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REPORT OF REVEGETATION SUCCESS AND
VEGETATION MONITORING OF RECLAIMED AND
REFERENCE AREAS AT SKYLINE MINE DURING
THE 1982 FIELD SEASON

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INTRODUCTION

This report supplies information on the revegetation success at the Skyline Mine. Quantitative data for three revegetated slopes and for all applicable reference areas is included. Methods employed in the studies were taken from the vegetation guidelines issued by the Division of Oil, Gas, and Mining (12 April 1982). The studies were completed during the month of July 1982. Exact dates are provided in the tables. Erosion pins were measured 19 August 1982 on slopes where the monitoring was possible. The results are included in the discussion.

The report is divided into three major parts: methodology, discussion of findings, and appendices. The data presented shows the current revegetation status at the Skyline mine. Since the measurements of the reference areas have been reported in two other reports (Welsh et al., 1979, 1980) and since the number or title of a reference area does not always correspond, a chart is provided which shows the different names or numbers and how they correspond to those in this report (see Table 1 at the end of the text).

METHODOLOGY

Measurements of revegetation success and remeasuring of reference areas was conducted according to recent DOGM guidelines. Measurements for cover and productivity were taken in all sites. Determination of stems per acre and average stem height was also made in the Conveyor Route sagebrush community reference area (site 2).

Cover was determined using an ocular estimation method. The percent of ground covered by individual species encountered in each plot was estimated to the nearest 1 percent. Total vegetation cover was estimated so as not to exceed 100 percent (including bare ground, litter, and rock). Measurements of cover in previous reports on the Skyline Mine area were relative and percent cover often exceeded 100 percent. For this reason reference areas were remeasured this season so future comparisons with revegetated areas would meet the stipulations of the new DOGM guidelines. The quadrat size used for the community types in this area was 2 X 5 decimeters.

Determination of productivity for each slope and reference area was made by use of a clipping method. A 0.96 sq. ft. hoop was used in all communities except the Conveyor Route sagebrush community reference area where a 9.6 sq. ft. hoop was considered more appropriate. In each site the quadrats were randomly located and each plot was clipped by life form (grass and grasslike, forbs, and shrubs). For grasses and forbs all standing biomass was clipped; for shrubs only the current years growth was clipped. Samples were weighed to the nearest gram in the field and sample adequacy was tested according to green weight values. All clippings were then taken to the laboratory, oven dried, and reweighed to

the nearest one-tenth of a gram. Sample adequacy was again computed using dry weight figures. Productivity was calculated in pounds per acre for both green and dry weights.

In reference site 2 (the Conveyor Route sagebrush community) number of stems per acre and stem height was determined by use of a 1 ft. X 40 ft. belt transect randomly placed in the community. The number of plants rooted in each plot were counted and placed in a stem size class (0 - 1/2 in., 1/2 - 1 in., 1 - 2 in., etc.). The height of each plant was also estimated. Number of plants per acre was extrapolated by counting those in the plots. Those numbers were multiplied by 43,560 and then divided by the total size of the plots.

Diversity of species in each community type was calculated using the Shannon-Wiener Index. Similarity of revegetated slopes and corresponding reference sites was calculated using Sorenson's Similarity Index.

On appropriate revegetated slopes a tubling success count was conducted. Either a 100 sq. meter plot or a circular plot with a radius of 10 meters was used. All previously planted locations within the plot were counted and indicated whether alive, dead, or missing.

Sample adequacy for cover, productivity, and density was calculated using the recommended formula from DOGM:

$$N(\text{min}) = \frac{t^2 s^2}{d^2}$$

where t is 1.645 for grassland or forb communities and 1.282 for shrubland communities; s is standard deviation; and d is one-tenth of the sample mean. Sample adequacy for productivity measurements was calculated in the field using green weight measurements in order to obtain some indication of adequacy. Calculations were redone in the

laboratory after the samples had been oven-dried. In most cases the laboratory calculations did not change significantly. In both cover and productivity measurements, the recommended maximum sample size was satisfied unless the adequacy test indicated a smaller sample size was adequate.

DISCUSSION OF FINDINGS

Precipitation

Two weather stations are monitored by the National Oceanic and Atmospheric Administration in the general vicinity of the Skyline Mine. One of these is at the town of Scofield and the other is at the Scofield Reservoir Dam. The study sites in the mine area are approximately ten miles away from Scofield Reservoir Dam and five miles from the town of Scofield. Since the studies were conducted during the month of July the effective precipitation is measured from October to June. The ten year monthly average is also for June. At the Scofield station the 10 year effective precipitation average from October to June is 12.77 inches of rainfall. This year's effective precipitation is 16.73 inches for the same time period. The ten year monthly average for June is 0.62 of an inch. This year's June precipitation is 0.66 of an inch. At the Scofield Dam station the 10 year effective precipitation is 8.1 inches. This year's effective precipitation is 8.88 inches. The 10 year average for the month of June is 0.56 of an inch of rainfall. This year 0.82 of an inch was recorded.

Portal Yard Area

In the Portal Yard Area five revegetated slopes occur, as well as two reference areas (see Figure 1). Three of the slopes were measured for cover and productivity data as were both of the reference areas. A discussion of each of the five slopes and the present condition follows. Also, comparison is made between the revegetated slopes and the appropriate reference areas.

Slope 1 is a south facing slope just west of the main office

buildings. The upper half of this slope is heavily revegetated and it was in this portion that the study was made. The vegetative cover of the slope was measured at 74.76 percent. Bromus carinatus and Lathyrus lanzwertii are the dominant species making up nearly fifty percent of the cover. The diversity index is 2.668. After 25 plots were sampled the sample adequacy test showed that only 11 plots were needed ($X = 74.76$, $S = 19.32$, $T = 1.282$). The T-value of 1.282 is used because this slope is being returned to an aspen community. For a complete breakdown of cover, diversity, and composition see Table 2 in Appendix I.

Productivity was measured using a 0.96 sq. ft. hoop. Sample adequacy was tested on the green weight measurements in the field and then again on the dry weight in the laboratory. After forty green weight plots had been clipped the sample adequacy test showed that 29 plots were adequate ($X = 168.4$, $S = 71.1$, $T = 1.292$). The green weights were measured to the nearest gram. The dry weight sample adequacy test was measured to the nearest 0.1 gram. This calculation indicated that 22 plots would have been adequate ($X = 40.0$, $S = 14.73$, $T = 1.282$). The green weight productivity is 1,684 lbs per acre; dry weight productivity is 400 lbs per acre. (See Table 3 in Appendix I.)

Reference site 4 represents the aspen community adjacent and uphill to slope 1. Revegetation of slope 1 is to correspond to this aspen community reference site (see Figure 1). Remeasurements in the aspen stand show that current vegetative cover is 96.5 percent. Bromus carinatus, Poa pratensis, and Lathyrus lanzwertii comprise nearly 70 percent of that total. After ten 2 X 5 decimeter plot frames were measured, the sample adequacy test indicated that a minimum of 10 plots were adequate ($X = 96.5$, $S = 6.25$, $T = 1.2982$). The diversity index total for the community is 2.6030. For a complete breakdown of cover

information see Table 4 in Appendix I.

Productivity for reference site 4 was obtained in the manner indicated in the methodology discussion. Sample adequacy was obtained after thirty plots were clipped and for the green weight measurements 16 plots were indicated adequate ($X = 159.8$, $S = 50$, $T = 1.282$). The dry weight sample adequacy test showed that 8 plots would have been sufficient ($X = 30.83$, $S = 6.72$, $T = 1.282$). Green weight productivity for the community is 1,598 lbs per acre; dry weight productivity is 308.3 lbs per acre. See Table 5 in Appendix I for more complete information.

No tree productivity is given for this type because the aspens on the revegetated slope are too small to yield timber measurements. However, the tree density data supplied in a previous report (Welsh et al., 1980) is considered appropriate and will be used to compare tree density measurements on revegetated slopes in the future.

In comparing reference area four with Slope 1 it is noticed that the cover of the revegetated slope is approximately 77 percent of that on the reference slope (Slope 1 cover = 74.76; Reference site 4 cover = 96.5). The dry weight productivity of slope 1 is approximately 90 lbs per acre more than that of reference site 4 (Slope 1 productivity = 400 lbs per acre; reference site 4 productivity = 308.3 lbs per acre). The diversity index of slope 1 is 2.668 and for reference site 4 it is 2.6030. Using the Sorenson Similarity Index the species composition of the paired sites is only 47 percent similar. Ten species were encountered during sampling in reference site 4, and 20 species during sampling of slope 1. Seven species are common to both communities. The low species similarity can be attributed to the increased diversity of the revegetated slope. The revegetated slope has no overstory and was recently without vegetation. The increased light and open space have

allowed a more diverse community to begin reestablishment. As the slope approaches maturity the similarity of species on the reclaimed slope and in the adjacent reference area should greatly increase. (For a summary comparison of these paired sites see Table 6 in Appendix I.)

Slope 2 is the southfacing slope of the soil stockpile just north of the main office buildings (see Figure 1). The vegetative cover for this area is 41.2 percent and is composed mostly of grasses. To this point the forbs have not germinated well, and the tubling shrubs have not yet shown much growth. After 40 plots were measured the sample adequacy test showed that 41 were needed. The additional plot was measured ($X = 41.2$, $S = 20.5$, $T = 1.282$). See Table 7 in Appendix I for more complete information.

