

REPORT OF STUDIES OF VEGETATION AND SOILS
FOR COASTAL STATES ENERGY COMPANY
CONVULSION CANYON MINE OF SOUTHERN UTAH FUEL COMPANY (SUFCO)
SEVIER COUNTY, UTAH

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ABSTRACT

Reported herein are the findings of investigations of vegetation, plant community analysis, threatened and endangered plant species, soils, and reclamation potential. These investigations were designed to provide answers to questions on environmental parameters as included in Office of Surface Mining regulations (783.19, 783.21, 784.13, 784.21), U. S. Forest Service requirements, and requirements of the Utah Division of Oil, Gas, and Mining.

Included is a description of the plant communities, a list of plant species by vegetative type, estimates based on random sampling of cover and productivity for areas to be disturbed, and maps showing vegetative and soil types and sample locations. Soils and general vegetation types are described. Recommendations are made regarding revegetation of areas to be disturbed.

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INTRODUCTION

The Convulsion Canyon mine lease area of Southern Utah Fuel Company (SUFCo) consists of about ten square miles of land situated on the Wasatch Plateau of Utah in Sevier County. The property lies principally within the Fishlake National Forest, with the eastern boundary about six miles west of the community of Emery. The property includes the part of Old Woman Plateau bounded by Quitchupah and Convulsion canyons as well as portions of those canyons. Included also in the study is land adjacent to the lease area immediately south of the portal area where a sedimentation pond is to be constructed.

Elevations vary from a low of about 7000 feet in the canyon bottoms to a high of 9022 feet on Little Duncan Mountain. Canyons are entrenched into the underlying coal-bearing strata; their slopes are steep and wooded. The plateau is vegetated with sagebrush, grassland, and a variety of forest and mountain brush types.

The purpose of this report is to provide information on vegetation, soils, and endangered and threatened plant species, and to recommend revegetation procedures following conclusion of mining activity. Intensive study has been made to provide information on vegetation, its kinds, communities, and productivity. Similarly, soils have been intensively studied to gain data as to the nature and productive potential of those substrates. Accumulated data will provide reference for any required reclamation action.

VEGETATION

General Description.--The Convulsion Canyon SUFCo properties and adjacent areas occur within a pinyon/juniper, ponderosa pine, fir, and aspen phase of the boreal forest biome. Representatives of the cool desert shrub biome are also evident with sagebrush/grass, black sagebrush, and mountain brush types present.

The pinyon/juniper community, including in some places a substantial curl-leaf mountain mahogany component, occupies about 26 percent of the lease area. The type occurs mostly on steep canyon slopes between 7,000 and 9,000 feet elevation. On slopes of 65% or steeper the vegetation is found growing widely dispersed, giving the appearance of almost barren slopes. Ponderosa pine with mixtures of mountain mahogany, manzanita, and aspen occurs on canyon rims and flat mesa tops. The type and its subtype variants occur at approximately 8,000 to 8,500 feet elevation. Often there are one or more subtype components lacking and a single dominant subtype may occupy areas of a few hundred square yards. Ponderosa pine and associated subtypes occur in about 20 percent of the lease area. Nearly 100 species were observed to occur in this general vegetative type. Some stands of mountain mahogany are included as understory co-dominants in ponderosa pine stands or as a subtype with fir, while about six percent of the lease area is mapped as mountain mahogany alone.

Where soils and topography are suitable, aspen groves form patches surrounded by big sagebrush, or form fringe stands bordering ponderosa

pine communities; aspen communities also occur as subtypes within the ponderosa pine forest. There is a rich diversity of species in aspen communities; about 70 species were recorded for the type. Of this number, 26 species occurred in the transect samples of those aspen stands on better soils; where soils are shallow and rocky only 16 species were encountered, and aspen trees are rather small in diameter and uniform in size and height.

The white fir community is a type mainly of north-facing slopes. In dense fir stands the forest floor is subjected to deep shade which results in almost complete lack of understory foliage. Variation in topography may promote subtype stands of aspen or mountain mahogany, and where steep canyon bottoms provide a cool and moist environment there is a replacement of pinyon and juniper with a Douglas-fir and fir mixture. The fir type is found at about 9,000 feet elevation or in canyon bottoms down to 7,000 feet, and occupies approximately 19 percent of the lease area.

The cool desert species of big sagebrush and black sagebrush each occupy approximately 11 percent of the lease area. Collectively these two types are remarkably diverse, with 97 species reported. As many as 28 species occur in the transect sample of the big sagebrush/grass community and 35 species in the well-developed black sagebrush types. Big sagebrush, bitterbrush, and rabbitbrush are the dominant shrubs, and along with numerous species of grass and forbs are important contributors to the forage for livestock in the big sagebrush community. The black sagebrush type is on gradual slopes of approximately 5 percent. In mixture with rabbitbrush, wildrye, and numerous species of forbs, black sagebrush provides important forage.

Mountain brush communities are dominated by Gambel oak thickets

approaching 15 feet in height. Mixtures of shrubs such as snowberry, Woods rose, and rabbitbrush along with many species of grasses, grass-like plants, and forbs distinguish this community as having the most dense understory canopy coverage of any community. Mountain brush occurs on intermediate slopes of approximately 40 to 50 percent and constitutes approximately 5 percent of the lease area.

Table 1 (page 39) summarizes the approximate proportion and amount of area occupied by each of the major vegetative types. Table 2 (page 40) lists alphabetically each of the species observed to occur in the study area, and indicates those vegetative types where each was noted. The species with their common names are listed in Appendix A.

Maps.--Maps of vegetative types and soils, which are included with this report, were made for the lease area and sedimentation pond at the mine portal area. These areas were mapped by use of a mosaic of aerial photographs. Community types were outlined on the photographic mosaics; accuracy was assured by correlation of communities as inspected on the ground with those discernible on the photographs.

Species Lists by Vegetative Type.--As each plant community was being sampled for its vegetation, a list of all species of vascular plants was compiled. The list was enlarged by checking subtypes within each of the plant communities and by inclusion of species which occur on vegetation units too small to be included on the maps as major types.

Community Analysis (Methods).--In each major vegetative type and in significant variants within types permanent transects, each 100 meters in length, were established at representative sites. The transects were permanently marked with steel rebar stakes painted red; these will serve as points for contemporary and future reference. Vegetative analysis of

the disturbed portal area was not conducted, but reference areas adjacent to the mining activities already under way and representative of the original communities were selected and analyzed.

Stratified random sampling was employed, in which location of transect lines and plots within homogeneous portions of the vegetative types was randomly determined.* From twenty to sixty 2 X 5 dm rectangular plots were placed along each transect. Randomness was ensured by using a table of random numbers to select three plots within each ten-meter section of the transect. At each sampling site in the various communities the sampling procedures followed those outlined by Daubenmire (1957) for the canopy coverage method. For each species of forb, grass, or shrub the canopy was projected as cover of the ground, and such cover was estimated in six cover classes. Total cover, frequency percent, and composition percent were computed for the species along each transect. The line intercept method was used where deemed applicable. Fir and aspen sites were studied further by application of the quarter method of Curtis (1956), which gives relative cover and relative density values. Tree species dynamics were studied by use of the quarter method, where selected trees in each class were measured for diameter, height, and age.

*Theoretically, failure to place sampling units randomly violates certain assumptions of statistical theory. While subjective placement of sampling units may seriously misrepresent actual conditions on the ground, random placement of quadrats is not the only objective means of placing samples. The stratified random system used here where placement points in each stratum are located randomly is objective since the sampling point is determined before the sampler sees the spot. Such a method has several advantages. It is far more practical for physical, temporal, and financial reasons; further, it ensures that all parts of the sample area are equally sampled. Application of statistical tests can be meaningfully applied.

Ages of trees were determined by counting core sample rings extracted from the tree with a Swedish increment borer. Average increments of growth in diameter per year were calculated.

Productivity measurements of grass and forb species were made by using 0.96 or 9.6 square-foot plots with weight estimates made on each species as outlined in the Range Analysis Handbook (USDA 1970). The weight estimate of each species in 10 randomly selected plots allows for determination of the total pounds of productivity available for grazing in each forb community. These studies were omitted in the dense forest communities due to a lack of meaningful ground cover.

In order to evaluate adequacy of sample size, the following formula (Harper 1980) was utilized:

$$N(\text{min}) = \left(\frac{1.64S}{x(0.1)} \right)^2$$

Sample Adequacy.--In preliminary studies prior to actual sampling it was determined that approximately twenty 2 X 5 plots would be adequate; with this number a 10 percent increase in the number of plots fails to yield to a 10 percent increase in number of species. This sample size is believed adequate to reveal the diversity of the community. However where indicated by sample adequacy tests, additional plots were added to the sample.

Results of adequacy of sample calculations are summarized in Table 3. In stands where the understory cover was very spotty such as beneath pinyon/juniper, quadrat cover data were extremely variable, resulting in a calculated requirement for a prohibitively large number of quadrats.

It should be noted that overstory canopy data are not included in transect cover data (with the exception of the mountain brush type, in which the line intercept method was employed); inclusion of such data would greatly diminish the variability of sample means as well as the projected required sample size.

Vegetation Summary.--Table 4 summarizes transect data. Transect data from individual sites is presented in Tables 5-35. Table 36 summarizes tree productivity data.

The aspen stand sampled at Site 1 was typical of aspen forests of vast acreages of the Wasatch Plateau. The soils are deep and well drained and support a rich understory of species contributing 169 percent cover. The understory is also typical in having a high productivity of 225 pounds per acre. Sampling data indicates a density of 1210 trees per acre; all intermediate size classes are well represented. Growth rate is greater at this location than at others studied, with an average annual increase in diameter of 3.4 mm per year. The average age was calculated as 47 years.

Transect Site 2 sampled an aspen stand on shallower more xeric soil. Total cover at this site is calculated to be 81 percent; productivity of the understory is 574 pounds per acre. Tree density, at 3326 trees per acre, is greater than at Site 1, but the trees are on the average shorter, smaller in diameter, and older. The growth rate, at 1.8 mm per year, is only half that of the more mesic aspen site.

Site 3 is in a black sagebrush dominated community. Eight shrub species contributed 40 percent of total composition. For the most part these are palatable shrubs; the shrubs, four species of grass, and 23 species of forbs contribute to a calculated production of 417 pounds per acre. The black sagebrush vegetative type is extensive, and is developed

wherever limestone substrates occur on suitable topography. Site 4 is in a black sagebrush/grass community on a limestone knoll protruding above an intensive sagebrush area. Due to exposure and soil differences it is a more xeric site than is Site 3, with fewer species (23) and lower productivity (355 pounds per acre).

Stands of fir on the lease area occupy north-facing slopes at higher elevations; the species is also found as a minor component with Douglas-fir in steep canyon bottoms. At Site 6 total calculated understory cover of 30 percent consisted of three grass species (16 percent composition), six shrub species (42 percent composition), and 11 forb species (42 percent composition). At this site, as at others where the understory is very sparse, no grazing productivity estimates were made. Density was calculated at 433 trees per acre; average diameter is 8.3 inches; average increase in diameter is 1.5 mm per year. A large number of seedling trees as well as numerous trees of intermediate size occurred in this single-species dominated fir forest. This indicates a near-climax stand with self-perpetrating characteristics.

In the mountain brush community (Site 7) the dense thickets of shrubs and small trees with overlapping canopies were measured by the line intercept method. Oak, rabbitbrush, and big sagebrush were principal components of the 544 percent total cover (Table 23). Herbaceous species and low growing shrubs represented an additional 78 percent (Tables 20,21). Forbs (19 species) constituted 69 percent of the total composition. Production in the mountain brush community was calculated at 935 pounds per acre.

Study Sites 8 and 9 are in a ponderosa pine/manzanita/mountain mahogany community. Understory coverage of grass, forbs, and low shrubs is typically sparse, with a calculated cover of only 58 percent. Shrubs

(six species) contribute 72 percent of the composition, grasses (five species) contribute five percent, and forbs (nine species of generally low palatability) contributed 23 percent. No productivity measurements were made for grass and forbs because of their minor contribution to productivity at this site.

Past intensive lumbering activities in the area explains the low quantity of ponderosa pine (five trees per acre at Site 8 and 18 trees per acre at Site 9). Aspen density for the two sites is 19 and 42 trees per acre. Density of curl-leaf mountain mahogany is respectively 84 and 81 trees per acre. Average annual growth rate of trees in the more mesic site (Site 8) is 4.8 mm per year; average age is 88 years. Cover is 58 percent. Trees of the more-xeric Site 9 are somewhat older and larger and have a growth increment of 2.6 mm per year. Cover is 52 percent.

Site 10 is a pinyon/juniper/mountain mahogany vegetation type on a sparsely vegetated steep slope. Cover of 38 percent and forage of 316 pounds per acre is contributed by three species of grass. Tree density is low, at 120 trees per acre. Growth rate is slow at 1.5 mm per year. The pinyon trees are old, with an average diameter of 14 inches and an average age of 236 years.

The big sagebrush/grass community, occurs on mesic valley bottoms and gentle slopes, covering about 11 percent of the lease area. Site 11 shows big sagebrush and bitterbrush to be co-dominant, and, with little rabbitbrush and wood rose, compose 46 percent of the vegetation. Wheatgrass with four other grass species make up 26 percent of the composition. The remaining 32 percent is attributable to 19 species of forbs. Canopy cover is 110 percent. Major species are well distributed along the transect. Productivity is 762 pounds per acre.

Site 12, in a pinyon/juniper/mountain mahogany vegetative type,

serves as a reference site for disturbed areas. The mine portal area and access road to the load-out facilities are located on nearby steep slopes and in the bottom of East Spring Canyon. Construction activities have left little if any of the natural communities. The immediate environs of the mine area had supported a steep-slope phase of the pinyon/juniper community. Site 12 sampled this vegetative type above the proposed sedimentation pond. The site is typical of extensive stands of pinyon/juniper in the lease area, occurring on almost barren xeric steep slopes. Slopes of about 65 percent are common, and barrenness is accentuated by the presence of large rock outcrops and talus slopes. These conditions of topography help explain the low (9 percent) canopy coverage provided by three grasses, five forbs, and three tree and shrub species. Woody species represent 42 percent of the undercover composition. Total tree density is 184 trees per acre and consists of four species, of which pinyon is the most abundant and has the most extensive size distribution. The growth rate of pinyon (1.7 mm per year) is about the same here as in the pinyon/juniper community at Site 10. The pinyon trees are somewhat smaller and younger on the average than the juniper trees with which they grow.

Site 13 is designated as a riparian site and will serve as both validation and reference site for a proposed sedimentation pond. Trees are the principal vegetation, which occurs in the very bottom of a steep-walled canyon. Trees are clustered on both sides of a mine-produced, impacted, perennial stream. The steep cliffs on each side of the stream provide an almost completely shaded cool moist environment for seven species of trees. Species present here do not typically occur together. Fir and Douglas fir are high elevation species, ponderosa pine, pinyon pine, and Rocky Mountain juniper are typical of intermediate elevations,

and Gambel oak and big tooth maple often occupy somewhat lower elevations. Tree density is only 60 trees per acre. Average growth rate was not calculated because of the low density of individual species. Fir is apparently the dominant species, occurring with the greatest frequency and having the most extensive size distribution.

The exact location of the sedimentation pond, construction of which will destroy a portion of the riparian community, is not yet known, but plans are in existence and will be a part of the new mine and reclamation plan submittal. The portion of this limited vegetation type which remains after construction must serve as reference site for revegetation and reclamation efforts, since no comparable steep sided canyon with a perennial stream is known. The type is heterogenous and small in size, making application of statistically acceptable tests difficult if not impossible.

THREATENED AND ENDANGERED PLANT SPECIES

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

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

A survey of the literature has failed to indicate the presence of any of the proposed endangered or threatened plant species in the area. This lack of critical or unique species is supported by the field surveys of the lease areas during this investigation. The region was searched by walking parallel transects on a quarter-section by quarter-section basis, with each community type within each quarter-section being traversed. None of the proposed threatened or endangered species were encountered in either the lease area or in the surrounding areas.

SOILS

Soils Analysis (methods). At each vegetation site a soil pit was excavated to the parent material, or to a depth of 60 inches, whichever occurred first. The exposed soil profile provided information for classification of the soils into taxonomic units. Samples were taken from each of the horizons exposed in the pit profile and analyzed for major chemical properties.

Soils were classified to family unit according to the system utilized for classification of soils by the Soil Conservation Service (Johnson, 1975). Use of this method will allow for correlation of these soils to series level when the Soil Conservation Service and Forest Service complete the current mapping effort of adjacent areas.

Chemical analyses for micro-nutrients were made by testing a soil extract with DTPA solution and were measured by use of an atomic absorption analyzer. Ammonium acetate was used to extract sodium, magnesium, and calcium for atomic absorption analysis. The Kjeldahl method was used for determination of percent organic matter. All analyses were conducted in the Agronomy Laboratory at Brigham Young University. The Ca content determined does not always represent the soil profile. It has been suggested that high Ca content in the surface has been blown in. There have been no suggestions as to why some determinations appear to be higher or lower than field experience indicates.

