Homestake Mining Company
Pitch Project

Annual Report 1979, 1980

Prepared by:
Western State College
of Colorado
Gunnison, Colorado 81230

Edited by: Dr. Hugo A. Ferchau
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Homestake Report 1979-1980

Submitted by Western State College
in fullfillment of a contract
with Homestake Mining Company

Participants:
1979

Jonathan Davis
Nicholas Durand
Robert Jennings Jr.
Paul Bryan Jones
Russell Kennedy
Leanne Lee
James Matthews
Bradley Purnell

Participants:
1980

Barry Brock
Kaye Blassingame
Karen Burns
Alan Carpenter
Kristine Laughlin
Paul Lewis
Leanne Lee
Kenneth Marr
Sherry Mayhan
Joann Peterson
Sandra Starr
Mark Wilkens
H. Thomas Williams

Project Director and Editor: Hugo A. Ferchau Ph.D.
January 28, 1981

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ACKNOWLEDGEMENTS

The completion of successful work requires the interaction of many individuals. In 1979, Jeff Thatcher and Bill Upton were representative of Homestake Mining and the personnel with whom we interacted. In 1980, Jerry Danni and Phil Barnes represented Homestake and were responsible for integrating the work efforts and plans with on-site realities. Many other people at the mine provided support which enabled the work to progress smoothly and although they remain nameless, we appreciate their efforts.

At Western State College a number of people work behind the scenes to provide the environment which enables productivity: L. Scott McRae, (Chairman of the Division of Natural Science and Mathematics), Pamela French (Natural Science Division Office), Arlene Buben (Financial Aid Office), Duffy Salinger (Accounting), Thomas McKelvie (Purchasing), Mirta Coleman (Business Office), and Jerry Piquette (Vice President for Business Affairs). All contributed time above and beyond the call of college duty. Without their help, the project will not function. Robert Arnold and Robert Ener of the College Print Shop provided patience and expertise to assemble the various reports. George Hill kept the vehicles running. Neil Cox (Director of the Maintenance Department), helped with resolving logistical problems in getting work done in Hurst Hall, and provided storage for summer equipment.

The U. S. Forest Service, specifically Terry Schneider, has been helpful in our having a successful reclamation program.

Chapter 1

Introduction

This report considers the work done over two years. In 1979, the entire effort was associated with a maintenance approach: maintaining test plots at Hale Gulch and near the present Water Treatment Plant; and revegetation of surfaces newly created or surfaces which provided limited success. Effort was also directed to developing a monitoring program to evaluate rates of hydromulch application and success of revegetation, after germination and growth has occurred.

In 1979 the group was staffed to develop a new test plot in the vicinity of the proposed mill site, at the request of the Colorado Mined Land Reclamation Board. That plot did not materialize because necessary agency approval was not forthcoming.

In 1980 the responsibilities were considerably extended and included:

a. Revegetation of newly distubed sites and previous sites which were developing unsatisfactorily.

b. Continuance of test plots at Hales Gulch and Water Treatment Plant.

c. Monitoring of previously revegetated sites.

d. Establish a new set of test plots to determine the capability of revegetating overburden with various degrees of slope.

e. Establish sites which will model the overburden deposits and tailings pond.

f. Establish a test site which will simulate abandoned pit wall benches.

g. Collect native plant species seed to be used in future revegetation.

Chapter 2

REVEGETATION - 1979, 1980

In 1979, the Marshall Creek Road was widened and straightened to accommodate increased traffic flow. During the same time period, an access road was constructed from Marshall Creek to the proposed Mill Site and on to the offices and mine. At the end of the summer, the completed roadsides were hydromulched by commercial contract. Some of the roadsides were reworked or altered in some manner after the hydromulching. Regardless, revegetation success was not overly evident in 1979.

In 1979, several tasks became self-evident. All of the Access Road was evaluated, visually, regarding revegetation need. Various categories of designation were provided. Those areas with considrable seedling development were considered successful. Those areas with obvious sheet erosion were given first priority for treatment. Those areas with no growth but with no erosion were given a low rating, but marked for revaluation before any further treatment was given. Areas on Marshall Creek which had not been completed in 1978 were noted for high priority.

The hydromulching work was part of the contract negotiated with Western State College. The Bowie Hydromulcher, truck and supplies were provided by Homestake.

During the summer of 1979, 80 runs were made with the hydromulcher. The mine not being fully operative caused much time to be spent getting water, supplies, and resolving logistical problems. The entire section from Sargents to the Access Road to the proposed Mill Site was treated where needed. Subsequent to the departure of the Western State College crew, the Homestake personnel performed additional work, which is not included in this report.

During 1979, 1000 pounds of seed (Table B-1), 1000 pounds of fertilizer (20-20-10), 2400 pounds of Con-Wed Hydromulch and 80 bags of tackifier were used.

TABLE B-1

Seed Mixes

Alpine Mix

Winter Rye

Smooth Brome: Manchar

*White Dutch Clover

Creeping Red Fescue: Pennlawn

*Cicer Milkvetch: Lutana

Hard Fescue: Durar

Timothy: Climax

Orchardgrass: Potomac

Meadow Foxtail

Creeping Foxtail: Garrison

Kentucky Bluegrass: Troy

Red Top

*Treated with Rhizo-Kote by Celpril

Mountain Mix

Smooth brome

Perennial ryegrass: Linn

Winter rye

Kentucky bluegrass

Orchardgrass: Potomac

Alsike clover

Several locations were noted as candidates for netting. As time was available, the areas were covered with hay and covered either with Gulf-Pacific paper netting (Holdgro) or Con-Web netting. A total of 3/16 of an acre were treated in 1979.

During 1980, the revegetation crew was made up of Western State College students who worked directly under Phil Barnes, of the Homestake staff. Work direction was provided from other sources only when equipment required repair or when supervision was not momentarily available.

Concentration was given to the fill side of the road between proposed Mill Site and Tie Camp Division (Figure B-1), and the roads to the pits and offices. The manner in which each of the areas was treated is considered in Figure B-1 legend.

Figure B-2 illustrates the lower Access Road regetation. Application was relatively light and sporatic, whenever conditions required application. Once the forested region was encountered, Douglas Fir was planted up to the parking lot. Above that point, Lodgepole Pine was planted.

Figure B-3 demonstrates where areas within Hales Gulch were revegetated.

Unless otherwise noted, application rates per acre were as follows: Con-Wed 2000, 2000 pounds; Con-Wed 1500, 2000 pounds; Seed, 50 pounds; fertilizer (18-46-0), 250 pounds; "Terra Tak", 120 pounds.

During the 1980 season, an estimated 33 acres were revegetated, which is approximately three times what was treated in 1979.

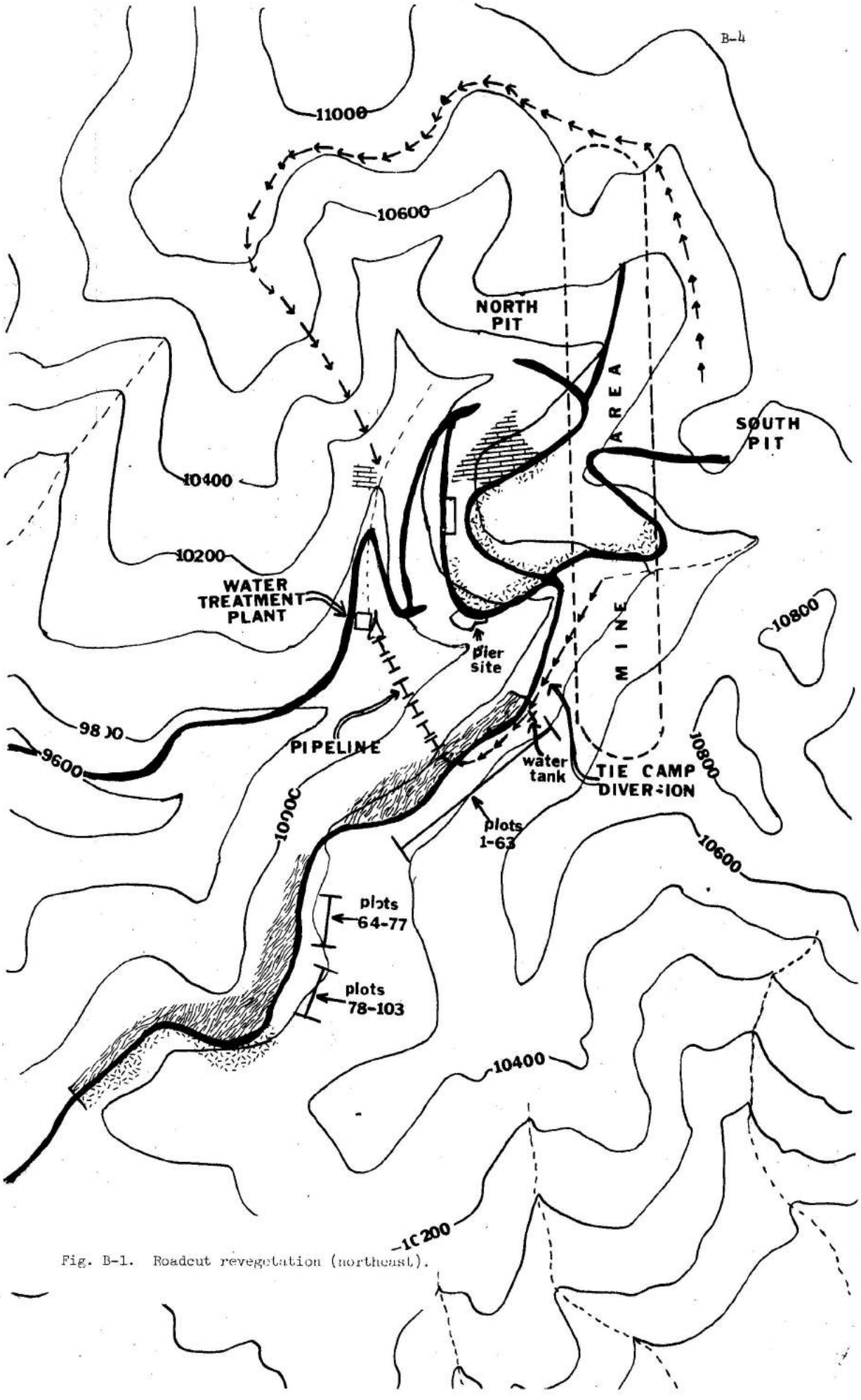


Fig. B-1. Roadcut revegetation (northeast).

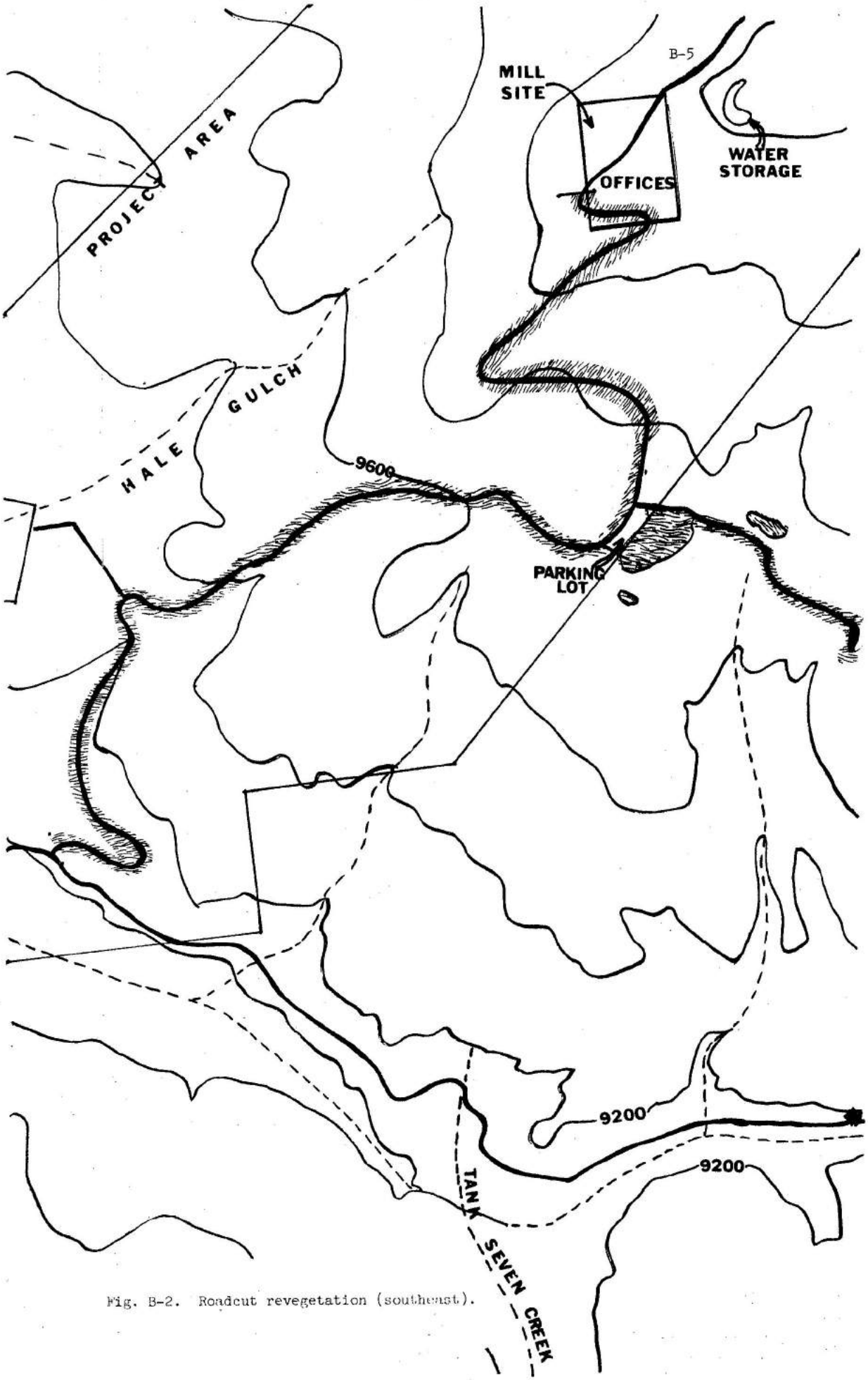


Fig. B-2. Roadcut revegetation (southeast).

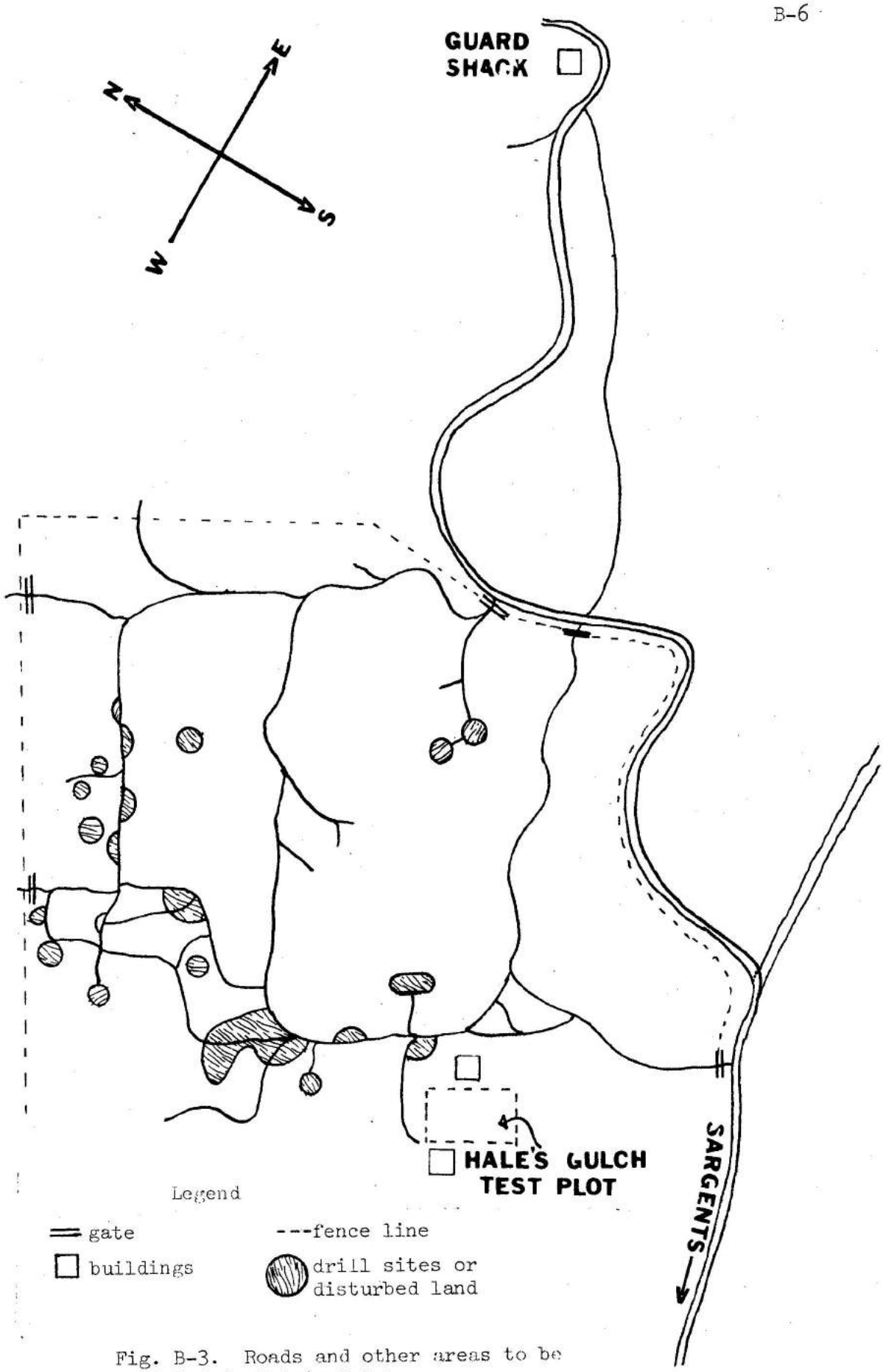


Fig. B-3. Roads and other areas to be revegetated in Hale's Gulch.

Chapter 3
ROOT DEPTH STUDIES

Penetration of roots represents a continuous concern because of ultimate tailings pond reclamation. Whenever an opportunity is available to note root depth, consideration is given to devoting some time for measurement. Because so much of Hale Gulch was disturbed in 1980 to carry out a variety of tests, two days (June 10-11) were taken to do some root depth measuring. Six individuals spent a total of 80 hours to do the work.

The accompanying table provides the data. The 1978 root studies indicate greater depths. The reason the 1980 work does not show as great depth is because most of the surfaces were relatively old and the exposed roots were brittle. For that reason, no further work was attempted.

Table C-1

1980 ROOT STUDIES

	Root Depth (cm)				Stem Height (cm)			
	$\bar{x}$ (cm.)	Range Hi	Range Low	# Indiv.	$\bar{x}$ (cm.)	Range Hi	Range Low	# Indiv.
Achillea lanulosa	9.6	21	6	9	8.4	11	5	7
Allium geyeri	12.7	19	9	3	10.7	12	10	3
Androsace septentrionalis	9.1	18	4.5	7	10	16	5	7
Antennaria parvifolia	17.7	32	5	10	9.6	17	2	7
Arctostaphylos uva-ursi	23.5	41	6	2	30	46	14	2
Arenaria congesta	32	32	32	1	5	5	5	1
Artemesia cana	28.3	36	20	3	21.2	28	17.5	3
Artemesia tridentata	48.6	83	19.5	14	48.6	120	3	14
Astragalus sp.	27.5	33	22	2	10.8	14	7.5	2
Carex sp.	11.2	20	4	7	13.6	22	8.5	6
Castilleja linariaefolia	19	20	18	2	17	20	14	2
Chaenactis douglasii	10	10	10	1	7	7	7	1
Chrysothamnus nauseosus	44.3	64	25	6	33.4	40	30	5
Delphinium nelsonii	65	65	65	1	5	5	5	1
Eriogonum unbellatum	19.7	24	17	3	2.3	3	2	3
Fragaria ovalis	12.1	16.5	9	4	6.2	8	4	4
Lupinus sp.	39.9	57	26	8	10.4	20	6.5	4
Mertensia lanceolata	23.4	50	9	11	12.1	16	9	10
Thlaspi montanum	9.4	18	3	7	12.1	20	7	7
Penstemon strictus	21	24	18	2	8	11	5	2
Pentaphylloides floribunda	56	56	56	1	56	56	56	1
Populus tremuloides	32	57	9	3	83	90	79	3

Chapter 4

REVEGETATION MONITORING

In 1979, the major efforts were directed to developing techniques to evaluate the application of hydromulch to a given site. This was prompted by the awareness that an occasion might arise to use contracted hydromulch application, and there appears to be no acceptable technique for determining how effectively material is applied.

The approaches attempted were:

a. Removal of a fixed circles of hydromulch, peeling the material off the ground.

b. Use of filter paper, applied prior to hydromulching.

c. Use of discs of "papersack" paper prior to hydromulching.

d. Patches of plastic applied to the surface before mulching.

e. Swaths of burlap applied before hydromulching.

In each of the categories, various shapes, sizes, and methods of application were attempted. The outcome of the study is as follows:

a. The removal of hydromulch using the lid of a soil moisture can provided erratic results. The biggest problem was removing the hydromulch without removing mineral soil. This partly compensated for by putting the sample into a muffle furnace and determining the amount of organic matter.

b. Filter paper posed several problems. The paper was difficult to anchor. The hydromulch did not stick well. The white coloration caused a bias among the hydromulch applicators. Application of colors was difficult.

c. "Papersack" paper overcame much of the color contrasts, but it was too smooth for hydromulch adherence.

d. Plastic does not allow liquid to penetrate and therefore the hydromulch had a tendency to "run".

e. The burlap proved to be excellent. Pins could be put through the fabric. The burlap blended with the soil and therefore

did not encourage bias. Liquid penetration easily. Hydromulch could be removed easily, or the burlap could be preweighed. Portions of the swath could be placed in a moist chamber, enabling a means of measuring seed viability and determining seed quality.

In 1979, the intent was to develop means of measuring productivity, to determine revegetation success. Sizes of plots, shapes of plots, distribution of plots were considered. Drawing conclusions was difficult because of the smallness of the seedlings and the attendant difficulty in handling. Tentative conclusions were that monitoring may best be conducted either at the end of the growing season after revegetation or two years after revegetation. Tentative monitoring recommendation was made to utilize the .1 mile markers as sampling points and using 1 meter plots for clipping.

In 1980, the decision was made not to monitor the mulching because it was being done by the Homestake mining crew and application was being carefully observed and optimal amounts of material were being applied.

In August, each alternative monitoring point was used for sampling, starting at the juncture of Marshall Creek Road and U.S. 50. The first point was bare rock on the cut side and a road at the other. Table D-1 provides a listing of the plants encountered in the plots. Table D-2 provides the standing crop at the cuts and fills at each odd tenth mile point. Table D-2 also indicates species dominance in each plot. The numbers refer to Table D-1. At the 1.1 mile point, a readjustment was made (inadvertent) and therefore sampling occurred at the even tenth points.

The general trend along Marshall Creek is for an increased standing crop on the fill side (310 herbacious lbs. per acre vs. 137.9 herbaceous lbs. per acre). Shrub activity is restricted almost entirely to the

Table D-1

Species Occurring in Roadside Vegetation

Productivity Sampling 1980*

1.	Bromus ciliatus	Fringed Brome	18.	Legume	Pea
1a.	B. inermis	Awnless Brome	19.	Oryzopsis hymenoides	Indian Ricegrass
2.	Secale cereale	Rye	20.	Arabis sp.	Rockcress
3.	Rosa woodsii	Wood Rose	21.	Agropyron sp.	Wheat Grass
4.	Salsola sp.	Russian Thistle	22.	Solanum triflorum	Cut-leaf Nightshade
5.	Artemisia frigida	Pasture Sagebrush	23.	Mentzelia sp.	Evening Star
6.	A. tridentata	Big Sagebrush	24.	Primula angustifolia	Colorado Primrose
7.	A. cana	Sagebrush	25.	Chenopodium sp.	Goosefoot
8.	Hymenoxys sp.	Mountain Sunflower	26.	Lupinus sp.	Lupine
9.	Melilotus officinalis	Sweet-clover	27.	Taraxacum officinale	Common Dandelion
10.	Chaenactis douglasii	Douglas Falseyarrow	28.	Populus tremuloides	Quaking Aspen
11.	Phlox sp.	Phlox	29.	Solidago sp.	Goldenrod
12.	Ribes sp.	Currant	30.	Penstemon strictus	Penstemon
13.	Prunus virginiana	Chokecherry	31.	Astragalus sp.	Milkvetch
14.	Achillea lanulosa	Western Yarrow	32.	Cirsium sp.	Thistle
15.	Androsace septentrionalis	Rockjasmine	33.	Phleum pratense	Timothy
16.	Corydalis aurea	Golden Corydalis	34.	Agrostis sp.	Red Top
17.	Stipa sp.	Needlegrass	35.	Ranunculus sp.	Buttercup

* Common names have been arbitrarily selected from lists indicating several for each taxonomic unit.

Table D-2

MARSHALL CREEK ROADCUT REVEGETATION PRODUCTIVITY

DATA 1980

Mile Marker	Species Ranked in Order of Abundance 1 - 2 - 3	(gm.) Herbaceous	(gm.) Shrub	Kilos/Hectare Herb	Kilos/Hectare Shrub	Lbs./Acre Herb	Lbs./Acre Shrub	Total Kilos/Hectare
.3 Cut	4	8.9		89		79.2		89
Fill	4	87.1		871		775.2		871
.5 Cut	2 1 5	54.5		545		485.0		545
Fill	4 5	23.6		236		210.0		236
.7 Cut	4 2	6.4		64		57.0		64
Fill	4 1	43.8		438		389.8		438
.9 Cut	4 P N S*							
Fill	Old Road Cut P N S							
1.1 Cut	Nothing on Slope							
Fill	4 6	32.4		324		288.4		324
1.2 Cut	8,9 1 10,11	18.8		188		167.3		188
Fill	P N S							
1.4 Cut	4	1.0		10		8.9		10
Fill	4 12 9	77.4	4.5	774	45	689	40.1	819
1.6 Cut	2 Sparse, P N S							
Fill	6 P N S							
1.8 Cut	1,2 P N S							
Fill	4 5	29.4		294		261.96		294
2.0 Cut	Nothing on Slope							
Fill	4 1 6	53.0	20.5	530	205	471.7	182.5	735
2.2 Cut	1 5	7.1		71		63.19		71
Fill	12 1 P N S							
2.4 Cut	2 1 P N S							
Fill	1,2 4 5	79.4	.3	794	3	706.7	2.7	797
2.6 Cut	1,2	9.1		91		81		91
Fill	1,2 Abundant P N S							
2.8 Cut	2 1 P N S							
Fill	3-2,1-14	4.3	79.5	43	795	383	706.7	837
3.0 Cut	15, 1-16,5-17	32.2	1.5	322	15	286.6	13.4	337
Fill	3	5.5	64.5	55	645	49	574.1	700
3.2 Cut	1 18 P N S							
Fill	2 1 P N S							
3.4 Cut	Old Road Cut P N S							
Fill	1-19,2-18,20	88.9	5.2	889	52	791.2	46.3	941
3.6 Cut	19-3 Old Road Cut	44.6		446		397		496
Fill	2 1-16-19	19.4		194		172.7		194
3.8 Cut	1 2 P N S							
Fill	21-22	8.9				79.2		89
4.0 Cut	3-2 P N S							
Fill	24 23 1	38.6				343.5		386
4.2 Cut	2 21-1-25 Old Road Cut							
Fill	25-22 P N S							
4.6 Cut	19 2-9 Old Road Cut	82.7	2,0	827	20	736	17,8	847
Fill	21 5	48,2		482		429		482
4.8 Cut	21 1 26	19.9		199		177.1		199
Fill	3 25 32	112.8	62.3	1128	623	1004	554.5	1751
5.0 Cut	6 21 Old Road Cut	117.7		1177		1047.5		1177
Fill	9 6 Old Road Cut	30.7		307		273.2		307
5.2 Cut	21 27 Gully at Hale							
Fill	4 21 Gulch Turn Off	83.5		835		743.2		835

AT THIS POINT, THE ACCESS ROAD JOINS MARSHALL CREEK ROAD

* P N S = Present, Not Sampled

fill side (1.2 lbs/acre versus 252 lbs/acre). The cut side is so sharply angled that development of a substantial vegetation is not to be expected, and any addition of desirable substrate will rapidly be lost by erosion.

