PLATEAU MINING COMPANY

1986 ANNUAL RECLAMATION REPORT
STAR POINT MINES

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TABLE OF CONTENTS

LIST OF TABLES

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 requires as part of Special Stipulation #10(c) that an annual revegetation monitoring report will be submitted to the Division each year. This report contains analyzed field data collected between June 30, 1986 and July 9, 1986 for areas that required monitoring in 1986. All of the data was collected and analyzed by Kent Crofts, Mark Jones and Michael Jones. Several changes in the scope monitoring program were negotiated with the Division based upon results obtained during the 1985 field season. Plateau's request to modify the previously approved monitoring program were discussed with Kathy Mutz, Lynn Kunzler and Dan Duce during May, June and July 1986. These changes were requested by Plateau via the 1985 Annual Reclamation Report. Approval for these changes was granted to Plateau in correspondence dated June 3, 1986 and the changes specifically approved by UDOGM included the following:

*Dropping the slope segment sampling on the refuse test plots;

*Allowing Plateau to sample the refuse test plots to sample until sample adequacy was achieved or 27 transects were collected, whichever value was less;

*Elimination of the annual monitoring requirement to sample non-topsoiled coal refuse;

*Elimination of monitoring of the Office Road Cut and Barrow Area shrub transplants;

*Realignment of the sampling schedule on reclaimed areas so that production, cover and density data are collected at intervals consistent with current Division policy.

SAMPLING METHODOLOGIES

All of the parameters collected in 1986 utilized the identical sample methodologies and equipment, and methods of data analysis as used previously and approved by UDOGM for this specific locale. The parameters sampled in 1986 included total plant cover, woody plant densities, and seedling densities for the newly reclaimed areas located along the Unit Train Loadout Conveyor and portions of the Star Point No. 1 Mine Area. Due to the

similarity of methodologies used, Plateau feels that 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 two previously approved techniques. On the flatter areas associated with the Refuse Test Plots, the topsoil and subsoil stockpiles, cover was collected using an inclined ten point metal frame. A 50 foot tape was outstretched in the area to be sampled and the ten point frame was randomly spaced at ten points along the tape. At each transect, 100 data points were collected. All 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 observed. Plant material that had dried prior to sampling (such as cheatgrass), but was a product of the 1986 growing season was counted as plant cover. Litter was defined to be plant material that had been on the ground 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 placed in terms of location and orientation using random numbers generated from a hand held calculator.

On the steeper road cut and fill slopes encountered along the Lion Deck Portion Access Road and Conveyor, it was unsafe to sample using the ten point frame. On these areas plant cover was obtained using a 2 x 5 dm quadrat. Transects 14.52 feet in length were randomly placed throughout the area and along each transect four quadrats were sampled. The four quadrat values were then averaged into a single transect observation.

Woody Plant Density

On the Refuse Test Plots, woody plant density values were obtained by sampling a 3 x 50 foot transect. The tape used for the cover transect also was used as the center point for the woody plant density transect. On all of the monitoring associated with the yearly reclamation seedings,

shrub densities were obtained by taking an average of two 3 x 14.52 foot belt plots per transect. This area was chosen because the area corresponds to one thousandth of an acre.

Seedling Densities

On the areas along the Unit Train Loadout Conveyor and in the Star Point No. 1 Mine Areas, seedling densities were evaluated using the previously described 2 x 5 dm quadrat. At each sample site seedling counts were made according to perennial grasses, perennial forbs, annual grasses, annual forbs and shrubs. Due to the immature growth of the grasses and forbs, it is not practical to separate out individual species. Shrub seedlings were identified to species whenever possible.

At each of the two sites sampled, a sufficient number of quadrats were randomly located throughout the area to determine the relative establishment of seeded species on the site. The data collected were then compared to previously collected data from the mine site and published research applicable to this area.

DESCRIPTION OF RECLAIMED SITES SAMPLED

RESULTS AND DISCUSSION

1981 Seeding

A total of 25 transects were taken to evaluate cover and density was based upon a total of 24 transects. A total of 18 transects were collected in the 47.45 acre seeding and 7 transects were taken in the 7.83 acre area. Fifth year total plant cover on these areas was found to equal 32.97 percent (Table 1). Shrub density was found to equal 647 stems per acre (Table 2). A comparison of cover and density for previous years is as follows:

