

S Scow, Kenneth Lee
581.524 Appendix C.,
M26acva vegetation/
1988 agricultural
resources of the
Beal Project area

APPENDIX C. VEGETATION/AGRICULTURAL
RESOURCES OF THE BEAL PROJECT AREA

STATE DOCUMENTS COLLECTION

JAN 8 1993

MONTANA STATE LIBRARY
1515 E. 6th AVE.
HELENA, MONTANA 59620



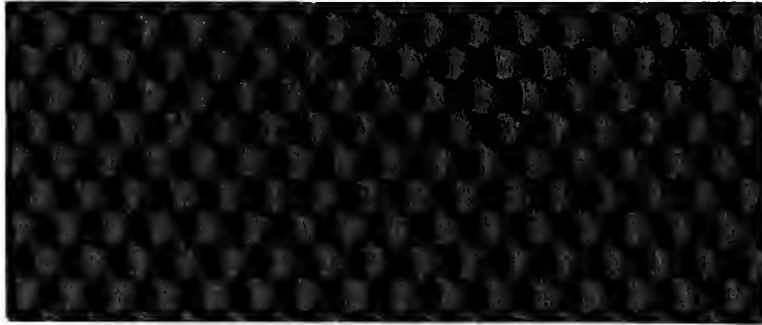
WESTECH

Western Technology and Engineering Inc.

MONTANA STATE LIBRARY
S 581.524 M26acva 1988 c.1 Scow
Appendix C., vegetation/agricultural res



3 0864 00082347 9



Dec

APPENDIX C. VEGETATION/AGRICULTURAL
RESOURCES OF THE BEAL PROJECT AREA

Prepared for:

Beal Mountain Mining, Inc.
P.O. Box 176
Jefferson City, Montana 59638

Prepared by:

Ken L. Scow
L. Dean Culwell

Western Technology and Engineering, Inc.
P.O. Box 6045
Helena, Montana 59604
406-442-0950

January, 1968

CONTENTS

	<u>Page</u>
INTRODUCTION	1
METHODS	1
OEA RESEARCH SURVEY	1
SAWYER SURVEY	3
WESTECH SURVEY	4
RESULTS AND DISCUSSION	6
PERMIT AREA	6
Habitat/Community Type Descriptions	6
Idaho Fescue/Bluebunch Wheatgrass Habitat Type ...	6
Idaho Fescue/Bearded Wheatgrass Habitat Type	13
Rough Fescue/Bluebunch Wheatgrass Habitat Type ...	14
Rough Fescue/Idaho Fescue Habitat Type	15
Tufted Hairgrass/Sedge Habitat Type	16
Shrubby Cinquefoil/Rough Fescue Habitat Type	17
Sitka Alder Community Type	18
Quaking Aspen Community Type	19
Douglas-fir/Pinegrass Habitat Type	19
Douglas-fir/Twinflower Habitat Type	20
Subalpine Fir/Elk Sedge Habitat Type	23
Subalpine Fir/Pinegrass Habitat Type	23
Subalpine Fir/Grouse Whortleberry Habitat Type ...	24
Subalpine Fir/Beargrass Habitat Type	25
Subalpine Fir/Sitka Alder Habitat Type	26
Subalpine Fir/Twinflower Habitat Type	26
Subalpine Fir/Rusty Menziesia Habitat Type	27
Subalpine Fir/Bluejoint Reedgrass Habitat Type ...	28
Disturbed Upland Community Type	30
Disturbed Riparian Community Type	32
Grazing/Agricultural Uses	33
Timber Resources	34
Noxious Weeds	36

	<u>Page</u>
ACCESS ROAD OPTIONS	39
Habitat/Community Type Descriptions	39
Bluebunch Wheatgrass/Native Bluegrass	
Habitat Type	41
Idaho Fescue/Bluebunch Wheatgrass	
Habitat Type	41
Rough Fescue/Bluebunch Wheatgrass	
Habitat Type	42
Rough Fescue/Idaho Fescue Habitat Type	42
Tufted Hairgrass/Sedge Habitat Type	42
Antelope Bitterbrush/Bluebunch Wheatgrass	
Habitat Type	43
Antelope Bitterbrush/Rough Fescue	
Habitat Type	43
Willow Community Type	43
Quaking Aspen Community Type	44
Douglas-Fir/Idaho Fescue Habitat Type	44
Douglas-Fir/Rough Fescue Habitat Type	44
Douglas-Fir/Pinegrass Habitat Type	45
Douglas-Fir/Common Snowberry Habitat Type	45
Douglas-Fir/Twinflower Habitat Type	46
Douglas-Fir/Mallow Ninebark Habitat Type	46
Engelmann Spruce/Twinflower Habitat Type	46
Subalpine Fir/Twinflower Habitat Type	47
Subalpine Fir/Bluejoint Reedgrass Habitat Type ...	47
Disturbed Riparian Community Type	47
Grazing/Agricultural Uses	47
Timber Resources	48
Noxious Weeds	49
 SPECIES LIST/RARE PLANTS	 50
 LITERATURE CITED	 56

LIST OF TABLES

<u>Table.</u>		<u>Page</u>
1	Site parameters and relative abundance of vegetation habitat/community types in the Beal Project permit area, Silver Bow County, Montana	7
2	Mean percent canopy cover/frequency of important vascular plant species by transect for five grassland and shrubland habitat types, Beal Project study area (data source: OEA Research, 1981)	9
3	Production values for grassland and shrubland habitat types on the Beal Project permit area	12
4	Mean percent canopy cover/frequency of vascular plant species by transect for five forest habitat types, Beal Project study area (data source: OEA Research, 1981)	21
5	Vascular plant species identified on disturbed sites in the Beal Project permit area	31
6	Tree density (stems/acre) by species, dbh class and habitat type	35
7	Mean basal area and 50-year site indexes by habitat type	37
8	Height, diameter and age of selected trees by habitat type and species	38
9	Site parameters and relative abundance of vegetation habitat/community types in the Beal Project access options, Silver Bow County, Montana	40

EXHIBIT

C-1	Vegetation map, Beal Project permit area..... map pocket
-----	--

INTRODUCTION

Vegetation of the Beal Project area was quantitatively sampled by OEA Research (1981) during July, 1981. A subsequent change in the permit area resulted in the collection of additional data and extension of habitat type mapping by Sawyer (1984) during October, 1984. The project has more recently been reevaluated, resulting in a change in the permit boundary and requiring reevaluation of vegetation. A vegetation reconnaissance was conducted during October and November, 1987 to evaluate vegetation of the new permit area and several access road options.

Rather than submitting three separate reports for the project, the results of all three investigations are included in this report. OEA Research (1981) and Sawyer (1984) have previously been submitted to MDSL should their review by the agencies be necessary.

METHODS

OEA RESEARCH SURVEY (Extracted From OEA Research, 1981)

During July 1981, 20 vegetation transects were established in the original study area. Ten transects were placed in forest stands and ten in grassland and shrubland stands. In forest stands, two types of sampling procedures were employed: 1) a circular, 375-square-meter macroplot to estimate overstory canopy cover; 2) twenty 2x5 dm

rectangular microplots placed along the contour and central axis of the circular macroplot to estimate understory cover. In each macroplot, total overstory canopy coverage was estimated for all trees as well as for each tree species. All trees in the macroplot were counted and recorded by size class. A vigorous, relatively open-growing tree of each species within the macroplot was selected and analyzed for growth information. This involved measuring tree height, diameter at breast height (dbh) and removing a core with an increment borer to determine age. Tree height was determined using a tape and a Suunto Clinometer for angle measurement.

Canopy coverage of all understory species occurring in each microplot was recorded by coverage class, adapted from the method developed by Daubenmire (1959).

Data for shrubland and grassland stands were gathered using techniques similar to those employed for the understory component of forest stands. In these types, the 20 microplots were spaced at two-meter intervals along a tape stretched along the contour.

All stands sampled were placed in homogeneous vegetation to avoid ecotones between community types; heavily disturbed stands were avoided. A general reconnaissance of the study area was used to add rare or uncommon species to the list. In sampled stands, species occurring in the stand but not in the microplots were recorded for

inclusion in the species list. Site parameters (slope, aspect, elevation, topographic position and slope configuration) were recorded for each transect.

A habitat type map (1" = 2000') was prepared of the OEA Research study area.

SAWYER SURVEY (Extracted From Sawyer, 1984)

Habitat type mapping was extended to an area south of German Gulch. Additional information was obtained in forested stands using two methods, Bitterlich's Variable Radius Method and the Point-Centered Quarter Method, as outlined by Mueller-Dombois and Ellenberg (1974). The Point-Centered Quarter Method was used to calculate tree density and basal area values for five sites (twenty points per site). The Bitterlich method was used to calculate a second value for basal area with an average of 22.4 sample points per site (ranging from 13 to 30 sample points per site). A Cruise Angle gauge (basal area factor of 20) was used in sampling the sites. Timber volumes were obtained as estimates from personal communication with Davis (1983). Stand data based on the point-centered quarter method were generated for trees with dbh greater than four inches.

Sawyer (1984) also summarized information on grazing for his study area.

WESTECH SURVEY

A field reconnaissance of the new permit area and access road options was conducted by foot and vehicle traverse during October and November 1987 to accomplish the following tasks:

- Extend habitat type mapping to cover the new permit area and modify previous mapping to ensure consistency of interpretation. The permit area was mapped on a topographic base at a scale of 1"=500' using July, 1983 color aerial photographs at a scale of 1"=1000'. Mapping units were based on potential plant associations following habitat type classifications of Pfister et al. (1977) for forested habitat types and Mueggler and Stewart (1980) for grassland and shrubland habitat types. Community type mapping units were based on existing species coverage. All identifiable mapping units over two acres in size were delineated. Habitat/community types were mapped for all access options on 1"=1000' black-and-white aerial photographs, using the same procedures. Abundance of permit area types was determined by planimetering the vegetation map. Relative abundance of access option types was determined using a 1/4 x 1/4-inch dot-grid overlay on access option mapping.
- Provide qualitative descriptions of habitat types identified by Sawyer but not described by either OEA Research or Sawyer,

- and describe any new types encountered, including those in the access options.
- Describe species composition on historic mining disturbances in the area.
 - Add to the species list prepared by OEA Research, keying on areas not covered by that survey particularly the access options. Species not readily identified in the field were verified in the laboratory with a stereozoom dissection microscope. Advanced phenology at the time of reconnaissance prohibited positive identification of some taxa.
 - Evaluate the presence of noxious weeds in the proposed permit area and along access road options.
 - Search for potential rare plants listed by Lesica et al. (1984), and review files of the Montana Natural Heritage Program for existing data on rare plant occurrence in the area.
 - Evaluate agricultural or grazing uses of areas not covered by previous surveys.

RESULTS AND DISCUSSION

PERMIT AREA

Habitat/Community Type Descriptions

Vegetation types identified in the Beal Project permit area are listed in Table 1, with site parameters and relative abundance. Five grassland habitat types and one shrubland habitat type were identified, following the classification of Mueggler and Stewart (1980). Two deciduous woodland community types were identified, serial to various forest habitat types. Ten forest habitat types were identified following the classification of Pfister et al. (1977), two in the Douglas-fir series and eight in the subalpine fir series. Disturbed types were also assessed, divided between upland and riparian sites. Quantitative data included in the following type descriptions are taken from OEA Research (1981). Vegetation/soils associations are also given in Appendix D. SOILS. A habitat/community type map of the permit area is included as Exhibit C-1.

Idaho Fescue/Bluebunch Wheatgrass (Fes ida/Agr spi) Habitat Type. The Fes ida/Agr spi type occupies moderate to steep slopes on warmer, usually southerly, aspects. Soils are less developed than those on which the more mesic grassland habitat types occur. Fes ida/Agr spi was generally found at elevations of 6650 to 7500 feet, ranging up to 7850 feet on the south slope of Beals Hill.

TABLE 1. SITE PARAMETERS AND RELATIVE ABUNDANCE OF VEGETATION HABITAT/COMMUNITY TYPES IN THE DEAL PROJECT PERMIT AREA, SILVER BOW COUNTY, MONTANA.