Table D-3 considers revegetation along the Access Road which branches from Marshall Creek Road. The Access Road was engineered by Homestake Mining and the construction by Tezak Construction was monitored by the U.S. Forest Service. The Marshall Creek Road roadsides are primarily southerly. The Access Road roadside slopes are variable in aspect. The cut side continues to provide a reduced average herbaceous standing crop (279.7 lbs/acre versus 658.7 lbs/acre), but higher than on the Marshall Creek cut slopes (279.7 lbs/acre versus 137.9 lbs/acre). The shrub standing crop is lower on the cut slopes (37.1 lbs/acre versus 67.9 lbs/acre). Compared to Marshall Creek Road, the Access Road has 37.1 lbs/acre on the cut side (as opposed to 1.2 lbs/acre). The fill slopes on the Access Road have an average of 67.9 lbs/acre whereas the fill slopes of the Marshall Creek Road have 252 lbs/acre.

The productivity of the roadcuts does not yet approximate what is found in the typical sage vegetation, as reported in the Dames and Moore report. Nor is the species diversity as extensive as before disturbance. However, a substantial cover is developing on all sites except the Marshall Creek roadcuts.

Table D-3

ACCESS ROAD ROADCUT PRODUCTIVITY

Mile Marker		Species Ranked In Order of Abundance 1 - 2 - 3	(gm.) Herbaceous	(gm.) Shrub	Kilos/Hectare Herb	Kilos/Hectare Shrub	Lbs./Acre Herb	Lbs./Acre Shrub	Total Kilos/Ha
.2	Cut	2 9	83.0		830		739		830
	Fill	21	128.7		1287		1145.4		1287
.4	Cut	21 9	94.2	28.8	942	288	838.4	256.3	1230
	Fill	21 9	62.0		620		552		620
.6	Cut	2-21 17 26	22.4		224		199.4		224
	Fill	2 21 1	155		155		113.8		155
.8	Cut	28 1 21	18.4	38.9	184	389	164	346.2	573
	Fill	1 14 28	23.6		236		210		236
1.0	Cut	1 2	4.8		48		43		48
	Fill	1- 2 6-29 30	44.8	2.7	448	27	399	24	426
1.2	Cut	2 1	14.6		146		130		146
	Fill	2 1-31	26.8		268		239		268
1.4	Cut	2 1	24.5		245		218.1		245
	Fill	6 P N S							
1.6	Cut	2	33.5		335		298.2		335
	Fill	1 2 14	242.8		2428		2161		2428
1.8	Cut	1 14 2	72.8	1.5	728	15	648	13.4	743
	Fill	9 1-2-31	219.6	118.6	2196	1186	1954	1056	3382
2.0	Cut	1 2	42.0		420		374		420
	Fill	1 2	83.5	1.0	835	10	743.2	8.9	845
2.2	Cut	28 1 26 P N S							
	Fill	2 1 P N S							
2.4	Cut	2 1	26.1		261		232.3		261
	Fill	2-33 34-31	125.4	3.5	1254	35	1116.1	31.2	1289
2.6	Cut	2	25.1		251		223.4		251
	Fill	1 21 2 P N S							
2.8	Cut	28 2 17	21.1		211		188		211
	Fill	2-1 9-28	162.7		1627		1448		1627
3.0	Cut	28 2-9 21-1	3.0		30		27		30
	Fill	1 2-9-26	65.6		656		584		656
3.2	Cut	2 28 1	14.2	1.7	142	1.7	126.4	15.1	169
	Fill	2 1 35	25.3		253		225.2		253
3.4	Cut	2 1 9 P N S							
	Fill	2 28 1 P N S	34.5	3.8	345	38	307.1	34	383

Chapter 5

Roadside Test Plots

In the Spruce-Fir Zone, between proposed mill site and Tie Creek Diversion, a series of strips were established to examine various treatments for revegetation. The initial strip is treated approximately 59 feet from the water diversion.

The revegetation crew, with timely additional help from the entire crew established the site, under the direction of Phil Barnes and commentary from Dr. Hugo A. Ferchau.

The slopes are almost entirely north-facing, and are generally 25° - 30°. The surface was not particularly altered from how the road installation left it. Most of the roadside slopes had been hydroseeded in 1979, in September and October, by a Homestake crew. None of the specifics relating to seed quantity, hydromulch quantity, or rates of application are available. Regardless, by mid-summer, it was evident that most of the efforts had been minimally successful. It should be recognized, however, a single treatment had been provided prior to the 1980 efforts, and virtually all had been treated similarly.

In many cases, there was evidence the previous treatment had been eroded from the surface because components of the revegetation seed mix were actively growing and well represented in the roadside ditch.

For a distance of nearly one-half mile, 3 foot laths were driven in at 20 foot intervals. Each 20 foot strip was 20-100+ feet long. Each 20 foot strip was given a number.

A number of treatments were devised and two replicates of each treatment were considered. The location of treatments was a random selection,

on the part of Phil Barnes.

Figures E-1 to E-3 indicate the treatment given, location of the treatments, and the dates treatments were initiated.

No monitoring of the strips had been completed during 1980. No significant precipitation had taken place and therefore no significant growth was expected. However, green growth was evident on several sites, particularly in the hay plots and Excelsior treatments.

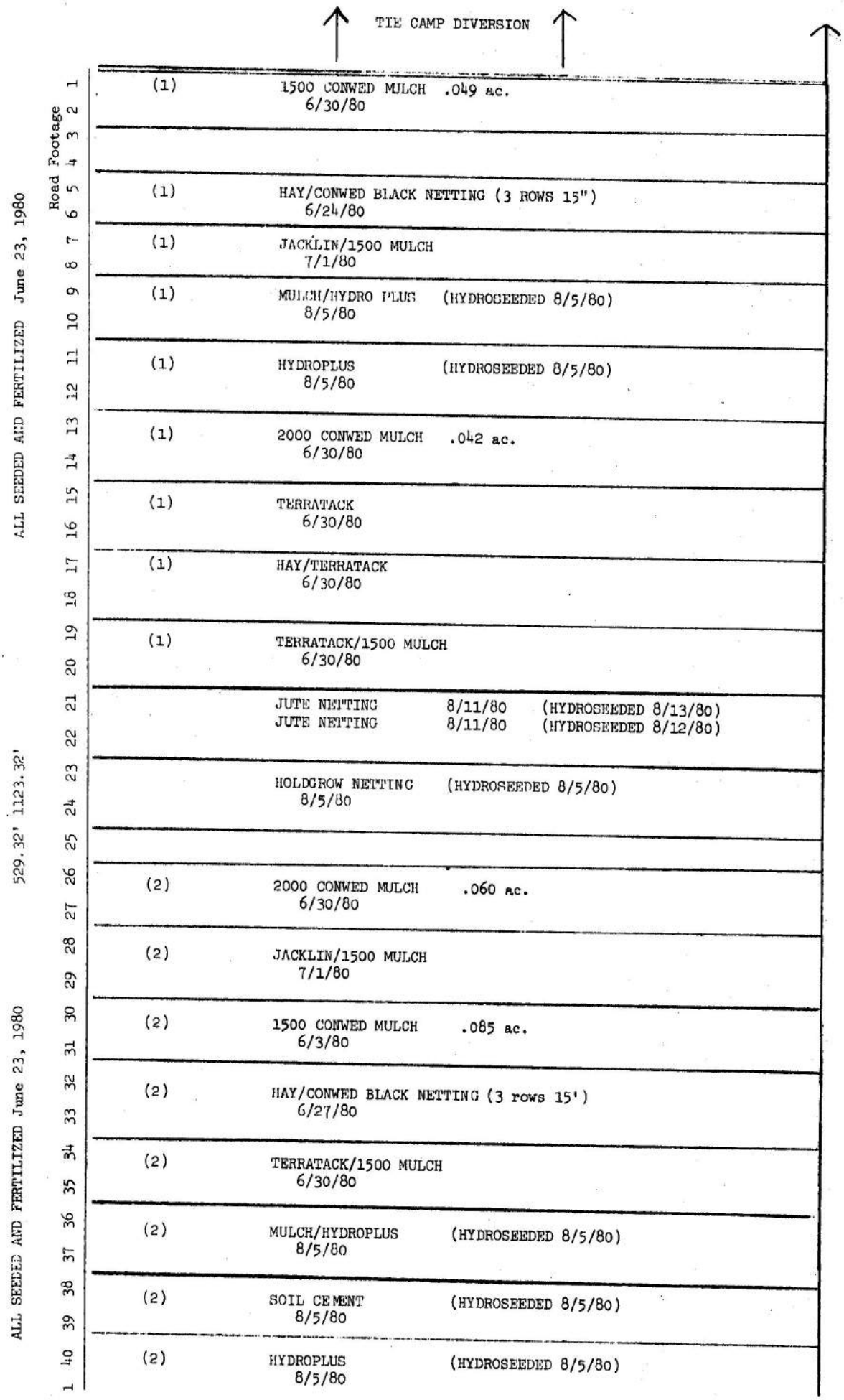


Figure E-1. Roadside test strips 1-41.

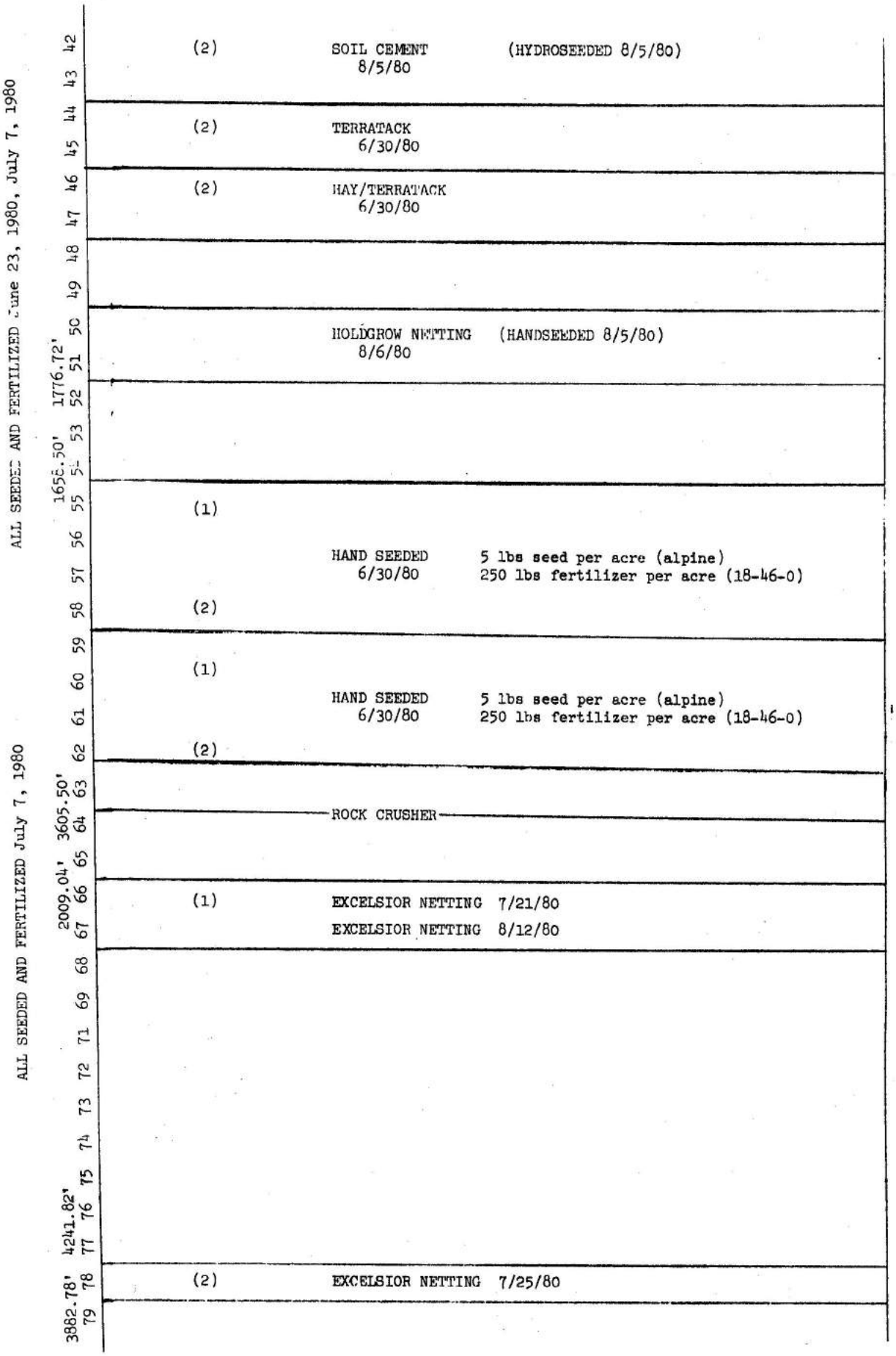


Figure E-2. Roadside test strips 42-79.

ACCESS ROAD REVEGETATION PLOTS 4261.9'

All seed = Alpine mix 50 lbs. per acre
Fertilizer = 18-46-0 @ 250 lbs. per acre
All Distances = measured from Tie camp diversion with roller tape
All Conwed mulchs = 2000 lbs. acre

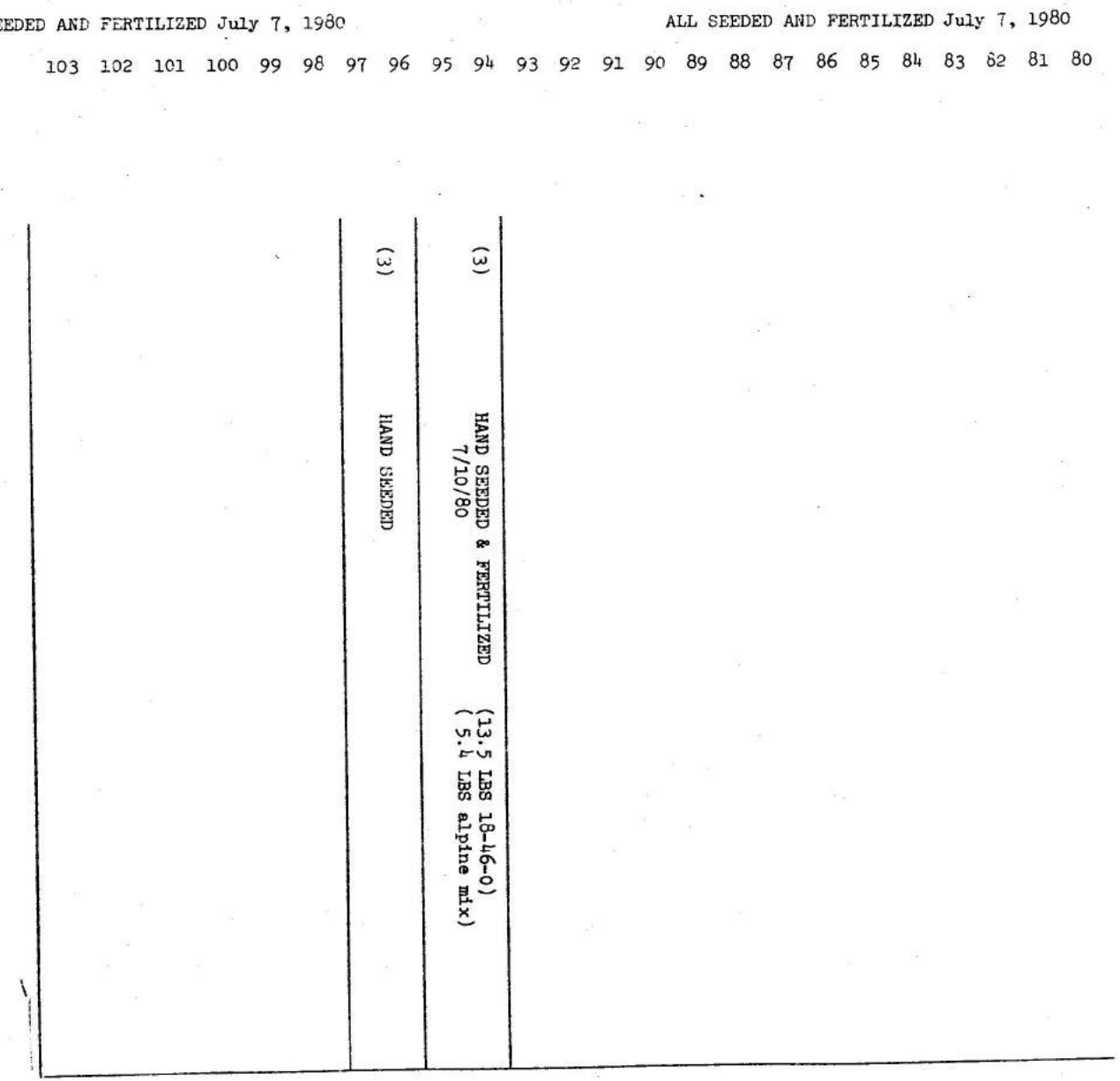


Figure E-3. Roadside test strips 80-103.

Chapter 6

Sage Test Plots and Water Treatment Plant Test Plots

In 1977, when the revegetation and reclamation considerations were initiated, the most evident concern was associated with how the industry would deal with the generation of new environments. Roadsides will be created with exposed subsoils. A tailings pond will be developed with topsoil on the surface, but revegetation will need to be rapid and successful. Raw rock of insufficient ore grade, or rock which needs to be removed to reach the ore, must be dumped and revegetated. The pit site, at the completion of mining represents a site not ordinarily encountered in nature. A mill was to be constructed which would include alteration of the surface vegetation.

In 1977, work was initiated on the basis of priority and availability of sites. A test plot was established southwest of the proposed tailings dam site. Adjacent to the proposed mill site, a Lodgepole Pine stand was available. On Indian Creek Road, near the present water treatment plant, on the site of an abandoned sawmill, an overburden deposition location was established.

Various objectives were considered. The tailings pond site is sufficiently close to what will be the top of the tailings pond to recognize what will succeed in such an environment. Secondly, because the soil is of good quality, it could also qualify as a control site. Species selected were those anticipated for revegetation because they are included in commercial seed mixes, native species being considered for revegetation, and those species which are not native, but which might be used on sites which do not resemble native natural habitats. The assumption was that if a plant cannot grow on the Hales Gulch site, it is unlikely it will grow on the Pitch Project.

The mill site plot was to specifically consider the conditions in that locale.

The water treatment plant site was developed to consider overburden as a potential substrate. Included are species which may grow only in such an environment.

The Hales Gulch plot had the vegetation removed with a bulldozer. The .5 acre site was torn up and graded, and fenced.

The mill site plot utilized a Lodgepole Pine habitat. At the time, it was speculated the mill established would not entail much surface disturbance, but rather would be associated with forest thinning. Therefore the trees were thinned and the site fenced.

The Water Treatment plot was established by dumping numerous loads of representative overburden. The piles were leveled with a bulldozer and the site fenced.

The physical conditions of all plots are included in the 1977-1978 reports. The specific treatments are included in the same reports.

The mill site plot was discontinued in 1978 because natural regrowth occurred more rapidly than what we could plant. The test plot was physically removed in the process of mill site preparation in 1979.

Table F-1 summarizes the various species and the treatments provided at Hales Gulch. The water treatment was administered only in 1979. The transplants were Symphoricarpos oreophilus, Fragaria ovalis, Artemesia tridentata, Chaenactis douglasii, Carex foenea, Penstemon strictus, Abies concolor, Lodgepole Pine, Juniperius virginiana, Pinus ponderosa, Pseudotsuga menziesii, Rosa woodsii, Domestic Iris, Yarrow and Picea pungens glauca. The Domestic Iris was included at the suggestion of Perry Plummer (Intermountain Forest and Range Experiment Station). He has found that any site which will not support Domestic Iris can be revegetated only with great difficulty, or not at all. Juniperus virginiana was used because it is furnished by the Colorado State Forest Service Nursery, for revegetation. Carex foenea had irregular growth because of irregular visitations by elk, which selectively grazed it. Despite transplanting occurred during severe droughts, maximum success was evident. It appears transplanting will be a successful venture on top of the tailings pond, if the soil quality is carefully considered. Soil amendments or considerable surface

TABLE F-1

SPECIES GROWTH ASSOCIATED WITH A VARIETY OF SURFACE TREATMENTS AT HALES GULCH (SAGEBRUSH)

		No treatment				Water				Fertilizer				Mulch				Rock				Slash			
		$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG
Symphoricarpos oreophilus	'78	2.3	3	1.0	3.3	4.0	2.3	3	.2	0.0	0.0	2.0	3	1.1	6.5	6.5	2.7	3	1.0	7.8	10.0	2.7	3	.5	6.3	8.8	3.0	3	0.0	2.8	3.9
	'79	3.0	3	3.5	15.0	5.0	2.8	3	5.8	15.0	3.3	2.8	3	6.0	9.0	6.0	3.0	3	8.6	7.8	5.0	2.9	3	7.8	11.8	6.3	2.9	3	9.0	12.3	9.3
	'80	3.6	4	33.5	6.5	2.0	3.4	4	29.8	3.2	3.0	3.5	4	32.5	9.5	3.0	3.1	4	21.2	14.8	4.0	3.4	4	43.0	2.0	- 5.0	3.6	4	36.5	.5	- 2.0
Fragaria ovalis	'78	2.0	3	.3	1.2	.1	3.3	5	.1	1.5	1.0	1.8	5	.1	1.0	.2	2.0	3	1.8	2.5	2.3	2.8	3	5.0	5.0	3.4	2.8	3	7.1	5.9	4.0
	'79	3.4	4	3.3	2.3	- .3	3.5	4	5.8	1.0	- .7	3.4	4	6.7	2.0	1.0	3.0	4	- 1.1	3.0	0.0	3.0	4	5.8	2.0	0.0	2.4	4	1.3	1.0	- 5.5
	'80	2.0	3	9.0	- 2.0	- 2.0	3.0	4	10.0	- 3.0	- 3.0	3.0	4	10.3	- 1.3	10.0	1.3	2	5.0	0.0	- 2.0	2.7	3	5.4	2.6	- 2.0	-	-	-	-	-
Artemisia tridentata	'78	3.0	3	7.5	14.5	14.8	3.8	4	5.0	13.5	15.5	3.8	4	6.5	16.0	16.1	3.8	4	4.2	11.5	11.0	3.8	4	4.2	11.5	11.0	3.8	4	10.5	18.5	18.5
	'79	3.3	3	12.3	12.0	- .5	3.3	3	13.7	13.7	- 1.5	3.3	3	7.8	18.3	- 2.8	3.3	3	5.7	14.3	1.0	3.3	3	7.7	14.0	4.3	3.3	3	8.5	11.0	6.3
	'80	3.6	4	46.8	18.8	- 6.0	3.7	4	41.3	8.7	5.0	3.4	4	38.0	26.0	1.0	3.3	4	35.5	27.5	- 3.0	3.2	4	43.5	26.5	-33.0	3.0	4	36.3	23.7	0.0
Chaenactis douglasii	'78	-	-	-	-	-	4.0	5	7.0	13.0	12.0											4.5	5	37.0	40.0	42.0	-	-	-	-	-
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	3.2	4	20.0	28.0	- 1.0	2.7	4	19.0	19.0	0.0	2.7	4	12.3	33.7	2.0	2.7	4	15.3	25.7	- 1.0	2.1	3	17.6	17.4	0.0	2.4	4	10.2	27.8	2.0
Carex foenea	'78	2.8	3	4.5	11.0	11.0	3.5	4	3.8	11.0	9.5	3.0	3	7.5	9.5	9.5	2.8	3	5.5	11.5	16.0	3.0	3	6.5	16.5	12.0	2.3	3	1.1	.1	.8
	'79	3.4	4	12.0	3.0	- 4.5	3.1	4	12.0	- 2.0	.3	3.3	4	16.0	- 5.7	1.0	3.9	4	9.8	3.8	- 2.3	3.2	4	7.3	5.0	- 7.3	2.8	4	3.8	4.3	.2
	'80	2.3	3	24.0	-15.0	1.0	2.3	3	28.0	-13.0	0.0	1.7	2	23.0	-15.0	2.0	2.0	3	21.0	-11.0	0.0	3.3	4	34.0	-19.0	0.0	3.0	4	12.0	1.0	- 3.0
Antennaria sp.	'78	1.8	2	.1	1.3	1.3	3.3	4	4.1	5.0	3.0	1.8	2	.5	1.1	1.1	2.8	3	1.5	1.5	.5	2.8	3	2.5	3.0	2.8	2.8	3	.5	1.0	.5
	'79	3.3	4	0.0	- .5	1.0	3.8	4	1.5	0.0	- 1.0	2.6	3	0.0	0.0	1.0	2.9	3	1.0	0.0	- .3	3.6	4	1.0	- .3	0.0	3.5	4	2.5	0.0	1.5
	'80	3.0	4	2.0	3.0	- 3.0	2.8	4	2.5	4.5	- 5.0	2.0	3	3.0	2.0	- 3.0	2.4	3	1.2	3.8	- 3.0	3.3	4	5.0	3.0	- 5.0	3.0	4	4.0	2.0	- 4.0
Penstemon strictus	'78	-	-	-	-	-	4.0	5	11.0	29.0	27.5	4.3	5	11.0	25.0	23.0	3.3	4	6.0	29.0	26.7	4.5	5	24.0	38.0	36.0	3.0	4	7.0	14.0	13.0
	'79	4.1	5	14.0	6.0	2.0	3.8	5	16.8	25.7	5.3	3.7	5	21.0	17.3	24.3	4.8	5	15.3	31.3	9.8	3.6	5	23.0	24.5	17.5	4.5	5	13.3	37.7	- 6.6
	'80	2.6	3	7.5	25.5	- 3.3	3.6	4	6.5	31.5	- 2.0	3.1	4	4.0	25.0	1.0	2.8	4	3.0	34.0	- 7.0	2.8	3	7.5	41.5	2.0	3.6	4	8.0	42.0	-20.0
Abies concolor	'78	2.8	3	.1	2.0	2.5	2.8	3	3.5	7.0	8.3	3.0	3	1.1	3.1	5.0	2.0	2	.1	2.0	2.2	2.8	3	1.1	3.0	4.8	1.8	2	.1	6.1	9.5
	'79	3.2	4	- 1.0	- 1.0	4.3	3.3	4	- .2	4.2	2.2	2.9	4	- .2	1.0	2.8	2.7	3	.4	.4	1.4	3.7	3	- .5	2.0	4.2	2.2	4	- 2.2	1.8	- 1.0
	'80	3.3	4	19.2	6.8	- 1.0	3.5	4	26.2	3.8	0.0	3.3	4	20.8	7.2	- 3.0	3.3	4	17.5	8.5	4.0	3.5	4	23.6	6.4	5.0	3.3	4	20.5	5.5	4.0

