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1986

STAR POINT MINES

PERMIT ACT/007/006

Plateau Mining Company
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1983 ANNUAL RECLAMATION REPORT

STAR POINT MINES

Plateau Mining Company

January 1984

INTRODUCTION

Mining has been conducted at the Plateau Mining Company's Star Point Mines location since 1917. The operation consists of three portals for the underground recovery of coal reserves from the Wattis and Hiawatha seams. Surface areas that have been affected by the mining operation over the years and the associated reclamation and reclamation study areas are shown on the attached Plateau Mining Company 1983 Reclamation Map #1 and Plateau Mining Company 1983 Reclamation Map #2.

Reclamation of disturbed areas began in 1980. During the Summer and Fall of 1980, all disturbed areas which could be reclaimed without affecting the operation were seeded using hand operated cyclone broadcast seeders. About 20 lbs/acre of the seed mix presented in Table 1, 1980 Seed Mixture, was planted. This was followed by mechanically blowing about 3,000 lbs/acre of cereal grain straw mulch over the area. Areas that could not be reached by the blower were mulched by hand. The area seeded comprised approximately 120.67 acres and represents all of the green areas shown on the attached maps. In November 1981, much of the same area, 55.28 acres was reseeded with about 24 lbs/acre of the same seed mixture used in 1980. The seed was incorporated with 140 lbs/acre of tackifier and mechanically sprayed over the area. Following seeding, the area was oversprayed with 2,000 lbs/acre of Conweb hydromulch. Again in 1983, portions of the same area on which revegetation was poor, was reseeded with the seed mixture given in Table 3, 1983 Seed Mix. The 1983 reclamation contained 10.07 acres which were seeded at a rate of 22 lbs/acre. After seeding, the areas were hydromulched with 2,000 lbs/acre of Conweb hydromulch.

A total of 120.67 acres have been seeded. This comprises all of the disturbed land currently available for reclamation.

The following annual reclamation report presents results of the 1983 reclamation monitoring program. This report is in fulfillment of the agreement between Plateau Mining Company and the Utah State Division of

Oil, Gas and Mining to provide annual progress of the reclamation effort and reclamation study results. Additional information is included on the Wildlife Mitigation Area stipulated as part of the Minor Modification of the Refuse Pile Expansion Plan submitted May 28, 1982.

TABLE 1
1980 SEED MIXTURE

	% MIXTURE
Russian Wildrye	15%
Streambank Wheatgrass	11%
Mountain Brome	5%
Big Sage Brush	5%
Fourwing Saltbush	8%
Western Wheatgrass	15%
Pubescent Wheatgrass	15%
Indian Ricegrass	5%
Rabbitbrush	3%
Alfalfa "Ranger"	10%
Yellow Sweetclover	10%

TABLE 2
1983 SEED MIXTURE

	POUNDS PLS/A
Pubescent Wheatgrass	3
Smooth Brome	3
Alsike Clover	1
Ladak Alfalfa	2
Great Basin Wildrye	1
Fourwing Saltbrush	2
Shadscale	1
Cicer Milkvetch	1
Rubber Rabbitbrush	0.25

14.25 #/A

1983 RECLAMATION MONITORING

In mid-July 1983, field data was collected on reclaimed and reclamation study sites as well as on the Wildlife Mitigation Area.

Reclaimed sites sampled were restricted to 1981 seedings. Study areas sampled were the Barrow Area, Refuse Pile Topsoil, Office-Road-Cut, Road Side Mulch, Castle Ridge Exploration, and Wildlife Mitigation Area. Locations are presented on Plateau Mining Company 1983 Reclamation Map 1 and Plateau Mining Company 1983 Reclamation Map 2. Each of these areas are described in the following narrative along with a discussion of the results and conclusion that can be made from the 1983 data.

Methods

The parameters measured on the various sites presented in this report includes plant cover, current annual plant production, plant densities, plant vigor, plant survival, and site factor descriptions. Not all parameters were measured on all sites, but where any of these were measured, the following descriptions of methods and procedures were used. A list of the measurements taken on each site is presented in the description section associated with each particular site.

Plant cover was estimated using a ten-point frame. The frame was placed every five meters (m) along a randomly placed 50m transect. A total of 100 data points were recorded for each transect and summarized by species. The transect average represents one datum.

Plant production was measured by clipping current annual production from a $\frac{1}{4}m^2$ quadrat. Five quadrats were randomly placed along the same 50m transect used for cover estimates. Grasses and forbs were clipped at ground level and the current annual twigs and leaves were clipped from shrubs. Production was not estimated for trees. Old plant material was removed from each sample which was segregated by species, oven dried and weighed to within 0.01 grams.

Plant densities were determined by counting the number of plants rooted within a quadrat. Woody plants density was measured using a 1 x 50m belt transect except on reclaimed sites where a 2 x 50m belt was used. The tape which was used to set up the 50m transect provided one side of the belt transect and a meter stick was used to determine if the woody plant was rooted within the quadrat. On the Barrow Area study plots, the Refuse Pile study plots, and the subsoil stockpile, herbaceous plant densities were estimated from $\frac{1}{4}m^2$ circular quadrats.

Plant vigor was recorded on shrub seedlings planted on the Barrow Area study plots and the Wildlife Mitigation Area study plots. Vigor was rated subjectively on a scale of 1 to 10 with 10 being the most vigorous. Consideration was given to the height, health and overall development of each individual plant. The vigor ratings presented in this report is an average for the particular species. The average was calculated by summing the numeric ratings given to each plant and dividing by the number of surviving plants for that species.

Percent plant survival was calculated by dividing the total number of seedings that were transplanted of a given species into the number of seedlings that were still alive.

On the Barrow Area study plots, site characteristics were recorded for each surviving transplanted shrub or tree. Site factors were micro relief, presence of herbivory, and presence of competing herbaceous vegetaion. Micro-relief is defined as being a depression which would accumulate surface water or a ridge which would not accumulate surface water. If soil moisture is a limiting factor for a particular species, transplanting them into depressions could influence the survival rate. The palatability of a species has been thought to affect the survival potential of that species due to herbivory by animals and insects. Removal of plant material by either animals or insects was recorded for each surviving plant. Likewise, competing herbaceous vegetation has the potential for reducing the survival and vigor of a transplanted shrub or tree. Transplants which had herbaceous vegetation growing within 10cm of a stem were recorded. An

average by species was calculated for each factor and expressed as the percent of the total surviving plants for that species.

Statistical analysis was performed on the effects of treatment on herbaceous seedling densities for the Barrow Area and the Refuse Pile study plots. An analysis of variance was used and the results subjected to a Duncan's Multiple-Range Test. All of the analysis was performed at the 0.05 level and run on Getty Oil Company's IBM computer network, SAS Institute, Statistical Analysis System.

1981 RECLAMATION SEEDING

Description

All of the reseeded areas shown on Plateau Mining Company 1983 Reclamation Map #1 and Plateau Mining Company 1983 Reclamation Map #2 were originally seeded and mulched with cereal grain straw in 1980. Portions of area was hydroseeded with 140 lbs/acre of tackifier in November of 1981 with the seed mixture shown in Table 1, 1980 Seed Mixture. After seeding, the area was hydromulched with 2,000 lbs/acre of Conweb. There were approximately 55.28 acres seeded in 1981. Data collected included cover, production, and woody plant density. Estimates are based on 12 transects plus an additional 24 clip plots for production.

Results

Reclamation monitoring results are presented in Table 3, Summary of Plant Cover On Reseeded Sites, Table 4, Summary of Production for Reseeded Sites, Table 5, Summary of Woody Plant Density on Reseeded Sites.

Cover on the 1981 reclamation averaged 15.67%. This compares with 45.6% total cover and 21.8% herbaceous cover, on the Mixed Sagebrush-Grass-Mountain Brush Community as presented in the Star Point Mines Mining and Reclamation Plan, Permit 006/007 Volume III, Appendix 9F, page 20. Cover on the 1982 reclamation was made up of approximately 38% grasses and 62% forbs. Sweetvetch represents the most dominant species with 42.55% of the overall relative composition. Wheatgrasses make up 23.9% and yellow sweetclover-alfalfa comprises 19.15%. The remaining 14.36% is attributed

TABLE 3

SUMMARY OF PLANT COVER ON RESEEDED SITES

SPECIES	PERCENT COVER	COMPOSITION
Grasses		
Desert Wheatgrass	0.67	04.26
*Wheatgrasses	2.92	18.62
Western Wheatgrass	0.08	00.53
Intermediate Wheatgrass	0.08	00.53
Bromegrass	1.33	08.51
Orchardgrass	0.75	04.79
Timothy	0.17	01.06
Forbs		
Sweetvetch	6.67	42.55
**Yellow Sweetclover/Alfalfa	3.00	19.15
TOTAL	15.67	100.00

*Wheatgrasses which could not be positively identified to species.

**Yellow sweetclover and alfalfa could not be identified to species due to lack of phenological development.

TABLE 4

SUMMARY OF PRODUCTION FOR RESEEDED SITES

SPECIES	GRAMS/M^2	COMPOSITION
Grasses		
Desert Wheatgrass	0.793	05.6
*Wheatgrasses	4.499	31.6
Western Wheatgrass	0.206	01.4
Bromegrass	1.662	11.7
Orchardgrass	0.110	00.8
Timothy	0.029	00.2
Forbs		
Sweetvetch	3.423	24.0
**Yellow Sweetclover/Alfalfa	3.515	24.7
Annual Forbs	0.008	00.6
TOTAL	14.245	100.0

*Wheatgrasses which could not be positively identified to species.

**Yellow sweetclover and alfalfa could not be separated by species at present growth stage development that prevailed at sampling time.

TABLE 5

SUMMARY OF WOODY PLANT DENSITY ON RESEEDED SITES

SPECIES	NO./100M^2	COMPOSITION
Big Sagebrush	0.84	22.7
Fourwing Saltbrush	0.66	18.2
Rubber Rabbitbrush	1.50	40.9
Douglas Rabbitbrush	0.34	09.1
Snowberry	0.34	09.1
TOTAL	3.68	100.0

to brome, orchardgrass, and timothy. Alfalfa and yellow sweetclover were combined in Table 1, Summary of Plant Cover on Reseeded Sites and Table 2, Summary of Production of Reseeded Sites because of the difficulty in separating them in the field at this time of year.

Plant production on the 1981 reseeded sites was 14.245 g/m^2 (127 lbs/acre). 51% of the production was produced by grasses and 49% by forbs. Of the grasses, approximately 39% of the production came from wheatgrasses, and 12% from brome. Sweetvetch and yellow sweetclover-alfalfa makeup almost 49% with the sweetvetch producing 24% and the yellow sweetclover-alfalfa producing 25%.

Additional production data were collected along the upper access road cut and fill. This data is not presented in a Table. The fill areas are dominated with mature, 1980 seeded vegetation. From the 24 clip plots on the fill material, it is estimated that it is producing 16.98 g/¼m^2 or 606 lbs/acre. There were 27 plots clipped on the cut side of the road which is predominately 1981 vintage plant material. It is producing 5.84 g/¼m^2 or 208 lbs/acre. Plots were not clipped by species and represents comparative differences in total production for cut and fill slopes. No cover or shurb density data were collected at these sites.

Woody plant density was 3.68/100m^2 on the 1981 reseeding. This converts to 150 stems per acre. Relative composition is madeup of 41% rubber rabbitbrush, 23% sagebrush, 18% fourwing saltbrush, 9% snowberry, and 9% green rabbitbrush.

Conclusions

Data collected on the 1981 reseeded sites represents two full growing season. Even though plant cover (15.67%) is less than on surrounding natural areas, as described above, it is expected to increase significantly as the stand matures over the next couple of years. Production estimates are likewise low in comparison, 127 to 208 lbs/acre on the 1981 seeding to 606 lbs/acre on the 1980 seeded fill slopes. The 1981 production is expected to increase as the stand matures. Woody plant density (150/acre)

is low, but still comprises a mean distance of one shrub every 17 feet. Since the species present have a strong tendency to propagate, it is expected tha woody plant density will continue to increase as the existing woody plants mature and become a seed source.

TOPSOIL AND SUBSOIL STOCKPILES

Description

Topsoil and subsoil stockpiles are located north of the refuse pile and loadout facility as shown on Plateau Mining Company 1983 Reclamation Map #2. These stockpiles store the topsoil material removed from the refuse pile expansion area as described in the May 29, 1982 Plateau Mining Company's request for a minor modification of the refuse pile expansion plan. Seedlings of the stockpiles was completed in the Fall of 1982 with the seed mixture described in Table 6, Topsoil Stockpile Seed Mixture. Seed was applied using a hydroseeding method at a rate of 42 lbs/acre in conjunction with 200 lbs/acre of 16-16-8 commercial fertilizer. Oats and barley was seeded at 20 lbs/acre to insure stabilization.

Monitoring was performed on July 14, 1983 and consisted of cover measurements on the topsoil stockpile and seedling density on the subsoil stockpile.

Results

Results are found on Table 7, Summary of Percent Plant Cover or Topsoil Stockpiles and Table 8, Summary of Seedling Density on the Subsoil Stockpile.

Cover on the topsoil stockpiles averaged 45.55%. Better than half, 56% was composed of annual species. Almost all of the annual forbs were Russian thistle with some mustards and pigweeds. Perennial grasses made up 38% of the cover.

TABLE 6
TOPSOIL STOCKPILE SEED MIXTURE

	PLS/ACRE
GRASSES	
Fairway Crested Wheatgrass	2
Smooth Brome (Southern Strains)	2
Intermediate Wheatgrass	2
Pubescent Wheatgrass	2
Bluestem Wheatgrass	2
Orchardgrass	2
Russian Wildrye	2
Sandbury Bluegrass	2
Subtotal	16
FORBS	
Alfalfa (Nomad)	2
Ladak - Equal Parts	2
Yellow Sweetclover	2
Subtotal	6
TOTAL PERENNIALS	22
COVER CROP	
Barley and Oats	20
OVERALL TOTAL	42

Seedling density was estimated on the subsoil stockpile as a more realistic measure of revegetation success because of the lack of plant development. Overall seedling density was $9.88/\frac{1}{4}m^2$. This is the equivalent to 3.67 per square foot. Perennial grasses represents 49%, perennial forbs 7%, and cereal grains, which were used as a cover crop/mulch, 44%. Perennial plant density is $5.52/\frac{1}{4}m^2$ or $2.05/ft.^2$.

TABLE 7

SUMMARY OF PERCENT PLANT COVER ON TOPSOIL STOCKPILES

SPECIES	PERCENT COVER	COMPOSITION
Grasses		
Desert Wheatgrass	01.78	03.90
*Wheatgrasses	01.67	03.66
Cheatgrass	06.44	14.15
Foxtail	07.44	16.34
Forbs		
**Yellow Sweetclover/Alfalfa	00.89	02.00
Scarlet Globemallow	00.11	00.24
Annual Forb	25.44	55.85
Shrubs		
Fourwing Saltbrush	01.78	03.90
TOTAL	45.55	100.04

*Wheatgrasses which could not be positively identified to species.

**Yellow sweetclover and alfalfa could not be separated at time of sampling.

TABLE 8

SUMMARY OF SEEDLING DENSITY ON THE SUBSOIL STOCKPILE

SPECIES	NO./1/4M^2	NO./SQ. FOCT
Cereal Grains	4.36	1.62
Perennial Grasses	4.85	1.80
Perennial Forbs	0.67	0.25
TOTAL	9.88	3.67

Conclusion

Topsoil stockpiles were seeded and hydromulched in the Fall of 1982. After the first growing season, total cover (45.55%) is adequate to control erosion in as much as there were no erosion features observed. As observed in the past, the annual forbs which represent 56% of the cover will diminish as the perennial species mature and become established. The subsoil stockpile has an excellent density (2.05/ft.^{2}) of perennial plants.

Standards for successful seedling establishment on improved range have been established for the foothill ranges of Utah. Cook, Stoddart and Sims (Effects of Season, Spacing and Intensity of Seeding on the Development of Foothill Range Grass Stands, 1967, Utah Agricultural Experiment Station Bulletin 467), evaluated successful stand establishment after the third year as "satisfactory" if there were 0.25 plants per square foot, "good" if there were an average of 0.50 plants per square foot, and "excellent" if there were an average of 0.75 or more plants per square foot.

In the Northern Great Plains, where precipitation and site potential is considerably greater than that of the Plateau Mine area, a "good" grass stand is one with 1.0 plants or more per square foot, "fair" if there were 0.5 to 1.0 plants per square foot and "poor" if there was less than 0.5 plants per square foot (Great Plains Agricultural Council, 1966, A Stand Establishment Survey of Grass Plantings in the Great Plains, Nebraska Agricultural Experiment Station Report 23).

In view of these success ratings, it is concluded that a first year seedling establishment of 2.05 plants per square foot on the subsoil stockpile represents acceptable revegetation success.

BARROW AREA STUDY

Description

Site preparation began in 1980 on the Barrow Area Study plots as shown on Plateau Mining Company 1983 Reclamation Map 2. It was seeded with the

seed mixtures presented in Table 9, Low Grass Seed Mix and Table 10, High Grass Seed Mix and mulched with 3,000 lbs/acre of grass hay mulch in the fall of that year. Containerized shrub seedlings (tubelings) were transplanted in April 1981 and the first year's survival data were taken five months later in mid-September 1981.

A total of 48, 12 x 12 foot plots were established. A diagram of the plot layout is given in Figure 1, Planting Pattern for the Barrow Area. Plots were designed to test cultural treatments, seed mixtures, and shrub transplant densities. The purpose of the study was to evaluate reclamation practices at the Star Point Mine site. The study was implemented by Native Plants Incorporated of Salt Lake City, Utah. A copy of the first year results is given in Star Point Mines, Mining and Reclamation Plan, Permit No. 007/006, Volume III, Appendix 9I.

Cultural practices established on the plots were mulch and no mulch. Approximately 3,000 lbs/acre of grass hay mulch was applied immediately after seeding in October 1980. Mulch was spread by hand, but was not incorporated or tacked to ground.

Seeding treatments consisted two seed mixtures and a no seed treatment. Both mixtures were hand broadcasted at a rate of 30 PLS/acre and raked into the soil. One seed mixture, Table 9, Low Grass Seed Mix, contained 15% grasses and 85% forbs and shrubs. The other seed mixture, Table 10, High Grass Seed Mix, was composed of 85% grasses and 15% forbs with no shrubs.

Shrub transplants (tublings) were planted at two densities and a no tubling treatment. A high tubling density treatment contained nine plants per plot. This amounts to a density of 2,723 plants per acre or approximately one shrub every 3 feet. The low tubling density contained four shrubs per plot, a stocking rate of 1,210 stems per acre or a shrub every 6 feet.

TABLE 9

LOW GRASS SEED MIX USED ON THE EXPERIMENTAL TEST PLOTS

LOW GRASS/HIGH FORB AND SHRUB MIX	PERCENT OF MIX*
Russian Wildrye	2.5
Western Wheatgrass	2.5
Streambank Wheatgrass "Sodar"	2.5
Pubescent Wheatgrass	2.5
Mountain Brome	2.5
Indian Ricegrass	2.5
Northern Sweetvetch	12.0
Sainfoin	2.0
Big Sagebrush	8.0
Hoary Aster	3.0
Rubber Rabbitbrush	10.0
Rocky Mountain Penstemon	3.0
White Yarrow	2.0
Fourwing Saltbush	10.0
Shadscale	9.0
Gardner Saltbush	7.0
Prairie Sage	4.0
True Mountain Mahogany	3.0
Green Mormon Tea	3.0
Curlleaf Mtn. Mohogany	3.0
Utah Serviceberry	3.0
TOTAL	100.0%

*Percentages calculated on a dry weight basis

TABLE 10

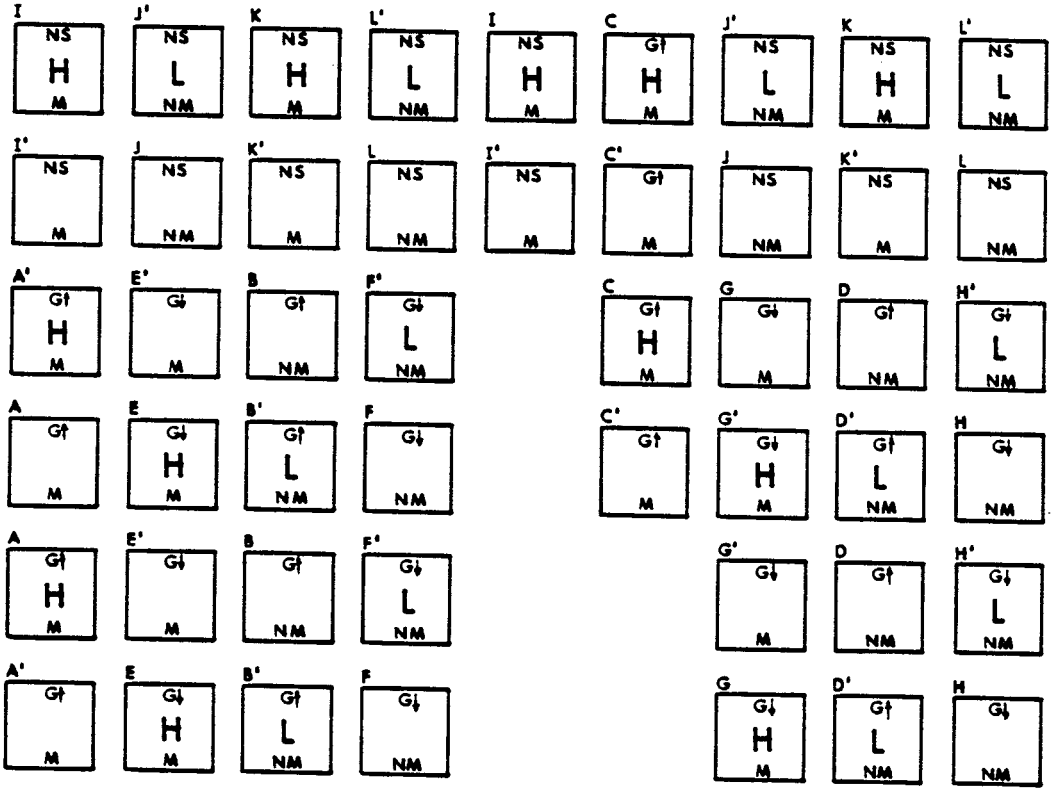
HIGH GRASS SEED MIX USED ON THE EXPERIMENTAL TEST PLOTS

HIGH GRASS/HIGH FORB AND SHRUB MIX	PERCENT OF MIX*
Western Wheatgrass	14
Indian Ricegrass	14
Pubescent Wheatgrass	14
Streambank Wheatgrass	14
Russian Wildrye	14
Mountain Brome	14
Northern Sweetvetch	4
Sainfoin	4
Alfalfa "Ranger"	4
Yellow Sweetclover	4
TOTAL	100%

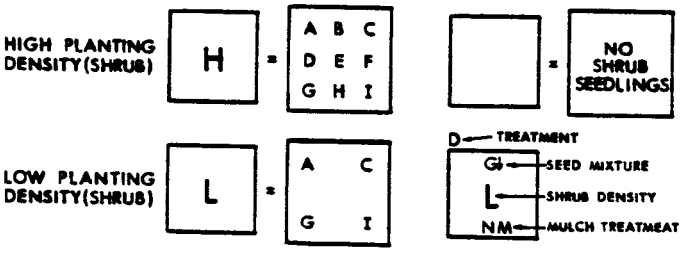
*Percentages calculated on a dry weight basis.

FIGURE 1

PLANTING PATTERN FOR THE BORROW AREA



TREATMENT KEY



A - Four-wing saltbush
B - Serviceberry
C - Rocky mtn. juniper
D - Gambels oak
E - Black sage
F - Siberian peavine
G - Rubber rabbitbrush
H - Curlleaf mtn. mahogany
I - True mtn. mahogany

G↑ = High grass seed mix
G↓ = Low grass seed mix
NS = No seed mix
M = Mulch
NM = No Mulch

The 1983 data presented in the following results section, were collected on July 13 and 14 and represents the third growing season.

Results

A summary of the results is given in Table 11, Comparison of 1983 and 1981 Shrub Survival, Barrow Area Plots, Table 12, Shrub Survival and Contributing Site Factors, Table 13, Perennial Seedling Density, Table 14, Comparison of the Relative Percent Seedling Composition to Mulched and Unmulched Plots, and Table 15, Comparison of Relative Percent Seedling Composition to Mulch and Seed Treatments.

Average shrub survival for 1983 is 54.5%. This compares to 78.8% in 1981. For this period of time, changes in survival ranged from no change for black sagebrush to a reduction of 53% for true mountain mahogany. Along with these data, an important field observation on fourwing saltbush was made. Fourwing saltbush survival declined from 96% in 1981 to 54.2% in 1981. Mortality apparently occurred from winter kill. Of those surviving in 1983, field notes indicate that the majority of them had severly suffered from the last winter. On almost all of the surviving plants, the above ground material had died and new growth was initiating from the root or the base of the stem. Apparently, the origin of the tublings was not adapted to the site. Dead material was about 30 cm high.

In general, none of the surviving shrubs had exceptional vigor. Favorable precipitation during the spring and early summer of this year had resulted in a flush of new growth, but the condition of the plants as indicated by the old growth and poor height reduced the overall vigor rating. Many of the plants had competing herbaceous vegetation within 10 cm of the stem and herbivory was the greatest on serviceberry and curlleaf mountain mahogany.

The results of the statistical analysis revealed that there was no significant differences in perennial plant density due to treatments of either the high and low seeding rate, mulch, or shrub (tubeling) density. There was, as might be expected, a significant difference between no seed

TABLE 11

COMPARISON OF 1983 AND 1981 SHRUB SURVIVAL ON THE BARROW AREA PLOTS

(# PLANTED)

SPECIES	(%) 1983	(%) 1981	% CHANGE
Serviceberry	41.7	67.0	-38
Black Sagebrush	50.0	50.0	0
Fourwing Saltbush	54.2	96.0	-44
Peashrub	59.3	92.0	-36
Curleaf Mtn. Mahogany	59.3	83.0	-30
True Mtn. Mahogany	29.1	62.0	-53
Rubber Rabbitbrush	62.5	71.0	-12
Rocky Mtn. Juniper	83.3	100.0	-17
Gambel Oak	41.7	75.0	-44
TOTAL	54.5	78.8	-31

TABLE 12

SHRUB SURVIVAL AND CONTRIBUTING SITE FACTORS

ON THE BARROW AREA EXPERIMENTAL PLOT

SPECIES	(%) SURVIVAL	(1-10) VIGOR	(%) FLUSHING	(CM) HEIGHT	(%) HERB	(%) TOPO	(%) COMPT
Serviceberry	41.7	3.6	40	11.0	60	80	60
Black Sagebrush	50.0	4.1	56	13.2	11	56	33
Fourwing Saltbush	54.2	4.4	75	19.1	58	67	42
Peashrub	59.3	5.3	80	14.2	70	60	40
Curleaf Mtn. Mahogany	59.3	4.7	73	11.7	91	54	18
True Mtn. Mahogany	29.1	2.6	71	07.0	14	71	14
Rabbitbrush	62.5	4.8	63	16.3	13	56	31
Rocky Mtn. Juniper	83.3	3.8	15	11.6	5	45	40
Gambel Oak	41.7	5.0	0	13.8	40	80	60

NOTE:
- VIGOR = Scale of 1 to 10 with 10 being the most vigorous
- FLUSHING = Shrubs exhibiting a flush of active new growth
- HERB = Shrubs exhibiting herbivory and/or insect damage
- TOPO = Shrubs growing in a surface depression on a micro relief basis
- COMPT = Shrubs with competing herbaceous vegetation within 10 cm of the stem

TABLE 13

PERENNIAL SEEDLING DENSITY ON THE BARROW STUDY PLOTS

TREATMENTS		DENSITY (#/M^2)
High Grass Mix	- Mulched	34.52
High Grass Mix	- Unmulched	32.80
Low Grass Mix	- Mulched	31.12
Low Grass Mix	- Unmulched	36.72
No Seeding	- Mulched	32.60
No Seeding	- Unmulched	18.60

TABLE 14

BARROW AREA STUDY PLOT

COMPARISON OF THE RELATIVE PERCENT SEEDLING COMPOSITION TO MULCHED AND UNMULCHED PLOTS

SEED MIXTURE	% OF MIX	MULCHED	UNMULCHED	AVERAGE
High Grass/Low Forb/No Shrub				
Grasses	84	79	61	70
Legumes	16	20	39	30
Shrubs	0	1	2	2
Non-seeded grasses*	(0)	(4)	(12)	--
Non-seeded shrubs*	(0)	(0.3)	(0.4)	--
Low Grass/Forb/High Shrub				
Grasses	15	71	73	72
Legumes	14	24	25	25
Shrubs	63	5	3	4
Other Forbs	5	0.3	0	0
Non-seeded Grasses*	(0)	(11)	(15)	--
Non-seeded Shrubs*	(0)	(0.6)	(0)	--
No Seed				
Grasses	0	86	82	84
Legumes	0	11	15	13
Shrubs	0	1	2	2
Non-seeded Grasses*	(0)	(10)	(5)	--
Non-seeded Shrubs*	(0)	(1)	(0.1)	--

*Non-seeded grass species are orchardgrass and timothy - both not available from either seed mixes or local seed producing plants - probable source is mulch material. Non-seeded shrubs are bitterbrush, oak, juniper, winterfat - probably local source.

TABLE 15

SEEDLING BARROW STUDY PLOTS COMPARISON OF RELATIVE PERCENT COMPOSITION TO MULCH AND SEED TREATMENTS

	MULCHED			UNMULCHED		
	HS*	LS*	NS*	HS*	LS*	NS*
Grasses						
Wheatgrass	70	53	68	44	50	63
Bromes	5	8	8	3	8	15
Indian Ricegrass	.3	--	--	--	--	--
Orchardgrass	4	9	7	11	15	5
Timothy	--	2	3	1	.3	--
Unknown Grass	--	--	--	1	--	--
Forbs						
Alfalfa	5	10	11	12	13	14
Sweetvetch	15	13	1	27	12	1
Yarrow	--	.3	--	--	--	--
Shrubs						
Fourwing Saltbrush	.3	2	1	--	1	1
Fringe Sagebrush	--	--	.4	--	--	--
Sagebrush	1	.3	--	--	--	.1
Bitterbrush	--	.3	.4	--	--	--
Juniper	--	--	.4	.4	--	.1
Rabbitbush	--	2	--	1	1	1
Ephedra	--	.3	--	--	1	--
Winterfat	--	.3	--	--	--	--
Oak	.3	--	--	--	--	--

*HS - High grass/low forb/no shrub seed mix

*LS - Low grass/high forb/high shrub seed mix

*NS - No seed planted

treatment plots and those that were seeded. The information presented in Table 13, Perennial Seedling Density on the Barrow Study Plots, shows that the highest perennial plant density, occurred in the low grass, unmulched treatment (36.72/m^2). The lowest perennial plant density was the no seeding, unmulched treatment (18.6/m^2). In contrast, the no seeding, mulched treatment (32.6/m^2) had densities similar to the plots that were seeded. Where neither seed, nor mulch was applied, a significantly lower density resulted. However, it is important to note that the lowest density of 18.6 perennial plants per m^2 (75,274/acre or 1.73/$ft.^2$) represents acceptable densities on reclaimed mined land using the documentation provided on page 14 in the Results Topsoil and Subsoil section. In that reference, herbaceous plant densities that averaged 0.5 plants per square foot were considered "good", where those stands with densities of 0.75 and greater were considered "excellent". Table 14, Barrow Study Plots, Comparison of Seed Mixtures to the Relative Percent Composition, and Table 15, Comparison of Relative Percent Seedling Composition to Mulch and Seed Treatments contains a comparison of the seed mixtures to the relative percent composition, based on density, of the mulched and unmulched plots. Relative percent composition of mulched and unmulched plots and high, low and no seed mixtures shows close similarity in the distribution of grasses, legumes/forbs, and shrub density. Where no seed was applied to the plots, realtive percent composition was about 10% higher for grasses and 10% lower for legumes compared to seeded plots.

Conclusion

After three growing seasons, there were no significant affects on perennial plant densities due to the ratio of grasses to forbs and shrubs in the mixtures. Where grasses made up 85% of the seed mixture, grasses represented about 70% of the reseeded plant community. In plots where grasses made up only 15% of the seed mixture, grasses still represented about 72% of the reseeded plant community. Likewise, seed mixtures which contained shrubs resulted in only slightly higher shrub densities, 2% where no shrubs were seeded and 4% where shrub seeds made up 63% of the mixture. From this, it can be concluded that the seeding of high rates of shrub seeds does not result in an increase in initial shrub densities.

Mulching combined with the high grass seed mixture had a detrimental affect on legumes (49% decrease), whereas either mulching or no-mulching combined with the low grass seed mix, or the no-seed mix did not affect the legume establishment. However, the opposite effect was observed for the wheatgrass and brome. Mulch resulted in a 37% increase in the wheatgrass and a 40% increase in the bromes. Orchardgrass tended to become better established on unmulched plots. Dissemination of the orchardgrass and timothy, which were introduced to the study area in the mulch, to unmulched plots is explained by the fact that the mulch which was not tacked down was blown by the wind. This was indicated on page 13, Appendix 9I, Star Point Mines Mining and Reclamation Plan, Volume III, which states that the mulch was not incorporated or otherwise anchored and the low snow year allowed the mulch to be scattered.

Shrub establishment from seed was highest in the mulched plots which had been seeded with the high-shrub seed mixture and the only mixture that contained shrub seed. Five seeded shrub species were growing in these plots whereas only two species were found in the unmulched, high shrub seed mixture plots.

Overall transplanted shrub seedling survival after three growing seasons was good at 54.5%, a 31% decrease from the first year percent survival. Vigor was only fair even with a high flushing rate. In general, herbivory, micro-relief, and competing herbaceous vegetation does not appear to have had a high correlation with survival. The planting of shrub seedlings in small surface depressions benefited four of the nine species evaluated in this study. Five species did not appear to benefit from being planted in depressions. Herbivory by animals and insects is not a factor significantly affecting shrub survival while competing herbaceous vegetation appears to have only a slightly negative affect. Attempts should be made to place shrub transplants away from competing herbaceous vegetation. Of these three micro-site factors, topographic manipulation is the only factor that can be controlled to any meaningful extent in the reclamation process and this appears to be benificial only when planting serviceberry, gambel oak, true mountain mahogany, and fourwing saltbush.

Lasting effects of planting seedlings away from competition from herbaceous vegetation would be minimal. Once the shrub seeding has been planted, control of intruding vegetation would be impossible. This is especially true where seedlings are planted in small depressions.

REFUSE PILE TOPSOIL STUDY

Description

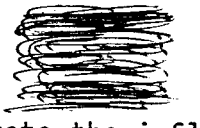
The study plots on the refuse pile were installed in the Fall of 1982 as stipulated by the Utah Division of Oil, Gas and Mining as part of the modification to the Refuse Pile Expansion Plan. Three topsoil treatments were applied to the coal refuse pile to determine the most successful method of reclaiming the refuse pile.

The location of the study plots is given on Plateau Mining Company 1983 Reclamation Map #2. In Figure 2, Refuse Pile Vegetation - Topsoil Test Plots, the physical layout of the treatment plots is shown. The treatments are as follows:

1. Soil material: subsoil, toposoil, topsoil over subsoil, and refuse material.

2. Soil depth: each soil material was applied at 10" and 20", and 10" of topsoil over 10" of subsoil.

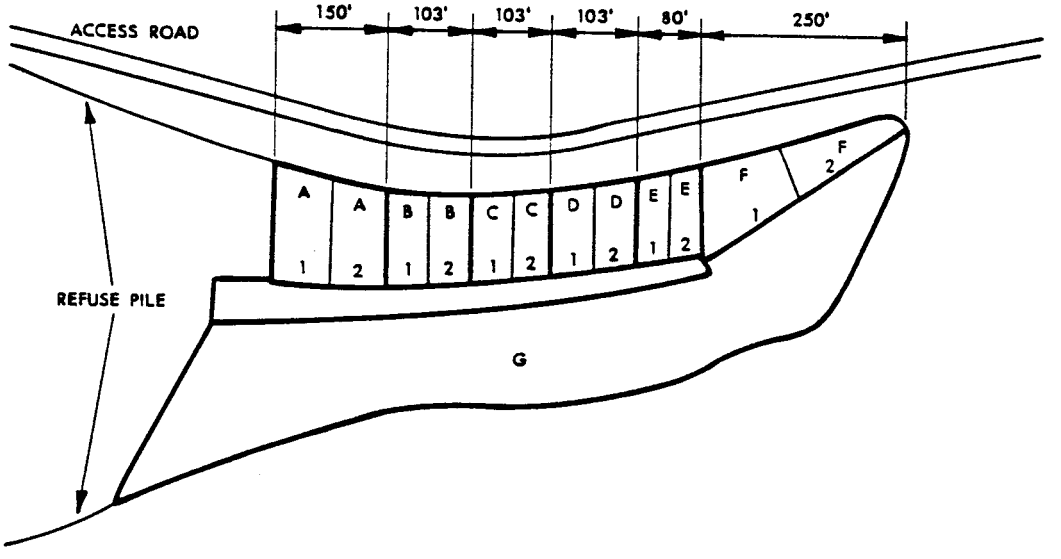
3. Fertilization (16-16-8) at 100 lbs. per acre and 200 lbs. per acre.



The objective of the 1983 field sampling was to evaluate the influence of these treatments on germination and seedling establishment and to determine which one is the most favorable for successful reclamation of the refuse pile.

FIGURE 2

REFUSE PILE VEGETATION - TOPSOIL TEST PLOT LAYOUT

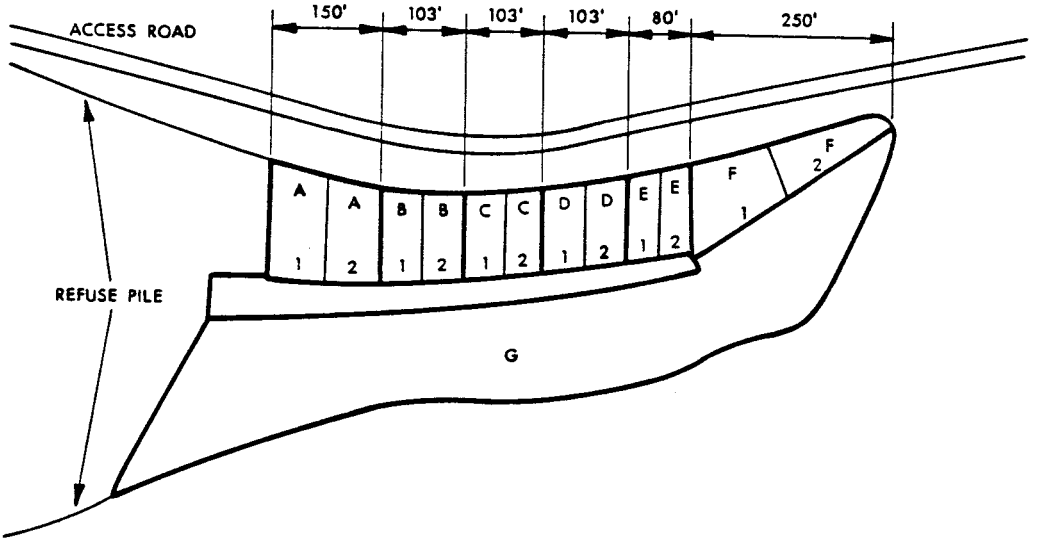


PLOT	TREATMENT KEY (INCHES) SOIL MATERIAL & DEPTH	(16-160-8) FERTILIZER LBS/ACRE
A1	Coal Waste	100
A2	Coal Waste	200
B1	20" Subsoil	200
B2	20" Subsoil	100
C1	10" Topsoil/10" Subsoil	100
C2	10" Topsoil/10" Subsoil	200
D1	10" Subsoil	200
D2	10" Subsoil	100
E1	20" Topsoil	100
E2	20" Topsoil	200
F1	10" Topsoil	200
F2	10" Topsoil	100
G	10" Subsoil	100

SEED MIX SPECIES	POUNDS PLS/ACRE
Slender Wheatgrass	3.0
Western Wheatgrass	3.0
Tall Fescue	2.0
G.B. Wildrye	3.0
Blue Bunch Wheatgrass	3.0
Scarlet Globemallow	0.5
Penstemon	0.5
Cicer Milkvetch	1.0
Yellow Sweetclover	1.0
Rubber Rabbitbrush	0.5
Big Sagebrush	0.1
Green Ephedra	2.0
4-wing Saltbrush	1.0
TOTAL	20.6

FIGURE 2

REFUSE PILE VEGETATION - TOPSOIL TEST PLOT LAYOUT



PLOT	TREATMENT KEY SOIL MATERIAL & DEPTH (INCHES)	(16-160-8) FERTILIZER LBS/ACRE
A1	Coal Waste	100
A2	Coal Waste	200
B1	20" Subsoil	200
B2	20" Subsoil	100
C1	10" Topsoil/10" Subsoil	100
C2	10" Topsoil/10" Subsoil	200
D1	10" Subsoil	200
D2	10" Subsoil	100
E1	20" Topsoil	100
E2	20" Topsoil	200
F1	10" Topsoil	200
F2	10" Topsoil	100
G	10" Subsoil	100

SEED MIX SPECIES	POUNDS PLS/ACRE
Slender Wheatgrass	3.0
Western Wheatgrass	3.0
Tall Fescue	2.0
G.B. Wildrye	3.0
Blue Bunch Wheatgrass	3.0
Scarlet Globemallow	0.5
Penstemon	0.5
Cicer Milkvetch	1.0
Yellow Sweetclover	1.0
Rubber Rabbitbrush	0.5
Big Sagebrush	0.1
Green Ephedra	2.0
4-wing Saltbrush	1.0
TOTAL	20.6

Results

The results of the 1983 monitoring is given in Table 16, Summary of Perennial Seedling Density, Table 17, Summary of Annual Weed Density, and Table 18, 1983 Seedling Density. The highest perennial seedling density, 45.76/m^2, occurred on the 20" subsoil material which had received 200 lbs. of fertilizer per acre. The lowest perennial seedling density, 9.70/m^2, occurred on the 10" topsoil material which had received 100 lbs. of fertilizer per acre. On the raw refuse material plot, there were 7.68 perennial seedlings per square meter.

Statistically significant differences in perennial plant densities exist within treatment levels for soil material, soil depth, and fertilizer rate, but not between these treatments. Perennial plant densities attributed to topsoil and subsoil are 13.01/m^2 and 37.15/m^2; 10" and 20" depth of soil material are 21.66/m^2 and 28.50/m^2; 100 lbs/acre and 200 lbs./acre of fertilizer are 23.10/m^2 and 27.47/m^2 respectfully. Thus, density is significantly (2.9X) greater for subsoil than for topsoil and only 1.3X greater for 20" soil depth over 10" soil depth and 1.2X greater for 200 lbs/acre fertilizer rate as opposed to 100 lbs./acre.

Where 10" of topsoil was placed over 10" of subsoil, there were 21.47/m^2 with 100 lbs/acre of fertilizer and 26.84/m^2 with 200 lbs/acre of fertilizer. In contrast to all of the soil treatments, perennial plant densities on the coal waste plot was 7.68/m^2.

Conclusion

First year germination and seedling establishment results from the refuse pile topsoil study reveals a highly significant difference between topsoil and subsoil material and to a lesser degree, between soil depths. However, the long term affects of these treatments on reclamation success needs to be evaluated. Of special interest in this arid region is the affect of fertilizer. The ultimate recommendation will have to be based on the lasting effects of these treatments. It should be noted that even the density on the refuse material (7.68/m^2 or 0.71/ft.^{2}) could represent acceptable reclamation, based on the documentation presented on page 14 of

TABLE 16

SUMMARY OF PERENNIAL SEEDLING DENSITY,

REFUSE PILE STUDY, FIRST YEAR GERMINATION, 1983

PERENNIAL SEEDLING DENSITY (#/M^2)

	FERTILIZER TREATMENTS		
SOIL DEPTHS	"0" LBS/A	100 LBS/A	200 LBS/A
20" Subsoil	---	38.42	45.76
10" Subsoil	---	30.00	34.40
20" Topsoil	---	12.00	17.82
10" Topsoil	---	9.70	12.52
10" Topsoil/10" Subsoil	---	21.47	26.84
10" Topsoil (South Aspect)	---	27.00	---
Coal Waste	7.68	---	---
Average	7.68	23.10	27.47

TABLE 17

SUMMARY OF ANNUAL WEED DENSITY, REFUSE PILE STUDY, FIRST YEAR GERMINATION, 1983

WEED DENSITY (#/M^2)

	FERTILIZER TREATMENTS		
SOIL DEPTHS	"0" LBS/A	100 LBS/A	200 LBS/A
20" Subsoil	---	7.16	9.88
10" Subsoil	---	8.04	7.52
20" Topsoil	---	13.96	17.28
10" Topsoil	---	18.44	17.64
10" Topsoil/10" Subsoil	---	9.84	6.20
10" Topsoil (South Aspect)	---	6.36	---
No Soil	10.64	---	---
Average	10.64	8.93	11.70

TABLE 18
1983 SEEDLING DENSITY REFUSE PILE STUDY
FIRST YEAR GERMINATION

	DENSITY (#/M^2)				
	A	B2	B1	C2	C1
TREATMENT:	No Soil	20" Subsoil	20" Subsoil	10" Topsoil 10" Subsoil	10" Topsoi 10" Subsoi
FERTILIZER RATE:	"0" lbs/a	200 lbs/a	100 lbs/a	200 lbs/a	100 lbs/a
Perennial Plants					
Seeded Species					
Grasses					
Wheatgrass	06.04	40.08	26.04	20.88	13.60
Tall Fescue	01.00	00.96	09.24	01.60	04.16
SUBTOTAL	07.04	41.04	35.28	22.48	17.76
Forbs					
Cicer Milkvetch	00.16	00.52	01.68	01.12	01.60
Yellow Sweetclover	00.16	01.88	00.80	01.16	01.48
Scarlet Globemallow	00.00	00.00	00.00	00.00	00.00
SUBTOTAL	00.32	02.40	02.48	02.28	03.08
Shrubs					
Big Sagebrush	00.00	00.08	00.00	00.16	00.00
Fourwing Saltbush	00.16	01.24	00.36	01.16	00.28
Rabbitbrush	00.00	00.00	00.00	00.00	00.00
Green Ephedra	00.16	00.96	00.28	00.52	00.28
SUBTOTAL	00.32	02.28	00.64	01.84	00.56
TOTAL SEEDED	07.68	45.72	38.40	26.60	21.40
Volunteer	00.00	00.04	00.02	00.24	00.07
TOTAL PERENNIAL	07.68	45.76	38.42	26.84	21.47
Volunteer Annuals					
Grasses	00.00	01.16	00.08	00.80	00.88
Forbs	10.64	08.72	07.08	05.40	08.96
SUBTOTAL	10.64	09.88	07.16	06.20	09.84
OVERALL TOTAL:	18.32	55.64	45.58	33.04	31.31

TABLE 18

1983 SEEDLING DENSITY REFUSE PILE STUDY

FIRST YEAR GERMINATION

(Cont'd)

DENSITY (#/M^2)

TREATMENT: FERTILIZER RATE:	D1 10" Subsoil 100 lbs/a	D2 10" Subsoil 200 lbs/a	E2 20" Topsoil 200 lbs/a	E1 20" Topsoil 100 lbs/a	F2 10" Topsoi 200 lbs/a
Perennial Plants					
Seeded Species					
Grasses					
Wheatgrass	20.96	28.80	13.96	07.84	09.68
Tall Fescue	05.76	00.52	00.08	01.88	00.28
SUBTOTAL	26.72	29.32	14.04	09.72	09.96
Forbs					
Cicer Milkvetch	01.24	00.80	00.44	00.72	00.52
Yellow Sweetclover	01.08	01.44	00.96	00.80	00.52
Scarlet Globemallow	00.00	00.08	00.00	00.00	00.00
SUBTOTAL	02.32	02.32	01.40	01.52	01.04
Shrubs					
Big Sagebrush	00.00	00.00	00.08	00.00	00.00
Fourwing Saltbush	00.16	01.76	01.16	00.72	00.64
Rabbitbrush	00.00	00.00	00.80	00.00	00.52
Green Ephedra	00.72	00.96	00.16	00.00	00.36
SUBTOTAL	00.88	02.72	02.20	00.72	01.52
TOTAL SEEDED	29.92	34.36	17.64	11.96	12.52
Volunteer	00.08	00.04	00.18	00.04	00.00
TOTAL PERENNIAL	30.00	34.40	17.82	12.00	12.52
Volunteer Annuals					
Grasses	03.04	00.96	09.44	06.68	10.56
Forbs	05.00	06.56	07.84	07.28	07.08
SUBTOTAL	08.04	07.52	17.28	13.96	17.64
OVERALL TOTAL:	38.04	41.92	35.10	25.96	30.16

TABLE 18
1983 SEEDLING DENSITY REFUSE PILE STUDY
FIRST YEAR GERMINATION
(Cont'd)

DENSITY (#/M^2)

TREATMENT: FERTILIZER RATE:	F1 10" Topsoil 100 lbs/a	G (South Aspect) 10" Topsoil 100 lbs/a	Average #/M^2
Perennial Plants			
Seeded Species			
Grasses			
Wheatgrass	05.44	21.92	17.94
Tall Fescue	01.76	02.48	02.48
SUBTOTAL	07.20	24.40	20.42
Forbs			
Cicer Milkvetch	01.16	00.12	00.84
Yellow Sweetclover	00.44	01.96	01.06
Scarlet Globemallow	00.00	00.00	00.01
SUBTOTAL	01.60	02.08	01.91
Shrubs			
Big Sagebrush	00.00	00.00	00.03
Fourwing Saltbush	00.88	00.20	00.73
Rabbitbrush	00.00	00.12	00.12
Green Ephedra	00.00	00.20	00.38
SUBTOTAL	00.88	00.52	01.26
TOTAL SEEDED	09.68	27.00	23.59
Volunteer	00.02	00.00	00.06
TOTAL PERENNIAL	09.70	27.00	23.65
Volunteer Annuals			
Grasses	09.96	00.12	03.64
Forbs	08.48	06.24	07.44
SUBTOTAL	18.44	06.36	11.08
OVERALL TOTAL:	28.14	33.36	34.73

the Topsoil and Subsoil section where reseeded grass stands with 0.75/ft.^{2} were given a rating of "excellent".