YEAR	% COVER	SHRUB DENSITY PLANTS/ACRE
1986	32.97	647
1985	18.81	160
1984	22.83	789
1983	15.67	150

As can be seen from comparison of Tables 1 and 2 for the 1986 monitoring data with Tables 1 and 2 in the 1985 Annual Reclamation Report, overall characteristics of the site between years is somewhat consistent. Although cover from the 22 transects sampled in 1985 yielded an average of 18.81 percent cover as compared to a 1986 value of 32.97 percent, differences can be readily explained by differences in areas sampled in 1985. Due primarily to safety considerations, only cut slopes were sampled in 1985. Although a considerable area of fill slopes are present, they were not sampled in proportion to the area they comprise. In 1986, the sampling program involved collecting a proportionally larger number of samples from the fill slope areas. Composition between 1985 and 1986 was found to be quite similar. Perennial grass composition averaged 65.37 percent in 1986 as compared to 78.68 percent for the 1985 sampling. Perennial forbs comprised 21.07 percent of the total plant cover in 1986 as compared to 18.72 percent for the previous year. Differences between areas sampled are evident in the shrub cover which in 1986 was found to equal 13.56 percent while no shrub cover was recorded for the previous year. Similar differences are found with respect to cicer milkvetch which in 1986 equaled 17.50 percent of the total plant cover, but was not encountered in the 1985 sampling. The decrease in alfalfa and sweetclover noted in the 1985 Annual Reclamation Report appear to be continuing. In 1984 these species composed 51.1 percent of the seeded stand, 18.72 percent in 1985 and in 1986 amounted to only 3.51 percent of the total plant cover.

Plateau is encouraged when comparing the revegetation success on this area as compared to the vegetative characteristics of the proposed reference areas which will be used as a revegetation success standard for this area. The reference area values for total plant cover as contained in the existing permit are as follows:

REFERENCE AREA	PERCENT COVER
Mountain Shrub	49.1
Douglas Fir	15.1
Sagebrush	33.7
Pinyon Juniper - East	32.5
Pinyon Juniper - West	12.8

Since the majority of the 1981 Seeding corresponds to the Pinyon - Juniper vegetation type, the plant cover value of 32.97 percent obtained during only the fifth growing season appears to be acceptable for reclamation of this area. Although woody plant densities are still lower than the reference area values, Plateau is optimistic that densities will continue to increase.

1983 Seeding

A total of 25 cover and woody plant density transects were taken to calculate plant cover and woody plant establishment on the 1983 seeded areas. Four transects were taken in both the 1.5 and 1.15 acre seeded tracts. Eight transects were taken in the 1.10 acre seeded tract and nine transects were taken in the 4.29 acre seeded tract. During the third growing season average plant cover for the 1983 reclamation seedings was determined to equal 13.92 percent (Table 1). Shrub density was found to equal 500 plants per acre (Table 2).

A comparison of the 1985 and 1986 data reveal that overall plant cover increased from 4.71 percent during the second growing season to 13.92 percent for the third growing season. Perennial grasses amounted to 82.33 percent of the total cover in 1985 and 83.90 percent in 1986. Perennial forbs amounted to 12.39 percent of the cover in 1985 and 14.88 percent in 1986. Annual forbs comprised 5.31 percent of the cover in 1985 and zero percent during 1986. In 1985 shrubs amounted to zero percent of the plant cover and in 1986 shrubs had increased to a point they accounted for 1.30 percent of the total cover.

No shrub density data was collected for this tract in prior years so no trends for this site are available. However, comparison of the third year shrub density data for the 1983 seeding with other reclaimed sites of similar age at Plateau is possible. Table 2 reveals that eight species were encountered which produced an average shrub density of 500 stems per acre. Comparison of 1985 shrub densities (Table 2, Plateau 1985 Annual Reclamation Report) indicate that no other reclamation seeding has as many species or similar third year shrub densities. Third year shrub densities for the 1982 seeding reported in the 1985 Annual Report

averaged only 200 stems per acre. Given the diversity of shrubs present and encouraging third year densities, Plateau believes that this site will continue to improve with regards to its reclamation potential.

1985 Seeding

During the Fall of 1985, 10.10 acres received final reclamation at the Star Point Mine No. 1 Portal Area and 8.0 acres received interim reclamation along the Unit Train Loadout Conveyor. The methodologies of seeding and seed mixtures are described in the 1985 Annual Reclamation Report.

Initial germination and plant establishment for these two areas were evaluated by counting the number of seedlings rooted within 25 randomly located 2 x 5 dm quadrats. Table 3 reveals that initial establishment of the seeded species was extremely successful. According to the most applicable guide available for evaluating initial success of reseeded stands (Cook, C.W., L.A. Stoddard and P.L. Sims. 1967. Effects of Season Spacing and Intensity of Seeding on the Development of Foothill Range Grass Stands. Utah Agr. Exp. Sta. Bul. 467) for this portion of Utah the following stand rating guide was developed:

# SEEDED PLANTS PER SQUARE FOOT	RATING
greater than 0.75	Excellent
0.5 - 0.75	Good
0.25 - 0.5	Fair
less than 0.25	Poor

The densities of desirable perennial plants from the conveyor seeding equals 21.18 seedlings per square foot while the Mine No. 1 seeded area equals 9.76 seedlings per square foot. These values compare with a first year perennial density value of 2.39 for the Refuse Test Plots (page 30 1983 Annual Reclamation Report). The 1983 reclamation seeding and subsoil stockpile produced first year perennial seedling densities of 1.30 and 4.00 plants per square foot (Table 4, 1984 Annual Reclamation Report).