Soil texture was determined by using a Bouyoucus hydrometer method, with sodium hexametaphosphate dispersing agent. Soil reaction was determined on a 1:1 soil/water mixture which was tested in a Corning pH meter Model 10. Salinity was analyzed by use of a Wheatstone conductivity cell on an extract of each soil sample. Carbonate content was estimated from observations of effervescence following application of a 10 percent solution of hydrochloric acid. The scale of effervescence follows the rating system suggested by the Soil Conservation Service (USDA Soil Survey Manual, 1937). Soil color was obtained by comparing a moist and a dry sample with the standard Munsel soil color charts. Observations of soil structural units also follow the Soil Conservation Service suggested designation as outlined in the Soil Survey Manual.

Soils Analysis (discussion, results, and conclusions). Details of analysis of soils at each of the sites are summarized in Tables 37 to 59. Local climatic data suggests cryic and frigid temperature regimes. The cryic regime is typically conifer-aspen related, and is generally developed in areas too cold for cultivation of crop plants by ordinary means. Frigid designation is given to soils typically developed on high sagebrush flats, mountain brush slopes, and ponderosa pine/mountain mahogany plateaus. The soils of this area border the ustic (moisture arriving in summer) includes the xeric (moist winters, dry summers) and aridic (dry all year) moisture regimes.

All soils have textures ranging from sandy loam to clay, and are considered neither unusual for the area in general nor for the vegetation types those soils support. The pH values range from 5.4, strongly acid, under spruce/fir, to 8.6, strongly alkaline, under black sagebrush. These are the extremes, however, and most of the soils are slightly acidic to mildly alkaline. The most saline soil, with an EC x 10

measurement of 6.34, is considered only slightly saline according to the USDA-SCS handbook. These slightly saline soils make up no more than 15 percent of the entire survey area.

High amounts of calcium, especially in mountain brush soil substratum, are not considered a problem in immobilization of phosphorus due to the mildly alkaline to neutral pH of these soils and depth to the layer of calcium concentration. Problems could arise if soils are altered to become more basic or if the calcium increases nearer the surface.

The most important fertilizer to be applied in reclamation is nitrogen. Increased available nitrogen would enhance fertility of soils present. Phosphorus should be applied at a moderate rate to aid productivity. The addition of any fertilizer should be applied at a time when there is suitable moisture content in the soil. This moisture content usually occurs in fall and spring. Where soil moisture is insufficient, supplemental irrigation should be provided.

Surface disturbance is to occur only in the sedimentation pond and road access areas; thus suitability rating for soils are given only for those areas. The suitability ratings for the pond reservoir area is determined by the guide set in the USDA's National Soils Handbook Section 403.

Soils with the best rating (slight) have a low seepage potential which is determined by permeability and by depth to fractured or permeable bedrock. The soil is rated on its properties in the upper 60 inches as a natural barrier against seepage into deeper layers without regard to features that may be installed under the pond embankment. Excessive slopes in the direction perpendicular to the axis of the pond embankment seriously reduce the storage capacity of the reservoir area.

Preliminary correlation was accomplished in consultation with Mr. Laurell Stott, Party Leader of the Sevier County Soil Survey. Final correlation can be satisfied only with Soil Conservation Service State Office officials.

Soil Mapping and Description. A soils map of the lease area and sedimentation area have been prepared and are included with this report (Appendix B). Mapping unit descriptions follow in the text. The soils are also classified by the vegetation type with which they are correlated, as is recommended by the Soil Conservation Service.

The general lease area has been surveyed at an Order 3 level of intensity. The base map used for the lease area is a 7.5 minute USGS topographic map, Acord Lakes quadrangle. The sediment pond area has been surveyed at an Order 1 level of intensity. The base map used for this area is a blueprint from the engineering division of Coastal States Energy Company with a scale of 1 inch to 30 feet. Map unit descriptions for the lease area are designated by letters A through Z. Map unit descriptions for the pond area are designated by numbers and symbols as indicated.

Taxonomic classification of the soil samples is summarized below.

Lease Area Map Units

<u>Lease Area Map Unit</u>	<u>Taxonomic Classification</u>	<u>Sample Site</u>
A	Sandy, mixed, frigid Shallow Typic Haploxerolls	1
B	Fine, mixed, frigid Typic Xerochrepts	2
C	Sandy, mixed shallows Lithic Cryoborolls	3
D	Fine, mixed, frigid Typic Argixerolls	4
E	Coarse-loamy, mixed Typic Cryoboralfs	5
F	Fine, mixed, frigid Typic Haploxeralfs	6
G	Fine-loamy, mixed, frigid Typic Haploxeralfs	7
H	Sandy, mixed, frigid Typic Haploxerolls	8
I	Fine, mixed Typic Cryoboralfs	9
J	Fine, mixed Aquic Cryoborolls	10
K	Fine-loamy, mixed, frigid Typic Haploxerolls	11
L	Fine, mixed Typic Cryoborolls	12
M	Fine, mixed Argic Pachic Cryoborolls	14
N	Fine, mixed, frigid Typic Xerorthent	15
O	Loamy-skeletal, mixed, frigid, Ustic Torriorthent	17
P	Complex of 50% of Unit D, 30% Unit F, 10% Unit G, 5% rock outcrop	
Q	Complex of 50% of Unit F, 30% Unit G, 5% Unit I, 10% rock outcrop	
R	Complex of 50% of Unit O, 25% Unit N, 5% Unit C, 5% Unit H, 10% rock outcrops	
S	Fine-loamy, mixed Typic Cryoboralfs	18
T	Loamy, skeletal, mixed, frigid Calcixerollic Xerochrepts	22

U	Fine-loamy, mixed, Typic Cryochrepts, with 40% Unit H, 20% unit O, and 15% rock outcrop	13
V	Fine, mixed, frigid Calcic Haploxeralfs	23
W	Loamy, skeletal, mixed, frigid Typic Xerorthents	24
X	Complex of 70% of sample site 20, 20% sample site 21, and 5% rock outcrop	
X	Clayey-skeletal, mixed, frigid Mollic Haploxeralfs	20
X	Loamy-skeletal, mixed, frigid, shallow Lithic Xeroithents	21
Y	Complex of 50% of Unit Z, and 40% Unit F	
Z	Fine-loamy, mixed, Typic Cryoboralfs with 45% Unit S, and 10% rock outcrop	19

Sedimentation Pond Area Map Units

<u>Sedimentation Pond Map Unit</u>	<u>Taxonomic Classification</u>
24	50% Loamy-skeletal, mixed, frigid Typic Xerorthents 20% rock outcrop 10% similar moderately deep 10% similar shallow
Overfill	Mine debris and coal dust
22	60% steep (60%) colluvium and residuum 30% rock outcrop
22a	25% rock outcrop 15% steep (60%) colluvium and residuum
20	70% Fine, loamy, mixed, frigid Mollic Haploxeralfs 15% rock outcrop 10% Loamy-skeletal, mixed, frigid, shallow Lithic Calcixeroll
22 8	65% steep (60%) colluvium and residuum 20% Sandy, mixed, frigid Typic Xerumbrept 10% rock outcrop
R	rubble
RO	road

Map Unit descriptions follow.

Map Unit A : This unit consists of somewhat excessively drained soils that have formed in residuum from sandstone. Slopes range from 2 to 8 percent. Elevation ranges from 8,400 to 8,600 feet. Present vegetation is predominantly ponderosa pine, aspen, and mountain mahogany. Available water holding capacity is 1.5 inches.

Analysis data and a representative profile are summarized in Table 37.

Range of characteristics includes a surface layer 4 to 10 inches thick with a texture of loamy fine sand to sandy loam, and a subsoil 4 to 14 inches thick with a rock fragment content of volume of 0 to 10 percent and a texture of loamy sand or sand. The substratum is 5 to 25 inches thick to a paralithic contact with sandstone. Percent rock fragment by volume ranges from 5 to 15 in the substratum. Texture is loamy sand or sand.

Erosion is slight at present; due to soil texture erosion hazard will be moderate if disturbed.

Included in this unit are 10 percent similar soils that have a paralithic contact at 20 inches, 20 percent similar soils whose paralithic contact is below 60 inches and 5 percent rock outcrop.

Map Unit B: Unit B consists of well drained soils that have formed in residuum and colluvium on limestone knolls. Slopes range from 15 to 35 percent. Elevation ranges from 8,500 to 8,700 feet. Present vegetation predominantly is black sagebrush and grasses. Available water holding capacity is six inches.

Analysis data and a representative profile are summarized in Table 38.

Range of characteristics includes a surface layer 2 to 5 inches thick with 10 to 20 percent rock fragments by volume. The subsoil is 4 to 9 inches thick; rock fragment is 10 to 20 percent. The substratum has a 3-inch thick coal seam at times that is 10 to 12 inches in depth.

Erosion is moderate at present and may be severe if disturbed due to rock fragment content and slope.

Included in this unit is 10 percent of the soil described in unit F and 5 percent similar soils.

Map Unit C: This unit consists of somewhat excessively drained soils that have formed in residuum from sandstone. Slopes range from 2 to 8 percent. Elevation ranges from 8,350 to 8,450 feet. Present vegetation is predominantly aspen. Available water holding capacity is 1.5 inches.

Chemical analysis data and a representative profile are shown in Table 39.

Range of characteristics includes a surface layer 6 to 10 inches thick with 10 to 20 percent rock fragment by volume and a texture of loam, sandy loam, or sandy clay loam. The substratum is 15 to 20 inches at depth to bedrock with rock fragment by volume of 20 to 30 percent.

Erosion is slight at present. Erosion hazard will be moderate if disturbed due to surface texture.

Included in this unit is 10 percent rock outcrop and 5 percent of similar soil.

Map Unit D: Unit D consists of well drained soils that have formed in residuum and alluvium. Slopes range 2 to 8 percent. Elevation ranges 8,200 to 8,600 feet. Present vegetation consists principally of bitterbrush, rabbitbrush, sagebrush, and western wheatgrass. Available water holding capacity is 7 inches.

Laboratory data of chemical analysis and a summary of the representative profile are on Table 40.

Range of characteristics includes a surface layer 6 to 12 inches thick. The subsoil extends to a depth of 20 to 35 inches with 0 to 3 percent rock fragment by volume. The texture of the subsoil is clay loam to clay. The substratum is clay loam or clay. There is a gravelly layer in the substratum 2 inches thick at 26 inches or deeper.

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

Included in this unit are 5 percent rock outcrop, 5 percent of the soil described in Unit G and 10 percent of soil described in Unit F.

Map Unit E: Unit E consists of somewhat excessively drained soils that have formed in residuum and colluvium. Slopes range from 35 to 60 percent. Elevation ranges from 8,450 to 8,750 feet. Predominant vegetation is spruce and fir. Available water holding capacity is 3.5 inches.

Analysis data and a representative profile description are presented in Table 41.

Range of characteristics includes a surface layer 1 to 4 inches thick with a texture of loam or sandy loam. The subsurface is a sandy loam to loamy sand layer 6 to 10 inches thick. The subsoil is 6 to 9 inches thick with 5 to 10 percent rock fragment by volume and a sandy loam or sandy texture. The substratum is deep with 35 to 40 percent rock fragment by volume and a sandy loam or sand texture.

Erosion is slight at present but the erosion hazard is severe if disturbed due to slope steepness.

Included in this unit are 5 percent rock outcrop and 5 percent of the soil described in Unit F.

Map Unit F: Unit F consists of well drained soils that have formed in residuum and colluvium. Slopes range from 15 to 35 percent. Elevation ranges from 8,300 to 8,700 feet. Predominant vegetation is black sagebrush and wildrye. Available water holding capacity is 6 inches.

Chemical analysis data and a representative profile are summarized in Table 42.

Range of characteristics includes a surface layer 9 to 12 inches thick with 15 to 35 percent rock fragment by volume and a texture of loam or sandy loam. The subsoil is 10 to 20 inches thick with 10 to 15 percent rock fragment by volume and a texture of clay loam or clay. There is a discontinuous coal seam at 23 to 25 inches. There is also a discontinuous gravel layer above the substratum that is 2 to 4 inches thick. The substratum is deep with 0 to 5 percent rock fragment by volume.

Erosion is moderate at present and the erosion hazard will be severe if disturbed due to high rock fragment content and steep slope.

Included in this unit are 20 percent rock outcrop and 10 percent of the soil described in Unit I.

Map Unit G: This unit consists of well drained soils that have formed in residuum and colluvium. Slopes range from 15 to 35 percent. Elevation ranges from 8,400 to 8,650 feet. Predominant vegetation at present is scrub oak and serviceberry. Average water holding capacity is 6.5 inches.

Chemical analysis data and a representative profile description are given in Table 43.

Ranges of characteristics includes a surface layer 2 to 4 inches thick with a texture of sandy loam or sandy clay loam. The subsoil is 6 to 18 inches thick with a loam or sandy clay loam texture. The substratum is deep with 10 to 20 percent rock fragment by volume and a loamy sand to sandy clay loam texture.

Erosion is slight at present. Erosion hazard will be severe if disturbed due to slope.

This soil may be later correlated with the Delleker or Lyonsoils series.

Included in this unit is 10 percent rock outcrop by volume and 20 percent of the soil described in Unit D.

Map Unit H: Unit H consists of well drained soils that have formed in residuum and colluvium. Slopes range from 8 to 15 percent. Elevation ranges from 1,300 to 8,300 feet. Predominant vegetation is presently pinyon, juniper, aspen, sage, and rabbitbrush. Available water holding capacity is 3 inches.

Chemical analysis and a description of the representative profile are summarized in Table 44.

Range of characteristics includes 1 to 3 inches of surface layer. The subsoil is 15 to 25 inches thick with 0 to 5 percent rock fragment by volume. The texture of the subsoil is loamy sand or sand. The substratum is deep, 40 inches or more to sandstone. Rock fragment by volume is 0 to 5 percent.

Erosion is slight at present and erosion hazard is moderate if disturbed.

Included in this unit are 5 percent rock ledges and 20 percent of the soil described in Unit A.

Map Unit I: This unit consists of deep, well drained soils that have formed in residuum and colluvium. Slopes range from 15 to 35 percent. Elevation ranges from 8,450 to 8,650 feet. Vegetation at present is predominantly sage and grasses. Available water holding capacity is 2.5 inches.

Analysis data and a representative profile description are given in Table 45.

Range of characteristics includes a surface layer 2 to 4 inches thick with 2 to 10 percent rock fragment by volume. The surface is 10 to 20 inches thick with 0 to 5 percent rock fragment by volume. The

substratum is 21 to 32 inches to sandstone. Rock fragment is 5 to 10 percent by volume.

Erosion is severe at present.

These soils may later be correlated with the Sicklesteets or Sluice series.

Included in this unit is 10 percent rock outcrop, 10 percent of the soil described in Unit G, and 5 percent of the soil described in Unit F.

Map Unit J: Unit J consists of poorly drained soil that have formed in alluvium. Slopes range from 2 to 8 percent. Elevation ranges from 8,300 to 8,600 feet. Predominant vegetation is presently grasses and sagebrush. Available water holding capacity is about 6 inches.

Chemical analysis data and a representative profile description are in Table 46.

Range of characteristics includes an upper surface layer 3 to 6 inches thick. The lower part of the surface layer is 6 to 10 inches thick. The underlying material has mottles in 15 to 30 percent of the matrix.

Erosion is slight at present and moderate if disturbed due to surface texture.

Included in this unit are 10 percent of the soil described in Unit I and 5 percent of the soil described in Unit F.

Map Unit K: This unit consists of well drained soils that have formed in residuum. Slopes range from 2 to 8 percent. Elevation ranges from 8,500 to 8,600 feet. Predominant vegetation is presently black sagebrush and grasses. Available water holding capacity is 5 inches.

Chemical analysis and a representative profile description are given in Table 47.

Range of characteristics includes a surface layer 6 to 12 inches thick with 5 to 15 percent rock fragment by volume. The substrate is 6 to 10 inches thick with 10 to 25 percent rock fragment by volume. Texture in the subsoil is sandy loam or sandy clay loam. The substratum has 0 to 5 percent rock fragments by volume to the paralithic at a depth of 25 to 35 inches.

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

Included in this unit is 5 percent similar soils.

Map Unit L: This unit consists of somewhat poorly drained soils that have formed in residuum and colluvium, and slopes which range from 35 to 60 percent. Elevation ranges from 8,400 to 9,100 feet. Predominant vegetation at present is aspen, serviceberry, and oak. Available water holding capacity is 7 inches.

Laboratory data and a representative profile description are summarized in Table 48.

Range of characteristics includes a surface layer 6 to 12 inches thick with a silt loam to clay loam texture. The subsoil is 5 to 8 inches thick with 0 to 5 percent rock fragment by volume. Texture of the subsoil is clay loam to sandy clay loam. The substratum is deep with a discontinuous coal seam at 36 to 48 inches. Texture of the substratum is clay loam to clay.

Erosion is severe at present, despite previous terracing by the Forest Service.

This soil may later be correlated with the Luth Series.

Included in this unit are 5 percent similar soils.

Map Unit M: This unit consists of well drained soils that have formed in residuum. Slopes range from 8 to 15 percent. Elevation ranges

from 8,300 to 8,600 feet. Presently predominant vegetation is aspen, snowberry, and wood rose. Available water holding capacity is 7 inches.