TYPE	CODE	ASPECT	SLOPE*	ELEVATION (FEET)	AREA	RELATIVE ABUNDANCE %
Grassland habitat types						
Idaho fescue/bluebunch wheatgrass	Fes Ida/Aggr spl	SE,S,SW,W	moderate to very steep	6650 - 7850	320.0	27.2
Rough fescue/bearded wheatgrass	Fes Ida/Aggr can	N,NE,E,SE	moderate to steep	7000 - 7700	131.8	11.2
Rough fescue/bluebunch wheatgrass	Fes sca/Aggr spl	SE,S,SW	gentle to moderate	7350 - 7680	18.6	1.6
Tufted hairgrass/sedge	Fes sca/Fes Ida	E,SW	gentle to moderate	7350 - 7590	45.6	3.0
	Des can/Care	N	gentle	7730 - 7760	119.5	10.1
					4.5	0.4
Shrubland habitat type						
Shrubby cinquefoil/rough fescue	Pot fru/Fes sca	SE,SW	gentle	7410 - 7530	2.1	0.2
					2.1	0.2
Deciduous woodland community types						
Sitka alder	Aln sin c.t.	SE	gentle to moderate	6720 - 7100	3.4	0.2
Quaking aspen	Pop tre c.t.	SE	moderate	7080 - 7120	2.9	0.2
					0.5	0.04
Forest habitat types						
Douglas-fir/pinegrass	Fes mon/Cat rub	SE,S, (SW)	moderate to very steep	6540 - 7450	707.8	67.5
Douglas-fir/twinflower	Fes mon/Ln bor	----- minor inclusions in Fes mon/Cat rub			121.0	10.2
Subalpine fir/crk sedge	Abf las/Cat grn	E,S,W, (NW)	gentle to steep	7100 - 7750	61.8	5.2
Subalpine fir/pinegrass	Abf las/Vac sco	E,SE,N	moderate to very steep	6600 - 7700	36.8	3.1
Subalpine fir/grouse whortleberry	Abf las/yer trn	NW,N,NE,E	gentle to very steep	6820 - 7670	394.2	33.4
Subalpine fir/beargrass	Abf las/yer trn	NE,E,SE	gentle to very steep	7000 - 7650	58.6	5.0
Subalpine fir/sitka alder	Abf las/Ln sin	N,NE,SE	moderate to very steep	6600 - 7370	17.3	1.5
Subalpine fir/twinflower	Abf las/Ln bor	N, (SE)	moderate to steep	6600 - 7320	13.1	1.1
Subalpine fir/rusty monkfish	Abf las/Hon for	NW,N,NE	moderate to very steep	6680 - 7430	39.0	3.3
Subalpine fir/bluejoint reedgrass	Abf las/Cat can	N,NE,E,SE	gentle to moderate	6580 - 7770	56.0	4.7
Disturbed community types						
Disturbed upland	Dist. upl.	variable (SE)	gentle to very steep	6880 - 7410	58.3	4.9
Disturbed riparian	Dist. rip.	variable (NE)	gentle to moderate	6520 - 6980	22.4	1.9
					35.9	3.0
Total					1181.6	100.0

* gentle = 0-10% slope, moderate = 10-30%, steep = 30-50%, very steep = >50%

Graminoid cover averaged 66 percent for four transects sampled in the type (Table 2) dominated by Idaho fescue (Festuca idahoensis, 22 percent), bluebunch wheatgrass (Agropyron spicatum, 17), sedge species (8), bluegrass species (5), prairie junegrass (Koeleria cristata, 5), native bluegrass (Poa sandbergii, 4) and threadleaf sedge (Carex filifolia, 3). One transect was in the more mesic Columbia needlegrass (Stipa occidentalis var. minor) phase of the Fes ida/ Agr spi habitat type, averaging 4 percent cover of that species in the stand sampled. Forb cover averaged 63 percent, dominated by eleven species which averaged two to seven percent cover each. These included, in decreasing order of cover, field chickweed (Cerastium arvense), silky lupine (Lupinus sericeus), leafy musineon (Musineon divaricatum), pale agoseris (Agoseris glauca), fernleaf fleabane (Erigeron compositus), common yarrow (Achillea millefolium), diverse-leaved cinquefoil (Potentilla diversifolia), sticky geranium (Geranium viscosissimum), cushion buckwheat (Eriogonum ovalifolium), ballhead sandwort (Arenaria congesta) and orange arnica (Arnica fulgens). Creeping Oregon-grape (Ferberis repens), a subshrub, averaged 3 percent cover, primarily on one transect.

Production for the Fes ida/ Agr spi habitat type is highly variable, with investigators in western Montana reporting total production values ranging from 53.4 to 179.0 grams/meter² (Table 3). Mueggler and Stewart (1980) speculated that differences in site potential and yearly weather fluctuations were responsible for extremes in production in

TABLE 2. MEAN PERCENT CANOPY COVERAGE/FREQUENCY OF IMPORTANT VASCULAR PLANT SPECIES BY TRAPNET FOR FIVE GRASSLAND AND SHURFLAND HABITAT TYPE IN ELM PROJECT STUDY AREA (DATA SOURCE: OEA RESEARCH, 1981).

Class/species	Eos_ids/Acc_spl				Mean	Fos Ida/ Acc_spl	Fos sca/ Acc_spl	3	Eos_sca/Eos_Ida			Mean	Pot fru/ Eos_sca
	1	2	11	12					7	8	9		
Bare ground	1.2/20	6.1/65	10.5/55	7.1/75	6.2/54	18.2/95	7.1/60	1.0/20	0.5/15	6.4/55	2.4/30	2.7/30	
Rock	15.5/90	5.5/90	1.5/30	12.5/90	8.8/75	7.7/80	7.4/50	0.3/10	1.8/20	1.8/45	1.3/25	0.9/10	
Litter	26.2/95	27.6/100	27.5/100	50.4/100	33.0/95	17.4/100	41.6/100	28.0/95	26.9/100	39.3/100	31.4/98	17.9/85	
Lichens	25.1/95	28.9/95	1.1/15	2.7/50	14.4/64	-	6.3/35	0.8/5	3.2/30	1.7/35	1.9/23	-	
Moss	0.6/20	0.9/10	0.6/20	0.5/15	0.6/16	0.5/15	4.8/40	0.2/5	0.9/10	0.9/30	0.7/15	-	
Graminoids													
Agr can	-	-	-	-	-	10.7/25	-	-	2.0/10	-	0.7/3	0.9/10	
Agr spl	22.5/75	12.9/60	19.7/75	13.3/75	16.9/71	-	13.0/50	2.8/15	4.1/20	0.9/10	2.6/15	-	
Bro car	-	-	-	-	-	6.5/40	-	-	-	-	-	-	
Bro vul	-	-	-	-	-	-	-	-	-	-	-	-	
Car flt	-	-	10.7/20	-	2.7/5	-	1.9/5	0.9/5	13.6/60	-	4.8/22	6.0/60	
Car obt	-	-	-	-	-	-	-	-	-	7.5/50	2.5/17	-	
Car pot	-	-	-	-	-	0.2/5	-	-	10.1/60	-	3.4/20	-	
Car spp.	6.7/45	24.8/85	1.8/20	-	8.3/39	-	5.2/35	19.7/75	-	-	6.6/25	2.9/75	
Dan int.	-	-	-	-	-	-	-	1.8/20	-	-	0.6/7	0.9/5	
Fos Ida	23.8/75	17.3/90	21.8/80	27.2/100	22.5/96	-	20.4/95	21.9/85	18.9/85	9.6/50	16.7/73	2.5/25	
Fos sca	-	1.9/5	2.6/10	-	1.1/4	-	17.6/55	26.3/75	28.7/75	47.5/100	34.2/83	-	
Koe grf	3.3/30	9.1/65	4.2/40	1.8/40	4.6/41	1.9/5	1.1/35	2.5/15	8.4/60	3.0/40	4.7/48	0.9/10	
Phi alp	-	-	-	-	-	0.9/10	-	-	-	-	-	2.9/35	
Poa san	14.2/45	-	-	-	3.6/11	-	-	-	-	0.5/15	0.2/5	-	
Poa spp.	-	13.9/70	1.7/15	4.3/25	5.9/23	56.6/90	6.7/15	6.5/20	6.8/30	0.2/5	4.5/18	28.5/80	
Stf occ	-	-	3.9/30	-	1.0/3	0.2/5	-	-	1.9/5	-	0.6/2	-	
Other Grams.	-	-	0.8/-	-	0.2/-	0.2/-	-	0.2/-	-	-	T/-	1.5/-	
Total Graminoids	70.6/-	79.8/-	66.2/-	16.6/-	65.8/-	76.7/-	66.9/-	92.5/-	94.4/-	69.2/-	82.0/-	73.7/-	
Forbs													
Ach mll	4.2/40	5.3/55	3.2/45	1.7/35	3.8/44	5.6/70	2.7/50	25.2/85	6.1/45	6.6/60	12.6/63	6.9/50	
App gla	12.0/70	4.6/40	-	-	4.2/28	-	1.1/5	4.1/55	-	-	1.4/18	2.0/25	
All Cer	-	0.3/10	T/5	0.5/15	0.9/6	-	1.1/15	-	-	0.3/10	0.1/3	-	
Ant mfc	-	-	-	3.6/25	0.9/6	-	-	-	-	-	-	4.5/15	
Ara div	2.3/20	-	-	-	0.6/5	-	-	-	-	-	-	-	
Ara con	6.8/50	3.4/35	0.3/10	-	2.6/21	-	8.7/55	6.3/70	-	-	-	1.7/15	
Arn ful	0.2/5	-	9.2/75	-	2.4/20	1.2/20	0.5/15	0.9/10	9.7/50	9.2/85	8.4/68	6.4/20	
Ast mfs	8.3/20	1.9/5	0.2/5	-	2.6/8	-	5.7/30	-	0.2/5	-	0.4/5	-	
Bes wyo	1.5/30	3.0/60	0.2/5	-	1.2/24	-	0.5/20	-	4.4/30	-	1.5/10	-	
Cas pil	-	1.4/25	-	-	0.4/6	-	-	-	1.1/35	2.7/55	1.3/30	-	
Cer arv	4.9/50	23.4/95	-	-	7.1/36	0.9/10	-	1.8/20	5.6/50	5.5/45	4.3/33	1.7/15	
Cfr sca	-	-	-	-	-	-	-	-	-	-	-	1.2/20	
Col par	-	-	1.1/35	1.4/55	0.6/22	0.2/5	0.3/10	-	-	X	X	-	
Col tin	-	-	1.5/30	1.5/30	0.4/8	0.6/25	T/5	-	-	-	-	-	
Del bic	-	-	-	-	-	T/5	-	1.8/20	-	-	0.6/7	-	

TABLE 2. (continued)

Class/species	Esp. Ids/Abund.			Mean	Esp. Ids/Abund.			Mean	Esp. Ids/Abund.			Mean	Pot fru/Es.sca/5
	1	2	13		10	11	12		14	15	16		
Dou ron	-	-	-	-	-	-	-	-	-	-	-	-	-
Dra ste	-	-	1.2/55	T/5	0.3/15	-	-	0.4/35	-	0.1/65	3.0/22	-	-
Epl min	-	-	-	0.8/30	0.2/8	-	-	-	-	-	-	-	-
Erl com	0.8/25	14.9/85	-	0.2/10	4.0/30	-	-	0.9/15	-	2.0/30	0.7/10	-	-
Erl ova	-	-	8.5/65	4.7/55	3.3/30	-	-	8.0/50	1.2/25	-	0.4/8	-	-
Erl urb	2.8/20	-	-	0.7/5	0.7/5	-	-	-	-	-	-	-	-
Ery rep	-	-	-	-	-	-	-	-	1.1/35	-	-	-	-
Ery vir	-	-	0.8/5	0.8/5	0.4/2	-	-	-	-	-	0.4/12	-	-
Ery spe	-	X	-	-	X	-	-	-	-	-	1.6/10	7.4/35	-
Gon aff	-	-	-	-	-	-	-	-	-	4.9/30	0.7/5	-	-
Gon ama	-	-	-	-	-	-	-	-	-	2.2/15	0.7/5	-	-
Gon vls	-	-	-	-	-	-	-	-	2.2/15	0.3/15	0.8/10	-	-
Gou trif	-	-	6.7/25	9.0/50	3.7/19	-	-	-	-	-	-	-	-
Hol unf	-	-	5.9/25	1.9/5	2.0/8	-	-	-	1.1/5/50	1.7/15	6.0/42	1.9/5	-
Hou par	X	-	-	2.8/15	0.7/4	-	-	-	-	-	-	1.7/15	-
Low pyg	-	-	-	-	X	-	-	-	0.2/5	1.2/25	0.5/10	-	-
Lit par	-	-	-	-	-	-	-	-	-	-	-	-	-
Lit rud	-	-	-	-	-	-	-	-	-	-	-	-	-
Lom trif	-	-	-	3.3/10	0.8/2	-	-	-	-	-	-	-	-
Lom spp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Lup ser	2.6/10	X	20.1/60	1.9/5	6.2/19	-	-	0.2/5	-	-	1.3/15	1.5/10	-
Mer cb1	-	-	0.3/10	-	T/2	-	-	28.6/90	1.7/15	-	12.5/32	0.5/15	-
Mys div	12.0/85	6.7/65	-	1.7/38	1.7/38	-	-	0.5/15	3.5/55	0.8/35	0.1/3	-	-
Pen alb	-	-	-	3.1/30	0.8/8	-	-	-	-	-	-	-	-
Pen pro	-	-	-	-	-	-	-	-	1.7/15	0.2/5	0.6/7	-	-
Pol b1s	-	-	-	-	-	-	-	-	-	-	T/2	-	-
Pol kol	-	-	-	-	-	-	-	-	-	-	-	-	-
Pot arg	-	-	-	0.3/15	T/4	-	-	-	-	-	-	-	-
Pot div	-	-	-	3.6/25	0.9/6	-	-	-	-	-	-	-	-
Pan unc	X	2.0/30	8.1/55	5.1/50	3.8/34	-	-	T/10	3.7/25	5.7/55	4.5/47	23.8/90	-
Sel don	1.5/10	3.3/30	-	-	1.2/10	-	-	-	-	-	-	3.4/15	-
Tir off	0.3/10	-	-	0.8/5	0.3/4	-	-	0.2/5	0.2/5	0.2/5	0.1/3	-	-
Zig ven	X	-	-	-	X	-	-	-	-	-	-	-	-
Other forbs	1.7/-	1.7/-	3.0/-	4.2/-	2.6/-	-	-	1.1/-	0.4/-	1.4/25	0.5/8	-	-
Total Forbs	61.9/-	72.9/-	68.8/-	50.2/-	63.4/-	-	-	71.6/-	52.3/-	54.6/-	70.1/-	99.2/-	-
Subshrub	-	-	-	-	-	-	-	-	-	-	-	-	-
Per rep	-	-	0.8/5	10.4/95	2.8/22	-	-	-	-	-	-	-	-
Shrub	-	-	-	-	-	-	-	-	-	-	-	-	-
Pot fru	-	-	-	-	-	-	-	-	-	-	-	-	13.1/25
Total veg.**	132.5/-	152.7/-	135.8/-	107.2/-	132.0/-	-	-	138.1/-	146.7/-	123.8/-	152.2/-	196.0/-	-