It may be concluded at this point, however, that the selective replacement of soil horizons did not have an advantage over subsoil alone and might indicate that a mixing of the horizons would not only be more economical, but provide near optimum revegetation potential.

OFFICE-ROAD-CUT STUDY PLOTS

Description

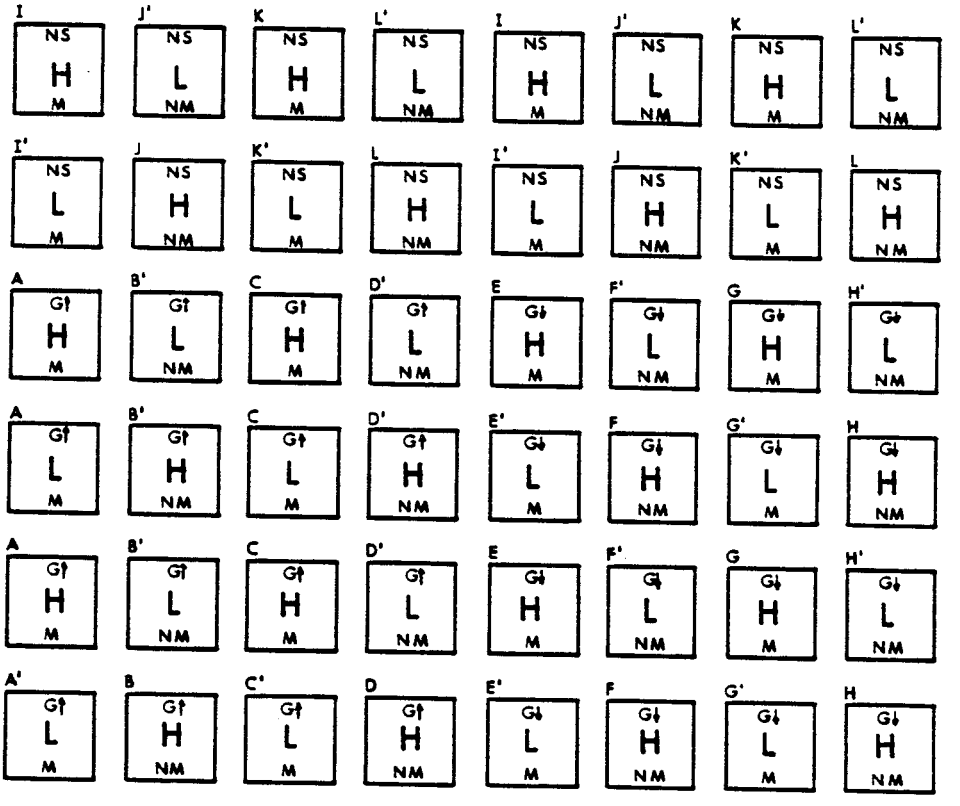
The study plots are located below the office and parking lot at the Lion Deck Portal area, as shown on Plateau Mining Company 1983 Reclamation Map 1. They are on a 70%, east southeast (30 degrees) facing slope. The plots were installed in October 1980. Seed mixtures, given in Table 9 and Table 10, were hand seeded at a rate of 30 pounds PLS/acre and raked into the soil. A grass hay mulch was applied at about 3,000 pounds per acre after seeding. Plots received mulch, and no-mulch treatments. Shrubs seedlings (tubelings) were planted at two rates; 9 tublings in the high density plots and 4 tublings in the low density. Plots are 12 x 12 feet square. A diagram of the plots and treatments is presented in Figure 3, Planting Pattern for the Office Road Cut.

All 48 plots, 24 plots with 9 per plot and 24 plots with 4 tubelings per plot, were planted with tubelings; each tubeling received an Agriform fertilizer pellet (10-20-10) placed in the hole with the tubeling. Tubelings were planted in April 1981 after seeding and mulching the previous Fall. The first year survival data were taken in mid-September, 1981. 1983 survival data were collected on July 7, after three growing seasons.

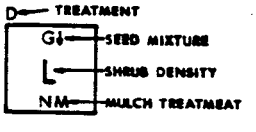
Shrub survival was the only parameter sampled in 1983.

FIGURE 3

PLANTING PATTERN FOR THE OFFICE ROAD CUT



TREATMENT KEY



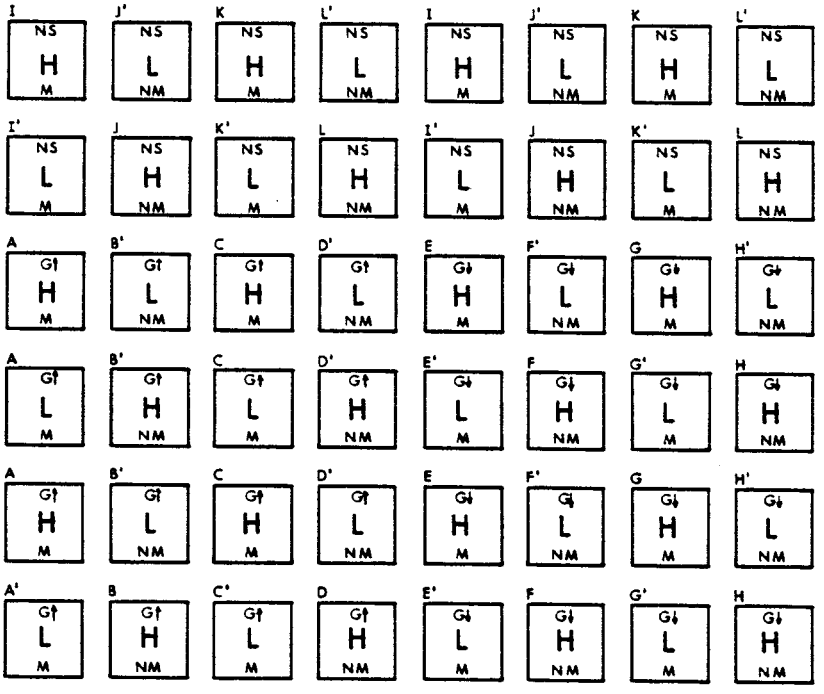
Artemisia tridentata*
Quercus gambelii
Atriplex canescens*
Chrysothamnus nauseosus
Rhus trilobata
Amelanchier utahensis
Cercocarpus ledifolius*
Cercocarpus montanus
Juniperus scopulorum*

*Species used in low density plantings

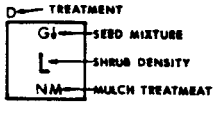
G↑ = High grass seed mix
G↓ = Low grass seed mix
NS = No seed mix
M = Mulch
NM = No Mulch

FIGURE 3

PLANTING PATTERN FOR THE OFFICE ROAD CUT



TREATMENT KEY



Artemisia tridentata*
Quercus gambelii
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*Species used in low density plantings

G↑ = High grass seed mix
G↓ = Low grass seed mix
NS = No seed mix
M = Mulch
NM = No Mulch

Results

Percent shrub survival is presented in Table 19, Percent Shrub Survival on the Office Road Cut Study Plots. This table shows a comparison of 1983 and 1981 survival. In 1983, survival was 21% as compared to 59% in 1981. Of the nine species planted, only one, gambel oak, has completely died out. One plant of oak sumac, (one out of twenty-four) was still living. Big sagebrush had the highest survival at 46%.

Conclusion

After three growing seasons, the overall survival is low at 21%. Factors that might be affecting survival may be the course rock that makes up the surface of the fill material on which the plots are located. This effect could stem from a reduced water holding capacity of the soil surface in the tubeling root zone or from rodent damage due to the favorable habitat created for rodents by the large rocks. Big sagebrush, rubber rabbitbrush, mountain mahogany, and fourwing saltbrush represent relatively successfully species for transplanting on this site (elevation 8,500'). Those species that did poorly are gambles oak, oak sumac, serviceberry, and Rocky Mountain juniper.

ROAD SIDE MULCH STUDY PLOTS

Description

During mid-March 1982, the mulch study plots were installed on steep road cuts, shown on Plateau Mining Company 1983 Reclamation Map 1, which had not been successfully revegetated due to excessive sloughing. Fourteen plots were established, each with Terra Tack II tackifier at 140 lbs/acre, fertilizer (16-16-8) at 200 lbs/acre, and 22 lbs/acre of the seed mix presented in Table 20, Roadside Mulch Study Plot Seed Mixture.

TABLE 19

PERCENT SHRUB SURVIVAL ON THE OFFICE-ROAD CUT STUDY PLOT

SPECIES	(%) 1983	(%) 1981	% CHANGE
Big Sagebrush	46	77	-40
Gambel Oak	0	54	-100
Fourwing Saltbush	17	79	-78
Rubber Rabbitbrush	29	29	0
Oak Sumac	4	75	-95
Utah Serviceberry	8	29	-72
Curleaf Mountain Mahogany	10	67	-85
True Mountain Mahogany	21	71	-70
Rocky Mountain Juniper	8	35	-77
TOTAL	21	59	-64

TABLE 20
ROADSIDE MULCH STUDY PLOT SEED MIXTURE

GRASSES

		POUNDS PLS/ACRE
1.	Fairway Crested Wheatgrass	2
2.	Smooth Brome (Southern Strains)	2
3.	Intermediate Wheatgrass	2
4.	Pubescent Wheatgrass	2
5.	Bluestem Wheatgrass	2
6.	Orchardgrass	2
7.	Russian Wildrye	2
8.	Sandbury Bluegrass	2

FORBS

Alfalfa (Nomad)	2
Ladak - Equal Parts	2
Yellow Sweetclover	2
TOTAL	22

Test plots 11, 12, 13, 14 have 10 lbs. of barley and 10 lbs. of rye	20
TOTAL	42

Treatments for each plot are given in Table 21, Description of the Roadside Mulch Study Treatments.

The plots were first monitored July 1982. Because of sloughing, many of the plot identification stakes have been lost. Eight of the 14 plots could be identified in the field and were sampled July 13, 1983. In general, the upper portions of the plots have few plants due to soil movement down the steep slope. Sampling as done on the mid-portions of the plot. A total of ten $\frac{1}{4}m^2$ quadrats were read per plot.

TABLE 21
DESCRIPTION OF THE ROADSIDE MULCH STUDY TREATMENTS

Plot #1 -	Seed & Tack & Fertilizer - Jute mesh - over spray conweb 2,000 mulch
*Plot #2 -	Seed & Tack & Fertilizer - Jute mesh
*Plot #3 -	Seed & Tack & Fertilizer - 1" over-cover straw
*Plot #4 -	Seed & Tack & Fertilizer - 1" over-cover straw held jute mesh
*Plot #5 -	Seed & Tack & Fertilizer - Nylon mesh
Plot #6 -	Seed & Tack & Fertilizer - Nylon mesh - over spray 2,000 lbs. conweb - 2,000 mulch
*Plot #7 -	Seed & Tack & Fertilizer - Covered with cellulose blanket
*Plot #8 -	Seed & Tack & Fertilizer - Cellulose blanket - over spray 2,000 lbs/acre over spray conweb 2,000 mulch
Plot #9 -	Seed & Tack & Fertilizer - 2,000#/acre - conweb 2,000 mulch
*Plot #10 -	Seed & Tack & Fertilizer - No mulch/net treatment
*Plot #11 -	Seed & Tack & Fertilizer - 20 lbs. cover crop seed
*Plot #12 -	Seed & Tack & Fertilizer - 20 lbs. cover crop seed over spray 2,000 lbs. conweb 2,000 mulch
Plot #13 -	Seed & Tack & Fertilizer - 20 lbs. cover crop seed - nylon mesh
Plot #14 -	Seed & Tack & Fertilizer - 20 lbs. cover crop seed - nylon mesh over spray 2,000 lbs/acre conweb 2,000 mulch

*Sampled in 1983, the only plots with stakes that can still be located in the field.

The purpose of this study was to determine the most cost efficient method of stabilizing slopes prone to sloughing for a period adequate to reestablish vegetation. This objective is stated in a memo to Coal File, March 24, 1982, Plateau Mining Company, and signed by Lynn M Kunzler, Reclamation Biologist, Utah Division of Oil, Gas, and Mining.

Results

A summary of the Results are given in Table 22, Perennial Seedling Density - Treatment Cost Comparison. Perennial seedling densities are highest where no mulch or netting had been applied. In Plot No. 10 where only seed, tackifier, and fertilizer were applied, the seedling density was 4.422/ft.^{2}. This plot not only had the highest density, but it was also the lowest treatment cost per acre ($238/acres) and the lowest cost per surviving seedling ($0.001). The next highest densities are on the nylon mesh plot with 2.560/ft.^{2} and $0.057/seedling and the cereal cover crop with conweb at 2.267/ft.^{2} and $0.010/seedling. The lowest densities were on the straw mulch plot which had 0.223/ft.^{2} at $0.073/seedling.

Conclusions

After two growing seasons, there appears to be some definite trends on the affect of mulch and netting material on the survival and establishment of perennial plants on steep road cuts. All treatments had a negative effect on seedling densities compared to Plot No. 10 which had received no mulch or netting. It had almost 2 times the number of seedlings over the next highest densities. The Plot #10 also had the lowest cost per acre and the lowest cost per surviving seedling (see Table 22). The application of conweb did have a strong positive influence on the cereal cover crop treatment. The cereal cover crop with conweb mulch had the fourth lowest cost per acre and the second highest seedling density.

Objectives of the study includes both the revegetation success and the economics of reclaiming the steep road cuts. In meeting these objectives and based on the 1983 data and application cost, it is recommended that no netting or mulch be used in reseeding steep slopes. Straw mulch alone had the lowest and most unacceptable seedling densities and is not recommended. From an economical standpoint, the use of the lowest cost netting (nylon) which had acceptable seedling densities (2.56/ft.^{2}) is 27 times more expensive than the no treatment plot (4.422/ft.^{2}), which had the highest seedling density. It is concluded that neither netting or mulch be used to revegetate steep road cuts.

TABLE 22

PERENNIAL SEEDLING DENSITY

TREATMENT COST COMPARISON, ROADSIDE MULCH STUDY

PLOT NO.	TREATMENT	($) COST/ACRE	(#/ft.^{2}) DENSITY	($) COST/SEEDLING
3	Straw	709	0.223	0.073
4	Jute/Straw	9,901	1.003	0.227
5	Nylon Mesh	6,358	2.560	0.057
7	Cello-Blanket	11,034	1.264	0.200
8	Cello-Blanket/Conweb*	11,824	1.747	0.155
10	No Treatment	238	4.422	0.001
11	Cereal Cover Crop	263	0.956	0.006
12	Cereal Cover Crop/Conweb	1,033	2.267	0.010

*Conweb = 2,000 lbs/acre Conweb Hydromulch over-spray

CASTLE RIDGE EXPLORATION

Description

Exploration roads and drill pads associated with the Castle Ridge exploration project were reclaimed in the Fall of 1982. Reclamation consisted of regrading the sites to achieve approximate original contour and to blend into surrounding topography, and respreading stored topsoil.

The road and drill sites were reseeded with the mixture presented in Table 23, Castle Ridge Exploration Seed Mixture. After seeding, 2,000 lbs/acre of Conweb hydromulch was applied.

TABLE 23

CASTLE RIDGE EXPLORATION SEED MIXTURE.

SPECIES	LBS/ACRE*
Smooth Brome	7.0
Streambank Wheatgrass	2.0
Intermediate Wheatgrass	3.0
Meadow Foxtail	2.0
Tall Oatgrass	2.0
Orchardgrass	2.0
Crested Wheatgrass	2.0
Englemann Spruce	0.5
Subalpine Fir	0.3
Douglas Fir	0.2
TOTAL	21.0

*80% PLS minimum per species

On July 13, 1983 plant density data were collected from the reclaimed exploration sites to determine the success of germination and seedling establishment. A total of 126 $\frac{1}{4}m^2$ quadrats were read in order to estimate seedling density.

Results

Densities of perennial grasses, perennial forbs, and shrubs is presented in Table 24, Density of Perennial Plant Seedlings on the Reclaimed Castle Ridge Exploration Road and Drill Pads. Relative percent composition of the life forms are 92% for perennial grasses, 7% for shrubs, and 1% for perennial forbs. Identification by species was difficult due to the immature development of the plants. It appeared that the drill pads supported mostly seeded species while the access road had a high mixture of both seeded and volunteer species from the topsoil material. Shrubs were composed of big, low, and fringed sagebrush. Shrub density is 1.22/¼m^2 which amounts to 19,750 stems per acre.

Conclusion

Reclamation of the Castle Ridge exploration project has been highly successful based on the number of perennial plants that have become established this first growing season. There should be no problem in providing good ground cover and a variety of species for wildlife and domestic livestock.

TABLE 24

DENSITY OF PERENNIAL PLANT SEEDLINGS

ON THE RECLAIMED CASTLE RIDGE EXPLORATION ROAD AND DRILL PADS

SPECIES	NO./1/4M^2	NO./SQ. FOOT
Perennial Grasses	16.41	6.10
Perennial Forbs	00.15	0.06
Shrubs	01.22	0.45
TOTAL	17.78	6.61

WILDLIFE MITIGATION AREA

Description

During the Fall of 1982, approximately 16 acres of the 40 acre wildlife mitigation area, shown on Plateau Mining Company 1983 Reclamation Map 2, was treated in an attempt to improve the site for deer winter range. The treatments consisted of (1) dozing pinyon and juniper trees that were enchroaching on a big sagebrush community; (2) crushing mature serviceberry shrubs to make new growth available for deer; (3) reseeding with the mixture given in Table 26, Wildlife Mitigation Area Seed Mixture and fertilizing at 200 lbs/a of 16-16-8; and (4) transplanting shrub seedlings into the scalps and other disturbed areas created by dozing and crushing the pinyon, juniper, and serviceberry trees. Shrub seedings were transplanted in April 1983 at an estimated density of 4,000/acres in the scalps and mechanically disturbed areas. The shrub species transplanted are given in Table 25, Shrubs Tranplanted on the Wildlife Mitigation Area.

On July 9 and 10, 1983 the treatment area and the adjacent control area were sampled. Parameters measured were plant cover, current annual plant production, and woody plant density. Percent shrub survival was taken on a test plot located within the treatment area. The test plot was established at the same time and using the same plant material used on the rest of the treatment area. Test shrubs were planted in a row with 3' distance separating each plant.

TABLE 25

SHRUBS TRANPLANTED ON THE WILDLIFE MITIGATION AREA.

SPECIES	NO. PLANTED	SOURCE
Fourwing saltbrush	500	Container
Bitterbrush	1,000	"
Serviceberry	700	"
Currant	300	"
Mormon Tea	500	"
True Mountain Mahogany	500	"

TABLE 26

WILDLIFE MITIGATION AREA SEED MIXTURE

	POUNDS LBS/ACRE
Pubescent Wheatgrass	1
Fairway Crested Wheatgrass	1
Russian Wildrye	3
Prostrat Kochia -	1
Ladak Alfalfa -	3
Pacific Aster	1
Yellow Sweet Clover	1
Blue Flax	1
Desert Globemallow	1
Small Burnet	1
Fourwing Saltbrush	2
	16

Mitigation work is in response to Stipulation 9-22-2 which concerns the deer winter range improvement to compensate disturbances associated with the refuse pile expansion and the unit train loadout.

Field sampling involved a total of 20 transects in the 16 acre treatment area and 20 in the 16 acre control area. Procudures are described in the Methods section.

Results

Results are summarized in Table 27, Summary of Plant Cover and Production, Wildlife Mitigation Treatment Area and Control Area; Table 28, Summary of Woody Plant Density, Wildlife Mitigation Area; and Table 29, Shrub Transplant Survival Test Plots, Wildlife Mitigation Area. Table 30, Plant Species Identified on or Adajacent to the Permit Area, contains the names of the plant species identified in the wildlife mitigation area as well as all of those identified in the other areas sampled in 1982 and 1983.

A review of Table 27 reveals that there is no difference in grass cover between the treatment and control areas, but there has been a significant increase in forb and shrub cover. By comparing relative percent cover composition between the treatment and control areas, it is evident that there has been a shift in composition in the treatment area. Grasses cover represents 34% and forbs 65% more of the cover on the treatment area than on the control. As may be expected from the impacts of the equipment used as well as the actual mechanical treatments on the treated area, the relative percent shrub cover on the treatment area is 38% less than the relative percent shrub cover on the control area. Increases in the relative forb composition on the treatment area is attributed to annual forbs and seeded forb species. Annual forbs would naturally increase as a result of openings in the natural plant community from surface disturbances. Non-seeded perennial forb cover remains about the same for both the treated and control areas.

TABLE 27

SUMMARY OF PLANT COVER AND PRODUCTION, WILDLIFE MITIGATION TREATMENT AREA AND CONTROL AREA, 1983

SPECIES*	COVER (%)		PRODUCTION (g/m^2)	
	TREATMENT	CONTROL	TREATMENT	CONTROL
Grasses				
Wheatgrass	1.55	2.30	5.888	7.412
Desert Wheatgrass	0.40	0.05	0.432	0.000
Intermediate Wheatgrass	0.00	0.05	0.000	0.000
Blue Grama	5.00	3.95	4.600	3.028
Cheatgrass	0.35	0.10	0.268	0.004
Foxtail	0.00	0.35	0.000	0.000
Indian Ricegrass	0.00	0.45	0.080	1.208
Bluegrasses	0.00	0.00	0.016	0.000
Squirreltail	1.00	0.05	1.488	1.332
Needle & Thread	1.10	2.25	1.888	3.840
SUBTOTAL	9.40	9.55	14.660	16.788
Forbs				
Yarrow	0.00	0.00	0.008	0.000
Mtn. Dandelion	0.00	0.00	0.004	0.000
Locoweed	0.30	0.75	0.920	1.536
Segolily	0.00	0.00	0.000	0.040
Indian Paintbrush	0.00	0.10	0.000	0.080
Cryptantha	0.00	0.25	0.024	0.644
Fleabane	0.20	0.00	0.440	0.000
Buckwheat	0.05	0.00	0.000	0.240
Sweetvetch	0.15	0.00	0.040	0.180
Yellow Sweetclover	0.85	0.00	0.360	0.000
Plantain	0.00	0.00	0.020	0.000
Scarlet Globemallow	1.35	0.15	1.480	0.180
Annual Forb	2.10	1.20	4.948	1.600
SUBTOTAL	5.00	2.45	8.244	4.500

TABLE 27

SUMMARY OF PLANT COVER AND PRODUCTION,

WILDLIFE MITIGATION TREATMENT AREA AND CONTROL AREA, 1983

(Cont'd)

	COVER (%)		PRODUCTION (g/m^2)	
SPECIES*	TREATMENT	CONTROL	TREATMENT	CONTROL
Shrubs				
Serviceberry	0.30	0.60	0.046	0.184
Big Sagebrush	9.40	22.50	12.088	12.380
Fourwing Saltbrush	0.00	0.00	0.032	0.000
Winterfat	0.05	0.00	0.000	0.000
Rubber Rabbitbrush	0.00	0.00	0.062	0.000
Green Rabbitbrush	0.40	0.70	0.000	1.956
Juniper	0.00	0.15	0.000	0.000
Prickly Pear	0.05	0.15	0.000	0.000
Pinyon Pine	0.00	1.95	0.000	0.000
Currant	0.00	0.00	1.494	0.000
SUBTOTAL	10.20	25.90	13.722	14.520
TOTAL:	24.60	37.90	36.626	36.808

TABLE 28

SUMMARY OF WOODY PLANT DENSITY,

WILDLIFE MITIGATION TREATMENT AREA, 1983

SPECIES	TREATMENT	CONTROL
Serviceberry	0.030	0.061
Big Sagebrush	0.890	1.240
Winterfat	0.001	0.003
True Mtn. Mahogany	0.004	0.000
Rubber Rabbitbrush	0.001	0.000
Green Rabbitbrush	0.077	0.170
Juniper	0.000	0.001
Pinyon Pine	0.022	0.046
Bitterbrush	0.001	0.000
Currant	0.001	0.000
TOTAL	1.027	1.521

*Plant symbols are identified in Table 22

TABLE 29

SHRUB TRANSPLANT SURVIVAL TEST PLOTS, WILDLIFE MITIGATION AREA

SPECIES	(1-10) VIGOR*	(cm) HEIGHT	PLANTED	PLANTED	% SURVIVAL
Fourwing Saltbush	6	08.0	42	17	40.5
Bitterbrush	7	03.5	39	24	61.5
Serviceberry	3	04.0	52	12	23.1
Currant	8	17.9	41	30	73.2
Morman Tea	2	04.0	33	8	24.2
True Mtn. Mahogany	5	07.5	39	7	17.9

*Vigor values 1-10 with 10 being the most vigorous

**NOTE: Plants were transplanted April 26, 1983. Survival data was collected July 14, 1983.

TABLE 30
PLANT SPECIES IDENTIFIED ON OR ADJACENT TO THE PERMIT AREA

PLANT SYMBOL	SCIENTIFIC NAME	COMMON NAME
GRASSES		
Agsm	Agropyron smithii	western wheatgrass
Agtr	Agropyron trachycaulum	slender wheatgrass
Agin	Agropyron intermedium	intermediate wheatgrass
Agex	Agrostis exarata	red top
Avba	Avena barbata	wild oats
Bogr	Bouteloua gracilis	blue grama
Brma	Bromus marginatus	mountain brome
Brte	Bromus tectorum	cheat grass
Calam	Calamagrostis spp.	reed grass
Dagl	Dactylis glomerata	orchard grass
Elci	Elymus cinereus	basin wildrye
Elsa	Elymus salina	salina wildrye
Elgl	Elymus glaucus	blue wildrye
Hoju	Hordeum jubatum	foxtail
Hovu	Hordeum vulgare	barley
Kocr	Koeleria cristata	June grass
Orhy	Oryzopsis hymenoides	Indian ricegrass
Poa	Poa spp.	blue grass
Sihy	Sitanion hystrix	squirreltail
Stco	Stipa comata	needle and thread
GRASS LIKE		
Carex	Carex spp.	sedge
Scirp	Scirpus maritimus	bulrush
FORBS		
Acmi	Achillea millefolium	western yarrow
Anten	Antennaria spp.	pussy toes
Aggl	Agoseris glauca	mountain dandelion

TABLE 30
PLANT SPECIES IDENTIFIED ON OR ADJACENT TO THE PERMIT AREA
(Cont'd)

PLANT SYMBOL	SCIENTIFIC NAME	COMMON NAME
FORBS		
Arco	Arnica cordifolia	heartleaf arnica
Ascle	Asclepias spp.	milkweed
Astra	Astragalus spp.	locoweed
Asco	Astragalus convallarius	narrowleaf vetch
Canu	Calochortus nuttallii	segolily
Casti	Castilleja spp.	Indian paint brush
Ceras	Cerastium spp.	chickweed
Chdo	Chaenactis douglasii	false yarrow
Cirs	Cirsium spp.	thistle
Clco	Clematis columbiana	clematis
Coar	Convolvulus arvense	bindweed
Cora	Cordylanthus ramosus	bird's beak
Crse	Cryptantha sericea	cryptantha
Erum	Eriogonum umbellatum	buckwheat
Erige	Erigeron spp.	fleabane, daisy
Eriog	Eriogonum spp.	buckwheat
Erysi	Erysimum spp.	wallflower
Fraga	Fragaria spp.	strawberry
Galiu	Galium spp.	bedstraw
Grsq	Grindelia squarrosa	gumweed
Hafl	Hackelia floribunda	false forget-me-not
Hebo	Hedysarum boreale	sweetvetch
Heuch	Heuchera spp.	alum root
Hepa	Heuchera parvifolia	alum root
Ipag	Ipomopsis aggregata	scarlet gilia
Kosc	Kochia scoparia	summer cypress
Lala	Lathyrus lanzwertii	peavine
Lathy	Lathyrus spp.	peavine

TABLE 30
PLANT SPECIES IDENTIFIED ON OR ADJACENT TO THE PERMIT AREA
(Cont'd)

PLANT SYMBOL	SCIENTIFIC NAME	COMMON NAME
FORBS		
Lygr	Lygodesmia grandiflora	skeleton weed
Meci	Mertensia ciliata	bluebells
Meof	Melilotus officinalis	sweet clover
Orfa	Orobanche fasciculata	broomrape
Osoc	Osmorhiza occidentalis	sweetanice
Oxytr	Oxytropis spp.	locoweed
Oxla	Oxytropis lambertii	locoweed
Penst	Penstemon spp.	penstemon
Peea	Penstemon eatonii	firecracker penstemon
Phace	Phacelia spp.	scorpion weed
Phid	Phacelia idahoensis	scorpion weed
Phau	Physaria australis	bladderpod
Plant	Plantago spp.	plantain
Saib	Salsola iberica	Russian thistle
Sedum	Sedum spp.	stonecrop
Sela	Sedum lanceolatum	stonecrop
Senec	Senecio spp.	oldman
Smst	Smilacina stellata	false soloman seal
Spco	Sphaeralcea coccinea	scarlet globemallow
Stpi	Stanleya pinnata	prince's plume
Taof	Taraxacum officinale	dandelion
Thfe	Thalictrum fendleri	meadow rue
Trdu	Tragopogon dubius	oster plant
Vicia	Vicia spp.	vetch
Viola	Viola spp.	violet

TABLE 30
PLANT SPECIES IDENTIFIED ON OR ADJACENT TO THE PERMIT AREA
(Cont'd)

PLANT SYMBOL	SCIENTIFIC NAME	COMMON NAME
HALF-SHRUBS		
Arno	Artemisia nova	black sagebrush
Arfr	Artemisia frigida	fringe sagebrush
Atcu	Atriplex cuneata	mat saltbrush
Bere	Berberis repens	Oregon grape
Xasa	Xanthocephalum sarothrae (Gutierrezia sarothrae)	snake weed
Yucca	Yucca spp.	yucca
Yuha	Yucca harrimaniae	yucca
SHRUBS		
Amut	Amelanchier utahensis	service berry
Amal	Amelanchier alnifolia	service berry
Artr	Artemisia tridentata	sagebrush
Atco	Atriplex confertifolia	shadscale
Atcu	Atriplex cuneata	mat saltbush
Cela	Ceratoides lanata	winterfat
Chna	Chrysothamnus nauseosus	rubber rabbitbrush
Chvi	Chrysothamnus viscidiflorus	green rabbitbrush
Epvi	Ephedra viridis	green mormon tea
Eriog	Eriogonum spp.	buckwheat
Opunt	Opuntia spp.	prickly pear
Phmo	Physocarpus monogynus	nine bark
Putr	Purshia tridentata	bitterbrush
Rimo	Ribes montegeum	currant
Rowo	Rosa woodsii	wild rose
Sambu	Sambucus spp.	elderberry
Same	Sambucus melanocarpa	elderberry
Save	Sarcobatus vermiculatus	greasewood

TABLE 30
PLANT SPECIES IDENTIFIED ON OR ADJACENT TO THE PERMIT AREA
(Cont'd)

PLANT SYMBOL	SCIENTIFIC NAME	COMMON NAME
SHRUBS		
Syor	Symphoricapos oreophilus	snowberry
Syal	Symphoricarpos albus	snowberry
Tape	Tamarix pentandra	tamarix
TREES		
Acgr	Acer grandidentatum	maple
Abla	Abies lasiocarpa	subapline fir
Cele	Cercocarpus ledifolius	curlleaf mountain mahogany
Cemo	Cercocarpus montanus	true mountain mahogany
Jusc	Juniperus scopulorum	rocky mountain juniper
Juos	Juniperus osteosperma	Utah juniper
Pied	Pinus edulis	pinyon pine
Pofr	Populus fremontii	cottonwood
Potr	Populus tremuloides	aspen
Prvi	Prunus virginiana	chokecherry
TREES		
Psme	Pseudotsuga menziesii	Douglas fir
Quga	Quercus gambellii	gambel oak
Salix	Salix spp.	willow
Tape	Tamarix pentandra	tamarix

Grass and shrub production and cover values between the treatment and control areas remained unchanged while forb production was approximately 45% greater on the treated area. Annual forb production was 68% greater on the treatment area. Perennial forb production was about the same for both areas.

As presented in Table 28, Summary of Woody Plant Density, the control area has a shrub density of 1.521/m^2 (6,155/acre) while the treatment area contains 1.027/m^2 (4,156/acre). The overall difference is 0.494/m^2 or a reduction of 2,000 stems per acre on the treated area. The treatment area contains 0.35/m^2 (1,416/acre) fewer big sagebrush plants. There were also 0.093/m^2 (376/acre) fewer green rabbitbrush shrubs and 0.031/m^2 (125/acres) fewer serviceberry plants on the treatment area.

Overall shrubs seedling transplant survival is 39.8%. By species, currant seedling transplants maintained the highest survival (73.2%) followed by bitterbrush (61.5%). The lowest percent survival was for true mountain mahogany (17.9%). Vigor ratings were also higher for current and bitterbrush (8 and 9), but the lowest value (2) was for Mormon tea.

Conclusions

First year's treatment affect on the vegetation was compared to the adjacent control area. The current year's data indicates that grass cover and grass production is unchanged. Forb cover and production on the treatment area was about 2X that of the control. This increase on the treated area was due to annual forb growth. A treatment affect is seen in the average production per woody plant. The treatment area has a woody plant density of 0.49/m^2 (2,000/acre) less shrubs; however, production was the same as the control area. This is especially true for sagebrush where 0.35/m^2 (1,416/acre) fewer stems on the treated area produced the same amount of biomass as the control area. This difference might be attributed to the influence of the fertilizer on sagebrush production.

Based on the first year percent shrub survival on the Wildlife Mitigation Area test plot, there are probably about 1,620 live shrub transplants growing on the scalps and disturbed areas within the treatment area. Bitterbrush and currant transplants show the most promise, but conclusions should not be made until more long term data is available.

File ACT/007/006
Folder # 13

PLATEAU MINING COMPANY

A Subsidiary of Getty Oil Company
P.O. Drawer PMC Price, Utah 84501
Telephone (801) 637-2875

February 14, 1984

Mr. Lynn Kunzler
Division of Oil, Gas & Mining
4241 State Office Building
Salt Lake City, Utah 84114

Re: 1983 Reclamation Report

Dear Lynn;

Enclosed please find three copies of the Annual Reclamation Report for the Star Point Mines, Plateau Mining Company.

We are proceeding with plans to plant twenty thousand seedlings in April of this year. This effort will increase our woody plant stocking rates. Species selection has been done according to our approved plan and taking into consideration the results of the enclosed report. Species showing adequate results in our test plots will be used in the proper locations.

If you have any questions, please call.

Sincerely,

PLATEAU MINING COMPANY

Ben Grimes
Environmental Coordinator

BG:sd

Enclosures

ANNUAL RECLAMATION REPORT

STAR POINT MINES

Plateau Mining Company

January 1984

INTRODUCTION

Mining has been conducted at the Plateau Mining Company's Star Point Mines location since 1917. The operation consists of three portals for the underground recovery of coal reserves from the Wattis and Hiawatha seams. Surface areas that have been affected by the mining operation over the years and the associated reclamation and reclamation study areas are shown on the attached Plateau Mining Company 1983 Reclamation Map #1 and Plateau Mining Company 1983 Reclamation Map #2.

Reclamation of disturbed areas began in 1980. During the Summer and Fall of 1980, all disturbed areas which could be reclaimed without affecting the operation were seeded using hand operated cyclone broadcast seeders. About 20 lbs/acre of the seed mix presented in Table 1, 1980 Seed Mixture, was planted. This was followed by mechanically blowing about 3,000 lbs/acre of cereal grain straw mulch over the area. Areas that could not be reached by the blower were mulched by hand. The area seeded comprised approximately 120.67 acres and represents all of the green areas shown on the attached maps. In November 1981, much of the same area, 55.28 acres was reseeded with about 24 lbs/acre of the same seed mixture used in 1980. The seed was incorporated with 140 lbs/acre of tackifier and mechanically sprayed over the area. Following seeding, the area was oversprayed with 2,000 lbs/acre of Conwed hydromulch. Again in 1983, portions of the same area on which revegetation was poor, was reseeded with the seed mixture given in Table 3, 1983 Seed Mix. The 1983 reclamation contained 10.07 acres which were seeded at a rate of 22 lbs/acre. After seeding, the areas were hydromulched with 2,000 lbs/acre of Conwed hydromulch.

A total of 120.67 acres have been seeded. This comprises all of the disturbed land currently available for reclamation.

The following annual reclamation report presents results of the 1983 reclamation monitoring program. This report is in fulfillment of the agreement between Plateau Mining Company and the Utah State Division of

Oil, Gas and Mining to provide annual progress of the reclamation effort and reclamation study results. Additional information is included on the Wildlife Mitigation Area stipulated as part of the Minor Modification of the Refuse Pile Expansion Plan submitted May 28, 1982.

TABLE 1
1980 SEED MIXTURE

	% MIXTURE
Russian Wildrye	15%
Streambank Wheatgrass	11%
Mountain Brome	5%
Big Sage Brush	5%
Fourwing Saltbush	8%
Western Wheatgrass	15%
Pubescent Wheatgrass	15%
Indian Ricegrass	5%
Rabbitbrush	3%
Alfalfa "Ranger"	10%
Yellow Sweetclover	10%

TABLE 2
1983 SEED MIXTURE

	POUNDS PLS/A
Pubescent Wheatgrass	3
Smooth Brome	3
Alsike Clover	1
Ladak Alfalfa	2
Great Basin Wildrye	1
Fourwing Saltbrush	2
Shadscale	1
Cicer Milkvetch	1
Rubber Rabbitbrush	0.25

1983 RECLAMATION MONITORING

In mid-July 1983, field data was collected on reclaimed and reclamation study sites as well as on the Wildlife Mitigation Area.

Reclaimed sites sampled were restricted to 1981 seedings. Study areas sampled were the Barrow Area, Refuse Pile Topsoil, Office-Road-Cut, Road Side Mulch, and Wildlife Mitigation Area. Locations are presented on Plateau Mining Company 1983 Reclamation Map 1 and Plateau Mining Company 1983 Reclamation Map 2. Each of these areas are described in the following narrative along with a discussion of the results and conclusion that can be made from the 1983 data.

Methods

The parameters measured on the various sites presented in this report includes plant cover, current annual plant production, plant densities, plant vigor, plant survival, and site factor descriptions. Not all parameters were measured on all sites, but where any of these were measured, the following descriptions of methods and procedures were used. A list of the measurements taken on each site is presented in the description section associated with each particular site.

Plant cover was estimated using a ten-point frame. The frame was placed every five meters (m) along a randomly placed 50m transect. A total of 100 data points were recorded for each transect and summarized by species. The transect average represents one datum.

Plant production was measured by clipping current annual production from a $\frac{1}{4}m^2$ quadrat. Five quadrats were randomly placed along the same 50m transect used for cover estimates. Grasses and forbs were clipped at ground level and the current annual twigs and leaves were clipped from shrubs. Production was not estimated for trees. Old plant material was removed from each sample which was segregated by species, oven dried and weighed to within 0.01 grams.

Plant densities were determined by counting the number of plants rooted within a quadrat. Woody plants density was measured using a 1 x 50m belt transect except on reclaimed sites where a 2 x 50m belt was used. The tape which was used to set up the 50m transect provided one side of the belt transect and a meter stick was used to determine if the woody plant was rooted within the quadrat. On the Barrow Area study plots, the Refuse Pile study plots, and the subsoil stockpile, herbaceous plant densities were estimated from $\frac{1}{4}m^2$ circular quadrats.

Plant vigor was recorded on shrub seedlings planted on the Barrow Area study plots and the Wildlife Mitigation Area study plots. Vigor was rated subjectively on a scale of 1 to 10 with 10 being the most vigorous. Consideration was given to the height, health and overall development of each individual plant. The vigor ratings presented in this report is an average for the particular species. The average was calculated by summing the numeric ratings given to each plant and dividing by the number of surviving plants for that species.

Percent plant survival was calculated by dividing the total number of seedings that were transplanted of a given species into the number of seedlings that were still alive.

On the Barrow Area study plots, site characteristics were recorded for each surviving transplanted shrub or tree. Site factors were micro relief, presence of herbivory, and presence of competing herbaceous vegetaion. Micro-relief is defined as being a depression which would accumulate surface water or a ridge which would not accumulate surface water. If soil moisture is a limiting factor for a particular species, transplanting them into depressions could influence the survival rate. The palatability of a species has been thought to affect the survival potential of that species due to herbivory by animals and insects. Removal of plant material by either animals or insects was recorded for each surviving plant. Likewise, competing herbaceous vegetation has the potential for reducing the survival and vigor of a transplanted shrub or tree. Transplants which had herbaceous vegetation growing within 10cm of a stem were recorded. An

average by species was calculated for each factor and expressed as the percent of the total surviving plants for that species.

Statistical analysis was performed on the effects of treatment on herbaceous seedling densities for the Barrow Area and the Refuse Pile study plots. An analysis of variance was used and the results subjected to a Duncan's Multiple-Range Test. All of the analysis was performed at the 0.05 level and run on Getty Oil Company's IBM computer network, SAS Institute, Statistical Analysis System.

1981 RECLAMATION SEEDING

Description

All of the reseeded areas shown on Plateau Mining Company 1983 Reclamation Map #1 and Plateau Mining Company 1983 Reclamation Map #2 were originally seeded and mulched with cereal grain straw in 1980. Portions of area was hydroseeded with 140 lbs/acre of tackifier in November of 1981 with the seed mixture shown in Table 1, 1980 Seed Mixture. After seeding, the area was hydromulched with 2,000 lbs/acre of Conwed. There were approximately 55.28 acres seeded in 1981. Data collected included cover, production, and woody plant density. Estimates are based on 12 transects plus an additional 24 clip plots for production.

Results

Reclamation monitoring results are presented in Table 3, Summary of Plant Cover On Reseeded Sites, Table 4, Summary of Production for Reseeded Sites, Table 5, Summary of Woody Plant Density on Reseeded Sites.

Cover on the 1981 reclamation averaged 15.67%. This compares with 45.6% total cover and 21.8% herbaceous cover, on the Mixed Sagebrush-Grass-Mountain Brush Community as presented in the Star Point Mines Mining and Reclamation Plan, Permit 006/007 Volume III, Appendix 9F, page 20. Cover on the 1982 reclamation was made up of approximately 38% grasses and 62% forbs. Sweetvetch represents the most dominant species with 42.55% of the overall relative composition. Wheatgrasses make up 23.9% and yellow sweetclover-alfalfa comprises 19.15%. The remaining 14.36% is attributed

TABLE 3

SUMMARY OF PLANT COVER ON RESEEDED SITES

SPECIES	PERCENT COVER	COMPOSITION
Grasses		
Desert Wheatgrass	0.67	04.26
*Wheatgrasses	2.92	18.62
Western Wheatgrass	0.08	00.53
Intermediate Wheatgrass	0.08	00.53
Bromegrass	1.33	08.51
Orchardgrass	0.75	04.79
Timothy	0.17	01.06
Forbs		
Sweetvetch	6.67	42.55
**Yellow Sweetclover/Alfalfa	3.00	19.15
TOTAL	15.67	100.00

*Wheatgrasses which could not be positively identified to species.

**Yellow sweetclover and alfalfa could not be identified to species due to lack of phenological development.

TABLE 4

SUMMARY OF PRODUCTION FOR RESEEDED SITES

SPECIES	GRAMS/M^2	COMPOSITION
Grasses		
Desert Wheatgrass	0.793	05.6
*Wheatgrasses	4.499	31.6
Western Wheatgrass	0.206	01.4
Bromegrass	1.662	11.7
Orchardgrass	0.110	00.8
Timothy	0.029	00.2
Forbs		
Sweetvetch	3.423	24.0
**Yellow Sweetclover/Alfalfa	3.515	24.7
Annual Forbs	0.008	00.6
TOTAL	14.245	100.0

.14245 K_g

= 5760 #/acre or

*Wheatgrasses which could not be positively identified to species.

**Yellow sweetclover and alfalfa could not be separated by species at present growth stage development that prevailed at sampling time.

TABLE 5

SUMMARY OF WOODY PLANT DENSITY ON RESEEDED SITES

SPECIES	NO./100M^2	COMPOSITION
Big Sagebrush	0.84	22.7
Fourwing Saltbrush	0.66	18.2
Rubber Rabbitbrush	1.50	40.9
Douglas Rabbitbrush	0.34	09.1
Snowberry	0.34	09.1
TOTAL	3.68	100.0

149/acre

to brome, orchardgrass, and timothy. Alfalfa and yellow sweetclover were combined in Table 1, Summary of Plant Cover on Reseeded Sites and Table 2, Summary of Production of Reseeded Sites because of the difficulty in separating them in the field at this time of year.

Plant production on the 1981 reseeded sites was 14.245 g/m^2 (127 lbs/acre). 51% of the production was produced by grasses and 49% by forbs. Of the grasses, approximately 39% of the production came from wheatgrasses, and 12% from brome. Sweetvetch and yellow sweetclover-alfalfa makeup almost 49% with the sweetvetch producing 24% and the yellow sweetclover-alfalfa producing 25%.

Additional production data were collected along the upper access road cut and fill. This data is not presented in a Table. The fill areas are dominated with mature, 1980 seeded vegetation. From the 24 clip plots on the fill material, it is estimated that it is producing 16.98 g/¼m^2 or 606 lbs/acre. There were 27 plots clipped on the cut side of the road which is predominately 1981 vintage plant material. It is producing 5.84 g/¼m^2 or 208 lbs/acre. Plots were not clipped by species and represents comparative differences in total production for cut and fill slopes. No cover or shurb density data were collected at these sites.

Woody plant density was 3.68/100m^2 on the 1981 reseeding. This converts to 150 stems per acre. Relative composition is madeup of 41% rubber rabbitbrush, 23% sagebrush, 18% fourwing saltbrush, 9% snowberry, and 9% green rabbitbrush.

Conclusions

Data collected on the 1981 reseeded sites represents two full growing season. Even though plant cover (15.67%) is less than on surrounding natural areas, as described above, it is expected to increase significantly as the stand matures over the next couple of years. Production estimates are likewise low in comparison, 127 to 208 lbs/acre on the 1981 seeding to 606 lbs/acre on the 1980 seeded fill slopes. The 1981 production is expected to increase as the stand matures. Woody plant density (150/acre)

is low, but still comprises a mean distance of one shrub every 17 feet. Since the species present have a strong tendency to propagate, it is expected tha woody plant density will continue to increase as the existing woody plants mature and become a seed source.

TOPSOIL AND SUBSOIL STOCKPILES

Description

Topsoil and subsoil stockpiles are located north of the refuse pile and loadout facility as shown on Plateau Mining Company 1983 Reclamation Map #2. These stockpiles store the topsoil material removed from the refuse pile expansion area as described in the May 29, 1982 Plateau Mining Company's request for a minor modification of the refuse pile expansion plan. Seedlings of the stockpiles was completed in the Fall of 1982 with the seed mixture described in Table 6, Topsoil Stockpile Seed Mixture. Seed was applied using a hydroseeding method at a rate of 42 lbs/acre in conjunction with 200 lbs/acre of 16-16-8 commercial fertilizer. Oats and barley was seeded at 20 lbs/acre to insure stabilization.

Monitoring was performed on July 14, 1983 and consisted of cover measurements on the topsoil stockpile and seedling density on the subsoil stockpile.

Results

Results are found on Table 7, Summary of Percent Plant Cover on Topsoil Stockpiles and Table 8, Summary of Seedling Density on the Subsoil Stockpile.

Cover on the topsoil stockpiles averaged 45.55%. Better than half, 56% was composed of annual species. Almost all of the annual forbs were Russian thistle with some mustards and pigweeds. Perennial grasses made up 38% of the cover.

TABLE 6
TOPSOIL STOCKPILE SEED MIXTURE

	PLS/ACRE
GRASSES	
Fairway Crested Wheatgrass	2
Smooth Brome (Southern Strains)	2
Intermediate Wheatgrass	2
Pubescent Wheatgrass	2
Bluestem Wheatgrass	2
Orchardgrass	2
Russian Wildrye	2
Sandburg Bluegrass	2
Subtotal	16
FORBS	
Alfalfa (Nomad)	2
Ladak - Equal Parts	2
Yellow Sweetclover	2
Subtotal	6
TOTAL PERENNIALS	22
COVER CROP	
Barley and Oats	20
OVERALL TOTAL	42

Seedling density was estimated on the subsoil stockpile as a more realistic measure of revegetation success because of the lack of plant development. Overall seedling density was $9.88/\frac{1}{4}m^2$. This is the equivalent to 3.67 per square foot. Perennial grasses represents 49%, perennial forbs 7%, and cereal grains, which were used as a cover crop/mulch, 44%. Perennial plant density is $5.52/\frac{1}{4}m^2$ or $2.05/ft.^2$.