Chemical analysis and a representative profile description are given in Table 49.

Range of characteristics includes a surface layer 6 to 12 inches thick with a sandy loam or sandy clay loam texture. The subsoil is 20 to 30 inches thick with a clay loam to clay texture.

Erosion is slight at present. Erosion hazard is moderate if disturbed due to slope.

These soils may be correlated with the Clayburn series at a later date.

Map Unit N: This unit consists of well drained soils that have formed in colluvium and residuum. Slopes are 60 percent or more. Elevation ranges from 7,900 to 8,400 feet. Present predominant vegetation is pinyon pine and mahogany.

Available water holding capacity is 6.5 inches.

Chemical analysis data and a representative profile description are summarized in Table 50.

Range of characteristics includes a surface layer 6 to 12 inches thick with 35 to 65 percent rock fragment by volume. Texture in the surface layer is a clay loam or clay. The subsoil is a clay loam or clay with a thickness of 30 to 45 inches. There is 0 to 10 percent rock fragment by volume in the subsoil. The paralithic is at a depth of 45 to 50 inches.

Erosion hazard is severe at present due to unstable slopes.

Included in this unit are 15 percent rock ledges and outcrops, 10 percent of the soil described in Unit H and 5 percent of the soil described in Unit S.

Map Unit O: This consists of somewhat excessively drained soils that have formed in residuum and colluvium. Slopes are 60 percent or more. Elevation ranges from 6,900 to 7,900 feet. Predominant vegetation at present is juniper, pinyon, and mahogany. Available water holding capacity is 3.5 inches.

Analysis data and a representative profile description are summarized on Table 51.

Range of characteristics includes a surface layer that is 8 to 13 inches thick with 35 to 60 percent rock fragment by volume. Texture of the surface layer is sandy loam to sandy clay loam. The underlying material has a depth of 28 to 35 inches above bedrock with 35 to 50 percent rock fragment by volume and a texture of loam or clay loam.

Erosion hazard is severe at present due to steep, unstable loam.

Included in this unit are 20 percent rock outcrop and 15 percent rock ledges.

Map Unit P: This unit is a complex consisting of 50 percent of the soil described in Unit D, 30 percent of the soil described in Unit F, 10 percent of the soil described in Unit G, and 5 percent rock fragment.

Map Unit Q: This unit is a complex consisting of 50 percent of the soil described in Unit F, 30 percent of the soil described in Unit G, 10 percent rock outcrop, and 5 percent of the soil described in Unit I.

Map Unit R: This is a complex consisting of 50 percent of the soil described in Unit O, 25 percent of a shallow phase of the soil described in Unit N, 10 percent rock outcrop and 5 percent each of the soils described in Units C and H.

Map Unit S: This unit consists of well drained soils that have formed in colluvium and residuum. Slopes range from 35 to 60 percent. Elevation ranges from 7,000 to 8,600 feet. The predominant vegetation at

present is Douglas-fir and Oregon grape. Available water holding capacity is 4.5 inches.

Chemical analysis data and a representative profile description are given in Table 52.

Range of characteristics includes a duff layer 2 to 5 inches thick. The subsurface is 2 to 4 inches thick with 0 to 5 percent rock fragment by volume. Subsurface texture is loam or sandy clay loam. The upper subsoil is 6 to 10 inches thick with 10 to 20 percent rock fragment by volume and a texture of clay loam or sandy clay loam. The lower subsoil is 5 to 8 inches thick with 35 to 45 percent rock fragment by volume. Depth to bedrock is 30 to 40 inches. Percent rock fragment by volume in the substratum is 35 to 50 and the texture is sandy clay loam or clay loam.

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

Included in this unit are 15 percent of the soil described in Unit N and 2 percent rock outcrop.

Map Unit T: This unit consists of excessively drained soils that have formed in colluvium and residuum. Slopes are 60 percent or more. Elevation ranges from 7,200 to 7,600 feet. Predominant vegetation at present is pinyon pine, juniper, and wildrye. Available water holding capacity is 4 inches.

Chemical analysis data and a representative profile description are given in Table 53.

Range of characteristics includes a layer on the surface composed of coal and road debris 2 to 4 inches thick. The surface layer is 10 to 12 inches thick with 35 to 60 percent rock fragments by volume. Texture in the surface layer is sandy clay loam to clay loam. The subsoil is 8

to 12 inches thick with 35 to 50 percent rock fragment by volume. The substratum is 55 to 60 inches depth to bedrock. There is 50 to 65 percent rock fragment by volume in the substratum.

Erosion is severe at present.

Included in this unit is 30 percent rock outcrop and 5 percent similar soils.

The stream in the bottom has been altered by mine and road work.

Map Unit U: This unit is a complex consisting of 25 percent of the soil described below, 40 percent of the soil described in Unit H, 20 percent of the soil described in Unit O, and 15 percent rock outcrop.

The soil described here occupies the north-facing slopes. Unit H occupies the drier and warmer south-facing slopes. The soil described as Unit O occupies the lower and drougter sites.

The fir component consists of excessively drained soils that have formed in residuum and colluvium. Slopes range from 35 to 60 percent. Elevation ranges from 7,000 to 8,600 feet. Predominant vegetation at present is Douglas fir, white fir and snowberry. Available water holding capacity is 2.5 inches.

Chemical analysis data and a representative profile description are summarized in Table 54.

Range of characteristics includes a duff layer 0 to 2 inches thick. The surface layer is 4 to 5 inches thick with 0 to 5 percent rock fragment by volume. Surface texture is sandy clay loam or sandy loam. The subsoil is 4 to 7 inches thick with 0 to 5 percent rock fragment by volume. The texture in the subsurface is sandy loam or loamy sand. The subsoil is 4 to 8 inches thick. There is 5 to 10 percent rock fragment by volume in the subsoil; texture is loamy sand or sandy loam. The

substratum is 20 to 25 inches deep to bedrock. There is 35 to 60 percent rock fragment by volume and the texture is sandy loam to sand.

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

These soils may later be correlated with the Azwell series.

This complex crosses temperature and moisture regimes. This does not cause a problem because all of the slopes are very steep and management will be the same.

Map Unit V: This unit consists of well drained soils that have formed in alluvium. Slopes range from 0 to 2 percent. Elevation ranges from 7,200 to 7,000 feet. Presently, the predominant vegetation is big sagebrush. Available water capacity is 7 inches.

Chemical analysis data and a representative profile description are given in Table 55.

Range of characteristics includes a surface layer that is 6 to 11 inches thick with a sandy loam, clay loam, or sandy clay loam texture. The subsoil is 15 to 20 inches thick with a clay loam or sandy clay loam texture. There are occasional gravel pockets 3 inches in diameter in the subsoil. The substratum is deep stratified layers of sandy clay loams and clay loams.

Erosion is slight at present. The erosion hazard is moderate if disturbed due to position on landscape.

Included in this unit are 15 percent of a similar soil under oak and 10 percent of a similar soil under rabbitbrush.

Map Unit W: This unit consists of excessively drained soils formed in colluvium and residuum. Slopes are 60 percent or more. Elevation ranges from 7,600 to 8,300 feet. Presently the predominant

vegetation is pinyon/juniper. Available water holding capacity is 3.5 inches.

Analysis data and a representative profile description are summarized in Table 56.

Range in characteristics includes a 4 to 8 inch thick covering of coal dust and mine refuse. The surface layer is 3 to 4 inches thick with 55 to 65 percent rock fragments by volume. The texture of the surface is sandy loam or sandy clay loam. The underlying material is deep with 35 to 55 percent rock fragment by volume. Texture of the underlying material is sandy loam or sandy clay loam.

Erosion is severe at present.

Included in this unit are 25 percent of moderately deep similar soils, 15 percent of shallow similar soils, and 30 percent rock outcrop.

Map Unit X: Unit X is a complex consisting of 70 percent of the first component described below, 20 percent of the second component described below, and 5 percent rock outcrop.

The first component consists of well drained soils that have formed in colluvium and residuum. Slopes range from 15 to 35 percent. Elevation ranges from 7,200 to 8,400 feet. Present vegetation is predominantly pinyon pine and juniper. Available water holding capacity is 3 inches.

Chemical analysis data and a representative profile description are in Table 57.

Erosion is moderate at present but the erosion hazard is severe if disturbed due to surface texture and steep slopes.

These soils may later be correlated to the Kilfuil series.

Range in characteristics includes a duff layer 2 to 4 inches thick. The surface layer is 4 to 6 inches thick. Rock fragment by

volume ranges from 5 to 10 percent and texture is sandy loam to sandy clay loam. The surface is 10 to 12 inches thick with 15 to 30 percent rock fragment by volume. The texture of the subsoil is clay loam or clay. The substratum is to a depth of 30 to 35 inches to paralithic contact. Percent rock fragment by volume is 35 to 55 percent.

The second component of this unit consists of well drained soils that have formed in residuum and colluvium. Slopes range from 35 to 60 percent. Elevation ranges from 7,200 to 8,400 feet. Pinyon and juniper are the predominant present vegetation. Available water holding capacity is 2 inches.

Chemical analysis data and a representative profile description are given in Table 58.

Range in characteristics includes a surface layer 4 to 5 inches thick with 20 to 30 percent rock fragment by volume. Texture of the surface is clay loam or sandy clay loam. The underlying material extends to a depth of 15 to 19 inches to bedrock. There is 35 to 60 percent rock fragment by volume in the underlying material; texture is clay loam or clay.

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

These soils may later be correlated with the Mike series.

Map Unit Y: Unit Y is a complex consisting of 50 percent of the second component described in Unit Z and 40 percent of the soil described in Unit F.

Map Unit Z: This unit is a complex consisting of 45 percent of the soil described in Unit S, 30 percent of the soil described below, and 10 percent rock outcrop.

The second component of Unit Z is of well drained soils that have formed in residuum and colluvium. Slopes range from 35 to 60 percent. Elevation ranges from 7,800 to 8,400 feet. Predominant vegetation is presently pinyon pine, mountain mahogany, and wildrye. Available water holding capacity is 5.5 inches.

Chemical analysis data and a representative profile description are given in Table 59.

Range in characteristics includes a surface layer that is 2 to 3 inches thick with 15 to 20 percent rock fragments by volume. The texture of the surface layer is loam or sandy clay loam. The subsoil is 15 to 22 inches thick with 15 to 30 percent rock fragments by volume. The substratum contacts bedrock at a depth of 45 to 50 inches. The substratum has 40 to 50 percent rock fragment by volume.

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

Map Unit 24: This unit of about 3.4 acres consists of 50 percent of the soil described in Unit W, 20 percent rock outcrop, 10 percent of a similar moderately deep soil, and 10 percent of a similar shallow soil.

Because of the greater disturbance of these areas, erosion is severe at present.

When disturbed, there is no suitable topsoil to store due to rock fragment content.

Overfill: The overfill, which occupies about 2 acres, has been pushed into the canyon from the mine site. There is an average of 8 inches of coal dust and mine waste over soil and rock materials from above.

When disturbed, there is no suitable topsoil to store.

Map Unit 22 8: This small unit (0.2 acres) consists of 65 percent of the soils described in Unit T, 20 percent of the soils described in Unit 4, and 10 percent rock outcrop.

Because of the greater disturbance of these areas, erosion is moderate to severe at present.

When disturbed, there is no suitable topsoil to store due to rock fragment content.

Rubble: The rubble unit consists of boulders and large stones that have moved down the slopes; it covers about 0.4 acres.

When disturbed there is no suitable topsoil to store.

Map Unit 22a: This unit consists of 75 percent rock outcrop and 15 percent of the soils described in Unit T, and covers about 0.6 acres.

Because of the greater disturbance of these areas erosion is severe at present.

When disturbed there is no suitable topsoil to store.

Map Unit 22: This 2 acre unit consists of 60 percent of the soils described in Unit T and 35 percent rock outcrop.

Because of the greater disturbance of these areas erosion is severe at present.

When disturbed there is no suitable topsoil to store due to rock fragment content.

Map Unit 20: This unit consists of 70 percent of the soils described as the first component of Unit X, 15 percent rock outcrop, and 10 percent of the second component of Unit X. It covers about 1 acre.

Because of the greater disturbance of these areas, erosion is severe at present.

When disturbed, the first average 15 inches could be stored for reclamation topsoil use. There is 1.125 acre feet of topsoil available.

STABILIZATION AND REVEGETATION OF DISTURBED AREAS

The biological aspects of OSM Regulation 784.13 in regard to stabilization and revegetation of disturbed areas are considered herein.

Schedule of Revegetation.--Initial revegetation attempts will be conducted in the season of disturbance, consistent with successful establishment of plantings - i.e. mainly during spring, summer, or early fall. Where too steep for topsoil placement, planting will follow immediately as the area becomes available during construction activities. Revegetation on slopes steeper than 1h:1.5v will not allow topsoil placement.

Native Species and Amounts.--Only native species are recommended for revegetation of the mine portal and pond areas. Diversity of species should allow ultimate utilization of plants by wildlife and by domestic livestock. Both mine portal and pond areas are regarded as harsh environments, and might require exceptional methodology before successful revegetation is realized.

Recommended species and amounts:

Grasses (seed)	lbs/acre
Bluebunch wheatgrass	2
Western wheatgrass	2
Basin wildrye	2
Salina wildrye	2
Forbs (seed)	
American vetch	2
Lewis flax	2

Shrubs (transplants)	interval (feet)
Rubber rabbitbrush	3
Utah juniper	3
Pinyon pine	3
Bitterbrush	3

Seeds and seedlings of native species are available from Native Plants, Inc., 360 Wakara Way, Salt Lake City, Utah, inter alia.

Tillage Practices and Mulching Techniques.--Tillage practices on the slopes and overfill areas will involve scarification and/or construction of small terraces on the slopes. It is recommended that hemp matting or some similar material be placed over the modified surfaces and that it be secured in place so as to prevent or retard down slope movement. Shrubs and seeds should be placed beneath or atop the matting. The prepared slope will tend to hold moisture and to allow for places where plants can grow.

Slopes in the portal yard and overfill areas are at or near 1.5h:lv, and it is recommended that reclamation be undertaken without application of topsoil. Seeds of grasses and forbs should be incorporated in hydromulch materials. The prepared slopes should be treated to hydromulching prior to placement of hemp or other matting, and the seedlings of shrubs and trees should be placed through the hemp and hydromulch material. It is recommended that fertilizer be applied to the slopes, especially nitrogen and phosphorus, at a rate of approximately 100 lbs of each per acre. Subsequent to treatment, both hand set plantings and hydromulch applications should be given supplemental irrigation, as needed, until plants are well established.

The pond area should be reclaimed using similar methodology at the conclusion of the mining operation. The same species and amounts can be used, but matting might not be necessary except on steeper slopes.

Revegetation Success Analysis.---Success of revegetation and stabilization of the portal yard and overfill areas will be evaluated during the middle of each growing season, when cover and composition studies are most feasible. Erosion pins will be placed on slopes at the time of reseeding operations; a table of random numbers will be used to determine pin placement. Statistically acceptable techniques will be used in determination of percent cover and composition of vegetation in disturbed areas. Pin survey and revegetation analysis will be conducted annually for at least five years. Where success is apparent, as represented by achievement of 80 percent of the cover in a reference site on an adjacent slope in the first five year period, subsequent analyses will be at five year intervals. Areas not achieving 80 percent of cover in adjacent vegetative types will be re-evaluated and other attempts made to successfully vegetate those areas.

Soils for Stockpiling.---Soil for stockpiling is not available in the portal yard area, and is limited in the pond area. It is recommended that topsoil be gleaned from within the pond area, stored, and revegetated for the time period of mine operation and pond use. It might need to be supplemented with additional topsoil from elsewhere upon termination of mining operations.