TABLE 2. (continued)

I	Important species are those which averaged one percent or greater cover on any one transect. Full binomials are given in Supplement A for the species codes in this table.
*	primarily <i>Foa pratensis</i>
**	stratified cover
T	= less than 0.1 percent canopy cover
X	= incidental species recorded on transect site but not in cover plots

data source: OEA Research (1991)

TABLE 2. PRODUCTION VALUES FOR GRASSLAND AND SUDANGRASS HABITAT TYPES ON THE BEAL PROJECT FERTILIZER AREA.

Habitat_Type	Production		Source
	acres/hectar	pounds/acre	
Idaho fescue/bluebunch wheatgrass h.t.	125.6	1120	Scow, Culwell and Larsen (1986)
	73.6 - 145.0	656 - 1293	Mungler and Stewart (1980)
	72.1 - 142.5 ($\bar{X}=109.0$)	706 - 1771 ($\bar{Y}=963$)	Culwell and Scow (1982)
	76.7 - 147.1	694 - 1312	Mungler (1983)
	130.4	1163	Cartbell et al. (1979)
	101.0 - 123.9 ($\bar{Y}=112.7$)	901 - 1105 ($\bar{Y}=1005$)	Culwell, Scow and Larsen (1984)
	53.4 - 116.2 ($\bar{Y}=83.4$)	476 - 1036 ($\bar{Y}=744$)	Hann (1982)
	66.1 - 74.0	590 - 668	Vogel and Van Dyne (1966)
	67.8 - 179.0	605 - 1597	Mungler (1977)
Idaho fescue/bearded wheatgrass h.t.	133.9 - 187.4	1104 - 1672	Mungler and Stewart (1980)
	235.4 - 257.8	2100 - 2300	Branson and Lemmasson (1958)
	181.1 - 293.9	1615 - 2622	Mungler (1967)
	155.0	1393	Scow, Culwell and Larsen (1986)
Pough fescue/bluebunch wheatgrass h.t.	89.9 - 134.7	807 - 1202	Mungler and Stewart (1981)
	68.5 - 121.8 ($\bar{X}=13.5$)	611 - 1176 ($\bar{Y}=923$)	Culwell, Scow and Larsen (1984)
	100.0 - 134.5	892 - 1500	Mungler and Stewart (1980)
	82.1 - 109.7 ($\bar{X}=95.9$)	732 - 979 ($\bar{X}=855$)	WESTICH (1986)
	267.3	2394	Scow, Culwell and Larsen (1986)
	181.8	1622	Culwell et al. (1980)
Pough fescue/Idaho fescue h.t.	120.2 - 182.8	1072	Mungler and Stewart (1981)
	156.1 - 170.6	1292 - 1572	Chaffee and Morris (1982)
	118.1 - 170.0 ($\bar{X}=148.1$)	1053 - 1516 ($\bar{X}=1321$)	Culwell, Scow and Larsen (1984)
	176.0 - 182.7	1124 - 1630	Mungler and Stewart (1980)
	136.5 - 140.8 ($\bar{X}=138.6$)	1218 - 1256 ($\bar{Y}=1236$)	WESTICH (1986)
	290.9	2505	Mungler and Stewart (1980)
Tufted hairgrass/ sedge h.t.	105.4 - 333.0	940 - 2970	Fierce (1986)
	103.1 - 199.8	920 - 1773	Mungler and Stewart (1980)
Shrubby cinquefoil/ rough fescue h.t.			

this type. Hann (1982) sampled 14 successional communities within the Fes ida/Agr spi habitat type in western Montana, and reported production values ranging from 53.4 to 116.2 grams/meter². His Fes ida/Agr spi community totalled 98.4 grams/meter², which is comparable to results of other investigators.

The Fes ida/Agr spi habitat type occurred on the Ac and Ad gravelly silty loam soils, 15-50 percent slope and greater than 50 percent slope.

Idaho Fescue/Bearded Wheatgrass (Fes ida/Agr can) Habitat Type. The Fes ida/Agr can type is found on concave, moderate slopes of relatively warm aspect. It occurs at elevations of 7000 to 7700 feet in the permit area. Graminoid cover averaged 77 percent for one transect sampled in the type (Table 2). Dominant graminoids (and percent cover) were bluegrasses (primarily Kentucky bluegrass, Poa pratensis, 57), bearded wheatgrass (Agropyron caninum, 10), California brome (Bromus carinatus, 6), prairie junegrass (2) and alpine timothy (Phleum alpinum, 1). These sites apparently represent degraded seres of the Fes ida/Agr can habitat type, where mid-grasses such as Idaho fescue, timber oatgrass and Columbia needlegrass have been largely replaced by Kentucky bluegrass due to historic grazing pressure. However, the indicator species bearded wheatgrass and California brome were conspicuous. Forb cover, which averaged 40 percent, is often lower in this type than other habitat types in the Idaho fescue and rough fescue

series. Dominant forbs also reflected historic grazing influence, including small-flowered willow-herb (Epilobium minutum, 9 percent), common yarrow (6), common dandelion (Taraxacum officinale, 5), tomatium species (3), diverse-leaved cinquefoil (2), Kellogg's knotweed (Polygonum kelloggii, 2) dwarf lewisia (Lewisia pygmaea, 2), smallflower woodlandstar (Lithophragma parviflorum, 1), orange arnica (1) and field chickweed (1).

Mueggler and Stewart (1980) reported production values of 133.9 to 187.4 grams/meter² for the Fes ida/Agr can habitat type, with graminoid production ranging from 30 to 60 percent of total production. Branson and Lommasson (1958) and Mueggler (1967) reported higher total production than did Mueggler and Stewart (1980) (Table 3). Within the permit area, it was apparent that this type was considerably more productive than was the Fes ida/Agr spi habitat type.

The Fes ida/Agr can habitat type occurred on the Ac gravelly silty loam soil, 15-50 percent slope.

Rough Fescue/Bluebunch Wheatgrass (Fes sca/Agr spi) Habitat Type. The Fes sca/Agr spi type occupies sites transitional between the Fes ida/Agr spi and Fes sca/Fes ida habitat types. Slopes are moderate to steep on variable aspects, with soil development generally intermediate between these two types. It was found at elevations between 7350 and 7680 feet in the permit area.

Graminoid cover averaged 67 percent for one transect sampled in the type, including Idaho fescue (20 percent), rough fescue (Festuca scabrella, 18), bluebunch wheatgrass (14), bluegrass species (7) and sedge species (5). Forb cover averaged 72 percent, dominated by silky lupine (29), prairiesmoke (Geum triflorum, 10), ballhead sandwort (9), cushion buckwheat (8), weedy milkvetch (Astragalus miser, 7), common yarrow (3), pale agoseris (1), nodding onion (Allium cernuum, 1) and fernleaf fleabane (1).

Annual production for the Fes sca/Agr spi habitat type is highly variable ranging from 68.5 to 155.0 grams/meter² (Table 3). Average² production, however, is in the range of 90 to 120 grams/meter². Mueggler and Stewart (1980) stated that variability in production was likely due to annual weather fluctuations.

The Fes sca/Agr spi habitat type occurred on the Ac gravelly silty loam soil, 15-50 percent slope.

Rough Fescue/Idaho Fescue (Fes sca/Fes ida) Habitat Type. This type is the most mesic in the rough fescue series in Montana. In the permit area, it occupies gentle to moderate slopes of variable aspect. Soils are well developed. The type is found at elevations of 7350 to 7580 feet in the permit area.

Graminoid cover averaged 82 percent for three transects sampled in the type. Dominants were rough fescue (34 percent cover), Idaho fescue (17), sedge species (7), prairie junegrass (5), threadleaf sedge (5), Kentucky bluegrass (4), Lidton sedge (Carex petasata, 3), bluebunch wheatgrass (3) and blunt sedge (Carex obtusata, 2). Forb cover averaged 70 percent, including common yarrow (13), silky lupine (12), ballhead sandwort (8), prairiesmoke (6), diverse-leaved cinquefoil (4), field chickweed (4), common dandelion (4) and Rocky Mountain douglasia (Douglasia montana, 3). Other forbs averaging more than one percent cover included pale agoseris, weedy milkvetch, kittentail (Besseyia wyomingensis), giant fraseria (Frasera speciosa), nineleaf lomatium (Lomatium triternatum) and oblongleaf bluebell (Mertensia oblongifolia).

Reported production values for the Fes sca/Fes ida habitat type range from 120.2 to 267.3 grams/meter², with most values averaging 135 to 165 grams/meter² (Table 3).

The Fes sca/Fes ida habitat type occurred on the Ac gravelly silty loam soil, 15-50 percent slope.

Tufted Hairgrass/Sedge (Des ces/Carex) Habitat Type. This is the most mesic grassland habitat type recognized for Montana (Mueggler and Stewart, 1980). It was found at only one location in the permit area, a gently sloping head of drainage, and appeared to be flooded for the

majority of the growing season. Elevation was 7730 to 7760 feet. The type is dominated by tufted hairgrass (Deschampsia cespitosa), sedge species, alpine timothy, bentgrasses (Agrostis) and rushes (Juncus). With heavy grazing pressure, tufted hairgrass decreases and is replaced by sedges, rushes, Kentucky bluegrass and forbs such as common yarrow, bistort (Polygonum bistortoides), diverse-leaved cinquefoil and common dandelion.

Production data for the Des ces/Carex habitat type are limited in western Montana. Mueggler and Stewart (1980) sampled only one stand with a total production of 290.9 grams/meter². This type is potentially the most productive grassland in western Montana. Pierce (1986) sampled several sedge-dominated community types in west-central Montana, which are probably more indicative of production expected in the wet phase of the Des ces/Carex type within the permit area.

Shrubby Cinquefoil/Rough Fescue (Pot fru/Fes sca) Habitat Type. This was the only shrubland habitat type identified in the permit area and covered only about two acres. It occupies gentle slopes of straight configuration on warm aspects at elevations of 7410 to 7530 feet.

Graminoid cover averaged 74 percent for one stand sampled, similar to adjacent mesic grassland types, and reflected historic grazing in that rough fescue had been replaced by aggressive increaser species. Dominant graminoids were sedge species (30 percent cover), bluegrass

species (primarily Kentucky bluegrass, 28), Columbia brome (Prunus vulgaris, 6), alpine timothy (3) and Idaho fescue (2). Forb cover was very high on these mesic sites, averaging 99 percent (stratified cover). Dominant forbs were diverse-leaved cinquefoil (24 percent cover), common dandelion (20), bistort (15), Virginia strawberry (Fragaria virginiana, 7), common yarrow (7), orange arnica (6), rose pussytoes (Antennaria microphylla, 4) and little buttercup (Ranunculus uncinatus, 3). Seven other forbs averaged one to two percent cover (Table 2). Shrubby cinquefoil (Potentilla fruticosa) averaged 13 percent cover and 25 percent frequency of occurrence.

Annual production data for the Pot fru/Fes sca habitat type are limited in western Montana (Table 3). Mueggler and Stewart (1980) reported a production range of 103.1 to 198.6 grams/meter², of which less than 10 percent is normally shrub production.

The Pot fru/Fes sca habitat type occurred on the Ac gravelly silty loam soil, 15-50 percent slope.