TABLE F-1 Continued

		No treatment					Water					Fertilizer					Mulch					Rock					Slash				
		$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG
Agropyron elymus	'78	0.0	0	0.0	0.0	0.0	2.0	2	0.0	2.0	4.0	0.0	0	0.0	0.0	0.0	2.0	2	1.0	7.0	9.0	2.0	2	0.0	6.0	24.0	2.0	2	0.0	5.0	16.0
	'79	2.8	3	1.0	2.0	3.0	3.0	3	1.0	5.0	1.0	2.8	3	0.0	3.0	2.0	3.4	4	5.0	3.0	8.0	2.9	3	2.0	7.0	- 1.0	2.9	3	- 4.0	9.0	1.0
	'80	2.6	4	9.3	30.7	-10.0	3.0	4	10.0	20.0	-13.0	2.7	4	7.0	5.0	- 2.0	2.7	3	15.0	35.0	-17.0	3.7	4	18.0	22.0	0.0	3.2	4	12.0	13.0	- 8.0
Penstemon strictus	'78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
	'79	3.0	3	2.0	4.0	3.0	3.0	3	2.0	4.0	2.0	3.0	3	2.0	5.0	2.0	3.4	4	4.0	25.0	13.0	3.0	3	1.0	3.0	2.0	3.0	3	1.0	3.0	3.0
	'80	2.9	4	6.0	6.0	0.0	2.4	3	5.0	15.0	- 9.0	3.3	4	9.2	.8	5.0	0.0	0	0.0	0.0	0.0	3.1	4	8.8	- 3.8	- 4.0	-	-	-	-	-
Lobularia maritima	'78	0.0	0	0.0	0.0	0.0	3.0	4	0.0	2.5	5.0	0.0	0	0.0	0.0	0.0	.3	4	.5	2.0	11.0	1.7	2	0.0	3.5	1.0	1.5	2	0.0	1.5	1.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Helianthus annuus	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.5	3	.5	2.5	10.0	2.0	2	0.0	1.5	0.0	2.3	3	0.0	3.0	5.0
	'79	2.9	-	2.0	15.0	29.0	2.9	-	2.0	10.0	42.0	3.0	-	3.0	15.0	31.0	3.1	-	1.0	21.0	24.0	3.0	-	2.0	10.0	10.0	2.9	-	3.0	16.0	9.0
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium angustifoluim	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
	'79	2.0	-	2.0	15.0	29.0	2.9	-	2.0	10.0	42.0	3.0	-	3.0	15.0	31.0	3.1	-	1.0	21.0	24.0	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aster tanacetifolius	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.0	2	0.0	1.5	2.0	2.0	2	0.0	2.0	5.0	2.0	2	0.0	2.0	2.0
	'79	4.0	4	-	-	12.0	3.5	4	-	-	10.0	3.5	4	-	-	12.0	3.5	4	-	-	10.0	3.0	3	-	-	0.0	2.5	3	-	-	4.0
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rudbeckia hirta	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.0	2	0.0	0.0	2.0	0.0	0	0.0	0.0	0.0
	'79	1.0	1	-	-	4.0	-	-	-	-	-	3.0	3	-	-	10.0	3.0	3	-	-	14.0	2.0	2	-	-	11.0	2.0	2	-	-	9.0
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE F-1 Continued

		No treatment				Water				Fertilizer				Mulch				Rock				Slash			
		$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG
Sporobolus sp.	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.7	2	0.0	0.0	1.0	0.0	0	0.0	0.0	0.0	2.0	2	0.0	0.0	2.0
	'79	2.0	2	0.0	0.0	0.0	2.0	2	0.0	0.0	0.0	3.0	3	0.0	0.0	7.0	2.5	3	0.0	0.0	3.0	2.5	3	0.0	0.0	2.0	3.0	3	0.0	0.0	6.0
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potomac Orchardgrass	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.5	3	1.0	5.0	8.0	1.7	2	0.0	2.0	7.0	2.5	3	0.0	6.0	7.0
	'79	3.0	3	0.0	3.0	15.0	2.5	3	1.0	6.0	11.0	2.4	3	3.0	9.0	2.0	2.7	3	3.0	3.0	7.0	2.5	3	2.0	4.0	1.0	2.1	3	- 4.0	5.0	7.0
	'80	3.1	4	12.4	0.0	- .4	2.7	4	12.2	- 7.2	7.0	2.8	4	9.6	.4	15.0	3.0	4	13.0	- 5.0	9.0	3.3	4	8.0	7.0	3.0	3.2	4	10.0	- 3.0	8.0
Long-Tall Wheatgrass	'78	0.0	0	0.0	0.0	0.0	1.5	2	0.0	2.0	6.0	0.0	0	0.0	0.0	0.0	2.5	3	3.0	9.0	8.0	2.5	3	0.0	9.0	11.0	2.5	3	0.0	9.0	11.0
	'79	2.1	3	2.0	1.0	11.0	2.5	3	1.0	7.0	9.0	2.5	3	1.0	10.0	13.0	3.0	3	3.0	19.0	7.0	3.1	4	4.0	24.0	9.0	3.1	4	10.0	25.0	1.0
	'80	2.0	3	4.4	9.6	8.0	2.0	2	7.0	6.0	5.0	2.7	4	9.0	17.0	4.0	3.0	3	12.0	48.0	- 3.0	3.7	4	22.0	74.0	28.0	3.0	3	14.0	53.0	33.0
Agropyron cristatum	'78	0.0	0	0.0	0.0	0.0	1.7	3	0.0	5.0	7.0	0.0	0	0.0	0.0	0.0	2.5	3	4.0	8.0	8.0	2.0	3	0.0	6.0	8.0	2.0	3	0.0	5.0	10.0
	'79	3.1	4	5.0	13.0	6.0	3.5	4	0.0	20.0	10.0	3.4	4	1.0	19.0	9.0	3.6	4	1.0	31.0	4.0	3.6	4	1.0	22.0	12.0	3.6	4	1.0	12.0	8.0
	'80	2.7	3	15.5	11.5	- 7.0	2.9	3	16.2	18.8	15.0	2.7	4	10.4	7.6	4.0	3.0	3	15.0	13.0	- 6.0	2.6	4	19.0	15.0	- 6.0	2.5	3	17.0	3.0	10.0
Elymus cinereus	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.0	2	0.0	4.0	4.0	2.0	2	0.0	3.0	8.0	2.0	3	0.0	3.0	8.0
	'79	3.0	4	7.0	10.0	4.0	2.6	3	3.0	15.0	5.0	2.9	3	5.0	19.0	4.0	2.9	3	4.0	28.0	1.0	3.1	4	9.0	17.0	- 3.0	3.1	4	8.0	23.0	- 8.0
	'80	2.0	2	17.0	- 7.0	8.0	3.0	4	12.0	23.0	- 7.0	3.0	3	15.0	10.0	3.0	1.5	2	12.0	0.0	4.0	1.7	3	21.0	-11.0	7.0	1.7	2	12.0	- 4.0	12.0
Agropyron dasystachyum	'78	0.0	0	0.0	0.0	0.0	1.5	2	0.0	10.0	12.0	2.5	3	2.0	7.0	9.0	0.0	0	0.0	0.0	0.0	1.7	2	0.0	5.0	10.0	2.0	3	0.0	6.0	10.0
	'79	2.3	3	0.0	8.0	- 2.0	2.8	4	1.0	4.0	0.0	2.5	3	0.0	8.0	- 2.0	3.5	4	0.0	40.0	6.0	3.5	4	2.0	35.0	2.0	3.3	4	5.0	13.0	9.0
	'80	2.9	4	8.5	3.5	5.0	3.1	4	12.1	3.9	5.0	3.0	4	8.0	12.0	18.0	3.3	4	16.0	19.0	- 5.0	3.3	4	17.0	0.0	5.0	3.3	4	13.0	7.0	10.0
Eschscholzia California Orange	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.5	3	1.0	2.5	12.5	1.7	2	0.0	2.0	4.0	2.0	2	3.0	4.0	5.0
	'79	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	4.3	5	0.0	5.0	9.0	0.0	0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE F-1 Continued

		No treatment				Water				Fertilizer				Mulch				Rock				Slash			
		$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG
Smoothbrome Lincoln	'78	1.8	2	0.0	2.0	10.0	2.0	2	0.0	7.0	8.0	1.5	2	0.0	3.0	8.0	2.5	3	3.0	7.0	11.0	2.0	3	0.0	9.0	15.0	2.0	2	0.0	6.0	12.0
	'79	2.6	3	4.0	7.0	- 1.0	3.6	4	6.0	41.0	8.0	3.6	4	4.0	8.0	4.0	3.9	5	6.0	33.0	8.0	3.6	4	3.0	41.0	- 5.0	3.6	4	6.0	29.0	4.0
	'80	2.0	2	14.0	0.0	2.0	3.0	3	18.0	2.0	0.0	3.0	3	11.0	7.0	- 4.0	2.7	3	13.0	7.0	- 5.0	2.3	3	17.0	13.0	-10.-	2.7	3	16.0	13.0	- 7.0
Meadow Brome	'78	2.0	2	0.0	8.0	10.0	2.0	2	0.0	5.0	9.0	2.0	2	0.0	1.0	2.0	2.5	3	3.0	10.0	10.0	3.0	3	4.0	12.0	24.0	2.5	3	5.0	11.0	21.0
	'79	2.1	3	2.0	5.0	- 5.0	3.5	4	7.0	16.0	3.0	2.5	3	1.0	10.0	8.0	3.8	4	13.0	19.0	-23.0	3.8	4	7.0	35.0	0.0	3.8	4	17.0	49.0	- 6.0
	'80	2.3	4	10.6	7.4	9.0	3.7	4	19.0	16.0	15.0	2.2	3	10.7	4.3	3.0	3.0	4	15.0	10.0	5.0	3.0	3	26.0	4.0	- 5.0	2.5	3	20.0	15.0	0.0
Bouteloua gracilis	'78	2.0	2	0.0	1.0	3.0	2.0	2	0.0	2.0	4.0	2.0	2	0.0	1.0	4.0	2.0	2	0.0	4.0	5.0	2.0	2	0.0	4.0	10.0	2.0	2	0.0	2.0	6.0
	'79	2.5	3	0.0	0.0	2.0	0.0	0	0.0	0.0	0.0	1.7	2	1.0	1.0	1.0	0.0	0	0.0	0.0	0.0	2.3	3	8.0	1.0	- 2.0	0.0	0	0.0	0.0	0.0
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Western Wheatgrass	'78	1.5	2	0.0	1.0	1.0	1.5	2	0.0	3.0	5.0	0.0	0	0.0	0.0	0.0	2.0	3	2.0	8.0	14.0	1.0	1	0.0	6.0	6.0	2.0	2	0.0	3.0	9.0
	'79	2.6	4	4.0	12.0	9.0	2.6	3	4.0	12.0	9.0	2.6	3	5.0	13.0	8.0	3.6	4	7.0	32.0	6.0	3.4	4	3.0	14.0	13.0	3.4	4	3.0	16.0	3.0
	'80	3.3	4	8.0	7.0	9.0	2.7	3	10.0	11.0	1.0	3.3	4	12.0	8.0	0.0	3.3	4	16.0	8.0	0.0	3.0	4	16.0	19.0	- 3.0	2.5	3	11.0	19.0	0.0
Sand Dropseed	'78	0.0	0	0.0	0.0	0.0	2.0	2	0.0	0.0	4.0	2.0	2	0.0	0.0	4.0	2.0	2	0.0	1.0	6.0	2.0	2	0.0	0.0	14.0	2.0	2	0.0	3.0	5.0
	'79	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.0	2	0.0	1.0	0.0	0.0	0	0.0	0.0	0.0	2.0	3	0.0	1.0	1.0	2.3	3	.5	.5	1.0
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Standard Crested Wheatgrass	'78	0.0	0	0.0	0.0	0.0	2.0	2	0.0	5.0	11.0	0.0	0	0.0	0.0	0.0	2.5	3	3.0	10.0	11.0	2.5	3	3.0	10.0	12.0	3.0	3	2.0	8.0	10.0
	'79	0.0	0	0.0	0.0	0.0	3.6	4	10.0	28.0	10.0	2.4	4	1.0	8.0	- 4.0	3.9	4	12.0	27.0	8.0	3.6	4	8.0	29.0	7.0	3.6	4	7.0	11.0	25.0
	'80	0.0	0	0.0	0.0	0.0	3.3	4	15.0	5.0	5.0	2.2	3	8.8	- 1.8	1.0	2.5	3	17.0	13.0	2.0	2.7	3	23.0	7.0	7.0	2.3	3	11.0	9.0	5.0
Lettuce Grand Rapids	'78	0.0	0	0.0	0.0	0.0	2.0	2	0.0	2.0	10.0	0.0	0	0.0	0.0	0.0	2.7	3	1.0	3.0	11.0	2.0	2	0.0	3.0	6.0	2.5	3	0.0	5.0	9.0
	'79	3.0	3	3.0	9.0	2.0	3.0	3	5.0	13.0	1.0	3.0	3	5.0	10.0	5.0	3.0	3	4.0	6.0	3.0	3.0	3	2.0	14.0	- 6.0	3.0	3	0.0	- 5.0	0.0
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE F-1 Continued

		No treatment					Water					Fertilizer					Mulch					Rock					Slash		
		$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG
Penn Lan Creeping Red Fescue	'78	0.0	0	0.0	0.0	0.0	2.0	2	0.0	3.0	4.0	2.3	3	5.0	7.0	9.0	2.5	3	2.0	7.0	9.0	2.5	3	2.0	6.0	11.0	2.0	2	3.0	6.0	3.0
	'79	2.0	2	1.0	2.0	0.0	3.0	3	3.0	1.0	7.0	2.8	3	9.0	6.0	- 1.0	3.6	4	6.0	14.0	12.0	3.6	4	7.0	22.0	2.0	0.0	0	0.0	0.0	0.0
	'80	0.0	0	0.0	0.0	0.0	2.3	3	13.0	- 5.0	7.0	3.7	4	23.0	- 5.0	1.0	2.7	3	16.0	- 7.0	1.0	3.7	4	24.0	- 5.0	- 1.0	0.0	0	0.0	0.0	0.0
Hard Fescue	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.5	3	1.0	5.0	7.0	2.0	2	0.0	5.0	8.0	2.0	2	0.0	6.0	7.0
	'79	2.3	3	0.0	3.0	- 2.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	3.8	4	7.0	19.0	-20.0	3.9	4	7.0	13.0	- 3.0	3.3	4	8.0	9.0	-10.0
	'80	3.0	3	10.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.0	1	0.0	6.0	0.0	2.1	3	13.9	- 7.9	0.0	2.6	3	14.8	- 8.8	2.0	2.4	3	11.3	- 4.3	3.0
White Dutch Clover	'78	0.0	0	0.0	0.0	0.0	2.3	3	.5	5.0	9.0	2.0	2	0.0	2.0	8.0	2.0	2	.5	3.0	3.0	2.0	2	.5	3.0	5.0	3.0	3	1.0	4.0	13.0
	'79	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.5	3	4.0	14.0	- 4.0	3.5	4	9.0	15.0	13.0	3.0	3	6.0	15.0	4.0
	'80	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.0	2	0.0	13.0	- 8.0	3.3	4	5.0	30.0	10.0	2.5	3	0.0	24.0	12.0
Manchar Bromegrass	'78	1.8	2	5.0	10.0	7.0	2.7	3	6.0	11.0	12.0	2.0	2	3.0	5.0	4.0	3.0	3	8.0	14.0	20.0	3.0	3	10.0	20.0	22.0	2.5	3	6.0	12.0	16.0
	'79	3.5	4	8.0	40.0	- 4.0	3.6	4	10.0	40.0	9.0	3.1	4	5.0	22.0	29.0	3.6	4	10.0	49.0	- 8.0	3.9	5	23.0	41.0	8.0	3.6	4	19.0	25.0	25.0
	'80	3.0	4	16.0	21.0	1.0	3.0	4	18.0	22.0	15.0	3.0	4	17.0	6.0	12.0	3.3	4	26.0	26.0	- 2.0	3.3	4	35.0	7.0	3.0	3.3	4	32.0	6.0	2.0
Ailanthus altissima	'78	0.0	0	0.0	0.0	0.0	1.8	2	0.0	0.0	2.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.0	2	0.0	2.0	4.0	0.0	0	0.0	0.0	0.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Russian Wild Rye	'78	0.0	0	0.0	0.0	0.0	1.8	2	2.0	3.5	5.0	1.0	1	0.0	1.5	3.0	3.0	3	.5	7.5	17.0	2.3	3	4.0	10.0	22.0	2.0	2	4.0	7.0	14.0
	'79	2.0	3	2.0	6.0	0.0	3.6	4	3.0	47.0	1.0	3.6	4	8.0	7.0	2.0	3.6	4	16.0	33.0	5.0	3.3	4	10.0	2.0	0.0	3.3	4	11.0	8.0	- 7.0
	'80	2.3	3	7.0	27.0	- 5.0	3.3	4	19.0	33.0	22.0	3.5	4	17.0	38.0	- 5.0	4.0	4	21.	39.0	-15.0	3.7	4	22.0	18.0	20.0	3.0	4	13.9	26.1	- 5.0
Kentucky Bluegrass	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.0	2	0.0	2.0	4.0	1.1	1	0.0	1.0	2.0	0.0	0	0.0	0.0	0.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE F-1 Continued

		No treatment					Water					Fertilizer					Mulch					Rock					Slash				
		$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG
Indian Rice-grass	'78	2.0	2	0.0	4.0	19.0	2.0	2	0.0	5.0	6.0	2.5	3	9.0	17.0	10.0	2.3	3	9.0	17.0	10.0	2.0	2	6.0	16.0	26.0	2.0	2	0.0	11.0	20.0
	'79	2.8	4	4.0	8.0	8.0	2.5	4	6.0	10.0	6.0	2.5	4	9.0	7.0	10.0	3.3	4	10.0	11.0	14.0	3.1	4	4.0	18.0	1.0	3.1	4	5.0	12.0	2.0
	'80	1.7	3	20.0	- 8.0	18.0	1.7	3	22.0	- 1.0	14.0	1.7	3	25.0	- 8.0	18.0	1.3	2	25.0	- 9.0	14.0	1.7	3	24.0	- 7.0	18.0	1.3	3	18.0	6.0	- 4.0
Climax Timothy	'78	0.0	0	0.0	0.0	0.0	1.5	2	0.0	4.0	0.0	2.0	2	0.0	0.0	1.0	2.5	3	0.0	3.0	4.0	3.0	3	2.0	7.0	12.0	2.5	3	0.0	4.0	5.0
	'79	2.7	3	2.0	2.0	1.0	0.0	0	0.0	0.0	0.0	2.2	3	5.0	- 4.0	2.0	0.0	0	0.0	0.0	0.0	3.6	4	8.0	32.0	22.0	2.8	3	0.0	12.0	-10.0
	'80	2.3	3	14.0	- 5.0	11.0	1.0	1	6.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.3	3	25.0	-15.0	20.0	0.0	0	0.0	0.0	0.0
Alfalfa Nomad	'78	2.5	3	0.0	3.0	9.0	2.0	2	1.0	4.0	3.0	2.0	2	1.0	3.0	2.0	2.5	3	1.0	3.0	3.0	2.5	3	1.0	7.0	11.0	2.5	3	1.0	5.0	15.0
	'79	2.1	3	- 1.0	9.0	- 3.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	3.3	4	9.0	20.0	6.0	3.0	3	8.0	0.0	15.0
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.7	4	19.0	1.0	10.0	2.6	3	15.0	0.0	- 7.0
Alkali Sacatoon	'78	0.0	0	0.0	0.0	0.0	2.0	2	1.0	1.0	2.0	1.0	1	.5	.5	.3	2.0	2	1.0	1.0	1.0	2.0	2	1.0	1.0	1.0	1.0	1	1.0	1.0	1.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strawberry Clover	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.0	2	1.0	1.0	1.0	2.0	2	2.0	2.0	2.0	2.0	2	0.0	0.0	2.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rye	'78	2.5	3	1.0	4.0	5.0	2.3	3	1.0	5.0	6.0	3.0	3	7.0	11.0	14.0	3.0	3	8.0	14.0	21.0	3.0	3	4.0	20.0	20.0	2.5	3	6.0	10.0	26.0
	'79	4.3	5	51.0	41.0	6.0	4.3	5	49.0	52.0	- 1.0	4.3	5	47.0	47.0	1.0	4.1	5	62.0	42.0	1.0	4.1	5	5.0	55.0	50.0	4.1	5	48.0	47.0	3.0
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Four Wing Saltbrush	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	2.0	2	0.0	4.0	9.0	2.0	2	2.0	4.0	6.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE F-1 Continued

		No treatment				Water				Fertilizer				Mulch				Rock				Slash			
		V	V	JN	JL	AG	V	V	JN	JL	AG	V	V	JN	JL	AG	V	V	JN	JL	AG	V	V	JN	JL	AG
Juniperus virginiana	'78	3.0	3	.8	1.0	.9	3.0	3	1.2	2.0	2.0	3.0	3	0.0	.9	.8	2.8	3	0.0	1.2	1.6	3.0	3	1.0	1.5	2.8	2.0	2	.1	3.0	4.1
	'79	3.0	3	- .3	3.5	3.3	2.9	3	- .8	1.6	2.2	2.3	3	.4	1.4	1.6	2.7	3	- 1.6	2.8	3.2	2.7	3	0.0	2.4	2.0	2.0	3	- 3.5	8.0	- .5
	'80	3.1	4	24.5	8.5	2.0	3.5	4	27.6	10.4	2.0	2.8	4	17.8	7.2	4.0	3.5	4	26.6	12.4	- 4.0	3.3	4	22.8	7.2	2.0	2.3	3	18.3	1.7	5.0
Pinus ponderosa	'78	2.0	2	.2	1.1	0.0	1.8	2	0.0	.8	1.2	3.0	3	.8	3.0	3.9	2.0	3	0.0	5.1	6.8	2.0	2	0.0	2.0	2.1	1.3	2	.1	3.8	6.3
	'79	2.8	4	0.0	- 2.8	8.3	3.0	4	- 3.0	4.6	4.8	3.3	4	- 3.5	4.3	7.0	3.4	4	- .8	3.2	5.4	3.4	4	- .4	2.0	2.6	2.4	4	- 6.7	2.0	6.7
	'80	3.1	4	27.8	12.2	- 5.0	3.2	4	23.5	8.5	6.0	3.6	4	36.8	21.2	2.0	3.5	4	32.8	14.2	3.0	2.9	4	27.2	9.8	6.0	2.0	3	21.7	5.3	2.0
Pseudotsuga menziesii	'78	1.0	1	0.0	0.0	.5	2.0	2	0.0	3.2	5.8	1.0	1	0.0	.8	0.0	1.0	1	0.0	1.0	2.0	2.0	2	0.0	0.0	1.5	1.0	1	0.0	2.2	3.2
	'79	2.7	4	- 3.8	- 3.0	3.0	2.8	4	- 2.7	- 2.7	5.3	1.2	4	- 1.0	- 4.0	0.0	2.5	4	- 1.0	.3	2.0	2.9	4	- .6	- 2.2	2.8	.4	1	-11.5	-13.0	0.0
	'80	2.4	3	24.0	- 1.0	2.0	3.0	4	39.6	1.4	4.0	2.6	3	12.0	3.0	0.0	2.8	3	29.0	- 7.0	3.0	3.3	4	35.5	- .5	3.0	0.0	0	0.0	0.0	0.0
Agropyron trichophorum	'78	.7	2	0.0	2.0	4.0	2.0	2	0.0	6.0	5.0	2.0	2	0.0	3.0	4.0	2.0	3	6.0	8.0	3.0	2.0	3	10.0	12.0	10.0	2.0	2	0.0	11.0	9.0
	'79	3.4	4	.5	3.5	14.5	2.9	4	3.5	2.0	9.0	2.7	3	- 2.3	5.5	1.5	3.4	4	1.0	4.0	14.5	3.4	4	5.5	13.5	15.5	3.4	4	4.0	10.5	18.5
	'80	3.5	4	8.9	14.1	7.0	2.5	3	9.5	14.5	- 9.0	3.0	3	11.0	26.0	-20.0	3.0	3	17.8	26.2	-23.0	3.5	4	23.7	36.3	25.0	3.0	3	15.5	14.5	15.0
Yellow Sweet Corn	'78	-	-	-	-	-	-		-	-	-	-	-	-	-	-	2.5	5	1.0	1.5	5.0	2.0	2	0.0	0.0	5.0	3.0	3	0.0	4.0	11.0
	'79	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-		-	-	-	3.8	4	10.0	29.0	50.0	3.6	4	17.0	65.0	45.0
	'80	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-
Corn sunglow	'78	2.0	3	0.0	5.5	8.5	1.5	2	0.0	3.0	0.0	2.0	3	0.0	7.1	21.6	2.0	3	4.5	19.0	34.1	3.0	4	10.0	42.5	57.0	2.0	3	7.0	23.0	41.0
	'79	2.3	3	0.0	0.0	5.0	2.5	3	0.0	2.0	8.0	2.3	3	0.0	0.0	7.0	2.7	3	0.0	0.0	9.0	2.7	3	0.0	0.0	4.0	0.0	0	0.0	0.0	0.0
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Little Marvel Peas	'78	-	-	-	-	-	2.8	4	0.0	5.0	19.0	3.0	4	0.0	7.1	15.5	4.0	5	3.5	16.0	19.0	3.0	4	0.0	10.0	25.0	3.3	4	4.0	14.8	33.5
	'79	2.5	3	0.0	0.0	7.0	2.5	3	0.0	1.0	12.0	2.3	3	0.0	0.0	9.0	2.7	3	0.0	0.0	13.0	2.7	3	0.0	0.0	19.0	2.5	3	0.0	0.0	3.0
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE F-1 Continued

		No treatment					Water					Fertilizer					Mulch					Rock					Slash		
		V̄	V	JN	JL	AG	V̄	V	JN	JL	AG	V̄	V	JN	JL	AG	V̄	V	JN	JL	AG	V̄	V	JN	JL	AG	V̄	V	JN	JL	AG
Robinia pseudoacacia	'78	0.0	0	0.0	0.0	0.0	1.8	2	0.0	1.0	6.0	2.3	3	0.0	2.0	6.0	2.0	2	0.0	2.0	0.0	1.0	2	0.0	1.0	3.0	0.0	0	0.0	0.0	0.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agropyron smithii	'78	1.3	2	0.0	2.0	8.0	2.0	2	0.0	3.0	6.0	0.0	0	0.0	0.0	0.0	2.5	3	0.0	9.0	11.0	2.0	2	0.0	9.0	14.0	2.0	2	0.0	0.0	9.0
	'79	2.5	3	6.0	4.0	- 1.0	2.5	3	8.0	1.0	0.0	2.1	2	2.0	7.0	9.0	3.3	4	15.0	- 3.0	5.0	2.8	3	12.0	- 2.0	4.0	2.9	3	13.0	- 5.0	4.0
	'80	2.3	3	8.0	- 2.0	4.0	2.6	3	9.0	4.0	2.0	2.6	3	8.0	2.0	2.0	3.3	4	10.	- 3.0	6.0	3.7	4	13.0	5.0	7.0	2.6	2	11.0	2.0	7.0
Cowania stanburyana	'78	0.0	0	0.0	0.0	0.0	1.5	2	0.0	.5	2.0	0.0	0	0.0	0.0	0.0	2.0	2	0.0	1.5	2.0	2.0	2	0.0	1.5	2.0	2.0	2	0.0	2.0	2.0
	'79	1.2	3	0.0	0.0	0.0	2.9	3	1.0	2.0	4.0	2.8	3	0.0	1.0	2.0	2.5	3	- 1.0	2.0	2.0	2.7	3	2.0	1.0	2.0	2.9	3	0.0	1.0	2.0
	'80	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	3.0	3	8.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-
Picea pungens glauca	'78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	1.5	2	0.0	27.0	- 2.0	1.5	2	0.0	33.0	0.0	.5	1	0.0	24.0	0.0	1.5	2	0.0	30.0	5.0	1.5	2	0.0	36.0	0.0	.5	1	0.0	26.0	0.0
Hilaria jamesii	'78	2.0	2	0.0	3.0	5.0	2.0	2	2.0	3.5	6.0	2.0	2	2.0	4.0	8.0	2.0	2	3.0	4.5	7.0	3.0	4	3.0	4.5	7.0	2.3	3	5.0	6.0	10.0
	'79	0.0	0	0.0	0.0	0.0	2.0	2	0.0	1.0	0.0	0.0	0	0.0	0.0	0.0	2.2	3	0.0	1.0	3.0	2.7	3	7.0	1.0	- 1.0	0.0	0	0.0	0.0	0.0
	'80	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	3.0	3	0.0	8.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
Meadow Foxtail	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.0	2	0.0	4.0	2.0	2.0	2	0.0	3.0	0.0	2.0	2	0.0	4.5	5.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alfalfa Ladak	'78	2.3	3	0.0	2.0	4.0	2.0	2	0.0	3.0	4.0	2.0	2	0.0	3.5	3.0	2.8	3	2.0	3.0	3.0	2.5	3	2.0	6.0	2.0	2.8	3	0.0	4.0	20.0
	'79	2.4	3	5.0	13.0	- 6.0	0.0	0	0.0	0.0	0.0	2.1	3	0.0	1.0	- 1.0	3.0	3	0.0	2.0	8.0	3.3	4	9.0	19.0	4.0	3.3	4	7.0	14.0	3.0
	'80	2.4	3	6.0	2.0	0.0	0.0	0	0.0	0.0	0.0	2.5	3	0.0	5.0	0.0	1.5	2	0.0	4.0	2.0	3.7	4	18.0	- 6.0	0.0	3.7	4	17.0	- 3.0	0.0

TABLE F-1 Continued

		No treatment					Water					Fertilizer					Mulch					Rock					Slash				
		$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG
Coreopsis tinctoria	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.5	3	0.0	0.0	3.0	2.0	2	0.0	0.0	8.0	0.0	0	0.0	0.0	0.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gilia purpuria leptantha	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.0	3	0.0	1.5	3.0	2.0	3	0.0	1.0	5.0	2.0	2	0.0	2.0	3.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rosa woodsii	'78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	2.5	3	0.0	23.0	0.0	2.0	2	0.0	18.0	- 3.0	1.5	2	0.0	12.0	3.0	2.5	3	0.0	22.0	3.0	2.0	2	0.0	20.0	- 3.0	0.0	0	0.0	10.0	0.0
Iris (Domestic)	'78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	2.8	3	16.2	2.8	- 1.0	3.3	4	17.5	2.5	2.0	2.5	3	13.2	1.8	3.0	3.5	4	16.2	5.8	- 2.0	3.0	4	16.8	3.2	- 2.0	3.0	4	16.2	3.8	- 2.0
Lodgepole pine	'78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	3.0	4	35.5	4.5	0.0	2.2	3	15.5	3.5	6.0	1.7	2	36.0	- 4.0	4.0	0.0	0	0.0	20.0	0.0	0.0	0	0.0	28.0	0.0	0.0	0	0.0	15.0	0.0
Yarrow	'80	3.2	4	6.3	19.7	4.0	3.2	4	4.7	15.3	0.0	3.3	4	5.5	19.5	5.0	3.1	4	7.2	21.8	2.0	2.5	3	5.2	4.8	2.0	3.3	4	5.3	32.7	- 8.0
Eriogonum	'80	.3	1	4.0	- 4.0	0.0	.3	1	3.0	- 3.0	0.0	2.0	3	2.0	1.0	0.0	.3	1	3.0	- 3.0	0.0	.3	1	1.5	- 1.5	0.0	.3	1	2.0	- 2.0	0.0

$\bar{V}$ average vigor
V maximum vigor achieved
Vigor numbers: increasing numbers represent vigor with 5 = flowering and seed set.