TABLES

Table 1: Plant communities of the Sufco Convulsion Canyon Lease Area
by percent of area covered

<u>Vegetation Type</u>	<u>Map Designation</u>	<u>Percent</u>
Aspen and subtypes	A, AAMO	1.0
Black sage-grass	BSG	37.0
Fir and subtypes	F, FA, FAMM, FMM	11.0
Mountain brush	MB	5.0
Mountain mahogany and subtypes	MM, MMMZ, MMD	6.0
Ponderosa pine and subtypes	PDA, PDAMZ, PDFAM, PDMM, PDMMA, PDMZMM	20.0
Pinyon-juniper and subtypes	PJ, PJMM	26.0
Sagebrush-grass	SG	<u>11.0</u>
Total		100%

Table 2. Species List by Plant Community Type

Sufco Convulsion Canyon mine lease area vegetative types:
 aspen (A), fir (F), ponderosa pine and subtypes (PP),
 mountain brush (MB), sagebrush/grass (SG), pinyon/juniper and
 subtypes (PJ), black sage/grass (BG), sedimentation pond area (S)

	A	F	PP	MB	SG	PJ	BG	S
<i>Abies concolor</i>	X	X						
<i>Achillea millefolium</i>	X	X	X	X	X			
<i>Agoseris aurantiaca</i>			X					
<i>Agoseris glauca</i>	X	X	X	X	X			
<i>Agropyron caninum</i> (<i>A. trachycaulum</i>)								X
<i>Agropyron cristatum</i>								X
<i>Agropyron spicatum</i>	X					X	X	X
<i>Agropyron smithii</i>			X	X	X	X	X	X
<i>Allium acuminatum</i>	X		X	X				
<i>Amelanchier alnifolia</i>	X	X			X			
<i>Amelanchier utahensis</i>			X	X		X	X	X
<i>Androstegium breviflorum</i>					X		X	
<i>Antennaria dimorpha</i>	X		X		X			
<i>Antennaria microphylla</i>		X	X	X	X			
<i>Aquilegia coerulea</i>	X	X						
<i>Arabis drummondii</i>	X	X		X				
<i>Arabis hirsuta</i>			X					
<i>Arabis hoelbellii</i>			X					
<i>Arabis microphylla</i>						X		X
<i>Arabis perennans</i>				X	X			
<i>Arctostaphylos patula</i>	X		X					
<i>Arnica cordifolia</i>	X	X						
<i>Artemisia dracunculus</i>			X					
<i>Artemisia frigida</i>			X		X	X	X	
<i>Artemisia ludoviciana</i>			X	X				
<i>Artemisia nova</i>					X		X	
<i>Artemisia tridentata</i>	X	X	X	X	X			
<i>Aster chilensis</i>			X		X			
<i>Astragalus agrestis</i>		X			X			
<i>Astragalus argophyllus</i>	X	X			X		X	
<i>Astragalus convallarius</i>	X			X	X			
<i>Astragalus drummondii</i>		X		X	X		X	
<i>Astragalus tenellus</i>					X		X	
<i>Balsamorhiza sagittata</i>				X	X		X	
<i>Barbarea orthoceras</i>								
<i>Bouteloua gracilis</i>	X				X			
<i>Bromus anomalus</i>			X					
<i>Bromus carinatus</i>		X		X				
<i>Bromus ciliatus</i>	X		X					X
<i>Bromus tectorum</i>			X					X
<i>Calamagrostis neglecta</i>					X	X	X	
<i>Calochortus nuttallii</i>								

	A	F	PP	MB	SG	PJ	BG	S
Carex geyeri	X	X	X	X		X		X
Castilleja chromosa					X		X	
Castilleja linariifolia	X	X	X	X	X		X	
Ceratoides lanata					X		X	
Cercocarpus ledifolius		X	X			X		X
Cercocarpus montanus			X	X				
Chaenactis douglasii	X		X		X	X	X	X
Chaenactis stevioides				X				
Chenopodium fremontii		X				X	X	X
Chrysothamnus depressus					X		X	
Chrysothamnus nauseosus				X				
Chrysothamnus parryi			X					
Chrysothamnus viscidiflorus	X	X	X	X	X	X	X	
Cirsium undulatum				X	X		X	
Cirsium utahense			X					
Collinsia parviflora	X		X	X	X			
Collomia linearis	X		X	X	X			
Comandra umbellata	X		X	X	X		X	
Crepis acuminata		X			X		X	
Crepis intermedia							X	
Crepis occidentalis					X		X	
Cryptantha affinis			X					
Cryptantha mensana						X		X
Cymopterus bulbosus							X	
Cymopterus purpureus						X	X	
Cymopterus purpurascens							X	
Cynoglossum officinale				X				
Delphinium menziesii	X		X	X	X			
Descurainia pinnata	X		X			X		
Echinocereus triglochidiatus								X
Elymus canadensis								X
Elymus cinereus					X			
Elymus salina						X	X	X
Epilobium paniculatum			X					
Erigeron eatonii	X	X	X	X	X			
Erigeron divergens			X					
Erigeron pumilus				X			X	
Erigeron speciosus	X	X		X				
Eriogonum alatum			X		X		X	
Eriogonum cernuum	X							
Eriogonum corymbosum			X			X	X	
Eriogonum racemosum	X	X	X	X	X		X	
Eriogonum umbellatum	X	X	X	X	X	X	X	
Erysimum asperum			X					
Euphorbia robusta	X		X		X			
Festuca ovina	X		X	X				
Frasera speciosa							X	
Fritillaria pudica			X					
Gayophytum ramosissimum			X	X	X			
Geranium fremontii	X			X	X			
Geranium richardsonii	X		X					
Gilia aggregata	X	X			X		X	

	A	F	PP	MB	SG	PJ	BG	S
<i>Gilia inconspicua</i>						X		
<i>Gilia tenerrima</i>			X					
<i>Hackelia micrantha</i>		X						
<i>Hedysarum boreale</i>							X	
<i>Helianthella uniflora</i>				X				
<i>Heliomeris multiflora</i>				X				
<i>Heterotheca villosa</i>	X		X		X			
<i>Hordeum jubatum</i>								X
<i>Hymenopappus filifolius</i>							X	
<i>Hymenoxys acaulis</i>							X	
<i>Hymenoxys richardsonii</i>		X			X		X	
<i>Juncus arcticus</i>			X	X				
<i>Juncus bufonius</i>			X					
<i>Juncus kelloggii</i>			X					
<i>Juncus longistylis</i>			X					
<i>Juncus tenuis</i>			X					
<i>Juniperus communis</i>	X	X						
<i>Juniperus osteosperma</i>		X				X		
<i>Juniperus scopulorum</i>	X	X				X		X
<i>Lappula occidentalis</i>					X			
<i>Lathyrus lanzwertii</i>	X	X						
<i>Lathyrus pauciflorus</i>	X			X				
<i>Lepidium virginicum</i>			X					
<i>Lesquerella alpina</i>							X	
<i>Lewisia pygmaea</i>			X					
<i>Ligusticum porteri</i>	X	X						
<i>Linum perenne</i>					X	X	X	
<i>Lithophragma bulbifera</i>	X	X	X					
<i>Lithophragma parviflora</i>		X	X					
<i>Lithospermum ruderales</i>			X	X		X	X	
<i>Lomatium dissectum</i>				X				
<i>Lomatium nuttallii</i>				X			X	
<i>Lupinus argenteus</i>	X	X	X	X			X	
<i>Lychnis drummondii</i>	X			X				
<i>Machaeranthera canescens</i>				X		X		X
<i>Machaeranthera grindelioides</i>						X	X	
<i>Mahonia repens</i>	X	X	X			X		X
<i>Melilotus officinalis</i>								X
<i>Mimulus rubella</i>			X					
<i>Muhlenbergia richardsonii</i>			X					
<i>Oenothera hookeri</i>			X					
<i>Oenothera pallida</i>	X							
<i>Opuntia fragilis</i>				X	X		X	X
<i>Orthocarpus tolmiei</i>	X				X			
<i>Oryzopsis hymenoides</i>			X		X	X	X	X
<i>Oryzopsis micrantha</i>						X		X
<i>Osmorhiza depauperata</i>	X	X						
<i>Oxytropis sericea</i>					X		X	
<i>Pachystima myrsinites</i>	X					X		X
<i>Paronychia sessiliflora</i>							X	
<i>Penstemon eatonii</i>			X					X
<i>Penstemon pachyphyllus</i>							X	

	A	F	PP	MB	SG	PJ	BG	S
Penstemon scariosus			X		X		X	
Penstemon watsonii		X		X	X			
Petradoria pumila			X			X		X
Phacelia sericea		X		X				
Phlox hoodii							X	
Phlox longifolia	X			X				
Physaria acutifolia						X		X
Picea flexilis			X	X				
Pinus edulis				X		X		X
Pinus ponderosa		X	X					
Poa fendleriana	X	X	X		X	X	X	X
Poa reflexa		X						
Poa secunda			X		X		X	
Polygonum kelloggii			X					
Polygonum sawatchense	X		X		X			
Populus tremuloides	X	X	X	X				
Potentilla gracilis	X	X	X	X	X			
Prunus virginiana	X	X		X				
Pseudotsuga menziesii		X						
Purshia tridentata	X	X	X	X	X			
Quercus gambelii				X		X	X	X
Ribes cereum		X						X
Rorippa tenerrima								X
Rosa woodsii	X	X	X	X	X			
Salsola iberica								X
Sambucus coerulea	X							
Sambucus racemosa			X			X		X
Schoenocrambe linifolia						X	X	
Sedum debile			X		X			
Sedum lanceolatum			X					
Senecio integerrimus			X	X	X			
Senecio multilobatus	X		X		X	X		
Senecio spartioides			X					
Sitanion hystrix			X		X			
Solidago nana		X	X					
Solidago parryi								
Solidago sparsiflora				X		X		X
Sorbus scopulina					X			
Sphaeralcea coccinea					X			
Stanleya viridiflora						X		
Stellaria jamesiana	X	X	X	X				
Stephanomeria tenuifolia								X
Stipa columbiana		X		X				
Stipa comata	X	X	X	X	X		X	
Stipa lettermanii	X	X	X	X	X		X	
Symphoricarpos oreophilus	X	X	X	X	X	X	X	X
Taraxacum officinale	X		X					
Tetradymia canescens					X		X	
Thalictrum fendleri		X						
Tragopogon dubius	X				X			
Trifolium gymnocarpon					X			
Vicia americana				X	X			

Viola adunca
Viola nephrophylla
Viola praemorsa
Yucca harrimaniae
Zygadenus paniculatus

	A	F	PP	MB	SG	PJ	BG	S
Viola adunca		X						
Viola nephrophylla	X							
Viola praemorsa								
Yucca harrimaniae							X	
Zygadenus paniculatus	X				X		X	

Table 3: Aduquacy of sample for Cover Area Analysis
of the Sufco Convulsion Canyon Proposed Lease Area

Transect Mapping No.	Location and Vegetative Type	No. of Quadrats	Projected Required Sample Size
1.	Aspen	40	17
3.	Black sage/grass	40	72
4.	Black sage/grass	30	36
6.	Fir	40	58
7.	Mountain brush	40	55
8 & 9.	Ponderosa pine/manzanita/ mountain mahogany	60	128
10.	Pinyon/juniper/ mountain mahogany	30	200
11.	Sagebrush/grass	30	36
12.	Sedimentation Pond area	30	826

Table 4: Summary of Vegetation Data

Site No.	Vegetation	Total Cover %	No. of Species	Prod. lbs/acres	Trees per acre
1	Aspen	169	16	2250	1210
2	Aspen	81	18	574	3326
3	Black sagebrush/Grass	44	35	417	-
4	Black sagebrush/Grass	48	23	355	-
5	Fir	-	-	-	589
6	Fir	30	20	-	444
7	Mountain brush	622*	30	935	-
8	Ponderosa/Manzanita/ Mountain brush	58	20	-	108
9	Ponderosa/Manzanita/ Mountain brush	52	28	-	141
10	Pinyon/juniper/ Mountain mahogany	38	3	316	120
11	Big sagebrush/grass	110	28	762	-
12	Sedimentation Pond, Pinyon/juniper, Ref.	9	11	-	184
13	Sedimentation Pond, Riparian Mountain mahogany	-	-	-	60

Don't know location

*544 percent attributable to tree cover as obtained from Line Intercepts method.

Table 5. Plant Community Characteristics

SITE 1 LOCATION T22S R5E Sec. 6 VEGETATION Aspen

	Taxa	% Cover	% Freq.	% Comp.
<u>Grasses</u>	Agropyron sp.	7.0	38	4
	Bromus ciliatus	<u>2.3</u>	18	<u>1</u>
	Total Grasses	9.3		5
<u>Forbs</u>	Ligustrum porteri	47.0	80	28
	Lupinus argenteus	11.4	50	7
	Geranium sp.	9.9	50	6
	Lathyrus lanzwertii	9.6	18	6
	Taraxacum officinale	6.8	42	4
	Erigeron speciosa	6.3	25	4
	Thalictrum fendleri	5.6	40	3
	Achillea millefolium	4.9	40	3
	Stellaria jamesiana	<u>3.3</u>	35	<u>2</u>
	Total Forbs	104.8		63
<u>Browse</u>	Symphoricarpos oreophilus	31.6	73	19
	Rosa woodsii	11.4	58	7
	Mahonia repens	7.7	38	4
	Amelanchier alnifolia	3.4	25	2
	Pachystima myrsinites	<u>.9</u>	10	<u>1</u>
	Total Browse	55.0		32
	Totals	169.1		100

Table 6. Grazing Productivity

SITE 1 LOCATION T22S R5E Sec. 6 VEGETATION Aspen

Plot Size: 0.96 sq. ft.

	Taxa	Dry Wt. Prod.	% Comp.
<u>Grasses</u>	Agropyron sp.	14.4	6
<u>Forbs</u>	Lathyrus lanzwertii	97.5	43
	Ligusticum porteri	13.2	6
	Achillea millefolium	11.9	5
	Lupinus argenteus	8.4	4
	Taraxacum officinale	6.6	3
	Geranium sp.	6.0	3
	Erigeron eatonii	5.8	3
	Stellaria jamesiana	5.2	2
	Thalictrum fendleri	2.4	1
	Total Forbs	157.0	70
<u>Browse</u>	Rosa woodsii	34.3	15
	Symphoricarpos oreophilus	15.8	7
	Mahonia repens	4.0	2
	Total Browse	54.1	24
	Totals	225.5	100
	Est. Potential Prod. for Site	2255 lbs/acre	

Table 7. Tree Productivity

SITE: 1

LOCATION: T22S R5E Sec. 6

VEGETATION: Aspen

Taxa	Mean Distance	Relative Frequency	Density per Acre
Populus tremuloides	6.0 ft.	98%	1186
Amelanchier alnifolia		2%	24

Taxa	< 1" Diameter		> 1" Diameter				
	< 3'tall	> 3'tall	1" - 3"d.	3" - 6"d.	6" - 12"d.	12" - 15"d.	> 15"d.
Populus tremuloides			7	20	12		
Amelanchier alnifolia			1				

Table 10. Tree Productivity

SITE: 2

LOCATION: T22S R4E NWNW Sec. 1

VEGETATION: Aspen

Taxa	Mean Distance	Relative Frequency	Density per Acre
Populus tremuloides	11.4 ft.	100%	3326

Taxa	< 1" Diameter		> 1" Diameter				
	< 3'tall	> 3'tall	1" - 3"d.	3" - 6"d.	6" - 12"d.	12" - 15"d.	> 15"d.
Populus tremuloides			3	26	11		

Table 11. Plant Community Characteristics

SITE

3

LOCATION

2795E
Sec 5

VEGETATION

Blacksage/Grass

Grasses

Forbs

Taxa	% Cover	% Freq.	% Comp.
<i>Elymus salina</i>	8.8	51	21
<i>Stipa comata</i>	2.5	11	7
<i>Poa fendleriana</i>	1.6	16	4
<i>Agropyron spicatum</i>	1.5	9	3
Total Grasses	14.4		35
<i>Castilleja chromosa</i>	2.0	26	5
<i>Hymenoxys acaulis</i>	1.9	24	5
<i>Machaeranthera grindelioides</i>	1.8	24	4
<i>Linum perene</i>	1.2	13	3
<i>Eriogonum alatum</i>	1.0	11	2
<i>Castilleja linariifolia</i>	.7	6	2
<i>Comandra umbellata</i>	.6	9	1
<i>Hymenopappus filifolia</i>	.6	4	1
<i>Hymenoxys richardsonii</i>	.6	9	1
<i>Androstephium breviflorum</i>	.5	4	1
<i>Chaenactis douglasii</i>	.3	6	1
<i>Erigeron pumilus</i>	.2	3	T
<i>Gilia aggregata</i>	.2	1	T
<i>Hedysarum boreale</i>	.2	1	T
<i>Lithospermum ruderale</i>	.2	1	T
<i>Lomatium nuttallii</i>	.2	1	T
<i>Lesquerella alpina</i>	.2	9	T
<i>Penstemon scariosus</i>	.1	6	T
<i>Astragalus convallarius</i>	T	1	T
<i>Calochortus nuttallii</i>	T	1	T
<i>Chenopodium fremontii</i>	T	1	T
<i>Paronychia sessiliflora</i>	T	1	T
<i>Penstemon pachyphyllus</i>	.7	1	T
<i>Phlox hoodii</i>	.7	1	T
Total Forbs	12.5		25
Totals			

(Continued next page)

Table 12. Plant Community Characteristics

SITE

LOCATION

VEGETATION

3, cont.

Blacksage/Grass

	Taxa	% Cover	% Freq.	% Comp.
<u>Browse</u>	Artemisia nova	13.1	66	31
	Chrysothamnus viscidiflorus	2.2	16	5
	Purshia tridentata	.8	3	2
	Chrysothamnus depressus	.7	3	2
	Tetradymia canescens	.2	1	T
	Ceratoides lanata	.1	3	T
	Artemisia frigida	<u>.1</u>	3	<u>T</u>
	Total Browse	17.2		40
	Totals	44.1		100

Table 14. Grazing Productivity

SITE

LOCATION

VEGETATION

3, cont.