Sitka Alder (Aln sin) Community Type. The Aln sin community is apparently seral to mesic, cool subalpine fir types where the conifer overstory is absent. These sites include small portions of the Abi las/Aln sin, Abi las/Lin bor and Abi las/Men fer habitat types. The Aln sin community is mapped as minor inclusions in these habitat types

on Exhibit C-1, occupying well under one percent of the permit area. Site parameters and floristic composition parallel those of the three subalpine fir habitat types listed above, with Sitka alder (Alnus sinuata) dominant in the overstory, and subalpine fir (Abies lasiocarpa) and Engelmann spruce (Picea engelmannii) seedlings the most successfully reproducing conifers in the understory.

The sitka alder community type occurred on the V loam soil, 0-25 percent slope.

Quaking Aspen (Pop. tre) Community Type. The Pop. tre community is a very minor type in the permit area, found at only one location. The site was relatively mesic and occurred on a moderately steep, southerly aspect at about 7100 feet elevation. Aspen stands share floristic similarities with the more open growth of adjacent forest habitat types such as Pse. men/Cal. rub.

The quaking aspen community type occurred on the X loam soil, 0-25 percent slope.

Douglas-fir/Pinegrass (Pse. men/Cal. rub) Habitat Type. This is the driest forest habitat type present in the permit area, approaching upper elevational limits for the type. It was found at elevations of

6540 to 7450 feet on moderate to steep slopes on relatively warm aspects, mostly southerly.

Graminoid cover averaged 31 percent for three transects sampled in the type (Table 4), including pinegrass (Calamagrostis rubescens, 24), elk sedge (Carex geyeri, 4) and bluegrass species (3). Forb cover averaged 35 percent, dominated by heartleaf arnica (Arnica cordifolia, 20), weedy milkvetch (4), Virginia strawberry (3), western meadowrue (Thalictrum occidentale, 3) and glacier-lily (Frythronium grandiflorum, 2). Shrub cover averaged 5 percent, primarily grouse whortleberry (Vaccinium scoparium). Tree cover was 58 percent, chiefly Douglas-fir (37) and lodgepole pine (Pinus contorta, 13). The presence of subalpine fir on a cool, moist microsite on one transect (Table 4) indicates upper elevational limits for the Pse men/Cal rub habitat type in the area.

The Pse men/Cal rub habitat type occurred on the Zc and Zd gravelly, cobbly silty loam soils, 15-50 percent slope and greater than 50 percent slope.

Douglas-fir/Twinflower (Pse men/Lin bor) Habitat Type. Small pockets of this type in the permit area are transitional between the drier, warmer Pse men/Cal rub habitat type and moister, cooler subalpine fir types such as Abi las/Lin bor and Abi las/Cal can. It was mapped as inclusions in these types (Exhibit 1), since it occupies well under one

TABLE 1. MEAN PERCENT CANOPY COVER/FREQUENCY OF VASCULAR PLANT SPECIES BY TRIMSECT FOR FIVE FOREST HABITAT TYPES. REAL PROJECT STUDY AREA (DATA SOURCE: OEA RESEARCH, 1981).

Class/Species	Decid. / Cal. rub.			Abt. las/ Cal. rub.			Abt. las/Vac. sco.			Abt. las/ Cal. con. 18.		
	13	17	20	11	12	15	4	6	9		15	18
Bare ground	-	0.2/5	-	-	-	-	-	-	-	-	-	-
Rock	-	1.5/35	11.6/70	-	11.7/75	-	-	-	-	-	-	-
Litter	97.5/100	92.5/100	83.0/100	85.2/100	87.5/100	97.0/100	70.2/100	90.2/100	95.8/100	90.1/100	90.1/100	0.2/1
Lichens	-	2.1/30	7.9/65	0.3/10	5.6/65	-	-	0.2/5	-	0.1/2	1.9/39	0.1/2
Moss	0.2/5	2.0/25	0.3/10	-	0.5/15	0.8/5	0.8/5	4.7/20	-	1.6/3	4.8/50	1.6/3
Graminoids												
Cal rub	5.6/30	34.4/100	32.2/80	3.3/30	20.0/75	24.5/100	0.3/10	-	8.9/65	8.4/44	0.8/6	8.4/44
Car con	-	-	-	-	-	-	-	-	3.2/30	0.8/8	-	0.8/8
Car dlo	-	-	-	-	-	-	-	-	-	-	0.9/11	-
Car qy	10.4/35	-	-	3.5/12	7.3/30	-	-	-	5.9/20	1.9/8	-	1.9/8
Poa spp.	9.5/40	-	0.2/5	3.2/15	0.2/5	-	-	1.5/10	-	-	-	-
Total Graminoids	25.5/-	34.4/-	33.1/-	16.7/-	27.5/-	34.5/-	0.3/-	1.5/-	18.0/-	11.1/-	1.7/-	11.1/-
Forbs												
All cor	0.3/10	-	-	0.1/3	-	-	-	-	-	-	-	-
Ant rac	-	-	-	-	-	-	-	-	-	-	-	-
Arn cor	41.2/100	2.0/30	15.4/75	19.5/75	-	-	-	-	0.8/5	0.2/1	-	0.2/1
Ast con	0.8/5	-	-	0.3/2	-	-	1.1/15	-	5.2/35	1.6/14	7.9/61	-
Ast mis	X	11.8/60	1.1/15	4.3/25	-	-	-	-	-	-	-	-
Ept ang	X	0.6/20	-	0.2/7	-	-	-	X	-	-	-	-
Ery gra	-	5.3/60	0.3/10	1.9/23	6.5/55	0.3/10	X	0.5/15	1.2/20	0.5/11	0.3/11	0.5/11
Fra vfr	1.7/35	0.8/25	5.3/70	2.9/43	2.0/30	-	-	0.9/10	0.5/15	0.4/6	0.2/11	0.4/6
Ger vif	-	-	-	-	0.2/5	-	-	-	-	-	-	-
Mit pen	-	-	-	-	-	-	-	-	-	-	0.8/6	-
Osm chi	-	-	0.2/5	-	-	-	-	-	-	-	0.2/6	-
Osm ecc	0.2/5	-	-	1/2	-	-	-	-	-	-	-	-
Ped rac	-	-	-	1/2	-	-	-	-	-	-	-	-
Pot div	-	0.8/5	0.8/5	0.5/3	-	0.9/10	-	-	-	X	-	X
Pyr sec	-	-	1.1/15	0.1/5	-	-	0.8/5	-	0.2/5	0.2/2	-	0.2/2
Pyr uni	-	-	-	-	-	-	-	-	-	-	-	-
Sax arg	-	-	-	-	-	-	-	-	-	-	-	-
Sml rac	-	-	0.8/5	-	-	-	-	-	-	-	-	-
Str amp	-	-	-	0.3/2	-	-	-	-	-	-	-	-
Tha ecc	3.3/10	-	5.9/25	3.1/12	0.2/5	-	-	-	-	-	-	-
Val dlo	0.9/10	-	-	0.3/3	-	-	-	-	-	-	-	-
Val sit	-	0.8/5	1.2/25	0.7/10	2.7/30	-	1.1/15	2.5/25	0.6/20	1.0/15	-	1.0/15
Vfo adu	-	0.5/15	-	0.2/5	X	-	-	-	T/5	T/1	0.5/17	T/1
Vfo orb	-	0.3/10	-	0.1/3	-	-	-	1.8/20	0.2/5	0.5/6	-	0.5/6
Vep ten	-	-	-	-	-	T/5	-	X	-	T/1	-	T/1
Total Forbs	48.4/4/-	22.9/-	33.1/-	34.8/-	16.9/-	0.4/-	3.0/-	5.7/-	9.5/-	4.6/-	29.6/-	4.6/-

TABLE 4. (Continued)

Class/species	13.	17.	Pse-men/Cal_rub	20.	Mean	11	Abi las/ Cal_rub.	12.	Abi las/ Cal_rub.	14.	15.	Abi las/Vac_sco	16.	Mean	Abi las/ Cal. can.	
Shrubs																
Jun com	-	-	0.8/5	0.3/2	-	-	-	-	-	-	-	-	-	0.2/1	-	
Lon uta	-	-	0.9/5	0.3/2	-	-	-	-	-	-	-	-	-	-	-	
Pos spp.	0.2/5	-	0.2/10	0.1/5	-	-	-	-	-	-	-	-	-	-	0.2/6	
Vac sco	-	14.0/55	X	4.7/12	-	-	50.1/100	-	-	40.4/75	-	63.3/95	19.0/75	43.2/85	0.2/6	
Total Shrubs	0.2/-	14.0/-	1.8/-	5.3/-	-	-	50.1/-	-	-	41.2/-	-	63.3/-	19.0/-	43.4/-	0.4/-	
Trees*																
Abi las	-	-	20/-*	6.7/-	-	4/-	5/-	1/-	-	10/-	-	30/-	10/-	13.8/-	5/-	
Pic eng	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40/-	
Pin alb	-	-	-	-	-	2/-	-	-	-	-	-	-	-	-	-	
Pin con	-	40/-	-	13.3/-	-	60/-	-	-	-	5/-	-	-	-	1.2/-	-	
Pop tre	-	-	5/-	1.7/-	-	-	45/-	-	-	35/-	-	30/-	30/-	35.0/-	5/-	
Pse men	50/-	10/-	50/-	36.7/-	-	-	-	-	-	-	-	-	-	-	-	
Total Trees	50/-	50/-	75/-	58.3/-	-	66/-	50/-	70/-	71/-	50/-	-	60/-	40/-	50.0/-	50/-	
Total Understory**	74.1/-	71.3/-	68.0/-	71.1/-	-	49.0/-	75.0/-	41.4/-	-	41.5/-	-	70.5/-	46.5/-	50.1/-	31.7/-	
Total Vegetation	124.1/-	121.3/-	143.0/-	122.5/-	-	114.0/-	125.0/-	115.4/-	-	94.5/-	-	130.5/-	86.5/-	109.1/-	81.7/-	

1 Full binomials are given in Supplement A for the species codes in this table.

* Tree cover is an ocular estimate for non-seedling trees in each stand; seedling tree cover was estimated on cover plots. Subalpine fir (Abi las) presence on transect 20 represents an atypical microsite in the Douglas-fir (Pse men) series.

** Total understory vegetation cover (stratified) excludes tree seedlings.

T = less than 0.1 percent canopy cover

X = incidental species recorded on transect site but not in cover plots

data source: CEA Research (1981)

percent of the area. Site parameters and floristic features are similar to the Abi las/Lin bor type, except that subalpine fir and Engelmann spruce are absent.

The Pse men/Lin bor habitat type occurred on the Zc gravelly, cobbly silty loam soil, 15-50 percent slope.

Subalpine Fir/Elk Sedge (Abi las/Car gei) Habitat Type. This is the driest, warmest habitat type in the subalpine fir series present in the permit area, occupying moderate to steep slopes at elevations of 7100 to 7750 feet.

Graminoid cover averaged 37 percent for one stand sampled in the type (Table 4), including elk sedge (33) and pinegrass (3). Forb cover was 11 percent, primarily glacier-lily (10) and Virginia strawberry (1). Tree cover averaged about 66 percent, mostly seral lodgepole pine (60), with subalpine fir and whitebark pine (Pinus albicaulis) seedlings in the understory.

The Abi las/Car gei habitat type occurred on the Zc gravelly, cobbly silty loam soil, 15-50 percent slope.

Subalpine Fir/Pinegrass (Abi las/Cal rub) Habitat Type. This type adjoins Pse men/Cal rub and Abi las/Car gei on slightly moister sites. It is found at elevations of 6680 to 7700 feet in the permit area.

Graminoid cover averaged 28 percent for one stand sampled in the type (Table 4), including pinegrass (20) and elk sedge (7). Forb cover was 17 percent, dominated by glacier-lily (6), heartleaf arnica (4), sitka valerian (Valeriana sitchensis, 3) and Virginia strawberry (2). Tree cover averaged about 70 percent, entirely seral Douglas-fir, with one percent cover of subalpine fir seedlings in the understory.

The Abi las/Cal rub habitat type occurred on the Zc and Zd gravelly, cobbly silty loam soils, 15-50 percent slope and greater than 50 percent slope.

Subalpine Fir/Grouse Whortleberry (Abi las/Vac sco) Habitat Type. The Abi las/Vac sco habitat type is the most common forest type in the area, found at elevations of 6820 to 7870 feet in the permit area. It is found on well-drained, gentle to moderate slopes and ridges of variable aspect, bordered on drier sites by Fes sca/Fes ida, Abi las/Cal rub and Abi las/Car gey, and on moister sites by Abi las/Xer ten and other moist subalpine fir habitat types.