Green weight productivity on slope 2 was measured at 518 lbs per acre. Forty plots were clipped and the sample adequacy test indicated that 38 plots were sufficient ($X = 51.8$, $S = 24.9$, $T = 1.282$). Dry weight productivity is 166 lbs per acre. The forty plots which proved adequate for the green weight measurements were not sufficient for the dry weights. The sample adequacy test indicated 46 plots were necessary ($X = 16.6$, $S = 8.8$, $T = 1.282$). However, according to current DOGM guidelines 40 samples are the maximum number of plots required. See Table 8 in Appendix I for more complete information.

Slope 2 will be compared eventually to reference site 4 for revegetation purposes. The cover of slope 2 is approximately 43 percent of the cover of reference site 4 (Slope 2 cover = 41.2 percent; reference site 4 cover = 96.5 percent). Dry weight productivity of slope 2 is 135 lbs per acre less than that of reference site 4 (slope 2 productivity = 166 lbs per acre; reference site 4 productivity = 301 lbs per acre). The diversity index shows slope 2 with a 1.8832 figure and reference four

with a figure of 2.6030. The Sorensen Similarity Index shows a species similarity of 40 percent. There are five species in common and a total of twenty-five species in the two areas. The low similarity percentage is due at least partially to the higher diversity of species in the reclaimed area. A greater number of species reinvades disturbed areas initially, however they will eventually be replaced by the more common dominant ones as the community matures. For a summary comparison of these paired sites see Table 9 in Appendix I.

Slope 3 is an east facing slope behind the coal storage silo in the portal yard (See Figure 1). This slope is in an area which was disturbed prior to the Skyline Mine development. No vegetation measurements were taken on it because of continued construction above and on the slope and because there is no reference site paired to it.

Slope 4 is a northfacing slope west of the main office buildings (see Figure 1). This slope is to be revegetated to a spruce-fir community. Tublings, jute, and hydro-mulched seed have been applied to this slope; however, during the winter and spring of 1981-82 the slope completely failed destroying a large percent of the revegetation efforts. No revegetation measurements were taken during the current season.

Slope 5 is the longest slope in the portal yard area. The bottom portion of this slope has little vegetation due to slumping and poor substrate conditons. However, the top portion is revegetating. Cover measurements were taken in the revegetating area this season using the occular estimation method. Data gathered indicated a total of 29.9 percent live cover, 40.8 percent litter, and 29.3 percent bare ground or rock. Of the live cover, grasses comprised the majority of species with Bromus carinatus comprising approximately 45 percent of the live composition, Agropyron spicatum approximately 14 percent, and Poa

pratensis approximately 11 percent. Total diversity is 2.8693. Forty plots were sampled and then tested for adequacy. Indications of the adequacy test were that 26 plots would have been sufficient ($X = 29.85$, $S = 11.96$, $T = 1.282$). A T-value of 1.282 was used because the slope is being revegetated to a spruce-fir community type. For a more complete breakdown of data see Table 10 in Appendix I.

Productivity of slope 5 was measured by clipping and weighing all sample plots. A 0.96 sq. ft. hoop was used for all measurements. Samples were weighed to the nearest gram in the field and then tested for sample adequacy. After 40 plots had been sampled adequacy was determined to be 31 ($X = 27.48$, $S = 9.84$, $T = 1.282$). After samples were oven dried in the laboratory they were weighed again to the nearest 0.1 gram. Sample adequacy was tested again with 25 plots indicated as sufficient ($X = 5.46$, $S = 2.13$, $T = 1.282$). Green weight productivity was 224.8 lbs per acre; dry weight productivity was 54.6 lbs per acre. See Table 11 in Appendix I for more information.

For the purpose of assessing successful revegetation, slope 5 will eventually be compared with reference site 3, a spruce-fir community type. This reference site was remeasured for cover and productivity this year with the following results.

Total live cover of the herbaceous ground layer in the spruce fir reference site is only 9.76 percent with 86.8 percent comprized of litter and the rest bare ground or rock. The understory forbs Epilobium angustifolium, Lathyrus lanzwertii, Arnica cordifolia, Pyrola secunda, and Ozmorhiza chilensis comprise approximately 80 percent of the ground layer cover. Sample adequacy was tested after 41 plots had been measured, with 294 plots deemed necessary to satisfy adequacy ($X = 9.76$, $S = 13.1$, $T = 1.282$). Species diversity was 3.0731. For a complete

breakdown of data see Table 12 in Appendix I.

Productivity for reference site 3 was obtained by clipping and weighing all plots sampled. A 0.96 sq. ft. hoop was randomly placed in the community type. After 40 plots had been sampled and weighed sample adequacy was tested. A total of 758 plots were deemed necessary for adequacy ($X = 3.4$, $S = 7.3$, $T = 1.282$). After oven drying the samples in the laboratory and re-weighing them to the nearest 0.1 gram sample adequacy was tested again with indications of 850 plots needed to satisfy adequacy. Green weight productivity for this community was 34 lbs per acre; dry weight productivity was 3.6 lbs per acre. See Table 13 in Appendix I for more complete information.

Tree density data from a previous report will eventually be used for comparison of reference and revegetated sites (Welsh et al., 1980).

In comparing reference area 3 with slope 5 it is seen that the cover of the reclaimed area far surpasses the understory cover of the mature spruce-fir community (slope 5 cover = 29.9 percent; reference site 3 cover = 9.8 percent). Productivity of the revegetated slope is also much higher than the reference site (productivity of slope 5 = 54.6 lbs per acre; reference site 3 productivity = 3.6 lbs per acre). The diversity index for slope 5 is 2.8693, while the index for reference site 3 is 3.0731. Using the Sorenson Similarity Index the species composition of the paired sites is only 11 percent similar. Twenty-two species were encountered on slope 5, and 14 species at reference site 3. However, only two of these species were common to both sites. The reason for this discrepancy in common species is probably the same as that discussed above for the comparison of slopes 1 and 2 to reference site 4. For a summary comparison of slope 5 and reference site 3 see Table 14 in Appendix I.

Conveyor Route

Plants on revegetated slopes along the conveyor route were not measured this season. Revegetation was initiated in late summer and autumn of 1981, and seeds were beginning to germinate and tublings were in their first season of growth. All cut slopes existing above the Eccles Canyon road are designated slope 6. All fill slopes below the road and between the road and Eccles Creek are designated slope 7 (see Figure 2). Some of these slopes were seeded in the fall of 1981 and some tublings were planted also. The rest were seeded this season. Vegetation monitoring should begin during the summer of 1983.

A reference site for the sagebrush community type along the conveyor route was resampled this season for cover and productivity data. Designated as reference site 2, measurements of this community indicated 85.45 percent cover, with Artemisia tridentata and Purshia tridentata comprising the majority of the community composition. Species diversity was 2.7304. For a more complete breakdown see Table 15 in Appendix II.

Productivity measurements were obtained according to the methods discussed previously. After 15 samples had been measured in the field the sample adequacy test indicated 14 samples were adequate ($X = 389.4$, $S = 114.3$, $T = 1.282$). The samples were then taken to the laboratory, oven dried and re-weighed. Adequacy was then determined to be 19 plots ($X = 131.2$, $S = 44.99$, $T = 1.282$). Average green weight productivity is 389.4 lbs per acre; dry weight productivity is 131.2 lbs per acre. For a more complete breakdown see Table 16 in Appendix II.

Stems per acre and stem height measurements were also taken in this sagebrush community type (see methodology section). Total stems per acre were 31,245; with Symphoricarpos oreophilus numbering 14,429 (all of these stems were under 1" in diameter); Artemisia tridentata 7,692 (over

3,000 of these were greater than 2" in diameter); Amelanchier utahensis 3,131; Purshia tridentata 2,998; Chrysothamnus viscidiflorus 817; Pachystima myrsinites 340; and Rosa woodsii 1,838. The average height was approximately 3 decimeters. Big sagebrush averaged almost 5 decimeters in height. For a more complete breakdown see Table 17 in Appendix II.

Loadout Area

The only revegetated area in the Loadout Area consists of portions along the new stream course and is designated as Area 10. Tublings were planted along the stream last season, however seeding with forbs and grasses was completed this year and no measuring of revegetation was undertaken (except a tubling success count to be discussed later). Other slopes eventually to be revegetated include the loadout topsoil pile, slope 9, and the spruce-fir community on the slope immediately south of the two storage silos, slope 11 (see Figure 3). The riparian community reference site 1 exists west of the new stream course along the undisturbed portion of Eccles Creek. This site was not remeasured this season as 1981 measurements were deemed adequate. Another revegetated slope exists east of the loadout area and Pleasant Valley Creek along the railroad right-of-way (slope 8). This area has been seeded and planted with experimental shrubs (to be discussed later). Slope 8 is under the jurisdiction of the Division of Wildlife Resources, and is not subject to the same stipulations as the other slopes in the mine area.