JN = June
JL = July
AG = August

Numbers indicate new growth since previous measurement.

treatment will not be necessary.

Table F-1 refers to corn, lettuce and peas. They were planted because they grow rapidly and because their mineral nutrition is well documented. No nutrient deficiences were noted. However, it was evident that the animal life of the area regarded the plants as choice morsels.

The herbaceous species (grasses and legumes) which might be applied for initial revegetation also fared well. It appears any of them may be used without concern regarding success.

The slash treatment proved to be a problem at times because snow weight matted plants to the ground. Sawdust mulch on occasion appears to be inhibitory. The rock treatment is an enhancement. The rock channels water and reduces surface evaporation.

Table F-1 generally indicates there will be a variety of species available for revegetation, without considerable surface modification.

Table F-2 reflects the growth at the overburden site. The transplants (same as in Table F-1) tended to be most successful. The corn, peas, lettuce did not show mineral deficiency. The herbaceous seeded species established to some degree did not flourish. Surface treatments provided same and in survival, but the growth did not approximate that at Hales Gulch.

By mid-1979, it became evident that the overburden lacked the physical properties necessary for promoting good root growth. As a result, some experiments were established, incorporating amendments to encourage root growth. This will be discussed in another section of this chapter.

In terms of overall success, including numbers of surviving individuals of non-transplants, surface treatment was helpful. Once again rock on the surface was desirable.

SUCCESSION

One of the concerns is to establish the natural successional patterns. The Overburden Site had no species appear which could be attributed to seed germination on the site. By the same token, no seed was in the

TABLE P-2

SPECIES GROWTH ASSOCIATED WITH A VARIETY OF SURFACE TREATMENTS AT THE WATER TREATMENT PLANT, INDIAN CREEK (OVERBURDEN)

		No treatment				Water				Fertilizer				Mulch				Rock				Slash			
		$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG
Symphoricarpos oreophilus	'78	2.0	2	- 1.2	- 1.5	- 1.2	2.0	2	1.2	1.0	1.0	2.0	2	.5	- 1.0	- 1.0	2.0	2	- .8	- .8	- .8	2.5	3	0.0	.5	- 2.5	2.5	3	2.5	3.0	3.0
	'79	2.7	3	7.8	3.8	- .4	2.3	3	9.1	- 1.1	- .2	2.6	3	6.2	5.2	- 4.0	2.7	3	11.9	5.6	- 1.5	2.6	3	11.6	5.4	5.2	2.7	3	13.1	.5	.4
	'80	1.8	2	9.5	4.0	2.4	1.4	2	7.0	- 1.0	- .3	1.9	2	10.4	6.1	- 5.3	1.9	2	10.5	1.2	- .5	2.2	3	17.5	1.0	- .8	1.7	2	13.7	1.3	- 1.0
Fragaria ovalis	'78	2.0	2	3.5	2.5	1.5	2.5	3	3.0	3.0	3.0	2.3	3	1.2	1.2	- 8.0	3.0	4	3.7	3.7	3.7	2.5	3	2.0	2.6	2.5	2.7	3	.8	1.8	1.2
	'79	.4	2	1.0	5.0	- 2.0	.8	2	3.5	2.5	- 1.0	.6	3	2.5	2.5	- 1.0	3.0	5	4.0	2.2	- 1.7	2.8	5	4.0	3.8	- 1.0	2.1	3	3.9	3.7	- 2.3
	'80	2.7	3	5.0	2.0	- 2.0	0.0	0	0.0	0.0	0.0	2.7	3	4.0	5.0	- 3.0	2.0	3	4.0	4.0	- .5	1.7	3	4.3	- .7	- 3.0	1.0	0	2.6	3.4	- .7
Artemisia tridentata	'78	2.5	3	.5	.5	.8	2.5	3	.8	1.0	1.0	2.5	3	0.0	1.0	1.2	2.3	3	.2	.5	.5	2.5	3	.2	.6	.8	3.8	4	10.5	18.5	18.5
	'79	1.5	3	14.5	2.5	1.0	2.8	3	11.1	1.7	6.8	2.9	3	15.4	5.8	7.6	2.9	3	14.8	5.0	1.0	3.0	3	15.1	3.7	2.4	1.1	3	10.0	.5	1.0
	'80	2.3	3	12.0	3.7	- .7	2.8	3	12.5	2.5	.2	3.0	3	21.5	6.0	- 1.8	2.3	3	19.8	6.7	.7	1.7	3	23.5	.2	.5	1.8	2	11.5	5.0	.5
Chaenactis douglasii	'78	3.5	5	20.0	33.0	37.0	2.5	3	11.0	11.0	11.0	0.0	0	2.0	3.0	2.0	3.5	5	20.0	21.0	29.0	3.8	5	24.0	30.0	30.0	0.0	0	1.0	3.0	0.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex foenea	'78	3.8	4	10.0	.3	13.0	3.3	4	4.0	7.0	7.0	3.0	3	11.0	16.0	13.0	3.3	4	9.0	12.0	11.0	2.5	3	13.0	18.0	16.0	2.3	3	-10.0	- 8.0	-10.0
	'79	4.3	5	15.0	1.2	1.6	.9	3	7.5	13.5	0.0	3.2	5	17.7	8.3	- 3.7	3.8	5	15.2	3.8	2.5	1.7	5	13.5	8.5	1.0	2.1	3	11.3	6.7	- 1.7
	'80	2.4	3	19.5	2.2	- .5	2.3	3	19.0	- 1.0	-10.0	2.4	3	20.0	6.3	- 5.6	1.7	2	15.7	5.0	5.8	1.7	2	16.0	6.0	3.5	1.9	3	9.3	6.7	- 2.7
Antennaria sp.	'78	2.8	4	1.4	- 1.8	- .7	3.8	4	.8	- 2.5	0.0	2.8	3	1.0	- 2.0	- .7	2.5	3	0.0	- .5	- .5	3.8	4	2.6	- 1.1	- .5	2.5	3	- .5	.5	- .5
	'79	2.8	5	2.8	2.9	- 2.7	3.2	5	5.5	1.0	- 2.0	2.7	5	3.5	3.5	- 4.0	3.5	5	3.1	2.7	- 1.6	4.4	5	4.1	3.7	- 4.6	2.0	3	2.2	.8	.3
	'80	2.8	3	3.0	3.0	- 3.3	2.5	3	4.2	3.3	- 4.0	1.7	3	4.3	2.4	- 3.7	2.2	3	4.7	3.0	- 3.2	2.1	3	2.5	3.0	- 2.3	1.7	2	5.0	- 1.7	- 1.0
Penstemon strictus	'78	3.8	5	20.1	21.0	20.0	4.0	5	18.0	22.0	22.0	3.0	4	13.0	15.0	15.0	3.5	4	16.0	19.0	21.0	3.0	4	18.0	26.0	24.0	1.5	0	2.0	2.0	2.0
	'79	3.3	3	3.8	12.5	- 1.3	3.5	5	15.5	1.7	- 5.0	2.1	5	3.5	8.5	- 2.0	2.4	5	8.5	11.3	- 7.8	2.1	5	3.0	5.0	- .7	.750		3.8	- .8	- 1.0
	'80	2.6	3	9.0	28.0	-10.3	2.0	3	4.5	13.7	3.8	3.0	4	10.5	34.5	- 2.0	1.7	3	4.2	18.1	- 7.6	1.9	4	6.2	14.0	.8	1.0	1	0.0	3.0	- .5
Abies concolor	'78	1.8	3	- 2.0	- 1.0	0.0	2.8	2	0.0	1.0	2.0	2.5	3	0.0	1.0	1.0	2.5	3	0.0	3.0	3.0	2.5	3	0.0	3.0	1.0	2.0	2	- 2.0	1.0	2.0
	'79	1.2	3	12.3	0.0	.4	2.4	3	12.2	1.1	1.0	1.9	3	16.0	2.5	2.3	2.8	3	17.8	- .3	1.2	1.8	3	21.2	.3	.3	2.1	3	13.4	1.4	- .1
	'80	2.0	3	8.0	3.0	- 2.5	1.7	3	14.3	1.5	1.6	2.6	4	18.7	2.5	.8	2.2	4	18.5	1.0	1.7	2.3	4	21.0	.7	.3	1.7	3	14.2	.2	1.6

TABLE F-2 Continued

		No treatment				Water				Fertilizer				Mulch				Rock				Slash			
		V̄	V	JN	JL	AG	V̄	V	JN	JL	AG	V̄	V	JN	JL	AG	V̄	V	JN	JL	AG	V̄	V	JN	JL	AG	V̄	V	JN	JL	AG
Juniperus virginiana	'78	2.3	3	- .8	3.8	4.5	2.5	3	- 2.0	1.0	4.0	2.5	3	2.5	1.2	1.5	2.5	3	- 2.0	3.0	2.5	2.3	3	2.0	6.0	2.5	2.5	3	- 1.0	2.0	1.0
	'79	2.8	3	16.0	2.2	- .2	2.9	3	16.8	2.4	2.2	2.7	3	17.2	1.3	1.7	2.9	3	18.0	1.2	.6	2.9	3	14.2	2.8	.2	2.5	3	15.8	2.6	.6
	'80	1.8	3	15.7	3.5	- .2	1.8	3	19.0	2.2	1.6	2.2	3	18.0	6.0	0.0	2.2	3	19.0	3.2	1.4	1.7	3	14.6	2.3	.2	1.6	3	15.6	3.0	1.2
Pinus ponderosa	'78	2.0	2	- 1.0	4.0	.2	2.0	2	- 3.0	4.5	4.5	2.0	2	- .5	6.0	9.0	2.0	2	- 3.5	1.0	2.0	1.8	2	- 6.5	1.5	1.0	2.0	2	- 6.0	3.0	6.0
	'79	2.6	3	12.8	2.7	3.3	2.7	3	16.2	4.6	2.8	2.6	3	13.2	8.8	5.2	2.4	3	20.4	- .6	2.6	2.7	3	18.2	1.2	2.2	2.8	3	22.3	2.0	4.4
	'80	1.7	2	29.5	2.5	- 2.0	1.8	3	29.2	1.4	1.2	2.1	3	36.2	4.0	- .5	1.9	3	26.2	2.2	- 1.4	2.0	3	27.7	- 2.3	.4	2.2	3	28.2	3.4	- 1.4
Pseudotsuga menziesii	'78	1.8	2	- 1.0	3.5	8.0	2.3	3	- 3.5	3.5	5.0	2.0	2	0.0	4.0	6.0	2.3	3	.5	3.0	12.5	2.3	3	- 2.0	2.0	3.0	2.0	2	- 1.0	4.5	6.0
	'79	2.7	3	20.2	.4	8.9	2.5	3	20.0	2.7	3.0	2.9	3	17.8	3.9	6.3	2.9	3	21.3	4.0	0.0	2.7	3	20.8	1.2	3.2	2.7	3	19.0	2.0	1.2
	'80	2.0	3	31.0	- .7	2.9	1.6	2	22.0	2.5	6.0	1.9	3	32.0	- 2.3	3.1	2.1	3	21.0	5.5	3.2	2.3	3	26.2	- .2	3.3	2.0	3	28.0	- .8	7.6
Agropyron trichophorum	'78	.7	1	0.0	4.0	6.0	0.0	0	0.0	0.0	0.0	1.7	2	4.0	3.3	3.3	1.7	2	6.0	4.0	2.0	2.0	2	6.0	7.0	6.0	1.7	2	5.0	4.0	2.0
	'79	3.0	0	4.0	0.0	0.0	0.0	0	0.0	0.0	0.0	3.0	0	4.0	0.0	0.0	1.0	0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-
	'80	1.3	2	6.0	1.0	8.0	0.0	0	0.0	0.0	0.0	2.2	3	9.6	15.4	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
Yellow Sweet Corn	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.3	2	1.0	2.0	2.0	1.3	2	2.0	0.0	1.0	1.3	2	.5	0.0	0.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corn Sunglow	'78	.7	1	0.0	4.0	6.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.0	2	3.8	7.5	6.0	2.0	2	6.3	10.2	8.4	2.0	2	5.6	9.2	6.6
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Little Marvel Peas	'78	1.7	3	0.0	2.4	6.3	0.0	0	0.0	0.0	0.0	1.3	2	3.5	6.0	5.1	1.3	2	3.6	8.6	6.2	0.0	0	0.0	0.0	0.0	1.7	2	4.0	5.0	3.0
	'79	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
	'80	0.0	0	0.0	0.0	0.0	0.0	1	0.0	5.0	2.0	2.2	3	0.0	4.5	21.5	1.0	1	0.0	7.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
Red Top	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.3	2	0.0	1.0	2.0	.7	2	0.0	1.0	0.0
	'79	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
	'80	0.0	0	0.0	0.0	0.0	1.0	1	4.0	0.0	0.0	1.3	2	3.0	0.0	4.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0

TABLE F-2 Continued

		No treatment					Water					Fertilizer					Mulch					Rock					Slash				
		V	V	JN	JL	AG	V	V	JN	JL	AG	V	V	JN	JL	AG	V	V	JN	JN	AG	V	V	JN	JL	AG	V	V	JN	JL	AG
Agropyron smithii	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	.7	1	0.0	4.0	4.0	0.0	1	0.0	0.0	0.0	0.0	2	0.0	2.0	2.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hilaria jamesii	'78	1.0	2	0.0	2.0	2.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.0	2	0.0	1.0	2.0	1.3	2	0.0	2.0	2.0	.7	2	0.0	2.0	0.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Penstemon palmeri	'78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	0.0	0	0.0	0.0	0.0	1.5	2	1.5	1.0	1.5	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
Meadow Foxtail	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.3	2	0.0	2.5	1.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	0.0	0	0.0	0.0	0.0	1.0	1	3.0	0.0	0.0	1.6	2	3.7	4.8	15.5	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
Alfalfa Ladak	'78	2.0	2	0.0	1.0	1.0	.7	1	0.0	.5	1.0	2.0	2	1.0	2.0	1.0	2.0	2	1.0	1.0	2.0	2.0	2	1.0	2.0	2.0	2.0	2	1.0	2.0	3.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	1.0	1	3.0	0.0	2.0	1.3	2	5.0	5.0	4.0	1.7	2	4.0	8.0	8.0	1.0	1	3.0	7.0	0.0	1.9	2	8.5	18.5	-12.0	1.7	2	6.8	13.2	- 5.0
Indian Ricegrass	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.0	2	0.0	5.0	4.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0	1	3.6	4.4	2.0	1.0	1	3.0	5.0	- 2.0
	'80	1.0	1	3.0	0.0	2.0	1.3	2	5.0	5.0	4.0	1.7	2	4.0	8.0	8.0	1.0	1	3.0	7.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
Climax Timothy	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.7	2	1.0	1.0	1.0	1.3	2	0.0	2.0	2.0	1.3	2	0.0	1.0	2.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	1.5	2	2.0	4.0	- 1.0	1.6	2	0.0	4.7	.3	2.1	3	4.5	1.0	4.5	0.0	0	0.0	0.0	0.0	1.7	2	5.5	1.5	1.0	0.0	0	0.0	0.0	0.0
Alfalfa Nomad	'78	2.0	2	2.0	1.0	1.0	1.3	2	0.0	1.0	2.0	1.3	2	0.0	1.0	1.0	2.0	2	1.0	1.0	3.0	2.0	2	0.0	2.0	2.0	1.3	2	0.0	1.0	2.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	2.5	3	9.2	16.8	- 6.0	1.7	2	4.0	6.0	0.0	3.0	3	11.5	10.5	-10.0	2.1	3	5.3	9.7	- 4.0	3.1	4	10.1	21.9	0.0	3.1	4	10.8	19.2	0.0

TABLE F-2 Continued

		No treatment						Water						Fertilizer						Mulch						Rock						Slash			
		$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG
Rye	'78	1.0	2	0.0	4.0	3.0	1.0	2	0.0	3.0	3.0	1.0	1	0.0	7.0	0.0	1.7	2	6.0	5.0	3.0	1.3	0	0.0	4.0	5.0	1.3	2	0.0	4.0	3.0					
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	0.0	0	0.0	0.0	0.0	1.5	2	11.0	6.0	0.0	1.5	2	5.0	9.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0					
Pennlan	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.0	2	0.0	2.0	1.0	0.0	0	0.0	0.0	0.0	1.3	2	0.0	2.0	2.0					
Creeping	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Red Fescue	'80	1.0	1	3.0	.3	1.7	1.0	1	2.0	0.0	0.0	2.0	3	3.0	4.0	0.0	0.0	0	0.0	0.0	0.0	1.1	2	5.0	1.0	0.0	0.0	0	0.0	0.0	0.0					
Hard Fescue	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.7	2	1.0	1.0	1.0	0.0	0	0.0	0.0	0.0	2.0	2	0.0	2.0	1.0					
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	1.0	1	2.0	3.0	2.7	1.0	1	2.0	.7	1.3	1.5	2	3.0	0.0	3.0	0.0	0	0.0	0.0	0.0	1.0	1	4.0	3.0	0.0	0.0	0	0.0	0.0	0.0					
White Dutch	'78	1.0	2	0.0	4.0	0.0	1.0	2	0.0	4.0	0.0	2.0	2	0.0	1.0	1.0	2.0	2	0.0	1.0	2.0	2.0	2	0.0	1.0	1.0	1.7	3	0.0	2.0	2.0					
Clover	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	0.0	0	0.0	0.0	0.0	3.0	3	13.0	0.0	17.0	2.5	3	6.0	0.0	8.0	2.3	3	6.3	0.0	3.7	2.0	3	4.0	0.0	3.0	2.3	3	7.6	0.0	7.4					
Manchar	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.0	2	0.0	3.0	1.0	0.0	0	0.0	0.0	0.0	2.0	2	0.0	1.0	2.0					
Bromegrass	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	1.6	2	6.3	1.5	2.2	1.8	3	5.1	2.3	2.6	1.8	3	6.0	4.5	- .5	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0					
Russian	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.0	2	0.0	2.0	1.0	2.0	2	0.0	3.0	1.0	2.0	2	0.0	3.0	3.0					
Wild Rye	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	1.0	1	0.0	3.0	0.0	1.6	2	3.7	1.3	0.0	1.0	1	0.0	1.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0					
Smoothbrome	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.0	2	0.0	4.0	2.0	1.0	2	0.0	0.0	3.0	2.0	2	0.0	3.0	2.0					
Lincoln	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	2.0	2	0.0	8.8	.2	1.8	2	2.2	- .2	0.0	1.8	3	4.5	2.5	3.0	0.0	0	0.0	0.0	0.0	1.0	1	5.0	0.0	0.0	0.0	0	0.0	0.0	0.0					
Meadow	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.7	2	3.0	2.0	1.0	1.0	2	0.0	0.0	7.0	2.3	2	0.0	3.0	3.0					
Brome	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	1.7	2	3.5	3.5	3.0	1.6	2	4.2	1.3	- .5	2.0	3	4.9	5.8	1.3	0.0	0	0.0	0.0	0.0	1.0	1	10.5	0.0	0.0	0.0	0	0.0	0.0	0.0					

TABLE F-2 Continued

		No treatment				Water				Fertilizer				Mulch				Rock				Slash			
		V	V	JN	JL	AG	V	V	JN	JL	AG	V	V	JN	JL	AG	V	V	JN	JL	AG	V	V	JN	JL	AG
Bouteloua gracilis	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.0	2	0.0	1.0	1.0	0.0	0	0.0	0.0	0.0	1.0	2	0.0	1.0	0.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Western Wheatgrass	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.0	2	0.0	3.0	2.0	0.0	0	0.0	0.0	0.0	1.0	2	0.0	2.0	0.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	1.7	2	7.0	3.0	10.0	1.7	2	4.4	4.6	1.0	2.7	3	10.0	5.0	6.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
Standard Crested Wheatgrass	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.0	2	0.0	4.0	1.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lettuce Grand Rapids	'78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'79	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.0	2	0.0	1.0	0.0
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sporobolus sp.	'78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	1.3	2	3.2	2.8	- 1.0	1.3	2	3.2	3.8	- 1.0	3.0	3	9.1	10.9	- 5.0	0.0	0	0.0	0.0	0.0	2.0	2	5.1	5.5	4.4	0.0	0	0.0	0.0	0.0
Potomac Orchardgrass	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.0	2	0.0	2.5	2.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	1.7	2	3.3	2.0	4.7	1.7	2	5.0	2.0	0.0	2.7	3	3.5	5.5	6.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
Long-tall Wheatgrass	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.0	2	0.0	3.0	0.0	2.0	2	0.0	4.0	4.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Muhlenbergia montana	'78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	1.0	1	3.1	1.9	2.0	1.0	1	2.5	2.5	3.0	2.7	3	3.4	12.6	- 4.0	0.0	0	0.0	0.0	0.0	2.0	2	5.1	5.5	4.4	0.0	0	0.0	0.0	0.0

TABLE F-2 Continued

		No treatment					Water					Fertilizer					Mulch					Rock					Slash				
		$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG
Agropyron cristatum	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.0	2	0.0	2.0	2.0	2.0	2	0.0	4.0	2.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	1.0	1	3.2	3.8	2.0	1.3	2	4.2	2.8	- 1.0	2.3	3	6.0	8.0	- 2.0	0.0	0	0.0	0.0	0.0	1.0	1	4.0	- 1.0	2.0	0.0	0	0.0	0.0	0.0
Elymus cinereus	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.0	1	1.0	1.0	1.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	1.0	1	3.7	3.3	1.0	1.0	1	2.9	3.1	0.0	2.3	3	4.0	7.0	6.0	0.0	0	0.0	0.0	0.0	1.0	1	4.3	0.0	0.0	0.0	0	0.0	0.0	0.0
Agropyron dasystachyum	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.0	1	0.0	2.0	1.0	1.0	1	0.0	1.0	3.0	2.0	2	0.0	2.0	3.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eschscholzia California Orange	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.0	2	0.0	1.5	0.0	2.0	2	0.0	1.0	0.0	1.0	2	0.0	2.0	0.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	1.3	2	1.7	6.3	- 2.0	1.3	2	3.7	.3	1.0	1.5	2	2.8	1.9	2.3	0.0	0	0.0	0.0	0.0	1.0	1	3.7	0.0	0.0	0.0	0	0.0	0.0	0.0
Agropyron elymus	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.0	1	0.0	1.0	1.0	1.5	2	0.0	1.5	1.0	1.5	2	0.0	3.5	1.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	1.7	2	1.7	1.8	.5	1.3	2	2.2	1.5	- .7	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
Penstemon strictus	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	.5	1	0.0	1.0	1.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Helianthus annus	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.0	2	0.0	1.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Epilobium angustifolium	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.0	2	0.0	1.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE F-2 Continued

		No treatment					Water					Fertilizer					Mulch					Rock					Slash				
		$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG	$\bar{V}$	V	JN	JL	AG
Gilia purpuria leptantha	'78	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	2.0	2	0.0	1.0	3.0
Iberis semperfloris	'78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	0.0	0	0.0	0.0	0.0	1.5	2	2.0	1.5	0.0	1.9	2	2.5	2.2	5.3	0.0	0	0.0	0.0	0.0	1.0	1	2.0	0.0	0.0	0.0	0	0.0	0.0	0.0
Iris (Domestic)	'78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	1.4	2	10.2	.5	1.6	1.8	2	4.3	1.7	.5	1.4	2	7.7	1.7	.3	1.9	2	9.0	1.5	0.0	1.6	2	6.4	.8	3.8	1.8	3	18.0	- 8.3	10.3
Juniperus communis	'78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	'80	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	1.5	2	10.0	0.0	0.0

$\bar{V}$ average vigor
V maximum vigor achieved
Vigor numbers: increasing numbers represent vigor with 5 = flowering and seed set.

JN = June
JL = July
AG = August

Numbers indicate new growth since previous measurement.

substrate and any seed on the site needed to be carried from neighboring habitats.

At the Hales Gulch Site, the surface was a homogeneous continuous cover of Androsace septentrionalis. In 1979, species composition became more diversified (Table F-3). Fifteen one square meter plots were distributed outside of the planted area and sampled (Table F-4). Another sampling of another fifteen plots a month later indicated a further development (Table F-5).

The data reflects a healthy situation in which a successional pattern of immediate increasing diversification is evident at what most closely simulates the tailings pond surface.

OVERBURDEN SOIL AMENDMENTS

In mid-1979, when it became evident the overburden substrate was going to provide an inhospitable physical environment, a series of experiments were designed to determine if root development might be enhanced.