Blacksage/Grass

Plot Size:

	Taxa	Dry Wt. Prod.	% Comp.
<u>Browse</u>	Artemisia nova	126.4	31
	Chrysothamnus depressus	21.5	5
	Ceratoides lanata	12.5	3
	Chrysothamnus viscidiflorus	12.0	3
	Artemisia frigida	<u>2.9</u>	<u>1</u>
	Total Browse	175.3	43
	Totals	417	100
	Est. Potential Prod. for Site	417 lb/ac	

Table 16. Grazing Productivity

SITE 4 LOCATION T22S R5E NW Sec. 8 VEGETATION Black sage/Grass

Plot Size: 9.6

	Taxa	Dry Wt. Prod.	% Comp.
<u>Grasses</u>	Stipa comata	76.8	22
	Stipa comata	9.8	3
	Poa secunda	1.5	T
	Total Grass	88.1	25
<u>Forbs</u>	Hedysarum boreale	38.8	11
	Machaeranthera grindelioides	24.6	7
	Hymenopappus filifolia	23.2	7
	Phlox hoodii	18.6	5
	Penstemon scariosus	10.8	3
	Hymenoxys acaulis	9.0	3
	Hymenoxys richardsonii	6.5	2
	Eriogonum alatus	3.5	1
	Eriogonum umbellatum	1.4	T
	Oxytropis sericea	1.2	T
	Castilleja chromosa	1.0	T
	Androstephium breviflorum	.5	T
	Total Forbs	139.1	39
<u>Browse</u>	Artemisia nova	50.0	14
	Ceratoides lanata	43.2	12
	Chrysothamnus viscidiflorus	17.2	5
	Tetradymia canescens	9.0	3
	Artemisia frigida	8.4	2
	Total Browse	127.8	36
Totals		355.0	100
Est. Potential Prod. for Site		355.0 lb/ac	

Taxa	Mean Distance	Relative Frequency	Density per Acre
<i>Pseudotsuga menziesii</i>	8.6	52.5%	309
<i>Abies concolor</i>		40.0%	236
<i>Juniperus scopulorum</i>		7.5%	44

Table 17. Tree Productivity

SITE: 5

LOCATION: T22S R4E

VEGETATION: Fir

59

Taxa	< 1" Diameter		> 1" Diameter				
	< 3'tall	> 3'tall	1" - 3"d.	3" - 6"d.	6" - 12"d.	12" - 15"d.	>15"d.
<i>Pseudotsuga menziesii</i>			2	5	10	3	1
<i>Abies concolor</i>			7	5	3	1	
<i>Juniperus scopulorum</i>			2		1		

Taxa	Mean Distance	Relative Frequency	Density per Acre
Juniperus scopulorum	9.9 ft	2.5%	11
Abies concolor		97.5%	433

Table 19. Tree Productivity

SITE: 6

LOCATION: T22S R5E Sec. 6

VEGETATION: Fir

61

Taxa	< 1" Diameter		> 1" Diameter				
	< 3'tall	> 3'tall	1" - 3"d.	3" - 6"d.	6" - 12"d.	12" - 15"d.	> 15"d.
Juniperus scopulorum					1		
Abies concolor			5	11	15	7	1

Table 23. Plant Community Characteristics
(Tree Cover Data)

SITE

LOCATION

VEGETATION

7

T21S R4E SW-SW Sec. 36

Mtn. Brush

Browse

Taxa	% Cover	% Freq.	% Comp.
<i>Artemisia tridentata</i>	131	37	24
<i>Quercus gambellii</i>	177	80	33
<i>Chrysothamnus viscidiflorus</i>	191	30	35
<i>Rosa woodsii</i>	13	37	2
<i>Symphoricarpos oreophilus</i>	32	33	6
Totals	544		100

Taxa	Mean Distance	Relative Frequency	Density per Acre
Pinus ponderosa	19.9	5.0%	5
Cercocarpos ledifolius		77.5%	84
Populus tremuloides		17.5%	19

Table 25. Tree Productivity

SITE: 8

LOCATION: T22S R4E NE SW Sec. 1

VEGETATION: Ponderosa pine/
manzanita/
mtn. mahogany

67

Taxa	< 1" Diameter		> 1" Diameter				
	< 3'tall	> 3'tall	1" - 3"d.	3" - 6"d.	6" - 12"d.	12" - 15"d.	> 15"d.
Pinus ponderosa					1		1
Cercocarpos ledifolius			2	17	12		
Populus tremuloides			4	3			

Table 26. Plant Community Characteristics

<u>SITE</u>	<u>LOCATION</u>	<u>VEGETATION</u>			
9	T22S R4E NE SW Sec. 1	Ponderosa pine/ manzanita/ mtn. mahogany			
		Taxa	% Cover	% Freq.	% Comp.
<u>Grasses</u>		<i>Poa fendleriana</i>	4.1	23	8
		<i>Carex geyeri</i>	2.3	17	5
		<i>Sitanion hystrix</i>	.1	3	T
		<i>Stipa lettermannii</i>	.1	3	T
		Total Grasses	6.6		13
<u>Forbs</u>		<i>Collinsia parviflora</i>	5.8	40	11
		<i>Geranium richardsonii</i>	.6	7	1
		<i>Allium acuminatum</i>	.5	3	1
		<i>Castilleja linariifolia</i>	.5	3	1
		<i>Cirsium utahense</i>	.5	3	1
		<i>Comandra umbellata</i>	.5	3	1
		<i>Cryptantha (annual)</i>	.5	3	1
		<i>Collomia linearis</i>	.5	20	1
		<i>Senecio integerrimus</i>	.5	3	1
		<i>Allium sp.</i>	.2	7	1
		<i>Lithophragma parviflora</i>	.2	7	1
		<i>Taraxacum officinale</i>	.2	7	1
		<i>Arabis drummondii</i>	.1	3	T
		<i>Antennaria microphylla</i>	.1	3	T
		<i>Antennaria dimorpha</i>	.1	3	T
		<i>Chaenactis douglasii</i>	.1	3	T
		<i>Lithophragma bulbifera</i>	.1	3	T
		<i>Sedum debile</i>	.1	3	T
		<i>Senecio integerrimus</i>	.1	3	T
		Total Forbs	11.2		22
<u>Browse</u>		<i>Arctostaphylos patula</i>	30.0	57	58
		<i>Rosa woodsii</i>	1.8	10	3
		<i>Mahonia repens</i>	1.6	17	3
		<i>Purshia tridentata</i>	.5	3	1
		<i>Cercocarpus ledifolius</i>	.1	3	T
	Total Browse	34.0		65	
Totals			51.8		100

Taxa	Mean Distance	Relative Frequency	Density per Acre
Pinus ponderosa	17.6 ft.	12.5%	18
Cercocarpus ledifolius		57.5%	81
Populus tremuloides		30.0%	42

Table 27. Tree Productivity

SITE: 9

LOCATION: T22S R4E NE SW Sec. 1

VEGETATION: Ponderosa pine/
manzanita/
mtn. mahogany

69

Taxa	< 1" Diameter		> 1" Diameter				
	< 3'tall	> 3'tall	1" - 3"d.	3" - 6"d.	6" - 12"d.	12" - 15"d.	> 15"d.
Pinus ponderosa				1			4
Cercocarpus ledifolius				11	6	3	3
Populus tremuloides			1	9	2		

Table 28. Plant Community Characteristics

<u>SITE</u>	<u>LOCATION</u>	<u>VEGETATION</u>
10	T22S R4E SE SE Sec. 1	Pinyon/Juniper/ Mtn. Mahogany

	Taxa	% Cover	% Freq.	% Comp.
<u>Grasses</u>	Elymus salina	29.3	67	77
	Agropyron spicatum	7.8	23	20
	Oryzopsis hymenoides	<u>1.2</u>	3	<u>3</u>
	Total Grasses	38.3		100
<u>Forbs</u>				
<u>Browse</u>				
	Totals	38.3		100

Taxa	Mean Distance	Relative Frequency	Density per Acre
Pinus edulis	19.1 ft	42.5%	51
Cercocarpus ledifolius		40.0%	48
Juniperus osteosperma		17.5%	21

Table 30. Tree Productivity

SITE: 10

LOCATION: T22S R4E SE SE Sec. 1

VEGETATION: Pinyon/Juniper/
Mountain Mahogany

72

Taxa	< 1" Diameter		> 1" Diameter				
	< 3'tall	> 3'tall	1" - 3"d.	3" - 6"d.	6" - 12"d.	12" - 15"d.	> 15"d.
Pinus edulis			3	2	2	3	7
Cercocarpus ledifolius				12	2	2	
Juniperus osteosperma				1	1	2	3

Table 32. Grazing Productivity

SITE 11 LOCATION T21S R4E SW SW Sec. 36 VEGETATION Sagebrush/Grass

Plot Size: 9.6

	Taxa	Dry Wt. Prod.	% Comp.
<u>Grasses</u>	Stipa lettermannii	103.2	14
	Poa fendleriana	60.0	8
	Agropyron smithii	48.0	6
	Total Grasses	211.2	28
<u>Forbs</u>	Erigeron eatonii	39.5	5
	Antennaria microphylla	27.9	4
	Delphinium menziesii	14.0	2
	Agoseris glauca	11.7	2
	Collinsia parviflora	10.5	1
	Trifolium gymnocarpon	8.5	1
	Collomia linearis	8.4	1
	Zygadenus paniculatus	4.2	1
	Castilleja linariifolia	3.2	T
	Lithophragma parviflora	2.2	T
	Penstemon watsonii	2.0	T
	Eriogonum racemosum	1.8	T
	Eriogonum alatum	1.4	T
	Astragalus argophyllus	.6	T
Androstephium breviflorum	.5	T	
Total Forbs	136.4	17	
<u>Browse</u>	Chrysothamnus viscidiflorus	198.4	26
	Artemisia tridentata	119.3	16
	Purshia tridentata	97.7	13
	Total Browse	414.9	55
	Totals	762.5	100
	Est. Potential Prod. for Site	762 lb/ac	

Table 33. Plant Community Characteristics

SITE 12, sed. pond reference
LOCATION T22S R5E Sec. 18
VEGETATION Pinyon/Juniper

	Taxa	% Cover	% Freq.	% Comp.
<u>Grasses</u>	Oryzopsis hymenoides	1.9	13	21
	Carex geyeri	.1	13	1
	Elymus salina	.1	3	1
	Total Grasses	2.1		23
<u>Forbs</u>	Arabis microphylla	2.4	17	27
	Physaria acutifolia	.3	10	3
	Chenopodium fremontii	.2	7	2
	Cryptantha mensana	.2	7	2
	Chaenactis douglasii	.1	3	1
	Total Forbs	3.2		35
<u>Browse</u>	Pinus edulis seedling	2.2	7	24
	Mahonia repens	1.2	17	13
	Quercus gambelii	.5	3	5
	Total Browse	3.9		42
	Totals	9.2		100

10.42

Taxa	Mean Distance	Relative Frequency	Density per Acre
Pinus edulis	6.32 ft	45.0%	83
Juniperus osteosperma		2.5%	5
Cercocarpus ledifolius		30.0%	55
Juniperus scopulorum		22.5%	41

Table 34. Tree Productivity

SITE: 12, sed. pond reference

LOCATION: T22S R5E Sec. 18

VEGETATION: Pinyon/Juniper

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Taxa	< 1" Diameter		> 1" Diameter				
	< 3'tall	> 3'tall	1" - 3"d.	3" - 6"d.	6" - 12"d.	12" - 15"d.	> 15"d.
Pinus edulis			4	4	1	2	7
Juniperus osteosperma				1			
Cercocarpus ledifolius			1	8	2	1	
Juniperus scopulorum				1	4	1	3

Taxa	Mean Distance	Relative Frequency	Density per Acre
Abies concolor	27.0 ft	40%	59.5
Pinus edulis		8%	
Juniperus scopulorum		25%	
Quercus gambellii		10%	
Pseudotsuga menziesii		10%	
Pinus ponderosa		2%	
Acer grandidentatum		5%	

Table 35. Tree Productivity

SITE: 13, sed. pond validation

LOCATION: T22S R5E Sec. 18

VEGETATION: Riparian

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Taxa	< 1" Diameter		> 1" Diameter				
	< 3'tall	> 3'tall	1" - 3"d.	3" - 6"d.	6" - 12"d.	12" - 15"d.	>15"d.
Abies concolor			1	5	4	1	4
Pinus edulis				2	1		
Juniperus scopulorum				2	3	5	
Quercus gambellii			2	2			
Pseudotsuga menziesii					3		1
Pinus ponderosa							1
Acer grandidentatum				1	1		

Table 36.

TREE PRODUCTIVITY SUMMARY

Site	Species	Average Height (ft.)	Diameter Average (in.)	Average Age (yrs.)	Diameter Growth (mm/yrs.)
8	ponderosa	32	16.5	88	4.8
	aspen	17	3.3	33	5.1
9	ponderosa	41	19.3	189	2.6
	aspen	15	4.5	43	2.7
2	aspen	24	6.3	47	3.4
	aspen	22	5.1	56	1.8
6	white fir	28	8.3	75	1.5
	Rocky Mountain juniper	30	11.8	538	0.6
1	aspen	25	6.4	49	3.3
5	white fir	27	8.0	106	1.9
	Douglas-fir	39	6.5	123	1.3
	Rocky Mountain juniper	30	6.0	115	1.3
	pinon	16	7.0	87	2.0
10	pinon	20	14.0	236	1.5
	Rocky Mountain juniper	14	5.1	130	1.0
	Douglas-fir	33	7.5	124	1.5
12	pinon	25	9.1	137	1.7
	Rocky Mountain juniper	11	5.8	197	0.7

Table 37.
Soil Analysis Data, Profile Description, Sample Site 1

Mapping Unit: A
Vegetative Type: Pinyon, Juniper
Location: T22S R4E Sec. 1 SW 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A1	0-5	10YR 5/3	10YR 3/2	72	17	11	Sandy loam	1 f sbk
B2	5-9	10YR 6/3	10YR 4/3	78	15	7	Loamy sand	1 m sbk
C	9-14	10YR 6/3	10YR 5/2	82	11	7	Loamy sand	10 gr
Cr	14-20							
R	20							

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A1	0	1.30	6.16	eo	0.41	52.8	14.2	35.8
B2	0	1.30	6.10	eo	0.32	44.6	10.3	26.7
C	10 gr	Trace	6.21	eo	0.23	29.9	5.9	30.9

Taxonomic classification: Sandy, mixed, frigid shallow Typic Haploxerolls

Table 38.
Soil Analysis Data, Profile Description, Sample Site 2

Mapping Unit: B
Vegetative Type: Blacksage, grass
Location: T22S R5E Sec. 8, NW 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A	0-3	2.5Y 6/4	2.5Y 4/4	32	33	35	Clay loam	2 mk pl
B	3-8	10YR 6/3	2.5Y 5/4	30	35	35	Clay loam	2 m sbk
C	8-21+	10YR 6/3	2.5Y 5/4	28	29	43	Clay	3 f abk

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A	15 gr	0.57	8.02	e	0.55	78.4	20.0	18.7
B	15 gr	0.48	8.23	es	0.54	67.2	23.4	25.6
C	15 gr	0.63	8.02	es	0.44	37.8	23.4	41.3

Taxonomic Classification: Fine, mixed, frigid Typic Xerochrepts

Table 39.
Soil Analysis Data, Profile Description, Sample Site 3

Mapping Unit: C
Vegetative Type: Aspen
Location: T22S R4E Sec. 1, NW 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A11	0-2	10YR 3/2	5YR 2.5/2	58	31	11	Sandy loam	1 vf gr
A12	2-9	10YR 4/2	7.5YR 3/2	66	21	13	Sandy loam	2 f sbk/3 mgr
C	9-18	10YR 6/2	10YR 5/3	68	18	14	Sandy loam	Massive
R	18							

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A11	8 gr	6.28	6.47	eo	0.73	122.4	24.7	7.5
A12	15 gr, 5 cob	1.50	6.69	eo	0.51	75.7	18.0	9.9

Taxonomic Classification: Sandy, mixed, shallow Lithic Cryoborolls

Table 40.
Soil Analysis Data, Profile Description, Sample Site 4

Mapping Unit: D
Vegetative Type: Sagebrush, grass
Location: T21S R4E Sec. 36, SW 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A1 ₁	0-5	10YR 3/3	10YR 2/2	49	28	23	Loam	2 f sbk/1vf gr
A1 ₂	5-11	10YR 5/3	10YR 3/2	43	26	31	Clay loam	3 f abk
B2 ₁	11-20	10YR 6/3	10YR 4/3	41	26	33	Clay loam	3 f abk
B2 ₂ ^t	20-30	2.5Y 6/3	2.5Y 5/4	27	36	37	Clay loam	3 m abk
C	30-51+	2.5Y 7/2	2.5Y 6/4	21	46	33	Clay loam	M

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A1 ₁	0	4.69	6.57	eo	0.69	90.2	23.7	9.3
A1 ₂	0	1.64	6.62	eo	0.71	90.5	24.2	13.8
B2 ₁	1 gr	0.55	6.61	eo	0.59	69.4	20.3	17.9
B2 ₂ ^t	0	0.13	6.64	eo	0.24	24.5	7.2	18.7
C	0	0.01	7.83	eo	0.33	36.5	13.1	16.5

Taxonomic Classification: Fine, mixed, frigid Typic Argixerolls

Table 41.
Soil Analysis Data, Profile Description, Sample Site 5

Mapping Unit: E
Vegetative Type: Fir
Location: T22S R5E Sec. 6, NW 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A1	0-3	10YR 5/2	10YR 3/2	65	24	11	Sandy loam	1 th pl
A2	3-7	10YR 6/2	10YR 4/2	69	18	13	Sandy loam	1 f sbk
A & B	7-11	10YR 6/2 10YR 5/2	10YR 5/2 10YR 4/2	*72	15	13	Sandy loam	2 m sbk
B3	11-19	10YR 6/2	10YR 4/3	76	15	9	Sandy loam	2 c sbk
C	19-31	10YR 6/3	10YR 5/3	78	13	9	Sandy loam	Massive

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A1	0	2.87	6.56	eo	0.47	75.8	11.1	7.0
A2	0	0.77	5.37	eo	0.70	105.0	20.8	18.0
A & B	0	0.46	5.88	eo	0.35	57.8	10.9	10.2
B3	8 gr	0.27	6.40	eo	0.30	48.8	9.3	12.6
C	10 cobbles 25 stones	Trace	6.38	eo	0.17	45.0	15.1	10.4

Taxonomic Classification: Coarse-loamy, mixed Typic Cryoboralfs

Note: Lab texture was run on mixture of A & B. Clay increase is not evident by lab data. There is evidence of alluvial clay in the field.