General Lease Area

During the original studies of vegetation communities in the Skyline Mine Area (Welsh et al., 1979) reference sites were chosen

throughout the general lease area to characterize the occurring vegetative types that might possibly be disturbed during future mining activities (see map, Appendix IV). During the current season selected reference sites were remeasured for cover and productivity so the recorded data would match the requirements of the most current DOGM stipulations. Currently acceptable methods now require that cover be calculated according to a maximum of 100 percent, whereas previous cover measurements in these areas were based on canopy cover estimates and could thus exceed 100 percent. Productivity methods now acceptable made it desirable to remeasure each community by clipping and weighing all sample plots. The following is a brief discussion of this season's data accumulation.

Three reference sites were measured in the area previously designated as Site WD (Welsh et al., 1979). Reference site 5 is a spruce-fir community type and calculation of live understory cover indicated a total of 16.98 percent. Over 77 percent of the understory area is comprized of litter, with the remaining percentage comprised of bare ground and rock. Forbs and grasses comprise the large majority of the species composition with Ozmorhiza chilensis, Stellaria jamesiana, and Carex geyeri being the dominant species. Species diversity is 3.1294. After 40 plots had been sampled a test for sample adequacy indicated a minimum of 85 plots were needed ($X = 16.98$, $S = 12.20$, $T = 1.282$). For more complete information see Table 18 in Appendix III.

Productivity measurements in reference site 5 were completed using methods discussed previously. After 25 samples were taken in the field, adequacy was tested and found to require 296 plots ($X = 2.73$, $S = 3.66$, $T = 1.282$). Upon returning to the laboratory and oven drying the samples, adequacy was tested again and 296 samples were again indicated as

necessary to satisfy adequacy in the community ($X = 0.45$, $S = 0.60$, $T = 1.282$). Green weight productivity was 27 lbs per acre; dry weight productivity was 4.5 lbs per acre. See Table 19 in Appendix III for more complete information.

Reference site 6 is a riparian community type and remeasurement of cover indicated a total of 91.6 percent cover for the vegetative type. The largest portion of plant life in the community consists of the forbs Cardamine cordifolia with approximately 20 percent of the species composition; Saxifraga odontoloma with 33 percent; and Delphinium menziesii with 15 percent of the species composition. Species diversity is 2.8167. After 10 plots were sampled, adequacy tests indicated only 2 were needed ($X = 91.6$, $S = 7.04$, $T = 1.645$). See Table 20 in Appendix III for more complete information.

Productivity measurements were obtained by clipping and weighing each randomly placed, 0.96 sq. ft., plot. Samples were weighed in the field and after 20 plots had been sampled, adequacy tests indicated only 18 were needed ($X = 102.5$, $S = 26.37$, $T = 1.645$). After oven drying and reweighing the samples, adequacy tests indicated only 15 plots were needed ($X = 11.14$, $S = 2.62$, $T = 1.645$). Green weight productivity for this type was 1,025 lbs per acre; dry weight productivity was 111.4 lbs per acre. See Table 21 in Appendix III for more complete information.

Reference site 7 is an aspen community type and total cover of the ground layer was measured at 95.6 percent. Poa pratensis and Lathyrus lanzwertii were the species with the highest percent composition in the community (21 and 24 percent respectively). The grass Bromus carinatus was next with 17 percent of the species composition. The number of forb species encountered was high (15) and diversity for the community was 3.2388. After 20 plots had been sampled a test for adequacy revealed

only 1 plot was needed ($X = 95.6$, $S = 6.4$, $T = 1.282$). See Table 22 in Appendix III for more complete information.

Productivity measurements were obtained using a 0.96 sq. ft. hoop and the methods previously discussed. Samples were clipped and weighed by life form in the field. After 13 plots had been sampled an adequacy test indicated only 6 plots were needed ($X = 103$, $S = 19.6$, $T = 1.282$). After oven drying and re-weighing the clippings sample adequacy was tested again with 7 plots indicated as necessary ($X = 22.2$, $S = 4.6$, $T = 1.282$). Green weight productivity equals 1,030 lbs per acre; dry weight equals 222 lbs per acre. For a more complete breakdown see Table 23 in Appendix III.

Reference site 8 corresponds with the community type at the currently proposed waste rock storage site, and has been discussed in a separate report.

Reference sites 9, 10, and 11 are summit communities corresponding with Reference Site 1 in the original report (Welsh, et al., 1979).

Reference site 9 is a grass-forb-elderberry community and remeasurement of cover indicated a total of 96.8 percent total cover. Of this percentage the greatest percent composition goes to Lathyrus lanzwertii with 46.6. Bromus carinatus, a Carex species, Melica bulbosa, Viola adunca, and Galium trifidum are other important species in the community. Species diversity was 2.6970. After 20 plots had been sampled an adequacy test indicated that 1 plot was adequate in characterizing the community ($X = 96.8$, $S = 5.4$, $T = 1.645$). See Table 24 in Appendix III for more information.

Productivity measurements were obtained using a 0.96 sq. ft. hoop and clipping and weighing methods previously outlined. Samples were weighed by life form in the field. After 20 plots were sampled an

adequacy test showed 16 plots were adequate ($X = 182.7$, $S = 44.2$, $T = 1.645$). After oven drying and remeasuring the samples another adequacy test indicated a minimum of 17 plots were needed ($X = 38.29$, $S = 9.72$, $T = 1.645$). Green weight productivity is 1,827 lbs per acre; dry weight productivity is 382.9 lbs per acre. For more complete information see Table 25 in Appendix III.

Reference site 10 is an aspen community. Measurements indicated a total of 94.3 percent cover in the vegetative type. Species with the greatest percent composition were Lathyrus lanzwertii (approximately 20 percent), Bromus carinatus (12 percent), Stellaria jamesiana (11 percent), and Nemophila breviflora (9 percent). After 20 plots had been sampled an adequacy test indicated a minimum of 1 sample was necessary in characterizing the community ($X = 94.3$, $S = 6.1$, $T = 1.282$). Species diversity for this type was 3.6862. See Table 26 in Appendix III for more complete information.

Productivity measurements were taken by clipping and weighing all plots during the sampling procedure. After 15 plots had been clipped an adequacy test indicated a minimum of 10 plots was adequate. When the samples had been oven dried and remeasured another adequacy test was calculated indicating 9 plots were adequate. Green weight productivity for this aspen community type was 1,361 lbs per acre; dry weight was 257.7 lbs per acre. For a more complete breakdown see Table 27 in Appendix III.

Reference site 11 is a spruce-fir community type. Measurements indicated a total of 18.43 percent cover in the vegetative type. Species with the greatest percent composition were Osmorhiza chilensis (28.2 percent), Fragaria virginiana (14.2 percent), and Epilobium angustifolium

(12.9 percent). After 40 plots had been sampled an adequacy test indicated 178 were needed ($X = 18.43$, $S = 19.17$, $T = 1.282$). Species diversity for the community is 3.3519. See Table 28 in Appendix III for a more complete breakdown of information.

Productivity measurements were obtained by clipping and weighing all plots. After 40 plots had been clipped a sample adequacy test was calculated indicating 322 plots were needed ($X = 3.125$, $S = 4.38$, $T = 1.282$). After oven drying and remeasuring the samples in the laboratory another adequacy test indicated a minimum of 316 plots were needed ($X = .51$, $S = .71$, $T = 1.282$). Green weight productivity is 31.25 lbs per acre; dry weight is 5.1 lbs per acre. See Table 29 in Appendix III for more information.

There is also a reference site for the spring stripe area (site 12) in Huntington Canyon. Measurements of this community indicated a total of 93.5 percent cover. Species with the greatest percent composition were Polemonium occidentale (23.7 percent), Deschampsia caespitosa (19.3 percent), Carex microptera (18.2 percent), Carex rostrata (8.1 percent), and Helenium hoopesii (7.2 percent). See Table 30 in Appendix III for more complete information.

Productivity measurements were taken in the spring stripe grass-forb community by clipping and weighing all plots. After 15 plots had been sampled an adequacy test was calculated. A minimum of 25 plots was deemed adequate ($X = 111.06$, $S = 34$, $T = 1.645$). When samples had been oven dried and re-weighed in the laboratory another adequacy test indicated a minimum of 29 samples were necessary ($X = 22.49$, $S = 7.34$, $T = 1.645$). The establishment of community trend was all that was necessary in the spring stripe area and so 15 plots were considered satisfactory. Green weight productivity was 1,110.6 lbs per acre; dry

bottom of the slump area to brace against the slope to help reduce further slumping. The area above the slump crack could be stabilized further by addition of topsoil and seed.

A tubling success count on Slope 1 showed that 58 percent of the tublings survived. A 100 sq. meter area was marked off and all tublings or places where tublings were originally planted were examined. Recordings were made by species and condition (alive/dead/missing). The dense vegetation made it difficult to relocate all of the unsuccessful plantings.

Slope 2. The soil stockpile was treated to 34 lbs/acre of available nitrogen early this summer. The middle of the stockpile slope is quite well vegetated with orchard grass, mountain brome, Kentucky blue grass, slender wheatgrass, and bluebunch wheatgrass being the best established species. The tublings on the soil stockpile have not shown substantial growth. A count was taken in a circle with a radius of 10 meters. Every living and dead shrub was counted as well as areas where shrubs were thought to have been planted. A total of 125 live tublings were counted. Sixty-five dead shrubs were also observed, however, the erosion and increasing grass-forb density made the search for dead tublings, or areas where tublings should have been planted, difficult to find. From the figures given approximately 66 percent of the tublings on Slope 2 survived.