Originally the experiment was established using various soil amendments at the Overburden Site, using the alpine grass mix (Table B-1), and at the Hale Gulch Site, using the mountain mix (Table B-1). The reason for using the Hales Gulch Site was to rule out the mixes as being toxic. This portion of the experiment was abandoned after it was set up. All plots had vigorous growth which was eliminated by "rodent-mowers". Regrowth continued to be eliminated, but it did answer our question regarding toxicity. The plots will be reseeded in 1981 to determine if the decomposition process has any toxic principals.

TABLE F-3

SPECIES LIST - SPECIES ENCOUNTERED INSIDE SAGE SITE - 1979

Achillea lanulosa
Androsace septentrionalis
Antennaria sp.
Arabis holboellii
Arctostaphylus uva-ursi
Arenaria congesta
Artemisia frigida
A. scopulorum
A. tridentata
Astragalus sp.
Campanula parryi
C. rotundifolia
Carex sp.
Chaenactis douglasii
Chrysothamnus viscidiflorus
C. nauseosus
Collomia linearis
Corydalis aurea
Epilobium angustifolium
Erigeron sp.
Eriogonum subalpinum
E. umbellatum
Fragaria ovalis
Galium boreale
Gayophytum ramosissimum
Ipomopsis aggregata
Juniperus communis
Linum lewisii
Lupinus argenteus
Mentha arvensis
Mertensia lanceolata
Orthocarpus luteus
Penstemon rydbergia
P. strictus
Phlox multiflora
Pinus ponderosa
Potentilla sp.
Prunus virginiana
Pseudocymopterus montanus
Purshia tridenta
Rosa woodsii
Sedum lanceolatum
Symphoricarpos orcophilus
Taraxacum sp.
Tetradymia canescens
Thermopsis montana

TABLE F-4

INTRUDERS WITHIN THE SAGE SITE JUNE 18, 1979

SPECIES	FREQUENCY (%)	DENSITY No./m	COVERAGE (%)
Gayophytum ramosissimum	100	325.7	20.3
Lupinus argenteus	93	5.0	11.0
Taraxacum	80	4.1	9.2
Grasses	67	2.1	5.0
Androsace septentrionalis	47	2.0	3.0
Mertensia lanceolata	40	1.0	4.3
Campanula rotundifolia	40	2.6	2.3
Unknown #1	33	8.5	1.7
Artemisia tridentata	33	.7	2.3
Chrysothamnus nauseosus	27	.3	2.0
Carex sp.	27	1.0	2.0
Arabis holboellii	20	.3	1.0
Potentilla fruticosa	20	.3	1.7
Phlox multiflora	13	.2	.7
Astragalus sp.	13	1.1	1.5
Orthocarpus luteus	13	7.0	1.7
Antennaria sp.	7	.1	.3
Achillea lanulosa	7	1.0	1.3
Thermopsis montana	7	.3	.3
Rosa woodsii	7	.1	.2

TABLE F-5

INTRUDERS WITHIN THE SAGE SITE JULY 23, 1979

SPECIES	FREQUENCY (%)	DENSITY No./m	COVERAGE (%)
Gayophytum ramosissimum	100	99.9	5.6
Lupinus argenteus	100	3.0	10.1
Taraxacum	73	2.9	9.1
Unknown #1	60	37.0	3.7
Campanula rotundifolia	53	2.8	3.7
Artemisia tridentata	47	1.3	1.7
Mertensia lanceolata	47	1.0	2.2
Carex sp.	33	1.0	1.3
Erigeron sp.	33	.9	2.7
Orthocarpus luteus	27	.8	.5
Chrysothamnus nauseosus	27	.3	1.7
Arabis holboellii	27	.3	.3
Androsace septentrionalis	27	.5	1.1
Collomia linearis	20	1.1	.9
Potentilla sp.	20	.3	2
Arenaria congesta	20	.3	.8
Astragalus sp.	13	.8	1.4
Phlox multiflora	13	.6	.8
Ipomopsis aggregata	7	.1	.5
Rosa woodsii	7	.1	.2
Penstemon rydbergia	7	.1	.3
Galium boreale	7	.3	.3
Thermopsis montana	7	.1	.3

Figure F-1 indicates the pattern of plot installation at the Overburden Site. Plot Group A (Figure F-1) is one meter square and 20 cm. deep. They were filled in 1980 with an "ideal" soil mix consisting of "Biogas" sludge, cow manure, hay, and fertilizer at rates of 2 tons/acre, 20 tons/acre, 5 tons/acre, and 200 lbs/acre, respectively. Amendment components were put into a wheelbarrow, by weight, mixed and put into the appropriate pit. Alpine seed mix (Table B-1) was seeded on 20 June, 1980 and 6 August, 1980 at a rate of 10 g. per plot. Group A was not monitored in 1980 because of limited germination.

Group B (Figure F-1) consisted of 64 plots which were .5 m. and 20 cm. deep. Table F-6 indicates rate of application of amendment components. Table F-7 indicates how each plot was treated and when the plot was initiated. The mixes were placed into plastic-lined pits, to ensure no interaction with the neighboring soil environment. Table F-8 lists the species found in the plots. Table F-9 reports the 1980 monitoring data.

Figure F-2 indicates the establishment of Group C and D plots, immediately adjacent to the plots shown in Figure F-1. Group C represents a surface application of sewage sludge. Group D represents a surface application of topsoil from the Hales Gulch test site.

Sewage sludge plots had virtually no growth in 1979. The 1980 data is shown in Table F-10. The exclusive use of sewage sludge on the surface does not appear encouraging.

Group D (topsoil application) was instituted in 1980. Insufficient progress was noted, but one may assume a more positive result, as opposed

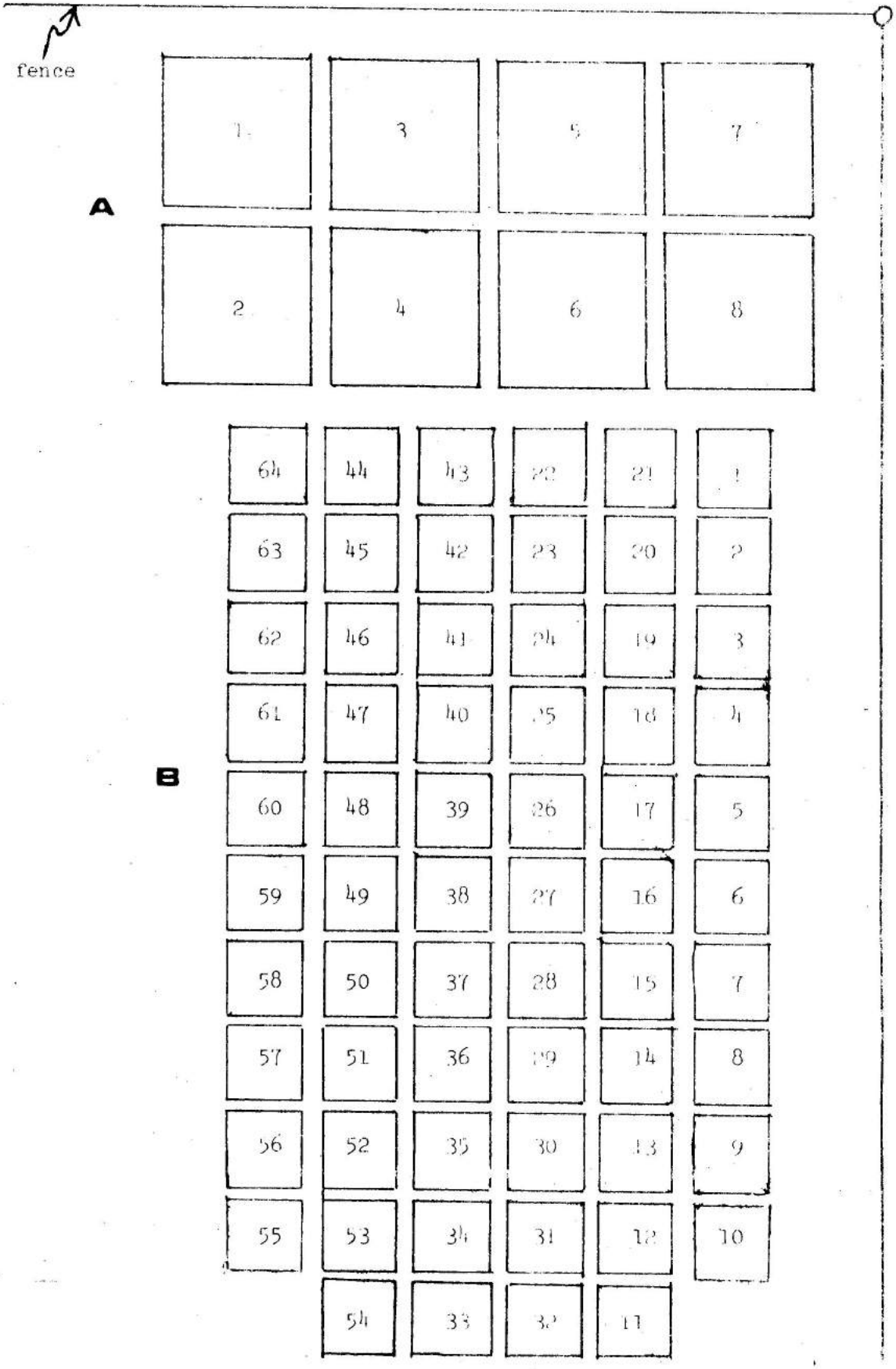


Figure F-1. Soil amendment test plots at Water Treatment Plant (Overburden). A = meter squares, B = one half meter squares.

TABLE F-6

Water Treatment Test Plot
Soil Amendment Application Rates

Amendment	1979		1980	
	dry weight equivalent (tons/acre)	amount per pit pounds/½ m^2 (wet weight)	approx. dry weight equivalent (tons/acre)	amount per pit (pounds/½ m^2)(wet weight)
Hay	-	-	5	0.5
Sawdust=saw	30	2.5	-	-
Cow manure=cm	25	3.1	30	1.5
Sewage sludge =sl	30	3.7	-	
Fertilizer (20-20-10) =fr.	200 lb.		200 lb.	
Biogas sludge = bs	-	-	2 (liquid)	1 qt. liquid @1:10 dilution

TABLE F-7

Water Treatment Test Plots
Group B (64 Plots)

Pit Number	Amendment mix	Date(s) Seeded
1		
2	sl	1979[1]
3	sl, saw, cm	1979
4	sl, saw	1979
5	sl, cm, fr	1979
6	saw, fr	1979
7	saw, cm, fr	1979
8	bg, hay	1980[2]
9	cm, fr	1979
10	sl, cm	1979
11		
12	sl, saw, cm	1979
13	sl	1979
14	sl, cm, fr	1979
15	sl	1979
16	fr	1979
17	bg, cm	1980
18	bg	1980
19	sl, saw, fr	1979
20	cm	1979
21	fr	1979
22	saw, fr	1979
23	fr	1980
24	fr	1980
25	bg	1980
26		
27		
28		
29	bg	1980
30	bg, cm	1980
31		
32		
33	saw, cm, fr	1979
34		
35		
36		
37	sl, cm, fr	1979
38		
39	sl, cm	1979
40	sl, fr	1979
41		
42	bg & cm	1980
43	sl, saw, cm, fr	1979
44	sl, fr	1979
45		
46	sl	1979
47		
48	cm, fr	1979
49		
50		
51	sl, cm, fr	1979
52	sl, saw, fr	1979
53	sl, saw	1979
54	bg, cm	1980
55	cm	1979
56	sl, cm	1979
57		
58	sl, cm	1979
59	sl	1979
60		
61	bg & hay	1980
62	sl, fr	1979
63		
64		

[1] 1979 plots seeded with Mountain mix and Alpine mix on same date

[2] 1980 plots seeded with Alpine mix June 20, 1980; Mountain mix Aug. 1980

TABLE F-8

SPECIES OCCURRING IN SOIL AMENDMENT TEST PLOTS (OVERBURDEN)

SPECIES:

1. Winter rye (Secale cereale)
2. Red fescue (Festuca rubra)
3. Smoothbrome (Bromus inermis)
4. Cicer milkvetch (Astragalus cicer)
5. Alsike clover (Trifolium hybridum)
6. Perennial ryegrass (Lolium perenne)
7. Unknown composite
8. Unknown mustard
9. Unknown grasses
10. Kentucky bluegrass (Poa pratensis)
11. Hard fescue (Festuca ovina var. duriscula)
12. Timothy (Phleum pratense)
13. Creeping foxtail (Alopecurus arundinaceus)
14. Chaenactis douglasii
15. Dandelion (Taraxacum sp.)
16. Unknown white mustard

TABLE F-9

RESULTS OF 1980 MONITORING OF GROUP BPLOTS (64 plots)

Plot No.	Species No.	Average Height		Average Vigor		Percent Cover		Percent Bare Ground		Flowering or Fruiting stems present		Oven Dry Weight	
		6/24	7/18	6/24	7/18	6/24	7/18	6/24	7/18	6/24	7/18	Species No.	Weight (grams)
	1	17	20	2	1	2.5	1	90	98	X		1	0.1
2	10	4		1		2.5							
	3	3		1		2.5							
	1	48	84	3	3	2.5	1	90	95	X	X	1	1.9
	10	12	30	1	3	2.5	1			X		4	0.1
3	3	7	6	1	2	2.5	1					3	0.2
	5	2	.5	1	1	2.5	1				X	9	0.3
	11	8	8	2	1	2.5	1						
	12	3.5	10	2	2	2.5	1				X		
	1	50	65	3	3	15.0	5.0	82	85	X	X	1	4.4
	5	1	1	1	1	2.5	1.0						
4	11	6	13	2	2	2.5	1.0			X	X		
	10	7	18	1	2	2.5	1.0			X	X		
	1	20	65	2	2	2.5	1.0	82	75		X	1	1.4
	5	6	2	2	1	15.0	2.0					4	13.6
5	11	14	10	2	2	2.5	1.0					5	0.3
	8	3	5	1	2	2.5	3.0					9	1.8
	13	18	17	2	2	2.5	2.0						
	3	7	8	2	1	2.5	5.0						
	1	25	69	1	2	2.5	1	90	97	X	X	1	2.5
	11	4	5	1	1	2.5	1					4	8.2
6	3	4	9	1	1	2.5	1					5	0.2
	5	1.5	.5	1	1	2.5	1						
	1	55	55	3	3	15.0	5	62	70	X	X	1	14.2
	10	15		2		2.5				X			
7	5	15	4	2	1	2.5	1				X		
	13	14	0	2		2.5							
	3	4	20	1	3	2.5	2						
	1	50	50	3	3	15.0	5.0	82	80	X	X		
9	3	16	15	2	2	2.5	2.5				X		
	5	4		1		2.5							
	10	19	25	2	3	2.5	2.5				X		
	11	12	10	1	2	2.5	1.0			X	X		
10	1	17	25	1	1	2.5	1.0	90	95	X	X		
	5	1	1	1	1	2.5	1.0						
	1	40	55	2	3	15.0	20.0	62	75	X	X		
	5	3	2	1	1	2.5	2.0					1	5.3
12	13	10	8	1	1	2.5	1.0						
	10	5		1		2.5							
	3	9	9	1	1	2.5	1.0						
	5	2	1	1		2.5	1.0	90	98				
13	10	9	5	1		2.5	1.0					1 5 9	5.0 0.2 0.1

TABLE F-9 Continued

Plot No.	Species No.	Average Height		Average Vigor		Percent Cover		Percent Bare Ground		Flowering or Fruiting stems present		Oven Dry Weight	
		6/24	7/20	6/24	7/18	6/24	7/18	6/24	7/18	6/24	7/18	Species No.	Weight (grams)
	1	35	65	3	3	15.0	10.0	62	80	X	X	1	18.3
	5	4	1	2	1	2.0	1.0					9	0.7
14	13	7	11	1	2	2.0	2.0					4	0.4
	10	7	8	1	1	2.0	1.0						
	1	55	85	3	3	37.0	25.0	62	65	X	X		
15	5	4	7	1	2	2.5	1.0					9	0.2
	3	8	9	2	1	2.5	1.0						
	11	9	7	1	1	2.5	1.0						
	10	3	8	1	1	2.5	1.0						
	1	15	27	1	2	2.5	1.0	90	95		X		
	3	6		1		2.5						9	0.8
16	11	7	10	1	1	2.5	1.0						
	10	4	12	1	1	2.5	1.0						
	1	55	90	3	3	15.0	5.0	82	93	X	X	1	9.5
	5	2	2	2	1	2.5	1.0						
19	3	9	8	1	1	2.5	1.0						
	1	25	30	2	2	2.5	5.0	90	90	X	X	1	12.7
	5	2	2	1	1	2.5	1.0					5	0.1
20	3	5	10	1	1	2.5	1.0						
	10	4		1		2.5							
	1	45	80	3	3	2.5	2	90	95	X	X	1	10.6
21	11	6	13	1	2	2.5	1						
	10	5		1		2.5							
	1	30	30	2	1	2.5	2	90	97	X	X	4	6.4
33	3	7	9	1	2	2.5	1						
	10	5		1		2.5							
	1	27	55	2	2	2.5	5	90	90	X	X	1	1.4
39	5	1	1	1	1	2.5	1				X		
	10	6		1		2.5							
	3	7	6	1	2	2.5	1				X		
	1	30	55	2	2	2.5	5	90	90		X		
40	3	8	8	1	2	2.5	1						
	1	35	58	3	2	15.0	15	37	50	X	X		
	3	12	7	2	1	15.0	15						
42	13	8	12	2	2	2.5	5						
	10	8	12	2	2	2.5	1						
	5	2	6	2	2	15.0	15						

TABLE F-9 Continued

Plot No.	Species No.	Average Height		Average Vigor		Percent Cover		Percent Bare Ground		Flowering or Fruiting stems present		Oven Dry Weight	
		6/24	7/18	6/24	7/18	6/24	7/18	6/24	7/18	6/24	7/18	Species No.	Weight (grams)
	1	38	70	3	3	15.0	1	82	85	X	X	1	10.1
43	3	10	20	2	3	2.5	1					3	3.6
	10	20	41	3	3	2.5	1						
	1	38	85	3	3	15.0	5	82	85	X	X	1	6.2
	5	4	4	2	2	2.5	1					4	0.7
44	3	15	14	2	2	2.5	1					9	0.2
	11	7	10	2	2	2.5	1						
	10	3	5	1	1	2.5	1						
	1	35	70	3	3	15.0	5	62	85	X	X	1	5.0
	5	2	9	1	2	2.5	1					9	0.4
46	3	10	30	2	2	2.5	1					4	0.1
	10	4	9	1	2								
	1	30	75	3	3	2.5	5	62	80	X	X	1	3.9
48	5	1	2	1	1	2.5	1					4	1.1
	16	14		3		2.5	1						
	10	14	15	2	1	2.5	1			X			
	13	10	14	2	1	2.5	1						
	3	10	9	1	1	2.5	1						
	11	6	9	1	1	2.5	1						
	1	18	20	1	1	2.5	1	90	95			1	3.8
50	5	1	1	1	1	2.5	1					5	0.1
	3	6	8	1	1	2.5	1					9	0.5
	10	5	7	1	1	2.5	1					3	0.3
51	1	35	50	3	3	15.0	5	62	90	X	X	1	6.1
	5	3	7	1	2	2.5	1					9	5.4
	10	12	15	2	2	2.5	1						
	13	10	11	2	2	2.5	1						
	11	10	9	2	2	2.5	1						
52	1	50	100	3	3	2.5	5	62	85	X	X	1	3.1
	5	5	3	3	2	15.0	2					5	0.7
	13	15	19	2	2	2.5	1					9	0.1
	11	9	13	2	1	2.5	1						
	10	10	9	2	1	2.5	1						
53	1	40	100	3	3	15.0	10	62	80	X	X	1	0.6
	5	2	3	1	2	2.5	2						
	10	4	8	1	2	2.5	1						
	11	8	10	1	2	2.5	1						
	13	8	6	1	2	2.5	1						
	3	16	-	1	2	2.5	2						

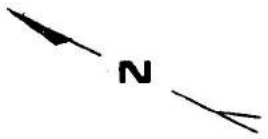
TABLE F-9 Continued

Plot No.	Species No.	Average Height		Average Vigor		Percent Cover		Percent Bare Ground		Flowering or Fruiting stems present		Oven Dry Weight	
		6/24	7/18	6/24	7/18	6/24	7/18	6/24	7/18	6/24	7/18	Species No.	Weight (grams)
55	1	30	50	2	2	15.0	5	82	90	X	X		
	5	1	2	1	1	2.5	1						
	3	7	7	1	1	2.5	1						
	10	5	6	1	1	2.5	1						
56	1	45	95	3	3	15.0	5	37	80	X	X		
	13	20	15	3	3	2.5	2						
	10	15	-	3	-	2.5	-			X		9	0.1
	11	14	18	1	3	2.5	3						
	5	2	-	1	-	2.5	-						
	3	8	15	1	3	2.5	1						
58	1	40	90	3	3	2.5	5	82	90	X	X	1	6.6
	5	10	19	3	3	2.5	2					9	1.7
	11	10	20	1	2	2.5	1						
	13	20	12	3	2	2.5	1						
	10	16	15	3	2	2.5	1						
59	1	20	52	2	2	2.5	1	90	95	X		1	5.3
	10	5	8	1	1	2.5	1					9	3.1
62	1	40	90	3	3	15.0	5	82	95	X	X	1	7.6
	3	6	10	1	1	2.5	1						

PERCENT COVER	NUMBER RECORDED	MIDPOINT REPORTED IN TABLES AS:
0-5	1	2
5-25	2	15
25-50	3	38
50-75	4	62
75-95	5	85
95-100	6	97

Vigor Classes

0 = dead or no germination
1 = poor or scanty germination
2 = good or good germination
3 = healthy, vigorous, or excellent germination



fence

C Surface applied sewage sludge

Plot No.	Application rate (tons/acre)
4,8,11	0
6,10,12	10
1,7,9	20
2,3,5	30

D Surface applied topsoil (from Hale Gulch test plot)

Plot No.	Inches of topsoil
2,6,7	0
1,5,8	6
3,4,9	12

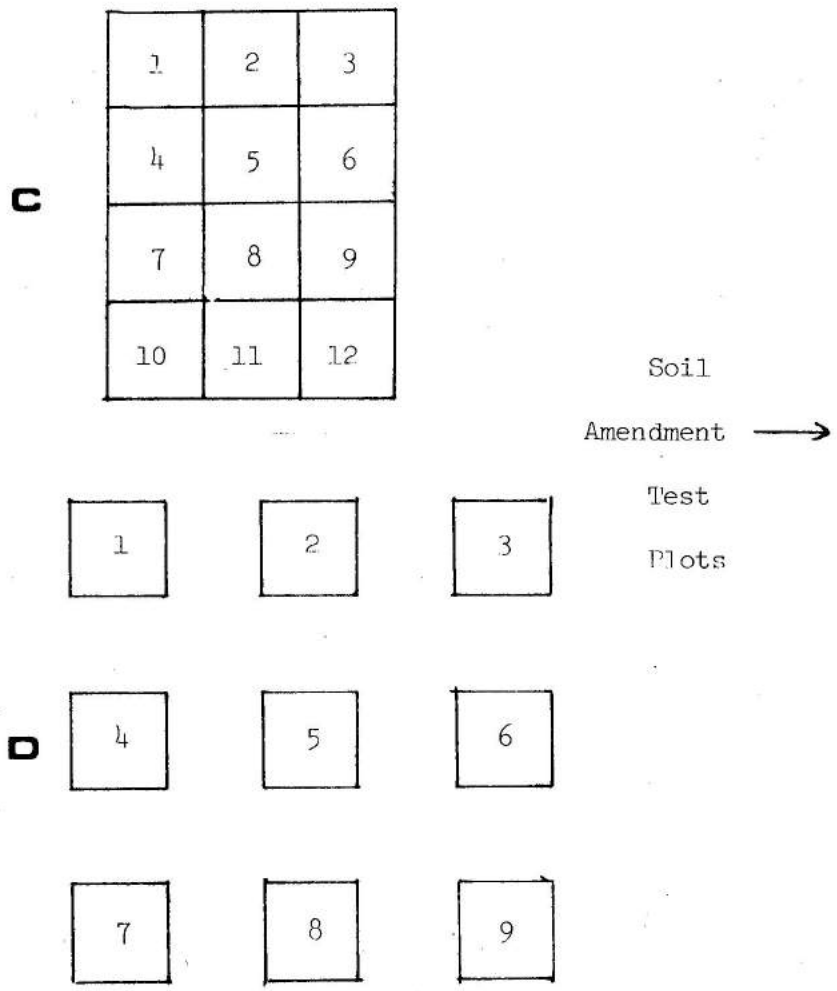


Figure F-2. Test plots with surface treatments.

Table F-10

SURFACE TREATED TEST PLOTS - SEWAGE SLUDGE 1980 MONITORING

Plot No.	Species No.	Average Height		Vigor		Average % Cover		% Bare Ground		Flowering or Fruiting stems present	
		6/24	7/23	6/24	7/23	6/24	7/23	6/24	7/23	6/24	7/23
1	1	50	75	2+	3	2.5	2.5	85	97	4	4
	3	3	4	1	1	2.5	2.5				2
	5	1	3	1	1	2.5	2.5				
2	1	45	70	2+	3	2.5	2.5	85	85	2	5
	3	3	4	1	1	15.0	2.5				
	5	3	3	2	1	2.5	2.5				
	10	3	15	1	2	2.5	2.5				
3	1	43	80	2+	2	2.5	2.5	85	97	2	2
	3	6	16	1+	1	2.5	2.5			1	
	5	3	3	2	1	15.0	2.5				
4	1	40	60	1+	2	2.5	2.5	97	97	1	1
	3	4	2	1	1	2.5	2.5				
5	1	35	70	2+	2	2.5	2.5	85	85	3	4
	3	3	5	1+	1	2.5	2.5			1	
	5	1	2	1	1	15.0	2.5				
	10	3	-	1		2.5	2.5				
	13	8	20	1	2	2.5	2.5				1
6	1	25	20	2+	2	2.5	2.5	85	97		2
	3	10	16	1+	1	2.5	2.5				
	5	2	3	1	1	2.5	2.5				
	10	3	3	1	1	2.5	2.5			5	
7	1	30	60	2+	2	2.5	2.5	63	85		3
	3	4	12	1+	1	15.0	2.5			1	2
	10	3	4	1	1	2.5	2.5				
8	1	10	18	1	1	2.5	2.5	97	97		3
9	1	30	55	2	2	2.5	2.5			4	4
	3	4	4	1	1	2.5	2.5	85	63		
	5	2	1	1	1	2.5	2.5				
	10	3	4	1	1	2.5	2.5				
10	1	23	35	2	2	2.5	2.5	97	97		2
	5	3	2	2	2	2.5	2.5				
	10	3	4	1	2	2.5	2.5				
11	1	7	12	1	1	2.5	2.5	97	97		1
12	1	7	21	1	1	2.5	2.5	97	97		4
	3	2	2	1	1	2.5	2.5				

to sewage sludge. The overburden does not possess any toxic properites which can move into the topsoil by capillarity and the soil should provide a desirable rooting substrate.

Chapter 7

Seed Collection

The use of native seeds is not considered an absolute for revegetation, but it is preferential. Commercial availability of seed is dubious because of price, collector techniques, ecotype, and general unpredictability of availability.

During 1980, two student employees were selected for seed collection. They collected over 50 lbs. of seed, working 500 hours. Because one student was on the Federal Work-Study program, the cost of the seed was $25.00 per pound. Although seed varies in price, related to size and availability, the cost compares favorably with cost from suppliers. The assumption is that cost can be reduced in the future because of the experience gained from the first summer.

The seed collected with annotated location follows:

Name: Chaenactis douglasii (Douglas Falseyarrow)
Location: Upper Harry Creek Rd., Marshall Pass east of fork.
Best Picking Time: 4th week, July, 1st & 2nd weeks of August.
1980 Quantity: 400 gms.
*Seeds may be dried with petals on and packed that way.