Table 42.
Soil Analysis Data, Profile Description, Sample Site 6

Mapping Unit: F
Vegetative Type: Black sagebrush
Location: T21S R5E Sec. 5, SW 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
Al ₁	0-2	10YR 5/3	10YR 4/2	50	29	21	Loam	2 th pl
Al ₂	2-12	10YR 5/3	10YR 4/3	43	26	31	Clay loam	1 f sbk/2 m gr
B2t	12-28	10YR 6/2	10YR 6/3	33	22	45	Clay	2 m abk
Cl	28-41	10YR 6/2	10YR 6/3	31	24	45	Clay	M
C2 ₁	41-46							

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
Al ₁	40 gr, 5 cob	2.01	7.53	e	0.75	111.8	28.7	9.8
Al ₂	15 gr	2.79	7.77	e	0.78	109.6	38.1	15.2
B2t	10 gr, 5 cob	0.84	8.21	es	0.37	26.9	24.6	25.0
Clca	0	0.04	8.61	ev	0.47	12.3	22.0	75.8
C21	73 gr							

Taxonomic Classification: Fine, mixed, frigid Typic Haploxeralfs

Table 43.
Soil Analysis Data, Profile Description, Sample Site 7

Mapping Unit: G
Vegetative Type: Mountain Brush
Location: T21S R4E Sec. 36, SW 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A1	0-3	2.5Y 6/2	10YR 4/3	59	20	21	Sandy clayloam	2 mk pl
B2 ₁ t	3-10	2.5Y 6/4	2.5Y 5/4	37	38	25	Loam	2 m sbk
B2 ₂	10-31	2.5Y 6/4	2.5Y 5/4	61	14	25	Sandy clayloam	2 m sbk
C	31-38+	2.5Y 7/4	2.5Y 5/4	61	14	25	Sandy clayloam	M

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A1	0	1.78	6.15	eo	0.50	67.7	15.8	11.4
B2 ₁ t	0	0.21	6.02	eo	0.25	27.8	6.0	11.2
B2 ₂	0	trace	6.46	eo	0.24	27.4	6.1	10.4
C	5gr, 5cob, 5 stones	trace	7.19	eo	0.33	36.6	9.5	14.9

Taxonomic Classification: Fine loamy, mixed, frigid Typic Haploxeralfs

Table 44.
Soil Analysis Data, Profile Description, Sample Site 8

Mapping Unit: H
Vegetative Type: Pinyon, Juniper
Location: T22S, R4E, Sec. 1, SW 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A1	0-2		10YR 2/3	84	9	7	Loamy sand	sg
B1	2-10	10YR 5/2	10YR 3/3	90	1	9	Sand	sg
B2	10-22	10YR 5/2	10YR 3/4	91	2	7	Sand	sg
C	22-60+	10YR 4/1	10YR 4/3	87	4	9	Loamy sand	sg

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A1	0	4.95	6.76	eo	0.53	72.5	10.5	8.8
B1	0	1.09	6.71	eo	0.28	32.0	4.9	6.1
B2	lgr	0.74	6.99	eo	0.19	22.1	3.2	6.2
C	lgr	1.16	6.94	eo	0.15	16.3	2.8	6.6

Taxonomic Classification: Sandy, mixed, frigid Typic Haploxerolls

Table 45.
Soil Analysis Data, Profile Description, Sample Site 9

Mapping Unit: I
Vegetative Type: Sagebrush, grass
Location: T21S R5E Sec. 31, NW 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A1	0-3	10YR 5/3	2.5Y 4/2	52	25	23	Sandy clayloam	2 mk pl
B2t	3-15		2.5Y 5/2	35	24	41	Clay	3 f abk
C	15-26			43	26	31	Clayloam	2 m pr
R	26							

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A1	5gr	1.44	7.00	eo	0.51	66.9	14.3	7.8
B2t	0	0.68	6.88	eo	0.40	50.6	11.1	20.2
C	5cob	0.69	7.75	eo	0.29	32.8	7.9	11.5

Taxonomic Classification: Fine, mixed Typic Cryoboralfs

Table 46.
Soil Analysis Data, Profile Description, Sample Site 10

Mapping Unit: J
Vegetative Type: Sagebrush, grass
Location: T21S R5E Sec. 31, SW 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A	0-4		10YR 3/1	25	36	39	Clayloam	3 m gr
AC	4-12		10YR 2/1	21	23	56	Clay	3 f abk
C	12-60+			17				M

Horizon	% Rock Fqts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A	0	5.22	7.19	eo	1.22	174.2	41.8	31.7
AC	0	2.56	7.58	eo	1.18	82.2	47.4	171.2
C	0	1.89	7.96	eo	6.10	472.0	383.0	105.0

Taxonomic Classification: Fine, mixed Aquic Cryoborolls

Table 47.
Soil Analysis Data, Profile Description, Sample Site 11

Mapping Unit: K
Vegetative Type: Black sagebrush, grass
Location: T22S R5E Sec.8 NW 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
Al ₁	0-3	10YR 4/3		66	19	15	Sandy loam	2 f gr
Al ₂	3-8	10YR 4/3		58	23	19	Sandy loam	2 m sbk
B2t	8-14	10YR 5/4		48	27	25	Sandy clayloam	3 m sbk
C	14-29			44	33	23	Loam	2 f sbk
Cr	29-35			68	21	11	Sandy loam	M
R	35							

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
Al ₁	10gr	2.12	6.77	e	0.45	57.4	10.2	6.1
Al ₂	5gr	1.32	7.05	eo	0.62	97.0	16.0	8.6
B2t	15gr	0.73	7.44	eo	0.53	70.6	10.4	9.3
C	1gr	0.04	8.24	eo	0.27	41.6	9.4	15.4
Cr	1gr	trace	8.55	eo	0.23	39.0	4.9	8.6

Taxonomic Classification: Fine-loamy, mixed, frigid Typic Haploxerolls

Table 48.
Soil Analysis Data, Profile Description, Sample Site 12

Mapping Unit: L
Vegetative Type: Aspen, Serviceberry, Oak
Location: T21S R5E Sec.31 NE 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A1	0-4		10YR 2/1	32.2	26.6	41.2	Clay	3 f gr
A3	4-8		10YR 3/1	38.2	23.6	38.2	Clay loam	2 m gr
B2	8-14		10YR 4/2	42.2	21.6	36.2	Clay loam	2 m sbk
C1	14-22		10YR 5/3	34.2	23.6	42.2	Clay	2 f sbk
C2	22-38		10YR 7/1	9.2	32.6	58.2	Clay	2 m abk

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A1	0	7.24	7.59	eo	1.31	171.4	18.2	8.5
A3	0	7.11	7.49	eo	1.26	180.0	16.6	10.7
B2	lgr	5.03	7.64	eo	.95	144.6	13.4	14.1
C1	0	3.97	7.87	eo	.71	92.2	14.1	16.6
C2	0	.43	7.85	eo	.54	54.6	13.6	23.7

Taxonomic Classification: Fine, mixed Typic Cryoborolls

Table 49.
Soil Analysis Data, Profile Description, Sample Site 14

Mapping Unit: M
Vegetative Type: Aspen
Location: T22S R5E Sec. 6 SW 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A1	0-8		10YR 3/2	50.2	21.6	28.2	Sandy clay loam	2 c gr
B21t	8-24		10YR 3/2	40.2	25.6	34.2	Clay loam	2 c sbk
B22	24-33		10YR 3/1	36.2	26.6	37.2	Clay loam	2 m abk
C1	33-54		10YR 7/8	26.2	25.2	48.2	Clay	2 m abk
C2	54-60		10YR 5/3	10.2	29.0	60.8	Clay	Massive

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A1	0	7.21	6.41	eo	0.81	97.3	22.1	7.2
B21t	0	2.14	6.50	eo	0.46	49.4	12.2	9.4
B22	0	1.67	6.27	eo	0.41	46.2	12.5	8.8
C1	0	trace	6.52	eo	0.41	45.8	14.6	13.0
C2	0	0.38	6.44	eo	0.33	34.6	11.0	12.8

Taxonomic Classification: Fine, mixed Argic Pachic Cryoborolls

Table 50.
Soil Analysis Data, Profile Description, Sample Site 15

Mapping Unit: N
Vegetative Type: Ponderosa Pine, Mountain
Location: T22S R5E Mahogany
Sec. 7 NW 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A11	0-4		10YR 5/3	34.2	24.0	41.8	Clay	2 fgr
A12	4-8		10YR 5/3	32.2	22.0	45.8	Clay	2 mgr
IIC	8-49		2.5Y 6/6	12.2	26.0	61.8	Clay	2 m abk

Horizon	% Rock Fqts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A11	25 gr 1 cob 1 stone	2.76	7.69	es	0.58	88.0	11.5	5.8
A12	40 gr 10 cob 10 stone	2.23	7.85	es	0.53	77.0	12.5	7.2
IIC	0	0.61	7.98	ev	0.40	37.1	21.9	18.6

Taxonomic Classification: Pine, mixed, frigid Typic Xerorthent

Table 51.
Soil Analysis Data, Profile Description, Sample Site 17

Mapping Unit: O
Vegetative Type: Pinyon, Juniper, Mountain Mahogany
Location: T22S R4E Sec. 12 NW 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A	0-2	10YR 6/3	10YR 4/2	52.2	22.0	25.8	Sandy Clay Loam	2 m pl
AC	2-12	10YR 5/4	10YR 4/2	50.2	18.0	31.8	Sandy Clay Loam	1 f sbk
C	12-31		2.5Y 6/4	45.2	23.0	31.8	Sandy Clay Loam	2 f sbk
R	31							

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A	15 gr	2.22	7.66	es	0.74	116.3	14.4	6.7
AC	15 gr, 10 cob 20 stones	2.21	7.73	ev	0.94	149.6	18.1	6.4
C	20 gr, 5 cob 5 stones	0.54	7.92	ex	0.56	82.9	11.7	9.4

Taxonomic Classification: Loamy-skeletal, mixed, frigid Ustic Torriorthent

Table 52.
Soil Analysis Data, Profile Description, Sample Site 18

Mapping Unit: S
Vegetative Type: Fir
Location: T22S R4E Sec.12 NE 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A2	0-2		10YR 5/2	55	18	27	Sandy clay loam	2 fim sbk
B2t	2-10		7.5YR 4/2	49	18	33	Sandy clay loam	2 m sbk
B3t	10-15		10YR 4/2	39	26	35	Clay loam	1 f sbk
C	15-35		10YR 5/8 10YR 6/3	31	34	35	Clay loam	Massive
R	35							

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A2	5 gr	3.17	7.44	eo	1.35	220.0	41.4	6.08
B2t	15 gr	2.58	7.56	e	0.90	129.0	27.2	7.20
B3t	5 gr, 30 cob 1 stone	3.99	7.59	em	0.67	97.4	17.0	10.1
C	10 gr, 20 cob 10 stones	1.25	7.62	em	0.58	76.8	14.6	10.9

Taxonomic Classification: Fine-loamy, mixed Typic Cryoboralfs

Table 53.
Soil Analysis Data, Profile Description, Sample Site 22

Mapping Unit: T
Vegetative Type: Pinyon-Juniper
Location: T22S R4E Sec. 12 SW 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A11	0-2		10YR 5/4	45	23	32	Sandy clay loam	Single grain
B1	2-12		10YR 4/3	37	29	34	Clay loam	3 fpl/2 m sbk
B2	12-24		10YR 5/3	35	27	38	Clay loam	1 m sbk
C	24-58		10YR 5/4	37	27	36	Clay loam	1 c sbk

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A11	5 gr	5.57	7.57	em	1.11	149	29.1	8.32
B1ca	10 gr, 5 cob 40 stones	4.07	7.45	es	1.34	182	35.0	7.36
B2	40 gr, 5 cob	2.63	7.66	es	.82	98.7	20.3	9.28
C	5 gr, 5 cob 40 stones		7.76	es	1.76	220	79.4	37.1

Taxonomic Classification: Loamy-skeletal, mixed, frigid Calcixerollic Xerochrepts

Table 54.
Soil Analysis Data, Profile Description, Sample Site 13

Mapping Unit: U
Vegetative Type: Fir
Location: T22S R5E Sec.5 NE 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A1	0-5	10YR 5/4	10YR 3/1	62.2	13.6	24.2	Sandy clay loam	1 vf gr
A2	5-11	10YR 7/4	10YR 6/3	70.3	11.7	18.0	Sandy loam	1 vf gr
B2	11-16	10YR 6/4	10YR 5/2	72.2	9.6	18.2	Sandy loam	1 f sbk
C	16-21	10YR 8/2	10YR 6/3	76.2	5.6	18.2	Sandy loam	Single grain

Horizon	% Rock Fqts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A1	1 gr	7.70	7.31	eo	1.29	208.0	26.1	9.9
A2	0	0.31	6.81	eo	1.39	102.1	64.0	32.6
B2	5 gr, 1 cob	0.41	7.38	eo	0.68	84.0	14.9	15.5
C	20 gr, 3 cob 15 stones	Trace	7.58	eo	0.54	81.4	15.0	13.0

Taxonomic Classification: Fine-loamy, mixed Typic Cryochrepts

Table 55.
Soil Analysis Data, Profile Description, Sample Site 23

Mapping Unit: V
Vegetative Type: Sage, grass
Location: T22S R5E Sec.18 SW 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A11	0-3		10YR 3/2	53	23	24	Sandy clay loam	1 th pl
A12	3-8		10YR 4/2	23	39	38	Clay loam	1 th pl & f gr
B1ca	8-17		10YR 4/2	67	11	22	Sandy clay loam	2 m sbk
Albca	17-25		10YR 3/2	27	37	36	Clay loam	2 c pr
Cbca	25-35		10YR 5/3	25	37	38	Clay loam	2 mic sbk

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A11	0	6.11	7.40	e	1.00	137	17.8	4.48
A12	0	3.67	7.34	em	0.92	149	18.6	5.60
B1ca	5 gr	0.44	7.48	es	0.73	104	18.6	6.40
Albca	0	2.25	7.76	es	1.22	138	61.4	33.1
Cbca	0		7.80	es	0.65	73.4	29.0	10.7

Taxonomic Classification: Fine, mixed, frigid Calcic Haploxeralfs

Table 56.
Soil Analysis Data, Profile Description, Sample Site 24

Mapping Unit: W
Vegetative Type: Sage/Grass or Mtn. Brush
Location: T22S R4E Sec. 12 NW 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A1	0-4		10YR 4/3	53	21	26	Sandy clay loam	3 f gr
C	4-60		10YR 4/3	53	21	26	Sandy clay loam	1 m sbk

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A1	40 gr 40 cob	1.54	7.50	em	3.30	430	118	42.2
C	25 gr 10 cob 10 stones	1.50	7.50	em	3.30	430	118	42.2

Taxonomic Classification: Loamy skeletal, mixed, frigid Typic Xerorthents

Table 57.
Soil Analysis Data, Profile Description, Sample Site 21

Mapping Unit: X
Vegetative Type: Pinyon-Juniper
Location: T22S R4E Sec. 12 NW 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
Al	0-4		7.5YR 3/2	43	29	28	Clay loam	1 vf & f gr
AC	4-8		7.5YR 3/2	33	25	42	Clay	2 vf sbk/ 2 m gr
Cca	8-17		5YR 4/4	35	23	42	Clay	3 f abk
R	17							

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
Al	25 gr	6.99	7.44	eo	1.28	205	27.0	6.56
AC	20 gr	5.49	7.92	em	0.51	73.0	18.6	3.36
Cca	40 gr, 15 cob	1.21	7.97	es	0.38	10.4	10.4	6.08

Taxonomic Classification: Clayey-skeletal, mixed, frigid, shallow Lithic Calcixerolls

Table 58.
Soil Analysis Data, Profile Description, Sample Site 20

Mapping Unit: X
Vegetative Type: Pinyon-Juniper
Location: T22S R4E Sec. 12 SE 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A	0-5		10YR 2/2	59	15	26	Sandy clay loam	2 csbk/3 f gr
AC	5-14		10YR 6/3	17	39	44		
Cca	14-34		2.5Y 6/2	11	37	52	Clay	3 f abk
CR	34							