Since the last three areas have subsequently developed into acceptable stands, Plateau sees no reason to believe that the areas seeded in 1985 will do differently.

TOPSOIL AND SUBSOIL STOCKPILES

Four year total plant cover for the topsoil stockpile was found to equal 37.50 percent (Table 4). No shrubs were encountered in the four transects sample (Table 5). A comparison of the previous years data reveals the following:

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

Total plant cover for the subsoil stockpile in 1986 was found to equal 22.75 percent. Shrub density was determined to equal 218 plants per acre. A comparison of this site for previous years yields the following:

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

A statistical comparison of the vegetation of the topsoil and subsoil stockpiles is presented in Table 5. Total plant cover and annual plant cover are significantly higher on the topsoil stockpile. Perennial plant cover is significantly higher on the subsoil stockpile. The composition of annuals continued to remain unusually high for the topsoil stockpile as compared to the subsoil stockpile. The trend toward the dominance of annual species is documented by the following comparison:

YEAR	TOPSOIL % COMP. OF ANNUALS	SUBSOIL % COMP. OF ANNUALS
1986	76.67	0
1985	92.48	0.17
1984	67.28	0.78
1983	55.85	-

Plateau reiterates its belief presented in the 1985 Annual Reclamation Report that in our opinion, an obvious trend exists which suggests that annual species are becoming more dominant with time on the topsoil and less dominant on the subsoil stockpile. Since both of these areas received equal treatments of supplemental fertilizer, we do not fully understand the arguments presented by the UDOGM staff upon reviewing last years Annual Report that differences in annual weed growth are attributable to differences between fertilization. A more detailed discussion of this issue will be presented in the discussion of the Refuse Test Plot Results.

REFUSE TEST PLOTS

The refuse test plots were established during the Fall of 1982 in response to UDOGM and BLM concerns raised during the permitting of the Refuse Pile Expansion Area. During 1985, a portion of the test plots was disturbed during the construction of the Unit Train Loadout Conveyor. At the time the 1985 field data and Annual Reclamation report were prepared, it was thought that Plot C1 had been lost as a result of the disturbance associated with the conveyor. The plot stakes were removed and the field sheet used by the sampling crew indicated that an insufficient area remained intact to merit sampling. Subsequent to writing the 1985 Annual Report last winter, it became necessary to revise the plot diagram to show the location of the existing plots. Since Figure 1 was prepared in 1983 without the benefit of accurate topographic control and was not drawn to scale, it was necessary to make a revised topographic map of the area and verify the location of permanently marked plot boundaries initially established to determine exactly how much of the test plots had been disturbed. Using the revised maps and the original plot diagrams, it was determined via a field survey (as shown on Figure 1 in the 1985 Annual Report) that a portion of Plot C1 remained behind of sufficient size to sample. Therefore, Plateau wishes to point out that all of the original plots were sampled and analyzed in 1986 and that no data points were lost as previous believed.

As described in the three previous Annual Reclamation Reports the Refuse Test Plots were established to test the following:

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 supplemental fertilizer applied either 100 or 200 pounds per acre.

In 1984 the UDOGM suggested that each plot be subdivided into segments which corresponded to the upper, middle and lower thirds of the slope. Data was collected in this manner in 1984 and 1985. A detailed evaluation of this practice was conducted on these two years data in the 1985 Annual Reclamation Report. Based upon Plateau's request to delete this monitoring segment, UDOGM notified Plateau in a letter dated June 6, 1986 that this sampling could be suspended for the 1986 monitoring program. The statistical techniques utilized to analyze the 1986 data were identical to those used in the 1985 Annual Report. As specified in the UDOGM letter of the April 18, 1985, a two tailed t-test was used to compare the various plant growth mediums and fertility interactions. Additional Analysis of Variance and Duncan's Multiple Range Tests were conducted on the 1986 field data. Statistical analyses were conducted using either an HP-11C hand-held calculator or an AT personal computer using the Number Cruncher Statistical System Software Package.

Soil Materials

A general comparison of plant cover and shrub density for the topsoil, subsoil and topsoil over subsoil are presented in Table 6. Significantly higher total plant cover and annual plant cover were associated with the topsoiled plots. Highest perennial plant cover was found on the subsoiled

plots. Shrub density was lowest on the topsoiled plots and similar on the subsoiled and topsoil over subsoil plots, although highest densities were found on the latter.