Name: Oryzopsis hymenoides (Indian Rice Grass)
Location: Hwy. 50, west of Sargents and Marshall Pass Rd.
Best Picking Time: 2nd week of July thru 2nd week of August.
1980 Quantity: 4,476 gms.
*Best results when we picked with combs.

Name: Eriogonum umbellatum (Sulpher-Flower)
Location: Shortcut Rd. east of guardshack, upper Harry Creek Rd.
Best Picking Time: 1st thru 3rd weeks of August.
1980 Quantity: 2,330 gms.

Name: Senecio wootonii (Golden Ragwort)
Location: Where shortcut Rds. & Marshall Pass Rd. meet & Water Treatment Plant.
Best Picking Time: 1st thru 2nd weeks, July
1980 Quantity: 35 gms.

Name: Thermopsis motana (Golden Banner)
Location: Shortcut Rd., east of pitwall test site., lower Harry Crk. Rd.
Best Picking Time: 3rd week of July thru 4th week of August.
1980 Quantity: 3,664 gms.

Name: Lupinus argenteus (Common Lupine)
Location: West of guardshack, shortcut Rd., lower Harry Creek Rd.
Best Picking Time: 3rd week of July thru 2nd week of August.
1980 Quantity: 1,280 gms.
*Cleaning: rolling the pods with rolling pin helps pop them open, then screen them to separate seed.

Name: Lonicera involucrata (Twinberry/Honeysuckle)
Location: Indian Creek Rd., Marshall Pass Rd., upper Harry Creek Rd.
Best Picking Time: 3rd week of July thru 4th week of August.
1980 Quantity: 80 gms.

Name: Iris missouriensis (Wild Iris)
Location: Chester and right after Creek crossing.
Best Picking Time: 4th week of July thru 3rd week of August.
1980 Quantity: 70 gms.
*Seeds are ready when pod cracks or rattles when shook.

Name: Arabis fendleri (Rockcress)
Location: Upper Harry Creek, Water Treatment Plant, Marshall Pass Rd.
Best Picking Time: 4th week of July thru 2nd week of August.
1980 Quantity: 85 gms.

Name: Antennaria rosea (Pussytoes)
Location: Water Treatment Plant, field north of Hales Gulch.
Best Picking Time: 2nd thru 4th weeks of July.
1980 Quantity: Was taken by Paul before weighed.

Name: Taraxacum officinale (Dandelion)
Location: Shortcut Rd., Rd. to mine after guardshack, Indian Creek Rd.
Best Picking Time: 3rd and 4th weeks of June
1980 Quantity: 1,848 gms.

Name: Astragalus sp. (Milk Vetch)
Location: Shortcut Rd., field above lower Harry Creek Rd.
Best Picking Time: 3rd week of July thru 4th week of August.
1980 Quantity: 3,111 gms.

Name: Hordeum jubatum (Foxtail Barley)
Location: Where Indian Creek Rd. meets Marshall Pass Rd, and on up Indian Creek Rd.
Best Picking Time: 2nd week of August thru 1st week of September.
1980 Quantity: 295 gms.

Name: Sambucus racemosa (Elderberry)
Location: Indian Creek Rd., upper Marshall Pass Rd.
Best Picking Time: 3rd week of July thru September.
1980 Quantity: 80 gms.

Name: Arctostaphylos uva-ursi (Kinnikinnik)
Location: Indian Creek Rd.
Best Picking Time: 2nd week of August thru September
1980 Quantity: 110 gms.

Name: Ribes inerme (Currant)
Location: Upper Harry Creek Rd., Marshall Pass Rd.
Best Picking Time: Berries turn deep purple. 2nd thru 4th week of August.
1980 Quantity: 80 gms.

Name: Physaria vitulifera (Double Bladder-Pod)
Location: Indian Creek Road
Best Picking Time: 2nd thru 4th weeks of August.
1980 Quantity: 45 gms.

Name: Rumex sp. (Dock)
Location: Upper Harry Creek Rd.
Best Picking Time: 1st thru 4th weeks of August
1980 Quantity: 1,664 gms.

Name: Thlaspi sp. #1 (Pennycress)
Location: Marshall Pass Rd. before fork.
Best Picking Time: 2nd thru 3rd weeks of August.
1980 Quantity: 3,000 gms.

Name: Erigeron sp. (Fleabane)
Location: Indian Creek Rd.
Best Picking Time: 3rd and 4th weeks August, early September
1980 Quantity: 25 gms.

Grass #1 100 gms.

Grass #2 40 gms.

The seed has been weighed, dried and containerized, and is presently stored at the Homestake Pitch Mine, under the supervision of Phil Barnes.

Chapter 8

Overburden Pier

Introduction

Work with Homestake overburden has been taking place for a number of years. The earlier data (Chapter 6) indicates overburden can support the growth of some species, although the growth was not at a rate acceptable for revegetation. In addition, our work received criticism because the earlier efforts were on flat surfaces, as opposed to the slopes which will ultimately need to be vegetated. The criticism failed to recognize the earliest work had a limited amount of space and material available, when the company was eager to resolve the problems we recognized might be on the horizon.

Regardless, the Overburden Pier was constructed to react to the criticism of a lack of test slopes and secondarily, to see if we could accelerate growth to an acceptable rate.

Location

The pier was established on a slope substantially above and east of the water treatment plant and approximately two hundred yards south of the temporary office buildings on the Access Road.

Pier Design

Figure H-1 shows the overall design of the pier. It is oriented in a southerly direction. Originally slopes of 10°, 20°, 30° and 40° had been anticipated. The 10° was estimated from the plan because corporate decision indicated a 10° slope was not within the realm of

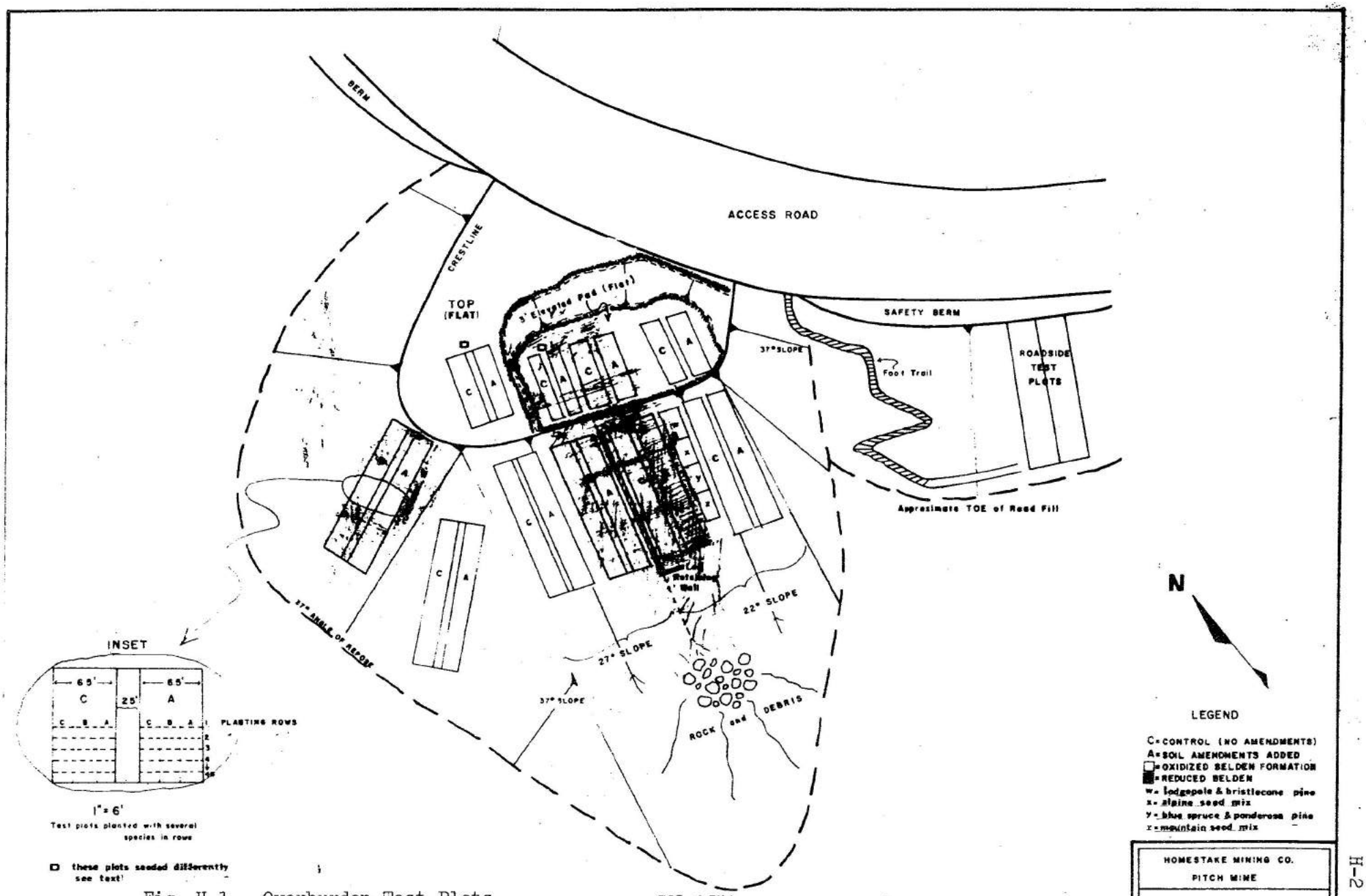


Fig. H-1. Overburden Test Plots.

of possibility. The actual angles proved to be 0^{o} (top of the pier), 22^{o}, 27^{o} and 37^{o} (angle of repose).

Each of the four slopes is made up of four 2 m. x 15 m. strips consisting of oxidized Belden and oxidized Belden plus amendments and reduced Belden and reduced Belden plus amendments.

All slopes and all treatments were dug to a depth of 8" to remove large rocks. The amendments strips were covered with amendments: hay (1 ton/acre), cow manure (18 tons/acre), sewage sludge (28 tons/acre), fertilizer (20-20-10, 200 lbs/acre). The amendments strips were dug up once again to incorporate the organic materials and fertilizer. The grading work was done with a D-9 tractor; finishing work was done by hand labor.

The inset of Figure H-1 shows the detail of planting. Forty-eight rows were planted (row numbers progress from upslope to downslope. Thirty-six herbaceous species or varieties were planted. The two meter row in each strip was divided into thirds and seeded. Each species was planted as a part of three rows in each strip; thereby providing three replications of each species.

Table H-1 lists the plants seeded in one replication (rows 1-14), the position in a row a species occupies (A,B, or C), the number of grams of seed planted and the date seed was planted. Tows 15-38 represent two additional replications. Each of the strips on each of the slopes repeats the pattern of Table H-1.

Table H-2 lists the species included which are transplants which had been raised at the Colorado State Forest Service Nursery and the AMAX Mt. Emmons Underground Nursery. The Table H-2 pattern is repeated on each of the four strips on each slope treatment.

Table H-1

OVERBURDEN SPECIES SEEDED ON THE PIER

Date Planted	Row Position	Common Name	Species	Amt seed/row
7/25	3A	Orchard Grass	Dactylis glomerata	2.5 g.
7/25	3B	Redtop	Agrostis alba	0.5 g.
7/25	3C	Hard Fescue	Festuca ovina	1.4 g.
8/06	4A	Golden Banner	Thermopsis montana	10 seeds
7/31	4B	Redroot Pigweed	Amaranthus sp.	1.0 g.
7/29	4C	Canada Bluegrass(Rubens)	Poa compressa	0.3 g.
7/29	5A	Meadow Foxtail	Alopecurus pratensis	1.6 g.
7/29	5B	Douglas Falseyarrow	Chaenactis douglasii	0.9 g.
7/29	5C	Alsike Clover	Trifolium hybridum	0.6 g.
8/06	6A	Arizona Wyethia	Wyethia arizonica	0.9 g.
7/29	6B	Kentucky Bluegrass	Poa pratensis	0.3 g.
7/29	6C	Manchar Brome	Bromopsis inermis	2.3 g.
8/01	7A	Winter Barley	Triticum sp.	9.9 g.
8/01	7B	Winter Rye	Secale cereale	10.4 g.
7/29	7C	Ricegrass	Oryzopsis hymenoides	1.5 g.
7/30	8A	Perennial Rye	Lolium perenne	3.3 g.
7/30	8B	Ladino Clover	Trifolium repens	1.0 g.
8/05	8C	Pussytoes	Antennaria rosea	0.4 g.
7/30	9A	Kentucky Bluegrass(Troy)	Poa pratensis	0.5 g.
7/30	9B	Rockcress	Arabis sp. (#2)	0.6 g.
7/30	9C	Tufted Hairgrass/timothy (mix)	Deschampsia caespitosa Phleum pratense	1.3 g.
7/30	10A	Red Fescue	Festuca rubra	2.6 g.
7/30	10B	Smoothbrome	Bromopsis inermis	0.5 g.
7/30	10C	Lupine	Lupinus sp.	1.3(25 seeds)
7/30	11A	Rockcress	Arabis sp. (#1)	0.7 g.
8/05	11B	Golden Ragwort	Senecio sp.	0.6 g.
8/01	11C	Broadleaf Trefoil	Lotus tenuis	1.0 g.
7/30	12A	White Dutch Clover	Trifolium pratense	1.0 g.
7/30	12B	Arnica	Arnica sp.	6.3 g.
8/01	12C	Russian Wild Rye	Elymus cinereus	2.2 g.

Table H-1 continued

Date Planted	Row Position	Common Name	Species	Amt. seed/row
8/01	13A	Winter Wheat	Triticum sp.	10.3 g.
8/01	13B	Cicer milkvetch	Astragalus cicer	1.0 g.
8/01	13C	Dandelion	Taraxacum sp.	0.8 g.
8/06	14A	Milkvetch	Astragalus sp.	0.7 g.
8/01	14B	Timothy (VNS)	Phleum pratense	0.7 g.
8/01	14C	Alfalfa-Teton/travois	Medicago sp.	1.3 g.
8/01	15A	Redroot Pigweed		*
8/06	15B	Arizona Wyethia		
8/01	15C	Douglas falseyarrow		
8/01	16A	Manchar Brome		
8/01	16B	Lupine		
8/01	16C	Perennial Rye		
8/06	17A	Arnica		
8/06	17B	Golden Banner		
8/01	17C	Kentucky Bluegrass (Newport)		
8/01	18A	Smoothbrome		
8/01	18B	Orchard Grass		
8/01	18C	Ladino Clover		
8/01	19A	Redtop		
8/01	19B	Kentucky Bluegrass (Troy)		
8/01	19C	Red Fescue		
8/01	20A	Hard Fescue		
8/01	20B	White Dutch Clover		
8/06	20C	Rockcress (#2)		
8/01	21A	Dandelion		
8/01	21B	Rockcress		
8/01	21C	Milkvetch		
8/01	22A	Broadleaf trefoil		
8/01	22B	Winter Barley		
8/06	22C	Arnica		
8/04	23A	Alfalfa-teton/travois		
8/04	23B	Meadow Foxtail		
8/04	23C	Cicer Milkvetch		

* Remaining amounts same as rows 3-14 for each species. Flat area seeded to row 14 only.

Table H-1 continued

Date Planted	Row Position	Common Name	Amt. seed/row
8/05	24A	Pussytoes	
8/04	24B	Alsike Clover	
8/05	24C	Golden Ragwort	
8/04	25A	Winter Rye	
8/04	25B	Russian Wild Rye	
8/04	25C	Timothy	
8/07	26A	Tufted Hairgrass/Timothy	
8/07	26B	Ricegrass	
8/07	26C	Winter Wheat	
8/07	27A	Rubens Canada Bluegrass	
8/07	27B	Manchar Brome	
8/07	27C	Winter Barley	
8/07	28A	Rockcress	
8/07	28B	Perennial Rye	
8/07	28C	Kentucky Bluegrass (Troy)	
8/07	29A	Kentucky Bluegrass (Newport)	
8/07	29B	Tufted Hairgrass/Timothy	
8/07	29C	Arizona Wyethia	
8/07	30A	Russian Wild Rye	
8/07	30B	Milk Vetch	
8/07	30C	Smoothbrome	
8/07	31A	Golden Ragwort	
8/07	31B	Dandelion	
8/07	31C	White Dutch Clover	
8/07	32A	Cicer Milkvetch	
8/07	32B	Pussy-toes	
8/07	32C	Redtop	
8/07	33A	Timothy	
8/07	33B	Red Fescue	
8/07	33C	Rockcress	
8/08	34A	Douglas falseyarrow	
8/08	34B	Rubens Canada Bluegrass	
8/08	34C	Winter Rye	

Table H-1 continued

Date Planted	Row Position	Common Name	Amt. seed/row
8/08	35A	Ladino Clover	
8/08	35B	Hard Fescue	
8/08	35C	Redroot Pigweed	
8/08	36A	Ricegrass	
8/08	36B	Alfalfa-Teton/Travois	
8/08	36C	Golden Banner	
8/08	37A	Alsike Clover	
8/08	37B	Broadleaf Trefoil	
8/08	37C	Orchardgrass	
8/08	38A	Lupine	
8/08	38B	Winter Wheat	
8/08	38C	Meadow Foxtail	

Table H-2

TRANSPLANT SPECIES ON THE OVERBURDEN PIER

Row No. Slope	Flat	Common Name	Species	Number Planted	Date	Source
40	15	Lodgepole Pine	Pinus contorta	slope-5,flat-6	8/12	Forest Service Nursery
41	16	Englemann Spruce	Picea engelmannii	slope-5,flat 6	8/12	Forest Service Nursery
42	17	Douglas Fir	Pseudotsuga menzeisii	5	8/13	Forest Service Nursery
43	18	Eastern Red Cedar	Juniperus scopulorum	5	8/13	Forest Service Nursery
44	19	Ponderosa Pine	Pinus ponderosa	5	8/13	Forest Service Nursery
45		Bristlecone Pine	Pinus aristata	5	8/19	AMAX Underground Greenhouse
46		Limber Pine	Pinus flexilis	5	8/19	AMAX Underground Greenhouse
47		Blue Spruce	Picea pungens	5	8/20	AMAX Underground Greenhouse
48		White Fir	Abies concolor	5	8/20	AMAX Underground Greenhouse

On the flat areas at the top of the slopes the space available is not organized in the same manner as on the slopes. Two plots were established which have a distinctive planting pattern. Table H-3 lists the planting pattern.

Outside of test strips, surfaces were available which are subject to erosion. These were hydromulched with a mixture shown in Table H-4. After the seeding, the area was hydromulched with 250 lbs. Con-Wed 2000 in 800 gallons of water.

Other miscellaneous areas were planted to Lodgepole Pine, Engelmann Spruce, Snowberry (Symphoricarpos oreophilus) and Bristlecone Pine. A variety of herbaceous plants were also seeded in the same areas.

Containers of seedlings from the Greenhouse Experiments (Chapter 10) were planted.

Results

Because of the lateness of the growing season, when the pier was completed, it was assumed any data of significance would not be available until June, 1981. However, some showers and unusually warm weather promoted a premature greening.

A monitoring of the pier was carried out on 13 September and the data is provided in Table H-5. Because the significance of the species in a potential stress environment is not evident until the survival of a winter, no discussion will ensue.

Table H-3

SEED PLANTED ON TWO NONCONFORMIST PLOTS
ON THE FLAT AREA

Planted 9/13/80

Row	Common Name	Species
1	Meadow Foxtail	Alopecurus pratensis
2	Canada Bluegrass (Rubens)	Poa compressa
3	Tufted Hairgrass	Deschampsia caespitosa
4	Timothy	Phleum pratense
5	Hard Fescue	Festuca ovina var. duriscula
6	Kentucky Bluegrass (Troy)	Poa pratensis
7	Orchardgrass	Dactylis glomerata
8	Alsike Clover	Trifolium hybridum
9	White Dutch Clover	Trifolium pratense
10	Smoothbrome	Bromopsis inermis
11	Russian Wildrye	Elymus cinereus
12	Kentucky Bluegrass (Newport)	Poa pratensis
13	*Manchar Brome/Redroot Pigweed	Bromopsis inermis/Amaranthus sp.
14	*Ladino Clover/Cicer Milkvetch	Trifolium repens/Astragalus cicer
15	*Winter Rye/Broadleaf Trefoil	Secale cereale/Lotus tenuis
16	*Winter Wheat/Perennial Rye	Triticum sp./Lolium perenne
17	[1]Alfalfa (teton/travois)/Winter Barley	Medicago sp./Hordeum sp.
18	[1]Red Fescue/Redtop	Festuca rubra/Agrostis alba
19	[2]Manchar Brome/Ladino Clover	Bromopsis inermis/Trifolium repens
20	[2]Broadleaf Trefoil/Perennial Rye	Lotus tenuis/Lolium perenne

*The second name occupies the full row in the oxidized substrate, the west half of the row in the reduced.
[1]The first name occupies the east half of the row in the oxidized material, and the west half in the reduced.
[2]These rows exist in oxidized plot only.

Table H-4

SEED MIX PLANTED AROUND OVERBURDEN TEST PLOTS

7 August, 1980

15 lb. Alpine mix

60 lb. Conwed 1500 mulch

50 lb. 20-20-10 fertilizer

Mix of:

Ricegrass	Oryzopsis hymenoides
Douglas Falseyarrow	Chaenactis douglasii
Lupine	Lupinus argenteus
Dandelion	Taraxacum sp.
Pussytoes	Antennaria rosea
Umbel	Unknown
Golden Banner	Thermopsis montana
Mustard	Thlaspi sp.
Mustard Rockcress	Arabis fendleri

Table H-5

OVERBURDEN PIER TEST STRIP MONITORING

13 September, 1980

		OXIDIZED								REDUCED							
Degree slope		0		22°		27°		37°		0		22°		27°		37°	
Row/position		+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
3	A	X								X							
4	B									X							
5	A	X								X		X					
5	C					X											
6	B	X															
6	C	X				X				X							
7	A			X	X	X	X	X[1]	X	X	X	X		X			
7	B	X	X	X[1]	X	X[1]	X		X	X[1]	X	X[1]		X		X	X
7	C															X	
8	A			X		X		X		X[1]		X		X		X	
8	B					X			X							X	X
9	A						X		X								
9	B								X								X
9	C																X
10	A	X								X		X		X			
10	B	X				X			X	X		X		X			
10	C													X			
11	A	X		X													
11	B								X								
12	A	X		X													X
12	B	X															X
12	C									X							
13	A	X	X	X[1]	X	X	X	X		X[1]		X[1]		X			
13	C									X	X					X	X
14	A			X				X	X[1]								
14	B			X		X				X				X			

[1] Indicates especially vigorous growth

Table H-5 continued

		OXIDIZED								REDUCED							
Degree Slope		0		22°		27°		37°		0		22°		27°		37°	
Row/position		+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−
14	C	X	X			X	X			X		X					
15	A	X	X	X		X		X	X	X	X	X		X			
15	B	X	X						X	X	X			X			
15	C	X	X							X	X						
16	A	X	X	X		X				X	X			X			
16	B	X	X							X	X						
16	C	X	X	X[1]		X	X	X		X	X	X		X			
17	A	X	X						X	X	X						
17	B	X	X							X	X						
17	C	X	X			X				X	X						
18	A	X	X	X		X	X	X	X	X	X	X					
18	B	X	X			X				X	X			X			
18	C	X	X			X				X	X						
19	A	X	X	X	X			X		X	X						
19	B	X	X							X	X	X					
19	C	X	X							X	X						
20	A	X	X			X				X	X	X		X			
20	B	X	X			X		X		X	X						
20	C	X	X							X	X						
21	A	X	X	X													
21	B	X	X	X				X									
21	C	X	X														
22	B			X	X	X[1]	X	X	X			X		X		X	X
23	A			X	X	X	X					X		X			
23	B			X								X		X			
25	A			X[1]	X[1]	X[1]	X		X[1]			X[1]		X[1]		X	X
25	B			X								X		X			
25	C					X						X					

Table H-5 continued

	OXIDIZED								REDUCED							
Degree Slope	0		22°		27°		37°		0		22°		27°		37°	
Row/position	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−
26 A							X									X
26 B					X		X						X			
26 C					X	X	X	X			X[1]		X		X	X
27 A							X									
27 B			X		X			X			X		X	X		
27 C			X	X	X						X[1]		X	X	X	X
28 A			X				X				X					
28 B			X		X		X				X		X	X		
28 C							X								X	
29 A			X													
29 C																X
30 A			X		X		X									
30 C							X									
31 B			X													
31 C			X													
33 A													X			
33 B													X			
33 C													X			
34 A															X	X
34 B			X										X			
34 C			X[1]	X	X		X	X			X		X	X		X
35 B				X								X				
35 C			X	X	X			X					X	X		
36 A														X		
36 B			X		X						X		X			
37 A			X										X			
37 B			X													
37 C			X		X								X			
38 B			X[1]	X	X[1]						X[1]		X	X	X	

Table H-5 continued

		OXIDIZED								REDUCED							
Degree Slope		0		22°		27°		37°		0		-22°		27°		37°	
Row/position		+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
38	B			X[1]	X	X[1]						X[1]		X	X	X	
38	C			X		X		X						X		X	
40	A			X	X	X	X	X	X			X	X	X	X	X	X
40	B			X	X	X	X	X	X			X	X	X	X	X	X
40	C			X	X	X	X	X	X			X	X	X	X	X	X
41	A			X	X	X	X	X	X			X	X	X	X	X	X
41	B			X	X	X	X	X	X			X	X	X	X	X	X
41	C			X	X	X	X	X	X			X	X	X	X	X	X
42	A			X	X	X	X	X	X			X	X	X	X	X	X
42	B			X	X	X	X	X	X			X	X	X	X	X	X
42	C			X	X	X	X	X	X			X	X	X	X	X	X
43	A			X	X	X	X					X	X	X	X		
43	B			X	X	X	X					X	X	X	X		
43	C			X	X	X	X					X	X	X	X		
44	A			X	X	X	X	X	X			X	X	X	X	X	X
44	B			X	X	X	X	X	X			X	X	X	X	X	X
44	C			X	X	X	X	X	X			X	X	X	X	X	X
45	A			X	X	X	X	X	X			X	X	X	X	X	X
45	B			X	X	X	X	X	X			X	X	X	X	X	X
45	C			X	X	X	X	X	X			X	X	X	X	X	X
46	A			X	X	X	X	X	X			X	X	X	X	X	X
46	B			X	X	X	X	X	X			X	X	X	X	X	X
46	C			X	X	X	X	X	X			X	X	X	X	X	X
47	A			X	X	X	X	X	X			X	X	X	X	X	X
47	B			X	X	X	X	X	X			X	X	X	X	X	X
47	C			X	X	X	X	X	X			X	X	X	X	X	X
48	A			X	X	X	X	X				X	X	X	X	X	X
48	B			X	X	X	X	X				X	X	X	X	X	X
48	C			X	X	X	X	X				X	X	X	X	X	X

Chapter 9

Roadside Overburden Strips

During the early part of June, while the Overburden Pier was being designed and installed, we recognized that adjacent to the pier on the access road, there was a site available to ideally test surface treatments on oxidized overburden at the angle of repose (37°). The recommendation was made to management and they provided rapid and enthusiastic approval.

Allowing a buffer next to the pier area, the south-facing roadside was staked at 3m intervals with .6m walkways at either side (Figure I-1). Each step is approximately 25m long. A total of 26 plots were established between 15 June and 5 August. A walkway was constructed to allow observers to walk to the bottom of the slope with minimum slope disturbance.

Table I-1 provides the information regarding strip description and how each strip was treated. Because of limited space, not all treatments were replicated. However, whenever a treatment appears promising, and the circumstances permit, the treatment will receive a more extensive trial.

