

## PLANTING EXPERIENCES AT THE ROSEBUD MINE, COLSTRIP, MT

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Abstract.--Western Energy Company has been actively involved in the evolution of reclamation seed mixes, equipment and technique since 1968. During this time the seed mix has changed from one all purpose mix composed primarily of introduced cool season grasses to four fundamental mixes (upland, lowland, conifer and supplemental). Over the years 28 variations of approved seed mixes have been planted at the Rosebud Mine. Equipment used for seeding and seedbed preparation have included a Rangeland drill with 12" row spacing, a gouger/seeder and a sunflower cultipacker. Presently used equipment includes a Brillion broadcast seeder, a Horizon drill with 6" row spacing and a Brillion roller-harrow-packer. Planting technique has evolved from a single planting through multiple phase plantings with treatments separated by 6 to 12 month periods to the present method which entails drill seeding the larger seeded grasses followed immediately by seeding of the smaller seeded species with the Brillion broadcast seeder.

### SEED MIXES

The first reclamation seed mixes used at the Rosebud Mine were "combination" mixes (Table 1). There were three of these mixes planted through 1979. They each had all the species to be planted contained in one package. From 15 to 19 different species or varieties were included in each mix. A significant percentage of these early mixes were introduced or non-native species. Forty percent of the first seed mix (Table 2), most of which was cool season grasses, fell into this category. There were no native forbs. The only shrub species in the mix, while native to Montana, was not found in any of the pre-mine surveys conducted in the Colstrip vicinity. The other two "combination" mixes were of similar composition and had 48.1 and 39.7 percent non-native species respectively.

In 1979 a major change in seed mix philosophy was implemented. Instead of one universal mixture which would be planted in every ecological niche, seed mixes were developed for specific topographic locations. Three separate mixes were obtained for planting on "North and East Slopes," "South and West Slopes" and "Drainages." Species were placed in these mixes based on their moisture tolerance levels. As in the previous mixes, species not common to the Colstrip vicinity were the major component, ranging from 40.3 to 51.7 percent of the Pure Live Seed (PLS) mix.

The introduced species quickly became dominant in the fields where these seed mixes were planted. The ability to meet the final bond release requirement of at least 51 percent native species (based on production and canopy cover data) was in serious jeopardy and another major change in seed mix composition was necessary.

Western Energy Company responded by limiting all of its reclamation seed mixes to mostly native or "naturalized" species. At the same time the commitment to planting forb species was expanded and the philosophy of separate mixes for different topographic features was retained. The result was four new seed mixtures: Uplands, Steep Uplands, Lowland/drainage and Supplemental. The first three, which included cool and warm season grass species, were designed for planting on the various topographic features and the "Supplemental" mix was intended to enhance the forb, shrub and warm season grass component of upland areas. These new mixes were first planted in 1980.

The same basic structure and philosophy persists in our current seed mixes. There have been some minor alterations since 1980. In 1981 a "Conifer" mix was formulated for planting in areas designated as Conifer Zones. In 1983 the "Steep Upland" mix was dropped. In 1986 the "Warm Season" mix replaced the "Conifer" mix reflecting an increase in the percentage and number of warm season species in the mix.

As a particular seed mix has been planted and reordered there has been some variation in species composition and PLS mix percentages resulting from seed availability and purity. In 1984 the last introduced forb species was dropped from the "Supplemental" seed mix and a common shrub species replaced another native not found in the Colstrip area. Over the years there have been eight (8) upland, three (3) lowland/drainage, five (5) supplemental and three (3) conifer/warm season seed mixes.

The seed mixes planted in 1986 were the following: Upland (Table 3), Supplemental (Table 4), Warm Season (Table 5) and Lowland/drainage (Table 6).

Western Energy Company has two other mixes it uses for special purposes. The "Scoria" mix is used to reclaim scoria pits and the "Topsoil Pile" mix is used to stabilize soil stockpiles.

In total there have been twenty eight (28) different seed mixtures utilized by Western Energy Company at its Rosebud Mine.