TABLE 7

SUMMARY OF PERCENT PLANT COVER ON TOPSOIL STOCKPILES

SPECIES	PERCENT COVER	COMPOSITION
Grasses		
Desert Wheatgrass	01.78	03.90
*Wheatgrasses	01.67	03.66
Cheatgrass	06.44	14.15
Foxtail	07.44	16.34
		38.05
Forbs		
**Yellow Sweetclover/Alfalfa	00.89	02.00
Scarlet Globemallow	00.11	00.24
Annual Forb	25.44	55.85
Shrubs		
Fourwing Saltbrush	01.78	03.90
TOTAL	45.55	100.04

*Wheatgrasses which could not be positively identified to species.

**Yellow sweetclover and alfalfa could not be separated at time of sampling.

TABLE 8

SUMMARY OF SEEDLING DENSITY ON THE SUBSOIL STOCKPILE

SPECIES	NO./1/4M^2	NO./SQ. FOOT
Cereal Grains	4.36	1.62
Perennial Grasses	4.85	1.80
Perennial Forbs	0.67	0.25
TOTAL	9.88	3.67

Conclusion

Topsoil stockpiles were seeded and hydromulched in the Fall of 1982. After the first growing season, total cover (45.55%) is adequate to control erosion in as much as there were no erosion features observed. As observed in the past, the annual forbs which represent 56% of the cover will diminish as the perennial species mature and become established. The subsoil stockpile has an excellent density (2.05/ft.^{2}) of perennial plants.

Standards for successful seedling establishment on improved range have been established for the foothill ranges of Utah. Cook, Stoddart and Sims (Effects of Season, Spacing and Intensity of Seeding on the Development of Foothill Range Grass Stands, 1967, Utah Agricultural Experiment Station Bulletin 467), evaluated successful stand establishment after the third year as "satisfactory" if there were 0.25 plants per square foot, "good" if there were an average of 0.50 plants per square foot, and "excellent" if there were an average of 0.75 or more plants per square foot.

In the Northern Great Plains, where precipitation and site potential is considerably greater than that of the Plateau Mine area, a "good" grass stand is one with 1.0 plants or more per square foot, "fair" if there were 0.5 to 1.0 plants per square foot and "poor" if there was less than 0.5 plants per square foot (Great Plains Agricultural Council, 1966, A Stand Establishment Survey of Grass Plantings in the Great Plains, Nebraska Agricultural Experiment Station Report 23).

In view of these success ratings, it is concluded that a first year seedling establishment of 2.05 plants per square foot on the subsoil stockpile represents acceptable revegetation success.

BARROW AREA STUDY

Description

Site preparation began in 1980 on the Barrow Area Study plots as shown on Plateau Mining Company 1983 Reclamation Map 2. It was seeded with the

seed mixtures presented in Table 9, Low Grass Seed Mix and Table 10, High Grass Seed Mix and mulched with 3,000 lbs/acre of grass hay mulch in the fall of that year. Containerized shrub seedlings (tubelings) were transplanted in April 1981 and the first year's survival data were taken five months later in mid-September 1981.

A total of 48, 12 x 12 foot plots were established. A diagram of the plot layout is given in Figure 1, Planting Pattern for the Barrow Area. Plots were designed to test cultural treatments, seed mixtures, and shrub transplant densities. The purpose of the study was to evaluate reclamation practices at the Star Point Mine site. The study was implemented by Native Plants Incorporated of Salt Lake City, Utah. A copy of the first year results is given in Star Point Mines, Mining and Reclamation Plan, Permit No. 007/006, Volume III, Appendix 9I.

Cultural practices established on the plots were mulch and no mulch. Approximately 3,000 lbs/acre of grass hay mulch was applied immediately after seeding in October 1980. Mulch was spread by hand, but was not incorporated or tacked to ground.

Seeding treatments consisted two seed mixtures and a no seed treatment. Both mixtures were hand broadcasted at a rate of 30 PLS/acre and raked into the soil. One seed mixture, Table 9, Low Grass Seed Mix, contained 15% grasses and 85% forbs and shrubs. The other seed mixture, Table 10, High Grass Seed Mix, was composed of 85% grasses and 15% forbs with no shrubs.

Shrub transplants (tublings) were planted at two densities and a no tubling treatment. A high tubling density treatment contained nine plants per plot. This amounts to a density of 2,723 plants per acre or approximately one shrub every 3 feet. The low tubling density contained four shrubs per plot, a stocking rate of 1,210 stems per acre or a shrub every 6 feet.

TABLE 9

LOW GRASS SEED MIX USED ON THE EXPERIMENTAL TEST PLOTS

LOW GRASS/HIGH FORB AND SHRUB MIX	PERCENT OF MIX*
Russian Wildrye	2.5
Western Wheatgrass	2.5
Streambank Wheatgrass "Sodar"	2.5
Pubescent Wheatgrass	2.5
Mountain Brome	2.5
Indian Ricegrass	2.5
Northern Sweetvetch	12.0
Sainfoin	2.0
Big Sagebrush	8.0
Hoary Aster	3.0
Rubber Rabbitbrush	10.0
Rocky Mountain Penstemon	3.0
White Yarrow	2.0
Fourwing Saltbush	10.0
Shadscale	9.0
Gardner Saltbush	7.0
Prairie Sage	4.0
True Mountain Mahogany	3.0
Green Mormon Tea	3.0
Curlleaf Mtn. Mohogany	3.0
Utah Serviceberry	3.0
TOTAL	100.0%

*Percentages calculated on a dry weight basis

TABLE 10

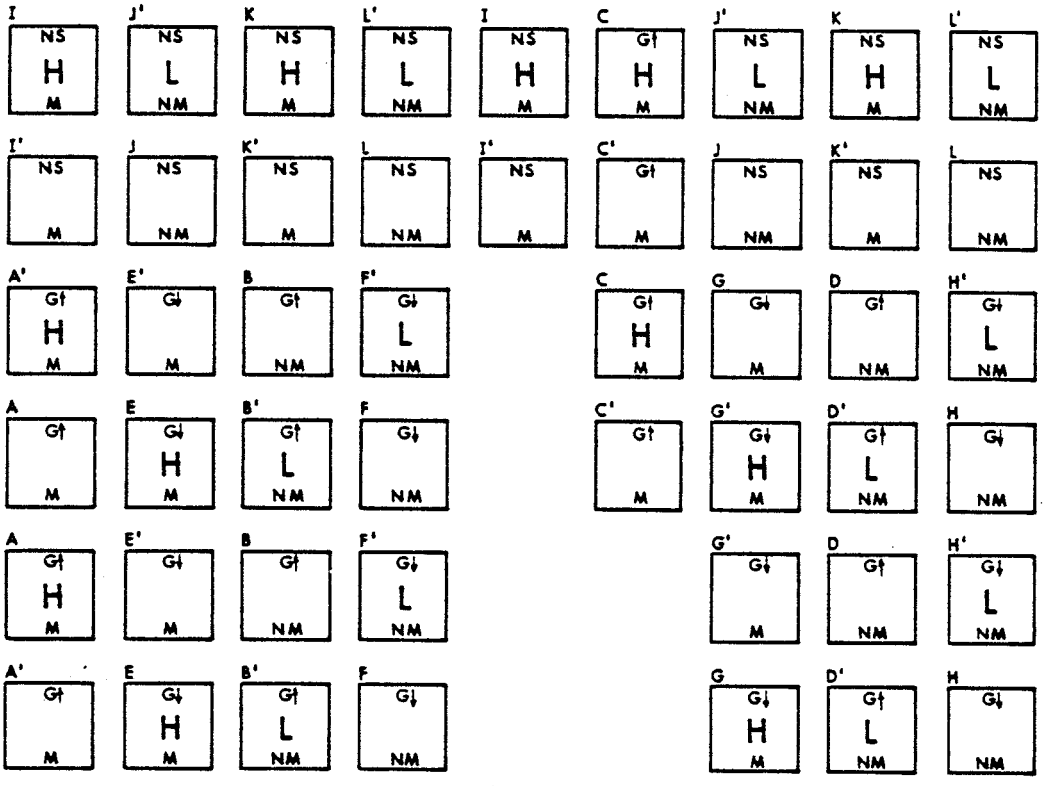
HIGH GRASS SEED MIX USED ON THE EXPERIMENTAL TEST PLOTS

HIGH GRASS/HIGH FORB AND SHRUB MIX	PERCENT OF MIX*
Western Wheatgrass	14
Indian Ricegrass	14
Pubescent Wheatgrass	14
Streambank Wheatgrass	14
Russian Wildrye	14
Mountain Brome	14
Northern Sweetvetch	4
Sainfoin	4
Alfalfa "Ranger"	4
Yellow Sweetclover	4
TOTAL	100%

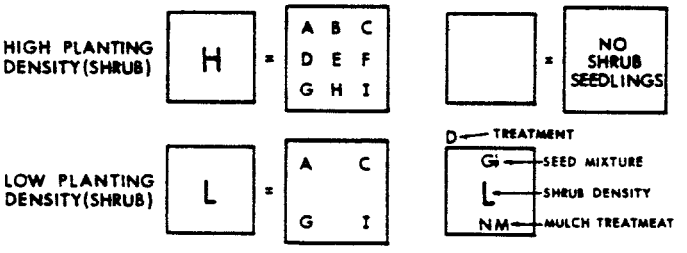
*Percentages calculated on a dry weight basis.

FIGURE 1

PLANTING PATTERN FOR THE BORROW AREA



TREATMENT KEY



A - Four-wing saltbush
B - Serviceberry
C - Rocky mtn. juniper
D - Gambels oak
E - Black sage
F - Siberian peavine
G - Rubber rabbitbrush
H - Curlleaf mtn. mahogany
I - True mtn. mahogany

G↑ = High grass seed mix
G↓ = Low grass seed mix
NS = No seed mix
M = Mulch
NM = No Mulch

The 1983 data presented in the following results section, were collected on July 13 and 14 and represents the third growing season.

Results

A summary of the results is given in Table 11, Comparison of 1983 and 1981 Shrub Survival, Barrow Area Plots, Table 12, Shrub Survival and Contributing Site Factors, Table 13, Perennial Seedling Density, Table 14, Comparison of the Relative Percent Seedling Composition to Mulched and Unmulched Plots, and Table 15, Comparison of Relative Percent Seedling Composition to Mulch and Seed Treatments.

Average shrub survival for 1983 is 54.5%. This compares to 78.8% in 1981. For this period of time, changes in survival ranged from no change for black sagebrush to a reduction of 53% for true mountain mahogany. Along with these data, an important field observation on fourwing saltbush was made. Fourwing saltbush survival declined from 96% in 1981 to 54.2% in 1981. Mortality apparently occurred from winter kill. Of those surviving in 1983, field notes indicate that the majority of them had severly suffered from the last winter. On almost all of the surviving plants, the above ground material had died and new growth was initiating from the root or the base of the stem. Apparently, the origin of the tublings was not adapted to the site. Dead material was about 30 cm high.

In general, none of the surviving shrubs had exceptional vigor. Favorable precipitation during the spring and early summer of this year had resulted in a flush of new growth, but the condition of the plants as indicated by the old growth and poor height reduced the overall vigor rating. Many of the plants had competing herbaceous vegetation within 10 cm of the stem and herbivory was the greatest on serviceberry and curlleaf mountain mahogany.

The results of the statistical analysis revealed that there was no significant differences in perennial plant density due to treatments of either the high and low seeding rate, mulch, or shrub (tubeling) density. There was, as might be expected, a significant difference between no seed

TABLE 11

COMPARISON OF 1983 AND 1981 SHRUB SURVIVAL

ON THE BARROW AREA PLOTS

(# PLANTED)

SPECIES	(%) 1983	(%) 1981	% CHANGE
Serviceberry	41.7	67.0	-38
Black Sagebrush	50.0	50.0	0
Fourwing Saltbush	54.2	96.0	-44
Peashrub	59.3	92.0	-36
Curleaf Mtn. Mahogany	59.3	83.0	-30
True Mtn. Mahogany	29.1	62.0	-53
Rubber Rabbitbrush	62.5	71.0	-12
Rocky Mtn. Juniper	83.3	100.0	-17
Gambel Oak	41.7	75.0	-44
TOTAL	54.5	78.8	-31

TABLE 12

SHRUB SURVIVAL AND CONTRIBUTING SITE FACTORS

ON THE BARROW AREA EXPERIMENTAL PLOT

SPECIES	(%) SURVIVAL	(1-10) VIGOR	(%) FLUSHING	(CM) HEIGHT	(%) HERB	(%) TOPO	(%) COMPT
Serviceberry	41.7	3.6	40	11.0	60	80	60
Black Sagebrush	50.0	4.1	56	13.2	11	56	33
Fourwing Saltbush	54.2	4.4	75	19.1	58	67	42
Peashrub	59.3	5.3	80	14.2	70	60	40
Curleaf Mtn. Mahogany	59.3	4.7	73	11.7	91	54	18
True Mtn. Mahogany	29.1	2.6	71	07.0	14	71	14
Rabbitbrush	62.5	4.8	63	16.3	13	56	31
Rocky Mtn. Juniper	83.3	3.8	15	11.6	5	45	40
Gambel Oak	41.7	5.0	0	13.8	40	80	60

NOTE:
VIGOR = Scale of 1 to 10 with 10 being the most vigorous
FLUSHING = Shrubs exhibiting a flush of active new growth
HERB = Shrubs exhibiting herbivory and/or insect damage
TOPO = Shrubs growing in a surface depression on a micro relief basis
COMPT = Shrubs with competing herbaceous vegetation within 10 cm of the stem

TABLE 13

PERENNIAL SEEDLING DENSITY ON THE BARROW STUDY PLOTS

TREATMENTS		DENSITY (#/M^2)
High Grass Mix	- Mulched	34.52
High Grass Mix	- Unmulched	32.80
Low Grass Mix	- Mulched	31.12
Low Grass Mix	- Unmulched	36.72
No Seeding	- Mulched	32.60
No Seeding	- Unmulched	18.60

TABLE 14

BARROW AREA STUDY PLOT

COMPARISON OF THE RELATIVE PERCENT SEEDLING COMPOSITION TO MULCHED AND UNMULCHED PLOTS

SEED MIXTURE	% OF MIX	MULCHED	UNMULCHED	AVERAGE
High Grass/Low Forb/No Shrub				
Grasses	84	79	61	70
Legumes	16	20	39	30
Shrubs	0	1	2	2
Non-seeded grasses*	(0)	(4)	(12)	--
Non-seeded shrubs*	(0)	(0.3)	(0.4)	--
Low Grass/Forb/High Shrub				
Grasses	15	71	73	72
Legumes	14	24	25	25
Shrubs	63	5	3	4
Other Forbs	5	0.3	0	0
Non-seeded Grasses*	(0)	(11)	(15)	--
Non-seeded Shrubs*	(0)	(0.6)	(0)	--
No Seed				
Grasses	0	86	82	84
Legumes	0	11	15	13
Shrubs	0	1	2	2
Non-seeded Grasses*	(0)	(10)	(5)	--
Non-seeded Shrubs*	(0)	(1)	(0.1)	--

*Non-seeded grass species are orchardgrass and timothy - both not available from either seed mixes or local seed producing plants - probable source is mulch material. Non-seeded shrubs are bitterbrush, oak, juniper, winterfat - probably local source.

TABLE 15

SEEDLING BARROW STUDY PLOTS COMPARISON OF

RELATIVE PERCENT COMPOSITION TO MULCH AND SEED TREATMENTS

	MULCHED			UNMULCHED		
	HS*	LS*	NS*	HS*	LS*	NS*
Grasses						
Wheatgrass	70	53	68	44	50	63
Bromes	5	8	8	3	8	15
Indian Ricegrass	.3	--	--	--	--	--
Orchardgrass	4	9	7	11	15	5
Timothy	--	2	3	1	.3	--
Unknown Grass	--	--	--	1	--	--
Forbs						
Alfalfa	5	10	11	12	13	14
Sweetvetch	15	13	1	27	12	1
Yarrow	--	.3	--	--	--	--
Shrubs						
Fourwing Saltbrush	.3	2	1	--	1	1
Fringe Sagebrush	--	--	.4	--	--	--
Sagebrush	1	.3	--	--	--	.1
Bitterbrush	--	.3	.4	--	--	--
Juniper	--	--	.4	.4	--	.1
Rabbitbush	--	2	--	1	1	1
Ephedra	--	.3	--	--	1	--
Winterfat	--	.3	--	--	--	--
Oak	.3	--	--	--	--	--

*HS - High grass/low forb/no shrub seed mix

*LS - Low grass/high forb/high shrub seed mix

*NS - No seed planted

treatment plots and those that were seeded. The information presented in Table 13, Perennial Seedling Density on the Barrow Study Plots, shows that the highest perennial plant density, occurred in the low grass, unmulched treatment (36.72/m^2). The lowest perennial plant density was the no seeding, unmulched treatment (18.6/m^2). In contrast, the no seeding, mulched treatment (32.6/m^2) had densities similar to the plots that were seeded. Where neither seed, nor mulch was applied, a significantly lower density resulted. However, it is important to note that the lowest density of 18.6 perennial plants per m^2 (75,274/acre or 1.73/$ft.^2$) represents acceptable densities on reclaimed mined land using the documentation provided on page 14 in the Results Topsoil and Subsoil section. In that reference, herbaceous plant densities that averaged 0.5 plants per square foot were considered "good", where those stands with densities of 0.75 and greater were considered "excellent". Table 14, Barrow Study Plots, Comparison of Seed Mixtures to the Relative Percent Composition, and Table 15, Comparison of Relative Percent Seedling Composition to Mulch and Seed Treatments contains a comparison of the seed mixtures to the relative percent composition, based on density, of the mulched and unmulched plots. Relative percent composition of mulched and unmulched plots and high, low and no seed mixtures shows close similarity in the distribution of grasses, legumes/forbs, and shrub density. Where no seed was applied to the plots, realtive percent composition was about 10% higher for grasses and 10% lower for legumes compared to seeded plots.

Conclusion

After three growing seasons, there were no significant affects on perennial plant densities due to the ratio of grasses to forbs and shrubs in the mixtures. Where grasses made up 85% of the seed mixture, grasses represented about 70% of the reseeded plant community. In plots where grasses made up only 15% of the seed mixture, grasses still represented about 72% of the reseeded plant community. Likewise, seed mixtures which contained shrubs resulted in only slightly higher shrub densities, 2% where no shrubs were seeded and 4% where shrub seeds made up 63% of the mixture. From this, it can be concluded that the seeding of high rates of shrub seeds does not result in an increase in initial shrub densities.

Mulching combined with the high grass seed mixture had a detrimental affect on legumes (49% decrease), whereas either mulching or no-mulching combined with the low grass seed mix, or the no-seed mix did not affect the legume establishment. However, the opposite effect was observed for the wheatgrass and brome. Mulch resulted in a 37% increase in the wheatgrass and a 40% increase in the bromes. Orchardgrass tended to become better established on unmulched plots. Dissemination of the orchardgrass and timothy, which were introduced to the study area in the mulch, to unmulched plots is explained by the fact that the mulch which was not tacked down was blown by the wind. This was indicated on page 13, Appendix 9I, Star Point Mines Mining and Reclamation Plan, Volume III, which states that the mulch was not incorporated or otherwise anchored and the low snow year allowed the mulch to be scattered.

Shrub establishment from seed was highest in the mulched plots which had been seeded with the high-shrub seed mixture and the only mixture that contained shrub seed. Five seeded shrub species were growing in these plots whereas only two species were found in the unmulched, high shrub seed mixture plots.

Overall transplanted shrub seedling survival after three growing seasons was good at 54.5%, a 31% decrease from the first year percent survival. Vigor was only fair even with a high flushing rate. In general, herbivory, micro-relief, and competing herbaceous vegetation does not appear to have had a high correlation with survival. The planting of shrub seedlings in small surface depressions benefited four of the nine species evaluated in this study. Five species did not appear to benefit from being planted in depressions. Herbivory by animals and insects is not a factor significantly affecting shrub survival while competing herbaceous vegetation appears to have only a slightly negative affect. Attempts should be made to place shrub transplants away from competing herbaceous vegetation. Of these three micro-site factors, topographic manipulation is the only factor that can be controlled to any meaningful extent in the reclamation process and this appears to be benificial only when planting serviceberry, gambel oak, true mountain mahogany, and fourwing saltbush.

Lasting effects of planting seedlings away from competition from herbaceous vegetation would be minimal. Once the shrub seeding has been planted, control of intruding vegetation would be impossible. This is especially true where seedlings are planted in small depressions.

REFUSE PILE TOPSOIL STUDY

Description

The study plots on the refuse pile were installed in the Fall of 1982 as stipulated by the Utah Division of Oil, Gas and Mining as part of the modification to the Refuse Pile Expansion Plan. Three topsoil treatments were applied to the coal refuse pile to determine the most successful method of reclaiming the refuse pile.

The location of the study plots is given on Plateau Mining Company 1983 Reclamation Map #2. In Figure 2, Refuse Pile Vegetation - Topsoil Test Plots, the physical layout of the treatment plots is shown. The treatments are as follows:

1. Soil material: subsoil, toposoil, topsoil over subsoil, and refuse material.

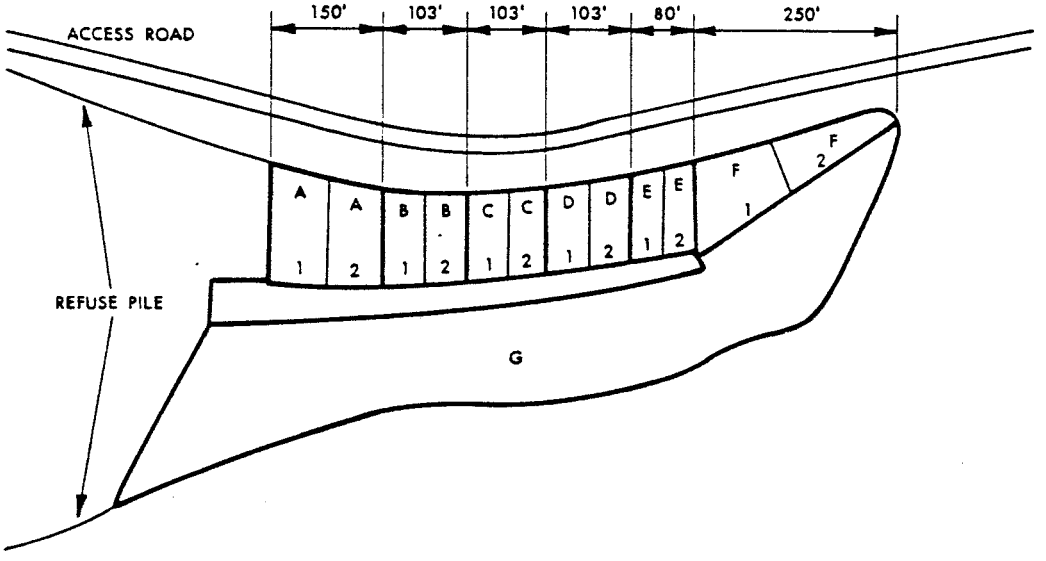
2. Soil depth: each soil material was applied at 10" and 20", and 10" of topsoil over 10" of subsoil.

3. Fertilization (16-16-8) at 100 lbs. per acre and 200 lbs. per acre.

The objective of the 1983 field sampling was to evaluate the influence of these treatments on germination and seedling establishment and to determine which one is the most favorable for successful reclamation of the refuse pile.

FIGURE 2

REFUSE PILE VEGETATION - TOPSOIL TEST PLOT LAYOUT



PLOT	TREATMENT KEY SOIL MATERIAL & DEPTH (INCHES)	(16-160-8) FERTILIZER LBS/ACRE	SEED MIX SPECIES	POUNDS PLS/ACRE
A1	Coal Waste	100	Slender Wheatgrass	3.0
A2	Coal Waste	200	Western Wheatgrass	3.0
B1	20" Subsoil	200	Tall Fescue	2.0
B2	20" Subsoil	100	G.B. Wildrye	3.0
C1	10" Topsoil/10" Subsoil	100	Blue Bunch Wheatgrass	3.0
C2	10" Topsoil/10" Subsoil	200	Scarlet Globemallow	0.5
D1	10" Subsoil	200	Penstemon	0.5
D2	10" Subsoil	100	Cicer Milkvetch	1.0
E1	20" Topsoil	100	Yellow Sweetclover	1.0
E2	20" Topsoil	200	Rubber Rabbitbrush	0.5
F1	10" Topsoil	200	Big Sagebrush	0.1
F2	10" Topsoil	100	Green Ephedra	2.0
G	10" Subsoil	100	4-wing Saltbrush	1.0
			TOTAL	20.6

Results

The results of the 1983 monitoring is given in Table 16, Summary of Perennial Seedling Density, Table 17, Summary of Annual Weed Density, and Table 18, 1983 Seedling Density. The highest perennial seedling density, 45.76/m^2, occurred on the 20" subsoil material which had received 200 lbs. of fertilizer per acre. The lowest perennial seedling density, 9.70/m^2, occurred on the 10" topsoil material which had received 100 lbs. of fertilizer per acre. On the raw refuse material plot, there were 7.68 perennial seedlings per square meter.

Statistically significant differences in perennial plant densities exist within treatment levels for soil material, soil depth, and fertilizer rate, but not between these treatments. Perennial plant densities attributed to topsoil and subsoil are 13.01/m^2 and 37.15/m^2; 10" and 20" depth of soil material are 21.66/m^2 and 28.50/m^2; 100 lbs/acre and 200 lbs./acre of fertilizer are 23.10/m^2 and 27.47/m^2 respectfully. Thus, density is significantly (2.9X) greater for subsoil than for topsoil and only 1.3X greater for 20" soil depth over 10" soil depth and 1.2X greater for 200 lbs/acre fertilizer rate as opposed to 100 lbs./acre.

Where 10" of topsoil was placed over 10" of subsoil, there were 21.47/m^2 with 100 lbs/acre of fertilizer and 26.84/m^2 with 200 lbs/acre of fertilizer. In contrast to all of the soil treatments, perennial plant densities on the coal waste plot was 7.68/m^2.

Conclusion

First year germination and seedling establishment results from the refuse pile topsoil study reveals a highly significant difference between topsoil and subsoil material and to a lesser degree, between soil depths. However, the long term affects of these treatments on reclamation success needs to be evaluated. Of special interest in this arid region is the affect of fertilizer. The ultimate recommendation will have to be based on the lasting effects of these treatments. It should be noted that even the density on the refuse material (7.68/m^2 or 0.71/$ft.^2$) could represent acceptable reclamation, based on the documentation presented on page 14 of

TABLE 16

SUMMARY OF PERENNIAL SEEDLING DENSITY,

REFUSE PILE STUDY, FIRST YEAR GERMINATION, 1983

PERENNIAL SEEDLING DENSITY (#/M^2)

	FERTILIZER TREATMENTS		
SOIL DEPTHS	"0" LBS/A	100 LBS/A	200 LBS/A
20" Subsoil	---	38.42	45.76
10" Subsoil	---	30.00	34.40
20" Topsoil	---	12.00	17.82
10" Topsoil	---	9.70	12.52
10" Topsoil/10" Subsoil	---	21.47	26.84
10" Topsoil (South Aspect)	---	27.00	---
Coal Waste	7.68	---	---
Average	7.68	23.10	27.47

TABLE 17

SUMMARY OF ANNUAL WEED DENSITY, REFUSE PILE STUDY,

FIRST YEAR GERMINATION, 1983

WEED DENSITY (#/M^2)

	FERTILIZER TREATMENTS		
SOIL DEPTHS	"0" LBS/A	100 LBS/A	200 LBS/A
20" Subsoil	---	7.16	9.88
10" Subsoil	---	8.04	7.52
20" Topsoil	---	13.96	17.28
10" Topsoil	---	18.44	17.64
10" Topsoil/10" Subsoil	---	9.84	6.20
10" Topsoil (South Aspect)	---	6.36	---
No Soil	10.64	---	---
Average	10.64	8.93	11.70

TABLE 18

1983 SEEDLING DENSITY REFUSE PILE STUDY

FIRST YEAR GERMINATION

	DENSITY (#/M2)				
	A	B2	B1	C2	C1
TREATMENT:	No Soil	20" Subsoil	20" Subsoil	10" Topsoil 10" Subsoil	10" Topsoil 10" Subsoil
FERTILIZER RATE:	"0" lbs/a	200 lbs/a	100 lbs/a	200 lbs/a	100 lbs/a
Perennial Plants					
Seeded Species					
Grasses					
Wheatgrass	06.04	40.08	26.04	20.88	13.60
Tall Fescue	01.00	00.96	09.24	01.60	04.16
SUBTOTAL	07.04	41.04	35.28	22.48	17.76
Forbs					
Cicer Milkvetch	00.16	00.52	01.68	01.12	01.60
Yellow Sweetclover	00.16	01.88	00.80	01.16	01.48
Scarlet Globemallow	00.00	00.00	00.00	00.00	00.00
SUBTOTAL	00.32	02.40	02.48	02.28	03.08
Shrubs					
Big Sagebrush	00.00	00.08	00.00	00.16	00.00
Fourwing Saltbush	00.16	01.24	00.36	01.16	00.28
Rabbitbrush	00.00	00.00	00.00	00.00	00.00
Green Ephedra	00.16	00.96	00.28	00.52	00.28
SUBTOTAL	00.32	02.28	00.64	01.84	00.56
TOTAL SEEDED	07.68	45.72	38.40	26.60	21.40
Volunteer	00.00	00.04	00.02	00.24	00.07
TOTAL PERENNIAL	07.68	45.76	38.42	26.84	21.47
Volunteer Annuals					
Grasses	00.00	01.16	00.08	00.80	00.88
Forbs	10.64	08.72	07.08	05.40	08.96
SUBTOTAL	10.64	09.88	07.16	06.20	09.84
OVERALL TOTAL:	18.32	55.64	45.58	33.04	31.31

TABLE 18
1983 SEEDLING DENSITY REFUSE PILE STUDY
FIRST YEAR GERMINATION
(Cont'd)

DENSITY (#/M^2)

TREATMENT:	D1 10" Subsoil	D2 10" Subsoil	E2 20" Topsoil	E1 20" Topsoil	F2 10" Topsoil
FERTILIZER RATE:	100 lbs/a	200 lbs/a	200 lbs/a	100 lbs/a	200 lbs/a
Perennial Plants					
Seeded Species					
Grasses					
Wheatgrass	20.96	28.80	13.96	07.84	09.68
Tall Fescue	05.76	00.52	00.08	01.88	00.28
SUBTOTAL	26.72	29.32	14.04	09.72	09.96
Forbs					
Cicer Milkvetch	01.24	00.80	00.44	00.72	00.52
Yellow Sweetclover	01.08	01.44	00.96	00.80	00.52
Scarlet Globemallow	00.00	00.08	00.00	00.00	00.00
SUBTOTAL	02.32	02.32	01.40	01.52	01.04
Shrubs					
Big Sagebrush	00.00	00.00	00.08	00.00	00.00
Fourwing Saltbush	00.16	01.76	01.16	00.72	00.64
Rabbitbrush	00.00	00.00	00.80	00.00	00.52
Green Ephedra	00.72	00.96	00.16	00.00	00.36
SUBTOTAL	00.88	02.72	02.20	00.72	01.52
TOTAL SEEDED	29.92	34.36	17.64	11.96	12.52
Volunteer	00.08	00.04	00.18	00.04	00.00
TOTAL PERENNIAL	30.00	34.40	17.82	12.00	12.52
Volunteer Annuals					
Grasses	03.04	00.96	09.44	06.68	10.56
Forbs	05.00	06.56	07.84	07.28	07.08
SUBTOTAL	08.04	07.52	17.28	13.96	17.64
OVERALL TOTAL:	38.04	41.92	35.10	25.96	30.16

TABLE 18

1983 SEEDLING DENSITY REFUSE PILE STUDY

FIRST YEAR GERMINATION

(Cont'd)

DENSITY (#/M^2)

not comparable w/ part 28 description

TREATMENT: FERTILIZER RATE:	F1 10" Topsoil 100 lbs/a	G (South Aspect) 10" Topsoil 100 ~~lbs/a~~	Average #/M^2
Perennial Plants			
Seeded Species			
Grasses			
Wheatgrass	05.44	21.92	17.94
Tall Fescue	01.76	02.48	02.48
SUBTOTAL	07.20	24.40	20.42
Forbs			
Cicer Milkvetch	01.16	00.12	00.84
Yellow Sweetclover	00.44	01.96	01.06
Scarlet Globemallow	00.00	00.00	00.01
SUBTOTAL	01.60	02.08	01.91
Shrubs			
Big Sagebrush	00.00	00.00	00.03
Fourwing Saltbush	00.88	00.20	00.73
Rabbitbrush	00.00	00.12	00.12
Green Ephedra	00.00	00.20	00.38
SUBTOTAL	00.88	00.52	01.26
TOTAL SEEDED	09.68	27.00	23.59
Volunteer	00.02	00.00	00.06
TOTAL PERENNIAL	09.70	27.00	23.65
Volunteer Annuals			
Grasses	09.96	00.12	03.64
Forbs	08.48	06.24	07.44
SUBTOTAL	18.44	06.36	11.08
OVERALL TOTAL:	28.14	33.36	34.73

the Topsoil and Subsoil section where reseeded grass stands with 0.75/ft.^{2} were given a rating of "excellent".

It may be concluded at this point, however, that the selective replacement of soil horizons did not have an advantage over subsoil alone and might indicate that a mixing of the horizons would not only be more economical, but provide near optimum revegetation potential.

OFFICE-ROAD-CUT STUDY PLOTS

Description

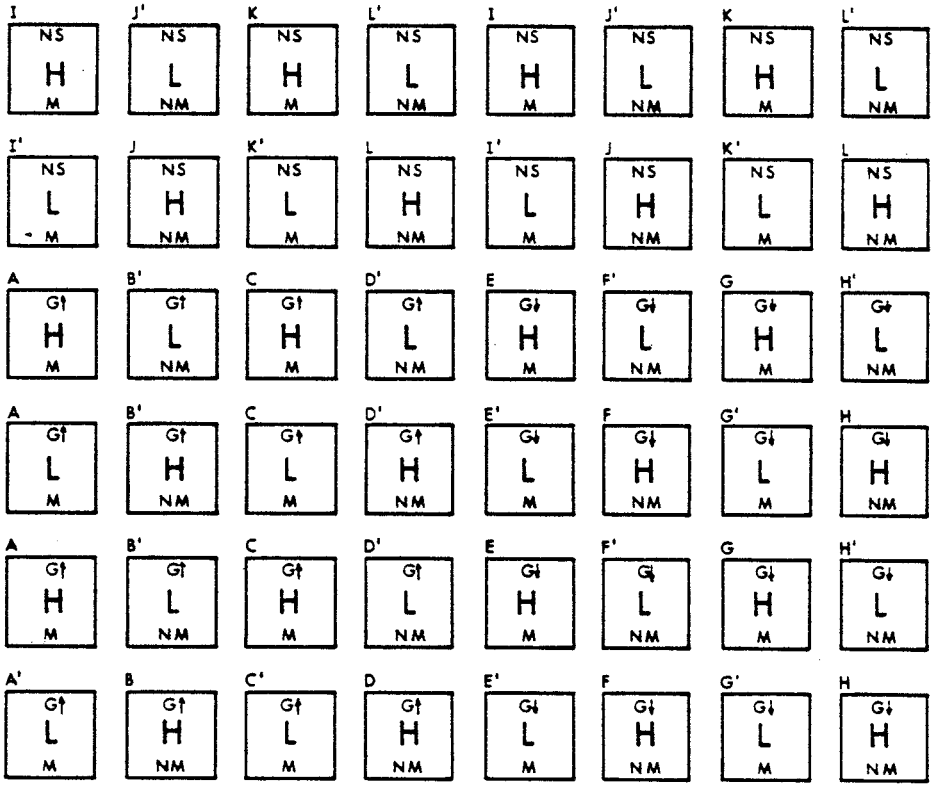
The study plots are located below the office and parking lot at the Lion Deck Portal area, as shown on Plateau Mining Company 1983 Reclamation Map 1. They are on a 70%, east southeast (30 degrees) facing slope. The plots were installed in October 1980. Seed mixtures, given in Table 9 and Table 10, were hand seeded at a rate of 30 pounds PLS/acre and raked into the soil. A grass hay mulch was applied at about 3,000 pounds per acre after seeding. Plots received mulch, and no-mulch treatments. Shrubs seedlings (tubelings) were planted at two rates; 9 tublings in the high density plots and 4 tublings in the low density. Plots are 12 x 12 feet square. A diagram of the plots and treatments is presented in Figure 3, Planting Pattern for the Office Road Cut.

All 48 plots, 24 plots with 9 per plot and 24 plots with 4 tubelings per plot, were planted with tubelings; each tubeling received an Agriform fertilizer pellet (10-20-10) placed in the hole with the tubeling. Tubelings were planted in April 1981 after seeding and mulching the previous Fall. The first year survival data were taken in mid-September, 1981. 1983 survival data were collected on July 7, after three growing seasons.

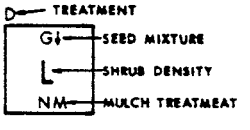
Shrub survival was the only parameter sampled in 1983.

FIGURE 3

PLANTING PATTERN FOR THE OFFICE ROAD CUT



TREATMENT KEY



Artemisia tridentata*
Quercus gambelii
Atriplex canescens*
Chrysothamnus nauseosus
Rhus trilobata
Amelanchier utahensis
Cercocarpus ledifolius*
Cercocarpus montanus
Juniperus scopulorum*

G↑ = High grass seed mix
G↓ = Low grass seed mix
NS = No seed mix
M = Mulch
NM = No Mulch

*Species used in low density plantings

Results

Percent shrub survival is presented in Table 19, Percent Shrub Survival on the Office Road Cut Study Plots. This table shows a comparison of 1983 and 1981 survival. In 1983, survival was 21% as compared to 59% in 1981. Of the nine species planted, only one, gambel oak, has completely died out. One plant of oak sumac, (one out of twenty-four) was still living. Big sagebrush had the highest survival at 46%.

Conclusion

After three growing seasons, the overall survival is low at 21%. Factors that might be affecting survival may be the course rock that makes up the surface of the fill material on which the plots are located. This effect could stem from a reduced water holding capacity of the soil surface in the tubeling root zone or from rodent damage due to the favorable habitat created for rodents by the large rocks. Big sagebrush, rubber rabbitbrush, mountain mahogany, and fourwing saltbrush represent relatively successfully species for transplanting on this site (elevation 8,500'). Those species that did poorly are gambles oak, oak sumac, serviceberry, and Rocky Mountain juniper.

ROAD SIDE MULCH STUDY PLOTS

Description

During mid-March 1982, the mulch study plots were installed on steep road cuts, shown on Plateau Mining Company 1983 Reclamation Map 1, which had not been successfully revegetated due to excessive sloughing. Fourteen plots were established, each with Terra Tack II tackifier at 140 lbs/acre, fertilizer (16-16-8) at 200 lbs/acre, and 22 lbs/acre of the seed mix presented in Table 20, Roadside Mulch Study Plot Seed Mixture.

TABLE 19

PERCENT SHRUB SURVIVAL ON THE OFFICE-ROAD CUT STUDY PLOT

SPECIES	(%) 1983	(%) 1981	% CHANGE
Big Sagebrush	46	77	-40
Gambel Oak	0	54	-100
Fourwing Saltbush	17	79	-78
Rubber Rabbitbrush	29	29	0
Oak Sumac	4	75	-95
Utah Serviceberry	8	29	-72
Curleaf Mountain Mahogany	10	67	-85
True Mountain Mahogany	21	71	-70
Rocky Mountain Juniper	8	35	-77
TOTAL	21	59	-64

TABLE 20
ROADSIDE MULCH STUDY PLOT SEED MIXTURE

		POUNDS PLS/ACRE
GRASSES		
1.	Fairway Crested Wheatgrass	2
2.	Smooth Brome (Southern Strains)	2
3.	Intermediate Wheatgrass	2
4.	Pubescent Wheatgrass	2
5.	Bluestem Wheatgrass	2
6.	Orchardgrass	2
7.	Russian Wildrye	2
8.	Sandbury Bluegrass	2
FORBS		
	Alfalfa (Nomad)	2
	Ladak - Equal Parts	2
	Yellow Sweetclover	2
	TOTAL	22
	Test plots 11, 12, 13, 14 have 10 lbs. of barley and 10 lbs. of rye	20
	TOTAL	42

Treatments for each plot are given in Table 21, Description of the Roadside Mulch Study Treatments.

The plots were first monitored July 1982. Because of sloughing, many of the plot identification stakes have been lost. Eight of the 14 plots could be identified in the field and were sampled July 13, 1983. In general, the upper portions of the plots have few plants due to soil movement down the steep slope. Sampling as done on the mid-portions of the plot. A total of ten $\frac{1}{4}m^2$ quadrats were read per plot.

TABLE 21
DESCRIPTION OF THE ROADSIDE MULCH STUDY TREATMENTS

Plot #1 -	Seed & Tack & Fertilizer - Jute mesh - over spray Conwed 2,000 mulch
*Plot #2 -	Seed & Tack & Fertilizer - Jute mesh
*Plot #3 -	Seed & Tack & Fertilizer - 1" over-cover straw
*Plot #4 -	Seed & Tack & Fertilizer - 1" over-cover straw held jute mesh
*Plot #5 -	Seed & Tack & Fertilizer - Nylon mesh
Plot #6 -	Seed & Tack & Fertilizer - Nylon mesh - over spray 2,000 lbs. Conwed - 2,000 mulch
*Plot #7 -	Seed & Tack & Fertilizer - Covered with cellulose blanket
*Plot #8 -	Seed & Tack & Fertilizer - Cellulose blanket - over spray 2,000 lbs/acre over spray Conwed 2,000 mulch
Plot #9 -	Seed & Tack & Fertilizer - 2,000#/acre - Conwed 2,000 mulch
*Plot #10 -	Seed & Tack & Fertilizer - No mulch/net treatment
*Plot #11 -	Seed & Tack & Fertilizer - 20 lbs. cover crop seed
*Plot #12 -	Seed & Tack & Fertilizer - 20 lbs. cover crop seed over spray 2,000 lbs. Conwed 2,000 mulch
Plot #13 -	Seed & Tack & Fertilizer - 20 lbs. cover crop seed - nylon mesh
Plot #14 -	Seed & Tack & Fertilizer - 20 lbs. cover crop seed - nylon mesh over spray 2,000 lbs/acre Conwed 2,000 mulch

*Sampled in 1983, the only plots with stakes that can still be located in the field.

The purpose of this study was to determine the most cost efficient method of stabilizing slopes prone to sloughing for a period adequate to reestablish vegetation. This objective is stated in a memo to Coal File, March 24, 1982, Plateau Mining Company, and signed by Lynn M Kunzler, Reclamation Biologist, Utah Division of Oil, Gas, and Mining.

Results

A summary of the Results are given in Table 22, Perennial Seedling Density - Treatment Cost Comparison. Perennial seedling densities are highest where no mulch or netting had been applied. In Plot No. 10 where only seed, tackifier, and fertilizer were applied, the seedling density was 4.422/ft.^{2}. This plot not only had the highest density, but it was also the lowest treatment cost per acre ($238/acres) and the lowest cost per surviving seedling ($0.001). The next highest densities are on the nylon mesh plot with 2.560/ft.^{2} and $0.057/seedling and the cereal cover crop with Conwed at 2.267/ft.^{2} and $0.010/seedling. The lowest densities were on the straw mulch plot which had 0.223/ft.^{2} at $0.073/seedling.

Conclusions

After two growing seasons, there appears to be some definite trends on the affect of mulch and netting material on the survival and establishment of perennial plants on steep road cuts. All treatments had a negative effect on seedling densities compared to Plot No. 10 which had received no mulch or netting. It had almost 2 times the number of seedlings over the next highest densities. The Plot #10 also had the lowest cost per acre and the lowest cost per surviving seedling (see Table 22). The application of Conwed did have a strong positive influence on the cereal cover crop treatment. The cereal cover crop with Conwed mulch had the fourth lowest cost per acre and the second highest seedling density.

Objectives of the study includes both the revegetation success and the economics of reclaiming the steep road cuts. In meeting these objectives and based on the 1983 data and application cost, it is recommended that no netting or mulch be used in reseeding steep slopes. Straw mulch alone had the lowest and most unacceptable seedling densities and is not recommended. From an economical standpoint, the use of the lowest cost netting (nylon) which had acceptable seedling densities (2.56/ft.^{2}) is 27 times more expensive than the no treatment plot (4.422/ft.^{2}), which had the highest seedling density. It is concluded that neither netting or mulch be used to revegetate steep road cuts.

TABLE 22

PERENNIAL SEEDLING DENSITY

TREATMENT COST COMPARISON, ROADSIDE MULCH STUDY

PLOT NO.	TREATMENT	($) COST/ACRE	(#/ft.^{2}) DENSITY	($) COST/SEEDLING
3	Straw	709	0.223	0.073
4	Jute/Straw	9,901	1.003	0.227
5	Nylon Mesh	6,358	2.560	0.057
7	Cello-Blanket	11,034	1.264	0.200
8	Cello-Blanket/Conwed*	11,824	1.747	0.155
10	No Treatment	238	4.422	0.001
11	Cereal Cover Crop	263	0.956	0.006
12	Cereal Cover Crop/Conwed	1,033	2.267	0.010

*Conwed = 2,000 lbs/acre Conwed Hydromulch over-spray

WILDLIFE MITIGATION AREA

Description

During the Fall of 1982, approximately 16 acres of the 40 acre wildlife mitigation area, shown on Plateau Mining Company 1983 Reclamation Map 2, was treated in an attempt to improve the site for deer winter range. The treatments consisted of (1) dozing pinyon and juniper trees that were enchroaching on a big sagebrush community; (2) crushing mature serviceberry shrubs to make new growth available for deer; (3) reseeding with the mixture given in Table 24, Wildlife Mitigation Area Seed Mixture and fertilizing at 200 lbs/a of 16-16-8; and (4) transplanting shrub seedlings into the scalps and other disturbed areas created by dozing and crushing the pinyon, juniper, and serviceberry trees. Shrub seedings were transplanted in April 1983 at an estimated density of 4,000/acres in the scalps and mechanically disturbed areas. The shrub species transplanted are given in Table 23, Shrubs Tranplanted on the Wildlife Mitigation Area.

On July 9 and 10, 1983 the treatment area and the adjacent control area were sampled. Parameters measured were plant cover, current annual plant production, and woody plant density. Percent shrub survival was taken on a test plot located within the treatment area. The test plot was established at the same time and using the same plant material used on the rest of the treatment area. Test shrubs were planted in a row with 3' distance separating each plant.

TABLE 23

SHRUBS TRANPLANTED ON THE WILDLIFE MITIGATION AREA.

SPECIES	NO. PLANTED	SOURCE
Fourwing saltbrush	500	Container
Bitterbrush	1,000	"
Serviceberry	700	"
Currant	300	"
Mormon Tea	500	"
True Mountain Mahogany	500	"

TABLE 24

WILDLIFE MITIGATION AREA SEED MIXTURE

	POUNDS LBS/ACRE
Pubescent Wheatgrass	1
Fairway Crested Wheatgrass	1
Russian Wildrye	3
Prostrat Kochia	1
Ladak Alfalfa	3
Pacific Aster	1
Yellow Sweet Clover	1
Blue Flax	1
Desert Globemallow	1
Small Burnet	1
Fourwing Saltbrush	2
	16

Mitigation work is in response to Stipulation 9-22-2 which concerns the deer winter range improvement to compensate disturbances associated with the refuse pile expansion and the unit train loadout.

Field sampling involved a total of 20 transects in the 16 acre treatment area and 20 in the 16 acre control area. Procedures are described in the Methods section.

Results

Results are summarized in Table 25, Summary of Plant Cover and Production, Wildlife Mitigation Treatment Area and Control Area; Table 26, Summary of Woody Plant Density, Wildlife Mitigation Area; and Table 27, Shrub Transplant Survival Test Plots, Wildlife Mitigation Area. Table 28, Plant Species Identified on or Adajacent to the Permit Area, contains the names of the plant species identified in the wildlife mitigation area as well as all of those identified in the other areas sampled in 1982 and 1983.

A review of Table 25 reveals that there is no difference in grass cover between the treatment and control areas, but there has been a significant increase in forb and shrub cover. By comparing relative percent cover composition between the treatment and control areas, it is evident that there has been a shift in composition in the treatment area. Grasses cover represents 34% and forbs 65% more of the cover on the treatment area than on the control. As may be expected from the impacts of the equipment used as well as the actual mechanical treatments on the treated area, the relative percent shrub cover on the treatment area is 38% less than the relative percent shrub cover on the control area. Increases in the relative forb composition on the treatment area is attributed to annual forbs and seeded forb species. Annual forbs would naturally increase as a result of openings in the natural plant community from surface disturbances. Non-seeded perennial forb cover remains about the same for both the treated and control areas.