Fertilization

Fertilizer was not found to have any effect when averaged across all treatments (Table 7). On all subsoil treatments combined, fertilizer was found to significantly increase total plant cover and shrub densities (Table 8). In both instances significantly higher values were associated with the 200 pound application rate. No measurable response to fertilization could be found for either perennial or annual cover on the subsoiled plots. On the respread topsoil plots the only response to fertilization was encountered for higher shrub densities on the lowest rate (Table 9). Fertilizer was not found to affect plant response on the plots receiving topsoil over subsoil (Table 10).

Thickness of respread plant growth material was found to have a minor, but measurable interaction with fertilization. On ten inches of respread topsoil, significant differences were detected only for shrub density, with some evidence that the 200 pound per acre application rate had a negative effect on shrub establishment (Table 11). On twenty inches of respread topsoil, (Table 12) shrub density was also significantly lower at the higher fertilizer rate. Annual plant cover on twenty inches of respread topsoil was also significantly higher for the higher fertility rate (Table 12). On subsoiled plots statistically significant responses to fertility were measured only on the ten inch subsoil thickness (Table 13). On these plots, significantly higher total plant cover and perennial plant cover were associated with the 100 pound fertilization rate. On twenty inches of respread subsoil, no statistically significant differences were found (Table 14).

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 affected plant response. Table 15 indicates that highest total plant cover was associated with the twenty inch topsoil plots, and the

ten inches of topsoil over ten inches of subsoil. Perennial plant cover was superior on the subsoil and topsoil over subsoil plots. Annual plant cover was significantly highest on the ten inch topsoil plot and lowest on the subsoil and topsoil over subsoil plots. Statistically there was no difference in annual plant cover between the subsoil plots and the plots having topsoil over subsoil. Shrub densities were found to be significantly lowest on the subsoiled plots and highest on the topsoil over subsoil plots. Topsoil plots yielded densities between the subsoil and topsoil over subsoil plots.

Conveyor Edge Effect

As was described in the 1985 Annual Reclamation Report, Plateau initiated a special sampling program in 1985 to address UDOGM concerns that the disturbance associated with the conveyor construction activities might adversely affect the data collected from the portions of the plots disturbed by construction by inducing an "edge effect" that might bias the data collected off the portion not originally disturbed. In order to quantify whether or not an "edge effect phenomenon" was developing, Plateau initiated this sampling effort. The sampling location and methodologies used in this sampling are described in the 1985 Annual Reclamation Report.

The results of this "edge effect" sampling program are presented in Table 16. The near transects are located five feet away from the cut, while the away transects are located 12 feet away from the cut. Analysis of the data in Table 16 reveal that no measurable "edge effect phenomenon" could be documented to exist within 12 feet of the cut. In addition to the comparisons presented herein, Plateau also statistically compared the "near" and "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 information confirms the conclusions reached in 1985 that the remaining plots are yielding unbiased and scientifically valid data. With the exception of the C1 plots, 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 the plot that remains.

Aspect

Since Plots D2 and G received identical treatments, consisting of ten inches of subsoil with 100 pounds of fertilization, with the only difference being aspect, these two plots were compared to evaluate the influence of aspect on plant growth. Table 17 which contains the results of this comparison, reveals that aspect was found to significantly influence plant growth. In 1986 statistically greater total plant cover and perennial plant cover were associated with the south facing aspect. This finding was in sharp contrast to the 1985 monitoring data, presented in Table 22 of the 1985 Annual Reclamation Report. In the previous year, it was reported that total plant cover and perennial plant cover were significantly higher for the northern aspect. A logical explanation for this inconsistency lies in the fact that the growing season precipitation during 1986 was quite limited. Deer grazed (as evidenced by numerous pellet groups) extensively along the northern aspect, due to its proximity to escape cover, but tended to avoid the more exposed south facing aspect due to its distance from cover. It appeared likely that deer concentrated so heavily on this area due to the fact the planted vegetation on the test plots was considerably more succulent and produced more palatable forage than was found in the undisturbed pinyon-juniper and sagebrush sites in this vicinity.

Sample Adequacy

Table 18 summarizes the number of samples needed to achieve sample adequacy for each plot based upon the 1986 field data. As can be observed, sampling was completed until sample adequacy at the Nm80/10 level was achieved or until a maximum of 27 transects per plot had been collected. The trends regarding the interaction of annual and perennial plant cover also appear to be influencing sample adequacy. Upon comparing Table 18 in the 1986 Annual Reclamation Report with Table 23 in the 1985 Annual Reclamation Report, it becomes evident that overall sample adequacy is increasing. In 1985 74 transects were needed to achieve adequacy while in 1986 123.7 transects were needed to sample at the same level of precision.

