nauseosus) and snowberry (Symphoricarpos oreophilus) are common but less frequent components of the shrub stratum. Commom forbs are Utah sweetvetch (Hedysarum boreale), pingue (Hymenoxys richardsonni), annual crypthanthas (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 IX-27. The comprehensive species list for Sagebrush-Grass is contained in Table IX-28.

Herbaceous vegetation cover from quadrats (Table IX-29) averages more than 36 percent. Grasses, annual and perennial, account for 93 percent of the relative herbacious 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 Agropynon spicatum over large areas (Harris 1967).

Shrub cover from line-intercept measurements averages 21 percent (Table IX-30). Total first-hit vegetation cover from point-line transects averages 77 percent (Table IX-31). Annual primary production was estimated by the U. S. Soil Conservation Service as 1000 pounds 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 123.5 acres (50 ha) are disturbed in this type.

Mountain Brush

The Mountain Brush vegetation type occurs from elevations of 7000 to 8600 feet (2133 to 2620 m). 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. Further information regarding these soils is included in Chapter VIII, Appendix 8.14.

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 IX-2). Shrub cover, estimated by line-intercept transects, is 26 percent (Table IX-3).

Understory cover, from quadrats, is estimated to be 10 percent (Table IX-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 IX-5. Point-line transect data indicates a total vegetation cover of 46 percent (Table IX-6). The comprehensive species list for the Mountain Brush vegetation

type is presented in Table IX-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 11.2 acres (4.5 ha).

Pinyon-Juniper

(*Pinus-Juniperus*)

The Pinyon-Juniper (PJ) vegetation type is found from an elevation of 6900 to 7600 feet (2102-2315 m). 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 (10 cm) 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 IX-8). Tree densities and basal areas are included in Table IX-9 and IX-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 (*Brassicaceae* spp.) the most common forbs. Complete understory cover and constancy data is presented in Table IX-11. A comprehensive species list is contained in Table IX-12.

Shrubs are numerous in this vegetation type, with densities over 300 shrubs per acre (822 per ha). True and curlleaf mountain mahogany (*Cercocarpus montanus* and *C. ledifolius*) and Stansbury cliffrose (*Cowania mexicana*) are the most frequently encountered members of the shrub strata (Table IX-13).

Understory vegetation cover from quadrats (Table IX-14) averages less than two percent. Shrub and tree cover (Table IX-8) from line intercept measurements averages 34 percent. Total first-hit cover from point-line transects (Table IX-15) averages 29 percent for all vegetation. Annual primary production is estimated by the SCS to be 200 pounds per acre (224 kh/ha).

Existing disturbances are an electrical substation, ventilation fans, and old portals. The disturbed acreage approximately equals 14.3 acres (5.8 ha).

Pinyon-Juniper/Grass

The Pinyon-Juniper/Grass vegetation type is found at elevations of 6400 to 6500 feet (1949 to 1980 m) 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 (12.5 cm) 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 IX-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 IX-17. Utah juniper has the greater amount of basal area per acre (Table IX-18), while pinyon pine produced far more seedlings per acre than the juniper (Table IX-19).

The dominant shrub component is true mountain mahogany (*Cercocarpus montanus*) while the dominant understory components are Indian ricegrass (*Oryzopsis hymenoides*), penstemon (*Penstemon subglaber*) and lobeleaf groundsel (*Senecio multilobatus*). Understory vegetation cover, estimated from quadrat data, is 9 percent (Table IX-20). Complete cover and constancy information for understory vegetation is included in Table IX-21.

A comprehensive species list is contained in Table IX-22.

Vegetation measurements from point-line transects indicated a first-hit total vegetation cover of 35 percent (Table IX-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 247.0 acres (100.0 ha) are disturbed in the Pinyon-Juniper/Grass Vegetation Type.