#### EQUIPMENT

Western Energy Company uses two major types of equipment in reclaiming mined land. The first is the heavy equipment used to regrade spoil material and laydown topsoil. These two procedures comprise the major portion of reclamation expense. Western Energy Company spends approximately \$5,638 per acre to reconstruct topography which will tie into the natural, undisturbed terrain. Most of this work is done with D10 and D9L Caterpillar dozers. A patrol with a three-shank ripper is used to scarify the spoil surface prior to topsoil laydown. Mobile 631 Caterpillar scrapers are used to pick up and lay down the various soil horizons. This process costs \$2,260 per acre. Getting a soil medium in place on topographic features capable of supporting a vegetative community in a state of "dynamic equilibrium" represents 92.0% of Western Energy's reclamation expense.

The second category of equipment includes everything used in seedbed preparation, planting (grass, shrubs and trees) and management. Our current inventory includes:

- Ford TW-20 Tractor
- Ford 9700 Tractor
- Ford 5000 Tractor
- IH 460 Tractor
- Miskin Sub-soiler
- 10' Chisel Plow
- 12' Disc
- 22' Disc
- Brillion Roller-harrow
- Tye Stubble Drill
- Horizon Drill
- Brillion Broadcast Seeder
- Cyclone Broadcast Seeder

- Hydromulch Truck
- Vermeer Tree-spade
- Tree "Planter" (S.C.S. Model)
- Modified Stakprocessor
- Crimper
- 9' Sickle Bar Mower
- Bush Hog Mower

Use of some equipment has been discontinued. These items and their last year of use include:

- Rotovator (1981)
- Whirlybird Broadcaster (1981)
- Sunflower Cultipacker (1981)
- Hodder Seeder-Gouger (1979)
- Rangeland Drill (1976)

#### CURRENT RECLAMATION TECHNIQUES

1. After topsoiling is completed, the work that is normally associated with reclamation is begun. This costs Western Energy Company \$689 per acre or 8.0% of the total reclamation expense. The first step in the process is "seedbed preparation." This is done on every acre of reclamation at a cost of \$42.82/ac. and consists of:

- (a) Subsoiling with the Miskin sub-soiler to the maximum depth possible to reduce soil compaction and to increase the potential for moisture infiltration and root penetration into the soil medium;
- (b) Discing and/or chisel-plowing to eliminate large clumps of dirt when required;
- (c) Packing with the Brillion roller-harrow to further reduce any dirt clumps making the seedbed firm and uniform for maximum seed to soil contact.

2. Seeding of grass, forb and shrub species is the next step and is normally done with the "two-pass" method ranging in cost from \$112.06 to \$225.63:

- (a) The "upland," "lowland/drainage," or "warm season" seed mix is planted in the first pass with a Tye or Horizon drill seeder at the rate of 10 PLS #/ac. (cost = \$112.06/ac.);
- (b) A second pass with the Brillion broadcast seeder and the "supplemental" seed mix is made immediately following the first pass in areas where the "upland" mix was planted at 6 PLS #/ac. (cost = \$113.57);
- (c) In areas deemed too steep for safe operation (i.e. the proposed terraced slope in Area E) seeding is done with the Hydro-mulch truck at 26 PLS #/ac. (cost = \$705/ac.);

3. Certain shrub and tree areas designated in the permits are planted with nursery stock to supplement seed stands. Western Energy is currently planting both bareroot and tubeling stock. Tubelings are planted by hand at the rate of 20-40/manhour and with the tree "planter" at the rate of 250-500/hour. Bareroot stock is always planted with the tree "planter." Shrub species have been planted at a minimum of

50/ac. and tree species (mainly Ponderosa pine) have been planted at a minimum of 100/ac.

4. Fertilizing is not needed for establishment of native species in areas of "direct haul" topsoiling. In fact it is somewhat detrimental as it enhances undesirable annuals. Fertilizer is applied to reclaimed "croplands" and in areas of "stockpiled" topsoiling at a cost of \$32.13/acre.

5. Straw or native grass hay mulch is applied with a modified Stakprocessor on slopes greater than 7:1 at a rate of 3000 #/acre. It is incorporated into the soil (crimped) to further reduce erosion potential. Total mulching and crimping cost is \$147.21/acre. Hydro-mulching is done on areas where erosion problems occur at a rate of 1500 #/ac and a cost of \$445.12/acre.

#### DISCONTINUED RECLAMATION TECHNIQUES

1. The Rangeland drill was one of the first drills used in reclamation seeding. It had a row spacing of 12" which was too wide for rapid establishment of an acceptable ground cover. It was last used in 1976 for general planting operations.