Because some areas of the stockpile slope were not showing much revegetation success, the bare parts of the slope were again reseeded with the standard seed mix. Also the back slope of the stockpile and the two new drainage ditches on top of the soil stockpile were reseeded. Experimental seedings on top of the soil stockpile are beginning to show some success. In addition to the seeding experiment, shrubs for

experimental plantings were obtained. Approximately 250 bare root shrubs were planted on the western edge of the soil stockpile. The species include: Amelanchier alnifolia (83), Ceanothus martinii (67), Artemisia tridentata (18), Chrysothamnus nauseosus (37), Purshia glandulosa (9), Artemisia cana (10), Cercocarpus intricatus (7), Cercocarpus ledifolius (10), and Purshia tridentata (12).

In June of 1982 a pump was brought to the stockpile and a sprinkling system was set up. The stockpile was irrigated twice a week when necessary until the first of July. At that time the irrigating was turned over to mine personnel.

The stockpile area has also been seriously impacted from ground squirrel and trespass sheep use during this past season.

Erosion pins were measured to determine amounts of erosion on the slope during the past year. Pins were originally buried with exactly 6 inches remaining above ground. This year the average height above ground was 6.3 inches indicating a slight erosion across the overall slope. However, one pin was as much as 8 inches above ground and another was buried, only 2.75 inches protruding above ground.

Slope 3. This slope is located immediately to the west of the coal silo in the portal yard area and was treated this summer with an application of fertilizer at the rate of 34 pounds of available nitrogen per acre. The slope is moderately well vegetated with mountain brome, Kentucky bluegrass, and some forbs. There is a stripe down the middle of the slope where it was rejuted after being disturbed last season. Plants are starting to come back in this area, however. There has been some slumpage on this slope and as a consequence some of the erosion pins have been lost. They will be replaced at the end of this growing season or when the construction on the silo and the slope has been completed.

Also, the southern end of the slope was disturbed this season during an attempt to construct the foundation for a conveyor platform. The slope was apparently not stable enough and has sloughed. Revegetation will be accomplished when construction is completed.

Slope 4. This north facing slope west of the office building has completely slumped. The erosion pins have been lost and the tublings are mostly destroyed. Grass and forb cover is also lost except at the top of the slope.

Slope 5. This is the longest slope in the portal yard area. A few erosion pins on this slope have been lost because of slumping. However, measurements were taken this year which indicated an average of 5.8 inches remaining above ground on the pins. Topsoil from the top of the slope has filled in areas toward the middle and bottom. The bottom portion of this slope has little vegetation. Poor topsoil conditions and slumping contribute to this fact. However, the top portion of the slope is well revegetated.

The tubling success count in this area showed no dead plants. In a 100 sq. meter plot, 102 plants were counted. There were 50 aspen, 31 spruce, 20 elderberry, and one serviceberry. During vegetation measurements this season numerous spruce seedlings were discovered. These seedlings come from the neighboring spruce-fir community and demonstrate the beginning of natural reinvasion.

Slope 6. All of the slopes in the canyon above the conveyor bench are called Slope 6. Erosion pins were placed this season on the third segment of this slope. The conveyor bench itself was reseeded after topsoil was applied this spring and, again on the third portion of this slope, 50 straw bales were placed along the edge where erosion channels were forming. The slopes below the conveyor bench received a fertilizer

application and all of the road cuts on the north side of the road below the conveyor bench and east of it were reseeded during the month of June. A tubling success count showed no dead plants. Thirty-three live tublings were counted (14 sagebrush, 17 Sambucus, and 2 rose). However the status of approximately 40 additional tublings that should have existed in the plot is unknown.

Slope 7. This includes all the slopes from the south side of the road to Eccles stream. These slopes were all treated to a standard seed mix of 16 lbs/acre.

Slope 8. This slope is east of the railroad right-of-way on the east side of Clear Creek. During the month of June more than 350 shrubs were planted on this slope. Approximately 25 river birch were transplanted from the load-out area to the streamside. In addition, 327 shrubs received for experimental plantings were planted on the slope. The species and numbers planted were Alnus incana (43), Cercocarpus ledifolius and C. intricatus (46), Artemisia tridentata (26), Cercocarpus betuloides (88), Rosa woodsii (31), Purshia tridentata (27), Ephedra viridis (28), Ceanothus martinii (12), Cowania mexicana (20), and Ceanothus velutinus (8). A portion of these have been buried and destroyed by construction activities.

Slope 9. The loadout soil stockpile area has not been revegetated.

Area 10. This area consists of the revegetated portions along the new stream course in the loadout area. During the end of May and the first part of June, over fifty transplanted tublings were buried more deeply. Approximately 25 river birch that had been planted too far away from the stream were transplanted to slope 8. Native Plants, Inc. also brought (gratis) one dozen large river birch and planted them along the

creek.

The tubling success count showed that 91 percent of the shrubs have survived. A total of 170 shrubs were counted and only 16 of those were dead. By the middle of July the seeds planted last fall were germinating well and, in some places, the grass was re-established. On the north side of the stream some of the native vegetation is re-invading the disturbed area.

Slope 11. This is the cut slope immediately south of the two silos in the loadout area. There have been no revegetation efforts made on this slope.

RECOMMENDATIONS FOR WORK IN 1983

It is recommended that remeasuring of the reference and reclaimed areas of the portal yard, conveyor route, and loadout areas be conducted during the 1983 field season. Revegetation of the loadout area soil stockpile (slope 9) and of the slope just south of the storage silos (slope 11) needs to be completed, as well as along the railroad right-of-way and stream margins adjacent to the loadout area. Ammonium nitrate (34-0-0) at the rate of 100 lbs per acre, ie. 34 lbs nitrogen per acre, needs to be applied to all slopes under DOGM authority. A rodent problem exists on some of the slopes and some measure of rodent control might be necessary during the years of revegetation establishment.

TABLE 1
 Current Revegetated Slopes, Reference Sites and
 Their Corresponding Designations in Previous Reports

CURRENT DESIGNATION	PREVIOUS DESIGNATIONS
<u>Portal Yard Area</u>	
Slope 1, reclaimed aspen	Aspen validation *
Reference site 4, aspen	Aspen reference *
Slope 2, reclaimed aspen topsoil pile	Aspen validation and Sagebrush validation *
Reference site 4, aspen	Aspen reference *
Slope 3, reclaimed grass-forb	Disturbed valley bottom *
Slope 4, reclaimed spruce-fir	Spruce fir validation *
Reference site 3, spruce-fir	Spruce-fir reference *
Slope 5, reclaimed spruce-fir	Spruce-fir validation *
Reference site 3, spruce-fir	Spruce-fir reference *
<u>Conveyor Route</u>	
Slope 6, reclaimed sagebrush	Sagebrush validation *
Reference site 2, sagebrush	Sagebrush reference *
Slope 7, reclaimed mixed aspen and riparian	
<u>Loadout Area</u>	
Slope 8, reclaimed riparian	Wildlife Resources jurisdiction
Slope 9, soil stockpile not yet reclaimed	Sagebrush validation *

Area 10, reclaimed riparian	Riparian validation *
Reference site 1, riparian	Riparian reference *
Slope 11, spruce-fir	Spruce fir validation *

General Lease Area

Reference site 5, spruce-fir	Spruce-fir, Reference Site WD **
Reference site 6, riparian	Riparian, Reference Site WD **
Reference site 7, aspen	Aspen, Reference Site WD **
Reference site 9, grass-forb	Grass-forb-elderberry, Reference Site 1 **
Reference site 10, aspen	Aspen, Reference Site 1 **
Reference site 11, spruce-fir	Spruce-fir, Reference Site 1 **
Spring stripe reference site	Grass-forb, riparian Spring stripe reference *

* Information taken from the 1980 report (see References).

** Information taken from the 1979 report (see References).

REFERENCES

- Welsh, Stanley L. and Joseph R. Murdock. 1979. Report of vegetation, plant community analysis, threatened and endangered plant species, soils, and reclamation plans for Coastal States Energy Company, McKinnon properties, Skyline project, Carbon-Emery Counties, Utah. Report prepared for Vaughn Hansen Associates, Inc. 133 pp.
- Welsh, Stanley L., Joseph R. Murdock, and Susan M. White. 1980. Coastal States Energy Company, Skyline Mines, Vegetation Stipulations and Addition Data on Revegetation and Stockpile Soils. Report prepared for Coastal States Energy Company. 58 pp.