Graminoid cover averaged 11 percent for four transects sampled in the type, primarily pinegrass (8) and elk sedge (2). Forb cover averaged only 5 percent, dominated by heartleaf arnica (2) and sitka valerian (1). Other conspicuous forbs were glacier-lily, roundleaf violet (Viola orbiculata) and Virginia strawberry. Shrub cover averaged 43 percent, almost entirely grouse whortleberry. Tree cover averaged

about 50 percent, chiefly seral lodgepole pine (35) which indicates fire history. Subalpine fir averaged 14 percent cover, with minor cover of whitebark pine (1 percent). At higher elevations in the permit area, small inclusions of the similar subalpine fir - whitebark pine/grouse whortleberry habitat type are associated with the Abi las/Vac sco type. On these sites, "whitebark pine is a long-lived, seral dominant approaching a 'persistent' status on disturbed, dry sites" (Pfister et al., 1977).

The Abi las/Vac sco habitat type occurred on the Zc and Zd gravelly, cobbly silty loam soils, 15-50 percent slope and greater than 50 percent slope. Less common associations were with the B loam soil, 0-10 percent slope and W very gravelly loam soil, 25-50 percent slope.

Subalpine Fir/Beargrass (Abi las/Xer ten) Habitat Type. This type is approaching its eastern limits in Montana at this location, represented by the grouse whortleberry phase. In the permit area it occupies sites transitional between drier Abi las/Car gey and Abi las/Vac sco types, and cooler, moister fir types such as Abi las/Cal can. It is found at elevations of 7000 to 7650 feet in the permit area. Floristics were very similar to the Abi las/Vac sco type, except that beargrass (Xerophyllum tenax) was dominant or codominant with grouse whortleberry in the understory.

The *Abi las/Xer ten* habitat type occurred on the Zc and Zd gravelly, cobbly silty loam soils, 15-50 percent slope and greater than 50 percent slope. A less common association was with the X loam soil, 0-25 percent slope.

Subalpine Fir/Sitka Alder (*Abi las/Aln sin*) Habitat Type. This type was present in the permit area as inclusions in the *Abi las/Men fer* and *Abi las/Lin bor* habitat types, representing intermediate site parameters and floristics. Since the stands of Pfister et al. (1977) were all 200 years old or less, "retention of *Alnus* at the theoretical climax is uncertain; in west-central Montana, *Abi las/Aln sin* sometimes forms a transitional zone between *Abi las/Men fer* and *Abi las/Xer ten - Vac sco* phase ... *Abi las/Aln sin* is often bordered below on warmer, similarly moist sites by *Abi las/Lin bor* stands in which *Alnus sinuata* is well represented; *Abi las/Vac sco* is often adjacent on drier sites". This pattern was indicated for limited inclusions of *Abi las/Aln sin* in the permit area on convex, generally steep, north slopes.

The *Abi las/Aln sin* habitat type occurred on the Zc and Zd gravelly, cobbly silty loam soils, 15-50 percent slope and greater than 50 percent slope.

Subalpine Fir/Twinflower (*Abi las/Lin bor*) Habitat Type. This type occurs at elevations of 6600 to 7320 feet in the permit area. It is found on moderate to very steep, cool slopes intermediate between *Abi*

las/Men fer and Abi las/Cal can (Exhibit C-1). In common with most stands in the moister subalpine fir habitat types in the permit area, the overstory was dominated by seral lodgepole pine and/or Engelmann spruce. Subalpine fir was reproducing successfully in the depauperate understory. Understory herb and shrub composition shares elements of Abi las/Men fer and Abi las/Vac sco; grouse whortleberry usually averages substantially higher canopy cover than does twinflower in area stands.

The Abi las/Lin bor habitat type occurred on the Zc gravelly, cobbly silty loam soil, 15-50 percent slope.

Subalpine Fir/Rusty Menziesia (Abi las/Men fer) Habitat Type. The Abi las/Men fer type is found on lower to middle, moderate to very steep slopes on north aspects in the permit area. It is bordered above by Abi las/Xer ten and Abi las/Vac sco on drier sites, and is bordered below by Abi las/Lin bor on gentler, slightly warmer slopes and by Abi las/Cal can on wetter sites. Elevation ranged from 6680 to 7430 feet. The overstory is primarily sapling to pole-size subalpine fir and lodgepole pine, with relatively dense subalpine fir seedlings in the understory. Rusty menziesia (Menziesia ferruginea) and grouse whortleberry dominated the understory. Other characteristic species in the depauperate understory included raceme pussytoes (Antennaria

racemosa), sidebells pyrola (Pyrola secunda), roundleaf violet and sitka alder.

The Abi las/Men fer habitat type occurred on the Zc and Zd gravelly, cobbly silty loam soils, 15-50 percent slope and greater than 50 percent slope.

Subalpine Fir/Bluejoint Reedgrass (Abi las/Cal can) Habitat Type. This is the wettest forest habitat type in the permit area. It is restricted to drainage bottoms and swales at drainage headwaters, most of which are cold air drainages in the area. Elevation ranged from 6580 to 7770 feet.

The overstory of most Abi las/Cal can stands in the area is dominated by mature Engelmann spruce, with good regeneration of subalpine fir and spruce in the understory. Most understory herbs characteristic of Abi las/Cal can are absent from or occur only very sporadically in adjacent, moist subalpine fir habitat types. Graminoid cover averaged 2 percent for one transect sampled in the type (Table 4), comprised of pinegrass and yellow bog sedge (Carex dioica). Characteristic graminoids usually present on these sites included bluejoint reedgrass (Calamagrostis canadensis), drooping woodreed (Cinna latifolia) and smallflowered woodrush (Luzula parviflora). Forb cover averaged 30 percent, dominated by western meadowrue (14), heartleaf arnica (8), brook saxifrage (Saxifraga arguta, 2), feather solomon's-

seal (Smilacina racemosa, 2) and clasping leaf twisted-stalk (Streptopus amplexifolius, 1). Other characteristic forbs variously present in Abi las/Cal can stands included common horsetail (Equisetum arvense), sweet-scented bedstraw (Galium triflorum), alpine mitrewort (Mitella pentandra), woodnymph (Pyrola uniflora), arrowleaf groundsel (Senecio triangularis) and green false hellebore (Veratrum viride). The presence of sweet-scented bedstraw indicated the Gal tri phase of Abi las/Cal can on warmer drainage sites at lower elevations. This phase was transitional to the spruce/twinflower habitat type at slightly lower elevations in drainage bottoms in the German Gulch access corridor. The more extensive, typical Cal can phase occupied colder drainages throughout the permit area.

Shrub cover averaged less than one percent for the stand sampled, although the diagnostic species smooth Labrador-tea (Ledum glandulosum) was well-represented in some Abi las/Cal can stands. Other characteristic shrubs included bearberry honeysuckle (Lonicera involucrata) and swamp gooseberry (Ribes lacustre). Tree cover averaged 50 percent for the stand sampled, comprised of Engelmann spruce (40), subalpine fir (5) and lodgepole pine (5).

The Abi las/Cal can habitat type occurred on the V and X loam soils, 0-25 percent slopes.

Disturbed Upland Community Type. Historic mining disturbance sites were inventoried to determine the success of natural recolonization by vascular plant species. In the permit area, these included the pit, waste dump and heap leach test site. Species identified at these sites are listed in Table 5. The pit was sparsely vegetated, with best revegetation on the slopes. Woody plants were more diverse than herbaceous species. Two noxious weeds were present, spotted knapweed (Centaurea maculosa) and Canada thistle (Cirsium arvense). Noxious weeds are addressed in a separate section of this report.

The waste dump was also sparsely vegetated, with steep, unstable slopes. There were ample fines, and angular coarse fragments ranged in size from gravels to boulders. Herbaceous species were more diverse than woody plants. Spotted knapweed was present.

The heap leach test site was very rocky with sandy fines, and generally barren with best revegetation on the periphery. Plant cover was greater on 3-inch minus gravel than on 0.5-inch minus gravel. Plants were generally healthy, with slight chlorosis evident. Trees were reproducing most successfully on west slope gravels near the periphery. Spotted knapweed and Canada thistle were present.

The disturbed upland vegetation type was correlated with portions of the D soils mapping unit (refer to Appendix D. SOILS).

Table 5. Vascular plant species identified on disturbed sites in the Beal Project permit area, 1987.

<u>Species</u>	<u>Disturbed Upland</u>			<u>Disturbed Riparian</u>
	<u>Pit</u>	<u>Waste Dump</u>	<u>Heap Leach</u>	
Graminoids				
Agr cri			X	
Agr can		X	X	
Agr int			X	
Agr alb				X
Agr sca		X	X	
Ero tec	X			
Cer gey			X	X
Carex spp.				X
Des ces		X	X	X
Hor jub			X	
Juncus spp.		X	X	
Phil pra			X	
Poa com				X
Poa pra	X		X	X
Poa spp.				X
Sti occ			X	
Forbs				
Ach mil			X	X
Ana mar				X
Ant mic				X
Arabis spp.			X	X
Artemisia spp.		X		X
Aster spp.				X
Cen mac	X	X	X	
Cir arv	X		X	X
Cir vul		X		
Epi min		X	X	X
Ecu arv				X
Eri umb				X
Fra vir			X	X
Ger vis				X
Goo obl				X
Her lan				X
Lup ser				X
Pha has	X	X		
Pyr sec				X
Rum sal		X		
Senecio spp.				X
Tar off			X	X
Trifolium spp			X	X
Urt dio				X
Ver tha			X	X

Table 5. (continued)

<u>Species</u>	<u>Disturbed Upland</u>			<u>Disturbed Riparian</u>
	<u>Pit</u>	<u>Waste Dump</u>	<u>Heap Leach</u>	
Shrubs				
Jun com				X
Rib lac				X
Rub ida				X
Tall Shrubs and Trees				
Abi las	X		X	X
Aln sin				X
Pic eng			X	X
Pin alb				X
Pin con	X	X	X	X
Pop tre	X			X
Pop tri	X			X
Pse men	X		X	X
Sal exi	X			X
Salix spp.	X	X	X	X

Disturbed Riparian Community Type. Historic placer mining has resulted in seral riparian community domination of the majority of the German Gulch bottom (6520 to 6980 feet elevation). Gold was discovered there in 1865 and hydraulic mining initiated in the early 1870's. The peak of mining activity continued through the 1890's, then occurred sporadically until about 1907.

The placered substrate consists of irregular stacks of gravels, cobbles and boulders, with few fines near the surface. The channel bottom is mostly dominated by willow (primarily Drummond willow, Salix drummondiana) and/or aspen, with scattered conifers. Channel banks and

toeslopes were dominated by various mixtures of lodgepole pine, Douglas-fir, willow and aspen, with slower regeneration of Engelmann spruce and scattered subalpine fir and whitebark pine. Understories throughout were very sparse, but numerous non-weedy species were present (Table 5). Canada thistle was present. Moss cover was very high on these sites, as it was in less disturbed, adjacent subalpine fir habitat types.

The disturbed riparian vegetation type was correlated with portions of the D soils mapping unit and the G very gravelly, cobbly sandy loam soil, 0-25 percent slope (refer to Appendix D. SOILS).

Grazing/Agricultural Uses

The permit area is unsuitable for cultivation, being more suited to livestock grazing. The Beal Pasture is part of an approximately 12,000-acre U.S. Forest Service grazing allotment leased to Maynard Smith of Glen, Montana and managed by Meg Smith. The allotment is designed as a six-pasture rotation grazing system and is grazed from mid-June to mid-October by about 220 animal units (cow-calf pairs), resulting in a total of 880 AUM's. Rated carrying capacity is 1,077 AUM's (Sawyer, 1984). The Beal Pasture was grazed during July and August, 1987 (Meg Smith, pers. comm.).

Sawyer (1984) stated that the range is rated in good to excellent condition, with all of it considered to be improving (based on

discussions with U.S. Forest Service personnel). He also indicated that much of the range receives high cattle use. Observations during October 1987 showed high cattle use on the south side of Beal Hill, with moderate to light use in other areas. A review of OEA Research (1981) data indicates a wider range of condition on the permit area, from fair to excellent.

The south half of the permit area receives very little livestock use as it is primarily forested, with low production of palatable understory.

Primary range sites include silty and shallow, 15 to 19-inch precipitation zone. These range sites are dominated by habitat types in the rough fescue and Idaho fescue series.

Timber Resources

The permit area north of German Gulch is primarily grassland, with open stands of Douglas-fir forest on steeper, drier aspects and lodgepole pine and subalpine fir at higher elevations or on cooler, moister sites. South of German Gulch (primarily north aspects), the permit area is dominated by extensive seral stands of lodgepole pine. Subalpine fir and Engelmann spruce generally occur in these stands, with spruce more abundant in drainage bottoms and on concave sites.

Tree density varies by habitat type (Table 6). Drier habitat types (Pse men/Cal rub, Abi las/Car gey and Abi las/Cal rub) have lower

Table 6. Tree density (stems/acre) by species, dbh class and habitat type (data from OEA Research, 1981).