2. The Hodder seeder-gouger was developed during the early days of reclamation research at Colstrip as an implement to seed and prepare a water-catchment basin simultaneously. It created a very rough surface and was inefficient in getting seed established. It was last used in 1979.

3. The rotovator was last used in the 1981 field season. It had been used to incorporate mulch into the soil surface after seeding was completed for the purpose of water erosion control. The problem was that it caused a major disturbance of the seedbed resulting in moisture loss and poor seed establishment.

It was replaced by the "Crimper", a vertical disc, which "tucks" the mulch into the soil surface without disturbing the seedbed.

4. One of the first seeders used at the Rosebud Mine was a Whirlybird Broadcast Seeder. It was replaced as the primary seeder after the 1981 field season because it wasted a lot of seed and because of poor seed establishment in wind eroded areas. Also known as a Cyclone seeder, this implement is still used to apply fertilizer.

5. The Sunflower cultipacker was used as a follow-up to the Whirlybird seeder to press the broadcast seed into the top layer of soil. It was retired after the replacement of the Whirlybird seeder with drills (Tye and Horizon).

6. During the first years of reclamation, planting was done either with a drill or a

broadcast seeder. Both implements were used at the Rosebud Mine but in different fields. As use of the Rangeland drill was being phased out, broadcast seeding became the dominant method. Generally speaking, each new method was gradually phased in over a period of time.

7. Western Energy Company initiated the "two-phased" seeding technique in 1980. In this method the supplemental mix (primarily forb and warm season grass species) was planted first. It was allowed at least one growing season to become established before the more competitive cool season grasses were planted. This technique was replaced in the Fall 1984 planting period with the "two-pass" system described above [C(2)] for the following reasons:

- Undesirable forb and annual grasses were becoming the dominant species in many fields greatly impeding the establishment of the desirable species;
- The subsequent seeding of the cool season grasses was difficult due to the heavy residuum of Russian thistle (*Salsola kali*) and often required the additional effort of mowing and/or burning prior to drilling;
- The start of the bonding responsibility period (and final bond release application date) was delayed from six months ago to more than a year.

Table 1.--Historical Seed Mix Summary

Seed Mix	Source	Date Obtained	Date(s) Seeded
A. Combination mixes			
1. Special purpose mix	Northrup	Unknown	Spring 78 & prior
2. "Grass" mix(a)	Jacklin	4/78	Fall 1978
3. "Grass" mix(b)	Jacklin	10/78	1979
B. Separated mixes			
4. North & East Slope	Jacklin	Unknown	1979
5. South & West Slope	Jacklin	Unknown	1979
6. Drainage	Jacklin	Unknown	1979
7. Uplands	Jacklin	9/79	1980
8. Uplands #2	Jacklin	10/79	1980
9. Steep Uplands	Jacklin	10/79	1980
10. Lowland/drainage	Jacklin	11/79	1980
11. Supplemental	Jacklin	1/80	1980
12. Lowland/drainage	Jacklin	9/80	1981 - 1986
13. Conifer	Jacklin	9/80	1981 - 1985
14. Uplands	Jacklin	9/80	1981 - 1982
15. Steep Uplands	Jacklin	9/80	1981 - 1982
20. Supplemental	Jacklin	3/81	1981 - 1982
16. Lowland/drainage	Sharp Bros.	9/80	1981 - 1986
17. Conifer	Sharp Bros.	9/80	1981 - 1985
18. Uplands	Sharp Bros.	11/80	1981
19. Uplands	Big Sky	8/81	1982
22. Uplands	Jacklin	10/82	1983 - 1985
24. Supplemental	Sharp Bros.	10/82	1983 - Spring 84
25. Supplemental	Native Plants	5/84	Fall 84 - 1985
26. Warm season	Sharp Bros.	11/85	1986
27. Supplemental	Forsyth Seed	3/86	1986
28. Upland	Forsyth Seed	3/86	1986
C. Special Purpose mixes			
21. Scoria mix	Sharp Bros.	4/82	Fall 82 - present
23. Topsoil pile mix	Jacklin	10/82	1983 - present