Unless otherwise noted (Table I-1) each plot was needed with the alpine mix (Table B-1) and fertilized with 20-20-10 fertilizer. Seed (50lbs/acre) and fertilizer (200lbs/acre) were broadcast by hand, and by the same person. Application was always made from the bottom, west side, and progressing directly upward. This reduced surface disturbance to a minumum.

All treatments except Strips 3,4,9,15 (Table I-1; Figure I-1) were raked after seeding. In some cases, the soil surface was covered; in some cases the surface was recontoured.

Table I-1

ROADSIDE TEST PLOTS

Plot No.	Treatment	Treatment Date	Seeding Date	Comments
1	Seed only	6/15	6/15	
2	Seed & fertilizer only	6/15	6/15	
3	Crimped hay[1]	6/15	6/15	Crimped with shovels
4	Hydromulch (½ Jacklin, ½ Conwed 1500+ tackifier)	7/1	7/1	Not hand seeded-Seed added to mulch
5	Terraces[2]	6/20	6/20	1 m deep, 1 m lip of one to top of the next.
6	Seed & fertilizer only	6/20	6/20	
7	Terraces[2]	6/20	6/23	Same as #5, but edges rounded off
8	Netting-Holdgro	6/20	6/20	
9	Rock	6/17	6/18	Rocks set on surface, at least 50% cover
10	Hydromulch (same as #4)	7/1	7/1	Seeded prior to mulching
11	Netting-Holdgro over hay[1]	6/20	6/20	
12	Log barricades[2]	6/19	6/19	3 m distance between logs
13	Basins	6/23	6/23	Shovelled hollows about 2'long, 1'wide, 1'deep
14	Netting-Conwed black plastic over hay[1]	6/19	6/19	
15	No treatment (control)			
16	Rilling	6/20	6/23	Shallow trenches going across slope with hoe
17	Terratack	6/27	6/30	
18	Terratack over hay[1]	6/27	6/30	
19	Hydromulch-Conwes 1500 + tackifier	6/27	6/30	
20	Hydromulch-Conwed 2000	6/27	6/30	
21	Netting-jute	7/21	7/21	
22	Netting-Conwed black plastic	7/21	7/21	
23	Seed + fertilizer only	8/5	8/5	
24	Hydromulch (Conwed 1500) + hydro-plus	8/5	8/5	
25	Hydro-plus	8/5	8/5	1 qt./800 gal. water
26	Soil Sement	8/5	8/5	4 gal./200 gal. water

[1] Hay added at the rate of approximately 5 tons/acre

[2] Hydromulched July 2 with Conwed 2000 at rate of 360 lb./800 gal., with 1½ lb. seed added per 800 gal. This covered 5 plots.

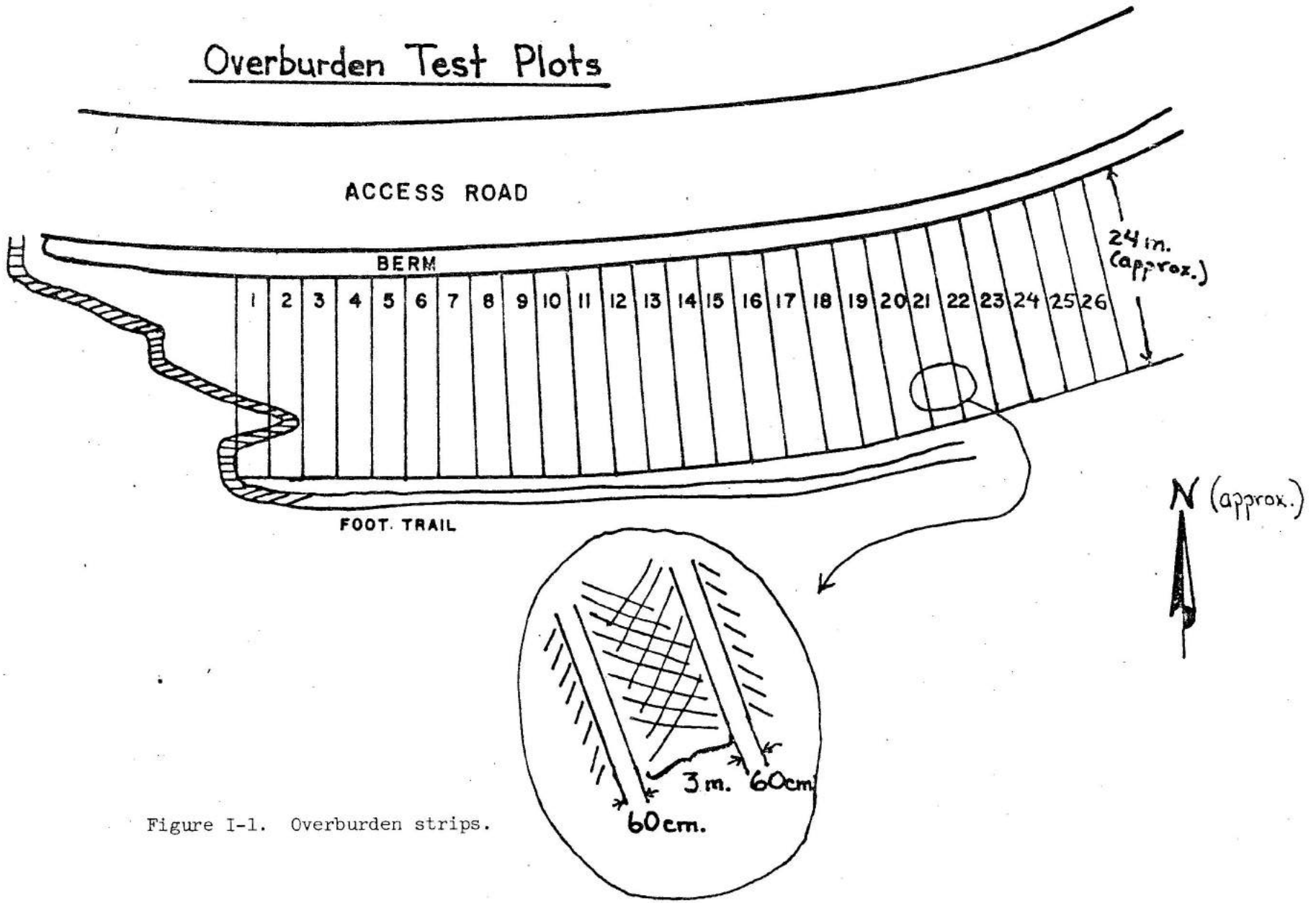


Figure I-1. Overburden strips.

Monitoring

Soil moisture was monitored (Table I-2) on four occasions. Superficially, erosion was considered (Table I-3). A single evaluation was made (Table I-4). The successes noted in the table are for Winter Rye, at the end of August. Numerous undividual sprigs were evident, rather evenly distributed, unless otherwise noted in the table.

An attempt was made to derive some awareness of the microbiology activity of the soil. It reflects when the overburden begins to function as a soil and incorporates the organic matter into the mineral cycle. It also reflects the potential for the development of a rhizosphere microflora, which is necessary for a successfull ecosystem.

Table I-2

SOIL MOISTURE

Plot No.	% moisture((weight of water/oven dry weight) x 100)			
	July 16	Aug. 8	Aug. 15	Aug. 21
1	7.3	6.7	8.3	4.7
2	1.7	6.6	3.9	2.9
3	3.9		9.2	2.6
4	6.7		7.9	5.1
5	5.1		5.6	5.1
6	10.7		5.7	1.4
7	8.4		9.1	7.0
8	6.2		6.9	2.3
9	5.5		6.6	1.0
10	2.8		2.8	4.3
11	8.9		6.6	4.6
12	4.6		4.5	3.8
13	10.1		10.5	4.1
14	6.1		7.5	2.5
15	10.1		7.3	5.3
16	6.3		6.9	1.2
17	9.6		5.4	6.2
18	5.1		8.0	4.0
19	8.2		6.5	5.6
20	6.1		8.3	3.5
21			7.1	1.2
22			4.7	3.1
23			6.9	5.4
24			6.0	5.5
25			4.9	2.9
26			5.5	0.6

Table I-3

EROSION

East row (between plots # 10 + 11)

Stake	Initial measurement (inches)	8/21	Difference inches	Difference mm
E1 (Slope bottom)	11	12.25	+1.25	+31.75
E2	17.5	17.75	+ .25	+ 6.35
E3	14.75	15.0	+ .25	+ 6.35
E4	14.19	13	-1.19	-30.23
West row (between plots # 6 + 7)				
W1 (Slope bottom)	10.18	10.5	+ .32	+ 8.13
W2	10.88	11.5	+ .62	+15.75
W3	12.18	12.5	+ .32	+ 8.13
W4	16.88	15.5	-1.38	-35.05

Table I-4

VEGETATION MONITORING

Strip No.	Estimated Vigor Increasing Number = Increasing Vigor	Comments
1	0	2 seedlings
2	0	
3	1	Very few near top, more at bottom
4	1-2	
5	1 2	sloped part flat part
6	1	
7	1 2	slope flat part
8	1	
9	1	
10	2	
11	1-2	
12	2 1	slope
13	3	bottom of basin
14	2	
15	0 0	slope
16	2-3	flat
17	1	most at bottom
18	1-2	much hay blown away
19	1	
20	2/3	
21	1	
22	0	
23-26	0	

Table I-5

SOIL MICROBIOLOGY-PLATE COUNTS

Number of colonies with indicated dilutions

Site	CZAPEK'S MEDIUM Dilution 10-3 Fungi(F)/Bacteria(B) F B	10-5 F B	10-6 F B	10-7 F B	NUTRIENT AGAR Dilution 10-3 Fungi(F)/Bacteria(B) F B	10-5 F B	10-6 F B	10-7 F B
Oxidized with amendments	14/22	7/11	2/TNTC*	0/0			3/118	
	114/14	1/TNTC*	2/24	1/1			2/132	
	46/32	1/10	2/24	0/0				
	56/TNTC*	2/2						
Oxidized without amendments	3/TNTC*	0/0		1/0	0/TNTC*			
	1/TNTC*	0/0		1/0	2/TNTC			
	1/3	1/0			2/TNTC			
					2/TNTC			
					0/TNTC			
North Pit	0/0				4/114			
	0/TNTC				3/160			
	1/0				0/TNTC			
	2/TNTC				1/TNTC			
	5/0				0/TNTC			
	5/0				0/TNTC			
	0/0				0/TNTC			
	2/18				0/13			
	0/0				0/0			
	4/11				0/15			
South Pit	4/19				0/7			
	0/0				2/6			
	1/3				0/6			
					0/1			

* TNTC = Too numerous to count

Chapter 10

Greenhouse Experiments-1980

Between February and June, greenhouse studies were carried out to gain preliminary information about a variety of substrates which were anticipated for use during the 1980 field season. Secondarily, a variety of slope angles were going to be constructed, and some insight was hoped for by greenhouse simulations.

The work was done at the commercial greenhouses of Alpine Gardens, North Colorado and Denver Sts., Gunnison, Colorado. The greenhouse is of rigid plastic construction. Temperature was maintained at 75°F during the day and 58°F at night. Photoperiod was not controlled and no supplemental light was provided. Irrigation was manual, with a garden hose, and occurred two to three times per week. Light conditions or soil moisture conditions were not monitored.

Substrates

The substrates used commercial potting soil (undeclared mixture of topsoil, vermiculite, peat moss and sand), topsoil (obtained from the Homestake Sage Test Plot near Hale Gulch), overburden (as provided by Homestake from the North Pit), overburden with conifer sawdust (1:1), overburden with cow manure and conifer sawdust (1:1:1), overburden with topsoil (1:1). Sewage sludge from the Gunnison Sewage Treatment Plant was used in some experiments. Osmocote (14-14-14) was used as a fertilizer in some cases. The hay utilized in some phases of the experiment was obatined from the Tomichi Creek drainage, across from the Gunnison cemetery.

The amendments used in the mixture were: Hay-3.6 tons/acre (pot

experiment) and 3.0 tons/acre (slope experiment); Sawdust-3.6 tons/acre and 11 tons/acre; Cow manure-12.5 tons/acre and 32 tons/acre; Sewage sludge-3.6 tons/acre and 6 tons/acre. All weights are based on oven-dry weights (105°C) and were adjusted to existing wet weights.

Conductivity, pH, or nutrient analysis were not conducted with any of the soils or mixes. Soil moisture was not monitored.

Species Used

A variety of plants were utilized. They included Field Corn (Yellow Dent), Radish (Scarlet Globe), Oats (Certified Russell), Lettuce (Grand Rapids), Peas (Alaska) and Corn (Burpee Sweet Golden Midget). These vegetables were used because of availability, growth rate, and because a growth success or failure may easily be interpreted. In addition, nutrient deficiency may be easily observed.

A grass mix was used in a portion of the study. The mix included: Manchar Brome (Bromus inermis), Timothy (Phleum pratense), Ladino Clover (Trifolium repens), Creeping Foxtail-Garrison (Alopecuris pratensis), Creeping Red Fescue (Festuca rubra). These species are represented in the grass mixes used in the revegetation process.

Prunus virginiana melanocarpa (Chokecherry) was raised from seed and transplanted in one of the experiments.

Experimental Design

Tray experiments. The six vegetables, Chokecherry and a grass mix were planted in potting soil, topsoil, overburden-sawdust (1:1) mix; overburden-cow manure-sawdust mix (1:1:1), overburden-topsoil mix (1:1). The trays were 12" x 18" x 2".

During the course of the experiment, height, vigor and cover (%) were measured. At the conclusion of the experiment, plants were clipped, dried (105°C) and weighed.

Pot experiment. Various mixtures included Control (overburden), and overburden plus hay, manure, sawdust, sludge, and fertilizer, plus all combination thereof. The quantities used of each was delineated earlier. Each treatment was represented by three units. (4" x 4" pressed paper pots). The pots were randomized (Figure J-1). The Grass mix listed earlier was planted at the rate of .2 gm per pot.

During the course of the experiment, height, vigor and cover (%) were measured. At the conclusion of the experiment, plants were clipped, dried (105°C) and weighed.

Slope experiment. Fifteen wooden boxes (12" x 18" x 4") were planted with the Grass mix. The substrate as a mixture of oxidized and reduced overburden, to which was added sewage sludge, hay, sawdust, manure and fertilizer. Availability of the additives dictated quantities used. The specific quantities were cited earlier.

The boxes were propped up to the desired degree of slope and arranged in a manner whereby the boxes faced in an easterly direction (Figure J-2).

After two months, the plants were clipped, dried (105°C) and the information tabulated.

Results

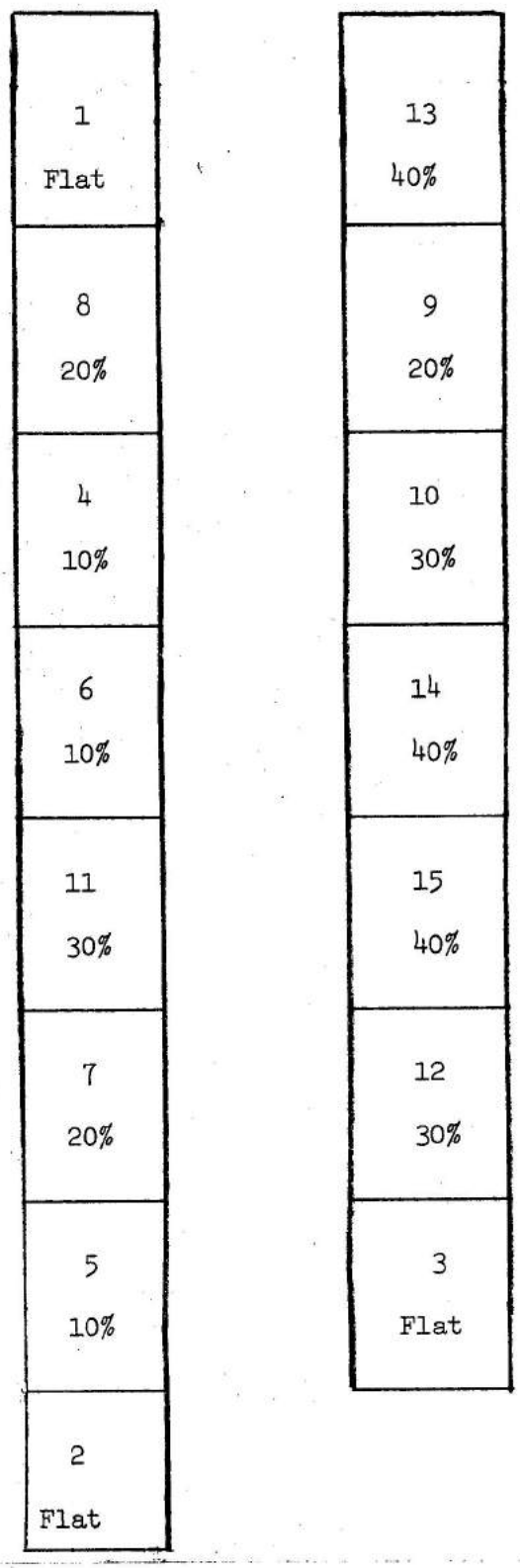
Tray Experiment. Table J-1 provides the data compiled from a number of observations.

Pot Experiment. Table J-2 ranks the treatment in terms of best dry weight production. In addition it provides measurements of height, cover

85	76	6	75	83	36	71	77	58	39	16	93
27	26	45	22	4	61	23	65	57	1	8	18
12	62	59	49	84	89	68	19	38	3	94	9
43	29	53	92	55	51	35	34	95	79	40	15
54	5	20	91	14	48	69	28	64	44	47	78
25	10	32	17	88	82	31	50	37	52	81	66
56	33	21	73	46	70	13	7	90	86	11	60
63	24	87	96	74	30	80	42	67	41	2	72

GREENHOUSE BENCH

Figure J-1. Random Arrangement of Pots on Growing Bench



Box no.	Slope (percent)
1 - 3	Flat
4 - 6	10
7 - 9	20
10 - 12	30
13 - 15	40

Figure J-2. Arrangement of slope angle boxes.

Table J-1

MONITORING MEASUREMENTS TO TEST

THE EFFECT OF ORGANIC ADDITIVES

	Potting Soil height (cm)					Topsoil height (cm)					Overburden & Sawdust height (cm)					Overburden & Manure & Sawdust height (cm)					Overburden & Topsoil height (cm)				
First Monitorings	$\bar{V}$	3/11	3/18	4/25	SC	$\bar{V}$	3/11	3/18	4/25	SC	$\bar{V}$	3/11	3/18	4/25	SC	$\bar{V}$	3/11	3/18	4/25	SC	$\bar{V}$	3/11	3/18	4/25	SC
Field Corn (Yellow Dent)	1.8	2.0	6.0	12.0	1.5	1.8	2.5	4.5	8.0	.9	3.0	4.5	6.5	9	1.0	2.7	4.5	8.0	10.0	1.6	1.7	1.0	2.0	4.0	.9
Radish (Scarlet Globe)	2.5	6.0	6.0	10.0	7.2	1.8	2.5	3.0	3.0	3.8	1.7	2.0	2.5	--	1.5	2.3	4.0	4.0	4.0	16.2	1.3	1.5	2.0	2.0	1.8
Oats (Certified Russell)	3.0	11.5	15.0	25.0	12.2	2.0	7.0	10.0	13.0	4.0	2.0	8.0	10.0	14.0	3.0	2.7	11.0	16.5	20.0	6.7	1.3	5.0	6.0	9.0	3.2
Peas (Alaskan)	2.8	9.0	25.0	25.0	7.6	1.8	6.5	14.0	34.0	6.9	2.7	7.5	16.5	35.0	4.9	3.0	9.0	20.0	27.0	13.8	2.0	4.0	5.0	18.0	5.7
Corn (Burpee Sweet Golden Midget)	2.0	4.0	6.0	14.0	2.1	1.8	1.0	3.0	7.0	.9	2.0	3.0	4.0	5.0	1.0	2.3	4.0	5.0	7.0	1.1	1.0	1.0	2.0	7.0	.3
Grass Mix	1.5	4.5	6.0	10.0	24.5	2.0	4.0	4.5	5.0	15.1	2.3	4.5	4.5	4.5	13.3	3.0	5.5	6.0	8.0	24.4	2.0	4.0	5.0	5.0	10.1
Transplants (1)	2.7	6.4	7.0	25.0	--	2.7	12.1	12.4	14.0	--	2.7	8.3	8.3	8.4	--	2.7	10.6	11.5	13.4	--					
Prunus (2)	3.0	8.3	10.5	28.6	--	3.0	7.4	8.0	14.0	--	3.0	10.5	10.5	10.5	--	2.7	9.3	9.5	11.8	--					
virginiana (3)	2.7	12.2	17.5	37.0	--	3.0	9.1	9.5	12.0	--	2.7	8.0	8.0	8.1	--	3.0	7.5	8.1	10.4	--					
(4)	.0	5.3	6.1	6.1	--	2.7	13.8	14.2	15.0	--	2.7	8.4	8.5	9.0	--	2.7	7.5	7.6	8.0	--					

*$\bar{V}$ = average vigor
*SC = standing crop (grass)

Vigor Classification
0 = Dead
1 = Poor
2 = Fair to Good
3 = Excellent

Table J-2

GREENHOUSE EXPERIMENTS

Ranking of best treatment in terms of dry weight

Rating	Pot No.	Mix	$\bar{H}$	S*	$\bar{DW}$	S*	$\bar{C}$	$\bar{V}$
1	67-69	ABCDE	6.7	1.53	7.2	.82	97.0	2.0
2	70-72	BDE	6.3	1.53	6.9	.72	97.0	2.0
3	55-57	ADE	4.6	.58	6.2	.85	93.0	2.0
4	91-93	ABDE	6.0	1.00	6.1	3.32	97.0	2.0
5	88-90	BCDE	5.7	1.15	5.8	.70	97.0	2.0
6	46-48	DE	6.3	1.15	5.4	.59	93.0	2.0
7	85-85	ACDE	4.8	.29	5.3	1.39	93.0	2.0
8	64-66	BCE	5.0	.00	5.2	.07	97.0	2.0
9	73-75	CDE	5.0	1.00	5.0	1.19	93.0	1.0
10	58-60	ABE	4.3	1.15	4.9	1.06	97.0	2.0
11	76-78	ABD	6.7	.58	4.7	.74	97.0	2.0
12	94-96	ABCE	4.7	.58	4.5	2.20	93.0	2.0
13	35-37	BE	5.7	.58	4.4	.20	97.0	2.0
14	16-18	E	4.6	.58	4.6	1.7	78.0	2.0
15	61-63	ACE	3.0	1.00	4.1	1.22	73.0	2.0
16	32-34	BD	6.0	1.73	4.0	.97	93.0	2.0
16	43-45	CE	4.0	.87	4.0	.96	93.0	2.0
17	49-51	ABC	5.2	.87	3.3	1.60	97.0	2.0
17	79-81	BCD	5.3	1.15	3.3	.40	97.0	2.0
18	28,41,42	AE	4.6	.58	3.1	.45	89.0	2.0
19	38-40	CD	5.3	.58	2.9	.52	97.0	2.0
20	82-84	ABCD	5.0	1.00	2.4	.71	93.0	1.0
21	52-54	ACD	4.3	.58	2.2	.95	62.0	2.0
21	13-15	D	6.0	.00	2.2	.44	97.0	2.0
22	25-27	AD	3.6	.58	1.9	.21	69.0	2.0
23	22-24	AB	2.6	.58	1.2	.26	69.0	1.5
24	10-12	B	4.2	.29	1.07	.43	78.0	1.8
25	7-9	C	3.0	.00	0.97	.06	63.0	1.5
26	1-3	Control	3.6	.58	0.77	.15	62.0	1.5
27	4-6	A	2.8	.29	0.70	.43	70.0	1.6
28	19-21	AC	2.5	.32	0.67	.15	39.0	1.3
29	29-31	BC	3.0	.00	0.40	.40	69.0	1.3

$\bar{H}$ = height (cm)
$\bar{DW}$ = average dry weight (gms)
$\bar{C}$ = cover (%)
$\bar{V}$ = vigor rating
S* = standard deviation

Control = Overburden
A = Hay
B = Manure
C = Sawdust
D = Sludge
E = Fertilizer

and vigor.

Slope Experiment. Table J-3 considers the dry weight production from the slope treatment.

Discussion and Conclusion

Table J-1 indicates, in a preliminary study, the amendments in overburden do no inhibit the growth of vegetables, grasses and Chokecherry. It appears the amendments permit a growth rate which is approximated to topsoil. The experiment provided an opportunity for quick evaluation.

An expansion of the question was accomplished with the Pot Experiment. A greater variety of combinations were developed. Although there was considerable Standard Deviation, it becomes apparent most of the treatments are superior to the Control (overburden). It is also apparent the various components of the combinations with maximum variety contribute to making an ideal mix. It should be recognized that a greenhouse experiment does not provide the stresses of the outdoors, and therefore parameters which were not considered may cause a rearrangement of results.

The slope experiment (Table J-3) had too much Standard Deviation to provide valid data. There is, however, an expressed tendency associated with diminishing returns with increased slope angle.

Table J-3
SLOPE STUDY

Slope Angle	Average Dry Weight (gms)	S*
Flat	11.6	8.6
10%	13.3	7.3
20%	6.8	5.4
30%	6.9	5.2
40%	8.2	4.2

CHAPTER 11

Pit-Wall Simulation

In the original Dames and Moore Homestake Environmental Report, and in the subsequent Environmental Impact Statement, reference was made to the development of a forest on the pit walls, once they became abandoned. At several public meetings and in writing I have indicated Homestake Mining Company should take the position that the pit walls cannot be revegetated even though a reasonable effort should be made. I have suggested this position because I prefer the route of delivering more than is promised (as opposed to the converse), because the original vegetation on the site was extremely poor, and because when the benches are left the substrate will be of low quality (but capable of being enhanced). After enhancement, the benches will prove to be incompetent in an irregular fashion, and thereby not permitting renewed reclamation efforts. Ultimately a variety of vegetation will appear, ranging from none, to dispersed grasses, to clumps of Lodgepole Pine.

To resolve the question, as addressed from many quarters, the company has selected to s imulate the abandoned pit walls and see in what manner revegetation can be accomplished.