APPENDIX I
PORTAL YARD AREA

TABLE 2
COVER DATA

Site: SLOPE #1	X = 74.76
Vegetation: Revegetated Aspen	S = 19.32
DATE: 7 July 1982	N = 25
Quadrat Size: 2 X 5 dm	N(min) = 11
	T-value = 1.282

TAXA	DIVERS.	% COVER	% COMP.
Bare ground		8.4	
Litter		13.36	
Rock		3.48	
<u>GRASSES</u>			
Bromus carinatus	.5307	28.12	37.6
Poa pratensis	.3257	6.96	9.3
Dactylis glomerata	.1635	2.40	3.2
Agropyron trachycaulum	.1557	2.24	3.0
Agropyron spicatum	.1330	1.80	2.4
<u>FORBS</u>			
Medicago sativa	.0347	0.32	0.4
Phacelia heterophylla	.0803	0.92	1.2
Agastache urticifolia	.0109	0.08	0.1
Gayophytum nuttallii	.0934	1.12	1.5
Achillea millefolium	.0575	1.32	1.8
Descurainia californica	.0236	0.20	0.3
Lathyrus lanzwertii	.5190	21.12	28.3
Polygonum sawatchense	.0274	0.24	0.2
Epilobium paniculatum	.0109	0.08	0.1
Hackelia floribunda	.2840	5.52	7.4
Urtica dioica	.0664	0.72	1.0
Labiata #1	.0060	0.04	0.1
Chenopodium fremontii	.0196	0.16	0.2
<u>SHRUBS</u>			
Symphoricarpos oreophilus	.0311	0.28	0.4
Populus tremuloides	.0934	1.12	1.5
TOTALS	2.6668	74.76	100.0

TABLE 3
PRODUCTIVITY MEASUREMENTS

	Green Weight	Dry Weight
Site: SLOPE 1	X = 168.4	X = 40
Vegetation: Revegetated Aspen	S = 71.1	S = 14.73
Date: 7 July 1982	N = 40	N = 40
Quadrat Size: 0.96 sq. ft. hoop	N(min) = 29	N(min) = 22
T-value = 1.282		

LIFE FORM	AVERAGE GREEN WT.	AVERAGE DRY WT.
Shrubs	0.5g	0.2g
Forbs	86.4g	16.8g
Grass and grasslike	81.5g	23.0g
TOTALS	168.4g	40.0g
Productivity	1,684 lbs/acre	400 lbs/acre

TABLE 4
COVER MEASUREMENTS

Site: Reference #4 X = 96.5
 Vegetation: Aspen S = 6.25
 Date: 7 July 1982 N = 10
 Quadrat Size: 2 X 5 dm N(min) = 1
 T-value = 1.282

TAXA	DIVERS.	%COVER	%COMP.
Bare ground		1.0	
Litter		1.8	
Rock		0.7	
<u>GRASSES</u>			
Bromus carinatus	.5007	25.0	25.9
Poa pratensis	.4661	20.1	20.8
Agropyron trachycaulum	.0667	1.0	1.0
<u>FORBS</u>			
Lathyrus lanzwertii	.5106	24.0	24.9
Achillea millefolium	.1523	3.0	3.1
Hackelia micrantha	.2811	7.5	7.8
Hackelia floribunda	.1630	3.3	3.5
Aster sp.	.0667	1.0	1.0
Galium trifidum	.0445	0.6	0.6
<u>SHRUBS</u>			
Symphoricarpos oreophilus	.3512	11.0	11.4
TOTALS	2.6030	96.5	100.0

TABLE 5
PRODUCTIVITY MEASUREMENTS

	Green Weight	Dry Weight
Site: REFERENCE # 4	X = 159.8	X = 30.83
Vegetation: Aspen	S = 50	S = 6.72
Date: 8 July 1982	N = 30	N = 30
Quadrat Size: 0.96 sq. ft. hoop	N(min) = 16	N(min) = 8
T-value = 1.282		

LIFE FORM	AVERAGE GREEN WT.	AVERAGE DRY WT.
Shrubs	2.9g	0.90g
Forbs	97.2g	16.10g
Grass and grasslike	59.7g	13.83g
TOTALS	159.8g	30.83g
Productivity	1,598 lbs/acre	308.3 lbs/acre

TABLE 6
DATA SUMMARY SHEET

VEGETATION TYPE: Aspen

DATE: 7 and 8 July 1982

SITE: Slope 1 and Reference site 4

PROJECT: Skyline

RECLAIMED AREA					REFERENCE AREA				
Characteristic	X	S	N	N(min)	X	S	N	N(min)	T
Cover	74.76	19.32	25	11	96.5	6.25	10	1	1.282
Productivity	400 lbs per acre				301 lbs per acre				
Aspect	Southern				Southern				

% Similarity: 47

TABLE 7
COVER DATA

Site: SLOPE #2	X = 41.2
Vegetation: revegetated aspen	S = 20.5
DATE: 7 July 1982	N = 41
Quadrat Size: 2 X 5 dm	N(min) = 41
	T-value = 1.282

TAXA	DIVERS.	% COVER	% COMP.
Bare ground		37.4	
Litter		7.5	
Rock		13.9	
<u>GRASSES</u>			
Dactylis glomerata	.3832	27.63	67.1
Poa pratensis	.2417	2.39	5.8
Agropyron spicatum	.2236	2.27	5.5
Bromus carinatus	.2616	3.0	7.3
Agropyron trachycaulum	.2432	2.41	5.8
<u>FORBS</u>			
Polygonum sawatchense	.1696	1.41	3.4
Epilobium paniculatum	.0446	0.24	0.6
Hackelia floribunda	.0446	0.24	0.6
Polygonum sp.	.0679	0.41	1.0
Trifolium sp.	.0065	0.05	0.1
Descurainia californica	.0253	0.12	0.3
Chenopodium fremontii	.0117	0.05	0.1
Penstemon sp.	.0294	0.15	0.4
<u>SHRUBS</u>			
Symphoricarpos oreophilus	.0970	0.66	1.6
Populus tremuloides	.0334	0.17	0.4
TOTALS	1.8832	41.20	100.0

TABLE 8
PRODUCTIVITY MEASUREMENTS

	Green Weight	Dry Weight
Site: SLOPE 2	X = 51.8	X = 16.6
Vegetation: Grass/Forb	S = 24.9	S = 8.8
Date: 7 July 1982	N = 40	N = 40
Quadrat Size: 0.96 sq. ft. hoop	N(min) = 38	N(min) = 46
T-value = 1.282		

LIFE FORM	AVERAGE GREEN WT.	AVERAGE DRY WT.
Shrubs	—	—
Forbs	—	—
Grass and grasslike	51.8g	16.6g
TOTALS	51.8g	16.6g
Productivity	518 lbs/acre	166 lbs/acre

TABLE 9
DATA SUMMARY SHEET

VEGETATION TYPE: Aspen

DATE: 7 and 8 July 1982

SITE: Topsoil Pile (Slope 2) and Reference site 4

PROJECT: Skyline

RECLAIMED AREA					REFERENCE AREA				
Characteristic	X	S	N	N(min)	X	S	N	N(min)	T
Cover	41.2	20.5	41	41	96.5	6.25	10	1	1.282
Productivity	166 lbs per acre				301 lbs per acre				
Aspect	Southern				Southern				

% Similarity: 40

TABLE 10
COVER DATA

Site: SLOPE #5	X = 29.85
Vegetation: Revegetated Spruce/Fir	S = 11.96
DATE: 9 July 1982	N = 40
Quadrat Size: 2 X 5 dm	N(min) = 26
	T-value = 1.282

TAXA	DIVERS.	% COVER	% COMP.
Bare Ground		22.20	
Litter		40.80	
Rock		7.15	
<u>GRASS AND GRASSLIKE</u>			
Bromus carinatus	.5177	13.525	45.3
Agropyron spicatum	.3989	4.225	14.2
Poa pratensis	.3480	3.250	10.9
Carex geyeri	.0434	0.175	0.6
<u>FORBS</u>			
Trifolium repens	.1639	1.000	3.4
Achillea millefolium	.1235	0.675	2.3
Descurainia californica	.2711	2.125	7.1
Polemonium foliosissimum	.0792	0.375	1.3
Collinsia parviflora	.0154	0.050	0.2
Penstemon stricta	.0154	0.050	0.2
Stellaria jamesiana	.0833	0.400	1.3
Chenopodium rubrum	.1132	0.600	2.0
Mertensia ciliata	.0217	0.075	0.2
Hackelia floribunda	.1301	0.725	2.4
Chenopodium album	.0330	0.125	0.4
Epilobium angustifolium	.0577	0.250	0.8
Agastache urticifolia	.0531	0.225	0.7
Polygonum sawatchense	.0275	0.050	0.2
<u>SHRUBS</u>			
Populus tremuloides	.0577	0.250	0.8
Sambucus racemosa	.1610	0.975	3.2
Artemisia tridentata	.0792	0.375	1.3
Rosa woodsii	.0751	0.350	1.2
TOTALS	2.8693	29.850	100.0

TABLE 11
PRODUCTIVITY MEASUREMENTS

	Green Weight	Dry Weight
Site: SLOPE #5	X = 22.48	X = 5.46
Vegetation: Grass, shrub, spruce	S = 9.84	S = 2.13
DATE: 8 July 1982	N = 40	N = 40
Quadrat Size: .96 sq. ft. hoop	N(min) = 31	N = 25
	T-value = 1.282	

LIFE FORM	AVERAGE GREEN WT.	AVERAGE DRY WT.
Shrubs	0.93g	0.22g
Forbs	5.50g	1.22g
Grass and grasslike	16.05g	4.02g
TOTALS	22.48g	5.46g
Productivity	224.8 lbs/acre	54.6 lbs/acre