TABLE 25

SUMMARY OF PLANT COVER AND PRODUCTION,

WILDLIFE MITIGATION TREATMENT AREA AND CONTROL AREA, 1983

	COVER (%)		PRODUCTION (g/m^2)	
SPECIES*	TREATMENT	CONTROL	TREATMENT	CONTROL
Grasses				
Wheatgrass	1.55	2.30	5.888	7.412
Desert Wheatgrass	0.40	0.05	0.432	0.000
Intermediate Wheatgrass	0.00	0.05	0.000	0.000
Blue Grama	5.00	3.95	4.600	3.028
Cheatgrass	0.35	0.10	0.268	0.004
Foxtail	0.00	0.35	0.000	0.000
Indian Ricegrass	0.00	0.45	0.080	1.208
Bluegrasses	0.00	0.00	0.016	0.000
Squirreltail	1.00	0.05	1.488	1.332
Needle & Thread	1.10	2.25	1.888	3.840
SUBTOTAL	9.40	9.55	14.660	16.788
Forbs				
Yarrow	0.00	0.00	0.008	0.000
Mtn. Dandelion	0.00	0.00	0.004	0.000
Locoweed	0.30	0.75	0.920	1.536
Segolily	0.00	0.00	0.000	0.040
Indian Paintbrush	0.00	0.10	0.000	0.080
Cryptantha	0.00	0.25	0.024	0.644
Fleabane	0.20	0.00	0.440	0.000
Buckwheat	0.05	0.00	0.000	0.240
Sweetvetch	0.15	0.00	0.040	0.180
Yellow Sweetclover	0.85	0.00	0.360	0.000
Plantain	0.00	0.00	0.020	0.000
Scarlet Globemallow	1.35	0.15	1.480	0.180
Annual Forb	2.10	1.20	4.948	1.600
SUBTOTAL	5.00	2.45	8.244	4.500

TABLE 25

SUMMARY OF PLANT COVER AND PRODUCTION,

WILDLIFE MITIGATION TREATMENT AREA AND CONTROL AREA, 1983

(Cont'd)

	COVER (%)		PRODUCTION (g/m^2)	
SPECIES*	TREATMENT	CONTROL	TREATMENT	CONTROL
Shrubs				
Serviceberry	0.30	0.60	0.046	0.184
Big Sagebrush	9.40	22.50	12.088	12.380
Fourwing Saltbrush	0.00	0.00	0.032	0.000
Winterfat	0.05	0.00	0.000	0.000
Rubber Rabbitbrush	0.00	0.00	0.062	0.000
Green Rabbitbrush	0.40	0.70	0.000	1.956
Juniper	0.00	0.15	0.000	0.000
Prickly Pear	0.05	0.15	0.000	0.000
Pinyon Pine	0.00	1.95	0.000	0.000
Currant	0.00	0.00	1.494	0.000
SUBTOTAL	10.20	25.90	13.722	14.520
TOTAL:	24.60	37.90	36.626	36.808

TABLE 26

SUMMARY OF WOODY PLANT DENSITY,

WILDLIFE MITIGATION TREATMENT AREA, 1983

SPECIES	TREATMENT	CONTROL
Serviceberry	0.030	0.061
Big Sagebrush	0.890	1.240
Winterfat	0.001	0.003
True Mtn. Mahogany	0.004	0.000
Rubber Rabbitbrush	0.001	0.000
Green Rabbitbrush	0.077	0.170
Juniper	0.000	0.001
Pinyon Pine	0.022	0.046
Bitterbrush	0.001	0.000
Currant	0.001	0.000
TOTAL	1.027	1.521

*Plant symbols are identified in Table 22

TABLE 27

SHRUB TRANSPLANT SURVIVAL TEST PLOTS,

WILDLIFE MITIGATION AREA

SPECIES	(1-10) VIGOR*	(cm) HEIGHT	PLANTED	PLANTED	% SURVIVAL
Fourwing Saltbush.	6	08.0	42	17	40.5
Bitterbrush	7	03.5	39	24	61.5
Serviceberry	3	04.0	52	12	23.1
Currant	8	17.9	41	30	73.2
Morman Tea	2	04.0	33	8	24.2
True Mtn. Mahogany	5	07.5	39	7	17.9

*Vigor values 1-10 with 10 being the most vigorous

**NOTE: Plants were transplanted April 26, 1983. Survival data was collected July 14, 1983.

TABLE 28
PLANT SPECIES IDENTIFIED ON OR ADJACENT TO THE PERMIT AREA

PLANT SYMBOL	SCIENTIFIC NAME	COMMON NAME
GRASSES		
Agsm	Agropyron smithii	western wheatgrass
Agtr	Agropyron trachycaulum	slender wheatgrass
Agin	Agropyron intermedium	intermediate wheatgrass
Agex	Agrostis exarata	red top
Avba	Avena barbata	wild oats
Bogr	Bouteloua gracilis	blue grama
Brma	Bromus marginatus	mountain brome
Brte	Bromus tectorum	cheat grass
Calam	Calamagrostis spp.	reed grass
Dagl	Dactylis glomerata	orchard grass
Elci	Elymus cinereus	basin wildrye
Elsa	Elymus salina	salina wildrye
Elgl	Elymus glaucus	blue wildrye
Hoju	Hordeum jubatum	foxtail
Hovu	Hordeum vulgare	barley
Kocr	Koeleria cristata	June grass
Orhy	Oryzopsis hymenoides	Indian ricegrass
Poa	Poa spp.	blue grass
Sihy	Sitanion hystrix	squirreltail
Stco	Stipa comata	needle and thread
GRASS LIKE		
Carex	Carex spp.	sedge
Scirp	Scirpus maritimus	bulrush
FORBS		
Acmi	Achillea millefolium	western yarrow
Anten	Antennaria spp.	pussy toes
Aggl	Agoseris glauca	mountain dandelion

TABLE 28
PLANT SPECIES IDENTIFIED ON OR ADJACENT TO THE PERMIT AREA
(Cont'd)

PLANT SYMBOL	SCIENTIFIC NAME	COMMON NAME
FORBS		
Arco	Arnica cordifolia	heartleaf arnica
Ascle	Asclepias spp.	milkweed
Astra	Astragalus spp.	locoweed
Asco	Astragalus convallarius	narrowleaf vetch
Canu	Calochortus nuttallii	segolily
Casti	Castilleja spp.	Indian paint brush
Ceras	Cerastium spp.	chickweed
Chdo	Chaenactis douglasii	false yarrow
Cirs	Cirsium spp.	thistle
Clco	Clematis columbiana	clematis
Coar	Convolvulus arvense	bindweed
Cora	Cordylanthus ramosus	bird's beak
Crse	Cryptantha sericea	cryptantha
Erum	Eriogonum umbellatum	buckwheat
Erige	Erigeron spp.	fleabane, daisy
Eriog	Eriogonum spp.	buckwheat
Erysi	Erysimum spp.	wallflower
Fraga	Fragaria spp.	strawberry
Galiu	Galium spp.	bedstraw
Grsq	Grindelia squarrosa	gumweed
Hafl	Hackelia floribunda	false forget-me-not
Hebo	Hedysarum boreale	sweetvetch
Heuch	Heuchera spp.	alum root
Hepa	Heuchera parvifolia	alum root
Ipag	Ipomopsis aggregata	scarlet gilia
Kosc	Kochia scoparia	summer cypress
Lala	Lathyrus lanzwertii	peavine
Lathy	Lathyrus spp.	peavine

TABLE 28
PLANT SPECIES IDENTIFIED ON OR ADJACENT TO
THE PERMIT AREA
(Cont'd)

PLANT SYMBOL	SCIENTIFIC NAME	COMMON NAME
FORBS		
Lygr	Lygodesmia grandiflora	skeleton weed
Meci	Mertensia ciliata	bluebells
Meof	Melilotus officinalis	sweet clover
Orfa	Orobanche fasciculata	broomrape
Osoc	Osmorhiza occidentalis	sweetanice
Oxytr	Oxytropis spp.	locoweed
Oxla	Oxytropis lambertii	locoweed
Penst	Penstemon spp.	penstemon
Peea	Penstemon eatonii	firecracker penstemon
Phace	Phacelia spp.	scorpion weed
Phid	Phacelia idahoensis	scorpion weed
Phau	Physaria australis	bladderpod
Plant	Plantago spp.	plantain
Saib	Salsola iberica	Russian thistle
Sedum	Sedum spp.	stonecrop
Sela	Sedum lanceolatum	stonecrop
Senec	Senecio spp.	oldman
Smst	Smilacina stellata	false soloman seal
Spco	Sphaeralcea coccinea	scarlet globemallow
Stpi	Stanleya pinnata	prince's plume
Taof	Taraxacum officinale	dandelion
Thfe	Thalictrum fendleri	meadow rue
Trdu	Tragopogon dubius	oster plant
Vicia	Vicia spp.	vetch
Viola	Viola spp.	violet

TABLE 28
PLANT SPECIES IDENTIFIED ON OR ADJACENT TO
THE PERMIT AREA
(Cont'd)

PLANT SYMBOL	SCIENTIFIC NAME	COMMON NAME
HALF-SHRUBS		
Arno	Artemisia nova	black sagebrush
Arfr	Artemisia frigida	fringe sagebrush
Atcu	Atriplex cuneata	mat saltbrush
Bere	Berberis repens	Oregon grape
Xasa	Xanthocephalum sarothrae (Gutierrezia sarothrae)	snake weed
Yucca	Yucca spp.	yucca
Yuha	Yucca harrimaniae	yucca
SHRUBS		
Amut	Amelanchier utahensis	service berry
Amal	Amelanchier alnifolia	service berry
Artr	Artemisia tridentata	sagebrush
Atco	Atriplex confertifolia	shadscale
Atcu	Atriplex cuneata	mat saltbush
Cela	Ceratoides lanata	winterfat
Chna	Chrysothamnus nauseosus	rubber rabbitbrush
Chvi	Chrysothamnus viscidiflorus	green rabbitbrush
Epvi	Ephedra viridis	green mormon tea
Eriog	Eriogonum spp.	buckwheat
Opunt	Opuntia spp.	prickly pear
Phmo	Physocarpus monogynus	nine bark
Putr	Purshia tridentata	bitterbrush
Rimo	Ribes montegeum	currant
Rowo	Rosa woodsii	wild rose
Sambu	Sambucus spp.	elderberry
Same	Sambucus melanocarpa	elderberry
Save	Sarcobatus vermiculatus	greasewood

TABLE 28
PLANT SPECIES IDENTIFIED ON OR ADJACENT TO
THE PERMIT AREA
(Cont'd)

PLANT SYMBOL	SCIENTIFIC NAME	COMMON NAME
SHRUBS		
Syor	Symphoricapos oreophilus	snowberry
Syal	Symphoricarpos albus	snowberry
Tape	Tamarix pentandra	tamarix
TREES		
Acgr	Acer grandidentatum	maple
Abla	Abies lasiocarpa	subalpine fir
Cele	Cercocarpus ledifolius	curlleaf mountain mahogany
Cemo	Cercocarpus montanus	true mountain mahogany
Jusc	Juniperus scopulorum	rocky mountain juniper
Juos	Juniperus osteosperma	Utah juniper
Pied	Pinus edulis	pinyon pine
Pofr	Populus fremontii	cottonwood
Potr	Populus tremuloides	aspen
Prvi	Prunus virginiana	chokecherry
TREES		
Psme	Pseudotsuga menziesii	Douglas fir
Quga	Quercus gambellii	gambel oak
Salix	Salix spp.	willow
Tape	Tamarix pentandra	tamarix

Grass and shrub production and cover values between the treatment and control areas remained unchanged while forb production was approximately 45% greater on the treated area. Annual forb production was 68% greater on the treatment area. Perennial forb production was about the same for both areas.

As presented in Table 26, Summary of Woody Plant Density, the control area has a shrub density of 1.521/m^2 (6,155/acre) while the treatment area contains 1.027/m^2 (4,156/acre). The overall difference is 0.494/m^2 or a reduction of 2,000 stems per acre on the treated area. The treatment area contains 0.35/m^2 (1,416/acre) fewer big sagebrush plants. There were also 0.093/m^2 (376/acre) fewer green rabbitbrush shrubs and 0.031/m^2 (125/acres) fewer serviceberry plants on the treatment area.

Overall shrubs seedling transplant survival is 39.8%. By species, currant seedling transplants maintained the highest survival (73.2%) followed by bitterbrush (61.5%). The lowest percent survival was for true mountain mahogany (17.9%). Vigor ratings were also higher for current and bitterbrush (8 and 9), but the lowest value (2) was for Mormon tea.

Conclusions

First year's treatment affect on the vegetation was compared to the adjacent control area. The current year's data indicates that grass cover and grass production is unchanged. Forb cover and production on the treatment area was about 2X that of the control. This increase on the treated area was due to annual forb growth. A treatment affect is seen in the average production per woody plant. The treatment area has a woody plant density of 0.49/m^2 (2,000/acre) less shrubs; however, production was the same as the control area. This is especially true for sagebrush where 0.35/m^2 (1,416/acre) fewer stems on the treated area produced the same amount of biomass as the control area. This difference might be attributed to the influence of the fertilizer on sagebrush production.

Based on the first year percent shrub survival on the Wildlife Mitigation Area test plot, there are probably about 1,620 live shrub transplants growing on the scalps and disturbed areas within the treatment area. Bitterbrush and currant transplants show the most promise, but conclusions should not be made until more long term data is available.

John Whitehead
ACT/007/006

PLATEAU MINING COMPANY

A Subsidiary of Cyprus Coal Company
P.O. Drawer PMC Price, Utah 84501
Telephone (801) 637-2875

March 27, 1986

RECEIVED
MAR 27 1986
DIVISION OF
OIL, GAS & MINING

Mr. Lowell Braxton
Division of Oil, Gas and Mining
355 West North Temple
3 Triad Center, Suite 350
Salt Lake City, Utah 84180-1203

Re: Annual Reports For 1985

Dear Mr. Braxton:

Enclosed you will find the reports and other information requested in your December 23, 1985 letter, with exception of 1985 hydrologic monitoring data.

As I discussed with you by phone on this date, we are having a problem getting our hydrology report out of our head office. All of the data has been entered into the Cyprus data base system, but we need additional time to refine the data and generate the report. A 45-day extension to submit this report will give us adequate time. We appreciate your verbal approval for this time extension.

The enclosed information consists of:

Precipitation Data	Raptor Report
Insurance Certificate	Vegetation Monitoring Data
Subsidence Report	1986 Mine Projection Map

As far as we can determine, we have satisfied all permit stipulations. If the Division is aware of any stipulations that are unresolved, please let us know; we are eager to finalize all stipulations.

Respectfully,

Ben Grimes
Environmental Coordinator

BG:sd

Enclosures

PLATEAU MINING COMPANY

1985 ANNUAL RECLAMATION REPORT

STAR POINT MINES

PREPARED BY:

Kent A. Crofts
P.O. Box 270
Yampa, CO 80483

INTRODUCTION

This report is submitted in accordance with the Plateau Mining Company (PMC) Mining and Reclamation Plan ACT/007/006 Special Stipulation #10(c) which requires that an annual revegetation monitoring report be submitted to the Division each year. This report contains field data collected in July and August 1985 on all revegetation areas of PMC. Reclaimed sites sampled included the 1980, 1981 and 1983 seedings. Revegetation research sites stipulated by UDOGM included the Barrow Area, Refuse Pile Research Plots, Office-Road-Cut and Wildlife Mitigation Area. Locations of each of these areas are contained on the enclosed Plateau Mining Company 1985 Reclamation Map 1 and Map 2. Each of these areas sampled are described in the following narrative along with a discussion of the current data in terms of the results, and conclusions presently available. Additional comparisons of revegetation trends are made between the 1983 and 1984 Annual Reclamation Reports previously submitted by PMC.

METHODS

The parameters measured on the sites sampled in this report included cover, current annual herbaceous plant production, plant densities on first year seedings, and plant survival for woody plant transplants. Not all parameters were measured on all sites, but at a minimum, cover was collected at each site. Specific measurements taken on each site are presented in the description section associated with each individual site. Methods of data collection and analysis are those recommended in the "Vegetation Information Guidelines" prepared in 1982 by UDOGM. Methods utilized on the Refuse Pile Test Plots were approved by the Division in an August 1, 1984 Memo to Coal File ACT 007/006. A copy of this letter was presented in Exhibit A of the 1984 Annual Reclamation Report.

COVER

Typical cover estimates were measured using a ten point frame spaced at regular five foot intervals along an outstretched tape. This technique was utilized on the topsoil stockpiles and Refuse Pile Test Plots. Along each transect, 100 observations were collected. At each data point, the observation was recorded by plant species, litter, rock or bare ground. Average cover per transect was used in all data analyses. To the extent

possible, all transects were placed in a random manner with respect to location and orientation.

On the steep slopes associated with the road cut and fill slopes a 20 x 50 centimeter quadrat was employed to measure cover. On these sites, percent cover was determined by averaging the values obtained from four 20 x 50 centimeter quadrats per 14.52 foot transect. Transect locations and orientation were randomly located on each site.

PRODUCTION

Typical production measurements were obtained by clipping at ground level all herbaceous plants rooted in three one-quarter square meter quadrats. Plant samples were clipped by life form, oven dried until free of moisture and weighed to the nearest 0.01 gram. A transect average of the three clipped plots was used for statistical analyses.

PLANT DENSITIES

Woody plant densities on the Refuse Test Plots were measured using a belt transect of 3 x 50 feet in length. On the Wildlife Mitigation Area belt transects of 1 x 50 meter were used. On all yearly reclamation seedings shrub densities were determined by taking an average of two 3 x 14.52 foot belt plots per transect.

SEED MIXTURES

The seed mixtures utilized in each planting are contained in the description to each reclaimed site, contained in the 1983 and 1984 Annual Reclamation Reports. Techniques used to reclaim areas in 1985 are explained in this report.

DESCRIPTION OF RECLAIMED SITES

As can be observed from the 1985 Reclamation Maps, a total of 153.51 acres of mining disturbance have been reclaimed. Of this total, the majorityof reclamation is associated with cuts and fills associated with roads and conveyors. The annual breakdown of reclamation by year is as follows:

Year	Acres Reclaimed
1980	58.37
1981	10.15
1982	56.82 (See page 4)
1983	10.07
1985	18.10
TOTAL	153.51

In addition to this acreage, another 12.74 acres were seeded on the Wildlife Mitigation Treatment Area. Counting this acreage, the total acreage revegetation at PMC equals 166.25 acres. It must be pointed out that PMC is contemporaneous in all of their reclamation, in that all areas not utilized for mining have been reclaimed.

RESULTS AND DISCUSSION

1980 Seedings

A total of 11 transects were taken to determine cover and shrub density. Ten transects were taken to calculate production. In the Fall of 1980, 58.37 acres of nontopsoiled cut and fill slopes were seeded. Fifth year cover of the seedings was found to average 15.16 percent (Table 1) total plant cover with 994 pounds per acre of air dry forage (Table 2). Woody plant density was of 364 stems per acre (Table 2). A comparison of cover, production and density by years is found below:

Year	% Cover	Production Lbs/Acre	Shrub Density Plants/Acre
1985	15.16	994	364
1984	12.13	1,236	183
1983	-	606	-

As can be seen from this comparison, cover and woody plant density increased from 1984 while production decreased. The reason for the decrease in production was due primarily to a decrease in alfalfa and yellow sweet clover. As can be observed on Table 2 of the 1984 Annual Reclamation Report, in 1984 these two species accounted for 34 percent of the composition, while in 1985 no sweet clover was sampled and alfalfa accounted for 0.7 percent of the composition.

1981 Seeding

A total of 22 transects were taken to calculate cover. Density was calculated based upon 20 transects and production was based upon 15 transects. In 1981, 56.82 acres of nontopsoiled cut and fill slopes were seeded. The fourth year performance yielded an average plant cover of 18.81 percent (Table 1) with an annual yield of 914 pounds per acre of air dry forage (Table 2). Shrub density was found to equal 160 stems per acre (Table 2). A comparison of cover, production and density by years is as follows:

Year	% Cover	Production Lbs/Acre	Shrub Density Plants/Acre
1985	18.81	914	160
1984	22.83	1,906	789
1983	15.67	127	150

As can be seen from this comparison, all vegetative parameters dropped from 1984. Once again, the explanation of this decrease is the decline of alfalfa and sweet clover from the seeded stand. Table 3 of the 1984 Annual Reclamation Report indicates that in 1984, these two species composed 51.1 percent of the seeded stand, while in 1985 these species comprised only 18.72 percent of the seeded stand.

1982 Seeding

Five transects were used to calculate production, cover and shrub density. In 1982, 10.15 acres of nontopsoiled cut and fill slopes were reseeded. The third year cover on these areas was found to equal 4.20 percent (Table 1) with an annual production of 913 pounds of air dry forage per acre (Table 2). Shrub density was found to equal 200 stems per acre. Since this type was combined with the 1983 seeding in previous years, a comparison by years is not possible.

1983 Seeding

Six transects were taken to calculate plant cover and seedling density. Second year cover of the 10.07 acres seed in 1983 was found to equal 4.71

percent (Table 1). Production and shrub densities were not collected on this site in 1985. In 1984, this area was not sampled.

1985 Seeding

Reclamation activities conducted in 1985 at PMC included the Phase I reclamation of the Star Point Mine No. 1 Portal Area which amounted to 10.10 acres being reclaimed. Reclamation at this site consisted of removing all structures, sealing the portals, covering the coal seam with soil and then spreading approximately 17 inches of topsoil on top. Following topsoiling, the seed mix was sprayed on with a hydromulch machine followed by 2000 pounds per acre of Conweb 2000 mulch and 120 pounds per acre of tackifier. Included in the mulch was 100 pounds per acre of 16-16-8 fertilizer.

The slope below the portal area was first cleaned of coal and debris with dozer tractors. Next, topsoil was spread on the slope. An attempt was made to cover the area with 10 to 17 inches of topsoil. Considering the steepness of the slope, the final depth varied, but the entire slope was covered. Seeding, mulching, and fertilizing were done in this area at the same application rates as was the portal area.

The two roads were reclaimed by pulling the sidecast original parent material back onto the road cut with a large trackmounted hoe. Seeding, mulching and fertilizing was done at the same application rates as above. The seed mix used is included as Attachment A to this writeup.

On the Unit Train Loadout Area, a total of 8.0 acres received final reclamation. Reclamation work at the Unit Train Project consisted of regrading the temporary construction roads and seeding and mulching those areas and all other disturbed areas associated with the Unit Train Project. The seed mixture used was the final approved list shown on Page 784-21 (Rev. 4/25/85) of the Unit Train Permit Application; a copy is included as Attachment B to this writeup.

The seed mix was sprayed on with a hydromulch machine followed by 2000 pounds per acre of Conweb mulch, 120 pounds per acre of tackifier and 100 pounds per acre of 16-16-8 fertilizer.

TOPSOIL AND SUBSOIL STOCKPILES

Third year total plant cover on the topsoil stockpile was found to equal 57.67 percent (Table 3), while production was found to equal 1,364 pounds of air dry forage per acre (Table 3). Shrub density was found to equal 333 stems per acre. A comparison by years are as follows:

Year	% Cover	Production Lbs/Acre	Shrub Density Plants/Acre
1985	57.67	1,364	333
1984	54.40	1,688	-
1983	45.55	-	-

As can be seen on Table 3 on the subsoil stockpiles, total plant cover in 1985 was found to equal 26.50 percent with production equal to 794 pounds of air dry forage per acre. A comparison by years reveals the following:

Year	% Cover	Production Lbs/Acre	Shrub Density Plants/Acre
1985	26.50	794	-
1984	34.45	495	-

A statistical comparison of the topsoil and subsoil stockpiles is contained in Table 4. Total production and total plant cover were significantly higher on the topsoil stockpile. However, perennial production and cover were significantly higher on the subsoil stockpiles. Since the regulatory requirement is to restore a "permanent" plant cover, one must conclude that this requirement appears to be best satisfied from the subsoil plant growth medium. Evidence appears to indicate the volunteer growth of annual weed seeds in the topsoil stockpile has a deleterious effect on the growth of perennial vegetation. A comparison of Table 5 in the 1984 Annual Reclamation Report reveal that the composition based upon cover of annuals on the topsoil and subsoil stockpiles accounted for 67.28% and 0.78% respectively. In 1985, the composition of annual species as determined from Table 3 amounted to 92.48% for the topsoil

and 0.17% for the subsoil. A trend appears to exist which suggests that annual species are becoming more dominant on the topsoil and less dominant on the subsoil stockpiles.

WILDLIFE MITIGATION AREA

Ten transects on cover, production and shrub density were taken on both the treated and control areas. Plant cover on the treated section of the wildlife mitigation area was found to respond positively to treatment. Table 5 indicates that perennial grass and forb cover have increased, while shrub cover has decreased. The species richness of the treated area is also higher than that of the control area. Shrub densities on the treated area have been reduced (Table 6). However, most importantly, no net loss in productivity has occurred which indicates that the fewer shrubs on the treated area are more productive than those on the control area. Perennial forb production on the treated areas has also increased.

A two tailed t-test comparison of the treated and control areas (Table 7) reveals that total forage production, perennial and annual forb production all increased due to treatment. Shrub density was significantly reduced, but overall shrub production remained unchanged.

Upon comparison of Table 6, in the 1984 Annual Reclamation Report with the 1985 data in Tables 5 and 6, relative cover, composition and productivity changed little between 1984 and 1985.

BARROW AND OFFICE ROAD CUT SHRUB TRANSPLANTS

These transplants were planted in April 1981. A complete description of the plot design is presented in the 1983 Annual Reclamation Report.

Results from the 1985 monitoring effort are presented in Table 8. Average shrub survival on the Office Road Cut Site was found to equal 19.2 percent as compared to 40.3 percent on the Barrow Area. These values compared to Tables 9 and 10 of the 1984 Annual Reclamation Report indicate that survival on the Office Road Cut appears to have stabilized as survival for 1984 and 1985 was unchanged. On the Barrow Area survival declined from 44.9 percent to 40.3 percent. At this site all of the Black sagebrush

died between 1984 and 1985 and nearly half of the Fourwing saltbrush plants alive in 1984 were dead in 1985. A slight decline (from 70.8 to 58.3 percent) in Rocky Mountain juniper survival was also noted. Survival of serviceberry and both mountain mahogany species appeared to increase, probably from root sprouts.

REFUSE PILE TEST PLOTS

As was pointed out in the 1984 Annual Reclamation Report, portions of some plots were disturbed in the construction activities associated with the Unit Train Loadout Conveyor. Figure 1 shows the original plot diagram including areas which were disturbed during the 1985 construction activities. As can be observed on Figure 1, all of Plot C_1 was disturbed and a large portion of Plot B_2. Plots B_1 and C_2 had only minor disturbance. This actual disturbance was significantly less than what was estimated in the August 1, 1984 UDOGM "Memo to Coal File", wherein it was believed that about half of Plots B_1 and C_2 were going to be destroyed. Instead of four plots initially proposed for disturbance, only three were affected and of those three, data was collected from two plots. Actually, only Plot C_1 was lost as a data point.

Analysis of the vegetation data collected from the Refuse Pile Test Plots in 1985 followed the recommended data comparisons specified in the UDOGM letter of April 18, 1984 regarding statistical analysis.

As described in the 1983 and 1984 Annual Reclamation Reports, the Refuse Pile Test Plots were established to:

1. Test the effectiveness of four plant growth mediums: topsoil, subsoil, coal refuse and topsoil over subsoil;

2. Compare the effects of varying soil depths: 10 inches topsoil, 20 inches topsoil, 10 inches subsoil, 20 inches subsoil and 10 inches topsoil over 10 inches subsoil; and

3. Determine the effects of difference of fertility applied at rates of 100 and 200 pounds per acre.

In 1984, the UDOGM suggested that each plot be subdivided into segments which correspond to the upper, middle and lower thirds of the slope. Statistical techniques utilized to analyze the data involved a two tailed t-test as specified in the UDOGM letter of April 18, 1985. Analysis of Variance and the Duncan's Multiple Range Tests were not utilized in 1985, due to the loss of the Getty Oil Company Computer System when Texaco sold Plateau Mining Company to Cyprus Minerals Company.

SOIL MATERIALS

A comparison of the productivity cover and shrub density of topsoil, subsoil, topsoil over subsoil and coal refuse are presented in Table 9. Highest total, and perennial production were associated with subsoil. Annual productivity was highest on coal refuse and topsoil, lowest on subsoil followed by topsoil over subsoil. Total and annual cover were highest on topsoil, while perennial cover was highest on topsoil over subsoil and subsoil. Shrub densities were highest on subsoil.

Statistically, the lowest production, cover and shrub density were associated with the coal refuse and all topsoiling treatments were superior to this control. A t-test comparison at topsoil and subsoil (Table 10) reveals that subsoil is superior to topsoil in terms of total and perennial production, and perennial cover. Shrub density was highest on subsoil, but not significantly. A comparison of topsoil over subsoil against subsoil (Table 11) reveals the two plant growth mediums to be equal for all parameters except annual production and total plant cover which were highest on topsoil over subsoil; the basis for this increase being the annual volunteer weed growth associated with the topsoil. It is Plateau's opinion that in terms of "permanent, effective and diverse" the subsoil stand comes closest to meeting the requirements of the revegetation success standards.

The inferiority of the respread topsoil on the Refuse Test Plots with respect to annual weed growth is consistent with trends from the topsoil and subsoil stockpiles. On the topsoil stockpiles, 92.48 percent of the total cover and 83.83 percent of the total production was composed

of annuals. On respread topsoil, these figures were 58.57 percent and 23.82 percent respectively. On respread subsoil, annuals accounted for 6.13 percent of the total cover and 1.42 percent of the total production, while on the subsoil stockpile, annuals accounted for 0.63 percent and 0 percent respectively.

In order to determine whether or not similar trends existed on the Refuse Test Plots, the data collected in 1983, 1984 and 1985 were examined to determine whether or not the composition of annual species correlated with the amount and thickness of topsoil. The 1983 data are taken from Table 18 of the 1983 Annual Reclamation Report, the 1984 data are taken from Table 12 of the 1984 Annual Reclamation Report. The trends of annual species composition are summarized below:

YEAR	A PLOTS REFUSE	B PLOTS 20" SUB	C_1 PLOTS 10" T/10" S	D PLOTS 10" SUB	E PLOTS 20" TOP	F PLOTS 10" TOP
1983	58.1	16.7	31.4	19.5	51.5	62.0
1984	67.3	14.8	37.7	30.6	61.5	69.0
1985	75.4	3.2	8.8	9.7	47.8	71.9

This comparison indicates that the trend toward the dominance of annual species on the straight topsoil (Plots E and F) and coal refuse (A Plots) are somewhat alarming and inconsistent with regulatory standards. From this comparison, it can be concluded that a trend toward the continued dominance of annual species on topsoiled plots is evident. Composition of annual species on the F plots which received 10 inches of topsoil is increasing, while on the E plots the 20 inch topsoil (which undoubtedly involves more mixing of the seed containing topsoil zone) is unusually high. The C_1 plot which contains 10 inches of topsoil over 10 inches of subsoil has an annual species composition significantly lower than the straight topsoiled plots. Since a 10 inch layer of topsoil was applied to the C_1 and F plots and since the other characteristics of the C_1 plot are so much like the 10 inch subsoil plots, one can only conclude that the topsoil and subsoil zones underwent mixing during application. The decrease in annual composition between the 10 and 20 inch tends to support

the belief that the amount of annual weed growth is directly correlated with the amount and thickness of the seed bearing zone in the respread topsoil. Conversely, it appears that the establishment of desired perennials is inversely correlated with the amount and thickness of respread topsoil.

Given the difficulties in reseeding dominant cheatgrass and broadleaf annual weed stands that are well documented in the scientific literature, it appears that the plant medium most suitable to establish perennials is subsoil followed by topsoil over subsoil, followed by respread topsoil.

FERTILIZER

The effects of different fertilizer levels (100# versus 200#) for coal refuse (A Plots, Table 12), for ten inches of subsoil (D Plots, Table 13), for twenty inches of subsoil (B Plots, Table 14), on ten inches of topsoil (F Plots, Table 15), on twenty inches of topsoil (E Plots, Table 16), were analyzed using a two tailed t-test. Table 12 indicates that fertilizer had no measurable effect on cover, production or shrub density. In 1984, significant increases in total production and cover were reported at the two hundred pounds per acre application rate. In 1985 it was found that on ten inches of subsoil (D Plots, Table 13), the higher rate of fertilizer produced significantly higher perennial production. This same trend was documented in 1984; however, last year significant increases were also reported for perennial and total production, as well as annual and total cover.

Plant data collected in 1985 on twenty inches of subsoil (B Plots, Table 14), indicate that fertilizer did not have an impact on any measured vegetative parameters. This contrasted with 1984 data showing decreased annual production, total perennial and annual cover at the two hundred pound application rate.

Fertilizer was found to produce significant differences in annual production in 1985 on ten inches of topsoil (F Plots, Table 15). Significantly more annual weeds grew on the lower rate. This contrasted with the 1984 data which produced no measurable response to fertility.

On twenty inches of respread topsoil (E Plots, Table 16), the higher fertilizer rate was found to significantly increase annual production, annual cover and total cover. Similar trends were reported in 1984.

Upon combining all topsoil plots, fertilizer was found to produce significant differences in annual production, annual cover and total production (Table 17). On the subsoil plots (Table 18), the fertilizer rate was negatively correlated with shrub density, annual cover and annual production. Perennial production was significantly higher on the two hundred pound application rate.

SOIL DEPTH INTERACTION

The 1985 topsoil and subsoil data were evaluated to see if depths of reapplied plant growth material affected plant growth. For straight topsoiled plots (Table 19), it was discovered that perennial production and perennial cover significantly increased as topsoil depth increased. Annual production and annual cover significantly decreased as topsoil depth increased.

On the subsoiled plots (Table 20), it was found that total production, perennial production, annual production, total cover, annual cover and shrub density were all negatively correlated with subsoil depth. For all these parameters, increasing depth produced significantly lower values.

CONVEYOR EDGE EFFECT

When Plateau originally discussed the possibility of sampling the undisturbed portions of Plots C_2, B_1 and B_2, UDOGM expressed concern that the conveyor cut might produce an edge effect wherein vegetation near the cut might be adversely affected. In order to quantify whether or not the cut had produced an edge effect, the following special sampling program was implemented. On each side of the cut, a transect was run parallel to the crown of the cut and was located five feet in from the cut. Since the transect covered three feet on each side of the tape sampling, it was separated from the cut by a two foot buffer zone. The center line of the nearest transect was centered five feet away from the

cut and a second transect (away) was centered twelve feet away from the edge of the cut.

The results of this edge effect sampling program are summarized in Table 21. As can be observed from this table, no measurable impact on production, cover or shrub density could be detected as the transects moved away from the cut. The conclusions to be drawn from this study are that there is no evidence of edge effect and the remaining B_2 and C_2 plots can be sampled to quantify plant response.

ASPECT

Since Plots D_2 and G received identical treatments of ten inches of subsoil with one hundred pounds of fertilizer, a comparison of these two plots was made to determine the influence of aspect on plant growth. Table 22 which contains this comparison, reveals that aspect was found to significantly affect plant growth. Total cover, perennial cover, and shrub density were all favored on the northern aspect. The southern exposure favored total production, perennial production and annual production.

SLOPE

In order to increase sample size, UDOGM recommended that each plot be divided into three subplots corresponding to upper, middle and lower slopes respectively. Since nine transects were to go into each subplot, each slope segment would need to be 54 feet long. Since the length of the plots decreases to the east, it is not possible to place three slope subplots in each plot. The statistical comparison that follows compares only those plots large enough to produce three complete slope subplots. The plots included in this analysis are: A_1, A_2, B_1, C_2, D_1 and D_2.

Total cover on the upper slope was found to equal 15.48 percent, middle slope cover was 17.44 percent and the lower slope cover was 16.61 percent. A t-test comparison of the high and low values produced a t-value of 0.537, which leads us to conclude that slope has no measurable impact on total cover. Total production on the same plots yield an average of 7.260 (grams/$\frac{1}{4}m^2$) for the upper slope, 8.907 (grams/$\frac{1}{4}m^2$) for the middle

slope and 8.802 (grams/¼m^2) for the lower slope. A t-test comparison of the high and low values produced a t-value of 0.918, which leads us to conclude that slope has no measurable impact on total production. Shrub density was also unaffected by slope. Density in stems per 150 $ft.^2$ was found to be 1.804 for the upper slope, 2.567 for the middle slope and 2.901 for the lower slope. A t-test comparison of the high and low values yielded a t-value of 0.824, which leads us to conclude that no significant differences exist in shrub density according to slope.

CONCLUSIONS

Data collected in 1985 from reclamation seedings ranging in age from recently seeded to five years in age remain consistent and somewhat predictable patterns regarding revegetation patterns at Plateau appear evident. Large scale seedings made in 1980, 1981, 1982 and 1983 appear to be well established and are approaching cover and production of undisturbed sites. Using the control area of the Wildlife Mitigation Area as a general comparison, we find that total plant cover is 35.45 percent, of which 16.79 percent is comprised of herbaceous vegetation (Table 5). Table 1 indicates that although total plant cover is substantially lower (1980 Seeding = 15.16 percent and the 1981 Seeding = 18.81 percent) all of this component is comprised of herbaceous vegetation. Plateau believes that this pattern suggests continued optimism regarding revegetation effects on nontopsoiled cut and fill slopes at the Star Point Mines.

Production on the reclaimed cut and fill slopes (Table 2) was found to be over 913 pounds of air dry forage per acre on three year old seedings, 914 pounds per acre on four year old seedings and 994 pounds per acre on five year old seedings. This compares with an undisturbed total production value of 439 pounds of air dry forage on the wildlife mitigation control area. Using this comparison, the productivity of the reclaimed areas at Plateau is very encouraging.

Upon comparing the topsoiled reclaimed areas at the topsoil and subsoil stockpiles and refuse test plots, which were both seeded in 1982, with the larger scale nontopsoiled seedings, we can see that topsoiling does

have an affect on stand establishment. Table 11 indicates that the average total production from topsoiled and subsoiled plots on the refuse test plots is 358 pounds of air dry forage per acre. Comparing this value with the production values in Table 2, we can readily conclude that all general seedings, whose production ranges from 913 to 994 pounds per acre, compare favorably with those on more favorable sites. In fact, these values compare favorable with the average total production of 1,079 pounds per acre of the topsoil and subsoil stockpiles (Table 3) and exceed the average total production of 358 pounds per acre for the respread topsoil and subsoil plots (Table 9).

Cover comparisons of the large scale seedings (Table 1), with those of the more traditional reclamation techniques involving topsoiling (Tables 3 and 10) indicate that total cover on topsoiled sites is higher than that found on nontopsoiled sites. Production on almost all large scale seedings exceed that of the topsoiled sites. An apparent explanation for this dichotomy might well be that establishment on steeper nontopsoiled slopes is more difficult, but once the plants are established they are more productive than those growing on more uniform sites.

A comparison of various topsoiling combinations leads Plateau to conclude that there is an inherent potential danger of aggressive annual weeds dominating respread topsoil. Evidence tends to indicate that this problem is directly associated with the seed bearing zone in the topsoil. Volunteer weed growth was inversely related to the depth of respread topsoil as well as the amount of mixing of topsoil with subsoil that occurs in combined topsoil and subsoil plots. Perennial plants were significantly more abundant on plant growth mediums containing lesser amounts of topsoil.

Fertilizer was found to have pronounced effects on plant growth on the refuse test plots. On topsoiled plots increased fertilizer rates significantly increased the amount of annual weed growth. On subsoiled plots, the higher fertilizer rate appeared to stimulate perennial plant growth at the expense of the annuals.

Slope position appeared to have no consistent affect on plant growth. In 1985, no response to slope could be found in terms of total production, total cover or woody plant density. In Table 11 of the 1984 Annual Reclamation Report, slope was reported to affect the production of perennial forbs on topsoiled plots only. (The 1985 data comparison included all reclaimed sites at the Refuse Test Plots and not simply the topsoiled plots, since a significant acreage of nontopsoiled disturbances have been reclaimed and not all disturbance will be topsoiled.) Plateau believes that the 1985 data comparison is more representative of future reclamation conditions and therefore, is a more accurate comparison.

RECOMMENDATIONS

Plateau believes that this report adequately addresses the requirement to monitor the general reclamation and test plots at the Star Point Mines. PMC also believes that adequate documentation exists to suggest that the third year monitoring data from the refuse test plots demonstrate that sufficient similarity exists between the remaining plots to draw scientifically valid conclusions. Comparison of the data available from Plot C_2 suggest it is almost identical to the subsoiled plots. In fact, PMC is of the opinion that given the similarity to fertilizer response to the remaining topsoiled and subsoiled plots in 1985, no significant data has been lost to this study through the loss of Plot C_1. The data trends documented in 1984 are consistent with the trends presented for 1985. Plateau is of the opinion that insufficient data exists to justify redoing any of the test plots.

Examination of the 1985 data in light of the study objectives set forth by UDOGM tend to indicate that adequate information exists to modify the reclamation monitoring scheme for 1986. Changes which PMC wishes to propose for 1986 include the following:

1. Dropping the slope monitoring requirement for the Refuse Test Plots. Data collected in 1984 and 1985 indicate that the requirement to take 27 transects in each plot is unnecessary. It is PMC's belief that additional replications such as the slope segments provide more data than are needed for a valid

scientific comparison. Table 23 contains sample adequacy calculations comparing the actual number of transects taken against the vegetation adequacy standard utilized by UDOGM. As can be observed by this table, the requirement to take 27 transects per plot results in significant over sampling which is not consistent with the current sample requirements. In order to balance the sampling scheme, Plateau proposes to conduct sampling based upon a combined sample size for each treatment until sample adequacy is met, (or either 27 samples per plot), whichever value is lower.

2. Since survival of the shrub transplants at the Office Road Cut and Barrow Area sites appears to have stabilized, Plateau proposes that monitoring of these sites be discontinued.

3. Since the data collected the past three years indicate a tremendous benefit to be gained in revegetating coal refuse through the use of soil and since Plateau has no intentions of reclaiming straight coal waste without some form of topsoiling, Plateau requests that the monitoring program of the Refuse Test Plots submitted to UDOGM by Plateau on April 23, 1985 be modified so that monitoring of the coal refuse (A Plots) occurs every third year.

TABLE 1
PLANT COVER AND COMPOSITION SUMMARY OF RECLAMATION SEEDINGS

	1980		1981		1982		1983	
	COVER	COMP.	COVER	COMP.	COVER	COMP.	COVER	COMP.
PERENNIAL GRASSES								
Intermediate wheatgrass	4.84	31.93	7.89	41.94	0.30	7.14	0.75	15.93
Salina wildrye	3.02	19.92	-	-	0.50	11.90	0.13	2.66
Western wheatgrass	0.11	0.73	0.53	2.82	0.40	9.52	0.29	6.20
Desert wheatgrass	1.59	10.49	0.47	2.50	0.30	7.14	0.54	11.51
Smooth brome	1.82	12.01	2.74	14.57	1.10	26.19	1.96	41.60
Slender wheatgrass	0.09	0.59	1.17	6.22	0.20	4.76	-	-
Orchardgrass	0.05	0.33	0.57	3.03	0.40	9.52	0.21	4.43
Russian wildrye	2.18	14.38	-	-	-	-	-	-
Great Basin wildrye	0.07	0.46	-	-	-	-	-	-
Blueburch wheatgrass	-	-	1.35	7.18	-	-	-	-
Foxtail barley	-	-	0.01	0.05	0.05	1.19	-	-
Mountain brome	-	-	0.07	0.37	-	-	-	-
Subtotal	13.77	90.84	14.80	78.68	3.25	77.36	3.88	82.33
PERENNIAL FORBS								
Alfalfa	0.11	0.73	1.44	7.66	0.40	9.52	-	-
Aster spp.	0.11	0.73	-	-	-	-	-	-
Cicer milkvetch	-	-	-	-	-	-	0.58	12.39
Small burnet	-	-	-	-	-	-	-	-
Yellow sweetclover	-	-	2.08	11.06	-	-	-	
Subtotal	0.22	1.46	3.52	18.72	0.40	9.52	0.58	12.39
SHRUBS								
Buckwheat	1.11	7.32	-	-	-	-	-	-
Fourwing saltbrush	-	-	-	-	-	-	-	-
Gardner saltbrush	-	-	-	-	-	-	-	-
Subtotal	1.11	7.32	0	0	0	0	0	0
ANNUAL GRASSES								
Japanese brome	-	-	0.02	0.11	-	-	-	-

TABLE 1
PLANT COVER AND COMPOSITION SUMMARY OF RECLAMATION SEEDINGS
(Cont'd)

	1980		1981		1982		1983	
	COVER	COMP.	COVER	COMP.	COVER	COMP.	COVER	COMP.
ANNUAL FORBS								
Russian thistle	-	-	-	-	0.55	13.10	0.25	5.31
Crepis spp.	-	-	0.02	0.11	-	-	-	-
Summer cypress	-	-	0.04	0.21	-	-	-	-
Subtotal	0	0	0.06	0.32	0.55	13.10	0.25	5.31
Total Plant Cover	15.16		18.81		4.20		4.71	4.02
Perennial Plant Cover	15.16		18.79		3.54		4.46	3.73
Annual Plant Cover	0		0.02		0.66		0.25	0.29
Total Ground Cover (includes litter)	22.87		29.16		5.65		-	4.02

TABLE 2

PRODUCTION AND WOODY PLANT DENSITY SUMMARY

OF RECLAMATION SEEDINGS

PRODUCTION

(pounds/acre)

	1980		1981		1982	
	PROD.	COMP.	PROD.	COMP.	PROD.	COMP.
Perennial Grasses	916	92.16	848	92.82	848	92.88
Perennial Forbs	77	7.84	60	6.59	60	6.57
Annual Forbs	1	0.10	6	0.60	5	0.55
Annual Grasses	0	0	0	0	0	0
TOTAL	994	100.00	914	100.00	913	100.00

WOODY PLANT DENSITY

(stems/acre)

SPECIES	1980	1981	1982
Green rabbitbrush	46	-	-
Big sagebrush	46	-	-
Buckwheat	272	-	-
Fourwing saltbrush	-	100	-
Rubber rabbitbrush	-	20	-
Bitterbrush	-	40	-
Woods rose	-	-	200
Shadscale	-	-	-
TOTAL	364	160	200

TABLE 3

TOPSOIL AND SUBSOIL STOCKPILES COMPARISON

	TOPSOIL STOCKPILE			SUBSOIL STOCKPILE		
	% COVER	% COMP.	PRODUCTION ($g/\frac{1}{4}m^2$)	% COVER	% COMP.	PRODUCTION ($g/\frac{1}{4}m^2$)
PERENNIAL GRASSES						
Intermediate wheatgrass	-	-	-	2.00	7.55	-
Wheatgrass species	2.33	4.05	-	-	-	-
Desert wheatgrass	0.67	1.16	-	1.67	6.29	-
Smooth brome	1.00	1.73	-	0.67	2.52	-
Orchardgrass	-	-	-	0.67	2.52	-
Russian wildrye	-	-	-	0.50	1.89	-
Subtotal	4.00	6.94	5.98	5.51	20.77	5.15
PERENNIAL FORBS						
Alfalfa	0.33	0.58	-	16.17	60.97	-
Gumweed	-	-	-	0.17	0.64	-
Yellow sweetclover	-	-	-	4.33	16.33	-
Subtotal	0.33	0.58	0.19	20.67	77.94	17.09
SHRUBS						
Rubber rabbitbrush	-	-	-	0.17	0.64	-
Subtotal	0	0	0	0.17	0.64	0
ANNUAL FORBS						
Summer cypress	46.67	80.92	-	-	-	-
Russian thistle	5.00	8.67	-	0.17	0.64	-
Chenopodium	1.67	2.89	-	-	-	-
Subtotal	53.34	92.48	32.02	0.17	0.64	0
TOTAL	57.67	100.00	38.19	26.52	100.00	22.24

TABLE 4

TOPSOIL VERSUS SUBSOIL STOCKPILES COMPARISON

SOIL	MEAN	STD. DEV.	N	T CAL.
Total Production (grams/¼m^2)				
Topsoil	38.197	3.276	3	3.432*
Subsoil	22.240	9.104	7	
Perennial Grasses (grams/¼m^2)				
Topsoil	5.980	4.569	3	0.335
Subsoil	5.150	4.154	7	
Perennial Forbs (grams/¼m^2)				
Topsoil	0.187	0.190	3	10.801*
Subsoil	17.099	7.667	7	
Annual Production (grams/¼m^2)				
Topsoil	32.020	4.010	3	27.661*
Subsoil	0	0	7	
Total Cover (%)				
Topsoil	57.667	2.517	3	12.736*
Subsoil	26.500	3.937	6	
Perennial Cover (%)				
Topsoil	4.333	2.082	3	28.686*
Subsoil	26.333	4.227	6	
Annual Cover (%)				
Topsoil	53.333	3.055	3	45.049*
Subsoil	0.167	0.408	6	

*Means are significantly different at alpha = .10

TABLE 5

WILDLIFE MITIGATION PLANT COVER

AND COMPOSITION COMPARISONS

	CONTROL		TREATED	
	COVER	COMP.	COVER	COMP.
PERENNIAL GRASSES				
Blue grama	6.00	16.93	11.20	34.57
Salina wildrye	4.78	13.48	3.30	10.19
Needle and Thread	1.67	4.71	1.50	4.63
Squirreltail	1.56	4.40	2.20	6.79
Indian ricegrass	0.89	2.51	0.40	1.23
Bluebunch wheatgrass	0.11	0.31	-	-
Intermediate wheatgrass	-	-	0.20	0.62
Bluegrass	-	-	0.20	0.62
Desert wheatgrass	-	-	3.60	11.11
Subtotal	15.01	42.34	22.60	69.76
PERENNIAL FORBS				
Globemallow	0.56	1.58	0.60	1.85
Penstemon	0.33	0.93	0.10	0.31
Aster	0.11	0.31	-	-
Alfalfa	0.11	0.31	1.50	4.63
Western yarrow	-	-	0.10	0.31
Blue flax	-	-	0.10	0.31
Lygodesmia spp.	-	-	0.10	0.31
Subtotal	1.11	3.13	2.50	7.72
SHRUBS				
Big sagebrush	15.22	42.93	5.50	16.98
Green rabbitbrush	1.33	3.75	1.00	3.09
Serviceberry	1.00	2.82	0.60	1.85
Pinyon pine	1.00	2.82	-	-
Buckwheat	0.11	0.31	-	-
Subtotal	18.66	52.63	7.10	21.92
ANNUAL GRASSES				
Cheatgrass	0.56	1.58	0.10	0.31
Subtotal	0.56	1.58	0.10	0.31
ANNUAL FORBS				
Russian thistle	0.11	0.31	-	-
Polygonum	-	-	0.10	0.31
Subtotal	0.11	0.31	0.10	0.31
TOTAL	35.45	100	32.40	100