Mersch Ward, Homestake exploration geologist, suggested two Precambrian sites which are on the Chester Fault (as is the ore body), and which had been radically disturbed prior to the enactment of present environmental laws, and are not subject to current revegetation requirements. Figure K-1 locates the two sites (A and B). A third site

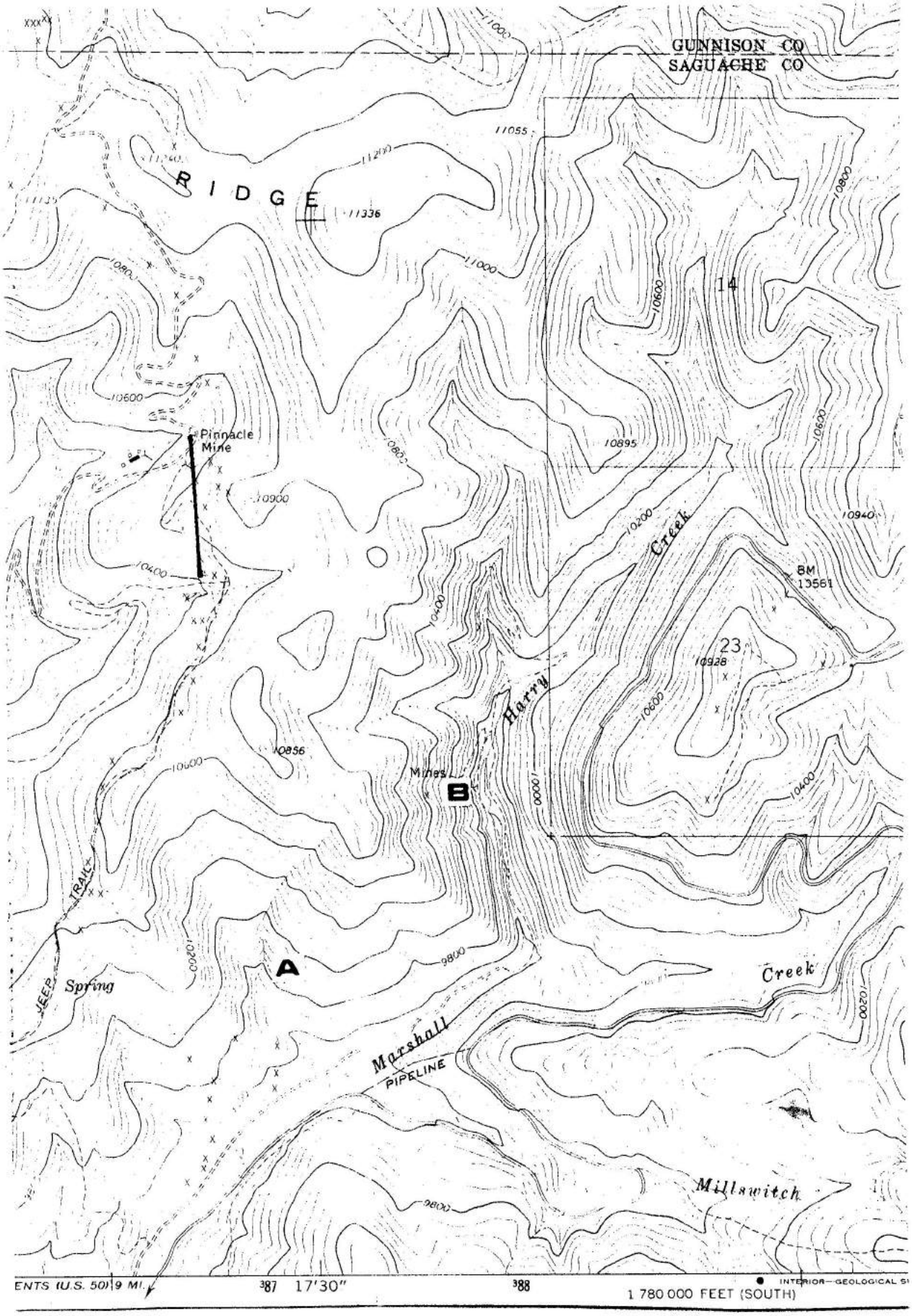


Figure K-1. Location of simulated pit walls (Site A and B)

(Belden Formation) north of the water treatment plant, will be available in 1981.

Early June, 1980, the sites were examined and corporately approved, and recommended to the U.S. Forest Service. Because many of the local U.S. Forest Service personnel were fighting fires at a variety of locations, approval was not obtained until near the end of July.

Pending approval, an inventory was made by Alan Carpenter, and a preliminary experimental design completed.

After approval, a final design was established by H. Thomas Williams, in cooperation with Homestake personnel. Burl Barnes dozed the benches, under the supervision of Ferchau and Williams. Because of the lateness of the growing season, no experimental plots were established.

INVENTORY

In mid-June, Alan Carpenter randomly distributed 24 1 m x 1 m plots, using a frame divided into 16 subplots, at Site A (Figure K-1). Sixteen 1 m x 1 m quadrats were established at Site B (Figure K-1).

The flora of Sites A and B is indicated in Table K-1. The vegetation analysis of the two sites is recorded in Tables K-2 and K-3.

SITE PREPARATION

At the end of July, the simulated walls were started. Figure K-2 is a diagram of the finished product at Site A. A permanent creek flows at the left side. Access from Marshall Creek is accomplished by utilizing the road from the right.

Figure K-3 is a drawing of the completed Site B. Access to the site is accomplished by using the foreground road, to the right. The

Table K-1

SIMULATED PIT WALL FLORA (SITE A AND B)

Scientific Name	Common Name
TREES	
Juniperus scopulorum	Rocky Mountain Juniper
Picea engelmannii	Englemann Spruce
Pinus contorta latifolia	Lodgepole Pine
P. ponderosa	Ponderosa Pine
Populus tremuloides	Aspen
Pseudotsuga menziesii	Douglas Fir
SHRUBS	
Alnus tenuifolia	Alder
Amelanchier alnifolia	Serviceberry
Artemisia frigida	Pasture Sagebrush
Arctostaphylos uva-ursi	Kinnikinick
Chrysothamnus sp	Rabbitbrush
Holodiscus dumosus	Ocean Spray
Mahonia repens	Oregon Grape
Physocarpus monogynus	Ninebark
Prunus virginiana	Chokecherry
Purshia tridentata	Bitterbrush
Ribes coloradense	Colorado Currant
Rosa woodsii	Woods Rose
Rubus idaeus ssp sachalinensis	Raspberry
Shepherdia argentea	Buffaloberry
Symphoricarpos oreophilus	Snowberry
Vaccinium myrtillus	Blueberry
HERBS	
Achillea lanulosa	Yarrow
Agropyron scribneri	Scribner's Wheatgrass
Androsace septentrionalis	Western Rock Jasmine
Antennaria rosea	Pussytoes
Aquilegia elegantula	Columbine
Arabis sp	Rockcress
Arenaria fendleri	Sandwort
Arnica cordifolia	Arnica
Artemisia biennis	Biennial Wormwood
Aster glaucodes	Glaucous Aster
Carex spp	Sedge
C. geyeri	Sedge
C. rossii	Sedge

Table K-1 (continued)

Cirsium sp.	Thistle
Corydalis aurea	Golden Corydalis
Eriogonum racemosum	False Buckwheat
Festuca saximontana	Fescue
Fragaria ovalis	Strawberry
Draba spp.	Whitlow Wort
Gilia pinnatifida var. *calcarea*	Gilia
Grindelia subalpina	Mountain Gumweed
Heuchera spp.	Alumroot
Leptodactylon pungens	Prickly Gilia
Muhlenbergia montana	Mountain Muhly
Orthocarpus luteus	Owl Clover
Oxytropis splendens	Showy Locoweed
Penstemon strictus	Beard-tongue
P. whippleanus	Beard-tongue
Poa epilis	Skyline Bluegrass
P. glauca	Bluegrass
P. nemoralis var. *interior*	Bluegrass
Pseudocymopteris montana	False Carrot
Ranunculus sp.	Buttercup
Rumex sp.	Dock
Sedum lanceolatum	Stonecrop
Senecio atratus	Ragwort
S. eremophilus ssp. *kingii*	Ragwort
S. fendleri	Ragwort
S. fremontii var. *blitoides*	Ragwort
S. wootonii	Ragwort
Sibbaldia procumbens	Sibbaldia
Taraxacum officinalis	Dandelion
Thermopsis divaricarpa	Golden Banner

Table K-2

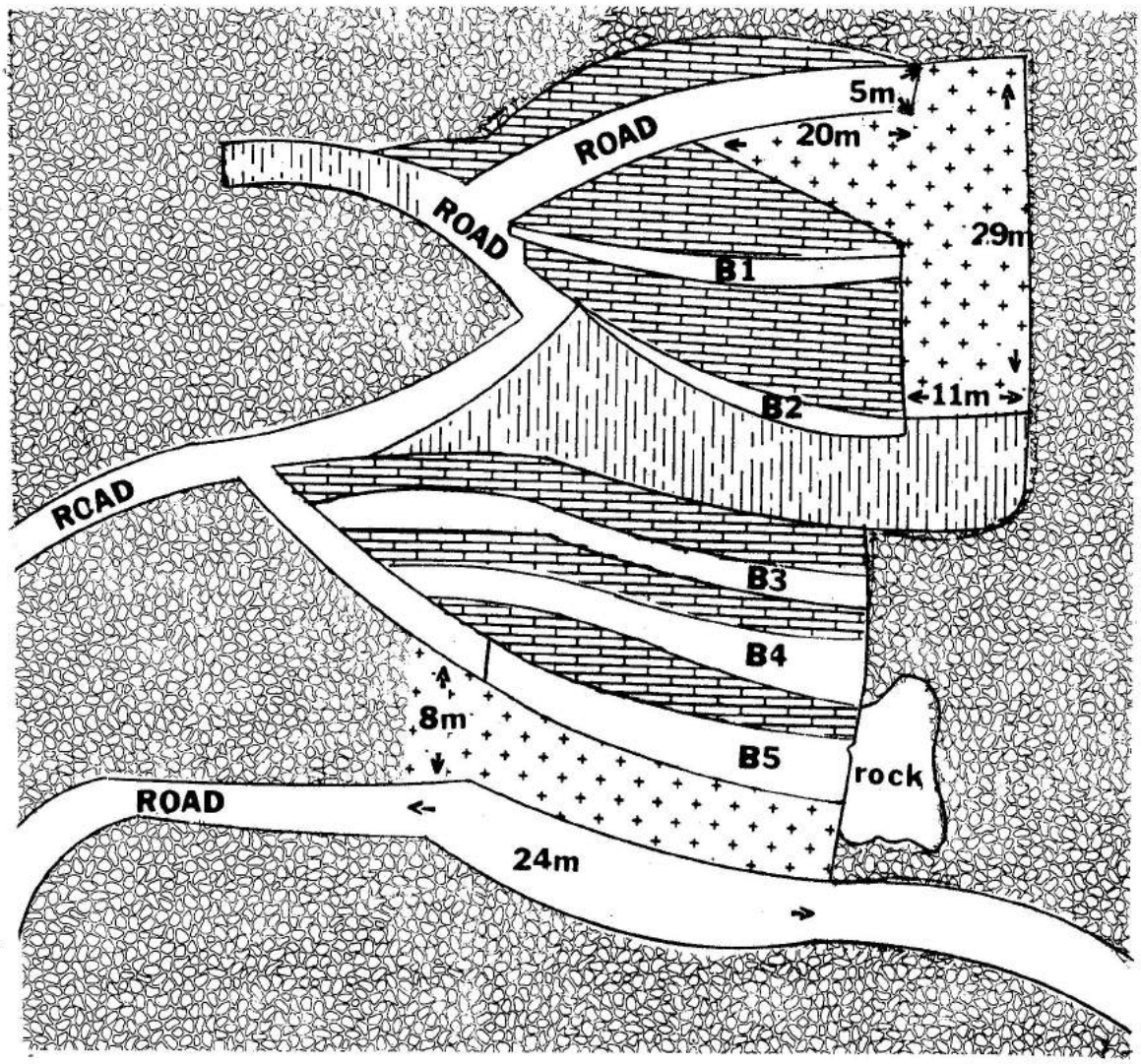
VEGETATION ANALYSIS
Simulated Pit Wall - West Facing (Site A)

Trees	Density (#/m^2)	Frequency (%)	Cover (%)
Populus tremuloides	.21	25.0	14.29
Juniperus scopulorum	.04	4.2	5.62
Pinus contorta	.04	4.2	2.14
Shrubs			
Rosa woodsii	4.46	37.5	2.96
Vaccinium myrtillus	3.50	16.7	2.47
Mahonia repens	1.33	30.8	.23
Symphoricarpos oreophilus	.17	8.3	2.60
Rubus idaeus	.29	8.3	.43
Alnus tenuifolia	.04	4.2	4.39
Herbs			
Grasses	10.42	45.8	3.30
Arnica cordifolia	11.58	29.2	3.14
Carex geyeri	5.29	29.2	1.14
Unknown spp.	4.00	16.7	.23
Fragaria ovalis	1.88	16.7	.57
Taraxacum officinalis	.29	16.7	.07
Senecio fendleri	.75	12.5	.20
Carex rossii	.62	12.5	.23
Achillea lanulosa	.83	8.3	.33
Aquilegia elegantula	.08	8.3	.07
Thermopsis divaricarpa	.38	4.2	.43
Chamerion angustifolium	.12	4.2	.17
Pseudocymopteris montana	.04	4.2	.04
Corydalis aurea	.04	4.2	.01
Carex spp.	.04	4.2	.01

Table K-3

VEGETATION ANALYSIS
Simulated Pit Wall - East Facing (Site B)

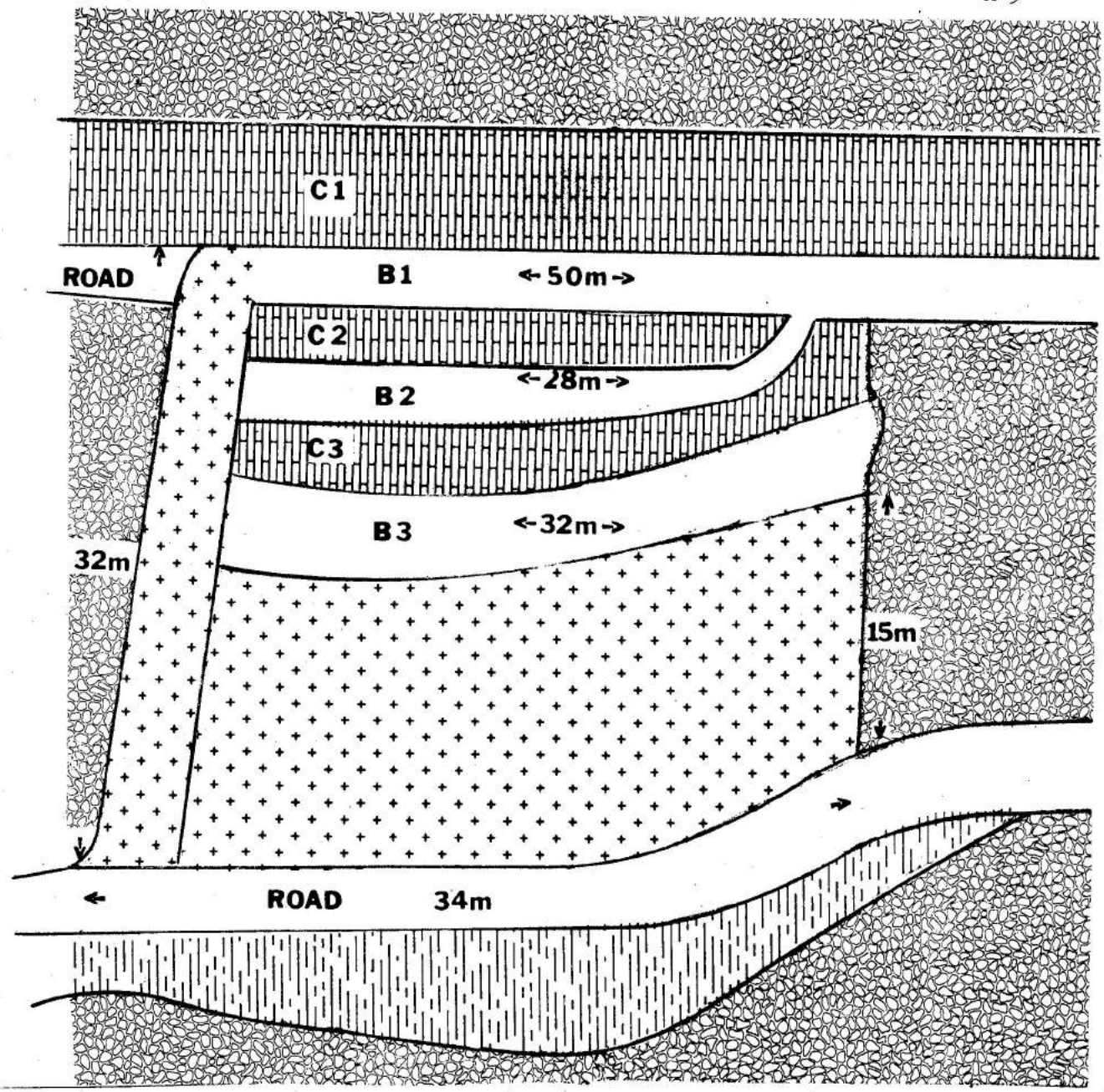
Trees	Density (#/m^2)	Frequency (%)	Cover (%)
Populus tremuloides	.38	25.0	3.15
Pinus contorta	.12	12.5	1.15
Picea englemannii	.12	6.2	.01
Shrubs			
Rubus idaeus	.69	31.2	.50
Vaccinium myrtillus	.06	6.2	.01
Herbs			
Grasses	9.00	31.2	1.23
Thermopsis divaricarpa	8.00	12.5	1.22
Unknown spp.	.25	12.5	.01
Chamerion angustifolium	.12	6.2	.01
Taraxacum officinalis	.06	6.2	.02



	benches	average width	length
cut			
bench	B1	3.2	30.0
slope	B2	2.2	14.0
platform	B3	2.7	42.8
trees and shrubs	B4	3.2	39.5
road	B5	3.6	33.0

Scale: 1cm.=6m

Figure K-2. Site A layout. Southwest-facing. Road at forefront provides access from Marshall Creek.



cut
bench
slope
platform
trees and shrubs
ROAD road
Scale: 1cm=6m

benches	average width	cutwall	height
B1	3.7	C1	5.3
B2	2.3	C2	2.4
B3	4.0	C3	3.2

Figure K-3. Site B layout. Northeast-facing. Road at forefront provides access to Harry Creek and then on to Marshall Creek.

upper roads at one time provided access to Site A. The connector has been scheduled for recontouring in preparation for revegetation.

STUDY DESIGN

A specific study design has been submitted to Homestake Mining Co. Because of the lateness of the season and the inability to carry out the study design, the specific design is not being included with the report. This will enable us to consider any positive input and study design revision prior to the 1981 season.

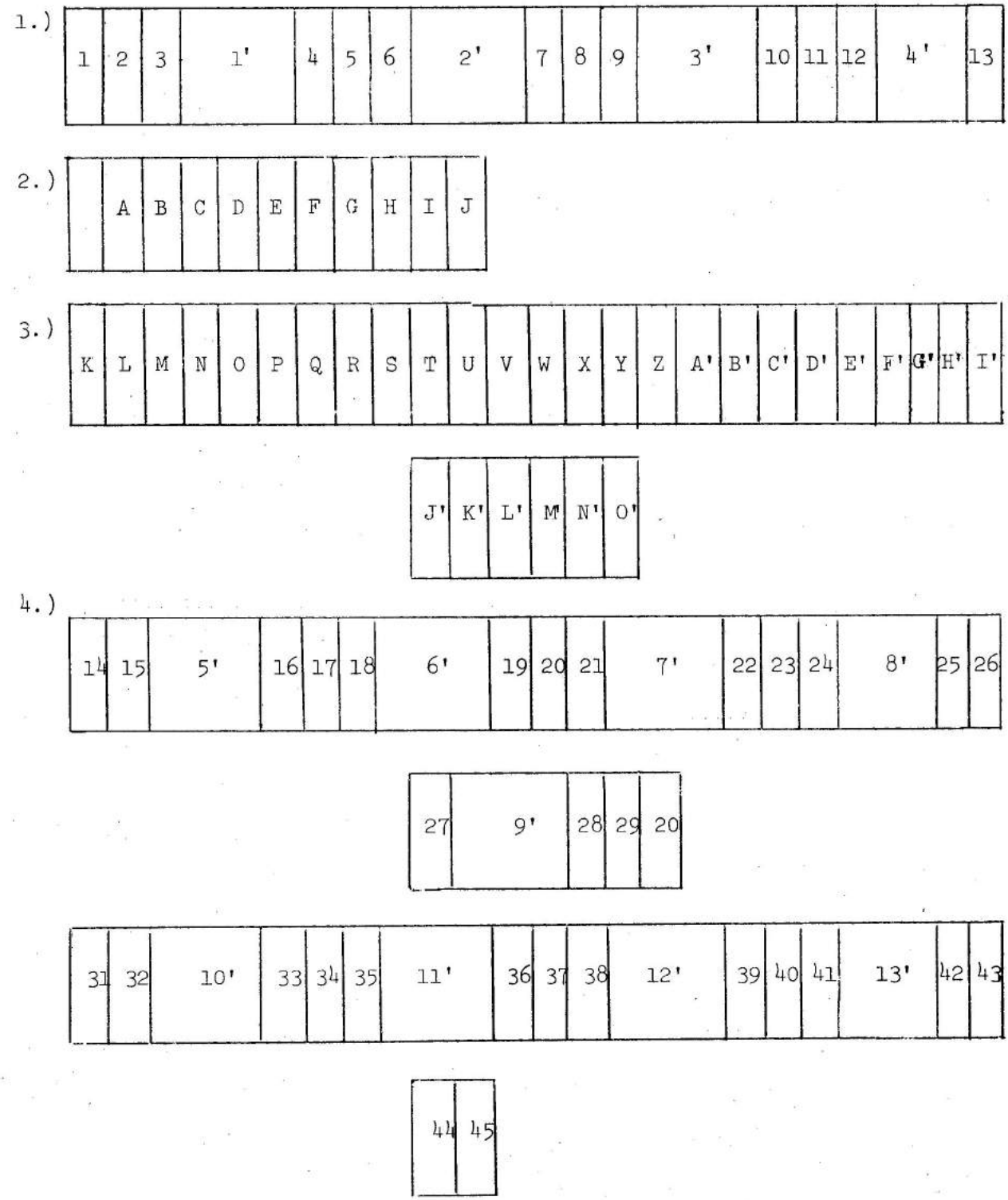
At the end of summer, a supply of conifers which had been obtained from the Colorado State Forest Service Nursery and from the AMAX Underground Nursery (Mt. Emmons) were available. Some of these were planted at Site A (Table K-4).

Table K-4

1980 PLANTING - SITE A - TRANSPLANTS

Plot (Figure K-4)	Plant Name	Source
O	Pinus contorta latifolia	State Forest Nursery
V	Pinus flexilis	AMAX
W	Pinus aristata	AMAX
X	Picea engelmannii	State Forest Nursery
Y	Pinus flexilis	AMAX
Z	Pseudotsuga menziesii	AMAX
A'	Picea pungens	AMAX
B'	Abies concolor	AMAX
C'	Abies concolor	State Forest Nursery
D'	Pinus ponderosa	AMAX
E'	Pinus aristata	AMAX
F'	Picea engelmannii	State Forest Nursery
G'	Pseudotsuga menziesii	AMAX
H'	Picea pungens	AMAX
I'	Abies concolor	AMAX
J'	Abies concolor	State Forest Nursery
K'	Pinus ponderosa	AMAX
O'	Pinus contorta latifolia	State Forest Nursery

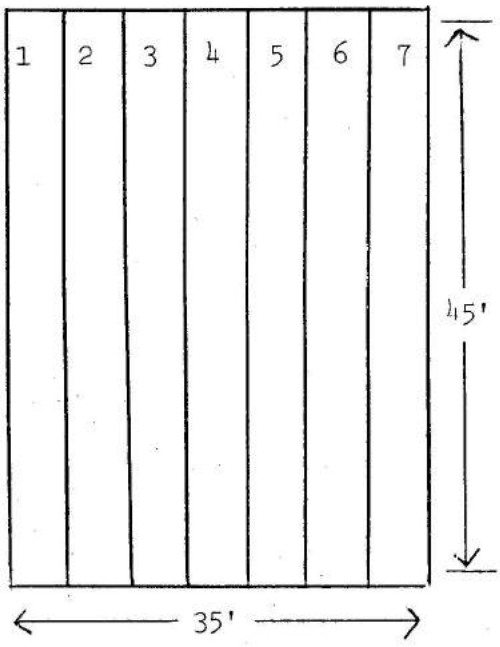
A. BENCHES

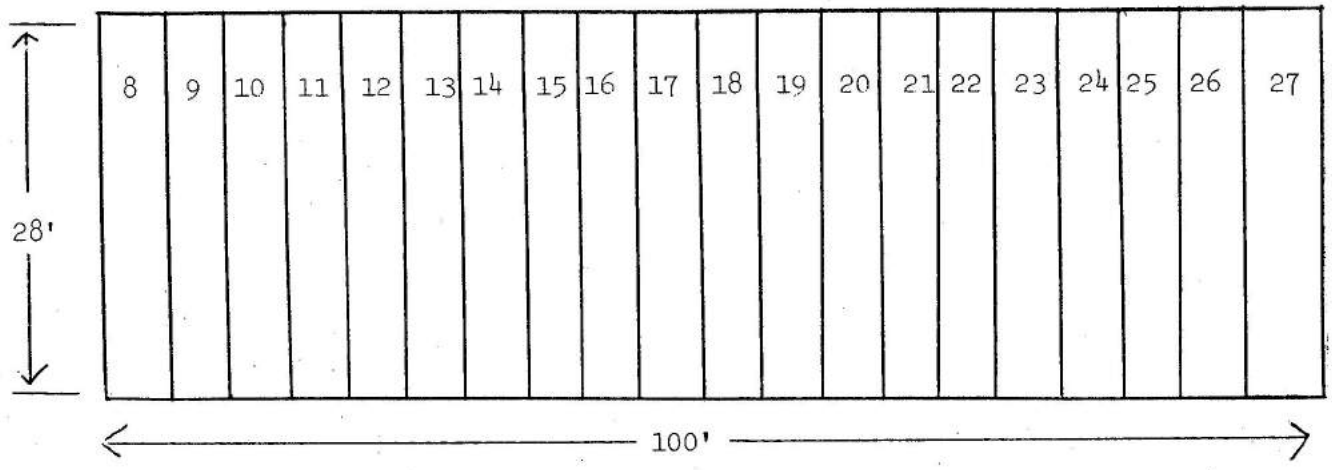


45 plots 1.23 m x 1.85 m = Numbered Plots
13 plots 1.85 x 3.7 m = Numbered Plots with prime designation
41 plots 1.23 m x variable = Lettered Plots

Figure K-4. Plot distribution on benches at simulated pit wall (Site A).

B. SLOPES





Lower Slope

27 plots _____ x length of the slope

27 plots 1.54 m x length of slope

Figure K-5. Plot distribution on slopes at simulated pit wall (Site A).

A. BENCHES

1.)

1	2	3	1'	4	5	6	2'	7	8	9	3'	10	11	12	4'	13

14	15	5'	16	17	18	6'	19	20	21

2.)

22	23	24	7'	25	26	27	8'	28	29	30	9'	31	32	33	10'

3.)

34	35	36	11'	37	38	39	12'		13'

B. SLOPES

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Plus 8 plots on adjoining slope

39 plots 1.23 m x 1.85 m = Numbered plots
18 plots 1.85 m x 3.7 m = Numberes with prime designation
28 plots 1.54 m x length of slope = Numbered plots

Figure K-6. Plot distribution at simulated pit wall (Site B).

Chapter 12

SUMMARY

In 1979, revegetation was restricted to treating some areas which were created after revegetation was completed in 1978, and following up on those sites where 1978 revegetation was unsuccessful. A total of 10 acres was seeded.

In 1979, test plots were maintained. Some additional work was initiated to alter overburden materials to allow root growth to take place with less impedence.

In 1980, revegetation occurred on over 30 acres, including many newly created areas in the vicinity of the pits and in Hale's Gulch.

The test plots were maintained with additional plots established to evaluate amendments.

Roadside treatment areas were established on the cut side of the road between the proposed Mill Site and the Tie Camp Diversion. Near the offices, strips were established on the overburden fill at roadside.

An overburden pier to test amendments and slope angles was designed and established. A pit wall scenario was designed and constructed at two sites near Harry Creek.

Whereas 1979 represented and "hold" pattern in which ongoing work was maintained, 1980 was a year where the concentration was given to establishing new programs facing the realities of the reclamation of specific areas.

TABLE L-1

TOTAL TIME SPENT
ON VARIOUS PROJECTS, 1980

	June	July	August	Total Hours
Revegetation	522.5	370.5	272.3	1175.3
Test Plot-Water Treatment Plant	132.5	34.0	16.8	183.3
Test Plot-Hale's Gulch	222.5	33.0	21.5	277.0
Root Depth Studies	105.0	-	-	105.0
Overburden	332.5	744.0	229.5	1306.0
Seed Collecting	42.0	297.0	193.8	532.8
Pit Wall Simulation	154.0	99.5	148.0	401.5
Miscellaneous	76.5	47.5	135.0	259.0
Hydromulch WSC field	-	-	56.0	56.0
Water Roads	-	-	33.0	33.0
	1597.5	1625.5	1105.9	4328.9