TABLE 12
COVER DATA

Site: REFERENCE #3	X = 9.76
Vegetation: Spruce-fir	S = 13.1
DATE: 9 July 1982	N = 41
Quadrat Size: 2 X 5 dm	N(min) = 294
	T-value = 1.282

TAXA	DIVERS.	% COVER	% COMP.
Bare ground		3.10	
Litter		86.80	
Rock		0.34	
<u>GRASS AND GRASSLIKE</u>			
Carex geyeri	.0216	0.02	0.2
<u>FORBS</u>			
Epilobium angustifolium	.3459	1.05	10.8
Pachystima myrsinites	.2232	0.51	5.2
Viola adunca	.1858	0.39	4.0
Lathyrus lanzwertii	.4687	2.00	20.5
Antennaria parviflora	.0216	0.02	0.2
Arnica cordifolia	.3459	1.05	10.8
Fragaria virginiana	.1129	0.20	2.0
Pyrola secunda	.4599	1.90	19.5
Ozmorhiza chilensis	.4528	1.83	18.8
Mitella stenopetala	.0529	0.08	0.8
<u>SHRUBS</u>			
Ribes cereum	.1776	0.37	3.8
Symphoricarpos oreophilus	.1021	0.17	1.7
Picea engelmannii	.1021	0.17	1.7
TOTAL	3.0731	9.76	100

TABLE 13
PRODUCTIVITY MEASUREMENTS

	Green Weight	Dry Weight
Site: REFERENCE #3	X = 3.4	X = 0.36
Vegetation: Spruce/Fir	S = 7.3	S = 0.82
Date: 8 July 1982	N = 40	N = 40
Quadrat Size: 0.96 sq. ft.	N(min) = 758	N(min) = 850
T-value = 1.282		

LIFE FORM	AVERAGE GREEN WT.	AVERAGE DRY WT.
Shrubs	0.4g	0.06g
Forbs	3.0g	0.30g
Grass and grasslike	—	—
TOTALS	3.4g	0.36g
Productivity	34 lbs/acre	3.6 lbs/acre

TABLE 14
DATA SUMMARY SHEET

VEGETATION TYPE: Spruce-fir

DATE: 8 and 9 July 1982

SITE: Slope 5 and Reference site 3

PROJECT: Skyline

RECLAIMED AREA					REFERENCE AREA				
Characteristic	X	S	N	N(min)	X	S	N	N(min)	T
Cover	29.85	11.96	40	26	9.8	13.1	41	294	1.281
Productivity	55 lbs per acre				4 lbs per acre				
Aspect	Northern				Northern				

% Similarity: 11

APPENDIX II
CONVEYOR ROUTE

TABLE 16
PRODUCTIVITY MEASUREMENTS

	Green Weight	Dry Weight
Site: Reference #2	X = 389.4	X = 131.2
Vegetation: Sagebrush, grass, and bitterbrush	S = 114.3	S = 44.99
Date: 12 July 1982	N = 15	N = 15
Quadrat Size: 9.6 sq. ft. hoop	N(min) = 14	N(min) = 19
T-value = 1.282		
LIFE FORM	AVERAGE GREEN WT.	AVERAGE DRY WT.
Shrubs	279.1g	92.4g
Forbs	34.5g	8.0g
Grass and grasslike	75.8g	30.8g
TOTALS	389.4g	131.2g
Productivity	389.4 lbs/acre	131.2 lbs/acre

TABLE 17
STEMS PER ACRE AND STEM HEIGHT MEASUREMENTS

Site: Reference #2 X = 28.6
 Vegetation: Sagebrush, grass, and bitterbrush S = 8
 Date: 12 July 1982 N = 16
 N(min) = 13

SPECIES	0-1/2 "	1/2-1 "	1-2 "	2" +	Totals
<u>Transect Totals</u>					
Symphoricarpos oreophilus	209	3	0	0	212
Artemisia tridentata	29	11	26	47	113
Amelanchier utahensis	29	16	1	0	46
Purshia tridentata	8	14	14	8	44
Chrysothamnus viscidiflorus	12				12
Pachystima myrsinites	5				5
Rosa woodsii	27				27
TOTALS	319	44	41	55	459

Stems per Acre

Symphoricarpos oreophilus	14,225	204			14,429
Artemisia tridentata	1,974	749	1,770	3,199	7,692
Amelanchier utahensis	1,974	1,089	68		3,131
Purshia tridentata	546	953	953	546	2,998
Chrysothamnus viscidiflorus	817				817
Pachystima myrsinites	340				340
Rosa woodsii	1,838				1,838
TOTALS	21,714	2,995	2,791	3,745	31,245

Average Height (in decimeters)

Symphoricarpos oreophilus	2.75	-	-	-	2.75
Artemisia tridentata	1.10	4.8	5.8	6.8	4.60
Amelanchier utahensis	2.20	6.0	4.0	-	4.10
Purshia tridentata	3.00	3.6	3.7	4.8	3.80
Chrysothamnus viscidiflorus	2.60	2.0	-	-	2.30
Pachystima myrsinites	1.00	-	-	-	1.00
Rosa woodsii	1.9	-	-	-	1.9

Average shrub height 2.9

APPENDIX III
GENERAL LEASE AREA

TABLE 18
COVER DATA

Site: REFERENCE # 5	X = 16.98
Vegetation: Spruce	S = 12.20
DATE: 13 July 1982	N = 40
Quadrat Size: 2 X 5 dm	N(min) = 85
	T-value = 1.282

TAXA	DIVERS.	% COVER	% COMP.
Bare ground		4.775	
Litter		77.525	
Rock		0.725	
<u>GRASS AND GRASSLIKE</u>			
Carex geyeri	.2563	1.10	6.5
Bromus carinatus	.0248	0.05	0.3
Poa sp.	.1157	0.35	2.1
<u>FORBS</u>			
Stellaria jamesiana	.3542	1.90	11.2
Mitella stenopetala	.1992	0.75	4.4
Osmorhiza chilensis	.5195	7.55	44.5
Unknown # 1	.0757	0.20	1.2
Fragaria virginiana	.0682	0.18	1.0
Collinsia parviflora	.0437	0.10	0.6
Descurainia californica	.0523	0.125	0.7
Galium trifidum	.1708	0.65	3.8
Viola canadensis	.1806	0.65	3.8
Polemonium foliosissimum	.1335	0.425	2.5
Unknown seed # 7	.0966	0.275	1.6
Hydrophyllum capitatum	.1992	0.75	4.4
Achillea millefolium	.0248	0.05	0.3
Taraxacum officinale	.0829	0.225	1.3
Mertensia ciliata	.1095	0.325	1.9
Claytonia lanceolata	.0682	0.175	1.1
Pyrola secunda	.0604	0.15	0.9
<u>SHRUBS</u>			
Ribes montigenum	.1901	0.70	4.1
Picea engelmannii	.1031	0.30	1.8
TOTALS	3.1294	16.98	100.0

TABLE 19
PRODUCTIVITY MEASUREMENTS

	Green Weight	Dry Weight
Site: REFERENCE # 5	X = 2.73	X = 0.45
Vegetation: Spruce	S = 3.66	S = 0.60
DATE: 13 July 1982	N = 25	N = 25
Quadrat Size: .96 sq ft hoop	N(min) = 296	N(min) = 296
	T-value = 1.282	

LIFE FORM	AVERAGE GREEN WT.	AVERAGE DRY WT.
Shrubs	0.3g	0.08g
Forbs	2.4g	0.36g
Grass and grasslike	0.03g	0.01g
TOTAL	2.73g	0.45g
Productivity	27 lbs/acre	4.5 lbs/acre

TABLE 20
COVER DATA

Site: REFERENCE AREA #6	X = 91.6
Vegetation: Riparian	S = 7.04
DATE: 13 July 1982	N = 10
Quadrat Size: 2 X 5 dm	N(min) = 2
	T-value = 1.645

TAXA	DIVERS.	% COVER	% COMP.
Bare Ground		0.7	
Litter		7.7	
<u>GRASS AND GRASSLIKE</u>			
Carex species	.2886	7.2	7.9
Bromus carinatus	.1729	3.4	3.7
<u>FORBS</u>			
Cardamine cordifolia	.4691	18.8	20.5
Saxifraga odontiloma	.5283	30.5	33.3
Delphinium menziesii	.4116	13.8	15.2
Geranium fremontii	.0411	0.5	0.5
Mertensia ciliata	.2040	4.2	4.6
Osmorhiza chilensis	.2231	4.8	5.2
Epilobium alpinum	.1500	2.7	2.9
Taraxacum officinale	.1068	1.7	1.9
Mimulus guttatus	.0411	0.5	0.5
<u>SHRUBS</u>			
Ribes montigenum	.1801	3.5	3.8
TOTALS	2.8167	91.6	100