TABLE 6
WILDLIFE MITIGATION SHRUB DENSITY
AND PRODUCTION COMPARISONS
(stems/acre and grams/¼m^2)

	DENSITY		COMPOSITION	
	CONTROL	TREATED	CONTROL	TREATED
SPECIES				
Big sagebrush	615	510	59.85	63.64
Green rabbitbrush	300	267	29.13	33.33
Pinyon pine	57	-	5.51	-
Utah serviceberry	41	16	3.94	1.01
Utah juniper	16	-	1.57	-
Caragana	-	16	-	2.02
TOTAL	1029	809	100.00	100.00

	PRODUCTION		COMPOSITION	
	CONTROL gm/m / #/a	TREATED gm/m / #/a	CONTROL	TREATED
LIFE FORM				
Perennial Grasses	8.408 33.6	9.249	68.40	60.01
Shrubs	3.106 12.4	4.146	25.27	26.90
Perennial Forbs	0.778 3.1	1.965	6.33	12.75
Annual Forbs	-	0.052	-	0.34
TOTAL	12.292 49.1 437	15.412 61.6	100.00	100.00

Original prod 750 - 900 #/ac
target " 2500 - 3000 #/a

TABLE 7

WILDLIFE MITIGATION AREA STATISTICAL COMPARISON

SITE	MEAN	STD. DEV.	N	T CAL.
Total Production (grams/¼m^2)				
Control	12.292	3.591	10	1.820*
Treated	15.412	3.681	10	
Perennial Grass Production (grams/¼m^2)				
Control	8.408	3.636	10	0.592
Treated	9.249	3.055	10	
Perennial Forb Production (grams/¼m^2)				
Control	0.778	0.660	10	2.959*
Treated	1.965	1.076	10	
Annual Forb Production (grams/¼m^2)				
Control	0	0	10	3.881*
Treated	0.052	0.164	10	
Shrub Production (grams/¼m^2)				
Control	3.106	1.392	10	1.180
Treated	4.146	2.227	10	
Total Cover (%)				
Control	35.444	5.725	9	1.195
Treated	32.400	5.082	10	
Shrub Density (stems/50m^2)				
Control	12.700	3.200	10	2.051*
Treated	9.900	2.558	10	

*Means are significantly different at alpha = .10

TABLE 8

SHRUB TRANSPLANT SURVIVAL DATA

SPECIES	% SURVIVAL	VIGOR (1-10	HEIGHT (cm)
Office Road Cut			
Black sagebrush	47.9	8.96	44.2
Gambel oak	4.2	5.0	7.0
Fourwing saltbrush	20.8	8.0	40.7
Rubber rabbitbrush	12.5	9.7	45.3
Sumac	20.8	6.6	23.6
Utah serviceberry	8.3	3.0	17.5
Curlleaf mtn. mahogany	12.5	6.8	17.2
True mtn. mahogany	33.2	7.8	19.4
Rocky Mtn. juniper	12.5	6.3	23.8
SITE AVERAGE	19.2	6.9	26.5
Barrow Area			
Fourwing saltbrush	20.8	6.2	22.0
Utah serviceberry	41.7	2.0	6.0
Rocky Mtn. juniper	58.3	4.4	18.1
Gambel oak	33.3	2.0	4.0
Black sagebrush	0	0	0
Pea shrub	66.7	6.1	15.6
Rubber rabbitbrush	50.0	5.2	18.5
Curlleaf mtn. mahogany	66.7	4.0	8.4
True mtn. mahogany	25.0	4.8	7.5
SITE AVERAGE	40.3	3.9	11.1

TABLE 9

PLANT GROWTH MEDIUM COMPARISON

MEDIUM	MEAN	STD. DEV.	N
Total Production (grams/¼m^2)			
Topsoil	9.591	3.016	62
Subsoil	10.444	5.521	107
Topsoil/Subsoil	10.377	2.630	27
Refuse	5.251	6.189	54
Perennial Production (grams/¼m^2)			
Topsoil	7.299	3.393	62
Subsoil	10.291	5.600	107
Topsoil/Subsoil	9.984	2.594	27
Refuse	1.871	4.076	54
Annual Production (grams/¼m^2)			
Topsoil	2.285	1.909	62
Subsoil	0.148	0.508	107
Topsoil/Subsoil	0.381	0.969	27
Refuse	3.378	5.323	54
Total Cover (%)			
Topsoil	27.097	5.827	62
Subsoil	18.741	3.990	108
Topsoil/Subsoil	20.222	4.782	27
Refuse	10.685	6.194	54
Perennial Cover (%)			
Topsoil	11.226	5.284	62
Subsoil	17.583	4.065	108
Topsoil/Subsoil	18.444	4.846	27
Refuse	2.630	3.350	54
Annual Cover ($)			
Topsoil	15.871	8.344	62
Subsoil	1.148	1.844	108
Topsoil/Subsoil	1.778	1.717	27
Refuse	8.056	5.790	54
Shrub Density (stems/150 ft^2)			
Topsoil	2.807	2.149	62
Subsoil	3.250	2.929	108
Topsoil/Subsoil	3.211	2.299	19
Refuse	0.204	0.711	54

TABLE 10

RESPREAD TOPSOIL VERSUS SUBSOIL COMPARISON

SOIL	MEAN	STD. DEV.	N	T CAL.
Total Production (grams/¼m^2)				
Topsoil	9.591	3.016	62	1.122
Subsoil	10.444	5.521	107	
Perennial Production (grams/¼m^2)				
Topsoil	7.299	3.393	62	3.816*
Subsoil	10.291	5.600	107	
Annual Production (grams/¼m^2)				
Topsoil	2.285	1.909	62	10.948*
Subsoil	0.148	0.508	107	
Total Cover (%)				
Topsoil	27.097	5.827	62	11.063*
Subsoil	18.741	3.990	108	
Perennial Cover (%)				
Topsoil	11.226	5.284	62	8.776*
Subsoil	17.583	4.065	108	
Annual Cover (%)				
Topsoil	15.871	8.344	62	17.634*
Subsoil	1.148	1.844	108	
Shrub Density (stems/150 ft^2)				
Topsoil	2.807	2.149	62	1.040
Subsoil	3.250	2.929	108	

*Means are significantly different at alpha = .10

TABLE 11

TOPSOIL OVER SUBSOIL VERSUS SUBSOIL COMPARISON

MEDIUM	MEAN	STD. DEV.	N	T CAL.
Total Production (grams/¼m^2)				
Topsoil/Subsoil	10.377	2.630	27	0.061
Subsoil	10.444	5.521	107	
Perennial Production (grams/¼m^2)				
Topsoil/Subsoil	9.984	2.594	27	0.277
Subsoil	10.291	5.600	107	
Annual Production (grams/¼m^2)				
Topsoil/Subsoil	0.381	0.969	27	1.727*
Subsoil	0.148	0.508	107	
Total Cover (%)				
Topsoil/Subsoil	20.222	4.782	27	1.656*
Subsoil	18.741	3.990	108	
Perennial Cover (%)				
Topsoil/Subsoil	18.444	4.846	27	0.946
Subsoil	17.583	4.065	108	
Annual Cover (%)				
Topsoil/Subsoil	1.778	1.717	27	1.609
Subsoil	1.148	1.844	108	
Shrub Density (stems/150 ft^2)				
Topsoil/Subsoil	3.211	2.299	19	0.055
Subsoil	3.250	2.929	108	

*Means are significantly different at alpha = .10

TABLE 12

FERTILIZER EFFECT ON COAL REFUSE

FERTILIZER RATE	PLOT	MEAN	STD. DEV.	N	T CAL.
Total Production (grams/¼m^2)					
100#/Acre	A1	4.430	5.046	27	0.974
200#/Acre	A2	6.072	7.156	27	
Perennial Production (grams/¼m^2)					
100#/Acre	A1	1.857	5.251	27	0.025
200#/Acre	A2	1.885	2.509	27	
Annual Production (grams/¼m^2)					
100#/Acre	A1	2.573	1.964	27	1.114
200#/Acre	A2	4.183	7.250	27	
Total Cover (%)					
100#/Acre	A1	11.111	5.813	27	0.502
200#/Acre	A2	10.259	6.637	27	
Perennial Cover (%)					
100#/Acre	A1	22.259	3.230	7	0.810
200#/Acre	A2	3.000	3.486	27	
Annual Cover (%)					
100#/Acre	A1	8.889	5.161	27	1.039
200#/Acre	A2	7.259	6.310	27	
Shrub Density (stems/150 ft^2)					
100#/Acre	A1	0.074	0.3849	27	1.351
200#/Acre	A2	0.333	0.920	27	

TABLE 13

FERTILITY COMPARISON ON TEN INCHES OF SUBSOIL

FERTILIZER RATE	PLOT	MEAN	STD. DEV.	N	T CAL.
Total Production (grams/¼m^2)					
100#/Acre	D_2	7.989	2.671	27	3.576*
200#/Acre	D_1	11.686	4.601	25	
Perennial Production (grams/¼m^2)					
100#/Acre	D_2	7.884	2.831	27	3.385*
200#/Acre	D_1	11.454	4.627	25	
Annual Production (grams/¼m^2)					
100#/Acre	D_2	0.105	0.454	27	0.342
200#/Acre	D_1	0.137	0.199	25	
Total Cover (%)					
100#/Acre	D_2	20.037	3.956	27	0.795
200#/Acre	D_1	20.846	3.426	26	
Perennial Cover (%)					
100#/Acre	D_2	18.259	3.809	27	0.982
200#/Acre	D_1	19.308	3.968	26	
Annual Cover (%)					
100#/Acre	D_2	1.778	1.601	27	0.519
200#/Acre	D_1	2.192	3.816	26	
Shrub Density (stems/150 ft^2)					
100#/Acre	D_2	5.593	3.422	27	1.394
200#/Acre	D_1	4.385	2.844	26	

*Means are significantly different at alpha = .10

TABLE 14

FERTILITY COMPARISON ON TWENTY INCHES OF SUBSOIL

FERTILIZER RATE	PLOT	MEAN	STD. DEV.	N	T CAL.
Total Production (grams/¼m^2)					
100#/Acre	B_2 lower 1/3	7.441	2.678	7	0.977
200#/Acre	B_1 lower 1/3	8.656	2.296	9	
Perennial Production (grams/¼m^2)					
100#/Acre	B_2 lower 1/3	7.283	2.722	7	1.095
200#/Acre	B_1 lower 1/3	8.656	2.296	9	
Annual Production (grams/¼m^2)					
100#/Acre	B_2 lower 1/3	0.159	0.285	7	1.692
200#/Acre	B_1 lower 1/3	0	0	9	
Total Cover (%)					
100#/Acre	B_2 lower 1/3	14.714	4.386	7	0.028
200#/Acre	B_1 lower 1/3	14.667	2.693	9	
Perennial Cover (%)					
100#/Acre	B_2 lower 1/3	14.000	4.619	7	0.237
200#/Acre	B_1 lower 1/3	14.444	2.877	9	
Annual Cover (%)					
100#/Acre	B_2 lower 1/3	0.714	0.756	7	1.636
200#/Acre	B_1 lower 1/3	0.222	0.441	9	
Shrub Density (stems/150 ft^2)					
100#/Acre	B_2 lower 1/3	1.364	1.120	11	0.969
200#/Acre	B_1 lower 1/3	0.889	1.054	9	

TABLE 15

COMPARISON OF FERTILIZER EFFECT ON TEN INCHES OF TOPSOIL

FERTILIZER RATE	PLOT	MEAN	STD. DEV.	N	T CAL.
Total Production (grams/¼m^2)					
100#/Acre	F_2	9.394	3.009	9	0.380
200#/Acre	F_1	8.720	2.306	17	
Perennial Production (grams/¼^2)					
100#/Acre	F_2	5.950	3.344	9	0.351
200#/Acre	F_1	6.376	2.725	17	
Annual Production (grams/¼^2)					
100#/Acre	F_2	3.444	0.899	9	1.911*
200#/Acre	F_1	2.501	1.321	17	
Total Cover (%)					
100#/Acre	F_2	27.444	3.972	9	0.943
200#/Acre	F_1	28.765	3.073	17	
Perennial Cover (%)					
100#/Acre	F_2	7.444	1.333	9	0.728
200#/Acre	F_1	8.353	3.587	17	
Annual Cover (%)					
100#/Acre	F_2	20.000	3.937	9	0.216
200#/Acre	F_1	20.412	4.938	17	
Shrub Density (stems/150 ft^2)					
100#/Acre	F_2	3.222	2.224	9	0.121
200#/Acre	F_1	3.353	2.805	17	

*Means are significantly different at alpha = .10

TABLE 16

COMPARISON OF FERTILIZER EFFECT ON TWENTY INCHES OF TOPSOIL

FERTILIZER RATE	PLOT	MEAN	STD. DEV.	N	T CAL.
Total Production (grams/¼m^2)					
100#/Acre	E_1	9.335	3.517	18	1.323
200#/Acre	E_2	10.766	2.950	18	
Perennial Production (grams/¼m^2)					
100#/Acre	E_1	8.419	3.299	18	0.442
200#/Acre	E_2	7.892	3.843	18	
Annual Production (grams/¼m^2)					
100#/Acre	E_1	0.913	0.962	18	2.953*
200#/Acre	E_2	2.874	2.648	18	
Total Cover (%)					
100#/Acre	E_1	23.778	6.585	18	2.206*
200#/Acre	E_2	28.667	6.713	18	
Perennial Cover (%)					
100#/Acre	E_1	14.111	4.789	18	0.642
200#/Acre	E_2	12.944	6.0437	18	
Annual Cover (%)					
100#/Acre	E_1	9.667	5.445	18	2.107*
200#/Acre	E_2	15.722	10.912	18	
Shrub Density (stems/150 ft^2)					
100#/Acre	E_1	3.000	1.732	18	1.433
200#/Acre	E_2	2.167	1.757	18	

*Means are significantly different at alpha = .10

TABLE 17

FERTILIZER EFFECT ON TOPSOIL

FERTILIZER RATE	MEAN	STD. DEV.	N	T CAL.
Total Production (grams/¼m^2)				
100#/Acre	9.355	3.298	27	0.535
200#/Acre	9.772	2.816	34	
Perennial Production (grams/¼m^2)				
100#/Acre	7.596	3.459	27	0.602
200#/Acre	7.070	3.373	35	
Annual Production (grams/¼m^2)				
100#/Acre	1.757	1.527	27	1.958*
200#/Acre	2.693	2.089	35	
Total Cover (%)				
100#/Acre	25.000	6.026	27	2.603*
200#/Acre	28.714	5.194	35	
Perennial Cover (%)				
100#/Acre	11.889	5.078	27	0.867
200#/Acre	10.714	5.453	35	
Annual Cover (%)				
100#/Acre	13.111	6.985	27	2.373*
200#/Acre	18.000	8.768	35	
Shrub Density (stems/150 ft^2)				
100#/Acre	2.889	1.867	27	0.263
200#/Acre	2.743	2.368	35	

*Means are significantly different at alpha = .10

TABLE 18

FERTILIZER EFFECT ON SUBSOIL

FERTILIZER RATE	MEAN	STD. DEV.	N	T CAL.
Total Production (grams/¼m^2)				
100#/Acre	10.444	7.013	52	0
200#/Acre	10.444	3.659	55	
Perennial Production (grams/¼m^2)				
100#/Acre	10.197	7.144	52	0.168
200#/Acre	10.380	3.652	55	
Annual Production (grams/¼m^2)				
100#/Acre	0.247	0.705	52	1.901*
200#/Acre	0.062	0.150	55	
Total Cover (%)				
100#/Acre	18.365	4.280	52	0.937
200#/Acre	19.089	3.704	56	
Perennial Cover (%)				
100#/Acre	16.769	4.273	52	2.034*
200#/Acre	18.339	3.743	56	
Annual Cover (%)				
100#/Acre	1.577	2.023	52	2.379*
200#/Acre	0.750	1.575	56	
Shrub Density (stems/150 ft^2)				
100#/Acre	3.714	3.108	56	1.725*
200#/Acre	2.750	2.663	52	

*Means are significantly different at alpha = .10

TABLE 19

TOPSOIL DEPTH COMPARISON

DEPTH	PLOTS	MEAN	STD. DEV.	N	T CAL.
Total Production (grams/¼m^2)					
10"	$F_1 + F_2$	9.030	2.604	26	1.315
20"	$E_1 + E_2$	10.051	3.281	36	
Perennial Production (grams/¼m^2)					
10"	$F_1 + F_2$	6.113	2.832	26	2.433*
20"	$E_1 + E_2$	8.156	3.540	36	
Annual Production (grams/¼m^2)					
10"	$F_1 + F_2$	2.827	1.259	26	1.942*
20"	$E_1 + E_2$	1.894	2.201	36	
Total Cover (%)					
10"	$F_1 + F_2$	28.308	3.914	26	1.370
20"	$E_1 + E_2$	26.222	7.007	36	
Perennial Cover (%)					
10"	$F_1 + F_2$	8.039	2.999	26	4.678*
20"	$E_1 + E_2$	13.528	5.406	36	
Annual Cover (%)					
10"	$F_1 + F_2$	20.269	4.539	26	3.922*
20"	$E_1 + E_2$	12.694	9.049	36	
Shrub Density (stems/150 ft^2)					
10"	$F_1 + F_2$	3.308	2.573	26	1.582
20"	$E_1 + E_2$	2.444	1.731	36	

*Means are significantly different at alpha = .1019

TABLE 20

SUBSOIL DEPTH COMPARISON

DEPTH	PLOTS	MEAN	STD. DEV.	N	T CAL.
Total Production (grams/¼m^2)					
10"	D_1, D_2 + G	11.188	6.494	70	1.942*
20"	B_1 + B_2	9.037	2.411	37	
Perennial Production (grams/¼m^2)					
10"	D_1, D_2 + G	10.970	6.611	70	1.742*
20"	B_1 + B_2	9.007	2.440	37	
Annual Production (grams/¼m^2)					
10"	D_1, D_2 + G	0.216	0.614	70	1.816*
20"	B_1 + B_2	0.030	0.132	37	
Total Cover (%)					
10"	D_1, D_2 + G	19.634	3.900	71	3.376*
20"	B_1 + B_2	17.027	3.625	37	
Perennial Cover (%)					
10"	D_1, D_2 + G	17.972	4.154	71	1.382
20"	B_1 + B_2	16.838	3.833	37	
Annual Cover (%)					
10"	D_1, D_2 + G	1.648	2.085	71	4.195*
20"	B_1 + B_2	0.189	0.462	37	
Shrub Density (stems/150 ft^2)					
10"	D_1, D_2 + G	4.324	3.037	71	6.109*
20"	B_1 + B_2	1.189	0.967	37	

*Means are significantly different at alpha = .10

TABLE 21

CONVEYOR EDGE EFFECT

SITE	MEAN	STD. DEV.	N	T CAL.
Total Production (grams/¼m^2)				
Near	8.676	2.268	8	0.525
Away	9.435	3.402	8	
Perennial Production (grams/¼m^2)				
Near	8.179	2.780	8	0.751
Away	9.338	3.364	8	
Annual Production (grams/¼m^2)				
Near	0.498	0.700	8	1.560
Away	0.099	0.183	8	
Total Cover (%)				
Near	19.750	5.148	8	0.508
Away	18.500	4.690	8	
Perennial Cover (%)				
Near	17.625	5.012	8	0.213
Away	17.125	4.357	8	
Annual Cover (%)				
Near	2.125	2.232	8	0.745
Away	1.375	1.768	8	
Shrub Density (stems/150 ft.^{2})				
Near	2.375	1.769	8	1.608
Away	1.250	0.886	8	

TABLE 22

ASPECT COMPARISON

ASPECT	PLOT	MEAN	STD. DEV.	N	T CAL.
Total Production (grams/¼m^2)					
North	D_2	7.989	2.671	27	3.693*
South	G	15.293	9.794	18	
Perennial Production (grams/¼m^2)					
North	D_2	7.884	2.831	27	3.355*
South	G	14.799	10.188	18	
Annual Production (grams/¼m^2)					
North	D_2	0.105	0.454	27	1.738*
South	G	0.493	1.023	18	
Total Cover (%)					
North	D_2	20.037	3.956	27	2.372*
South	G	17.278	3.611	18	
Perennial Cover (%)					
North	D_2	18.259	3.809	27	2.212*
South	G	15.611	4.118	18	
Annual Cover (%)					
North	D_2	1.778	1.601	27	0.255
South	G	1.611	2.789	18	
Shrub Density (stems/150 ft.^{2})					
North	D_2	5.593	3.422	27	3.876*
South	G	2.333	1.188	18	

*Means are significantly different at alpha = .10

TABLE 23

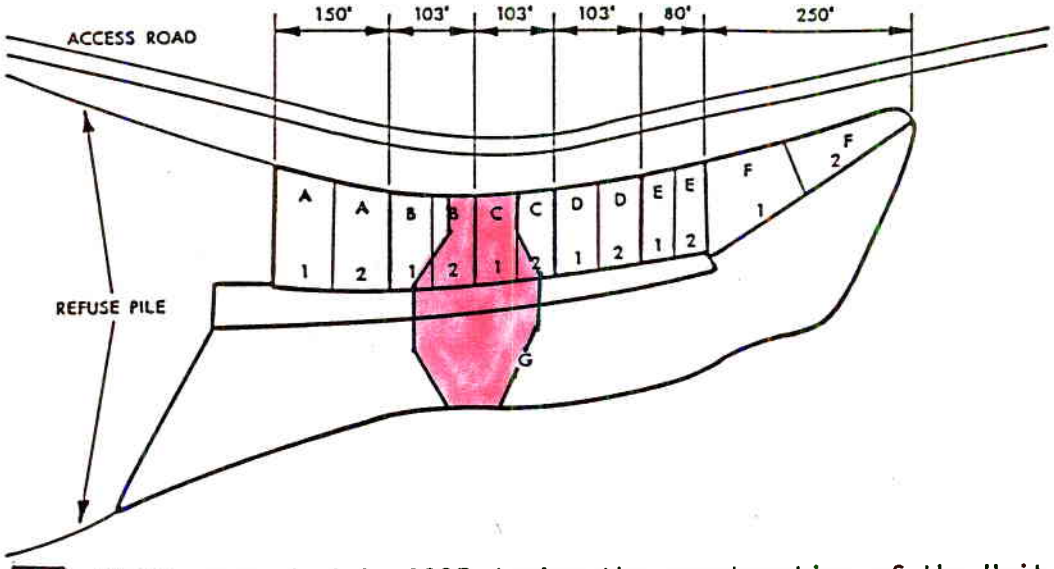
NUMBER OF SAMPLES NEEDED TO MEET SAMPLE ADEQUACY

PLOT	NUMBER OF SAMPLES COLLECTED	SAMPLES REQUIRED $N_{80/10}$
A_1	27	45
A_2	27	69
B_1	30	6
B_2	7	15*
C_2	27	10
D_1	26	5
D_2	27	7
E_1	18	13
E_2	18	10
F_1	17	2
F_2	9	6

*Disturbed plot

FIGURE 1

REFUSE PILE VEGETATION - TOPSOIL TEST PLOT LAYOUT



Plots disturbed in 1985 during the construction of the Unit Train Loadout Conveyor.

PLOT	TREATMENT KEY (INCHES) SOIL MATERIAL & DEPTH	(16-160-8) FERTILIZER LBS/ACRE	SEED MIX SPECIES	POUNDS PLS/ACRE
A1	Coal Waste	100	Slender Wheatgrass	3.0
A2	Coal Waste	200	Western Wheatgrass	3.0
B1	20" Subsoil	200	Tall Fescue	2.0
B2	20" Subsoil	100	G.B. Wildrye	3.0
C1	10" Topsoil/10" Subsoil	100	Blue Bunch Wheatgrass	3.0
C2	10" Topsoil/10" Subsoil	200	Scarlet Globemallow	0.5
D1	10" Subsoil	200	Penstemon	0.5
D2	10" Subsoil	100	Cicer Milkvetch	1.0
E1	20" Topsoil	100	Yellow Sweetclover	1.0
E2	20" Topsoil	200	Rubber Rabbitbrush	0.5
F1	10" Topsoil	200	Big Sagebrush	0.1
F2	10" Topsoil	100	Green Ephedra	2.0
G	10" Subsoil	100	4-wing Saltbrush	1.0
			TOTAL	20.6

ATTACHMENT A

STAR POINT MINE NO. 1 SEED MIXTURE

GRASSES	POUNDS (PLS)/ACRE
Slender Wheatgrass	3.0
Salina Wildrye	4.0
Indian Ricegrass	2.0
Alkali Sacatoon	0.2
Western Wheatgrass	3.0
Tall Fescue	2.0
Great Basin Wildrye	2.0
Bluebunch Wheatgrass	3.0
FORBS	
Western Yarrow	0.1
Scarlet Globemallow	0.5
Palmer Penstemon	0.5
Cicer Milkvetch	1.0
Yellow Sweetclover	1.0
Pacific Aster	0.1
SHRUBS	
Winter Fat	2.0
Whitestem Rubber Rabbitbrush	0.5
Basin Big Sagebrush	0.1
Green Ephedra	2.0
Fourwing Saltbush	1.0
Shad Scale	2.0
Sulfur Flower	0.1
Birchleaf Mountain Mahogany	2.0
Basin Big Sagebrush	0.1
Douglas Rabbitbrush	0.1
Oats (cover crop)	20.0
TOTAL	52.30

ATTACHMENT B

UNIT TRAIN LOADOUT SALTBUSH SEED MIXTURE

GRASSES	POUNDS (PLS)/ACRE
Thickspike Wheatgrass	1.5
Salina Wildrye	1.5
Western Wheatgrass	2.0
Indian Ricegrass	2.0
Squirreltail	1.5
Sandberg Bluegrass	0.5
SUBTOTAL	9.0
FORBS	
Blue Flax	1.50
Utah Sweetvetch	2.00
Ladak Alfalfa	1.00
Yellow Sweetclover	1.50
SUBTOTAL	6.00
SHRUBS	
Gardner Saltbush	1.5
Fourwing Saltbush	1.5
Mat Saltbush	1.5
Black Sagebrush	0.5
Shadscale	1.5
SUBTOTAL	6.5
TOTAL	21.50

ANNUAL RECLAMATION REPORT

1987

STAR POINT MINES

ACT 007/006

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INTRODUCTION

This annual reclamation report is submitted by Plateau Mining Company in accordance with their approved Mining and Reclamation Plan (Utah Division of Oil, Gas and Mining (UDOGM) Permit Number ACT/007/006) which commits Plateau to submit an annual revegetation monitoring report to the Division each year. This report contains the results of field data collected between June 29, 1987, and July 3, 1987, for all areas that required monitoring in 1987. Since no new areas were reclaimed by Plateau during the past year the overall status of reclamation for the 1987 Annual Reclamation Report is identical to the maps previously submitted and no new reclamation status maps are being submitted with this report.

All of the data was collected and analyzed by Kent Crofts and Michael Jones of IME, an environmental consulting firm located in Yampa, Colorado. The monitoring effect implemented in 1987 was directly supervised by Plateau and is consistent with changes approved by the Division during 1986 and submitted in Plateau's recently approved permit renewal document.

SAMPLING METHODOLOGIES

All of the data collected during the 1987 monitoring effort used identical sampling methodologies, equipment, observers, and methods of data analysis previously used and approved by the Division for this site. The vegetative parameters sampled in 1987 included total plant cover and woody plant densities. Due to the similarity of methodologies utilized, Plateau believes that a comparison of data between years is possible to establish trends regarding the successfulness of current and previous revegetation efforts.

Cover

Plant cover was measured using the two sampling techniques previously approved by the Division. On the flatter areas associated with the Refuse Test Plots, the Topsoil and Subsoil Stockpiles, plant cover was collected using an inclined, metal, ten-point frame. A fifty-foot tape was randomly located in the area to be sampled, and the ten point frame was randomly spaced at ten points along the outstretched tape. Along each transect, 100 data points were collected. All foliar plant cover less than one meter in height was sampled. At each data point, the observation was recorded by plant species, or whether or not litter, rock, or bare ground was encountered. Plant material that had dried prior to sampling (such as cheatgrass), but was a product of the 1987 growing season, was counted as plant cover. Litter was defined as that material that had been on the ground or was a dead part of the plant for approximately one year prior to sampling. The one hundred datum points were summarized into a single observation which was used for subsequent data analysis. To the extent possible, all transects were randomly located with

respect to location and orientation using random numbers generated from a hand held calculator. Cover on the Wildlife Mitigation Area was sampled using a similar sampling technique, except in these areas the transect length was 50 meters.

On the steeper road cut and fill slopes encountered along the Mine #1 access roads, it was relatively unsafe to use the ten point frame. On these areas, plant cover was estimated using a 2 x 5 dm quadrat. The transect length used in these areas was 14.52 feet in length, and were randomly located throughout the area to be sampled. At each transect, three quadrats were sampled. The three quadrat values were then averaged into a single transect observation.

Sampling on all areas was conducted until sample adequacy with respect to total plant cover was achieved. This is the same technique used in previous monitoring.

Woody Plant Density

On the Refuse Test Plots and on the Topsoil and Subsoil Stockpiles, woody plant density values were obtained by sampling a 3 x 50 foot belt transect. The tape used for the cover transect was also used as the center point for the woody plant density transects. Each side of the transect was sampled for woody plant densities. On the Wildlife Mitigation Area, the belt transect was 1 x 50 meters.

RESULTS AND DISCUSSION

1985 Conveyor Seeding

A total of 25 transects were taken to evaluate plant cover, Second year total plant cover on this area was found to equal 16.89 percent (Table 1).

The second year plant cover for this site compares quite well with the second year plant cover obtained on other two year old reclaimed sites sampled by Plateau. The 1981 Reclamation Seeding sampled in 1983 yielded a second year plant cover of 15.67 percent. Since overall conditions between these two sites is similar, and the 1981 Site has developed into a satisfactory stand Plateau believes that the 1985 Conveyor Seeding will also develop into a satisfactory stand.

1985 Mine #1 Seeding

Two sperate areas reclaimed during 1985 were sampled during the 1987 monitoring program. These areas correspond to the southern area to the south of the existing access road containing the old coal shoot area and the small area north of the existing access road running towards the coal preparation plant. A total of twenty transects were taken on the southern tract to determine plant cover, and six transects were taken on the northern area to determine total plant cover. The average plant cover on the southern area was 22.55 percent, and the northern area had a total plant cover of 10.61 percent.

The average plant cover on the southern area compares very

favorably with other second year stands monitored by Plateau and seems to be developing at a satisfactory rate. The northern area average plant cover is somewhat lower than are similar aged seedings at this mine site. The most logical explanation for the lower plant cover is due to the small width of this seeding and the corresponding amount of wildlife and livestock utilization that this site had received prior to sampling. The small width and corresponding increase in "edge effect" have caused greater utilization on this site than on other areas. Examination of this area reveals that seedling densities are adequate and that with time this site will develop into a suitable stand. Due to the method of regrading and topsoiling used the site is quite rough and exhibits essentially no signs of surface erosion. Plateau believes on such areas surface roughness is more desirable in controlling erosion during the initial stages of reclamation than is plant cover.

Wildlife Mitigation Area

A total of 4 transects were taken on the control area, and six transects were taken on the treated area to evaluate plant cover and woody plant densities. Examination of the species cover and composition values in Table 2 reveal that the vegetation still continues to show a response to treatment. There are increases in perennial grass and forb cover on the treated areas. Since the area is on the edge of a defined deer wintering range, the most critical need is for high energy forage during this period, and prior to the spring green up. It appears that the treated areas have partially achieved the desired objective of increasing high energy forage during this critical period. Shrub cover has been partially reduced, but indications are that the remaining shrubs on the treated area are more vigorous and are producing more desirable forage than are the shrubs on the untreated area. Table 3 shows that the shrub densities on the treated area is slightly more than the densities found on the untreated areas. A statistical comparison of the shrub densities on the control and treated areas (Table 4) reveals that the treatment has increased the shrub densities over the control area, but these differences are no longer significantly different. Since shrub cover is slightly lower on the treated areas, but the overall shrub density is higher, it is logical to conclude that the smaller and more vigorous shrubs growing on the treated areas are more desirable as a wildlife forage than the older, more decadent, and mature shrubs growing on the control area. These observations are substantiated by the shrub production data collected during the 1985 monitoring effort which are presented in the 1985 Annual Reclamation Report which documented that the treated areas produced a significantly higher biomass and shrub density than did the control areas. The differences documented in the 1985 Annual Reclamation Report, with respect to increases in total and annual cover as well as shrub densities, has diminished to the point where there was no statistical difference evident in the 1987 monitoring data. These

data suggest that the benefits of treating wildlife winter range tend to decrease over time.

Topsoil and Subsoil Stockpiles

Fifth year total plant cover for the Topsoil Stockpile was found to equal 37.50 percent (Table 5). No shrubs were encountered in the four sample transects (Table 6). A comparison of the 1987 data for the Topsoil Stockpile with the previous years data reveals the following:

YEAR	%COVER	SHRUB DENSITY PLANTS/ACRE
1987	37.50	0
1986	37.50	0
1985	57.67	333
1984	54.40	-
1983	45.55	-

Total plant cover for the Subsoil Stockpile in 1987 was found to equal 44.50 percent (Table 5). No shrubs were encountered in the four sample transects (Table 6). A comparison of the 1987 data for the Subsoil Stockpile with the previous years data reveals the following:

YEAR	%COVER	SHRUB DENSITY PLANTS/ACRE
1987	44.50	0
1986	22.75	218
1985	26.50	-
1984	34.45	-

A statistical comparison of the Topsoil and Subsoil Stockpiles is presented in Table 6. Examination of these data reveal that total plant cover and perennial plant cover are significantly higher on the Subsoil Stockpile, while annual plant cover is significantly higher on the Topsoil Stockpile. There is no difference in shrub density between the two stockpiles. The reasons for this difference appear to be explained by the composition of annuals and perennial forbs (Table 5). Annuals comprised 23.33 percent of the total plant cover on the Topsoil Stockpile and zero percent on the Subsoil Stockpile. Alfalfa and sweetclover comprised 66.85 percent of the plant cover on the Subsoil Stockpile and only 1.33 percent on the Topsoil Stockpile.

The apparent trend towards the dominance of annuals on the Topsoil Stockpile suggested in the 1986 Annual Reclamation Report appears to be reversed somewhat in 1987 as suggested by the following comparison:

YEAR	TOPSOIL % COMP. ANNUALS	SUBSOIL % COMP. ANNUALS
1987	23.33	0.00
1986	76.67	0.00
1985	92.48	0.17
1984	67.28	0.78
1983	55.85	-

REFUSE TEST PLOTS

The Refuse Test Plots were established in the fall of 1982 to address agency concerns relative to the reclamation potential of the washed coal refuse generated by Plateau. An extensive volume of literature has been exchanged between the Division and Plateau relative to these test plots. This material will not be repeated here. The best summary of these test plots can be found in the 1983, 1984, 1985, and 1986 Annual Reclamation Reports previously submitted by Plateau. In summary, these test plots were initially established to test the following:

1. The effectiveness of four plant growth mediums; topsoil, subsoil, topsoil over subsoil, and straight coal refuse;

2. Compare the effects of varying soil depths: 10 inches of topsoil, 20 inches of topsoil, 10 inches of subsoil, 20 inches of subsoil, and 10 inches of topsoil over 10 inches of subsoil; and

3. Determine the effects of supplemental fertilizer applied at the rates of 100 and 200 pounds per acre to the combinations described in one and two above.

Minor modifications in the sampling scheme have been presented by Plateau and approved by the Division over the past few years based upon the findings of the study. Specific agency recommendations relevant to statistical comparisons and techniques were described in the 1986 Annual Reclamation Report. This Report utilizes the identical analytical techniques and methodologies described in the previous report.

Soil materials

A general comparison of the various plant growth mediums described in item one of the study objectives listed above and their associated vegetative parameters collected during the 1987 field sampling effort are presented in Table 7. As can be observed from Table 7, total plant cover and annual plant cover were significantly higher on the topsoil plant growth medium. No statistical differences were observed between the plant growth mediums, with respect to perennial plant cover and shrub density. Compared with the 1986 Annual Reclamation Report, the topsoil plant growth medium has improved much more relative to the subsoil or segregated topsoil over subsoil.

Fertilization

Fertilization, when averaged across all treatments, was found only to have measurable effect on total plant cover (Table 8). Although there was a slight tendency for perennial and annual plant cover to respond positively to fertilization, the differences between means were not significantly different. There

appeared a weak tendency for the heavier rate of fertilization to reduce shrub growth, but this difference was not statistically significant. In 1986, no significant differences in fertilization could be detected.

On straight Coal Refuse, fertilization was found to significantly affect all measured vegetative parameters five years after application (Table 20). Total and perennial plant cover, along with shrub density values were highest on the 200 pounds per acre fertilizer rate. Annual cover appeared to be higrest on the 100 pound per acre application rate. These 1987 results are somewhat inconsistent with the results obtained from the 1985 monitoring of the coal refuse. During the 1985 monitoring it was reported that means between the various plant parameters were not significantly different. The conflicting results are probably partially explained by the fact that the 1987 monitoring data was collected during a much wetter growing season.

On Subscil, fertilization was found to significantly depress shrub densities at the 200 pound per acre application rate (Table 9). This firding is consistent with the results reported in the 1986 Annual Reclamation Report. In 1987, no other statistically sigrificant differences were observed. There was a slight increase in total plant cover with the heaviest rate of fertilizatior, but these means were not significantly different. This apparent shift in response to fertilization suggests that the documented response to fertilization documented in previous years has now diminished. Possibly, the supplemental fertilizer has either been lost from the system, or is immobilized and is no longer available to positively affect plant growth, or else its effect is closely related to available growing season moisture.

On Topsoil, fertilization was found to significantly increase total and annual plant cover five years after seeding (Table 10). These trends are not totally consistent with results presented in the 1986 Annual Reclamation Report. During the previous year, the only significant difference detected was for shrub densities. Since fertilization in arid environments is dramatically affected by the amount of precipitation, it is possible that insufficient moisture was received during 1986 to detect any interaction with fertilization.

On Topsoil over Subsoil, fertilization was found to significantly increase the total and annual plant cover (Table 11). These differences are also somewhat inconsistent with the results obtained for the 1986 sampling. The 1986 Annual Reclamation Report states that no differences, with respect to fertilization, could be documented. It is entirely possible that the lack of response to fertilization from the 1986 sampling was a result of a lack of growing season moisture.

Fertilization did not have a consistent affect on the plots containing either the Ten Inches or Twenty Inches of Topsoil (Tables 12 and 13). In both of these instances, the means between the various vegetative parameters were not significant. These results are similar to those reported in the 1986 Annual

Reclamation Report. However, for the previous year, significant differences existed between annual cover and shrub densities for the Twenty Irches of Topsoil. In 1987, the higher means for these two parameters were associated with the higher fertilization rates, but the means were not significantly different.

Fertilization did produce some significant differences on Subsoil. On the Ten Inches of Subsoil treatments, significantly higher shrub densities were associated with the lowest rate of fertilizatior (Table 14). Although most other paramsters for these treatments had higher values associated with the nigher rates of fertilization, the differences between means were not sigrificantly different. For the Twenty Inches of Topsoil treatments (Table 15), no differences between means could be detected for any of the parameters evaluated.

Soil Thickness

All possible combinations of Toosoil and Subsoil depths were evaluated through analysis of variance to determine whether or not the thickness or source affected plant response. Table 16 indicates that the highest total and annual plant cover were associated with the Ten Inch Topsoil plots. This is identical to the trends reportec in the 1986 Annual Reclamation Report. The highest perennial plant cover encountered in the 1987 sampling was associated with the Twenty Inch Topsoil plots, followed by the Ten Inch Subsoil plots. These data suggest that a shift in perennial plant cover associated with the Twenty Inch Topsoil plots has improved the desirability of this plant growth medium. Since the Subsoil plots have consistently produced greater perennial plant cover in previous years, future monitoring will have to determine whether or not this shift is a long term trend or simply a short term fluctuation. Shrub density was highest on the Ten Inch Subsoil treatments. This represents an increase in shrub densities on these plots from the 1986 sampling. Future monitoring will determine whether or not this is a long term trend.

Conveyor Edge Effect

In order to address potential agency concerns that the construction activities associated with the conveyor disturbance might bias the data collected from the plots adjacent to the conveyor cut, Plateau initiated a special sampling effort in 1985 in order to quantify whether or not the disturbance had altered the data prcduced by these plots. The methodologies employed in this special sampling program are described in considerable detail in the 1985 and 1986 Annual Reclamation Reports.

The results of the 1987 "edge effect" sampling are presented in Table 17. The "near" transects are located five feet away from the cut and the "away" transects are located twelve feet away from the cut. Examination of the data in Table 17 reveals that no measurable "edge effect phenomenon" could be documented to exist within twelve feet of the cut. In addition to the comparisons presented herein, Plateau also statistically compared the "near"

and the "away" transect values both separately and collectively to the overall plot transect values obtained across the entire plot. Statistically, no differences between any of these areas could be detected. Plateau believes that this information confirms the conclusions reached in the 1985 and 1986 Annual Reclamation Reports; that the remaining plots are yielding unbiased and scientifically valid data. With the exception of Plot C1 , data collected from the "edge effect" sampling program were not used in the comparison of treatment responses. The "edge effect" samples for Plot C1 were used, however, due to the small size of this plot that remains.

Aspect

Since Plots D2 and B received identical treatments consisting of Ten Inches of Subsoil with 100 pounds of fertilizer with the only difference being aspect, these two plots were compared to evaluate the influence of aspect on plant growth. Table 18 contains the results of this comparison. Examination of this table reveals that aspect has a significant influence on plant growth. In 1987, statistically greater total, and perennial plant cover were associated with the south facing slope. This finding is totally consistent with the 1986 Annual Reclamation Report, which showed identical trends.

Sample Adequacy

Table 19 summarizes the number of sample plots needed to achieve sample adequacy for each sample plot based upon the 1987 field data. As can be observed, sampling was conducted until sample adequacy at the Nm 80/10 level was achieved, or until a maximum of 27 transects per plot had been collected. The apparent correlation between the percent composition of annual plants and sample adequacy suggested in the 1986 Annual Reclamation Report appears to be apparent in the 1987 field data. During the 1985 and 1986 monitoring efforts, the composition of annual plants, as well as sample adequacy, increased. In 1987, there was an obvious decline in the composition of annual plants, which was expressed in a reduced sample adequacy.

CONCLUSIONS

Monitoring data collected during the 1987 monitoring effect continue to document the relative feasibility of successfully reclaiming lands during by coal mining activities at the Plateau Mine complex. Trends presented in previous years continue to be apparent in the 1987 monitoring data. The 1985 Seedings appear to be extremely promising with respect to the potential of establishing native shrubs. The 1985 Seed Mixtures contained more species and were designed with the intention of increasing the establishment of native shrubs. Examination of Table 1 suggests that the composition of shrubs is higher on the areas seeded in 1985, than on previously seeded areas at the site. The 8.06 percent shrub composition on the Conveyor Seeding is extremely promising and supports Plateau's contention that disturbed areas

in the Salt Desert Shrub Type can be successfully seeded in this area, with predominately native species.

Treatment of mature sagebrush areas such as those found in the Wildlife Mitigation Area appear to have the potential of increasing the abundance of perennial forbs and more desirable and accessible native shrubs. The treatment effect is evident five years after treatment but appears to be decreasing in overall effectiveness.

A comparison of the plant response on the Topsoil and Subsoil Stockpiles continues to support the findings obtained from the Refuse Test Plots. The data collected to date continue to suggest that in many respects subsoil is superior to topsoil as a plant growth medium. Little advantage gain can be documented from these data to justify the segregation of topsoil and subsoil during the mining and reclamation process as is often assumed by the regulatory process. Due to the problems of volunteer annuals it appears that better compliance with the regulatory goals of establishing a permanent, effective and predominately native plant cover can best be achieved with either subsoil or mixed topsoil and subsoil instead of commonly perceived notion of using segregated topsoil.

Five years after seeding there is still a significant response to fertilization. There seems to be a more residual effect of fertilization on topsoil than subsoil. The primary response to fertilization seems to be associated with the increased response to annuals, particularity cheatgrass. These data seemingly suggest that the regulatory requirements to apply supplemental fertilizer and achieve a reclaimed plant community dominated primarily by perennial natives are to a certain degree mutually exclusive.

The optimum soil depth to cover processed coal refuse material appears to be associated with the ten inches of subsoil treatment. This treatment has consistently yielded the highest perennial plant cover and shrub densities over the years. However, between 1986 and 1987 the percentage of perennial plant cover associated with the twenty inch topsoil plots has increased at a faster rate than any other treatment. It is possible that this is the development of a significant long term trend, or perhaps may be nothing more than a short term fluctuation in the data.

Plant growth on the fertilized coal refuse is quite encouraging considering the relatively small amount of inputs used on these treatments. Table 20 and 21 document that perennial plant cover on the 200 # per acre fertilization rate on the coal refuse is as effective in promoting plant growth as is every other topsoil treatment with exception of the twenty inch topsoil treatment. Plateau believes that this finding is

extremely important and demonstrates that with proper shaping to reduce runoff and fertilization that abandoned coal refuse piles in this area can be successfully reclaimed without the use of topsoil. Although Plateau has committed to topsoil its coal refuse piles, these data seemingly indicate that these areas can be successfully reclaimed without the expense commitment to topsoiling.

TABLE 1

1985 Seedings Plant Cover and Composition Summary

	CONVEYOR		MINE #1		ACCESS ROAD	
	COVER	COMP.	COVER	COMP.	COVER	COMP.
PERENNIAL GRASSES						
Inter. Wheatgrass	1.00	5.92	1.97	0.09	2.94	27.71
Smooth Bromegrass	.61	3.61	3.93	17.43	0.50	4.71
Orchardgrass	1.00	5.92	2.67	11.84	1.11	10.46
Foxtail Barley	–	–	.08	.35	–	–
Desert Wheatgrass	1.03	6.10	–	–	–	–
Western Wheatgrass	.39	2.31	–	–	–	–
Tall Fescue	.03	.18	–	–	–	–
Indian Ricegrass	.04	.24	–	–	–	–
SUBTOTAL	3.10	18.36	8.65	38.36	4.55	42.88
PERENNIAL FORBS						
Cicer Milkvetch	–	–	.32	1.42	.11	1.04
Yellow Sweetclover	9.64	57.00	9.65	42.79	4.00	37.70
Aster spp.	–	–	.23	1.02	–	–
Eriogonum spp.	.16	.95	–	–	–	–
Alfalfa	.71	4.20	.58	2.57	–	–
Dandelion	–	–	.12	.53	–	–
Senecio spp.	–	–	–	–	.11	1.04
Small Burnet	.03	.18	–	–	–	–
SUBTOTAL	10.54	62.33	10.97	48.60	4.22	39.78
ANNUAL FORBS						
Chorispora	2.07	9.18	.67	6.31	–	–
Summer Cypress	.15	.89	.05	.22	.06	.57
Russian Thistle	1.17	6.92	.52	2.31	.78	7.35
Saltbush	.17	1.01	–	–	–	–
Halogeton	.41	2.43	–	–	–	–
SUBTOTAL	1.90	11.25	2.64	11.71	1.51	14.23
SHRUBS						
Rubber Rabbitbrush	.03	.18	–	–	–	–
Big Sagebrush	.04	.24	.25	1.11	.17	1.60
Shadscale	.48	2.84	–	–	–	–
Fourwing Saltbush	.28	1.66	–	–	–	–
Mat Saltbush	.04	.24	–	–	–	–
Cuneate Saltbush	.49	2.90	–	–	–	–
Eriogonum	–	–	.05	.22	–	–
Snowberry	–	–	–	–	.17	1.60
SUBTOTAL	1.36	8.06	.30	1.33	.34	3.20
TOTAL	16.90	100	22.55	100	10.61	100

TABLE 2

WILDLIFE MITIGATION AREA PLANT COVER
AND COMPOSITION COMPARISONS

	CONTROL		TREATED	
	COVER	COMP.	COVER	COMP.
PERENNIAL GRASSES				
Blue grama	6.25	15.92	5.83	14.76
Salina wildrye	6.50	16.56	5.83	14.76
Needle and Thread	0.25	0.64	0.33	0.84
Squirreltail	0.75	1.91	0.17	0.43
Indian ricegrass	0.75	1.91	1.50	3.80
Western wheatgrass	0.75	1.91	0.17	0.43
Slender wheatgrass	-	-	0.17	0.43
Bluegrass	-	-	-	-
Desert wheatgrass	-	-	2.83	7.16
Subtotal	15.25	38.85	16.83	42.61
PERENNIAL FORBS				
Globemallow	-	-	1.17	2.96
Cryptantha	-	-	0.17	0.43
Aster	-	-	0.33	0.84
Alfalfa	-	-	1.50	3.80
Eriogonum	-	-	0.17	0.43
Blue flax	-	-	0.50	1.27
Machaeranthera	-	-	0.33	0.84
Subtotal	0.00	0.00	4.17	10.57
SHRUBS				
Big sagebrush	20.50	52.23	16.50	41.77
Broom snakeweed	0.75	1.91	1.33	3.37
Serviceberry	1.50	3.82	-	-
Pinyon pine	0.75	1.91	-	-
Echin. spp.	0.25	0.64	-	-
Subtotal	23.75	60.51	17.83	45.14
ANNUAL GRASSES				
Cheatgrass	0.25	0.64	0.67	1.70
Subtotal	0.25	0.64	0.67	1.70
TOTAL	39.25	100	39.50	100

TABLE 3

WILDLIFE MITIGATION AREA SHRUB DENSITY COMPARISONS
(plants/acre)

	DENSITY		COMPOSITION	
SPECIES	CONTROL	TREATED	CONTROL	TREATED
Big sagebrush	4553	4195	57.70	49.73
Green rabbitbrush	20	14	0.25	0.17
Pinyon pine	243	40	3.08	0.47
Utah serviceberry	405	95	5.13	1.13
Broom snakeweed	2670	4061	33.84	48.16
Fourwing saltbush	-	14	-	0.17
Woods Rose	-	14	-	0.17
TOTAL	7891	8433	100	100

TABLE 4

WILDLIFE MITIGATION AREA STATISTICAL COMPARISON

SITE	MEAN	STD. DEV.	N	T CAL.
Total cover (%)				
Control	39.25	4.99	4	
				0.006
Treated	39.50	6.75	6	
Perennial cover (%)				
Control	39.00	5.23	4	
				0.004
Treated	38.83	7.25	6	
Annual cover (%)				
Control	0.25	0.50	4	
				0.752
Treated	0.67	1.21	6	
Shrub density (#/50m2)				
Control	96.25	12.45	4	
				1.405
Treated	110.17	18.88	6	

TABLE 5

1987 TOPSOIL AND SUBSOIL STOCKPILES PLANT COVER

	Topsoil Stockpile		Subsoil Stockpile	
	COVER	COMP.	COVER	COMP.
Perennial Grasses				
Intermediate Wheatgrass	0.25	0.67	1.00	2.25
Desert Wheatgrass	21.50	57.33	12.00	26.97
Smooth Brome	2.75	7.33	1.50	3.37
Tall Fescue	0.25	0.67	-	-
Western Wheatgrass	3.00	8.00	-	-
Orchard Grass	0.50	1.33	0.25	0.56
Subtotal	28.25	75.33	14.75	33.15
Annual Grasses				
Cheat Grass	3.50	9.33	0.00	0.00
Annual Forbs				
Summer Cypress	5.25	14.00	0.00	0.00
Russian Thistle	-	-	0.00	0.00
Subtotal	8.75	23.33	0.00	0.00
Perennial Forbs				
Alfalfa	0.50	1.33	25.25	56.74
Yellow Sweetclover	-	-	4.50	10.11
Subtotal	0.50	1.33	29.75	66.85
TOTAL	39.50	99.99	44.50	100

TABLE 6

1987 TOPSOIL VERSUS SUBSOIL STOCKPILES COMPARISON

SOIL	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)				
Topsoil	37.50	3.11	4	
				3.03*
Subsoil	44.50	3.42	4	
Perennial Cover (%)				
Topsoil	28.80	3.77	4	
				6.19*
Subsoil	44.50	3.42	4	
Annual Cover (%)				
Topsoil	8.80	2.22	4	
				7.93*
Subsoil	0.00	0.00	4	
Shrub Density (plants/150 ft2)				
Topsoil	0.00	0.00	4	
				0.00
Subsoil	0.00	0.00	4	

*Means are significantly different at alpha = .10 using the two tailed t-test.