Table 2.--Western Energy's First Seed Mixture

Scientific Name	Common Name	PLS Mix Percent
COOL SEASON PERENNIAL GRASSES		
<i>Agropyron dasystachyum</i>	Thickspike Wheatgrass	13.20
<i>Agropyron riparium</i>	Streambank Wheatgrass	8.50
<i>Agropyron smithii</i>	Western Wheatgrass	10.60
<i>Agropyron trachycaulum</i>	Slender Wheatgrass	8.70
<i>Oryzopsis hymenoides</i>	Indian Ricegrass	1.30
<i>Stipa viridula</i>	Green Needle Grass	10.90
WARM SEASON PERENNIAL GRASSES		
<i>Bouteloua curtipendula</i>	Side Oats Grama	2.60
<i>Bouteloua gracilis</i>	Blue Grama	2.60
<i>Calamovilfa longifolia</i>	Prairie Sandreed	1.30
<i>Sporopolus airoides</i>	Alkali Sacaton	0.70
INTRODUCED PERENNIAL GRASSES		
<i>Agropyron cristatum</i>	Crested Wheatgrass	2.70
<i>Agropyron trichophorum</i>	Pubescent Wheatgrass	12.40
<i>Bromus inermis</i>	Smooth Bromegrass	6.70
PERENNIAL FORBS		
<i>Astragalus cicer</i>	Cicer Milkvetch	6.20
<i>Onobrychis viciaefolia</i>	Sainfoin	9.10
SHRUBS		
<i>Atriplex canescens</i>	Four-wing Saltbush	2.40

Table 3.--Upland Seed Mix - 1986 Plantings

Scientific Name	Common Name	PLS Mix Percent
COOL SEASON PERENNIAL GRASSES		
<i>Agropyron dasystachyum</i>	Thickspike Wheatgrass	4.00
<i>Agropyron smithii</i>	Western Wheatgrass	12.00
<i>Agropyron spicatum</i>	Bluebunch Wheatgrass	17.50
<i>Agropyron trachycaulum</i>	Slender Wheatgrass	17.50
<i>Oryzopsis hymenoides</i>	Indian Ricegrass	17.50
<i>Stipa comata</i>	Needle-and-thread Grass	3.00
<i>Stipa viridula</i>	Green Needle Grass	17.50
WARM SEASON PERENNIAL GRASSES		
<i>Bouteloua curtipendula</i>	Side Oats Grama	11.00

Table 4.--Supplemental Seed Mix - 1986 Plantings

Scientific Name	Common Name	PLS Mix Percent
COOL SEASON PERENNIAL GRASSES		
<i>Poa canbyi</i>	Canby Bluegrass	21.00
WARM SEASON PERENNIAL GRASSES		
<i>Bouteloua gracilis</i>	Blue Grama	27.00
PERENNIAL FORBS		
<i>Achillea millefolium</i>	Common Yarrow	9.00
<i>Linum perenne</i>	Perennial Flax	9.00
<i>Petalostemon candidum</i>	White Prairie Clover	4.00
<i>Petalostemon purpureum</i>	Purple Prairie Clover	27.00
<i>Sphaeralcea coccinea</i>	Scarlet Globe Mallow	2.00
SHRUBS		
<i>Artemisia cana</i>	Silver Sagebrush	1.00

Table 5.--Warm Season Seed Mix - 1986 Plantings

Scientific Name	Common Name	PLS Mix Percent
COOL SEASON PERENNIAL GRASSES		
<i>Agropyron smithii</i>	Western Wheatgrass	5.00
<i>Agropyron spicatum</i>	Bluebunch Wheatgrass	10.00
WARM SEASON PERENNIAL GRASSES		
<i>Andropogon hallii</i>	Sand Bluestem	20.00
<i>Andropogon scoparius</i>	Little Bluestem	20.00
<i>Bouteloua gracilis</i>	Blue Grama	25.00
<i>Calamovilfa longifolia</i>	Prairie Sandreed	20.00

Table 6.--Lowland/Drainage Seed Mix - 1986 Plantings

Scientific Name	Common Name	PLS Mix Percent
COOL SEASON PERENNIAL GRASSES		
<i>Agropyron dasystachyum</i>	Thickspike Wheatgrass	10.00
<i>Agropyron smithii</i>	Western Wheatgrass	45.00
<i>Agropyron trachycaulum</i>	Slender Wheatgrass	15.00
<i>Bromus marginatus</i>	Mountain Brome	10.00
INTRODUCED PERENNIAL GRASSES		
<i>Poa compressa</i>	Canada Bluegrass	10.00
<i>Poa pratensis</i>	Kentucky Bluegrass	10.00