<u>Species/dbh class</u>	<u>Habitat type</u>				
	<u>Pse men/ Cal rub</u>	<u>Abi las/ Car gev</u>	<u>Abi las/ Cal rub</u>	<u>Abi las/ Vac sco</u>	<u>Abi/las Cal can</u>
Pse men					
< 1" dbh	234		108		
1-6" dbh	68		97		
> 6" dbh	173		205		
Total	475		410		
Pin con					
< 1" dbh	140	11		46	
1-6" dbh	18	88		84	
> 6" dbh	76	238		246	
Total	234	335		376	
Picea					
< 1" dbh					248
1-6" dbh					173
> 6" dbh					151
Total					572
Abi las					
< 1" dbh	0	281		421	86
1-6" dbh	0	65		127	183
> 6" dbh	14	65		38	356
Total	14	411		586	625
Pin alb					
< 1" dbh		22		38	
1-6" dbh		0		22	
> 6" dbh		0		32	
Total		22		92	
Total	723	768	410	1,054	1,197

densities ranging from 410 to 768 stems/acre. More mesic types (Abi las/Vac sco and Abi las/Cal can) are overstocked with densities of 1,054 to 1,197 stems/acre. Densities of merchantable trees (six-inch dbh or greater) ranged from 205 to 316 stems/acre, except in the Abi las/Cal can habitat type (507 stems/acre). Sawyer (1984) found densities of trees over four-inch dbh to be 363 to 428 stems/acre in the proposed waste dump area. This site was dominated by lodgepole pine and subalpine fir, with fewer spruce.

Table 7 presents mean basal area and 50-year site indexes (Pfister et al., 1977) for forested habitat types occurring on the permit area. Mean basal area is fairly consistent, ranging from 175 square feet/acre for the Abi las/Vac sco type to 247 square feet/acre for the Abi las/Cal can type. Sawyer (1984) calculated basal areas of 121 to 196 square feet/acre for several sites within and adjacent to the permit area. OEA Research (1981) measured height, diameter and age of trees on forested transects in the permit area (Table 8).

Commercial volume was estimated at 5,000-6,000 board feet/acre in the more dense forest stands and 2,000-3,000 board feet/acre in more open stands (Davis, pers. comm.).

Noxious Weeds

Two weed species listed by the state as noxious in Montana were identified in the permit area. Canada Thistle (Cirsium arvense) and spotted knapweed (Centaurea maculosa) were recorded on areas disturbed

Table 7. Mean basal area and 50-year site indexes by habitat type (from Pfister et al., 1977).

<u>Habitat Type</u>	<u>Basal area (sq.ft/acre)</u>	<u>Site Index by Species</u>				
		<u>Pin pon</u>	<u>Pse men</u>	<u>Pin con</u>	<u>Picea</u>	<u>Abi las</u>
Pse men/Cal rub	206±19	45±?	38±3	45±4	-	-
Abi las/Car gey	-	-	-	-	-	40±12
Abi las/Cal rub	222±85	-	40±10	-	57±?	50±12
Abi las/Vac sco	175±20	-	-	40±5	45±7	40±5
Abi las/Xer ten	226±39	-	-	43±?	-	-
Abi las/Aln sin	-	-	-	-	50±?	46±?
Abi las/Lin bor	191±20	-	43±9	46±11	44±5	43±11
Abi las/Men fer	195±41	-	-	-	50±?	52±?
Abi las/Cal can	247±56	-	-	50±13	45±4	43±5

Note: Means are shown where n=3 or more; confidence limits (95 percent) for estimating the mean are given where n=5 or more.

Table 8. Height, diameter and age of selected trees by habitat type and species (data from OEA Research, 1981).

<u>Transect</u>	<u>Habitat Type</u>	<u>Species</u>	<u>Height (feet)</u>	<u>DBH (inches)</u>	<u>Age (breast height)</u>
4	Abi las/Vac sco	Pin con	69	10	-
6	Abi las/Vac sco	Abi las	59	9	~ 125
		Pin con	61	10	~ 118
9	Abi las/Vac sco	Abi las	52	8	82
		Pin alb	45	10	76
		Pin con	54	10	69
11	Abi las/Car gey	Pin con	57	13	90
12	Abi las/Cal rub	Pse men	65	12	98
13	Pse men/Cal rub	Pse men	44	8	65
16	Abi las/Vac sco	Abi las	48	8	81
		Pin con	70	11	102
17	Pse men/Cal rub	Pin con	59	10	112
		Pse men	49	10	77
18	Abi las/Cal can	Abi las	50	7	77
		Picea	43	7	65
20	Pse men/Cal rub	Abi las	86	23	115
		Pin con	62	12	72
		Pse men	53	9	43

by previous mining activity. Both species were uncommon in 1987 and were not recorded during the 1981 vegetation survey (OEA Research, 1981), implying fairly recent migration into upper German Gulch. Both species are more prevalent down-drainage.

The USDA Forest Service has sprayed knapweed within the permit area during the past few years (P. Grinde, pers. comm.)

Additional non-noxious, weedy species encountered on disturbed areas in the permit area are listed in Table 5.

ACCESS ROAD OPTIONS

Habitat/Community Type Descriptions

Vegetation types identified on the Beal Project access options are listed in Table 9, with site parameters and relative abundance. Five grassland habitat types and two shrubland habitat types were identified, following the classification of Mueggler and Stewart (1980). Two deciduous woodland community types were identified, associated with stream bottoms and moist toeslopes. Nine forest habitat types were identified following the classification of Pfister et al. (1977), six in the Douglas-fir series, one in the Engelmann spruce series and two in the subalpine fir series. Disturbed types were also assessed, including the disturbed riparian community in German Gulch and agricultural land.

TABLE 9. SITE PARAMETERS AND RELATIVE ABUNDANCE OF VEGETATION HABITAT/COMMUNITY TYPES IN THE FFW PROJECT ACCESS OPTIONS, SILVER BOW COUNTY, MONTANA.

TYPE	CODE	ASPECT	SLOPE	ELEVATION (FT.)	RELATIVE ABUNDANCE (%)						
					Scruboak	Fairmont Gulch	Wiles Crossing	Stairor	Chalfor		
Grassland habitat types											
Bluebunch wheatgrass/native bluegrass	For spi/Fec can	uniform	level to steep	5120 - 5600	38 (5) 6 (2)	16 (28) 1 (5)	10	50 (4) 1 (4)	22 (20) 10 (28)		
Idaho fescue/bluebunch wheatgrass	Fec ida/For spi	variable	moderate to steep	5160 - 6100	5	8 (18)	10	37	4		
Pough fescue/bluebunch wheatgrass	Fec sca/For spi	variable	gentle to moderate	5280 - 6300	16	8 (5)	4	22	6 (1)		
Pough fescue/Idaho fescue	Fec sca/Fec ida	variable	gentle to moderate	5100 - 6100	8 (3)	-	-	<1	1 (4)		
Tufted halgrass/crook	Fec croa/Fec can	variable	level to gentle	6440 - 6600	2	-	-	-	1		
Shrubland habitat types											
Antelope bitterbrush/bluebunch wheatgrass	Fur tri/For spi	S	steep	5100 - 5600	5	2	-	13	4		
Antelope bitterbrush/rough fescue	Fur tri/Fec sca	S	moderate to steep	5400 - 6200	5	2	-	12	4		
Deciduous woodland community types											
Killow	Sally c.st.	bottom	gentle	5110 - 5800	11	1	3	2	7		
Quaking aspen	Pop. tr/c.st.	variable	gentle to moderate	5640 - 6100	6	4	2	2	1		
Forest habitat types											
Douglas-fir/Idaho fescue	Fec mon/Fec ida	variable	moderate to steep	5220 - 6000	35	21 (1)	06	15	24		
Douglas-fir/rough fescue	Fec mon/Fec sca	variable	moderate to steep	5200 - 6500	4	2 (1)	6	5	1		
Douglas-fir/fescue	Fec mon/Cal rub	variable	moderate to steep	5200 - 6500	12	16	2	7	4		
Douglas-fir/common snowberry	Fec mon/Syb alb	S	moderate to steep	5500 - 6600	10	3	23	2	10		
Douglas-fir/whiteflower	Fec mon/Lin bor	R	gentle to moderate	5700 - 6000	-	-	3	-	-		
Douglas-fir/mallow pinebark	Fec mon/Fly mal	R	moderate	5900 - 6000	-	-	8	-	-		
Pinebark spruce/whiteflower	Fic can/Lin bor	R	moderate to moderate	5900 - 6150	4	-	-	-	-		
Subalpine fir/whiteflower	Abf las/Lin bor	R	gentle to moderate	5400 - 6150	-	-	9	-	-		
Subalpine fir/Roughleaf redgrass	Abf las/Cal can	bottom	gentle	6170 - 6200	-	-	3	-	-		
Disturbed rangeland community type	Diet. rfp.		moderate to moderate	6160 - 6440	-	-	1	-	-		
Agricultural (grain, hay)											
Miscellaneous											
Residential/Industrial											
Rock outcrop, scree											
Reservoir											
Railroad right-of-way											

*Numbers in parentheses indicate significantly altered, woody sites; asterisks are shown in Exhibit 2 of Appendix D, SOILS

Bluebunch Wheatgrass/Native Bluegrass (Agr spi/Poa san) Habitat Type.

Agr spi/Poa san is found at lower elevations on the access corridors (primarily 5100-5600 feet). It occurs on gentle slopes of variable aspect and steep slopes of warm (southerly) aspect with often poor soil development. Much of the type on gentler terrain has been disturbed, with subsequent invasion of weedy species. These sites are generally dominated by spotted knapweed, Kentucky bluegrass, Canada bluegrass (Poa compressa), big bluegrass (Poa junceifolia) and rubber rabbitbrush (Chrysothamnus nauseosus). Less disturbed sites are typically dominated by bluebunch wheatgrass, native bluegrass, prairie junegrass, common yarrow, moss phlox (Phlox muscoides) and other dry site forbs and cushion plants, fringed sagewort and rubber rabbitbrush. Rocky Mountain juniper (Juniperus scopulorum) is often conspicuous. Including severely disturbed sites, the Agr spi/Poa san type occupies about 36 percent of the Stauffer route, 15 percent of the Fairmont la route, 8 percent of the Spangler route and 5 percent of the Miles Crossing route.

Idaho Fescue/Bluebunch Wheatgrass (Fes ida/Agr spi) Habitat Type.

Fes ida/Agr spi is found on rolling terrain and steep hillsides of variable aspect at elevations of 5160-6600 feet. This type has been described for the permit area. It occupies 36 percent of the Miles Crossing route, 26 percent of the Fairmont la route, 10 percent of the German Gulch corridor and 4-5 percent of the Spangler and Stauffer routes (Table 9). About 70 percent of this type on the Fairmont route is

severely altered by invasion of spotted knapweed and other weedy species.

Rough Fescue/Bluebunch Wheatgrass (Fes sca/Agr spi) Habitat Type. Fes sca/Agr spi is found on gentle to moderate slopes of variable aspect at elevations of 5280-6300 feet. This type has been described for the permit area. It occupies 22 percent of the Miles Crossing route, 16 percent of the Spangler route, 13 percent of the Fairmont la route and 7 percent of the Stauffer route. This type shows less severe disturbance than do the previous two grassland types.

Rough Fescue/Idaho Fescue (Fes sca/Fes ida) Habitat Type. This type occupies gentle to moderate slopes of variable aspect at elevations of 5500-6100 feet. It has been described for the permit area. It occupies 11 percent of the Spangler route and one percent of the Stauffer route. Portions of the type on the Spangler route near German Gulch are degraded, dominated by Kentucky bluegrass, Richardson needlegrass (Stipa richardsonii) and various moist-site, increaser forbs.

Tufted Hairgrass/Sedge (Des ces/Carex) Habitat Type. This type is found on level to gentle slopes at 5440-6060 feet elevation in three percent of the Spangler route and one percent of the Stauffer route. It has been described for the permit area. Dominant species were tufted hairgrass, Nebraska sedge (Carex nebraskensis), Kentucky

bluegrass, common timothy (Phleum pratense) and meadow barley (Hordeum brachyantherum).

Antelope Bitterbrush/Bluebunch Wheatgrass (Pur tri/Agr spi) Habitat Type.

Pur tri/Agr spi is limited to less than one percent of the Stauffer access route, found on very steep southerly slopes at about 5600-5800 feet elevation. It is similar to the Pur tri/Fes sca habitat type, except that soils are less developed and less stable on generally steeper slopes. Antelope bitterbrush (Purshia tridentata) dominates over an understory which is floristically similar to Agr spi/Poa san grassland.

Antelope Bitterbrush/Rough Fescue (Pur tri/Fes sca) Habitat Type.

Pur tri/Fes sca is found on moderate to steep, warm slopes at 5480-6240 feet elevation. Floristics are similar to Fes sca/Agr spi grassland, with the addition of bitterbrush; many stands had substantial cover of Kentucky bluegrass. The type occupies 13 percent of the Miles Crossing route and 2-5 percent of the Spangler, Fairmont and Stauffer routes (Table 9).