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A	5 gr	6.93	7.63	e	1.62	168	71.7	25.9
AC	5 gr 15 cob	3.82	7.48	em	6.34	517	279	317
Cca	10 gr 20 cob 10 stones	1.70	7.87	es	9.59	374	579	704

Taxonomic Classification: Fine, mixed, frigid Mollic Haploxeralfs

Table 59.
Soil Analysis Data, Profile Description, Sample Site 19

Mapping Unit: Z
Vegetative Type: Fir
Location: T22S R4E Sec. 12 NE 1/4

Horizon	Depth	Color		Texture			Class	Structure
		Dry	Moist	Sand	Silt	Clay		
A1	0-2		10YR 4/2	49	22	29	Sandy clay loam	3 mk pl/2vf gr
B2ltca	2-12		10YR 5/3	39	26	35	Clay loam	3 m sbk
B22t	12-21		10YR 5/3	41	24	35	Clay loam	2 f sbk
C1	21-32		10YR 6/3	49	23	28	Sandy clay loam	Massive
C2	32-47		10YR 4/1	35	35	30	Clay loam	Massive
R	47							

Horizon	% Rock Fgts.	% Org. Mat.	pH	Effervescence	EC x 10 ³	Solubility ppm		
						Ca	Mg	Na
A1	15 gr	3.30	7.43	em	0.81	137	10.2	4.16
B2ltca	20 gr	1.83	7.31	es	1.02	167	20.2	2.88
B22t	10 gr	2.76	7.51	es	0.59	84.8	12.2	3.52
C1	10 gr 20 cob 5 stones	0.09	7.68	es	0.51	66.6	15.7	5.60
C2	40 cob 5 stone	0.54	8.05	em	0.45	32.8	27.8	5.92

Taxonomic Classification: Fine, mixed, frigid Typic Cryoboralfs

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APPENDIX A

Scientific and common names of plant species on the SUFCO Convulsion Canyon Mine lease area

<u>Scientific Name</u>	<u>Common Name</u>
<i>Abies concolor</i>	White fir
<i>Achillea millefolium</i>	Yarrow
<i>Agoseris aurantiaca</i>	Orange agoseris
<i>Agoseris glauca</i>	Pale agoseris
<i>Agropyron caninum</i> (A. <i>trachycaulum</i>)	Slender wheatgrass
<i>Agropyron cristatum</i>	Crested wheatgrass
<i>Agropyron spicatum</i>	Bluebunch wheatgrass
<i>Agropyron smithii</i>	Western wheatgrass
<i>Allium acuminatum</i>	Tapertip onion
<i>Amelanchier alnifolia</i>	Serviceberry
<i>Amelanchier utahensis</i>	Utah serviceberry
<i>Androstephium breviflorum</i>	Purple funnellily
<i>Antennaria dimorpha</i>	Low pussytoes
<i>Antennaria microphylla</i>	Pussytoes
<i>Aquilegia coerulea</i>	Columbine
<i>Arabis drummondii</i>	Rockcress
<i>Arabis hirsuta</i>	Hairy rockcress
<i>Arabis holboellii</i>	Holboell rockcress
<i>Arabis microphylla</i>	Littleleaf rockcress
<i>Arabis perennans</i>	Perennial rockcress
<i>Arctostaphylos patula</i>	Manzanita
<i>Arnica cordifolia</i>	Heartleaf arnica
<i>Artemisia dracuncululus</i>	Wormwood
<i>Artemisia fridida</i>	Fringed sagebrush
<i>Artemisia ludoviciana</i>	Mountain sagebrush
<i>Artemisia nova</i>	Black sagebrush
<i>Artemisia tridentata</i>	Big Sagebrush
<i>Aster chilensis</i>	Pacific aster
<i>Astragalus agrestis</i>	Field milkvetch
<i>Astragalus argophyllus</i>	Silver-leaved milkvetch
<i>Astragalus convallarius</i>	Lesser rushy milkvetch
<i>Astragalus drummondii</i>	Drummond milkvetch
<i>Astragalus tenellus</i>	Looseflower milkvetch
<i>Balsamorhiza sagittata</i>	Arrowleaf balsamroot
<i>Barbarea orthoceras</i>	Wintercress
<i>Bouteloua gracilis</i>	Blue grama
<i>Bromus anomalus</i>	Bromegrass
<i>Bromus carinatus</i>	Mountain brome
<i>Bromus ciliatus</i>	Fringed brome
<i>Bromus tectorum</i>	Cheatgrass
<i>Calamagrostis neglecta</i>	Slimstem reedgrass

Calochortus nuttallii
Carex geyeri
Castilleja chromosa
Castilleja linariifolia
Ceratooides lanata
Cercocarpus ledifolius
Cercocarpus montanus
Chaenactis douglasii
Chaenactis stevioides
Chenopodium fremontii
Chrysothamnus depressus
Chrysothamnus nauseosus
Chrysothamnus parryi
Chrysothamnus viscidiflorus
Cirsium undulatum
Cirsium utahense
Collinsia parviflora
Collomia linearis
Comandra umbellata
Crepis acuminata
Crepis intermedia
Crepis occidentalis
Cryptantha affinis
Cryptantha crassisejala
Cryptantha mensana
Cymopterus bulbosus
Cymopterus purpureus
Cymopterus purpurascens
Cynoglossum officinale
Delphinium menziesii
Delphinium occidentale
Deschampsia caespitosa
Descurainia pinnata
Echinocereus triglochidiatus
Elymus canadensis
Elymus cinereus
Elymus salina
Epilobium paniculatum
Equisetum arvense
Erigeron eatonii
Erigeron divergens
Erigeron pumilus
Erigeron speciosus
Eriogonum alatum
Eriogonum cernuum
Eriogonum corymbosum
Eriogonum racemosum
Eriogonum umbellatum
Erysimum asperum
Euphorbia robusta
Festuca ovina
Frasera speciosa
Fritillaria pudica
Gayophytum ramosissimum
Geranium fremontii

Segolily
Elk sedge
Desert Indian paintbrush
Wyoming painted-cup
Winterfat
Curlleaf mountain mahogany
Birch-leaf mountain mahogany
Douglas chaenactis
Dusty maiden
Fremont goosefoot
Dwarf rabbitbrush
Rubber rabbitbrush
Parry rabbitbrush
Low rabbitbrush
Wavyleaf thistle
Utah thistle
Blue-eyed mary
Slenderleaf collomia
Bastard toadflax
Tapertip hawksbeard
Gray hawksbeard
Western hawksbeard
Cryptantha
Plains hiddenflower
Cryptantha
Onion spring parsley
Spring parsley
Purple spring parsley
Common houndstongue
Menzies larkspur
Western larkspur
Tufted hairgrass
Pinnate tansy mustard

Canada wildrye
Great Basin wildrye
Salina wildrye
Autumn willowherb
Horsetail
Eaton fleabane
Spreading fleabane
Low fleabane
Oregon fleabane

Nodding eriogonum
Corymbed eriogonum
Redroot eriogonum
Umbellate buckwheat
Wallflower
Robust euphorbia
Sheep fescue
Showy frasera
Yellow fritillary
Branchy groundsmoke
Fremont geranium

Geranium richardsonii
Gilia aggregata
Gilia inconspicua
Gilia tenerrima
Hackelia micrantha
Hedysarum boreale
Helianthella uniflora
Heliomeris multiflora
Heterotheca villosa
Hordeum jubatum
Hymenopappus filifolius
Hymenoxys acaulis
Hymenoxys richardsonii
Juncus arcticus
Juncus bufonius
Juncus kelloggii
Juncus longistylis
Juncus tenuis
Juniperus communis
Juniperus osteosperma
Juniperus scopulorum
Lappula occidentalis
Lathyrus lanzwertii
Lathyrus pauciflorus
Lepidium virginicum
Lesquerella alpina
Lewisia pygmaea
Ligusticum porteri
Linum perenne
Lithophragma bulbifera
Lithophragma parviflora
Linanthus harknessii
Lithophragma bulbifera
Lithospermum ruderale
Lomatium dissectum
Lomatium nuttallii
Lupinus argenteus
Lychnis drummondii
Machaeranthera canescens
Machaeranthera grindelioides
Mahonia repens
Melilotus officinalis
Mimulus rubella
Muhlenbergia richardsonis
Oenothera hookeri
Oenothera pallida
Opuntia fragilis
Orthocarpus tolmiei
Oryzopsis hymenoides
Oryzopsis micrantha
Osmorhiza depauperata
Oxytropis sericea
Pachystima myrsinites
Paronychia sessiliflora
Penstemon eatonii

Richardson geranium
Skyrocket gilia
Shy gilia
Gilia
Stickseed
Northern sweetvetch
One flower helianthella
Golden eye
Hairy goldaster
Foxtail barley
Fineleaf hymenopappus
Stemless hymenoxys
Pingue hymenoxys
Arctic rush
Toad rush
Rush
Longstyle rush
Poverty rush
Mountain common juniper
Utah juniper
Rocky Mountain juniper
Western waterleaf
Lanswert sweetpea
Utah sweetpea
Virginia pepperweed
Alpine bladderpod
Lewisia
Porter ligusticum
Flax
Woodland star
Smallflower woodland star
Harkness gilia
Woodland star
Wayside gromwell
Carrotleaf leptotaenia
Nuttall lomatium
Silver lupine
Drummond campion
Hoary aster
Aster
Oregon grape
Yellow sweetclover
Monkey flower
Mat muhly
Hookder evening primrose
Pale evening primrose
Brittle pricklypear
Tolmiei owllover
Indian ricegrass
Littleseed ricegrass
Bluntseed sweet root
Silky crazyweed
Mountain lover
Creeping nailwort
Eaton penstemon

Penstemon pachyphyllus
Penstemon scariosus
Penstemon watsonii
Petradoria pumila
Phacelia sericea
Phlox hoodii
Phlox longifolia
Physaria acutifolia
Picea flexilis
Pinus edulis
Pinus ponderosa
Poa fendleriana
Poa interior
Poa reflexa
Poa secunda
Polygonum kelloggii
Polygonum sawatchense
Populus tremuloides
Potentilla gracilis
Prunus virginiana
Pseudotsuga menziesii
Purshia tridentata
Quercus gambelii
Ribes cereum
Ribes viscosissimum
Rorippa tenerrima
Rosa woodsii
Salsola iberica
Sambucus coerulea
Sambucus racemosa
Schoenocrambe linifolia
Sedum debile
Sedum lanceolatum
Senecio integerrimus
Senecio multilobatus
Senecio spartioides
Sitanion hystrix
Solidago nana
Solidago parryi
Solidago sparsiflora
Sorbus scopulina
Sphaeralcea coccinea
Stanleya viridiflora
Stellaria jamesiana
Stipa columbiana
Stipa comata
Stipa lettermanii
Symphoricarpos oreophilus
Taraxacum officinale
Tetradymia canescens
Tragopogon dubius
Trifolium gymnocarpon
Vicia americana
Viola adunca
Viola nephrophylla

Thickleaf penstemon
Penstemon
Watson beardtongue

Silky phacelia
Hoods phlox

Common twinpod
Limber pine
Pinyon
Ponderosa pine
Muttongrass
Island bluegrass
Nodding bluegrass
Bluegrass
Kellogg knotweed
Sawatch knotweed
Aspen
Slender cinquefoil
Chokecherry
Douglas fir
Antelope bitterbrush
Gambel oak
Squaw currant
Sticky currant
Watercress
Woods rose
Woods rose
Blue elderberry
Red elderberry

Stonecrop
Lanceleaved sedum
Lambstongue
Lobeleaf groundsel
Broom groundsel
Bottlebrush
Baby goldenrod
Parry goldenrod
Goldenrod
Mountain ash
Scarlet globemallow
Princesplume
Tuber starwort
Subalpine needlegrass
Needle-and-thread
Letterman needlegrass
Mountain snowberry
Dandelion
Gray horsebrush
Yellow goatsbeard
Hollyleaf clover
American vetch
Hook violet
Wanderer violet

Viola praemorsa
Yucca harrimaniae
Zigadenus paniculatus

Yellow violet
Harriman yucca
Foothill deathcamas

Note -- Common names were derived in large part from the following publication: Plummer, A. P., S. B. Monsen, and R. Stevens, 1977. Intermountain Rangeplant names and symbols. USDA Forest Service General Technical Report INT-38. 82 pp.

APPENDIX B: LIST OF MAPS

Maps:

- A - Vegetation map, lease area**
- B - Soils map, lease area**
- Vegetation map, sedimentation pond area**
- D - Soils map, sedimentation pond area**

1981 SUPPLEMENT

FEDERAL COAL LEASE NO. U-47080

PRELIMINARY REPORT ON SOILS AND VEGETATION
OF THE CONVULSION CANYON MINE, EMERGENCY LEASE AREA,
SOUTHERN UTAH FUEL COMPANY (SUFCO),
SEVIER COUNTY, UTAH

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Date: March, 1981

ABSTRACT

Reported herein are the findings of a preliminary investigation of vegetation and soils of the emergency lease area of the SUFCO Mine.

Included is a description of plant communities, a description of soil types, and maps showing soil types and plant communities. Future studies in the emergency lease area based upon findings of this preliminary investigation are also discussed.

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INTRODUCTION

The emergency lease area contiguous to the existing SUFCo lease area ranges in elevation from 8,300 to 9,200 feet msl, and covers approximately two square miles. Five community types and two subtypes have been identified from aerial photographs and from comparison with data taken from the main lease area during the 1981 field season. Community and soil descriptions are extrapolated from previous work on the existing SUFCo lease area (Welsh et al, 1980). Some field studies have been conducted in 1981 to confirm the preliminary information presented in this report.

PLANT COMMUNITY DESCRIPTIONS

Preliminary community descriptions are as follows:

Mountain brush. The mountain brush community is dominated by oak thickets. Co-dominants are rabbitbrush, rose, and big sagebrush. These thickets primarily occur adjacent to sagebrush-grass flats where drifted snow has accumulated to provide the needed additional water. The mountain brush community comprises 24 percent of the emergency lease area.

Black sagebrush-grass. The black sagebrush-grass community occurs on the south facing white limestone substrates of Duncan Mountain. This community is extensive throughout the emergency lease area and consists of a mix of black sagebrush, mountain mahogany and many forbs from the sunflower family. Previous studies of the SUFCo lease area indicate that this community type has the greatest number of species present. Twenty-three percent of the emergency lease area consists of this community type.

Sagebrush-grass. The sagebrush-grass community occurs on the mesic valley bottoms and gentle slopes around Duncan Mountain. Included in this community are big sagebrush, wheat-grasses, little rabbitbrush, bitterbrush, and scattered mountain mahogany. The sagebrush-grass community comprises 27 percent of the emergency lease area.

Aspen. The aspen stands occur mainly on the north facing slopes of Duncan Mountain. These stands support a rich diversity of forb species, including Lupines, sweet pea, and Ligusticum. Past sampling indicates that this community type is the most productive in available forage of the SUFCo lease area. A previous study (Welsh et al, 1980) on the existing SUFCo lease area showed an average of 2,268 trees per acre in the aspen community (1,186 trees in site 1, 3,326 trees in site 2). This community comprises 7 percent of the emergency lease area.

Fir. The fir community occurs primarily on the north facing slopes of Duncan Mountain. White fir (and possibly sub-alpine fir) is present. It is expected that this community has low diversity, understory cover, and productivity values. The fir community comprises 5 percent of the emergency lease area.

Aspen, Amelanchier, Oak. This community sub-type occurs along the edge of sagebrush-grass communities, where drifted snow has provided a more mesic environment. This community comprises 5 percent of the emergency lease area.

Fir, Aspen. This sub-type occurs primarily on the north facing summits of Duncan Mountain. Past studies have not sampled this mixture, however, future studies will be conducted. The fir-aspen community comprises 9 percent of the emergency lease area.

Listed in the following are the vegetative types with corresponding soil type associations. The map unit of each soil type is listed in parentheses.

<u>Vegetative Type</u>	<u>Soil Type</u>
Mountain brush	Fine-loamy, mixed, frigid Typic Haploxeralfs (G)
Black sagebrush-grass	Fine, mixed, frigid Typic Haploxeralfs (F)
	Fine-loamy, mixed, frigid Typic Haploxerolls (K)
Sagebrush-grass	Fine, mixed, frigid Typic Argixerolls (D)
	Fine, mixed Typic Cryoboralfs (I)
	Fine, mixed Aquic Cryoborolls (J)
Aspen	Fine, mixed Argic Pachic Cryoborolls (M)
Fir	Coarse-loamy, mixed Typic Cryoboralfs (E)
Aspen, amelanchier, oak	Fine, mixed Typic Cryoborolls (L)

The preliminary soils map accompanying this report has been largely based upon the vegetative-soil type associations.

THREATENED AND ENDANGERED PLANT SPECIES

In a previous report (Welsh et al, 1980) on the existing SUFCo lease area, it was indicated that none of the proposed or listed threatened or endangered species were encountered in either the lease area or in the adjacent vicinity. A literature survey also failed to indicate the presence of any threatened or endangered plant species.

It is not expected that the emergency lease area will contain any threatened or endangered species. Vegetative habitat and geological substrates are similar to those of the existing lease area.