TABLE 7

COMPARISON OF PLANT GROWTH MEDIUMS

Total Cover (%)		
Refuse	11.58	a*
Topsoil	27.72	c
Subsoil	15.75	b
Topsoil over Subsoil	15.10	ab
Perennial Cover (%)		
Refuse	9.12	a
Topsoil	16.86	b
Subsoil	15.54	b
Topsoil over Subsoil	14.20	b
Annual Cover (%)		
Refuse	2.46	a
Topsoil	10.86	b
Subsoil	0.21	a
Topsoil over Subsoil	0.90	a
Shrub Density (stems/150 ft2)		
Refuse	0.32	a
Topsoil	3.27	b
Subsoil	3.33	b
Topsoil over Subsoil	3.17	b

*Means within a group followed by a different letter are significantly different at the 0.05 level using the Duncan's Multiple Range Test.

TABLE 8

FERTILIZER EFFECT ON PLANT GROWTH

FERTILIZER RATE	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)				
100#/Acre	20.83	8.31	46	
				1.802*
200#/Acre	24.61	10.41	31	
Perennial Cover (%)				
100#/Acre	15.74	4.84	46	
				0.907
200#/Acre	16.65	3.33	31	
Annual Cover (%)				
100#/Acre	5.09	7.66	46	
				1.468
200#/Acre	7.97	9.50	31	
Shrub Density (stems/ 150 ft2)				
100#/Acre	3.48	2.57	54	
				1.271
200#/Acre	2.79	2.31	34	

*Means are significantly different at alpha = .10 using the two tailed t-test

TABLE 9

FERTILIZER EFFECT ON SUBSOIL

FERTILIZER RATE	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)				
100#/Acre	15.43	3.30	14	
				0.599
200#/Acre	16.20	2.82	10	
Perennial Cover (%)				
100#/Acre	15.21	2.89	14	
				0.656
200#/Acre	16.00	2.91	10	
Annual Cover (%)				
100#/Acre	0.21	0.58	14	
				0.006
200#/Acre	0.20	0.42	10	
Shrub Density (stems/150 ft2)				
100#/Acre	4.21	2.86	14	
				2.157*
200#/Acre	2.10	1.37	10	

*Means are significantly different at alpha = .10 using the two tailed t-test

TABLE 10

FERTILIZER EFFECT ON TOPSOIL

FERTILIZER RATE	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)				
100#/Acre	25.50	7.99	26	
				2.117*
200#/Acre	31.12	9.18	17	
Perennial Cover (%)				
100#/Acre	16.62	5.79	26	
				0.390
200#/Acre	17.24	3.78	17	
Annual Cover (%)				
100#/Acre	8.88	8.42	26	
				1.830*
200#/Acre	13.88	9.25	17	
Shrub Density (stems/150 ft2)				
100#/Acre	3.21	2.51	38	
				0.156
200#/Acre	3.10	2.67	20	

*Means are significantly different at alpha = .10 using the two tailed t-test

TABLE 11

1987 FERTILIZER EFFECT ON TOPSOIL OVER SUBSOIL

FERTILIZER RATE	PLOT	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)					
100#/Acre	C1	13.17	2.93	6	
					3.163*
200#/Acre	C2	18.00	0.82	4	
Perennial Cover (%)					
100#/Acre	C1	13.17	2.93	6	
					1.492
200#/Acre	C2	15.75	2.22	4	
Annual Cover (%)					
100#/Acre	C1	0.00	0.00	6	
					3.000*
200#/Acre	C2	2.25	1.50	4	
Shrub Density (stems/150 ft2)					
100#/Acre	C1	3.50	0.71		
					0.284
200#/Acre	C2	3.00	2.31		

*Means are significantly different at alpha = .10 using the two tailed t-test.

TABLE 12

FERTILIZER EFFECT ON TEN INCHES OF TOPSOIL

SOIL	PLOT	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)					
100#/Acre	F2	31.75	6.82	8	
					1.204
200#/Acre	F1	36.10	8.18	10	
Perennial Cover (%)					
100#/Acre	F2	13.50	5.10	8	
					1.379
200#/Acre	F1	16.40	3.84	10	
Annual Cover (%)					
100#/Acre	F2	18.25	7.34	8	
					0.426
200#/Acre	F1	19.70	7.06	10	
Shrub Density (stems/150 ft2)					
100#/Acre	F2	2.80	1.99	20	
					0.496
200#/Acre	F1	3.25	3.17	12	

TABLE 13

FERTILIZER EFFECT ON TWENTY INCHES OF TOPSOIL

SOIL	PLOT	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)					
100#/Acre	E1	22.72	6.94	18	
					0.443
200#/Acre	E2	24.00	4.90	7	
Perennial Cover (%)					
100#/Acre	E1	18.00	5.66	18	
					0.185
200#/Acre	E2	18.43	3.64	7	
Annual Cover (%)					
100#/Acre	E1	4.72	4.74	18	
					0.417
200#/Acre	E2	5.57	4.08	7	
Shrub Density (stems/150 ft2)					
100#/Acre	E1	3.67	2.97	18	
					0.690
200#/Acre	E2	2.88	1.89	8	

TABLE 14

FERTILIZER EFFECT ON TEN INCHES OF SUBSOIL

SOIL	PLOT	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)					
100#/Acre	D2	15.70	3.83	10	
					0.702
200#/Acre	D1	17.00	3.10	6	
Perennial Cover (%)					
100#/Acre	D2	15.40	3.34	10	
					0.735
200#/Acre	D1	16.67	3.33	6	
Annual Cover (%)					
100#/Acre	D2	0.30	0.67	10	
					0.104
200#/Acre	D1	0.33	0.52	6	
Shrub Density (stems/150 ft2)					
100#/Acre	D2	5.40	2.46	10	
					2.629*
200#/Acre	D1	2.50	1.38	6	

*Means are significantly different at alpha = .10 using the two tailed t-test

TABLE 15

FERTILITY COMPARISON ON TWENTY INCHES OF SUBSOIL

SOIL	PLOT	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)					
100#/Acre	B2	14.75	1.50	4	
					0.190
200#/Acre	B1	15.00	2.16	4	
Perennial Cover (%)					
100#/Acre	B2	14.75	1.50	4	
					0.190
200#/Acre	B1	15.00	2.16	4	
Annual Cover (%)					
100#/Acre	B2	0.00	0.00	4	
					0.000
200#/Acre	B1	0.00	0.00	4	
Shrub Density (stems/150 ft2)					
100#/Acre	B2	1.25	0.96	4	
					0.311
200#/Acre	B1	1.50	1.29	4	

TABLE 16

SOIL DEPTH INTERACTIONS

TREATMENT	COVER
Total Cover (%)	
10" Topsoil	34.17 c*
10" Subsoil	16.19 a
20" Topsoil	23.08 b
20" Subsoil	15.00 a
10" Topsoil/10" Subsoil	15.10 a
Perennial Cover (%)	
10" Topsoil	15.11 ab
10" Subsoil	15.88 ab
20" Topsoil	18.12 b
20" Subsoil	14.88 ab
10" Topsoil/10" Subsoil	14.20 a
Annual Cover (%)	
10" Topsoil	19.06 c
10" Subsoil	0.31 a
20" Topsoil	4.96 b
20" Subsoil	0.00 a
10" Topsoil/10" Subsoil	0.90 a
Shrub Density (stems/150 ft2)	
10" Topsoil	2.96 ab
10" Subsoil	4.31 b
20" Topsoil	3.42 ab
20" Subsoil	1.38 a
10" Topsoil/10" Subsoil	3.17 ab

*Means within a group not followed by the same letter are significantly different at the 0.05 level using Duncan's Multiple Rule Range Test.

TABLE 17

1987 CONVEYOR EDGE EFFECT

SOIL	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)				
Near	13.88	4.52	8	
				0.165
Away	14.25	4.59	8	
Perennial Cover (%)				
Near	13.25	3.81	8	
				0.200
Away	12.88	3.68	8	
Annual Cover (%)				
Near	0.63	1.19	8	
				0.869
Away	1.38	2.13	8	
Shrub Density (stems/150 ft2)				
Near	1.75	1.83	8	
				0.849
Away	1.13	0.99	8	

TABLE 18

ASPECT COMPARISON

SOIL	PLOT	MEAN	STD. DEV.	N	T_CAL.
Total Cover (%)					
North	D2	15.70	3.83	10	3.950*
South	G	23.60	3.21	5	
Perennial Cover (%)					
North	D2	15.40	3.34	10	4.536*
South	G	23.60	3.21	5	
Annual Cover (%)					
North	D2	.30	0.67	10	1.429
South	G	0.00	0.00	5	
Shrub Density (stems/150 ft2)					
North	D2	5.40	2.46	10	2.372*
South	G	2.67	1.75	6	

*Means are significantly different at alpha = .10 using the two tailed t-test

TABLE 19

NUMBER OF SAMPLES NEEDED TO MEET SAMPLE ADEQUACY

PLOT	NUMBER OF SAMPLES COLLECTED	SAMPLES REQUIRED N80/10
A1	27	34.3
A2	14	12.6
B1	4	3.4
B2	4	1.7
C1	6	8.1*
C2	4	0.3
D1	6	5.5
D2	10	9.8
E1	18	15.3
E2	7	6.3
F1	10	8.4
F2	8	7.6
G	5	3.0
TOPSOIL	4	1.1
SUBSOIL	4	1.0

*Disturbed Plot

TABLE 20

FERTILIZER EFFECT ON COAL REFUSE

FERTILIZER RATE	PLOT	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)					
100#/Acre	A1	10.41	4.76	27	
					2.508*
200#/Acre	A2	13.86	3.84	14	
Perennial Cover (%)					
100#/Acre	A1	7.44	5.49	27	
					3.103*
200#/Acre	A2	12.36	4.41	14	
Annual Cover (%)					
100#/Acre	A1	2.96	2.71	27	
					2.376*
200#/Acre	A2	1.50	1.22	14	
Shrub Density (stems/150 ft2)					
100#/Acre	A1	0.19	0.48	27	
					1.969*
200#/Acre	A2	0.57	0.65	14	

*Means are significantly different at alpha = .10 using the two tailed t-test

TABLE 21

COMPARISON OF PLOT MEANS BY VEGETATIVE CHARACTERISTIC

PLOT	PERCENT ANNUAL COVER	PERCENT PERENNIAL COVER	PERCENT TOTAL COVER	SHRUB DENSITY (stems/150 ft2)
A1	2.96 ab*	7.44 a*	10.41 a*	0.19 a*
A2	1.50 ab	12.36 ab	13.86 ab	0.58 ab
B1	0.00 a	15.00 bc	15.00 ab	1.50 abc
B2	0.00 a	14.75 bc	14.75 ab	1.25 abc
C1	0.00 a	13.17 bc	13.17 ab	3.50 cd
C2	2.25 ab	15.75 bc	18.00 bcd	3.00 bcd
D1	0.33 a	16.67 bc	17.00 bc	2.50 abc
D2	0.30 a	15.40 bc	15.70 b	5.40 d
E1	4.72 ab	18.00 bc	22.72 cd	3.67 cd
E2	5.57 b	18.43 c	24.00 d	2.88 bcd
F1	19.70 c	16.40 bc	36.10 e	3.25 cd
F2	18.25 c	13.50 bc	31.75 e	2.80 bc
G	0.00 a	23.60 d	23.60 d	2.67 abc

*Means within columns followed by a different letter are significantly different at the 0.05 level using the Duncan's Multiple Rule Test.

file ACT/007/006
#2

CYPRUS-PLATEAU MINING CORP.
An Affiliate of Cyprus Coal Company
P.O. Drawer PMC Price, Utah 84501
Telephone (801) 637-2875

January 5, 1988

Bernadette Urioste
Law Enforcement (69400)
U.S. Fish and Wildlife Service
P.O. Box 25486, D.F.C.
Denver, Colorado 80225

Re: **Permit PRT-719890 Annual Report - 1987**

Dear Ms. Urioste:

Enclosed please find a copy of the 1987 Annual Report for Permit PRT-719890. This report fulfills the requirements of our Permit and 50 CFR 21.27(c)(1).

If you have any questions, please contact me.

Respectfully yours,

Ben Grimes
Sr. Environmental Engineer

BG:sd

Enclosure

cc: Larry Dalton - DWR Price
John Whitehead - DOGM

File: ENV 2-5-5-8
Chrono: BG 880101

PLATEAU

ANNUAL REPORT

1987

PERMIT NO. PRT-719890

Cyprus-Plateau Mining Corporation
P.O. Drawer PMC
Price, Utah 84501

Introduction

This is the first report for Permit PRT-719890 as required by 50 CFR 21.27(c)(1).

The following areas of the monitoring plan as approved by the U.S. Fish and Wildlife Service and incorporated into the permit will be addressed:

Cliff Subsidence Monitoring
Cliff Face Spalling
Eagle Activity
Monitoring Schedule

In addition, nest screening conducted in 1987 will be detailed under Permit Action.

Based on exploration drilling conducted in October and November and subsequent data analysis, longwall panel No. 1 as shown on Maps 2 and 3 of the permit application is not mineable. The coal was washed out by a beach front during formation of the prehistoric swamp. This discovery has necessitated a change in the mine plan as previously detailed. Maps 2 and 3 and Table 1 showing the monitoring schedule have been revised to reflect the change in mine plan and schedule. Revised copies of Maps 2 and 3 and Table 1 are included in this report.

In addition, mining of longwall panels will begin approximately June 15 instead of August 1 as shown on Table 1 in the original permit application.

Since longwall panel No. 1 is not mineable, mining will begin at the east end of panel No. 2 and will proceed westward. Panel No. 3 has been revised to include mining two longwall subpanels, 3A and 3B, instead of one longwall panel and a panel of room and pillar mining. Subpanels 3A and 3B will be separated by a stream barrier zone as shown on Map 2. This barrier zone will not be mined to protect the stream flowing above the coal seams.

Mining of longwall panel No. 2 may not cause subsidence that affects nests No. 20 and 21. The angle-of-draw from the north edge of panel No. 2 reaches just south of nest No. 20. The angle-of-draw is the point at the surface where no subsidence occurs. The angle documented at our operation is 21.5 degrees.

Monitoring will be conducted in 1988 as previously outlined to document subsidence effects and raptor activity.

Cliff Subsidence Monitoring

Subsidence of the nests is not possible until 1988 and probably not until 1990.

Surveying in 1987 consisted of preliminary work to establish State Plane Coordinates and elevation control in the area of the cliff. Monitoring point locations were selected as well as the main control point for EDM surveys.

Monitoring in 1988 will consist of horizontal and vertical surveys of the cliff as detailed in the approved plan.

Cliff Face Spalling

In 1987, a location to take ground based photographs of the cliff was selected and photographic equipment was evaluated and purchased.

Evaluation of a suitable cliff to serve as a control was initiated in 1987. A cliff with similar characteristics, i.e., height, orientation, shape and geologic formation was not found. Evaluations will continue in 1988 and a site will be selected by the time longwall mining starts in mid-June.

Eagle Activity

In 1987, neither nest 20 or 21 was active. Nest 22 as shown on Map 2 was used by the study pair of Golden Eagles. Two young were successfully fledged in August. Both immature birds were observed in the area on several different occasions during August, September and October.

Monitoring Schedule

Monitoring during 1988 will be conducted as shown on Table 1 as revised, a copy of which is included in this report. This schedule reflects the revised mine plan as discussed previously.

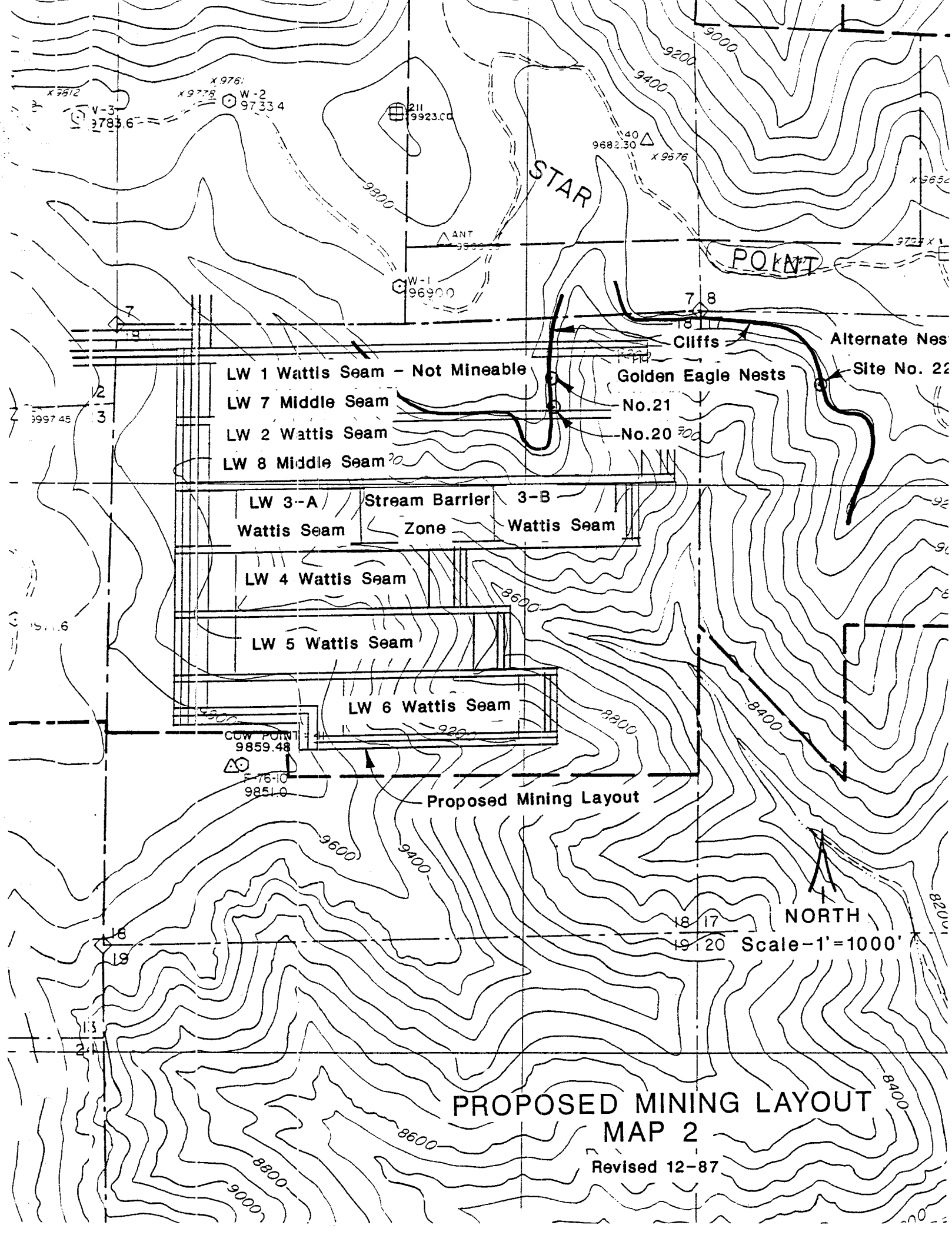
Permit Action

On October 7, 1987 nests 20 and 21 were covered with wire mesh screen in accordance with the permit.

Personnel involved in the project were: Larry Dalton and Miles Moretti of the Utah Division of Wildlife Resources, Ben Grimes of Cyprus-Plateau Mining Corporation, and Brandon Grebence, a mountain climber hired by Cyprus-Plateau Mining Corporation.

Wire mesh screen material was secured to the cliff by drilling holes into the rock, securing eye bolts in the holes with epoxy resin and fastening the wire mesh to the eye bolts with locking C-clamps. Photographs 1 through 6 show various aspects of the project and a view of the final result. Nest No. 21 is located on a vertical face where obtaining close-up photographs was extremely difficult; therefore, the only photograph (No. 6) of it was obtained from a helicopter.

An article on the project appeared in the Salt Lake Tribune on November 30, 1987; a copy is included in this report.



PROPOSED MINING LAYOUT
MAP 2

Revised 12-87

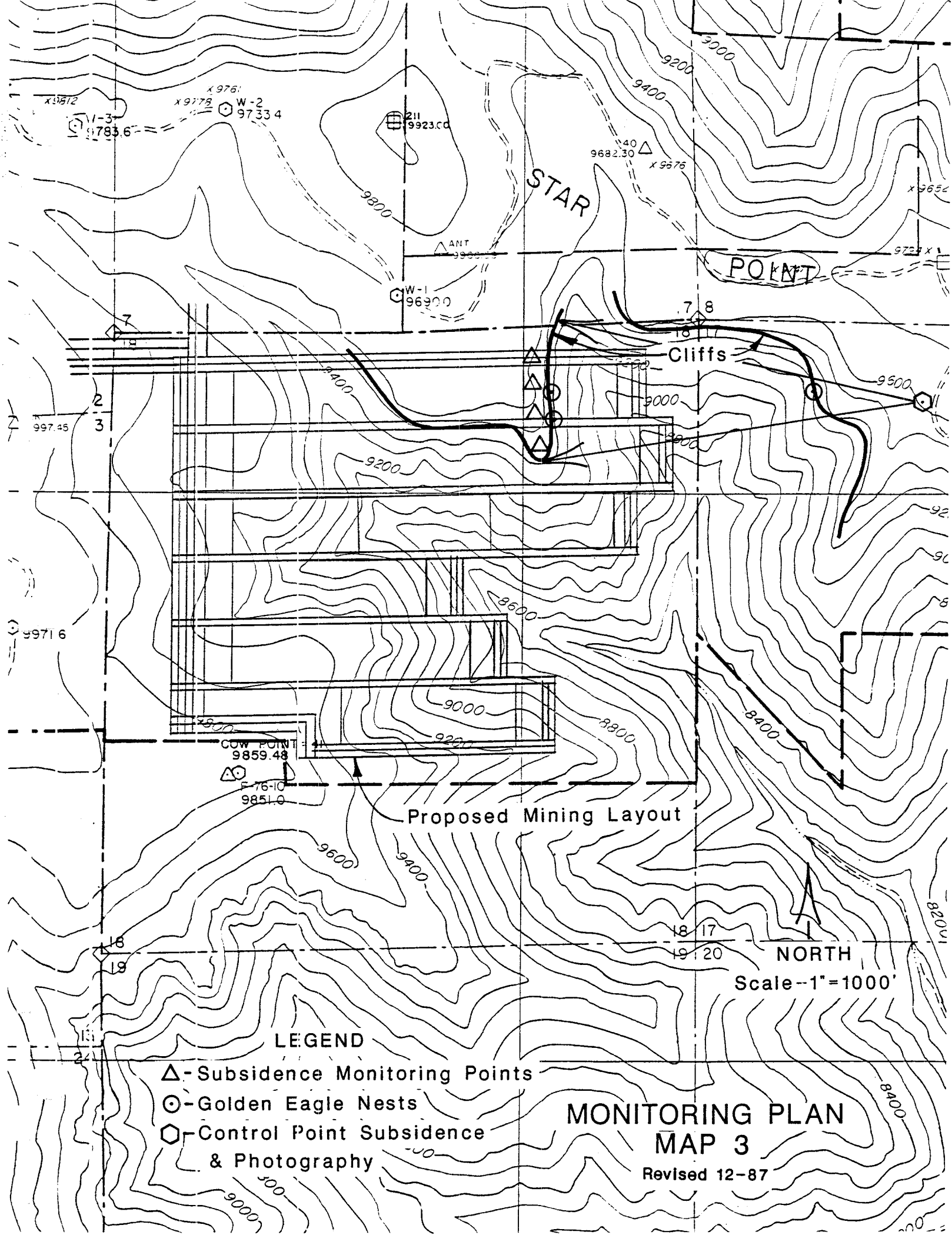

STAR
POINT
Cliffs
W-2
9733.4
W-1
9690.0
I-3
9783.6
ANT
9682.30
COW POINT
9859.48
F-76-10
9851.0
9997.45
9971.6
Proposed Mining Layout
NORTH
Scale-1"=1000'
LEGEND
△-Subsidence Monitoring Points
⊙-Golden Eagle Nests
⬡-Control Point Subsidence & Photography
MONITORING PLAN
MAP 3
Revised 12-87

TABLE 1

RAPTOR – CLIFF FACE MONITORING SCHEDULE

TABLE 1

REVISED 12-87

LONGWALL MINING 3rd SEAM | WATTIS SEAM

LW1 NOT MINEABLE

LW2 2

LW3 A & B 3A, 3B

LW4 4

LW5 5

LW6 6

LW7 7

LW8 8

7th-NESTS SCREENED

NESTS LOCATION

NESTS LOCATION

ESTIMATED SUBSIDENCE

NESTING SEASONS

MONITORING

1987: S; C; R1 R1 / R2 R3 R3

1988: S S S S; C C C C; R2 R3

1989: S S4 S S4 S S4 S S S; C C1 C C1 C C1 C C C; R2 R5 R2 R1 R1 R1 R1 / R3 R3 R3 R3

1990: S S4 S S4 S S4 S S S; C C1 C C1 C C1 C C C; R2 R5 R2 R1 R1 R1 R1 / R3 R3 R3 R3

1991: S S4 S S4 S S4 S S S; C C1 C C1 C C1 C C C; R2 R5 R2 R1 R1 R1 R1 / R3 R3 R3 R3

ESTIMATED SUBSIDENCE

NESTING SEASONS

MONITORING

1992: S S4 S S4 S S4 S S S; C C1 C C1 C C1 C C C; R2 R5 R2 R1 R1 R1 R1 / R3 R3 R3 R3

1993: S S4 S S4 S S S; C C1 C C1 C C C; R2 R5 R2 R1 R1 / R3 R3

1994 1995 1996

MONITORING LEGEND

S=SUBSIDENCE MONITORING EDM

C=CLIFF FACE SPALLING MONITORING

R=RAPTOR ACTIVITY MONITORING

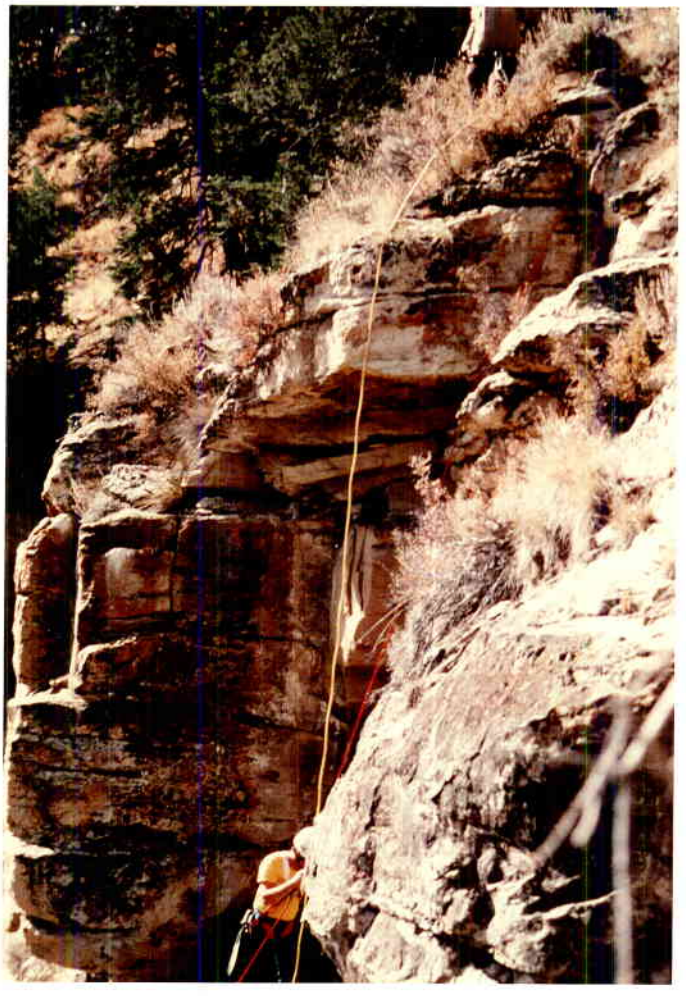
1=IF RAPTORS SHOW ACTIVITY IN PREVIOUS MONTH

2=MONITORING BY RAPTOR BIOLOGIST

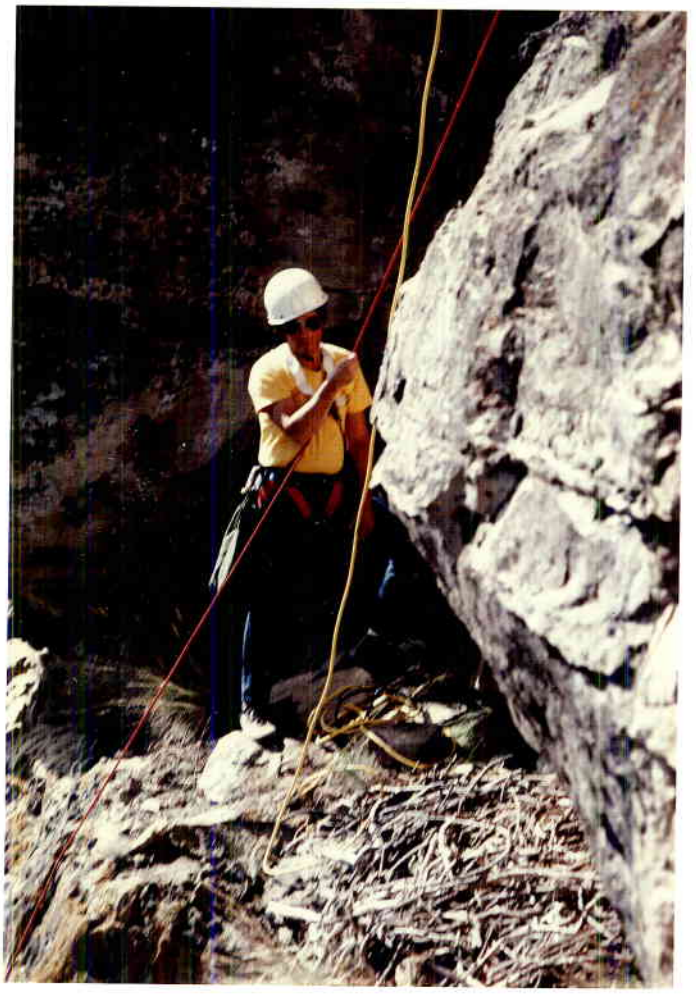
3=MONITORING BY PMC

4=IF RAPTORS SHOW NESTING ACTIVITY

5=RAPTOR MONITORING=2 TIMES PER MONTH BY RAPTOR BIOLOGIST



1. Nest No. 20 in relationship to top of cliff. Nest is at climber's feet.



2. Nest No. 20

3. Nest No. 20. Shows climber drilling anchor hole to secure wire mesh.

4. Nest No. 20. Shows wire mesh in place.
Notice anchor bolt in lower left of picture.

5. Nest No. 20. Shows completed project taken from a helicopter. Nest is in the center of the photo.

6. Nest No. 21. Shows completed project taken from a helicopter. Nest is in the center of the photo.

Chain-Link Fence May Save Golden Eagles

Chain-link fencing has been placed over two golden eagle nests near Price in an experiment to protect the birds from the effects of coal mining.

Larry B. Dalton, a resource analyst for the Utah Division of Wildlife Resources, said underground activity at the Star Point Mine is predicted to cause a nearby cliff face to collapse. This is a routine consequence of ground subsidence associated with underground coal mining.

Two golden eagle nests are located on the 100-foot-high cliff which is expected to collapse. If nothing had been done to prevent the eagles from using those nests, the adults and their young would face death by falling rocks when the cliff fails.

To reduce this risk, biologists recently lowered themselves on ropes to the ledges on which the eagles nest and bolted 20-foot-long sections of chain-link fence over the opening. This preserves the nest but keeps the birds away until the danger has passed.

Golden eagles typically maintain several nest sites within their territory. In this case, biologists believe a single pair of eagles alternately use both of the nests which were covered and a third nest located across the canyon in an area which is not endangered by the mine.

Mr. Dalton said the eagles will either move to the safety of that third nest or build a new nest — perhaps somewhere outside the danger zone.

If the cliff face survives the subsidence caused by the mine, biologists can simply remove the fence and allow the eagles to reoccupy the nests.

If the nests are destroyed by the mining, the company will be required to "mitigate," or offset, the loss. The type of mitigation has not been determined, but Mr. Dalton said it could include the construction of man-made nests for the eagles.

"They'd have to find a spot, gather up the sticks, and stack them up," he said. Because of the precarious nest sites preferred by golden eagles, this can be a dangerous and expensive project.

The fencing experiment is being overseen by the Utah Division of Wildlife Resources; Utah Division of Oil, Gas and Mining; U.S. Fish and Wildlife Service; and Cyprus/Plateau Mining Co. — owners of the Star Point Mine.

If the experiment is successful, a similar process could be required at other coal mines to protecting golden eagles, red tailed hawks and prairie falcons.

Mr. Dalton said a similar problem occurred last year at Utah Power & Light Co.'s Cottonwood Mine. In that case, a cliff holding one nest collapsed just prior to the breeding season and the second nest fell soon after the young birds had learned to fly.

"It was just luck" that none of the eagles was killed, said Mr. Dalton.

Golden eagles are common throughout Utah. Even so, they and all other birds of prey are protected by federal law. This is why the mining companies are working so hard to take care of the eagles that live near their facilities.

Brandon Grebence bolts chain-link fence over a golden eagle nest near Price. The fence will protect nests from falling rocks caused by underground mining activity.

SALT LAKE TRIBUNE NOV 30, 1987

ANNUAL REPORT

1988

PERMIT NO. PRT-719890

CYPRUS PLATEAU MINING CORPORATION
P. O. DRAWER PMC
PRICE, UT 84501

Introduction

This is the second annual report for Permit PRT-719890, as required by 50 CFR 21.27(c)(1) and conditions of the Permit.

The following areas of the monitoring plan, as approved by the U.S. Fish and Wildlife Service, will be addressed:

Cliff Subsidence Monitoring
Cliff Face Spalling
Eagle Activity
Monitoring Schedule

As discussed in the 1987 Report, coal does not exist directly beneath the nests in the Top or Wattis Coal Seam, therefore, mining was not conducted beneath the nests in 1988. As shown on the enclosed map, mining has been conducted 220 feet south of Nest 20; with the edge of longwall mining being 390 feet south of Nest 20. As can be seen on the map, the northern edge of Longwall Panel 8 just clips the end of the cliff face.

Mining of Longwall Panel 8 began on August 2, 1988, with mining passing the tip of the cliff face on September 10, 1988. Panel 8 was halted on December 1, 1988, and Panel 9 mining began on December 12, 1988.

Mining conditions and market conditions dictate mining schedules; it is impossible to conform to strict schedules. Based on our best estimate, mining of the Third Coal Seam, which does exist directly beneath the nests, will begin in late 1990.

Cliff Subsidence Monitoring

Four permanent monitoring points, U1 through U4, were established on top of the cliff, as shown on the enclosed map. The points were surveyed on July 7th before longwall mining began, on September 23rd, 13 days after the longwall passed by the tip of the cliff, and on November 1, 52 days after the longwall passed by the tip of the cliff.

Horizontal movement plots for points U1 through U4 are included as Figures 1 through 4. Vertical subsidence is noted on these figures.

Some surface cracks have appeared, as shown on the enclosed map. The widest and longest crack is located near point U1, almost directly above the edge of the longwall panel. This crack was approximately 8 inches wide on November 22. The cracks located just south of point U2 were approximately 4 inches wide, and the cracks located between U2 and U3 were approximately one-eighth of an inch wide.

Cliff Face Spalling

Photographs of the cliff were taken on August 20th before mining was conducted beneath the cliff, and again on October 6th, 26 days after the longwall passed by the tip of the cliff. Color copies of the photographic composite are included in this report.

As can be seen on the photographs, the largest surface crack is visible near point U1. A slab of rock fell from the face near Nest 20. No other apparent spalling has occurred on the cliff face, although Nest 21 is hidden by trees.

An extensive search was made for a reference cliff to use as a control. The primary objective of the search was to locate a cliff in the same formation with similar height, aspect, and shape. There are no cliffs in the area that were even close to meeting the requirements. Photographs were taken of a cliff in the area, but no more photographs will be taken until the last series of photographs of the undermined cliff are made.

Eagle Activity

On May 31, Miles Moretti and Larry Dalton, of UDWR, and Ben Grimes, of Cyprus Plateau, conducted a survey, by helicopter, of the cliff and general area and territory of the target eagle pair. No nesting activity was found in the area. The nest not fenced in the territory (No. 22) was inactive and no new attempts to build a new nest were observed.

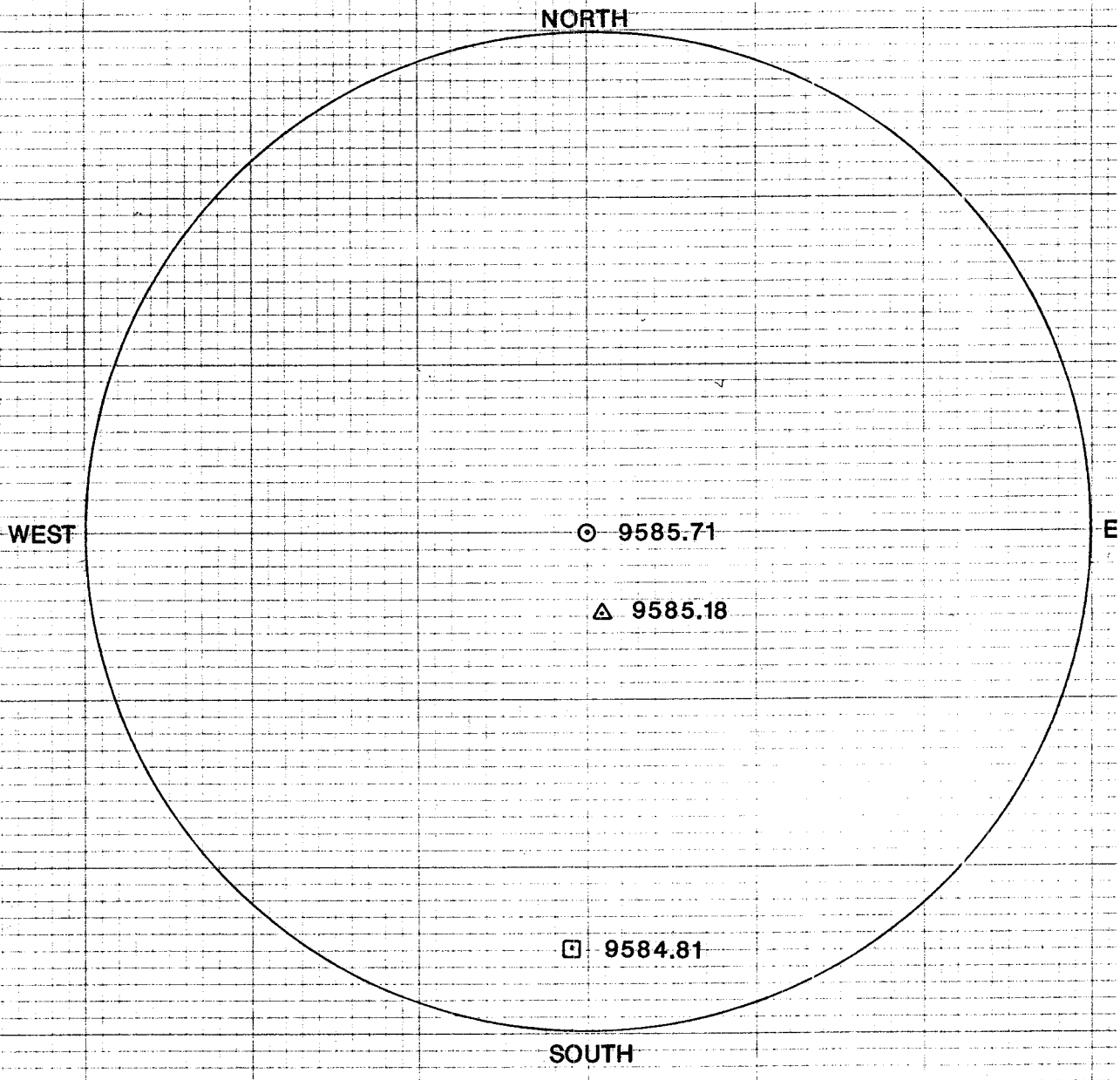
Observations from the ground were made weekly during the Summer and Fall in the territory. Two adult Golden Eagles were observed soaring and perched on many occasions throughout the period. In addition, juvenile eagles were observed on several occasions in the territory.

Monitoring Schedule

Table 1, enclosed, has been revised to show actual monitoring and mining schedules as of January 5, 1989. As discussed previously, mining schedules change because of several factors. The best estimate of mining is shown on Table 1.

Discussions were held with Clark Johnson (USFWS, Salt Lake City), and with Miles Moretti and Larry Dalton (UDWR, Price, Utah), to review monitoring results and future monitoring. A letter summarizing the meeting with Clark Johnson is included in the back of this report.