TABLE 21
PRODUCTIVITY MEASUREMENTS

	Green Weight	Dry Weight
Site: REFERENCE # 6	X = 102.5	X = 11.14
Vegetation: Riparian	S = 26.37	S = 2.62
DATE: 13 July 1982	N = 20	N = 20
Quadrat Size: .96 sq ft hoop	N(min) = 18	N(min) = 15
	T-value = 1.645	
LIFE FORM	AVERAGE GREEN WT.	AVERAGE DRY WT.
Shrubs	1.0g	0.17g
Forbs	94.3g	9.77g
Grass and grasslike	7.2g	1.20g
TOTALS	102.5g	11.14g
Productivity	1,025 lbs/acre	111.4 lbs/acre

TABLE 22
COVER DATA

Site: REFERENCE #7	X = 95.6
Vegetation: Aspen	S = 6.4
DATE: 14 July 1982	N = 20
Quadrat Size: 2 X 5 dm	N(min) = 1
	T-value = 1.282

TAXA	DIVERS.	% COVER	% COMP.
Bare Ground		1.35	
Litter		3.05	
<u>GRASS AND GRASSLIKE</u>			
Bromus carinatus	.4363	16.40	17.2
Poa pratensis	.4739	20.20	21.1
Carex geyeri	.0224	0.25	0.3
<u>FORBS</u>			
Lathyrus lanzwertii	.4945	23.00	24.0
Thalictrum fendleri	.2137	4.70	4.9
Helenium hoopesii	.1231	2.15	2.2
Nemophila breviflora	.2961	7.85	8.2
Achillea millefolium	.0868	1.35	1.4
Viola praemorsa	.0741	1.10	1.2
Epilobium paniculatum	.0146	0.15	0.2
Galium trifidum	.1676	3.30	3.5
Agastche urticifolia	.1123	1.90	2.0
Stellaria jamesiana	.1101	1.85	1.9
Hydrophyllum capitatum	.0634	0.90	0.9
Osmorhiza occidentalis	.0224	0.25	0.3
Collinsia parviflora	.0261	0.30	0.3
Hackelia floribunda	.0892	1.40	1.5
Rudbeckia occidentalis	.1167	2.00	2.0
<u>SHRUBS AND TREES</u>			
Sambucus racemosa	.2493	5.95	6.2
Populus tremuloides	.0459	0.60	0.6
TOTALS	3.2388	95.60	99.9

TABLE 23
PRODUCTIVITY MEASUREMENTS

	Green Weight	Dry Weight
Site: REFERENCE # 7	X = 103	X = 22.2
Vegetation: Aspen	S = 19.6	S = 4.6
DATE: 14 July 1982	N = 13	N = 13
Quadrat Size: .96 sq ft hoop	N(min) = 6	N(min) = 7
	T-value = 1.282	

LIFE FORM	AVERAGE GREEN WT.	AVERAGE DRY WT.
Shrubs	-	-
Forbs	39.46g	7.0g
Grass and grasslike	63.54g	15.2g
TOTALS	103.00g	22.2g
Productivity	1,030 lbs/acre	222 lbs/acre

TABLE 25
PRODUCTIVITY MEASUREMENTS

	Green Weight	Dry Weight
Site: SUMMIT REFERENCE # 9	X = 182.7	X = 38.29
Vegetation: Grass-forb	S = 44.2	S = 9.72
DATE: 15 July 1982	N = 20	N = 20
Quadrat Size: .96 sq ft hoop	N(min) = 16	N(min) = 17
	T-value = 1.645	

LIFE FORM	AVERAGE GREEN WT.	AVERAGE DRY WT.
Shrubs	-	-
Forbs	108.6g	19.19g
Grass and grasslike	74.1g	19.10g
TOTALS	182.7g	38.29g
Productivity	1,827 lbs/acre	382.9 lbs/acre

TABLE 26
COVER DATA

Site: REFERENCE # 10

X = 94.3

Vegetation: Aspen

S = 6.1

DATE: 15 July 1982

N = 20

Quadrat Size: 2 X 5 dm

N(min) = 1

T-value = 1.282

TAXA	DIVERS.	% COVER	% COMP.
Bare Ground		2.5	
Litter		3.2	
Rock		-	
<u>GRASS AND GRASSLIKE</u>			
Poa reflexa	.1643	3.25	3.4
Bromus carinatus	.3932	10.80	11.5
Melica bulbosa	.1625	3.20	3.4
Poa pratense	.0859	1.35	1.4
Carex geyeri	.0145	0.15	0.2
<u>FORBS</u>			
Lathyrus lanzwertii	.4580	18.70	19.8
Delphinium menziesii	.2057	4.50	4.8
Nemophila breviflora	.3143	8.80	9.3
Rudbeckia occidentalis	.1023	1.70	1.8
Osmorhiza occidentalis	.2445	5.85	6.2
Helenium hoopesii	.1713	3.45	3.7
Stellaria jamesiana	.3447	10.35	10.9
Hydrophyllum capitatum	.0484	0.65	0.7
Viola praemorsa	.1301	2.35	2.5
Achillea millefolium	.1534	2.95	3.1
Galium trifidum	.0293	0.35	0.4
Epilobium paniculatum	.0145	0.15	0.2
Phacelia hastata	.0222	0.25	0.3
Collinsia parviflora	.0931	1.40	1.5
Collomia linearis	.0454	0.60	0.6
Agastache urticifolia	.0733	1.10	1.2
Hackelia floribunda	.0454	0.60	0.6
<u>SHRUBS</u>			
Sambucus racemosa	.3699	11.80	12.5
TOTALS	3.6862	94.30	100

TABLE 27
PRODUCTIVITY MEASUREMENTS

	Green Weight	Dry Weight
Site: REFERENCE #10	X = 136.1	X = 25.77
Vegetation: ASPEN	S = 33.5	S = 5.95
Date: 15 July 1982	N = 15	N = 15
Quadrat Size: .96 sq. ft. hoop	N(min) = 10	N(min) = 9
T-value = 1.282		
LIFE FORM	AVERAGE GREEN WT.	AVERAGE DRY WT.
Shrubs	-	-
Forbs	121.2g	22.12g
Grass and grasslike	14.9g	3.65g
	TOTALS	
	136.1g	25.77g
Productivity	1,361 lbs/acre	257.7 lbs/acre

TABLE 28
COVER DATA

Site: REFERENCE # 11	X = 18.43
Vegetation: Spruce-fir	S = 19.17
DATE: 15 July 1982	N = 40
Quadrat Size: 2 X 5 dm	N(min) = 178
	T-value = 1.282

TAXA	DIVERS.	% COVER	% COMP.
Bare ground		1.50	
Litter		80.08	
<u>GRASS AND GRASSLIKE</u>			
Bromus carinatus	.1488	0.58	3.1
Carex geyeri	.2034	0.90	4.9
<u>FORBS</u>			
Mitella stenopetala	.2183	1.00	5.4
Osmorhiza chilensis	.5217	5.20	28.2
Viola canadensis	.1194	0.42	2.3
Stellaria jamesiana	.2556	1.28	6.9
Epilobium angustifolium	.3680	2.37	12.9
Fragaria virginiana	.3875	2.63	14.2
Pyrola secunda	.1711	0.18	1.0
Hydrophyllum capitatum	.0860	0.27	1.5
Arnica cordifolia	.1245	0.45	2.4
Draba sp.	.0463	0.13	0.7
Collinsia parviflora	.0219	0.05	0.3
Aquilegia coerulea	.2426	1.17	6.4
Hackelia floribunda	.0672	0.20	1.1
<u>SHRUBS</u>			
Ribes montigenum	.1441	0.55	3.0
Sambucus racemosa	.2254	1.05	5.7
TOTALS	3.3519	18.43	100.0

TABLE 29
PRODUCTIVITY MEASUREMENTS

	Green Weight	Dry Weight
Site: REFERENCE # 11	X = 3.125	X = .51
Vegetation: Spruce-fir	S = 4.38	S = .71
DATE: 15 July 1982	N = 40	N = 40
Quadrat Size: .96 sq. ft. hoop	N(min) = 322	N = 316
	T-value = 1.282	

LIFE FORM	AVERAGE GREEN WT.	AVERAGE DRY WT.
Shrubs	0.4g	0.09g
Forbs	2.725g	0.42g
Grass and grasslike	-	-
TOTALS	3.125g	.51g
Productivity	31.25 lbs/acre	5.1 lbs/acre

TABLE 30
COVER DATA

Site: SPRING STRIPE	X = 93.5
Vegetation: Grass-forb	S = 9.39
DATE: 28 July 1982	N = 12
Quadrat Size: 2 X 5 dm	N(min) = 3
	T-value = 1.645

TAXA	DIVERS.	% COVER	% COMP.
Bare ground		1.33	
Litter		4.83	
Rock		.33	
<u>GRASS AND GRASSLIKE</u>			
Carex kelloggii	0.4472	17.00	18.2
Carex microptera	0.1745	3.42	3.7
Carex rostrata	0.2939	7.58	8.1
Poa pratensis	0.1259	2.17	2.3
Juncus ensiphormis	0.0457	.58	0.6
Callamagrostis canadensis	0.0229	.25	0.4
<u>FORBS</u>			
Deschampsia caespitosa	0.4576	18.00	19.2
Polemonium occidentale	0.4923	22.17	23.7
Galium boreali	0.0509	.67	0.7
Fragaria virginiana	0.0654	.92	1.0
Potentilla fruticosa	0.1654	3.17	3.4
Cirsium scariosum	0.1223	2.08	2.2
Helenium hoopesii	0.2717	6.67	7.1
Cardamine cordifolia	0.1150	1.92	2.1
Achillea millefolium	0.1259	2.17	2.3
Equisetum arvense	0.0229	.25	0.4
Veronica wormskjoldii	0.1329	2.33	2.5
Phleum alpina	0.0163	.16	0.2
Mimulus guttatus	0.1074	1.75	1.9
TOTAL	3.2786	93.51	100.0