Upon averaging all subsoil plots, 33 transects were required in 1985 while 29.5 transects were necessary in 1986. On the topsoil over subsoil

plot 10 transects were needed to achieve adequacy in 1985, while in 1986 the need of transects to achieve the same level of precision was 7.3 transects. The topsoil plots instead of reducing in the number of transects, increased from requiring 31 transects in 1985 to 86.9 transects in 1986 to achieve the same level of sampling precision.

Conclusions

Data collected in 1986 from general reclamation seedings completed in 1981 and 1983 reveal that the reclaimed areas appear to be successfully established and yield plant cover values similar to established reference areas. The 32.97 percent plant cover from the 1981 reclaimed areas corresponds well with plant cover found on several of Plateau's approved reference areas. The third year plant cover on the 1983 reclaimed area compares favorably with the fourth year plant cover of 18.8 percent obtained in 1985 from the 1981 seeding. Plateau continues to believe that this pattern suggests optimism regarding Plateau's ability to successfully reclaim non-topsoiled cut and fill slopes at the Star Point Mines to satisfy existing revegetation success criteria.

Data collected from the topsoil and subsoil stockpiles continues to support the general comparison of topsoil and subsoil plots from the Refuse Test Plot Study. Trends between these two areas appear to be very similar and tend to confirm that the establishment of exotic annual weeds that appear to be residual in the topsoil seed bearing zone can negatively influence the establishment of desired perennial species. Data collected from the past four years indicate that the dominance of annual weeds on the topsoil plots is reason for obvious concern. The data suggest that the standard recommendation to segregate topsoil and subsoil horizons may be counterproductive to reestablishing "a diverse, effective, and permanent vegetative cover" capable of supporting the approved post mining land use. Plateau believes that a careful analysis of the 1986 data confirms the conclusions presented in the 1985 Annual Reclamation Report that the topsoiled plots raise a serious concern regarding the utility of using straight respread topsoil that is live handled for reclamation at the Plateau Mine. The alarming trend of increased dominance of annual species (cheatgrass) on straight topsoiled plots is continuing to increase, while

the composition of annuals on the subsoiled plots is continuing to decline. The summary presented last year is repeated with the addition of the 1986 field data.

YEAR	B PLOTS 20" SUB	C1 PLOTS 10" T/10" S	D PLOTS 10" SUB	E PLOTS 20" TOP	F PLOTS 10" TOP
1983	16.7	31.4	19.5	51.5	62.0
1984	14.8	37.7	30.6	61.5	69.0
1985	3.2	8.8	9.7	47.8	71.9
1986	0	6.7	6.5	40.4	74.8

In Plateau's opinion, we believe the data demonstrate that the composition of cheatgrass is directly related to the plant growth medium used for reclamation to a much greater degree that the effect of supplemental fertilizer. Tables 7, 8, 9 and 10 clearly demonstrate that when the effects of fertilizer are averaged across all treatments (subsoil, topsoil and topsoil over subsoil) respectively, fertilizer had no effect on annual plant response in 1986. On the various depths of topsoil and subsoil (Tables 11, 12, 13 and 14) only on twenty inches of topsoil was a fertilizer response documented. Since the greatest annual weed response was on ten inches of topsoil and there was no fertility response, we must conclude that some factor other than fertilization is responsible for the increased dominance of cheatgrass. Since the dominance of cheatgrass on the twenty inch topsoil plots is decreasing, but at a slower rate than the subsoil or topsoil over subsoil plots, we believe that the evidence point to the mixing of the seed bearing zone in the topsoil as being the agent responsible for the dominance of cheatgrass. The ranking of the plots according to the potential seed bearing zone present in the plant growth medium parallels the composition of cheatgrass. Since available literature documents the seed bearing zone of the undisturbed topsoil is in the top 5 to 7 cm, Plateau calculated the percentage of the seed bearing zone in the topsoils having the greatest amount of cheatgrass. Using an average of 6 cm depth for the seed bearing zone 23.62% of the 10" topsoil and 11.81% of the 20" topsoil treatments would be made up of seed bearing material. Also, by assuming spillage of topsoil onto

subsoil accounted for 1% at the seed bearing zone, it is possible to determine the potential relationship between cheatgrass cover and the percentage of seed bearing zone by thickness of the reapplied soil materials. Using the percentage of seed bearing material in the respread soil and percent cover of cheatgrass as the variables, a coeffecient of correlation of $r^2 = 0.97$ $P \leq 0.11$ is calculated. Plateau believes this comparison demonstrates 97% of the cheatgrass on these plots can be explained on the basis of the amount of seed bearing soil present in the respread topsoil. Therefore, it is inappropriate to use total plant cover which is largely composed of annuals as an indicator of revegetation success for the Refuse Test Plots.