FIGURE 1
U-NORTH CLIFF SUBSIDENCE MONITORING
STATION U1
HORIZONTAL MOVEMENT PLOT



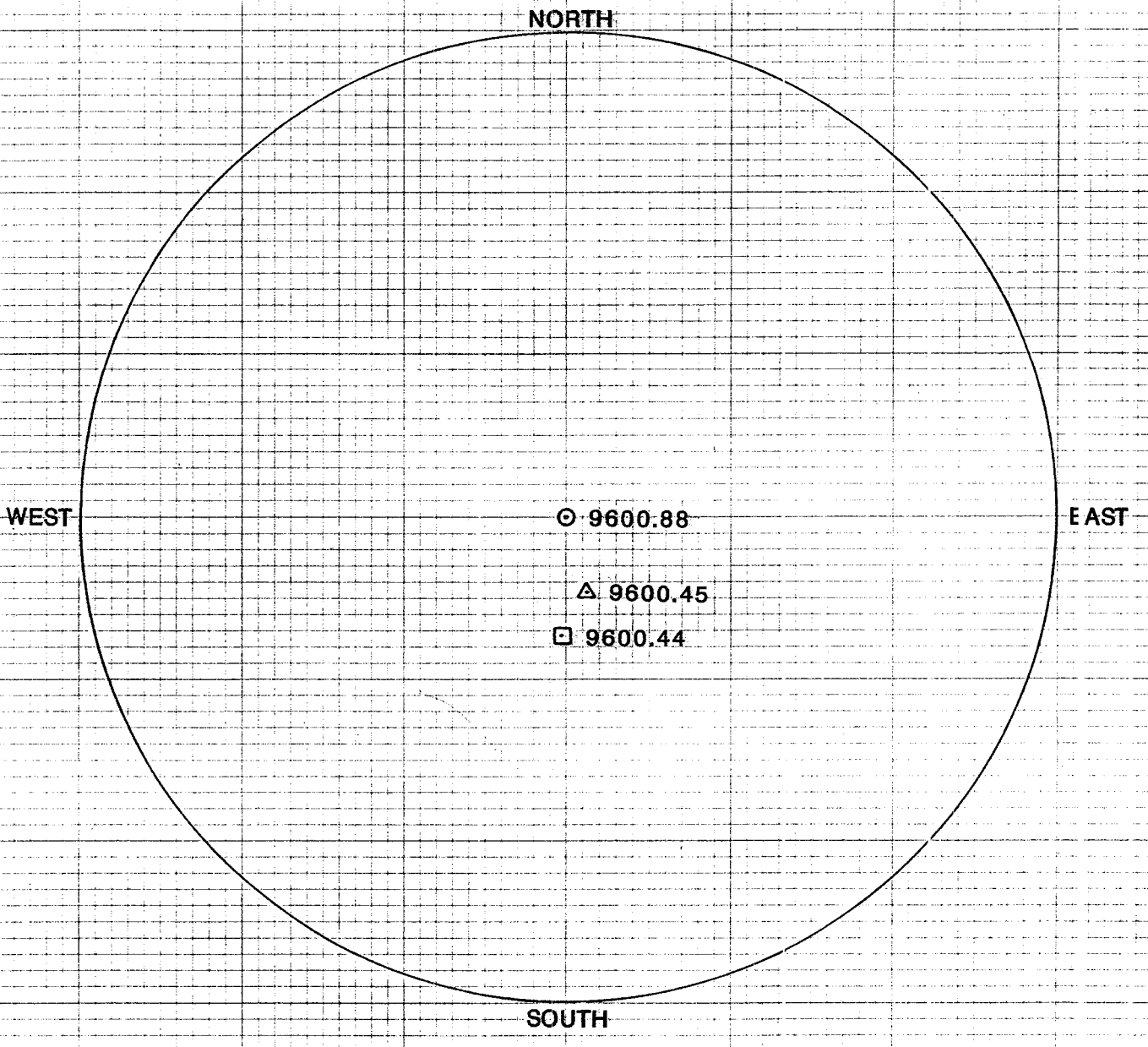
LEGEND

⊙ PREMINING JULY 7,1988
△ SEPTEMBER 23,1988
⊡ NOVEMBER 1,1988

TOTAL VERTICAL SUBSIDENCE -0.90 FEET

SCALE = 1"=1'

FIGURE 2
U-NORTH CLIFF SUBSIDENCE MONITORING
STATION U2
HORIZONTAL MOVEMENT PLOT



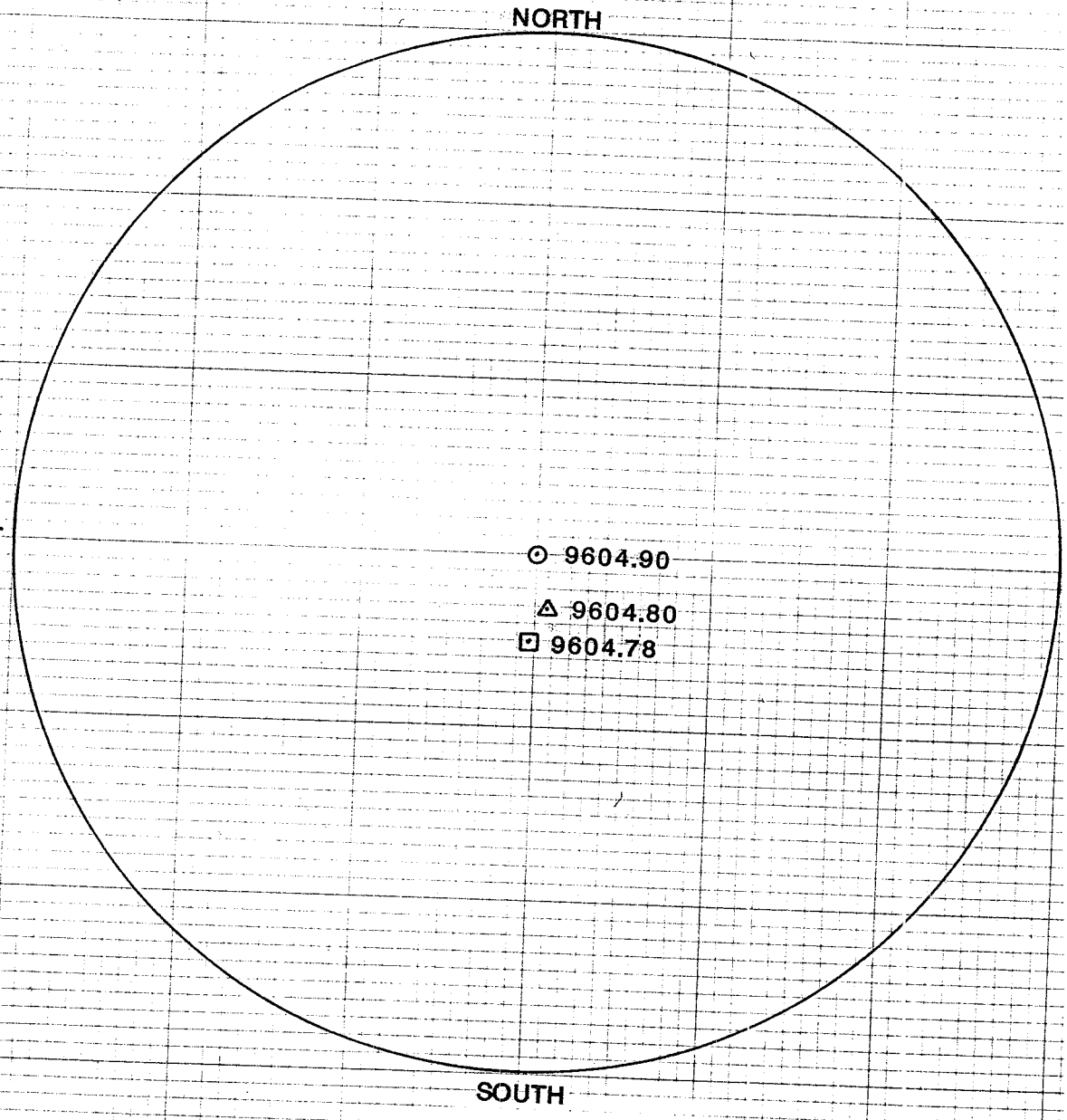
LEGEND

⊙ PREMINING JULY 7,1988
△ SEPTEMBER 23,1988
⊡ NOVEMBER 1,1988

TOTAL VERTICAL SUBSIDENCE -0.44 FEET

SCALE = 1"=1'

FIGURE 3
U-NORTH CLIFF SUBSIDENCE MONITORING
STATION U3
HORIZONTAL MOVEMENT PLOT



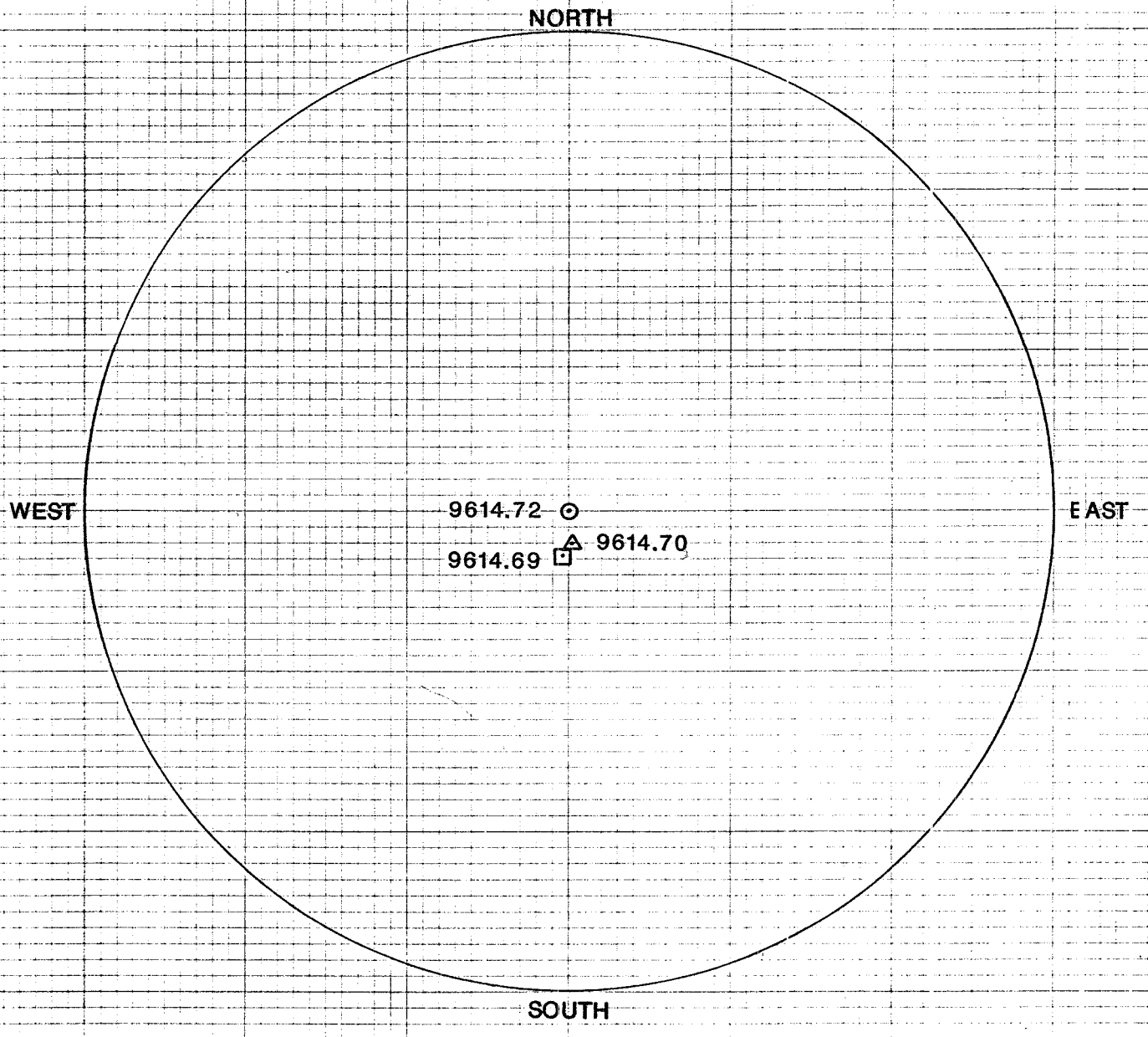
LEGEND

⊙ PREMINING JULY 7,1988
△ SEPTEMBER 23,1988
⊡ NOVEMBER 1,1988

TOTAL VERTICAL SUBSIDENCE -0.2 FEET

SCALE = 1"=1'

FIGURE 4
U-NORTH CLIFF SUBSIDENCE MONITORING
STATION U4
HORIZONTAL MOVEMENT PLOT



LEGEND

⊙ PREMINING JULY 7,1988
△ SEPTEMBER 23,1988
⊡ NOVEMBER 1,1988

TOTAL VERTICAL SUBSIDENCE -0.03 FEET

SCALE = 1"=1'

TABLE 1
RAPTOR-CLIFF MONITORING SCHEDULE

	1987												1988												1989											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
LONGWALL MINING WATTIS SEAM PANEL 8										NESTS SCREENED										8	NESTS LOCATION NORTH OF PANEL 8	8												
PANEL 9																										9										
PANEL 10																													10							
PANEL 11																																	11			
PANEL 12																																				12
THIRD SEAM PANEL 13																																				
PANEL 14																																				
SUBSIDENCE																																				
NESTING SEASONS		1	1	1	1	1	1	1						1	1	1	1	1	1	1	1						1	1	1	1	1	1	1			
MONITORING CLIFF SURVEY							S												S		S		S		S		S4	S	S4	S	S4	S		S		S
PHOTOS																				C		C			C		C4	C	C1	C	C1	C		C		C
EAGLE ACTIVITY					R2	R1,R3	R1,R3										R2	R3	R3	R3	R3	R3	R3		R3	R2	R5	R2	R1,R3	R1,R3	R1,R3	R1,R3				

	1990												1991												1992											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
LONGWALL MINING WATTIS SEAM PANEL 8										NESTS LOCATION SOUTH OF PANEL 13						NESTS LOCATION ABOVE PANEL 14																						
PANEL 9																																				
PANEL 10																																				
PANEL 11																																				
PANEL 12	12																																			
THIRD SEAM PANEL 13									13																											
PANEL 14															14																					
SUBSIDENCE																																				
NESTING SEASONS		1	1	1	1	1	1	1						1	1	1	1	1	1	1							1	1	1	1	1	1	1			
MONITORING CLIFF SURVEY		S	S4	S	S4	S	S4	S		S		S		S	S4	S	S4	S	S4	S		S		S		S	S4	S	S4	S	S4	S		S		S
PHOTOS		C	C1	C	C1	C	C1	C		C		C		C	C1	C	C1	C	C1	C		C		C		C	C1	C	C1	C	C1	C		C		C
EAGLE ACTIVITY		R2	R5	R2	R1,R3	R1,R3	R1,R3	R1,R3						R2	R5	R2	R1,R3	R1,R3	R1,R3	R1,R3						R2	R5	R2	R1,R3	R1,R3	R1,R3	R1,R3				

MONITORING LEGEND
S=SUBSIDENCE MONITORING BY EDM
C=CLIFF FACE SPALLING MONITORING PHOTOS
R=RAPTOR ACTIVITY MONITORING
1=IF RAPTORS SHOW ACTIVITY IN PREVIOUS MONTH
2=MONITORING BY RAPTOR BIOLOGIST
3=MONITORING BY CPMC
4=IF RAPTORS SHOW NESTING ACTIVITY
5=RAPTOR MONITORING-2 TIMES PER MONTH BY RAPTOR BIOLOGIST

CYPRUS
Plateau Mining

An Affiliate of Cyprus Coal Company
P.O. Drawer PMC
Price, Utah 84501
(801) 637-2875

January 5, 1989

Mr. Clark Johnson
U.S. Fish and Wildlife Service
2060 Administration Building
1745 West 1700 South
Salt Lake City, UT 84104-5110

Re: Permit PRT-719890 - Update

Dear Mr. Johnson:

Thank you for meeting with me yesterday regarding our monitoring program.

To summarize our meeting, I updated you on our mining plan and schedule and we discussed future monitoring. The following items were discussed:

- The mine layout has been revised because of geologic features that prevented us from mining the northern-most longwall panel and the western part of the next panel south.
- The mining schedule has been different than presented on Table 1 which is a part of our permit application.
- The monitoring schedule approved as a part of our permit has had to be different than shown on Table 1.
- Monitoring of the cliff has been done before, during, and after mining beneath the cliff.
- Subsidence is taking place at the cliff, but the nests have not been damaged; one small slab of rock has fallen (5' x 15' x 2' thick).
- Monitoring of the cliff, nests, and eagle activity will continue essentially as shown on Table 1.
- The survey points will be surveyed during the last week of January and cliff photographs will be taken.

- Surveying of the points will not be done in February because: (1) access to the area is by helicopter; (2) helicopter noise and movements may disturb the pair of eagles if they have started courtship or nest building.

- The cliff will be observed by a biologist for eagle activity during the third week of February.

- Monitoring beyond February will be contingent upon the results of January and February monitoring. A meeting will be scheduled after February to plan further monitoring.

- Mining in the second coal seam beneath the nests is tentatively scheduled for late 1990 and during 1991. Monitoring will continue on an agreeable schedule.

You were going to find out when the eagles may be expected to show courtship activity and nest building activity, i.e., morning, mid-day, or evening, so we can plan the February observation.

If I have misrepresented anything from our meeting, please let me know.

Respectfully,

Ben Grimes
Sr. Environmental Engineer

/kam

cc: Bernadette Urioste
Larry Dalton

File: ENV 2-5-5-8

Chrono: BG890102

PLATEAU MINING COMPANY

1988 ANNUAL RECLAMATION REPORT

STAR POINT MINES

PREPARED BY

IME
P.O. BOX 270
YAMPA, CO. 80483

INTRODUCTION

This annual reclamation report is submitted by Plateau Mining Company in accordance with their approved Mining and Reclamation Plan which requires that all reclaimed areas would be sampled during years 1, 2, 3, 5, 9 and 10 and that an annual reclamation monitoring report would be submitted to the Division each year. This report contains the results of field data collected on July 28, 1988 which will satisfy the 1988 monitoring requirements. All of the data was collected and analyzed by Kent Crofts, Michael Jones and Ken Jones of IME of Yampa, Colorado. The monitoring program conducted in 1988 is identical with previous reclamation monitoring efforts and is consistent with the sampling methodologies and frequency outlined in Plateau's permit.

SAMPLING METHODOLOGIES

All of the data were collected during the 1988 monitoring effort using identical sampling methodologies, equipment, recorders and methods of data analysis previously used and approved by the Division for this site. The vegetative parameters sampled in 1988 included total plant cover and woody plant densities. Due to the similarity of methodologies utilized, Plateau believes that a comparison of data between years is possible to establish trends regrading the successfulness of current and previous revegetation efforts.

Cover

Plant cover was measured using a sampling technique previously approved. Plant cover was estimated using 2 by 5dm quadrates. The transect length used in these areas was 14.52 feet in length, and the transects were randomly located throughout the area to be sampled. At each transect, five quadrati were sampled. The five quadrati values were then averaged into a single transect observation which was used for subsequent data analysis. At each plot, the observation was recorded by plant species, or wheter or not litter, rock or bare ground was encountered. Plant material that had dried prior to sampling (such as cheatgrass), but was a product of the 1988 growing season, was counted as plant cover. Litter was defined as that material that had been on the ground or was a dead part of the plant for approximately one year prior to sampling.

Woody Plant Density

Woody plant density values were obtained by sampling a 3 by 14.52 feet belt transect. The tape used for the cover transect was also used as the center point for the woody plant density transects. Each side of the transect was sampled, and the two corresponding values were then averaged and used as a single datum.

RESULTS AND DISCUSSION

1985 Conveyor Seeding

A total of 25 transects were taken to evaluate plant cover and to determine woody plant density. Third year total plant cover on this area sampled in 1988 was found to equal 16.23 percent (Table 1). This compares with a total plant cover value of 16.9 percent obtained in the 1987 reclamation sampling for this area, as reported in the 1987 Annual Reclamation Report. Shrub density on this area was found to equal 0.92 plant per 100th acre (Table 2).

Upon comparing the existing revegetation success of this area with the proposed reference area vegetative characteristics reported in the Plateau Permit these values are very encouraging. The total plant cover values for the various plant communities are as follows:

REFERENCE AREA	% TOTAL PLANT COVER
Mountain Shrub	49.0
Douglas Fir	15.1
Sagebrush	33.7
Pinyon Juniper-East	32.5
Pinyon Juniper-West	12.8
Saltbush	17.5
Mountain Grassland	43.6

This reclaimed area corresponds almost entirely to the Saltbush Vegetation Type. Using the predisturbance total plant cover colleceted from this area the revegetation success value would be approximately 17.5 percent total plant cover. Since the third year total plant cover for this area was determined to equal 16.9 percent it is likely that sufficient plant cover has established on this site to satisfy the total plant cover requirements for revegetation. The ultimate determination of revegetation success will be made at the time of bond release sampling, however, these data suggest that the site has been successfully reclaimed.

1985 Mine #1 Seeding

Two seperate areas reclaimed during 1985 were sampled during the 1988 monitoring program. These areas correspond to the southern area to the south of the existing access road containing the old coal shoot area and its associted access road and a much smaller access road to the north of the existing access road and running towards the direction of the coal preparation plant. A total of 25 transects was taken on the southern tract to determine plant cover and 20 transects were taken on the northern area to determine plant cover.

The average plant cover on the southern area was determined to equal 32.71 percent (Table 1). The shrub density on this area was calculated to be 0.12 shrubs per 100th acre (Table 2). In the 1987 sampling of this area, reported in the 1987 Annual Reclamation Report, the total plant cover was determined to equal

22.6 percent. Thus it appears with the maturing of the reclaimed area the total plant cover of this area is continuing to increase.

This area corresponds roughly to the Douglas Fir and Mountain Grassland Vegetation Types which have total cover values of 15.1 and 43.2 percent respectively, based upon earlier sampling. This comparison suggests that the standard of revegetation success for the Douglas Fir Community has been meet for this site and that the proposed standard for the Mountain Grassland Community is close to the present total plant cover for this site. These data suggest that the revegetation success achieved on this site in only three years is quite safisfactory.

1985 Access Road Seeding

The northern access road was found to have an average total plant cover of 16.46 percent (Table 1). The average shrub density for this reclaimed site was determined to be 0.15 shrubs per 100th acre (Table 2). This area was reported in the 1987 Annual Reclamation Report to have a total plant cover of 10.6 percent. Thus, the total plant cover on this site is continuing to increase with time.

This area corresponds almost entirely with the Mountain Shrub Community. According to the previous comparison the average total plant cover of this community based on previous sampling is 49.0 percent. The total plant cover on the reclaimed site is less than that found on the reference area but this is not totally unexpected since the majority of the reference area cover is attributed to the woody plant portion. As are demonstrated by the increase in total plant cover between 1987 and 1988 the cover of the reclaimed site will continue to increase over time but it is not known whether or not total plant cover on the reclaimed site will ever be able to provide all of the total plant cover contributed by the woody plants.

1983 Seeding

A total of 27 sampling transects were taken to characterize the 1983 Reclamation Seeding. The average total plant cover of these transects was determined to be 27.8 percent. This reclaimed area corresponds largely to the Pinyon Juniper Community and has a predominately southern exposure. The Pinyon Juniper-West Reference Area is most typical of this area. According to the previous sampling of this reference area the ultimate revegetation success standard will be approximately 12.8 percent. The present average cover of 27.8 percent is therefore above the apparent cover of the corresponding reference area and is appears the the reclamation of this site as measured by the total plant cover is successful. The average shrub density for this area was calculated to be 0.85 plants per 100th acre. A comparison of the total plant cover and shurb density values obtained from previous sampling on this area are is presented below:

YEAR	%COVER	SHURB DENSITY PLANTS/ACRE
1988	27.8	850
1986	13.9	500
1985	4.7	0

This comparison suggests that total plant cover and shrub denisty are continuing to increase and have not yet reached a new equalibrium. Given the apparent trends of increasing cover and density it appears that this site can be considered to be successfully reclaimed.

CONCLUSIONS

All sites previously reclaimed by Plateau were not sampled during the 1988 monitoring effort, however, for the sites that were sampled and from previous sampling of these reclaimed sites it appears that the 1983 and 1985 reclaimed sites have successfully established and are progressing towards a new equalibrim between the reclaimed site and the environment. All of these data and trends suggest that all sites are continuing to increase in total plant cover and shrub density. It appears that all of the reclaimed sites are producing total plant cover consistent with the corresponding reference areas or are increasing towards that goal. All evidence suggests that these reclaimed sites can be considered to be successfully reclaimed and no problems with respect to revegetation appear evident on these sites.

TABLE 1. 1985 Seedings Plant Cover and Composition Summary.

	Conveyor		Mine #1		Access Road	
	% Cover	% Comp.	% Cover	% Comp.	% Cover	% Comp.
Perennial Grasses						
Fairway wheatgrass	1.69	10.41	--	--	--	--
Thickspike wheatgrass	--	--	0.08	0.25	0.10	0.61
Intermediate wheatgrass	0.83	5.11	11.62	35.52	7.38	44.84
Western wheatgrass	1.34	8.28	0.20	0.61	--	--
Smooth brome	0.99	6.10	0.12	0.37	0.08	0.49
Big mountain brome	--	--	--	--	0.02	0.12
Orchardgrass	0.08	0.50	14.75	45.09	4.92	29.89
Great Basin wildrye	0.02	0.10	0.20	0.61	0.12	0.73
Salina wildrye	0.02	0.10	--	--	0.30	1.82
Sheep fescue	--	--	0.36	1.10	--	--
Foxtail barley	--	--	0.40	1.22	--	--
Indian ricegrass	0.13	0.80	--	--	--	--
Bottlebrush squirreltail	0.12	0.74	--	--	--	--
Subtotal	5.22	32.14	27.73	84.77	12.92	78.50
Perennial Forbs						
Cicer milkvetch	0.74	4.58	0.07	0.22	0.78	4.74
Spreading aster	0.20	1.23	0.29	0.89	--	--
Purple Mustard	--	--	0.52	1.59	0.30	1.82
Elk thistle	--	--	--	--	0.04	0.24
Corymbed eriogonum	0.24	1.48	0.78	2.39	--	--
Fleabane	--	--	0.14	0.43	--	--
Curlycup gumweed	--	--	1.73	5.29	0.30	1.82
Halogeton	0.08	0.50	--	--	--	--
Fineleaf hymenoppapus	--	--	--	--	0.02	0.12
Mentzelia	0.02	0.10	--	--	--	--
Yellow sweatclover	0.89	5.48	0.41	1.25	0.10	0.61
Alfalfa	2.87	17.69	0.59	1.80	1.96	11.91
Russian thistle	3.89	23.95	0.43	1.31	0.04	0.24
Small burnet	0.03	0.20	--	--	--	--
Field pennycress	0.01	0.06	--	--	--	--
Subtotal	8.97	55.27	4.96	15.16	3.54	21.50
Shrubs						
Big sagebrush	--	--	0.02	0.06	--	--
Fourwing saltbush	0.40	2.46	--	--	--	--
Shadscale	0.46	2.86	--	--	--	--
Cuneate saltbush	1.10	6.77	--	--	--	--
Rubber rabbitbrush	0.08	0.50	--	--	--	--
Subtotal	2.04	12.59	0.02	0.06	0.00	0.00
Total	16.23	100.00	32.71	100.00	16.46	100.00

TABLE 2. Shrub Density and Composition Summary of 1985 Reclamation Seeding (# of plants per 1/100th acre)

	Conveyor		Mine #1		Access Road	
	Dens.	% Comp.	Dens.	% Comp.	Dens.	% Comp.
Shrubs						
Saskatoon serviceberry	--	--	--	--	0.05	33.33
Big sagebrush	0.02	2.17	0.08	66.67	0.10	66.67
Fourwing saltbush	0.20	21.74	--	--	--	--
Shadscale	0.34	39.96	--	--	--	--
Cuneate saltbush	0.24	26.09	--	--	--	--
Rubber rabbitbrush	0.10	10.87	0.04	33.33	--	--
Mountain snowberry	0.02	2.17	--	--	--	--
Total	0.92	100.00	0.12	100.00	0.15	100.00

TABLE 3. Plant Cover and Cmposition Summary of 1983 Reclamation Seedings.

	% Cover	% Composition
Perennial Cover		
Fairway wheatgrass	0.05	0.21
Intermediate wheatgrass	11.15	44.95
Western wheatgrass	0.22	0.89
Bluebunch wheatgrass	0.04	0.15
Smooth brome	2.79	11.25
Orchardgrass	1.25	5.05
Indian ricegrass	0.22	0.89
Timothy	0.17	0.69
Kentuchy bluegrass	0.30	1.19
Sandbery bluegrass	0.04	0.18
Subtotal	16.23	65.45
Perennial Forbs		
Cicer milkvetch	0.05	0.21
Spreading aster	0.01	0.06
Milkvetch	0.04	0.15
Smooth fleabane	0.22	0.89
Yellow sweetclover	4.21	16.98
Alfalfa	2.77	11.19
Rocky Mountain penstemon	0.07	0.30
Russian thistle	0.11	0.44
Subtotal	7.48	30.22
Shrubs		
Big sagebrush	0.07	0.30
Fourwing saltbush	0.59	2.39
Curlleaf mountain mahogany	0.07	0.30
Antelope bitterbrush	0.33	1.34
Subtotal	1.06	4.33
Total	24.77	100.00

TABLE 4. Shrub Density and Composition Summary of 1983 Reclamation Seedings.

	# of plants/ 1/100th Acre	% Composition
Shrubs		
Big sagebrush	0.17	20.00
Fourwing saltbush	0.31	37.78
Curlleaf mountain mahogany	0.04	4.44
True mountain mahogany	0.02	2.22
Rubber rabbitbrush	0.06	6.67
Broom snakeweed	0.02	2.22
Douglas-fir	0.06	6.67
Antelope bitterbrush	0.13	15.56
Woods rose	0.02	2.22
Mountain snowberry	0.02	2.22
Total	0.85	100.00

Table 5. List of Plants Encountered In 1988 Monitoring.

Grasses	Common Name	Scientific Name
Agcr	Fairway wheatgrass	Agropyron cristatum
Agin	Intermediate wheatgrass	Agropyron intermedium
Agsm	Western wheatgrass	Agropyron smithii
Agsp	Bluebunch wheatgrass	Agropyron spicatum
Brin	Smooth brome	Bromus inermis
Brma	Big mountain brome	Bromus marginatus
Dagl	Orchardgrass	Dactylis glomerata
Elci	Great Basin wildrye	Elymus cinereus
Elsa	Salina wildrye	Elymus salina
Feov	Sheep fescue	Festuca ovina
Hoju	Foxtail barley	Hordeum jubatum
Orhy	Indian ricegrass	Orysopsis hymenoides
Phpr	Timothy	Phleum pratense
Popr	Kentucky bluebunch	Poa pratensis
Pose	Sandberg bluegrass	Poa secundo
Sihy	Bottlebrush squirreltail	Sitanion hystrix
Forbs		
Asci	Cicer milkvetch	Astragalus cibarius
Asgl	Spreading aster	Aster glancodes
Astrag	Milkvetch	Astragalus spp.
Chte	Purple mustard	Chorispora tenella
Cidr	Elk thistle	Cirsium drummondii
Erco	Corymbed eriogonum	Erigeron corymbosus
Ergl	Smooth fleabane	Erigeron glabellus
Erig	Fleabane	Erigeron ssp.
Grsq	Curlycup gumweed	Grindelia squarrosa
Hagl	Halogeton	Halogeton glomeratus
Hyri	Fineleaf hymenopappus	Hymenoxys richardsonii
Ment	Mentzelia	Mentzelia spp.

Meof	Yellow sweetclover	Melilotus officinale
Mesa	Alfalfa	Medicago sativa
Pest	Rocky Mountain penstemon	Penstemon strictus
Saka	Russian thistle	Salsola kali
Sami	Small burnet	Sanguisorba minor
Thar	Field pennycress	Thlaspi arvense

Shrubs

Amal	Saskatoon serviceberry	Amelanchier alnifolia
Artr	Big sagebrush	Artemisia tridentata
Atca	Four-wing saltbrush	Atriplex canescens
Atco	Shadscale	Atriplex confertifolius
Atcu	Cuneate	Atriplex cuneata
Cele	Curlleaf mountain mahogany	Cercocarpus ledifolius
Cemo	True mountain mahogany	Cercocarpus montanus
Chna	Rubber rabbitbrush	Chrysothamus nanseosus
Gusa	Broom snakeweed	Guitierrezia sarothrae
Psme	Douglas-fir	Pseudotsuga menziesii
Putr	Antelope bitterbrush	Purshia tridentata
Rowo	Woods rose	Rosa woodsii
Syor	Mountain snowberry	Symphoricarpos oreophilus

COAL MINING AND RECLAMATION OPERATIONS FOR 1988
(Authority UMC 784)

(Must be submitted to the Division by March 31, 1989)

State of Utah
Department of Natural Resources
Division of Oil, Gas and Mining
3 Triad Centter, Suite 350
355 West North Temple
Salt Lake City, Utah 84180-1203

(801) 538-5340

RECEIVED
MAR 23 1989
DIVISION OF
OIL, GAS & MINING

Operator: CYPRUS PLATEAU MINING CORP.

Mine Name: STAR POINT MINES

Mailing Address: P.O. DRAWER PMC PRICE, UT 84501

Company Representative: BEN GRIMES / BOB LAUMAN

Permit Number: ACT/007/006

Date of Most Recent Permanent Program Permit: AUG 7, 1987

Quantity of Coal Mined (tonnage) 1988: 1.9 MM

Attach Updated Mine Sequence Map.

All monitoring activities during the report period must be submitted with this report (including, but not limited to):

A. Summarized Water Monitoring Data

B. Precipitation or Other Climatological Data

C. Subsidence Monitoring Report

D. Vegetation Data (test plots) or Revegetation Success Monitoring (includes interim and final)

E. Permit Stipulation Status

djh
AT57

PLATEAU MINING COMPANY

1989 ANNUAL RECLAMATION MONITORING REPORT

STAR POINT MINES

PERMIT ACT/007/006

PREPARED BY

IME

P. O. BOX 270

YAMPA, COLORADO 80483

19 MARCH 1990

INTRODUCTION

This annual reclamation report is submitted by Plateau Mining Company in accordance with their approved Mining and Reclamation Plan which commits Plateau to sample all reclaimed areas in years 1, 2, 3, 5, 9 and 10 following reclamation and submit an annual revegetation monitoring report to the Division each year. This report contains the results of field data collected on June 19, 1989 and June 20 1989, for all areas that required monitoring in 1989. Since no new areas were reclaimed by Plateau during the past year the overall status of reclamation for the 1989 Annual Reclamation Report is identical to the maps previously submitted and no new reclamation status maps are being submitted with this report.

All of the data was collected and analyzed by Kent Crofts and Mark Jones of IME, an environmental consulting firm located in Yampa, Colorado. The monitoring implemented in 1989 was directly supervised by Plateau and is consistent with monitoring requirements previously approved by the Division in Plateau's presently approved permit renewal document.

SAMPLING METHODOLOGIES

All of the data collected during the 1989 monitoring effort used identical sampling methodologies, equipment, observers, and methods of data analysis previously used and approved by the Division for this site. The vegetative parameters sampled in 1989 included total plant cover, production and woody plant densities. Due to the similarity of methodologies utilized, Plateau believes that a relative comparison of data between years is possible to establish trends regarding the successfulness of current and previous revegetation efforts.

Cover

Plant cover was measured using sampling techniques previously approved by the Division. Since only steep cut and fill slopes were sampled in the 1989

sampling effort, plant cover was sampled on these areas through the use of a 2 x 5 dm quadrat. The length of transects used in these areas was 14.52 feet in length. Transects were randomly located throughout the area to be sampled. At each transect, five cover quadrats were sampled. The quadrat locations were placed at five regular intervals along the transect. The five quadrat values for plant cover obtained from each transect were then averaged into a single datum for purposes of statistical evaluation.

Only foliar plant cover less than one meter in height was sampled. At each quadrat, plants growing or having foliage within the quadrat frame were identified to plant species and recorded onto field data forms. Whenever litter, rock, or bare ground were encountered within the quadrat, the cover of these materials was also estimated to the closest percent. Plant material that had dried prior to sampling (such as cheatgrass), but was a product of the 1989 growing season, was counted as plant cover. Litter was defined as that plant material that had been on the ground or was a dead part of the plant for approximately one year prior to sampling. To the extent possible, all transects were randomly located with respect to location and orientation using random numbers generated from a hand held calculator.

Sampling on all areas was conducted until sample adequacy with respect to total plant cover was achieved or until the maximum sample size specified by the Division for this sampling technique had been achieved. This is the same technique used in previous monitoring.

Production

Total forage production was estimated along each transect by clipping at ground level all plants growing within the 20 X 50 dm quadrat. Herbaceous plants were clipped at ground level and placed into labeled paper sacks. Along each transect, five quadrats were sampled using the placement method described for plant cover. Production from woody plants was estimated by clipping all current annual growth and placing this material into labeled paper sacks. Materials from

each sample point were separated by major growth forms. Since no annual plants were encountered in any of the plots, materials were grouped into perennial grasses, perennial forbs and shrubs. Initially, sample adequacy was determined in the field using green weights. Following field clipping, the samples were returned to the laboratory where they were placed in a drying oven and dried at a temperature of 100 degrees C for 24 hours. All of the samples were weighted on an electronic scale to the closest tenth of a gram. Production estimates in this report have been converted from grams per quarter meter and are presented in pounds per acre. Since bond release is not sought in connection with this sampling no reference areas were sampled.

Woody Plant Density

Woody plant density values were obtained by sampling a 3 x 14.52 foot belt transect along each side of the outstretched transect tape. This plot size was selected since it corresponds to a 1/1000 acre plot. The tape used for the cover transect was also used as the center point for the woody plant density transects. Each side of the transect was sampled for woody plant densities and the two values averaged for a transect value.

RESULTS AND DISCUSSION

1980 Reclamation Seeding

The only reclaimed site that required sampling according to Plateau's sampling program in 1989 was the 1980 reclaimed site. This area consists of 58.37 acres of nontopsoiled cut and fill road slopes reclaimed in the fall of 1980. These areas were initially seeded by hand with a cyclone hand seeder. The mixture seeded in 1980 is presented on Table 1, 1980 Seed Mixture. The seeding rate was approximately 20 pounds per acre. Following seeding the entire site was mulched by blowing a cereal grain straw over the entire site at the rate of approximately 3,000 pounds per acre. Due to the lack of proper vegetation establishment, portions of this area were reseeded in November 1981 using the same seed mixture but seeded at the rate of approximately 24 pounds of pure live seed per acre. At this time these areas were hydroseeded with the seed mixture shown in Table 1, 1980 Seed Mixture. A commercial tackifier was applied at the time of seeding at the rate of 140 pounds per acre. Immediately following seeding, the entire area was hydromulched with Conwed mulch at the rate of 2,000 pounds per acre.

Cover

A total of 15 transects were taken to evaluate plant cover on the 1980 reclaimed site. Ninth year total plant cover on this area was found to equal 16.19 percent (Table 2, 1989 Plant Cover, Composition and Frequency Summary of 1980 Reclamation Seeding). Upon comparing the data collected from this site during the 1989 monitoring effort with prior reclamation monitoring efforts and submitted to the Division in previous reclamation monitoring reports, it is evident that this specific site was sampled separately in 1984 and 1985 (1984 Annual Reclamation Monitoring Report and 1985 Annual Reclamation Monitoring Report). Total plant cover from these monitoring efforts was found to be 12.13 percent in 1984 and 15.16 in 1985. The data collected from 1989 document that the total plant cover is continuing to increase but that it appears to be increasing at a slower rate.

Absolute comparisons of the successfulness of the present revegetation efforts are not possible since the reference areas corresponding to these reclaimed sites were not sampled during this evaluation. However, a relative comparison of the revegetation success can be made by comparing the values obtained from this sampling effort with the plant cover values obtained from the corresponding references areas. A preliminary examination reveals that the 1980 Reclamation Seeding largely corresponds to the Douglas Fir and Mountain Grassland Vegetation Types. Total plant cover for these two reference areas obtained from 1981 sampling equalled 15.1 and 43.6 percent, respectively. These data therefore suggest that the total plant cover on the 1980 Reclamation Seeding is within the range of plant cover obtained from the Douglas Fir Reference Area but lower than the plant cover encountered on the Mountain Grassland Reference Area.

Successional trends for the planted species appear evident when comparing the plant cover data from the 1984, 1985 and 1989 monitoring periods. The Division's regulations emphasize the planting of native species in preference to introduced species due to concerns regarding the potential dominance of the reseeded stands with introduced species. One of the foremost species of regulatory concern is Crested or Desert Wheatgrass. In 1984 this species contributed 9.0 percent of the total plant cover. In 1985, Crested wheatgrass contributed 10.5 percent of the total plant cover on the 1980 reclaimed site, while in 1989 this species was found to contribute 13.9 percent of the total plant cover of this site. These data suggest that this species is slowly increasing in abundance over time on this site. Pubescent Wheatgrass is another species of regulatory concern. Upon comparing the trend of this species over time, it is found that the percentage of total plant cover contributed by this species was 28.0, 31.9 and 25.5 percent for the 1984, 1985 and 1989 sampling periods, respectively. There is insufficient evidence to suggest that this species is increasing in abundance over time. Alfalfa is another species of regulatory concern. Upon comparing the composition data over the same period, this species contributed 22.0, 0.73 and 0.91 percent, respectively. Since this species is so valuable in

contributing plant available nitrogen to the soils and definitely decreases over time, it appears that the past regulatory concerns of this species dominating this site appear unfounded. In fact, it would appear that these evidences suggest that more emphasis should be placed on increasing the role of this species in formulating future seed mixtures. Yellow sweetclover is a species that has raised similar regulatory concerns as alfalfa. These monitoring data document that the composition of this species has deceased from 12.0, 0, 0.1 percent during the 1984, 1985 and 1989 sampling periods. It would appear that regulatory concerns regarding Yellow sweetclover, as for alfalfa, are largely unfounded for this site.

The growth of native species definitely appears to be increasing over time. A large spreading aster contributed 2.0 percent of the total plant cover in 1984 and 6.7 percent in 1989. Big sagebrush contributed only 0.1 percent of the total plant cover in 1984 and had increased to 2.64 percent in 1989.

Production

Forage production on the 1980 Reclamation Seeding was determined based upon 34 sample transects. Results obtained from the production sampling are summarized on Table 3, 1989 Forage Production Summary of 1980 Reclamation Seeding. These data suggest that at the time the 1980 Reclamation Seeding was sampled it produced a total of 460 pounds of air dry forage per acre. Comparing this value with previously collected data it is reported in the 1984 Annual Reclamation Monitoring Report that this site produced 1,236 pounds of air dry forage, while the 1985 Annual Reclamation Monitoring Report reports that this site was producing 994 pounds of air dry forage per acre. The number of samples used to calculate the 1984 production estimate are not reported and only ten transects (30 clip plots) were collected for the 1985 monitoring effort. When taken at face value, these data suggest that there has been a decline in production from 1,236 to 994 to 460 pounds of air dry forage between 1984 and 1989. However, since the sample size is omitted from the 1984 Annual Reclamation Report, and is admittedly small in the 1985 monitoring effort, and since total plant cover during

this same period has increased from 12.13 percent to 16.19 percent during this same period it would appear that the 1984 and 1985 data were based upon too small a number of samples for any definitive conclusions. Since the 1989 data were obtained from clipping 170 20 X 50 dm quadrats these data can naturally be considered to be more indicative of site conditions than the data collected previously.

Examination of the existing baseline vegetation information contained in Plateau's current permit document states that forage production from the Mountain Grassland Reference Area was determined to be 2,300 pounds of air dry forage while the Douglas Fir Reference Area was found to be producing 822 pounds of air dry forage per acre when these areas were sampled in 1981. Unfortunately, these data conflict somewhat with measurements taken by the Soil Conservation Service from the same area in 1981. They reported the Douglas Fir Vegetation Community was in excellent range condition and was producing 500 pounds of forage. Since differences between these sites and values are so dramatic, it would appear that the differences are based upon climatic differences but perhaps most importantly sampling methods. The forage production data from this evaluation of 460 pounds of air dry forage per acre is very similar to the 500 pound value reported for the Soil Conservation Service for this specific area.

Shrub Density

A total of 40 transects were sampled to determine shrub density on the 1980 Reclamation Seeding. The results obtained from this sampling effort are summarized in Table 4, 1989 Shrub Density and Composition Summary of 1980 Reclamation Seeding. This summary suggests that the shrub density on the 1980 Reclamation Seeding averages 1675 plants per acre. Upon comparing the data from the 1984 and 1985 Annual Reclamation Monitoring Reports it can be seen that the shrub density on this reclaimed site has increased from 183 woody plants per acre in 1984, to 364 woody plants per acre in 1985, to 1675 woody plants per acre in 1989. These data suggest a definite increase in woody plant densities due

to natural successional processes over time. Evidence suggests that all of the shrub species have increased with time, but that Eriogonum and Big sagebrush have particularly increased. In 1984 and 1985 only three woody plant species were encountered in the sampling. This value increased to ten woody plant species encountered in the 1989 monitoring. This increase is supported by increases in shrub cover during this same time. In 1984, shrubs contributed 3.71 percent of the total plant cover, while in 1989 shrubs contributed 4.35 percent of the total plant cover. Since many of the invading shrubs are seedlings and are quite small, it is significant to observe that densities are increasing. Since woody plants typically have much slower growth rates that herbaceous plants, it is obvious that with time there will be a corresponding increase in cover contributed by these plants.

Plateau's permit establishes a post mining woody plant density standard of 2200 plants for north and east facing slopes and 900 plants for south and east facing slopes. All of the areas sampled in this evaluation corresponded to north and east facing slopes. While the present shrub density of 1675 woody plants per acre is below the required revegetation success standard, this deficiency does not pose a problem to the operation since it will be several years before these areas will be deactivated and suitable for bond release. Given the definite increase in woody plant densities over time this deficiency appears to be largely self correcting and should not pose a problem of being able to achieve the revegetation success criteria with respect to woody plant densities for this site.

Sample Adequacy

The Vegetation Guideline published by the Division requires that a statistically adequate sample size be collected from all areas sampled in connection with baseline or bond release sampling. Although neither condition applies specifically to the 1980 Reclamation Seeding, the Division's sample adequacy requirements were applied to these data. The number of sample plots

needed to achieve sample adequacy for each vegetative parameter sampled on the 1980 Reclamation Seeding during the 1989 monitoring effort are summarized on Table 5, Sample Adequacy Requirements for Data Collected in the 1989 Monitoring Effort. As can be observed in this summary, sampling was conducted until sample adequacy at the Nm 80/10 level was achieved, or until a maximum of 40 transects per parameter had been collected.

This comparison reveals that for total plant cover sample adequacy was achieved with 9.7 samples. Sample adequacy for production was achieved with 34.1 samples and only 34 samples were taken. Rounding would render 34.1 samples to 34 samples. The reason that only 34 samples were collected is that sample adequacy in the field was initially calculated using green weights. Using this indice, sample adequacy at Nm 90/10 level was achieved with 33.8 samples and only 20.5 samples at Nm 80/10 level. Since these 34 samples represent 170 clip plots, the sample size utilized in this evaluation can be considered as adequacy for purposes of the present evaluation. Sample adequacy for woody plant densities was achieved by collected the maximum number of samples required by the Division's Vegetation Guideline.

CONCLUSIONS

Monitoring data collected during the 1989 monitoring effect continue to document the feasibility of successfully reclaiming lands disturbed by coal mining activities at the Plateau Mine complex. Trends identified in 1984 and 1985 Annual Reclamation Monitoring Reports for the 1980 Reclamation Seeding continue to be apparent in the 1989 monitoring data. These data suggest that reclamation efforts at this site appear promising with respect to the meeting the established revegetation success criteria.

Table 1, 1980 Seed Mixture.

Plant Species	% Mixture
Russian Wildrye	15%
Streambank Wheatgrass	11%
Mountain Brome	5%
Big Sagebrush	5%
Fourwing Saltbrush	8%
Western Wheatgrass	15%
Pubescent Wheatgrass	15%
Indian Ricegrass	5%
Rabbitbrush	3%
Ranger Alfalfa	10%
Yellow sweetclover	10%

Table 2, 1989 Plant Cover, Composition and Frequency Summary of 1980 Reclamation Seeding.

Perennial Grasses			
Pubescent wheatgrass	4.13	25.54	86.7
Smooth bromegrass	2.75	16.97	80.0
Salina wildrye	2.71	16.72	40.0
Desert wheatgrass	2.53	13.92	73.3
Western wheatgrass	0.68	4.20	33.3
Orchardgrass	0.33	2.06	26.7
Bluebunch wheatgrass	0.23	1.40	13.3
Sheep fescue	0.23	1.40	6.7
Russian wildrye	0.19	1.15	6.7
Kentucky bluegrass	0.17	1.07	6.7
subtotal	13.95	84.43	
Perennial Forbs			
Spreading aster	1.08	6.67	20.0
Pingue hymenoxys	0.24	1.48	6.7
Alfalfa	0.15	0.91	20.0
Lewis flax	0.05	0.33	6.7
Rocky Mtn. penstemon	0.04	0.25	6.7
Common dandelion	0.01	0.08	6.7
Yellow sweetclover	0.01	0.08	6.7
subtotal	1.58	9.80	
Annual Forbs			
Pepperweed	0.07	0.41	6.7
Summer cypress	0.07	0.41	6.7
subtotal	0.14	0.82	
Shrubs			
Big sagebrush	0.43	2.64	6.7
Eriogonum	0.32	1.98	13.3
Rubber rabbitbrush	0.05	0.33	6.7
subtotal	0.80	4.95	
TOTAL PLANT COVER	16.19	100	
BARE GROUND	26.53	-	
LITTER	26.52	-	
ROCK	30.76	-	

Table 3, 1989 Forage Production Summary of 1980 Reclamation Seeding.

Life form	Lbs./acre
Grasses	348
Forbs	29
Shrubs	83
TOTAL	460

Table 4, 1989 Shrub Density and Composition Summary of 1980 Reclamation Seeding (# plants per acre).

Shrub Species	# plants per acre	Percent Composition
Eriogonum	975	58.21
Big sagebrush	338	20.18
Mountain snowberry	88	5.25
Douglas rabbitbrush	75	4.48
True mountain mahogany	75	4.48
Rubber rabbitbrush	50	2.99
Saskatoon serviceberry	38	2.27
Winterfat	13	0.78
Douglas fir	13	0.78
Fringed sagebrush	13	0.78
TOTAL	1675	100

Table 5, Sample Adequacy Requirements for Data Collected in the 1989 Monitoring Effort.

Parameter	Sample Size	Nm90/10	Nm80/10	Maximum Sample Size
Cover	15	15.9	9.7	40
Production	34	56.1	34.1	40
Density	40	312.3	189.7	40

CYRPUS-PLATEAU MINING CORPORTATION

STAR POINT MINES

1990 ANNUAL RECLAMATION REPORT

RECEIVED
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DIVISION OF
OIL GAS & MINING

Prepared by

IME
P.O. BOX 270
YAMPA, CO 80483

2 MAY 1991

INTRODUCTION

This annual reclamation monitoring report is submitted by Cyprus-Plateau Mining Company, hereafter referred to as Plateau, in accordance with their approved Mining and Reclamation Plan, which requires that all previously reclaimed sites be monitored during years 1, 2, 3, 5, 9 and 10 following reclamation to determine the relative degree of revegetation success on these areas and that the results and interpretation of this monitoring effort be submitted in an annual reclamation monitoring report which will be submitted each year to the Division. This report contains the results of field data collected between July 11 and August 3, for all areas which required monitoring in 1990. These data were collected by Kent Crofts, Mark Jones and John Jones. The reclamation monitoring program conducted in 1990 is consistent with previously collected data and with Plateau's presently approved permit.

Plateau has collected reclamation success data since 1981 from all previously reclaimed sites, the results of which have been annually submitted to the Division. Due to the voluminous nature of this information it is not practicable to provide a complete comparison of the revegetation trends for each reclaimed site which was evaluated in this monitoring effort. Therefore, in order to completely understand the history and results of the previous reclamation monitoring information the reviewer is referred to these previous submittals. Where it is possible, summaries of these previously collected information are compared with the 1990 vegetation data.

SAMPLING METHODOLOGIES

The data collected during the 1990 monitoring effort utilized identical sampling methodologies, equipment, observers and methods of data collection and analysis used previously and which have previously been approved by the Division. The vegetative parameters sampled in 1990 included total plant cover, woody plant densities and total production. Due to the similarity of sampling methodologies which have been utilized, Plateau believes that a comparison of

the 1990 data with previously collected data is possible to establish trends regarding the successfulness of current and previous revegetation efforts.

Cover

Plant cover was measured using two different sampling techniques previously approved by the Division. On flatter areas associated with the Refuse Test Plots, and Topsoil Stockpile, plant cover was collected using an included metal ten point frame. Along the fifty foot transect tape, the ten point frame was randomly located at different intervals using random numbers assigned to the field data forms prior to going to the field. Along each transect, 10 sample sites equaling 100 data points were evaluated. All foliar plant cover less than one meter in height was sampled. At each sample point, the observation was recorded by plant species, or whether or not litter, rock bare ground or lichens was encountered. Plant material that had dried prior to sampling (such as annuals), but which were a product of the 1990 growing season, was counted as plant cover. Litter was defined as that plant material that had been on the ground or portions of the plant material which had been dead for approximately one year prior to sampling. The one hundred datum points were summarized into a single observation which was used for subsequent data and statistical analysis. To the extent that site configuration allowed, all transects were randomly located with respect to orientation and location using random numbers generated from a hand held calculator.

On the steeper slopes, encountered along the 1980 Mine # 1 Access Road and along the 1980 and 1985 Conveyor seedings, it was determined unsafe to use the ten point frame. On these areas, plant cover was visually estimated using a 2 X 5 dm quadrat. The length of these transects was 14.52 feet. These transects were randomly located throughout the area to be sampled using the randomization methodology described above. At each transect location, five quadrats were sampled. These five datums were then averaged into a into transect value for purposed of statistical analysis.

According to the present Division Vegetation Guidelines, it is now necessary to resample each approved Reference Area at least every five years to ensure that Range Condition is acceptable. Range condition estimates are based upon the percent composition of climax plant species growing on a particular Range Site. On each approved Reference Area, plant composition information was evaluated using plant cover as an index of plant species composition. On each Reference Area plant cover information was collected using the metal ten point frame technique identical to that described above except a 50 meter transect length was used.

Woody Plant Densities

On the Refuse Test Plots and on the Topsoil Stockpile, woody plant densities were obtained by sampling a 3 X 50 foot belt transect. The tape used for the cover transect was also used as the center point for the woody plant density transects. Each side of the transect tape was sampled for woody plant densities and these two values were averaged into a single observation for purposes of data summarization.

On the steeper reclaimed areas such as the 1980 and 1985 Access Road and 1980 and 1985 Conveyor Seedings, woody plant densities were sampled using a 3 X 14.52 belt transect. Observations were taken along each side of the transect tape and averaged as described above.