DESCRIPTIONS OF SOIL TYPES

Local climatic data suggests cryic and frigid temperature regimes. The cryic regime is typically conifer-aspen related, and is generally developed in areas too cold for cultivation of crop plants by ordinary means. Frigid designation is given to soils typically developed on high sagebrush flats, mountain brush slopes, and mountain mahogany plateaus. The soils of this area border the ustic (moisture arriving in summer), and include the xeric (moist winter, dry summers) and aridic (dry all year) moisture regimes.

Map unit descriptions are as follow.

Map Unit G: This unit consists of well drained soils that have formed in residuum and colluvium. Slopes range from 15 to 35 percent. Predominant vegetation at present is scrub oak. Average water holding capacity is 6.5 inches.

Range of characteristics includes a surface layer 2 to 4 inches thick with a texture of sandy loam or sandy clay loam. The subsoil is 6 to 18 inches thick with a loam or sandy clay loam texture. The substratum is deep with 10 to 20 percent rock fragment by volume and a loamy sand to sandy clay loam texture.

Erosion is slight at present. Erosion hazard will be severe if disturbed because of the steepness of slope.

This soil may be later correlated with the Delleker or Lyonsoils series.

Included in this unit is 10 percent rock outcrop by volume and 20 percent of the soil described in Unit D. This unit comprises 24 percent of the emergency lease area.

Map Unit F: Unit F consists of well drained soils that have formed in residuum and colluvium. Slopes range from 15 to 35 percent. Predominant vegetation is black sagebrush and wildrye. Available water holding capacity is 6 inches.

Range of characteristics includes a surface layer 9 to 12 inches thick with 15 to 35 percent rock fragment by volume and a texture of loam or sandy loam. The subsoil is 10 to 20 inches thick with 10 to 15 percent rock fragment by volume and a texture of clay loam or clay. There is a discontinuous coal seam at 23 to 25 inches. There is also a discontinuous gravel layer above the substratum that is 2 to 4 inches thick. The substratum is deep with 0 to 5 percent rock fragment by volume.

Erosion is moderate at present and the erosion hazard will be severe if disturbed because of the high rock fragment content and the steep slope.

Included in this unit are 20 percent rock outcrop and 10 percent of the soil described in Unit I. This unit comprises 22 percent of the emergency lease area.

Map Unit K: This unit consists of well drained soils that have formed in residuum. Slopes range from 2 to 8 percent. Predominant vegetation is presently black sagebrush and grasses. Available water holding capacity is 5 inches.

Range of characteristics includes a surface layer 6 to 12 inches thick with 5 to 15 percent rock fragment by volume. The substrate is 6 to 10 inches thick with 10 to 25 percent rock fragment by volume.

Texture in the subsoil is sandy loam or sandy clay loam. The substratum has 0 to 5 percent rock fragments by volume to the paralithic at a depth of 25 to 35 inches.

Erosion is slight at present and the erosion hazard will be moderate if disturbed because of surface textures.

Included in this unit is 5 percent similar soils. This unit comprises 1 percent of the emergency lease area.

Map Unit D: Unit D consists of well drained soils that have formed in residuum and alluvium. Slopes range from 2 to 8 percent. Present vegetation consists principally of bitterbrush, rabbitbrush, sagebrush, and western wheatgrass. Available water holding capacity is 7 inches.

Range of characteristics includes a surface layer 6 to 12 inches thick. The subsoil extends to a depth of 20 to 35 inches with 0 to 3 percent rock fragment by volume. The texture of the subsoil is clay loam to clay. The substratum is clay loam or clay. There is a gravelly layer in the substratum 2 inches thick at 26 inches or deeper.

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

Included in this unit are 5 percent rock outcrop, 5 percent of the soil described in Unit G, and 10 percent of the soil described in Unit F. This unit comprises 19 percent of the emergency lease area.

Map Unit I: This unit consists of deep, well drained soils that have formed in residuum and colluvium. Slopes range from 15 to 35 percent. Vegetation at present is predominantly sagebrush and grasses. Available water holding capacity is 2.5 inches.

Range of characteristics includes a surface layer 2 to 4 inches thick with 2 to 10 percent rock fragment by volume. The surface is 10 to 20 inches thick with 0 to 5 percent rock fragment by volume. The substratum is 21 to 32 inches to sandstone. Rock fragment is 5 to 10 percent by volume.

Erosion is severe at present.

These soils may later be correlated with the Sicklesteets or Sluice series.

Included in this unit is 10 percent rock outcrop, 10 percent of the soil described in Unit G, and 5 percent of the soil described in Unit F. This unit comprises 2 percent of the emergency lease area.

Map Unit J: Unit J consists of poorly drained soils that have formed in alluvium. Slopes range from 2 to 8 percent. Predominant vegetation is presently grasses and sagebrush. Available water holding capacity is about 6 inches.

Range of characteristics includes an upper surface layer 3 to 6 inches thick. The lower part of the surface layer is 6 to 10 inches thick. The underlying material has mottles in 15 to 30 percent of the matrix.

Erosion is slight at present and moderate if disturbed because of surface texture.

Included in this unit are 10 percent of the soil described in Unit I and 5 percent of the soil described in Unit F. This unit comprises 6 percent of the emergency lease area.

Map Unit M: This unit consists of well drained soils that have formed in residuum. Slopes range from 8 to 15 percent. Presently predominant vegetation is aspen, snowberry, and Woods rose. Available water holding capacity is 7 inches.

Range of characteristics includes a surface layer 6 to 12 inches thick with a sandy loam or sandy clay loam texture. The subsoil is 20 to 30 inches thick with a clay loam to clay texture.

Erosion is slight at present. Erosion hazard is moderate if disturbed because of the steepness of the slope.

These soils may be correlated with the Clayburn series at a later date. This unit comprises 7 percent of the emergency lease area.

The remaining 9 percent of the soils in the emergency lease area is comprised of a combination of Map Unit M and Map Unit E, and corresponds with the fir-aspen vegetative community type.

Map Unit E: Unit E consists of somewhat excessively drained soils that have formed in residuum and colluvium. Slopes range from 35 to 60 percent. Predominant vegetation is fir. Available water holding capacity is 3.5 inches.

Range of characteristics includes a surface layer 1 to 4 inches thick with a texture of loam or sandy loam. The subsurface is a sandy loam to loamy sand layer 6 to 10 inches thick. The subsoil is 6 to 9 inches thick with 5 to 10 percent rock fragment by volume and a sandy loam or sandy texture. The substratum is deep with 35 to 40 percent rock fragment by volume and a sandy loam or sand texture.

Erosion is slight at present but the erosion hazard is severe if disturbed because of the steepness of slope.

Included in this unit are 5 percent rock outcrop and 5 percent of the soil described in Unit F. This unit comprises 5 percent of the emergency lease area.

Map Unit L: This unit consists of somewhat poorly drained soils that have formed in residuum and colluvium, and slopes which range from 35 to 60 percent. Predominant vegetation at present is aspen, serviceberry, and oak. Available water holding capacity is 7 inches.

Range of characteristics includes a surface layer 6 to 12 inches thick with a silt loam to clay loam texture. The subsoil is 5 to 8 inches thick with 0 to 5 percent rock fragment by volume. Texture of the subsoil is clay loam to sandy clay loam. The substratum is deep with a discontinuous coal seam at 36 to 48 inches. Texture of the substratum is clay loam to clay.

Erosion is severe at present despite previous terracing by the Forest Service.

This soil may later be correlated with the Luth Series.

Included in this unit are 5 percent similar soils. This unit comprises 5 percent of the emergency lease area.

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1981 SUBMITTAL

COMPLETENESS REVIEW FOR REPORT OF VEGETATION AND SOILS OF THE CONVULSION
CANYON MINE, SOUTHERN UTAH FUEL COMPANY (SUFCO)

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Date: 15 August 1981

RESPONSE TO DEFICIENCIES

A letter, dated 5 June 1981, from the Utah Division of Oil, Gas, and Mining to Coastal States Energy Company outlined apparent deficiencies with regard to the portal mine area in the permit application submitted for the SUFCo Convulsion Canyon Mine. This report is in response to the request for additional information concerning the study of vegetation and soils outlined in that letter.

Each item is discussed separately below.

783.19

The applicant should provide in the plant community description section, the acreage calculations for each major vegetation type in the affected area and in the reference areas.

The area to be disturbed by activities in the portal yard vicinity is entirely within a Pinyon-Juniper community type. The affected area consists of approximately 17 acres. The reference area covers approximately 2 acres on an adjacent slope.

The "statistically acceptable techniques" to be used in determination of percent cover and vegetation composition in revegetated disturbed areas (p. 37) should be specifically indicated by the applicant.

Herbaceous and understory cover will be measured by an ocular estimation method. A 2 X 5 decimeter quadrat, divided into segments for accurate estimation, will be randomly placed along transects in the

community type and the percent cover will be estimated by species. Shrub cover will be measured by the ocular method and/or the line intercept method where deemed applicable. Tree density will be measured by the point quarter method of Curtis.

The applicant should submit standard deviation data which correlate with the mean species cover and production data for each plant community.

Plant community characteristics were measured and are listed in Table 33 of the report. Mean percent cover is slightly different from that indicated and should be 10.42. Standard deviation is 18.4. Total number of plots measured was 30.

The applicant has indicated only Site 12 as a vegetation reference area. Site 12 includes the Pinyon/Juniper vegetation community at a sedimentation pond site. The applicant must establish and describe adequate reference areas, indicate their locations on a map, and submit reference area data for cover, productivity, and shrub/tree density for each vegetation community. The applicant should also clearly indicate the status of vegetation reference areas with respect to a grazing plan and restrictions.

The pinyon-juniper community is the only vegetative type affected by the portal yard activities. The reference site, number 12, is on a slope adjacent to the affected area, and data is included in Tables 33 and 34. Location of the reference area is given on a map appended with this report, which also shows the vegetation types adjacent to the portal yard area. The location data for this site is incorrect as indicated on the tables. Correct information should be T22S, R4E, Section 12.

The area in question is not a grazing site, slopes are extremely steep, the area is small, and there are no restrictions with respect to a grazing plan.

784.13

In the 1980 Vegetation and Soils study (Vol. 4), several conclusions and recommendations were made. The applicant should address the following statements which were made in this report and verify what is to be actually performed.

(a) A list of only native species was recommended on pages 35-36 of the Vegetation and Soils study to be used for the revegetation mix. This list is in contradiction with those species proposed for revegetation in the 1979 Mine Plan Submission. The applicant needs to clarify what seed mixture, seedlings, or transplants will be used for revegetation. Also, indicate the rates of application (as pounds pure live seed per acre), and the species, subspecies, and scientific name for each species in the mixture. The applicant should also address if specific revegetation seed mixtures will be utilized for different situations, including steep areas, mesas, along drainages, around sedimentation ponds, topsoil piles, and any saline, alkaline, or sandy soil areas. The applicant must also address if any introduced species (such as Yellow Sweetclover) is to be used in revegetation. The applicant should demonstrate that each introduced species to be utilized is necessary for controlling erosion, consistent with the approved postmining land use, compatible with native plant and animal species, and not poisonous or noxious.

Recommended species for revegetation and stabilization of

disturbed areas are listed, with the live seed mixture amounts for forb and grass species and with the planting intervals for seedlings, in the submitted report (p. 35-36). Scientific names are included in Appendix A. They are also listed below.

Bluebunch wheatgrass	Agropyron spicatum
Western wheatgrass	Agropyron smithii
Basin wildrye	Elymus cinereus
Salina wildrye	Elymus salinus
American vetch	Vicia americana
Lewis flax	Linum lewisii
Rubber rabbitbrush	Chrysothamnus nauseosus
Utah juniper	Juniperus oestesperma
Pinyon pine	Pinus edulis
Bitterbrush	Purshia tridentata

Additional forb species are proposed below for inclusion in the revegetation plan.

COMMON NAME	SCIENTIFIC NAME	PLANTING RATIO (lbs/acre)
Strict beardtongue	Penstemon strictus	1/4
Palmer beardtongue	Penstemon palmeri	1/4
Blue flax	Linum perrene	1/4
Cicer milkvetch	Astragalus cicer	1
Alfalfa	Medicago sativa	1
Yellow sweetclover	Melilotus officinalis	1/4
Alsike clover	Trifolium hybridum	1/4
Yarrow	Achillea millefolium	1/4

A uniform seed mixture will be used over this relatively small scale area (approximately 17 acres), and no attempt will be made to differentiate between changes in slope and aspect. Sufficient diversity is established with this seed mixture regardless of substrate textures, pH content, or slope.

Some introduced species will be used, such as Yellow sweetclover and alfalfa. Because of previous success in controlling erosion and establishing stability their use in revegetation is deemed warranted. They are consistent with approved postmining land use and are compatible

with wildlife. No species proposed for revegetation are poisonous or noxious.

(b) On page 36 of the Vegetation and Soils study, a recommendation is made that reclamation on steeper slopes (1.5:1 or steeper) be accomplished without application of topsoil. In the 1979 Mine Plan submission, topsoil was to be spread at a one-inch minimum depth. The applicant should clarify plans for topsoil redistribution and should substantiate that no harm will be caused to vegetation with a topsoil thickness of less than six inches. The applicant should also provide clarification as to the source, quality, and quantity of additional topsoil needed for revegetation. The applicant should also address what amount of fertilizer will be used, since 150 lbs/acre was proposed in the 1979 Mine Plan submission and 100 lbs/acre was recommended in the 1980 Vegetation and Soils study.

Slopes 1.5:1 or steeper will not hold topsoil, and application thereof is unnecessary. Hydromulching and the placement of hemp matting, as indicated in the report, is considered sufficient in insuring no harm will be done to revegetation efforts.

There is no need in this small area for an additional source of topsoil.

The report recommends that 100 lbs each of nitrogen and phosphorous fertilizer per acre be applied as part of the revegetation process. This makes a total of 200 lbs of fertilizer per acre, not 100 lbs/acre.

(c) With respect to both the reference areas and the affected area, plans for fencing and a livestock grazing management plan should be

addressed by the applicant.

The reference and affected areas are so small, and the total productivity low enough that there is no need for fencing to be undertaken. Slopes are extremely steep and preclude the need for a livestock grazing plan.

(d) Shrub and subshrub density data should be provided in the applicable tables of the 1980 Vegetation and Soils study. The applicant should indicate the tree, shrub, and subshrub species, stocking rates, and mapped planting locations to be utilized for wildlife habitat.

Tree and shrub density information for the Pinyon/Juniper community type is included in the report on Table 34. The stocking rates to be used in the planting of seedlings are listed on pages 35 and 36. All planting locations will be eventually utilized for wildlife habitat.

(e) The proposed schedule of revegetation seeding (p. 35, Vol. 4) is too general in its reference to spring, summer, and early fall plantings. The schedule should be more specifically discussed.

Seeding and planting will be undertaken at the most feasible time following disturbance activities. Generally, planting will begin as early as possible following disturbance and when the soil has sufficient growth storage water. This usually happens in the spring or fall seasons. Specifically, grasses and forbs will be tentatively planned for seeding in late May or early June; shrubs and seedlings in late August or early September. If seasonal conditions prohibit this schedule from being carried out, grasses and forbs may be seeded the spring following fall planting of shrubs and seedlings.

(f) More specific information needs to be submitted with respect to mulching techniques. The rates of application, the type of mulch, and the areas of use should be specifically discussed. The applicant should also address if temporary cover crops will be used, providing specific details about the type of crop, application rates, locations where utilized, and that the cover crops will not adversely affect revegetation efforts.

Hydromulching will be utilized on slopes 1.5:1 or steeper, and will consist of chopped straw or fiber mixed with water and machine blown at the rate of 2,000 lbs/acre. Mulching will not be attempted on sheer rock outcrops.

Seeding efforts will be concerned with permanent vegetation. No cover crops are intended for this area.

(g) The applicant should address if irrigation and/or pest and disease control will be utilized in revegetation efforts. If either is used, the applicant should discuss the details which will be utilized.

During revegetation small ponding basins will be established around each shrub or tree seedling and initial irrigation will be undertaken. Subsequent irrigation will occur at 7 to 10 day intervals until the plantings are established. If revegetation efforts are undertaken during a season of drought, sprinkler irrigation will be tried in critical areas.

Should rodents, other pests, or disease become a problem pest and disease control efforts will be established to protect plantings,

(h) The applicant should include sufficient discussion that a perennial vegetation cover will be established within a year of the final

regrading of topsoil, how this will be accomplished, and whether a cover crop will be used between the time topsoil is prepared and the perennial seed mixture is used.

Perennial vegetation will be planted initially and success of the revegetation efforts will be analyzed the following year. If perennial vegetation has not been established in one year the vegetation will be replanted. This process will continue until perennial vegetation is permanently established.

Additional comments. In the Table of Species included in the original report three species were listed without designation of a corresponding community type. Viola praemorsa is found in the aspen and fir community types; Solidago parryi is found in the aspen community type; and Calochortus nuttallii is found in the sagebrush community type.

Corrections were also made on the original Plant Communities Map. Transect 6 was moved so that it is contained entirely in the fir community. Transects for sites 12 and 13 were clarified. A revised copy of this map is also included with this report (see Appendix).