Willow (Salix) Community Type.

The willow community is found on wet drainage bottoms at 5110-5800 feet elevation. Common willows include Salix drummondiana and S. myrtilifolia; understories are variously dominated by tufted hairgrass, Kentucky bluegrass, timothy, bluejoint reedgrass, sedges and wet-site forbs. The type occupies 6 percent of

the Spangler route and 1-3 percent of the German Gulch, Miles Crossing and Stauffer routes.

Quaking Aspen (Pop. tre) Community Type. The aspen community is found on gentle to moderate slopes at 5440-6100 feet elevation. The type has been described for the permit area; most access corridor stands have a closed aspen canopy and many show past disturbance in the understory, dominated by Kentucky bluegrass and mesic, often weedy forbs such as common dandelion. Aspen stands occupy 6 percent of the Stauffer route, 5 percent of the Spangler route and 1 percent of the Fairmont la route.

Douglas-Fir/Idaho Fescue(Pse men/Fes ida) Habitat Type. Pse men/Fes ida is found on moderate to steep slopes of variable aspect at 5320-6000 feet elevation. Most stands have an open Douglas-fir canopy, with understories floristically similar to Fes ida/Agr spi grassland but averaging less herbaceous cover. Pse men/Fes ida occupies 5-6 percent of the German Gulch and Miles Crossing routes and 1-3 percent of the Fairmont and Stauffer routes (Table 9).

Douglas-Fir/Rough Fescue(Pse men/Fes sca) Habitat Type. Pse men/Fes sca is found on sites similar to Pse men/Fes ida, often immediately upslope. Douglas-fir canopy is generally less open than in Pse men/Fes ida stands but understory composition is rather similar, with the addition of rough fescue. Antelope bitterbrush is a conspicuous component of Pse men/Fes sca stands which adjoin stands of Pur tri/Fes

sca. Pse men/Fes sca is the second most abundant Douglas-fir habitat type in the access corridor options, occupying 16 percent of the Fairmont la route, 12 percent of the Spangler route and 1-7 percent of the other three routes (Table 9).

Douglas-Fir/Pinegrass (Pse men/Cal rub) Habitat Type. Pse men/Cal rub is found on moderate to steep slopes of variable (often warmer) aspect at elevations of 5500-6600 feet. The type has been described for the permit area; many lower to mid-elevation stands are dominated by seral lodgepole pine with depauperate understories dominated by Canada buffaloberry (Shepherdia canadensis) and kinikinnick (Arctostaphylos uva-ursi). Pinegrass, elk sedge, showy aster (Aster conspicuus) and creeping Oregon-grape were usually present in these seral stands. More mature stands were similar to permit area stands. Pse men/Cal rub is the most abundant Douglas-fir type in the access corridor options, occupying 23 percent of the German Gulch route, 19 percent of the Spangler route, 18 percent of the Stauffer route and 2-3 percent of the other two routes (Table 9).

Douglas-Fir/Common Snowberry (Pse men/Sym alb) Habitat Type. Pse men/Sym alb is found on relatively small, mesic swales and concavities of generally warm aspect. It is floristically similar to adjacent Pse men/Cal rub, with the addition of common snowberry and higher cover of mesic forbs such as western meadowrue. It occupies only 3 percent of the German Gulch corridor, at 5760-6560 feet elevation.

Douglas-Fir/Twinflower (Pse men/Lin bor) Habitat Type. Pse men/Lin bor is found on gentle to moderate to slopes and concavities on north aspects at 5600-6160 feet elevation. Sites were transitional between moister Pic eng/Lin bor stands, and drier Pse men/Cal rub stands. The type has been described for the permit area. Douglas-fir is dominant in the overstory, with relatively small amounts of seral lodgepole pine. Conspicuous species in the understory include northwest sedge (Carex concinnoides), raceme pussytoes (Antennaria racemosa), twinflower, creeping Oregon-grape, Scouler willow (Salix scouleriana), quaking aspen and occasionally grouse whortleberry. Pse men/Lin bor occupies about 8 percent of the German Gulch access corridor.

Douglas-Fir/Mallow Ninebark (Pse men/Phy mal) Habitat Type. This is the most mesic Douglas-fir habitat type found on the access options; occupying about 4 percent of the Spangler route. It is found on moderate slopes of north and east aspect at 5600-6080 feet elevation. Floristic composition is rather similar to that of Pse men/Cal rub, with the addition of mallow ninebark (Physocarpus malvaceus). Dominant herbs are elk sedge, pinegrass and showy aster. Shrubs and subshrubs are particularly conspicuous, including creeping Oregon-grape, kinikinnick, ninebark, common snowberry, prickly rose (Rosa acicularis) and Canada buffaloberry.

Engelmann Spruce/Twinflower (Pic eng/Lin bor) Habitat Type. Pic eng/Lin bor is found on gentle to moderate, northerly slopes and

bottoms at 5600-6150 feet elevation, occupying 9 percent of the German Gulch corridor. Floristics are very similar to the Abi las/Lin bor habitat type described for the permit area, with the absence of subalpine fir. Most stands are dominated by seral Douglas-fir and quaking aspen in the overstory, with spruce seedlings conspicuous in the understory.

Subalpine Fir/Twinflower (Abi las/Lin bor) Habitat Type. Abi las/Lin bor occupies sites similar to Pic eng/Lin bor, at higher elevations (6170-6600 feet) covering 3 percent of the German Gulch corridor (Table 9). This type has been described for the permit area.

Subalpine Fir/Bluejoint Reedgrass (Abi las/Cal can) Habitat Type. Abi las/Cal can is found on cold drainage bottoms at 6160-6440 feet elevation, occupying about one percent of the German Gulch corridor. This type has been described for the permit area.

Disturbed Riparian Community Type. The disturbed riparian community is primarily found in the German Gulch corridor, occupying 31 percent of this route along the entire drainage bottom. This type has been described for the permit area.

Grazing/Agricultural Uses

All access road options primarily traverse grazing lands. The common corridor along German Gulch is an exception, passing through forest and

areas disturbed historically by hydraulic mining. This area has limited utility for grazing except for grassland openings and open Douglas-fir stands on the south-facing slope above German Gulch.

Agricultural land (hay meadows and grain fields) is found along lower stretches of the existing Fairmont and Stauffer roads. The Spangler option will pass adjacent to a wheat field in Section 2, T3N, R10W. Hay meadows are found adjacent to the Stauffer road along Little Gulch in Sections 29 and 30, T3N, R9W.

Range condition on grazing land varies from poor to excellent. The best range condition is found on the Mt. Haggin Wildlife Management Area where weed control and grazing management plans have been implemented. Range condition on the WMA is generally good to excellent. Lower stretches of the access road options are in poor to fair condition, primarily due to invasion by spotted knapweed and other exotic species.

Timber Resources

The majority of the access road options pass through non-forested areas (Table 9). Exceptions include:

- the common corridor along German Gulch. Open stands of Douglas-fir occur along the south-facing slope above the Gulch. The Gulch bottom supports scattered spruce, Douglas-

fir and lodgepole pine in the rock piles left by hydraulic mining. The north-facing slope has a dense canopy of Douglas-fir, with fewer spruce and lodgepole pine.

- the Fairmont, Spangler and Stauffer options pass through or near several stands of Douglas-fir and lodgepole pine, some of which have been logged.

Very little commercial timber will be impacted by access road construction, regardless of the option selected.

Noxious Weeds

Unlike the permit area, where noxious weeds are relatively uncommon, portions of the access road options have high populations of noxious weeds. Canada thistle is restricted to mesic microsites, however, spotted knapweed is abundant along lower reaches of the Fairmont and Stauffer roads.

On the existing Fairmont road, knapweed is abundant from the Hot Springs turnoff to the boundary of the Mt. Haggin Wildlife Management Area. Knapweed decreases substantially on the WMA and occurs only as scattered plants by the time the road crosses German Gulch.

On the Stauffer road, knapweed occurs occasionally from German Gulch to Little Gulch (NE1/4 Section 30). From Little Gulch east, knapweed increases along the right-of-way.

The Miles Crossing option has low populations of noxious weeds in native grassland and shrubland. Knapweed increases on lower slopes in Sections 16 and 17 where the route approaches historic disturbances from the railroad and activities at Miles Crossing.

The Spangler option (new construction only) has low populations of knapweed in the N1/2 Section 14 and S1/2 Section 11, increasing substantially to the north.

The Butte-Silver Bow Weed Control Board lists several weeds in addition to those on the state list (Leo Mock, pers. comm.), however they were not identified along the access road options. Several weedy species not listed as noxious were identified including musk thistle (Carduus nutans), henbane (Hyoscyamus niger), butter-and-eggs (Linaria vulgaris) and flannel mullein (Verbascum thapsus).

SPECIES LIST/RARE PLANTS

A list of vascular plant species (Supplement A) was compiled for the Beal Project permit area from the July 1981 quantitative inventory (OEA Research, 1981) and the October-November 1987 WESTECH reconnaissance. The list also includes taxa identified at lower elevations in the

access road options during the WESTECH reconnaissance as well as species identified by Richard Proegers for the High Rye area (John Joy, pers. comm.). A number of species which bloom in spring or early summer are undoubtedly omitted from the list.

In the permit area, 195 vascular plant species have been identified, including 37 graminoids, 123 forbs, 4 subshrubs, 20 low shrubs, and 11 tall shrubs and trees. Most of these species were also recorded in the access road options. An additional 83 taxa were identified only in the access options, primarily species which are more restricted to lower elevations. These included 17 graminoids, 50 forbs, 3 subshrubs, 9 low shrubs, and 4 tall shrubs and trees. An additional 12 graminoids and 27 forbs have been documented for the High Rye area.

The combined list of 317 taxa was comprised of 66 graminoids, 200 forbs, 7 subshrubs, 29 low shrubs, and 15 tall shrubs and trees. Cordilleran flora dominate the list, with some Pacific maritime influence. Lower intermontane valleys (lower elevations of access options) exhibit moderate Great Plains influence.

The status of rare plants in the Beal Project permit area and access options was ascertained by contact with the Montana Natural Heritage Program (MTNHP) and review of the Montana rare plant monograph by Lesica et al. (1984). A search of MTNHP files suggested seven taxa as candidates for the study area, although there was a rather low

potential of occurrence for four of them (J. Stephen Shelly, pers. comm.). The seven candidates are:

- Carex parryana spp. idahoensis ("C. idahoensis") and Erigeron gracilis have both been recorded in the vicinity of Humbug Spines. The former was considered for listing but rejected by Lesica et al. (1984). Dorn (1984) gives distribution of Carex parryana as moist areas in the west and north-central floristic region of Montana. Hitchcock and Cronquist (1973) give its distribution as meadows and moist, low ground in the plains and foothills, chiefly east of the Continental Divide. Erigeron gracilis is listed by Lesica et al. (1984) as occurring in meadows and open slopes at mid- to high elevations in the Absaroka Mountains in Park County; it is a regional endemic. Dorn (1984) lists E. gracilis for hills and slopes of southwestern and south-central Montana. Neither species has been recorded for the Beal Project area.

- Castilleja exilis, an annual paintbrush, is known from an old, imprecise record in the general vicinity of Warm Springs. Dorn (1984) has records for Silver Bow and Gallatin counties, and describes habitat as "often alkaline or marly meadows and marshes". Lesica et al. (1984) did not consider the species for listing. Hitchcock and Cronquist (1973) describe C. exilis as occurring in saline marshes in the valleys; it is widespread in the western U.S., east of the Cascades from southern Canada to

northern Arizona and New Mexico. Appropriate habitats are not available in the Beal Project area, and the species has not been recorded there.

- Claytonia lanceolata var. flava has not been recorded in the Beal Project area, but may potentially occur there since no botanical survey has been conducted in the area during spring (the taxon is most readily identified during late April to late May). Lesica et al. (1984) recommended its status as threatened in Montana; records were cited for moist meadows at mid-elevations in Deer Lodge and Powell counties. "C. lanceolata var. flava is thought to be extinct at the type locality in Idaho and one of the two other known stations in Montana. It may still occur in the vicinity of Anaconda where it was collected 70 years ago" (Lesica et al., 1984). More recent records (J.S. Shelly, pers. comm.) indicate that the taxon is extant at the type locality near Henrys Lake in Idaho. There are two historical and three recent records for the taxon in Montana. Of the two historical records cited by Lesica et al. (1984), the Powell County record is likely a 1966 record from near Champion Pass in Deer Lodge County, which has not been relocated despite recent field investigation by P. Lesica. Recent Montana records include:

- 1) one plant in a subalpine forb meadow in the northern East Pioneer Mountains in Beaverhead County (WESTECH, 1982);

- 2) a large population of perhaps 2,000 individuals near Hebgen Lake in Gallatin County (Jan Nixon 1986 pers. comm. to J. S. Shelly); C. lanceolata var. lanceolata was not present in this population;
- 3) a population of undetermined size near State Highway 274 about 10-15 miles south of Anaconda (P. Lesica 1987 pers. comm. to J. S. Shelly). There are four additional recent records from northwestern Wyoming, in all of which C. lanceolata var. lanceolata was present.