Table 19 contains a comparison of all of the individual plots contained in the Refuse Test Plot Study. The highest perennial cover is associated with Plot G which contains ten inches of subsoil. Second highest perennial plant cover was associated with Plot D1 also located on ten inches of subsoil. In fact, four of the top best performers as measured by perennial cover are subsoil plots. Shrub density was highest on the ten inches of topsoil over ten inches of subsoil, followed closely by the two ten inch subsoil plots.

Using the fourth year plant response as an indicator of relative success, the best overall treatment as measured by perennial plant cover and shrub density appears to be the ten inch subsoil plots. The ten inch topsoil over ten inch subsoil plots also could be rated as successful, but current information indicates that due to the significant operational expenses that are associated with segregating topsoil and subsoil plant response does not justify this practice. Operationally, there are serious concerns associated with using straight topsoil to justify suggesting that this option be recommended. Since extensive areas have been successfully reclaimed without topsoil and since large areas are permitted to be reclaimed without respreading topsoil, Plateau believes that the findings, to date, from the Refuse Test Plots substantiate the prior reclamation plantings and the currently approved reclamation plan.

TABLE 1

PLANT COVER AND COMPOSITION SUMMARY OF RECLAMATION SEEDINGS

	1981		1983	
GRASSES	COVER	COMP.	COVER	COMP.
Perennial Grasses				
Intermediate Wheatgrass	16.00	48.53	4.52	32.49
Wheatgrass Species	-	-	-	-
Desert Wheatgrass	1.66	5.04	0.86	6.18
Smooth Brome	3.00	9.10	3.42	24.59
Orchardgrass	-	-	1.16	8.34
Indian Rice Grass	-	-	0.58	4.17
Blue Bunch Wheatgrass	0.75	2.28	-	-
Kentucky Bluegrass	0.10	0.30	0.03	0.22
Bottle Brush Squirreltail	0.04	0.12	-	-
Timothy	-	-	0.02	0.14
Western Wheatgrass	-	-	0.45	3.24
Foxtail Barley	-	-	0.63	4.53
SUBTOTAL	21.55	65.37	11.67	83.90
Perennial Forbs				
Aster spp.	-	-	1.10	7.91
Cicer Milkvetch	5.77	17.50	0.05	0.36
Yellow Sweetclover	1.03	3.12	0.63	4.53
Alfalfa	0.13	0.39	0.29	2.08
Eriogonum spp.	0.02	0.06	-	-
SUBTOTAL	6.95	21.07	2.07	14.88
Shrubs				
Rubber Rabbitbrush	1.45	4.40	-	-
Sagebrush	-	-	0.14	1.01
Antelope Bitterbrush	0.07	0.21	0.04	0.29
Fourwing Saltbrush	2.95	8.95	-	-
SUBTOTAL	4.47	13.56	0.18	1.30
TOTAL	32.97	100.00	13.92	100.08

TABLE 2

WOODY PLANT DENSITIES ON RECLAMATION SEEDINGS

(Stems/Acre)

SPECIES	1981 SEEDING	1983 SEEDING
Fourwing Saltbush	292	100
Rubber Rabbitbrush	167	20
Broom Snakeweed	125	40
Antelope Bitterbrush	21	80
Aster spp.	42	-
Big Sagebrush	-	140
Currant	-	40
Snowberry	-	40
Winterfat	-	20
TOTAL	647	500

TABLE 3

FIRST YEAR SEEDLING DENSITIES FOR THE UNIT TRAIN LOADOUT CONVEYOR AND STAR POINT MINE NO. 1 RECLAMATION AREAS

(Plants/2 x 5 dm quadrat)

	CONVEYOR	MINE NO. 1
Perennial Grass	14.77	8.12
Perennial Forbs	7.87	2.33
Annual Forbs	0.09	0.76
Shrubs	0.16	0.07
TOTAL	22.89	11.27

TABLE 4

TOPSOIL AND SUBSOIL STOCKPILES PLANT COVER

	Topsoil Stockpile		Subsoil Stockpile	
GRASSES	COVER	COMP.	COVER	COMP.
Perennial Grasses				
Intermediate Wheatgrass	0.25	0.70	4.25	18.68
Desert Wheatgrass	6.0	16.0	4.75	20.88
Smooth Brome	1.0	2.7	0.50	2.20
Blue Bunch Wheatgrass	0.50	1.30	-	-
Blue Grass	0.50	1.30	-	-
SUBTOTAL	8.25	22.0	9.50	41.76
Annual Grasses				
Cheat Grass	1.75	47.0	-	-
Annual Forbs				
Summer Cypress	27.0	72.0	-	-
Russian Thistle	0.50	1.30	-	-
SUBTOTAL	27.50	73.30	-	-
Perennial Forbs				
Alfalfa	-	-	8.75	38.46
Yellow Sweetclover	-	-	4.50	19.78
SUBTOTAL	0	0	13.25	58.24
TOTAL	37.50	100.00	22.75	100.00