Production

Total forage production was determined by clipping at ground level all biomass produced during the 1990 growing season rooted within a one quarter square meter circular quadrat. On each production transect five randomly spaced quadrats were clipped and these five data points were averaged into a single datum. Clipped plant materials were placed into labeled paper sacks and weighted to determine green weights for initial sample adequacy determinations.

Following completion of the field sampling the samples were returned to the laboratory where each sample bag was dried until free of moisture then weighted on an electric scale to an accuracy of one tenth of a gram.

Reference Area Sampling

There are no reclaimed areas at the Plateau Mine which are eligible for bond release at this time and no sampling in this monitoring effort was conducted with this object in mind. However, do to the insistence of the Division that the Refuse Test Plots be treated with respect to monitoring as if they were permanent reclamation, it was necessary to sample the Sagebrush Reference Area concurrently with the Refuse Test Plot monitoring to determine whether or not the revegetation success on these plots might be considered successful with respect to potential bond release criteria. The Sagebrush Reference Area was sampled because this plant community was the dominate predisturbance plant community found on in the Refuse Pile Area.

Range Condition

The existing Vegetation Guidelines of the Division require that all established reference areas be periodically monitored to determine whether or not these areas still possess suitable Range Condition ratings. In order to satisfy this criteria all of the established Reference Areas were sampled to determine plant species composition in order to evaluate whether the Range Condition rating was "fair" or higher. In this evaluation, plant composition determinations were made based upon cover sampling of each Reference Area. At each designated Reference Area, located in the field by means of the permanent steel metal fence posts, four cover transects were taken and the composition of the existing plant communities determined. This sampling size is considerably larger and more quantitative than those utilized by the SCS in their original Range Condition determinations of these sites.

The plant composition data were then compared to the original SCS

determinations for these sites. Since some of the SCS Range Condition determinations were originally made on new or as then poorly described range site descriptions, in this evaluation all of the range site determinations were correlated with the most recent information of this area found in the 1988 Soil Survey of the Carbon Area, Utah. This document contains excellent correlations of Range Sites with soils mapping units which was unavailable at the time the original SCS Range Site evaluations were completed in 1981. For example, many of the Range Sites named in the 1981 evaluations are no longer utilized and have been revised and most of the original Range Site names and descriptions are no longer considered valid. In this evaluation the potential climax vegetation of these sites was determined using the most recent descriptions found in the 1988 Soils Survey. Range Condition estimations were made using the allowable species composition limits found in these descriptions and using the methodologies found in the SCS National Range Handbook.

Data Analysis

All of the field data were summarized using hand held calculators to determine mean plot values. Sample adequacy equations recommended by the Division were calculated on all data collected from each plot or sample location. Total plant cover and shrub density sample adequacy calculations were made in the field prior to leaving each sample area using field data summaries and final sample adequacy calculations were made on the completed data summaries finalized in the laboratory. Sample adequacy calculations on production samples were initially based on field green weights and were determined at the completion of each field sampling day. In accordance with the previously approved sampling program for the Refuse Test Plots, a sufficient number of samples was taken to satisfy the 80/10 confidence interval requirement or until a maximum of 27 samples per plot had been collected. Statistical analyses of these data were accomplished using the NCSS statistical software package on an AT personal computer. Statistical tests performed included two tailed t-tests and ANOVA. Unless otherwise noted, the confidence

interval for all statistical comparisons was the 0.10 percent level.

Revegetation Success Criteria

Since only one of the approved Reference Areas was sampled to the required sample adequacy level, absolute comparisons regarding revegetation success on each individual reclaimed areas with its appropriate Reference Area could not be made. All Reference Areas were resampled during this field effort but not with the objective of achieving sample adequacy. Therefore, comparisons of the apparent degree of revegetation success of each reclaimed area were firstly compared with the 1990 data collected from the corresponding Reference Area as well as with the original Reference Area data collected either in 1981 or 1983. A summary of the 1981-3 Reference Area Plant Cover values is presented below:

REFERENCE AREA	% TOTAL PLANT COVER
Mountain Shrub	45.3
Sagebrush	42.1
Douglas Fir	15.1
Mountain Grassland	43.6
Pinyon Juniper-West	12.8
Pinyon Juniper-East	32.5
Saltbush	17.5
Corner Canyon	87.6

Moisture

The soil moisture conditions at the time the Plateau reclamation sites were sampled were very dry. Examination of the available precipitation information from the Plateau and Hiawatha weather stations reveals that the area has been unusually dry for at least the last two years. The thirty year average rainfall for the Hiawatha station is 13.18 inches, while the 1984-89 average for the Plateau station is 16.18 inches. Numerous studies regarding vegetation growth in response to precipitation in this area indicate that winter snow and particularly spring rainfall are most important in terms of plant growth. Examination of the Plateau weather data for the past two years indicates that late winter and spring moisture have been considerably below the long term average. In 1989 the

spring precipitation averaged only 54 percent of the long term average and in 1990 the amount of spring precipitation was only 44 percent of normal. The precipitation for May of 1990 was only 0.28 inches or 27 percent of the normal amount received for this month. The dryness of the area is mentioned to point out that the vegetation response under such conditions may be particularly stressful.

RESULTS AND DISCUSSION

Reference Area Range Condition Sampling

The existing range condition classes for each approved reference area for the Plateau Permit Area were resampled and the present range condition determined. The results of this evaluation are presented on Table 1, Reference Area Range Condition Classes. This comparison suggests that all of the approved Reference Areas for the Plateau Mine possess suitable range condition classes.

Sagebrush Reference Area

To determine the successfulness of the reclamation efforts for the Refuse Test Plots the vegetative characteristics of these plots were compared to those associated with the Sagebrush Reference Area. This comparison utilizes the Reference Area Comparison Method described in the Division's Vegetation Guidelines. A total of eight cover and density transects and 50 production transects were taken on this site. Sample adequacy was achieved at the 80/10 confidence interval level with 6.3 cover, 2.5 density and 45.43 production transects. Summaries of these data are presented in Table 2, Sagebrush Reference Area Cover, Table 3, Sagebrush Reference Area Shrub Density and Table 4, Sagebrush Reference Area Production.

Comparing these data with previously collected data collected from this site it can be determined that when this site was sampled in 1981 total plant cover was reported to be 42.1 percent. This compares with a cover value of 23.5 percent from the 1990 sampling effort (Table 2, Sagebrush Reference Area Cover).

Shrub density comparisons between 1981 and 1990 reveal that 17,336 woody plants per acre were reported for the 1981 sampling while 2,521 plants

per acre were encountered in the 1990 sampling (Table 3, Sagebrush Reference Area Shrub Density.

No previous production estimates have been collected from this site due to the requirement in the Division's Vegetation Guidelines which rely on productivity estimates from the SCS during the permit application phase. The original SCS description of this site reported that this site produced 800 pounds of forage in October of 1981. The present SCS Range Site Description of this site suggests that production averages 1,100 pounds and ranges from 800 to 1,300 pounds of air dry forage per acre. No production samples appear to have been taken for this site in the 1981 sampling, however, statements in this report suggest that the productivity of the sagebrush areas in the vicinity of Sagebrush Reference Area was 1,400 pounds of air dry forage per acre with a potential site productivity of 2,000 pounds per acre. These values compare with a productivity estimate of 221 pounds per acre from the 1990 sampling (Table 4, Sagebrush Reference Area Production).

Absolute comparisons regarding changes in the vegetative characteristics of the Sagebrush Reference Area between 1981 and 1990 can not be made due to differences in sampling methodologies and observers. However, it would appear that given the very dry growing conditions encountered during the 1990 sampling effort, some of the differences in plant growth can be attributed to this factor.

1980 Topsoil Stockpile Seeding

This site is located to the north of the Refuse Test Plots and contains stockpiled topsoil material originally placed in 1980. Portions of this seeding have been disturbed by subsequent placement of topsoil. Only those original portions placed in 1980 were sampled. A total of 5 transects were taken to evaluate plant cover and shrub density on this site. Sample adequacy at the 80/10 level was found to equal 2.79 transects for cover and 0 transects for

shrub density. Plant cover ten years following reseeding was found to average 23.49 percent (Table 5, 1980 Topsoil Stockpile Cover). Production was not sampled at this site due to the temporary nature of the reclamation effort. No shrubs were encountered in any of the density transects.

This site largely corresponds to the Sagebrush Plant Community. Based upon the sampling conducted on the Sagebrush Reference Area during this monitoring effort the revegetation success standard for cover would equal 23.50 percent (Table 2, Sagebrush Reference Area Cover). Using the criteria of total plant cover as an index of revegetation success, it can concluded that the revegetation effort on this site can be deemed to be successful.

1980 Conveyor Seeding

This site is located along the mine conveyor connecting the Lion Deck facilities area with the coal stockpile and preparation plant located at the lower facilities area on steep to very steep cut and fill slope areas. No areas within this reclaimed site were topsoiled and many of the slopes appear to have been constructed at angle of repose, suggestive of very harsh reclamation site conditions. In the west portion of this seeding, areas between the Lion Deck Access Road and the conveyor were sampled. While in the east, those reclaimed areas located to the south and north of the conveyor were sampled.

A total of 30 cover and shrub density transects were evaluated on this site. Sample adequacy was found to equal 20.3 cover and 697.5 density transects (Table 6, Reclamation Seedings Shrub Density). Average plant cover was found to equal 10.41 percent (Table 7, 1980 Conveyor Reclamation Plant Cover). A comparison of the previously collected cover data from this site is as follows:

YEAR	PERCENT PLANT COVER
1990	10.4
1989	16.2
1985	15.2
1984	12.1

This comparison suggests that there has been a decline in total plant cover since this site was sampled in 1989. Observations of the site did not indicate any unusually high levels of herbivory or other types of perturbations and it is believed that the fluctuation in total plant cover was largely attributable to the unusually dry growing season associated with the 1990 monitoring effort.

The average shrub density for this site was determined to equal 565 woody plants per acre (Table 6, Reclamation Seedings Shrub Density). This value compares with the following previously collected shrub density values for this site:

YEAR	SHRUB DENSITY (#PLANTS/ACRE)
1990	565
1989	1,675
1985	364
1984	183

Given the extremely high number of samples needed to achieve sample adequacy, it is difficult to conclude that shrub density has declined since 1989. It appears that the variability in the average shrub density values between different sampling periods are probably more a function of the high variability associated with this site rather than years fluctuations.

This disturbed area corresponds to the Douglas Fir, Mountain Grassland and Sagebrush Plant Communities. A comparison of the total plant cover values of these Reference Areas with the plant cover encountered on this reclaimed site from the 1990 sampling, suggests that this site would not satisfy the revegetation success criteria with respect to plant cover for any of these three plant communities. This site occupies a north facing slope, meaning that the shrub density standard would be 2,200 woody plants per acre. This site also fails to satisfy this parameter with respect to considering the revegetation effort successful.

1980 Access Road Seeding

This reclaimed site is located along the old access road running between the old Mine # 1 Portal Area and the Lion Deck facilities area. Visual observations suggest that this reclaimed site is among the oldest disturbances which have been artificially revegetated at Plateau. These materials are cut and fill slopes located above and below the road. No attempts to salvage any topsoil materials or reduce the over steepened slopes appear evident. Due to the slopes involved there is a pronounced increase in the size of the coarse fragments with increasing distance down slope from the road cut.

A total of 24 cover and density transects were evaluated on this site. Sample adequacy was found to equal 15.6 transects for cover and 257 transects for shrub density. Total plant cover was determined to average 15.2 percent for this site (Table 8, 1980 Mine # 1 Access Road Plant Cover). Woody plant density values were found to average 830 plants per acre (Table 6, Reclamation Seedings Shrub Densities). Although this site was previously monitored, the data were combined with those from the 1980 Conveyor Area so a comparison of vegetation trends of this site between different monitoring years is not possible.

This site occupies the same plant communities as are found on the 1980 Conveyor Reclamation Site. When compared to the three corresponding reference areas plant cover values, it would appear that this site satisfies the revegetation success criteria for the Douglas Fir Plant Community but is deficient with respect to the Mountain Grassland and Sagebrush Reference Areas.

1985 Access Road

This reclaimed site is located to the southwest of the coal preparation plant on an old access road which ran towards the old Mine # 1 Portal Area. This site involved less disturbance than associated with the 1980 Access Road

due to the narrower width of the road and the gentler slopes found on this site. Reclamation efforts consisted of recontouring this site with a tracked backhoe. During the regarding process numerous pockets of undisturbed soil material were uncovered and whenever possible this material was placed on top of the replaced fill material.

A total of 20 cover and 50 shrub density transects were evaluated on this site. Sample adequacy was found to equal 13 cover and 168.4 density transects. The average total plant cover found on this site was found to be 10.92 percent (Table 9, 1985 Access Road Reclamation Plant Cover). Previous reclamation monitoring information from this site is summarized below:

YEAR	% PLANT COVER
1990	10.9
1988	16.5

Reasons for the apparent decline in plant cover on this site are believed to be similar to those discussed for the 1980 Conveyor Site.

Shrub density was found to average 810 plants per acre (Table 6, Reclamation Seedings Shrub Densities). This value compares with an average for the 1988 sampling of 150 plants per acre. Since neither the 1988 or 1990 shrub sampling efforts achieved sample adequacy, it is difficult to say whether this increase is a result of natural succession or merely site variability.

This site is located almost totally in the Mountain Shrub Vegetation Type. The corresponding total plant cover values obtained from the Mountain Shrub Reference Area from the 1981 and 1990 sampling are 45.3 percent and 38.3 percent, respectively. Shrub densities appear to have increased from 150 to 810 plants per acre. This comparison suggest that this site needs more successional development before the revegetation success criteria with respect to plant cover or shrub density will be satisfied.

1985 Conveyor Seeding

This reclaimed site is located to the south of the Refuse Test Plots adjacent to the conveyor running to the Unit Train Loadout Silo. This site is a steep south and east facing Mancos Shale outcrop dominated by the Saltbush Vegetation Community.

A total of 32 cover and 30 density transects were evaluated on this site. Sample adequacy was found to equal 32 cover and 150.1 density transects. The average total plant cover on this site was estimated to equal 10.49 percent (Table 10, 1985 Conveyor Reclamation Plant Cover). This value compares with 16.2 percent and 16.9 percent obtained from the 1988 and 1987 monitoring efforts for this site. It is believed that the decline in plant cover is largely a function of the dry moisture conditions during the 1990 growing season.

The average shrub density value for this site was found to equal 2,550 plants (Table 6, Reclamation Seedings Shrub Densities). This compares with an average value of 920 plants per acre from the 1988 monitoring effort. These data suggest that shrub densities have increased over time.

A t-test comparison of the cover values of 10.49 percent from this reclaimed site with the 1983 Saltbush Reference Area value of 17.5 percent and 1990 value of 16.8 percent reveals that this site did not satisfy the revegetation success criteria with respect to plant cover for either year. However, indications are that the 1987 and 1988 cover values would satisfy the revegetation criteria with respect to plant cover. Both the 1988 and 1990 shrub density values exceed the revegetation success standard of 900 plants per acre for south facing slopes. Considering the harshness of this site, the degree of revegetation success is most encouraging.

1985 Mine # 1 Reclamation

This reclaimed area consists of the old coal shoot area and mine access

road of the Mine # 1 Area. This site was reclaimed by recontouring the old mine area with a dozer and the mine access road using a tracked backhoe. No topsoil materials were salvaged or available for reclamation at the old mine portal area, while during the recontouring of the road considerable soil materials were uncovered under the fill slopes. Whenever possible these soil materials were applied as a topdressing on the recontoured area.

A total of 40 cover and 50 density transects were evaluated on this site. Sample adequacy was determined adequate with 11.5 cover and 229.2 density transects. Average total cover for this site was estimated to be 14.29 percent (Table 11, 1985 Mine # 1 Reclamation Plant Cover). This value compares with 32.7 percent and 22.6 percent from the 1988 and 1987 monitoring efforts, respectively. Of all of the sites examined this site had the most evidence of grazing use, especially from deer.

Shrub density averaged 1,790 plants per acre in 1990 (Table 6, Reclamation Seedings Shrub Densities). This value compares with 120 woody plants per acre obtained from the 1988 sampling effort. Although sample adequacy was not achieved with respect to shrub densities in either 1988 or 1990, the available information suggest an increase in woody plant densities over time.

This disturbance area corresponds to the Douglas Fir, Mountain Grassland and Mountain Shrub Communities. Using a t-test comparison of the total plant cover values for these Reference Areas from the 1981 monitoring effort with the 1990 data for this site, the plant cover means between the Douglas Fir are equal while the means of the latter two are different. This comparisons suggests that the total plant cover on this site satisfies the revegetation success criteria for the Douglas Fir portion while it is deficient for the other two Reference Area types.

The woody plant density revegetation success criteria for this north facing slope is 2,200 plants per acre, a value slightly higher than the present woody plant density found on this site.

Refuse Test Plots

The Refuse Test plots were established to address Division concerns relative to the reclamation potential of the washed coal refuse material generated by Plateau. An extensive volume of information has been exchanged between the Division and Plateau relative to these test plots. This material will not be repeated here. The best summary of these test plots can be found in the 1983, 1984, 1985, 1986 and 1987 Annual Reclamation Monitoring reports previously submitted to the Division. These test plots were initially established to study the following objectives:

1. Evaluate the effectiveness of four plant growth mediums; topsoil, subsoil, topsoil over subsoil, and straight coal refuse;

2. Compare the effects of varying soil depths: 10 inches of topsoil, 20 inches of topsoil, 10 inches of subsoil, 20 inches of subsoil, and 10 inches of topsoil over 10 inches of subsoil; and

3. Determine the effects of supplemental fertilization applied at rates of 100 and 200 pounds per acre to the combinations described in one and two above.

Based upon the results obtained from previous monitoring efforts, minor modifications in the sampling regime have been periodically presented by Plateau and approved by the Division over the past several years. Specific agency recommendations relevant to the statistical comparisons and field sampling techniques are summarized in considerable detail in the 1986 Annual Reclamation Monitoring Report. The present evaluation utilizes the identical analytical techniques and methodologies used in all of the previously described reports. The only modification to be data analysis being that due to the very low composition of annuals, plant cover was only analyzed using total plant cover.

In sampling the Refuse Test Plots, where sufficient area was available a sufficient number of samples was collected until sample adequacy at the 80/10 confidence interval level had been achieved or until a maximum of 27 samples per plot had been collected as previously approved by the Division. The number of samples collected and the appropriate sample adequacy for each plot are presented in Table 12, Number of Refuse Plot Samples Needed for Sample Adequacy.

Soil Materials. A general comparison of the various plant growth mediums described in item one of the study objectives listed above and their associated vegetative parameters collected during the 1990 field sampling effort are presented in Table 13, Refuse Test Plots Comparison of Plant Growth Mediums. The highest overall plant cover is associated with the topsoil plots followed by the topsoil over subsoil and subsoil plots. No differences in shrub density or production could be detected between any of the soil materials.

Analysis of the percent annual cover on these plots revealed that topsoiled plots had 2.18 percent composition from annuals, subsoil plots had 0.01 percent annuals and topsoil over subsoil averaged 5.5 percent annuals. This identical trend observed in previous monitoring efforts suggests that the increased dominance of annuals on the plots with increasing amounts of topsoil, or specifically the seed bearing zone is still evident. The composition of annuals on the topsoiled plots was 39 percent from the 1987 monitoring and only 9 percent in 1990. It is not known whether the growth of annuals on the topsoiled plots will continue to decrease with time.

Soil Thickness. All possible combinations of topsoil and subsoil depths were evaluated through Analysis of Variance to determine whether or not the thickness or source of soil material affected plant growth. The results of this comparison suggest plant growth is significantly affected by the thickness and type of soil plant growth medium (Table 14, Refuse Test Plots Soil Depth

Interactions).

Highest total plant cover values are consistently associated with the topsoil plots, with no differences between the 10 and 20 inch topsoil depths. On subsoil materials, the 10 inch depth produced significantly less cover than the 20 inch depth. Topsoil over subsoil material produced a plant cover greater than the 20 inch subsoil depth but less than either of the topsoil thicknesses. Shrub densities appeared to be depressed on the topsoil treatments and overall higher on plots having subsoil. Production followed similar patterns as did plant cover, but exhibited less fluctuations between different materials.

Fertilization. When averaged across all treatments, fertilization was found to have statistically significant influences on plant cover (Table 15, Refuse Test Plots Fertilizer Effect On Plant Growth). The highest total plant cover was associated with the higher fertilizer rate while significantly higher shrub density levels were associated with the lower rate. Given the obvious long term affect of fertilizer, it is obvious that the influences of fertilization should be considered with respect to its potential influence on long term plant growth on these sites. The findings regarding cover are consistent with findings summarized in the 1987 monitoring report.

On the Subsoil materials, fertilizer was found to significantly influence all three measured plant parameters (Table 16, Refuse Test Plots Fertilizer Effect on Subsoil). Plant cover was stimulated by the higher fertilizer rate but shrub densities and production were depressed. Results obtained from the 1987 sampling found a similar relationship for shrub density and the 1986 results showed identical trends with respect to cover and shrub densities to those described from the 1990 sampling. These data document that fertilization has a significant influence on plant growth on subsoil many years following fertilization and in situations were shrub density and production may be limiting factors it may not be desirable to fertilizer such sites if subsoil materials are the

primary plant growth medium.

On the Topsoil materials, fertilizer was found to significantly influence only shrub densities (Table 17, Refuse Test Plots Fertilizer Effect on Topsoil). In 1987 both plant cover and shrub densities were influenced by fertilization while in 1986 only shrub densities were affected. Given the consistent documentation across all monitoring periods suggesting that shrub densities are increased as a result of fertilization on topsoil materials, it appears that fertilization might be an option to increase shrub densities on sites topdressed only with topsoil materials.

On the Topsoil Over Subsoil materials, fertilizer was found to have no measurable effect on plant growth (Table 18, Refuse Test Plots Fertilizer Effect On Topsoil Over Subsoil). In 1987 fertilizer was found to increase total plant cover but no such response could be documented from the 1986 or 1990 data.

On the ten inch Subsoil plots, significant differences in plant growth were found for total cover and production (Table 19, Refuse Test Plots Fertilizer Effect On Ten Inches of Subsoil). In the 1987 monitoring, significantly higher shrub densities were associated with the higher fertilization rate while in 1986 higher plant cover was associated with the lower fertility rate.

On the twenty inch Subsoil plots significant differences in shrub densities existed between the two levels of fertilization (Table 20, Refuse Test Plots Fertility Comparisons On Twenty Inches of Subsoil). In the 1987 and 1986 monitoring efforts no difference were encountered, but much smaller sample sizes were compared.

On the ten inch Topsoil plots, fertilization was found to significantly influence shrub densities as well as annual forage production (Table 21, Refuse

Test Plots Fertilizer Effect On Ten Inches of Topsoil). Highest shrub densities were associated with the higher rate of fertilization while the oppose trend was evident for production. Results from the 1987 and 1986 monitoring efforts revealed no differences in any vegetative parameters for the ten inch topsoil plots.

On twenty inches of Topsoil, fertilizer was found to significantly influence only production (Table 22, Refuse Test Plots Fertilizer Effect On Twenty Inches of Topsoil). In 1987, no differences in any parameters could be detected while in 1986 shrub densities were found to be higher with the higher level of fertilization.

Conveyor Edge Effect. In order to address potential agency concerns that the construction activities associated with the Unit Train Loadout Conveyor might bias the data collected for the plots adjacent to the conveyor cut, Plateau initiated a special sampling effort in 1985 to quantify whether or not the disturbance had altered the data collected from the disturbed plots. Identical sampling methodologies have been used in the 1985, 1986, 1987 and 1990 monitoring efforts. This comparison involves sampling the "edge effect" of plots located at varying distances from the crown of the cut. The "near" transects are located five feet away from the crown of the cut while the "away" plots are located twelve feet away.

The results from this comparisons are presented in Table 23, Refuse Test Plots Conveyor Edge Effect. This comparison suggests that no measurable differences in plant growth occur between the "near" and "away" plots located near the conveyor cut. In addition to these comparisons, the "near" and "away" plot values were compared both seperately and collectively with the remainder to the plots. Statistically, no differences between any of these areas could be detected. Plateau believes that these comparisons confirms the conclusions reached in the 1985, 1986 and 1987 Annual Reclamation Monitoring Reports,

that the undisturbed portions of the remaining plots are yielding unbiased and scientifically acceptable data.

Aspect Comparison. All but one of the Refuse Test Plots possesses a northern aspect. In all of the previous comparisons only plots having a similar aspect were compared. However, Plots D2 and G received identical treatments consisting of ten inches of Subsoil with 100 pounds of fertilizer with the only difference being aspect. Plot D2 has a northern aspect and Plot G has a southern aspect.

Comparing the 1990 results with previously collected data from these plots reveals consistent trends in the results over time (Table 24, Refuse Test Plots Aspect Comparison). In both 1986 and 1987 plant cover was statistically higher on the south facing slope, while the shrub densities were highest on the north facing slope. Differences in plant growth appear to largely be a function of differences in plant species composition. On the north facing slope the dominate plants contributing towards the plant cover are Intermediate wheatgrass, 67 percent composition, and Fourwing saltbush, 17 percent composition. On the south facing slope the dominate plant is Western Wheatgrass, 42 percent composition and Rubber rabbitbrush, 13 percent composition. With respect to shrub densities, on the north facing slope Green ephedra is the dominate shrub comprising 60 percent of all of the shrubs while on south facing slope the dominate shrub was Rubber rabbitbrush comprising 67 percent of the shrubs found on this site.

A comparison of the mean cover, shrub density and production by each of the Refuse Test Plots which was sampled in 1990 is presented in Table 25, Comparison of Refuse Test Plot Means by Vegetative Characteristic.

CONCLUSIONS

The most consistent factor regarding the vegetation response on the reclaimed areas at the Plateau Mine from the 1990 monitoring information is the fact that when plant growth on these sites is compared between different years the 1990 response is typified as having reduced plant growth in terms of cover and forage production. There appears to be an almost consistent decrease in plant growth in 1990 when compared to previous monitoring efforts conducted under more favorable moisture conditions. Therefore, it appears that the plant responses associated with the 1990 monitoring data are according to moisture conditions among the driest encountered at this site since reclamation monitoring commenced in 1981.

While the vegetation responses on nearly all of the reclaimed sites was reduced when compared to other years there are numerous areas indicative of successful reclamation at this site. This is demonstrated by the comparison on Table 26, Revegetation Successfulness of Refuse Test Plots which shows that many of these plots would qualify for bond release at this time. While plant cover seemed to be below levels previously encountered, one feature that was consistently improved on nearly all reclaimed sites monitored and especially the Refuse Test Plots which have been much more intensively monitored that any other areas would be the continued increase in shrubs on these reclaimed areas. When the average shrub density for the Refuse Test Plots for the 1987 monitoring is compared with the 1990 data, it can determined that the average shrub density increased from 840 plants per acre to 2,479 woody plants per acre. This change is significant in demonstrating that revegetation of this area is possible.

Upon comparing the various sites that have been reclaimed at this mine there is a consistent trend for the more recently reclaimed areas to be more successful that are the earlier less intensive reclamation efforts which consisted largely or scattering seed on the site and hoping that something grew.

Especially when the 1985 reclamation efforts, which commonly involved regrading and some attempts at topsoiling are compared with the 1980 reclamation efforts it can be readily observed that as a rule plant cover and particularly shrub densities are higher on the more recently reclaimed areas.

Table 1, Reference Area Range Condition Classes.

REFERENCE AREA	% COVER	CONDITION CLASS
Mountain Shrub	38.3	Good
Sagebrush	23.5	Fair
Douglas Fir	21.5	Fair
Mountain Grassland	47.3	Good
Pinyon Juniper	28.8	Fair
Saltbush	16.8	Fair
Corner Canyon	75.0	Fair

Table 2, Sagebrush Reference Area Cover.

Species	Percent Cover	Percent Composition
Perennial Grasses		
Indian ricegrass	2.13	9.04
Bottlebrush squirreltail	1.50	6.38
Salina wildrye	1.13	4.79
Blue grama	0.25	1.06
Needle and thread	0.13	0.53
Shrubs		
Big sagebrush	18.00	76.60
Broom snakeweed	0.13	0.53
TOTAL PLANT COVER	23.59	99.99
ROCK	0.38	
LITTER	30.13	
BARE	46.00	
LICHENS	0.25	

N = 8, Mean = 23.50, SD = 4.60, Sample Adequacy 80/10 = 6.3

Table 3, Sagebrush Reference Area Shrub Density.

Species	Density (# 150 m2)	Percent Composition
Big sagebrush	81.87	87.61
Broom snakeweed	8.06	8.63
Rubber rabbitbrush	2.50	2.68
Eriogonum	0.25	0.27
Pinyon pine	0.25	0.27
Utah serviceberry	0.19	0.20
Winterfat	0.13	0.14
Cactus	0.13	0.14
Douglas rabbitbrush	0.06	0.06
TOTAL	93.44	100

N = 8, Mean = 93.44, SD = 11.61, Sample Adequacy 80/10 = 2.5

Table 4, Sagebrush Reference Area Production.

Species	Production (grams/1/4 m2)	Percent Composition
Perennial Grasses		
Indian ricegrass	0.85	13.70
Bottlebrush squirreltail	0.54	8.63
Western wheatgrass	0.41	6.60
Salina wildrye	0.15	2.36
Blue grama	0.03	0.41
Sheep fescue	0.01	0.16
Needle and thread	T	0.15
Sandberg bluegrass	T	0.01
Annual Grasses		
Cheatgrass brome	T	0.08
Annual Forbs		
Summer cypress	0.10	0.03
Unknown	0.03	0.41
Russian thistle	0.01	0.12
Rockcress	T	T
Biennial Forbs		
Curleycup gumweed	T	0.02
Shrubs		
Big sagebrush	4.03	64.93
Broom snakeweed	0.10	1.61
Rubber rabbitbrush	0.03	0.41
Winterfat	0.01	0.16
Utah serviceberry	T	0.06
TOTAL PRODUCTION	6.21	99.99

N = 50, Mean = 6.21, SD = 3.27, Sample Adequacy 80/10 = 45.4

Table 5, 1980 Topsoil Stockpile Reclamation Plant Cover.

	% Cover	% Composition	Frequency
Perennial Grasses			
Intermediate wheatgrass	6.80	29.06	100
Desert wheatgrass	6.40	27.35	100
Western wheatgrass	1.80	7.69	60
Smooth bromegrass	1.20	5.13	40
Sandberg bluegrass	0.20	0.85	20
Perennial Forbs			
Alfalfa	0.60	2.56	40
Annual Forbs			
Summer cypress	3.60	15.38	60
Russian thistle	1.80	8.55	100
Lambsquarters goosefoot	0.80	3.42	60
TOTAL PLANT COVER	23.40	99.99	
LITTER	15.60		
ROCK	0		
BARE	61.00		

Table 6, Reclamation Seedings Shrub Densities (# woody plants per acre).

Species	1980 Conveyor	1980 Access Road	1985 Access Road	1985 Conveyor	1985 Mine # 1
Winterfat	16				
Bitterbrush	150				
Big sagebrush	33	20	80	20	540
Rubber rabbitbrush	300		140	530	60
Snowberry	50	40	250		
Cinquefoil	16				
Douglas rabbitbrush		20	50	20	50
Fringed sagebrush		310	10		10
Eriogonum		440		850	1,070
Douglas fir			20		10
Horsebrush			10		
Broom snakeweed			80		50
Shadscale			70	480	
Cuneate saltbush				400	
Fourwing saltbush				250	
Utah serviceberry			10		
Mountain mahogany			10		
TOTAL	565	830	810	2,550	1,790
N	30	24	50	30	50
Mean	0.567	0.833	0.810	2.550	1.790
SD	1.097	1.080	0.820	2.437	2.114
Adequacy	615.2	276.3	168.4	150.1	229.2

Table 7, 1980 Conveyor Reclamation Plant Cover.

	% Cover	% Composition	Frequency
Perennial Grasses			
Intermediate wheatgrass	5.15	49.50	100
Smooth bromegrass	1.87	17.93	73
Desert wheatgrass	0.57	5.44	47
Orchardgrass	0.53	5.06	50
Kentucky bluegrass	0.13	1.28	17
Timothy	0.02	0.19	3
Indian ricegrass	0.02	0.19	3
Salina wildrye	0.01	0.06	3
Sandberg bluegrass	0.01	0.12	7
Perennial Forbs			
Alfalfa	0.73	6.98	50
Spreading Aster	0.62	5.96	27
Yellow sweetclover	0.17	1.67	13
Cicer milkvetch	0.09	0.90	7
Phacelia	0.03	0.26	3
Eaton fleabane	0.02	0.19	3
Curlycup gumweed	0.02	0.19	10
Annual Forbs			
Russian thistle	0.02	0.19	3
Summer cypress	0.01	0.06	3
Shrubs			
Big sagebrush	0.22	2.11	7
Antelope bitterbrush	0.09	0.90	3
Winterfat	0.06	0.58	3
Rubber rabbitbrush	0.02	0.19	10
TOTAL PLANT COVER	10.41	99.95	
LITTER	20.91		
ROCK	27.90		
BARE	40.79		

Table 8, 1980 Mine # 1 Access Road Plant Cover.

Plant Species	% Cover	% Composition	Frequency
Perennial Grasses			
Desert wheatgrass	3.98	26.15	79
Salina wildrye	3.04	20.00	67
Intermediate wheatgrass	2.98	19.63	75
Smooth bromegrass	2.24	14.75	67
Russian wildrye	0.38	2.52	17
Kentucky bluegrass	0.11	0.71	8
Sheep fescue	0.04	0.27	4
Orchardgrass	0.03	0.17	4
Annual Grasses			
Cheatgrass	0.27	1.75	21
Perennial Forbs			
Cicer milkvetch	0.47	3.07	8
Spreading Aster	0.43	2.80	21
Sulfur eriogonum	0.12	0.76	4
Louisiana sagebrush	0.10	0.66	4
Western yarrow	0.09	0.60	8
Lewis flax	0.09	0.60	4
Curlycup gumweed	0.05	0.33	8
Penstemon	0.05	0.33	4
Phacelia	0.03	0.22	4
Annual Forbs			
Shrubs			
Fringed Sagebrush	0.12	0.76	4
Mountain snowberry	0.12	0.66	4
Douglas rabbitbrush	0.04	0.27	4
TOTAL PLANT COVER	15.20	99.99	
LITTER	25.58		
ROCK	35.48		
BARE	23.74		

Table 9, 1985 Access Road Reclamation Plant Cover.

Plant Species	% Cover	% Composition	Frequency
Perennial Grasses			
Intermediate wheatgrass	3.54	32.44	100
Orchardgrass	2.28	20.84	100
Salina wildrye	0.90	8.20	50
Great Basin wildrye	0.27	2.44	10
Sheep fescue	0.18	1.66	15
Smooth bromegrass	0.16	1.48	15
Indian ricegrass	0.10	0.87	10
Desert wheatgrass	0.04	0.35	10
Perennial Forbs			
Alfalfa	2.07	18.93	85
Cicer milkvetch	0.55	5.06	55
Curlycup gumweed	0.15	1.40	20
Prickly lettuce	0.15	1.40	5
Elk thistle	0.14	1.31	5
Sulfur eriogonum	0.11	0.01	10
Eaton fleabane	0.02	0.17	5
Common dandelion	0.02	0.17	5
Spreading Aster	0.02	0.17	5
Cryptantha	0.02	0.17	5
Looseflower milkvetch	0.02	0.17	5
Annual Forbs			
Russian thistle	0.04	0.35	10
Shrubs			
Mountain snowberry	0.10	0.87	10
Utah serviceberry	0.03	0.26	5
Broom snakeweed	0.02	0.17	5
TOTAL PLANT COVER	10.92	100	
LITTER	12.81		
ROCK	23.39		
BARE	52.88		

Table 10, 1985 Conveyor Reclamation Plant Cover.

Plant Species	% Cover	% Composition	Frequency
Perennial Grasses			
Intermediate wheatgrass	2.63	25.02	94
Desert wheatgrass	1.87	17.81	53
Smooth bromegrass	0.77	7.33	53
Indian ricegrass	0.16	1.49	10
Western wheatgrass	0.04	0.36	3
Sand dropseed	0.04	0.42	3
Annual Grasses	5.51		
Perennial Forbs			
Yellow sweetclover	0.48	4.59	44
Sulfur eriogonum	0.29	2.80	19
Cicer milkvetch	0.16	1.49	13
Cryptantha	0.01	0.12	3
	.94		
Annual Forbs			
Russian thistle	1.81	17.28	75
Halogeton	1.16	11.02	38
Summer cypress	0.03	0.30	3
	3.0		
Shrubs			
Shadscale	0.41	3.93	16
Cuneate saltbush	0.31	2.92	13
Rubber rabbitbrush	0.18	1.67	16
Fourwing saltbush	0.15	1.43	9
	1.05		
TOTAL PLANT COVER	10.49	99.98	
LITTER	11.48		
ROCK	20.42		
BARE	57.62		

Table 11, 1985 Mine # 1 Reclamation Plant Cover.

Plant Species	% Cover	% Composition	Frequency
Perennial Grasses			
Intermediate wheatgrass	5.59	39.13	100
Orchardgrass	3.82	26.71	88
Sheep fescue	0.58	4.06	35
Great Basin wildrye	0.37	2.55	13
Foxtail barley	0.27	1.85	18
Smooth bromegrass	0.24	1.64	8
Desert wheatgrass	0.20	1.36	18
Slender wheatgrass	0.13	0.87	5
Salina wildrye	0.10	0.66	10
Kentucky bluegrass	0.06	0.42	8
Indian ricegrass	0.06	0.42	3
Sandberg bluegrass	0.05	0.32	13
Western wheatgrass	0.02	0.13	3
Bottlebrush squirreltail	0.02	0.10	3
Annual Grasses			
Cheatgrass brome	0.08	0.52	3
Perennial Forbs			
Curlycup gumweed	1.42	9.90	60
Alfalfa	0.41	2.83	28
Sulfur eriogonum	0.20	1.36	8
Eaton fleabane	0.16	1.08	5
Yellow sweetclover	0.14	0.98	20
Spreading Aster	0.08	0.52	5
Canada thistle	0.02	0.14	5
Looseflower milkvetch	0.01	0.07	3
Western yarrow	0.01	0.07	3
Cicer milkvetch	0.01	0.07	3
Annual Forbs			
Chorispora	0.03	0.21	3
Russian thistle	0.01	0.07	3
Summer cypress	0.01	0.07	3
Shrubs			
Big sagebrush	0.21	1.43	13
Rubber rabbitbrush	0.04	0.24	3
Broom snakeweed	0.01	0.07	3
Douglas rabbitbrush	0.01	0.07	3
TOTAL PLANT COVER	14.29	99.92	
LITTER	22.36		
ROCK	16.05		
BARE	47.31		

Table 12, Number of Refuse Plot Samples Needed for Sample Adequacy.

PLOT	PARAMETER	# OF SAMPLES COLLECTED	SAMPLES REQUIRED N80/10
B1	Cover	15	9.7
	Density	23	22.8
	Production	15	17.6
B2*	Cover	10	7.8
	Density	9	4.9
	Production	10	16.5
C1*	Cover	10	6.9
	Density	26	17.3
	Production	4	26.4
C2	Cover	10	4.4
	Density	26	23.9
	Production	20	44.7
D1	Cover	7	6.8
	Density	10	9.7
	Production	27	22.0
D2	Cover	14	11.7
	Density	20	18.3
	Production	27	41.9
E1	Cover	8	7.6
	Density	6	2.3
	Production	27	33.4
E2**	Cover	14	13.0
	Density	28	26.9
	Production	9	28.0
F1	Cover	5	2.8
	Density	14	13.2
	Production	27	96.4
F2	Cover	8	7.7
	Density	11	8.2
	Production	27	15.7
G	Cover	15	13.3
	Density	27	50.5
	Production	27	93.2

* Denotes plots disturbed by construction of the Unit Train Loadout Conveyor in 1985. Due to the reduced area of these plots insufficient area existed on some plots to take a sufficient number of samples to achieve sample adequacy.

**One bag of production samples was lost enroute to the office.

Table 13, Refuse Test Plots Comparison of Plant Growth Mediums.

Total Cover %	Mean
Topsoil	23.20c*
Subsoil	12.63a
Topsoil Over Subsoil	17.55b
Shrub Density (# stems/150 ft2)	
Topsoil	6.78a
Subsoil	6.42a
Topsoil Over Subsoil	5.93a
Production (grams per 1/4 m2)	
Topsoil	9.88a
Subsoil	8.60a
Topsoil Over Subsoil	10.40a

*Means within a given parameter followed by a different letter are significantly different at the 0.05 level using the Duncan's Multiple Range Test.

Table 14, Refuse Test Plots Soil Depth Interactions.

TREATMENT	Mean Value
Total Cover (%)	
10" Topsoil	24.31d*
10" Subsoil	9.86a
20" Topsoil	22.55d
20" Subsoil	14.96b
10" Topsoil Over 10" Subsoil	17.55c
Shrub Density (# plants/150 ft2)	
10" Topsoil	7.90b
10" Subsoil	13.28d
20" Topsoil	9.88c
20" Subsoil	4.21a
10" Topsoil Over 10" Subsoil	11.58d
Production (grams per 1/4 m2)	
10" Topsoil	6.63b
10" Subsoil	5.55a
20" Topsoil	6.72b
20" Subsoil	6.43ab
10" Topsoil Over 10" Subsoil	5.95ab

*Means within a given parameter followed by a different letter are significantly different at the 0.05 level using the Duncan's Multiple Range Test.

Table 15, Refuse Test Plots Fertilizer Effect On Plant Growth.

FERTILIZER RATE	MEAN	STD. DEV.	N	T. CAL.
Total Cover (%)				
100 #/Acre	16.14	3.58	50	
				3.316*
200 #/Acre	18.64	4.04	53	
Shrub Density (# plants/150ft2)				
100 #/Acre	11.22	3.16	37	
				3.616**
200 #/Acre	9.05	3.03	89	
Production (grams per 1/4 m2)				
100 #/Acre	6.29	2.47	95	
				1.163
200 #/Acre	6.76	3.24	116	

* Means are significantly different at alpha = 0.01 using the two tailed t-test.

** Means are significantly different at alpha = 0.001 using the two tailed t-test.

Table 16, Refuse Test Plots Fertilizer Effect On Subsoil.

FERTILIZER RATE	MEAN	STD. DEV.	N	T. CAL.
Total Cover (%)				
100 #/Acre	11.38	2.74	24	2.948*
200 #/Acre	13.99	3.26	22	
Shrub Density (# plants/150ft2)				
100 #/Acre	14.13	4.17	20	7.600**
200 #/Acre	6.76	1.91	29	
Production (grams per 1/4 m2)				
100 #/Acre	6.79	2.40	37	3.567**
200 #/Acre	4.98	2.11	42	

* Means are significantly different at alpha = 0.01 using the two tailed t-test.

** Means are significantly different at alpha = 0.001 using the two tailed t-test.

Table 17, Refuse Test Plots Fertilizer Effect On Topsoil.

FERTILIZER RATE	MEAN	STD. DEV.	N	T. CAL.
Total Cover (%)				
100 #/Acre	23.00	4.95	16	
				0.326
200 #/Acre	23.56	5.33	21	
Shrub Density (# plants/150ft2)				
100 #/Acre	7.79	1.33	17	
				2.012*
200 #/Acre	9.55	3.49	42	
Production (grams per 1/4 m2)				
100 #/Acre	7.18	2.66	54	
				1.416
200 #/Acre	6.19	3.98	36	

* Means are significantly different at alpha = 0.10 using the two tailed t-test.

Table 18, Refuse Test Plots Fertilizer Effect On Topsoil Over Subsoil.

FERTILIZER RATE	PLOT	MEAN	STD. DEV.	N	T. CAL.
Total Cover (%)					
100 #/Acre	C1	16.60	3.41	10	1.318
200 #/Acre	C2	18.50	3.03	10	
Shrub Density (# plants/150ft2)					
100 #/Acre	C1	-	-	-	
200 #/Acre	C2	10.40	3.97	18	
Production (grams per 1/4 m2)					
100 #/Acre	C1	7.79	3.12	4	1.382
200 #/Acre	C2	5.58	2.91	20	

* Means are significantly different at alpha = 0.10 using the two tailed t-test.

Table 19, Refuse Test Plots Fertilizer Effect On Ten Inches of Subsoil.

FERTILIZER RATE	PLOT	MEAN	STD. DEV.	N	T. CAL.
Total Cover (%)					
100 #/Acre	D2	9.21	2.46	7	
					1.738*
200 #/Acre	D1	11.14	2.27	14	
Shrub Density (# plants/150ft2)					
100 #/Acre	D2	14.13	4.71	20	
					1.551
200 #/Acre	D1	11.60	2.86	10	
Production (grams per 1/4 m2)					
100 #/Acre	D2	4.22	2.13	27	
					4.198**
200 #/Acre	D1	6.88	2.52	27	

* Means are significantly different at alpha = 0.10 using the two tailed t-test.

** Means are significantly different at alpha = 0.001 using the two tailed t-test.

Table 20, Refuse Test Plots Fertilizer Effect On Twenty Inches of Subsoil.

FERTILIZER RATE	PLOT	MEAN	STD. DEV.	N	T. CAL.
Total Cover (%)					
100 #/Acre	B2	14.40	3.13	10	
					0.653
200 #/Acre	B1	15.33	3.72	15	
Shrub Density (# plants/150ft2)					
100 #/Acre	B2	5.00	0.87	9	
					2.086*
200 #/Acre	B1	3.91	1.46	23	
Production (grams per 1/4 m2)					
100 #/Acre	B2	6.52	2.07	10	
					0.183
200 #/Acre	B1	6.36	2.08	15	

* Means are significantly different at alpha = 0.05 using the two tailed t-test.

Table 21, Refuse Test Plots Fertilizer Effect On Ten Inches of Topsoil.

FERTILIZER RATE	PLOT	MEAN	STD. DEV.	N	T. CAL.
Total Cover (%)					
100 #/Acre	F2	23.63	5.10	8	
					0.688
200 #/Acre	F1	25.40	3.29	7	
Shrub Density (# plants/150ft2)					
100 #/Acre	F2	6.09	1.36	11	
					3.680*
200 #/Acre	F1	9.32	2.64	14	
Production (grams per 1/4 m2)					
100 #/Acre	F2	8.14	2.52	27	
					3.365*
200 #/Acre	F1	5.12	3.92	27	

* Means are significantly different at alpha = 0.01 using the two tailed t-test.

Table 22, Refuse Test Plots Fertilizer Effect On Twenty Inches of Topsoil.

FERTILIZER RATE	PLOT	MEAN	STD. DEV.	N	T. CAL.
Total Cover (%)					
100 #/Acre	E1	22.38	4.81	8	0.103
200 #/Acre	E2	22.64	6.36	14	
Shrub Density (# plants/150ft2)					
100 #/Acre	E1	10.92	1.28	6	0.769
200 #/Acre	E2	9.66	3.91	28	
Production (grams per 1/4 m2)					
100 #/Acre	E1	6.21	2.80	27	2.595*
200 #/Acre	E2	9.38	4.15	9	

* Means are significantly different at alpha = 0.01 using the two tailed t-test.

Table 23, Refuse Test Plots Conveyor Edge Effect.

FERTILIZER RATE	MEAN	STD. DEV.	N	T. CAL.
Total Cover (%)				
Near	15.00	2.98	8	
				1.302
Away	17.50	4.54	8	
Shrub Density (# plants/150ft2)				
Near	5.00	2.56	8	
				1.622
Away	6.38	3.78	8	
Production (grams per 1/4 m2)				
Near	4.99	2.55	8	
				0.854
Away	7.21	2.91	8	

Table 24, Refuse Test Plots Aspect Comparison.

ASPECT	PLOT	MEAN	STD. DEV.	N	T. CAL.
Total Cover (%)					
North	D2	9.21	2.46	14	
					6.509*
South	G	19.93	5.68	15	
Shrub Density (# plants/150ft2)					
North	D2	14.13	4.71	20	
					9.323*
South	G	4.33	2.40	27	
Production (grams per 1/4 m2)					
North	D2	4.22	2.13	27	
					2.281**
South	G	6.59	4.96	27	

* Means are significantly different at alpha = 0.001 using the two tailed t-test.

** Means are significantly different at alpha = 0.05 using the two tailed t-test.

Table 25, Comparison of Refuse Test Plots by Vegetative Characteristic.

PLOT	% TOTAL COVER		PRODUCTION (grams/1/4M2)		SHRUB DENSITY (stems/150 ft2)
B1 20" sub	15.33b*	10.5 I J	6.36ab	7.2	3.91a
B2 20" sub	14.40ab	13.0	6.52ab	6.3	5.00b
C1 10"/10"	16.60bc	13.8 A	7.79b	8.1	-
C2 10"/10"	18.50c	17.0 A	5.56a	12.6	10.40d
D1 10" sub	11.14a	12.0 A	6.88b	8.7	11.60e
D2 10" sub	9.21a	12.0 A	4.22a	8.7	14.13e
E1 20" top	22.38d	13.4 A	6.21ab	9.6	10.92d
E2 20" top	22.64b	13.4 A	9.38b	11.7	9.66d
F1 10" top	25.40d	21.4 J	5.12a	10.5	9.32d
F2 10" top	23.63d	26.7 A	8.14b	16.8	6.09c
G 10" sub	19.33cd	18.4 A	6.59ab		4.33ab

*Means with a column followed by a different letter are significantly different at the 0.05 level using the Duncan's Multiple Rule Test.

20" - 18.3 % cover, 6.97gr/.25m² production

10" - 17.3 % cover, 6.09 gr/.25m²