TABLE 31
PRODUCTIVITY MEASUREMENTS

	Green Weight	Dry Weight
Site: SPRING STRIPE	X = 111.06	X = 22.49
Vegetation: Grass-forb	S = 34	S = 7.34
DATE: 28 July 1982	N = 15	N = 15
Quadrat Size: .96 sq. ft. hoop	N(min) = 25	N = 29
	T-value = 1.645	

LIFE FORM	AVERAGE GREEN WT.	AVERAGE DRY WT.
Shrubs	-	-
Forbs	49.6g	6.48g
Grass and grasslike	61.46g	16.01g
TOTALS	111.06g	22.49g
Productivity	1,110.6 lbs/acre	224.9 lbs/acre

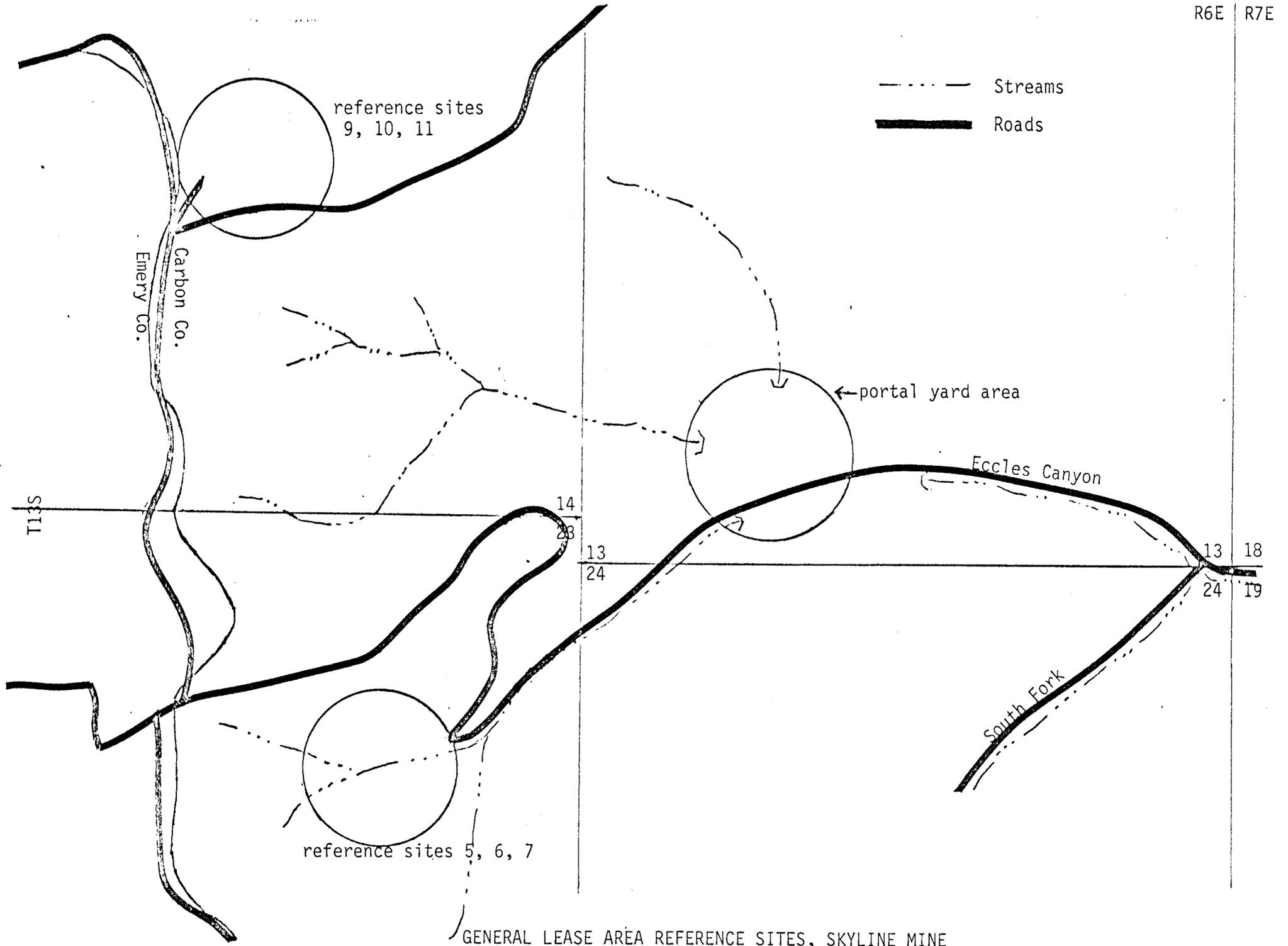
TABLE 32
 JULY 1982 MEASUREMENTS
 COVER/DENSITY

SITE	VEGETATION TYPE	X	N(min)	N	S	PERCENT COVER	DENSITY (STEMS PER ACRE)	COVER (LINE INTERCEPT)	T-VALUE
Slope 1	Aspen	74.2	11	25	19	74.2			1.282
Slope 2	Grass	41.2	41	41	20.5	41.2			1.282
Slope 5	Spruce-fir	29.9	26	40	11.96	29.9			1.282
Ref. 2	Sagebrush	85.5	4	20	12.9	85.5	31,245	51.3	1.282
Ref. 3	Spruce-fir	9.8	294	41	13.1	9.8			1.282
Ref. 4	Aspen	96.5	1	10	6.25	96.5			1.282
Ref. 5	Spruce-fir	16.98	85	40	12.45	16.98			1.282
Ref. 6	Riparian	91.6	2	10	7.04	91.6			1.645
Ref. 7	Aspen	95.6	1	20	6.4	95.6			1.282
Ref. 9	Grass-forb	96.8	1	20	5.4	96.8			1.645
Ref. 10	Aspen	94.3	1	20	6.1	94.3			1.282
Ref. 11	Spruce-fir	18.4	178	40	19.17	18.4			1.282
Spring stripe	Grass-forb	93.5	3	12	9.39	93.51			1.645

TABLE 33
 JULY 1982 MEASUREMENTS
 PRODUCTIVITY

SITE	GREEN WEIGHT				DRY WEIGHT				PRODUCTIVITY (lbs per acre)
	N	N (min)	X	S	N	N(min)	X	S	
Slope 1	40	29	168.4	71.1	40	22	40	14.73	400
Slope 2	40	38	51.8	24.9	40	46	16.6	8.8	170
Slope 5	40	31	22.48	9.84	40	25	5.46	2.13	55
Ref. 2	15	14	389.4	114.3	15	19	131.2	44.99	131
Ref. 3	40	758	3.4	7.3	40	850	0.36	0.82	4
Ref. 4	30	16	159.8	50	30	6	30.1	5.82	301
Ref. 5	40	296	2.73	3.66	40	247	0.38	0.46	4
Ref. 6	20	18	102.5	26.37	20	15	11.14	2.62	111
Ref. 7	13	6	103	19.6	13	7	15.24	5.66	152
Ref. 9	20	16	182.7	44.2	20	17	38.29	9.72	383
Ref. 10	15	10	136.1	33.5	15	9	25.77	5.95	258
Ref. 11	40	322	3.13	4.38	40	316	0.51	0.71	5
Spring stripe	15	25	111.06	34	15	29	22.49	7.34	225

APPENDIX IV
MAP



GENERAL LEASE AREA REFERENCE SITES, SKYLINE MINE

Scale: 1"=1,000'



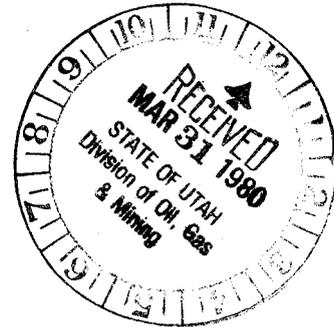
**Coastal States
Energy Company**

411 West 7200 South
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Midvale, Utah 84047
(801) 566-0691

Subsidiary of
The Coastal
Corporation

March 31, 1980

Mr. Cleon B. Feight
Director
Division of Oil, Gas, and Mining
1588 West North Temple
Salt Lake City, Utah 84116



Dear Mr. Feight:

Enclosed herewith please find two copies of material entitled, "Initial Response to the Office of Surface Mining's Apparent Completeness Review--Skyline Mines Project." This material is submitted in response to the Office of Surface Mining's apparent completeness review letter dated March 20, 1980.

Four copies of the same material were also transmitted to the Office of Surface Mining, Denver, Colorado; two copies to the U. S. Department of the Interior Geological Survey, Salt Lake City, Utah; and the U. S. Department of Agriculture Forest Service, Manti-LaSal National Forest, Price, Utah.

Sincerely,

Vernal J. Mortensen
Vice President
Utah Operations

VJM/jc

Enclosures