TABLE 5

TOPSOIL VERSUS SUBSOIL STOCKPILES COMPARISON

SOIL	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)				
Topsoil	37.500	2.380	4	10.069*
Subsoil	22.750	1.708	4	
Perennial Cover (%)				
Topsoil	8.750	2.630	4	8.929*
Subsoil	22.750	1.708	4	
Annual Cover (%)				
Topsoil	28.750	3.304	4	17.403*
Subsoil	0.000	0.000	4	
Shrub Density (plants/150 ft^2)				
Topsoil	0.000	0.000	4	1.567
Subsoil	0.750	0.957	4	

*Means are significantly different at alpha = .10

TABLE 6

COMPARISON OF PLANT GROWTH MEDIUMS

Total Cover (%)	
Topsoil	24.58 a*
Subsoil	11.65 b
Topsoil over Subsoil	17.00 b
Perennial Cover (%)	
Topsoil	9.01 a
Subsoil	11.33 a
Topsoil over Subsoil	15.64 b
Annual Cover (%)	
Topsoil	18.82 a
Subsoil	0.38 b
Topsoil over Subsoil	0.95 b
Shrub Density (stems/150 ft^2)	
Topsoil	3.56 a
Subsoil	5.77 b
Topsoil over Subsoil	6.56 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 7
FERTILIZER EFFECT ON PLANT GROWTH

SOIL	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)				
100#/Acre	27.017	9.929	28	0.581
200#/Acre	25.735	5.835	27	
Perennial Cover (%)				
100#/Acre	11.746	3.216	28	0.235
200#/Acre	11.544	3.165	27	
Annual Cover (%)				
100#/Acre	14.849	11.144	28	0.260
200#/Acre	14.191	7.070	27	
Shrub Density (plants/150 ft^2)				
100#/Acre	4.257	1.693	27	0.353
200#/Acre	4.427	1.833	27	

TABLE 8
FERTILIZER EFFECT ON SUBSOIL

SOIL	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)				
100#/Acre	14.076	2.248	11	1.910*
200#/Acre	16.000	2.369	10	
Perennial Cover (%)				
100#/Acre	13.788	2.438	11	1.542
200#/Acre	15.450	2.499	10	
Annual Cover (%)				
100#/Acre	0.288	0.528	11	0.988
200#/Acre	0.550	0.685	10	
Shrub Density (stems/150 ft^2)				
100#/Acre	2.396	1.516	16	2.552*
200#/Acre	4.214	1.704	7	

*Means are significantly different at alpha = .10

TABLE 9

FERTILIZER EFFECT ON TOPSOIL

SOIL	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)				
100#/Acre	29.286	9.334	28	0.120
200#/Acre	29.000	8.224	27	
Perennial Cover (%)				
100#/Acre	11.018	3.500	28	0.690
200#/Acre	10.407	3.032	27	
Annual Cover (%)				
100#/Acre	18.268	9.704	28	0.132
200#/Acre	18.593	8.365	27	
Shrub Density (stems/150 ft^2)				
100#/Acre	5.741	2.375	27	3.515*
200#/Acre	3.704	1.851	27	

*Means are significantly different at alpha = .10

TABLE 10
FERTILIZER EFFECT ON TOPSOIL OVER SUBSOIL

SOIL	PLOT	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)					
100#/Acre	C1	16.182	3.763	11	0.535
200#/Acre	C2	17.000	3.406	11	
Perennial Cover (%)					
100#/Acre	C1	15.545	4.083	11	0.120
200#/Acre	C2	15.727	2.901	11	
Annual cover (%)					
100#/Acre	C1	0.636	0.674	11	1.400
200#/Acre	C2	1.273	1.348	11	
Shrub Density (stems/150 ft^2)					
100#/Acre	C1	insufficient area to sample			
200#/Acre	C2	insufficient area to sample			

TABLE 11

FERTILIZER EFFECT ON TEN INCHES OF TOPSOIL

SOIL	PLOT	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)					
100#/Acre	F_2	35.571	13.249	28	1.165
200#/Acre	F_1	39.800	11.755	20	
Perennial Cover (%)					
100#/Acre	F_2	8.900	3.417	20	1.014
200#/Acre	F_1	10.000	3.896	28	
Annual Cover (%)					
100#/Acre	F_2	25.571	12.659	20	1.437
200#/Acre	F_1	30.900	12.678	28	
Shrub Density (stems/150 stems ft^2)					
100#/Acre	F_2	5.055	1.862	18	3.100*
200#/Acre	F_1	3.125	2.092	24	

*Means are significantly different at alpha = .10

TABLE 12

FERTILIZER EFFECT ON TWENTY INCHES OF TOPSOIL

SOIL	PLOT	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)					
100#/Acre	E_1	18.947	6.501	19	1.293
200#/Acre	E_2	22.259	9.725	27	
Perennial Cover (%)					
100#/Acre	E_1	12.947	4.801	19	1.212
200#/Acre	E_2	11.296	4.366	27	
Annual Cover (%)					
100#/Acre	E_1	6.000	4.371	19	1.984*
200#/Acre	E_2	10.963	10.241	27	
Shrub Density (stems/150 ft^2)					
100#/Acre	E_1	5.889	3.355	27	1.823*
200#/Acre	E_2	4.370	2.734	27	

*Means are significantly different at alpha = .10

TABLE 13
FERTILIZER EFFECT ON TEN INCHES OF SUBSOIL

SOIL	PLOT	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)					
100#/Acre	D_2	18.125	3.482	8	4.284*
200#/Acre	D_1	11.909	2.844	11	
Perennial Cover (%)					
100#/Acre	D_2	16.750	4.234	8	3.324*
200#/Acre	D_1	11.272	2.969	11	
Annual Cover (%)					
100#/Acre	D_2	1.375	1.408	8	1.275
200#/Acre	D_1	0.636	1.120	11	
Shrub Density (stems/150 ft^2)					
100#/Acre	D_2	6.300	3.268	7	0.108
200#/Acre	D_1	6.143	2.410	10	

*Means are significantly different at alpha = .10

TABLE 14

FERTILITY COMPARISON ON TWENTY INCHES OF SUBSOIL

SOIL	PLOT	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)					
100#/Acre	B_2	14.125	2.696	8	0.193
200#/Acre	B_1	14.400	3.204	10	
Perennial Cover (%)					
100#/Acre	B_2	14.125	2.696	8	0.194
200#/Acre	B_1	14.400	3.204	10	
Annual Cover (%)					
100#/Acre	B_2	0.000	0.000	8	0.000
200#/Acre	B_1	0.000	0.000	10	
Shrub Density (stems/150 ft^2)					
100#/Acre	B_2	1.400	1.472	10	0.625
200#/Acre	B_1	1.833	1.265	6	

TABLE 15
SOIL DEPTH INTERACTIONS

TREATMENT	COVER
Total Cover (%)	
10" Topsoil	36.70 b d*
10" Subsoil	15.23 a
20" Topsoil	21.19 b c
20" Subsoil	14.40 a
10" Topsoil/10" Subsoil	17.00 a c
Perennial Cover (%)	
10" Topsoil	9.68 a
10" Subsoil	14.52 b
20" Topsoil	11.91 a
20" Subsoil	14.40 b
10" Topsoil/10" Subsoil	15.64 b
Annual Cover (%)	
10" Topsoil	27.02 b d f
10" Subsoil	0.71 a
20" Topsoil	9.28 b d e
20" Subsoil	0.00 a
10" Topsoil/10" Subsoil	0.95 b c
Shrub Density (stems/150 ft^2)	
10" Topsoil	3.83 b c e
10" Subsoil	3.32 b c
20" Topsoil	5.13 b d e
20" Subsoil	1.50 a
10" Topsoil/10" Subsoil	6.56 b d f

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

TABLE 16
CONVEYOR EDGE EFFECT

SOIL	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)				
Near	16.625	4.033	8	1.805
Away	13.500	2.777	8	
Perennial Cover (%)				
Near	16.375	4.069	8	1.919
Away	13.125	2.532	8	
Annual Cover (%)				
Near	0.250	0.463	8	0.403
Away	0.375	0.744	8	
Shrub Density (stems/150 ft^2)				
Near	3.500	2.203	8	0.207
Away	3.750	2.605	8	

TABLE 17
ASPECT COMPARISON

SOIL	PLOT	MEAN	STD. DEV.	N	T CAL.
Total Cover (%)					
North	D_2	11.909	2.844	11	6.083*
South	G	21.600	3.209	5	
Perennial Cover (%)					
North	D_2	11.272	2.970	11	6.298*
South	G	21.600	3.209	5	
Annual Cover (%)					
North	D_2	0.636	1.120	11	1.246
South	G	0.000	0.000	5	
Shrub Density (stems/150 ft^2)					
North	D_2	6.300	3.268	10	4.737*
South	G	1.625	1.784	16	

*Means are significantly different at alpha = .10

TABLE 18

NUMBER OF SAMPLES NEEDED TO MEET SAMPLE ADEQUACY

PLOT	NUMBER OF SAMPLES COLLECTED	SAMPLES REQUIRED $N_{80/10}$
B_1	10	8.1
B_2	8	5.9*
C_1	4	3.4*
C_2	10	7.3
D_1	9	6.1
D_2	11	9.4
E_1	19	19.4
E_2	27	31.4
F_1	20	18.2
F_2	28	17.9
G	5	3.6

*Disturbed Plot