Intensive field investigations of the status of C. lanceolata var. flava in Montana will likely be implemented in spring - early summer, 1988 (J. S. Shelly, pers. comm.).

- Juncus hallii is accorded rare status for Montana as a peripheral species by Lesica et al. (1984), occurring in moist to dry meadows at mid- to high elevations in the mountains in Madison and Powell Counties and reported for Silver Bow County. The record for Silver Bow County is that of OEA Research (1981) for the Beal Project permit area; the taxon averaged well under one percent cover on one transect (#10) in the Idaho fescue/bearded wheatgrass habitat type and on one transect (#3) in the rough fescue/Idaho fescue habitat type. It averaged 1.5 percent cover on one transect (#5) in the shrubby cinquefoil/rough fescue habitat type.

- Penstemon lewisiensis, currently one of the more sensitive vascular plant species in Montana, is endemic to extreme southwestern Montana and adjacent Idaho (J. S. Shelly, pers. comm.). In Montana, its distribution is primarily low to mid-elevation sites scattered along the south and east periphery of the Pioneer Mountains. The locality nearest the Beal Project area is a recent (1986) record from the northern East Pioneer Mountains, Beaverhead County by J. S. Shelly (pers. comm.). Lesica et al. (1984) recommended the taxon for threatened status in Montana, since most populations are small and threatened by grazing and road maintenance. The distribution was described as sagebrush grasslands at mid-elevations (6,000 - 7,000 feet) in Beaverhead and Ravalli Counties. Historic records from Ravalli County have not been relocated despite recent field investigation. A recent, detailed report on the status of Penstemon lewisiensis in Montana (Shelly, 1987) summarizes current knowledge of its distribution and habitat requirements.

- Agoseris sp. nov. has been recorded near the Beal Project area at the head of Jerry Creek in NE/4 Section 18 at 7760 feet elevation. There is therefore potential for its occurrence in subalpine meadows in the permit area. The taxon will be formally named Agoseris lackschewitzii (J.S. Shelly, pers. comm.).

A review of Lesica et al. (1984) revealed no additional taxa as likely rare plant candidates for the Beal Project area. In the eight years preceding Lesica et al. (1984), 22 vascular plant taxa were considered in Montana for federal status as threatened or endangered; these included Carex parryana ssp. idahoæ, Claytonia lanceolata var. flava and Penstemon lemhiensis. Observations by John Joy in the area have not indicated the presence of any sensitive plant species.

LITERATURE CITED

- Branson, F. A. and T. Lommasson. 1958. Quantitative effects of twenty-three years of controlled use on mountain range. J. Range Management 11(2): 67-70.
- Campbell, G., J. Cornish and R. Portch. Eds. 1979. Preliminary ecological studies for the M-D/CDIF test site, Butte Valley (FH 77/78 data summary). Tech. rept. prepared for U.S. Dept. of Energy by Montana Energy and M-D Research and Development Institute, Butte. 79 p. + append.
- Chaffee, G. B. and M. S. Morris. 1982. Response of subalpine needlegrass Stipa occidentalis var. minor (Vasey) C. L. Hitchcock to grazing and disturbance in western Montana, Proc. Mont. Acad. Sci. 41:71-78. 7 p.
- Culwell, L. D. and K. L. Scow. 1982. Vegetation inventory of the Jardine project area, Park County, Montana. Unpub. tech. report prepared for Homestake Mining Co. by WESTECH, Helena, MT. 138 p.
- Culwell, L. D., K. L. Scow, P. Husby and P. Lesica. 1980. Cover and production on a rough fescue/Idaho fescue habitat type. Unpublished data.
- Culwell, L. D., K. L. Scow and L. A. Larsen. 1984. Vegetation inventory of the Montana Tunnels study area, Jefferson County, Montana. Prepared for Centennial Minerals, Inc., Helena, MT. 87 p.
- Daubenmire, R. 1959. A canopy-coverage method of vegetational analysis. Northwest Science 33(1):43-64.

- Davis, Merrill. 1988. District Ranger, Butte District, Deerlodge National Forest, Butte, Montana. Personal communication, February.
- Dorn, R. D. 1984. Vascular plants of Montana. Mountain West Publ., Cheyenne, WY. 176 p.
- Grinde, Pete. 1988. Range scientist, Butte District, Deerlodge National Forest, Butte, Montana. Personal communication, January.
- Hann, W. J. 1982. A taxonomy for classification of seral vegetation of selected habitat types in western Montana. Ph.D. thesis, Univ. of Idaho, Moscow. 235 p.
- Hitchcock, C. L. and A. Cronquist. 1973. Flora of the Pacific Northwest. Univ. of Washington Press, Seattle. 730 p.
- Hitchcock, C. L., A. Cronquist, M. Ownbey and J. W. Thompson. 1955-1969. Vascular plants of the Pacific Northwest. Vol. 1-5. Univ. of Washington Press, Seattle.
- Joy, John. Forest Ecologist, Supervisor's Office, Deerlodge National Forest, Butte, Montana. Personal communication, February.
- Lesica, P., G. Moore, K. M. Peterson and J. H. Rumely. 1984. Vascular plants of limited distribution in Montana. Montana Academy of Sciences Monograph No. 2. 61 p.
- Mueggler, W. F. 1967. Response of mountain grassland vegetation to clipping in southwestern Montana. Ecology 48: 942-949.
- Mueggler, W. F. 1972. Variation in plant development and herbage yield on a mountain grassland in southwestern Montana. USDA Forest Service Res. Pap. INT-124, Intermt. For. and Range Exp. Stn., Ogden, UT. 20 p.
- Mueggler, W. F. 1983. Variation in production and seasonal development of mountain grasslands in western Montana. Res. Pap. INT-316. USDA Forest Service, Intermt. For. and Range Exp. Stn., Ogden, UT.
- Mueggler, W. F. and W. L. Stewart. 1980. Grassland and shrubland habitat types of western Montana. USDA Forest Service, Ogden, Utah. General tech. rept. INT-66. 154 p.
- Mueggler, W. F. and W. L. Stewart. 1981. Forage production on important rangeland habitat types in western Montana. J. Range Management 34(5):347-353.

- Mueller-Dombois, D. and H. Ellenberg. 1974. *Plants and patterns of vegetation ecology*. John Wiley and Sons, Inc., New York. 847 p.
- CEA Research. 1981. *Beal Mining Company Gernan Gulch environmental studies, vegetation analysis*. Unpub. tech. report prepared for Hydrotechnics, Inc. by CEA Research, Helena, Montana. 82 p. + appendices.
- Pfister, F. D., E. L. Kovalchik, S. F. Arno, and P. C. Frestly. 1977. *Forest habitat types of Montana*. USDA Forest Service Gen. Tech. Rep. INT-84. 174 p.
- Pierce, J. P. 1966. *Wetland community types of west-central Montana*. Unpublished draft report to USDA Forest Service, Region One, Missoula, MT. 87 p.
- Saxyer, F. T. 1984. *Vegetation report in the immediate area of the Beal Project, Silver Bow County, Montana*. Unpub. tech. report prepared for Montana Gold Company by Saxyer-Haring Associates, Butte, Montana. 10 p.
- Soer, R. L., L. D. Colwell and L. A. Larsen. 1981. *Vegetation inventory of the Grantan Project area, Broadwater County, Montana*. Unpub. tech. report prepared for Westam Energy Company by WESTECH, Helena, Montana. 41 pages + appendices.
- Shelly, C. S. 1987. *Ecotaxist, Montana National Heritage Program, Personal communication, November*.
- Shelly, C. S. 1987. *Status report of Banisteria Canadensis, U.S. Forest Service, Region 2, Beaverhead and Bitterroot National Forests, Montana*. Unpub. tech. report prepared for USA Forest Service, Missoula by Montana National Heritage Program, Helena. 72 p.
- Smith, Meg. 1987. *Grazing permitted, Beal Allotment, Glen, Montana, Personal communication, November*.
- Vogel, H. G. and G. M. Van Dyne. 1966. *Vegetation responses to grazing management on a foothill steep range*. *J. Range Manage.* 19(2):80-85.
- Western Technology and Engineering, Inc. (WESTECH). 1982. *Reconnaissance of vegetation resources of the Carnation Gulch - Black Lion study area, Beaverhead County, Montana*. Unpub. tech. report prepared by WESTECH, Helena, Montana. 53 p. + appendix.
- Western Technology and Engineering, Inc. (WESTECH). 1985. *Valley Vixen Hills conservation easement documentation report*. Tech. report prepared for The Nature Conservancy, Helena. 60 p.

Supplement A. Vascular plant species by morphological class with life habitat information, Beal Project study area, Silver Bow County, Montana, 1987.

1

<u>Binomial</u>	<u>Code</u>	<u>Common Name</u>	<u>Life Habit</u>
GRASSES AND GRASS-LIKE PLANTS			
<i>Agropyron cristatum</i>	Agr cri	Crested wheatgrass	IP
<i>Agropyron caninum</i>	Agr can	Slender wheatgrass	NP
<i>Agropyron intermedium</i>	Agr int	Intermediate wheatgrass	IP
<i>Agropyron smithii</i> †	Agr smi†	Western wheatgrass	NP
<i>Agropyron spicatum</i>	Agr spi	Bluebunch wheatgrass	NP
<i>Agrostis alba</i>	Agr alb	Redtop	IP
<i>Agrostis scabra</i>	Agr sca	Rough bentgrass	NP
<i>Alopecurus alpinus</i> ††	Alo alp	Alpine foxtail	NP
<i>Bromus carinatus</i>	Ero car	California brome	NP
<i>Bromus tectorum</i>	Ero tec	Cheatgrass	IA
<i>Bromus vulgaris</i>	Ero vul	Columbia brome	NP
<i>Calamagrostis canadensis</i>	Cal can	Bluejoint reedgrass	NP
<i>Calamagrostis montanensis</i> †	Cal mon†	Plains reedgrass	NP
<i>Calamagrostis rubescens</i>	Cal rub	Pinegrass	NP
<i>Carex concinnoides</i>	Car con	Northwest sedge	NP
<i>Carex dioica</i>	Car dio	Yellow bog sedge	NP
<i>Carex filifolia</i>	Car fil	Threadleaf sedge	NP
<i>Carex geyeri</i>	Car gey	Elk sedge	NP
<i>Carex hoodii</i>	Car hoo	Hood's sedge	NP
<i>Carex limnophila</i> †	Car lim†	Pond sedge	NP
<i>Carex mertensii</i> ††	Car mer	Mertens' sedge	NP
<i>Carex microptera</i> †*	Car mic	Small-winged sedge	NP
<i>Carex nebraskensis</i> †	Car neb†	Nebraska sedge	NP
<i>Carex obtusata</i>	Car obt	Blunt sedge	NP
<i>Carex petasata</i>	Car pet	Liddon sedge	NP
<i>Carex raynoldsii</i> †*	Car ray	Raynold's sedge	NP
<i>Carex species</i>	Car spp.	Sedge species	NP
<i>Cinna latifolia</i> *	Cin lat*	Drooping woodreed	NP
<i>Danthonia intermedia</i>	Dan int	Timber oatgrass	NP
<i>Deschampsia cespitosa</i>	Des ces	Tufted hairgrass	NP
<i>Deschampsia elongata</i>	Des elo	Slender hairgrass	NP
<i>Elymus canadensis</i> †*	Ely can	Canada wildrye	NP
<i>Elymus cinereus</i> †	Ely cin†	Basin wildrye	NP
<i>Elymus glaucus</i> †	Ely gla†	Blue wildrye	NP
<i>Festuca idahoensis</i>	Fes ida	Idaho fescue	NP
<i>Festuca scabrella</i>	Fes sca	Rough fescue	NP
<i>Hordeum brachyantherum</i> †	Hor bra†	Meadow barley	NP
<i>Hordeum jubatum</i>	Hor jub	Foxtail barley	NP
<i>Juncus balticus</i>	Jun bal	Wire rush	NP
<i>Juncus bufonius</i> *	Jun buf*	Toad rush	NA
<i>Juncus ensifolius</i> †	Jun ens†	Dagger-leaf rush	NP
<i>Juncus hallii</i>	Jun hal	Hall's rush	NP

Supplement A. (continued)

1

<u>Binomial</u>	<u>Code</u>	<u>Common Name</u>	<u>Life Habit</u>
GRASSES AND GRASS-LIKE PLANTS (continued)			
Juncus parryi [→]	Jun par	Parry's rush	NP
Juncus tenuis [→]	Jun ten [→]	Slender rush	NP
Koeleria cristata	Koe cri	Prairie junegrass	NP
Luzula campestris ^{→*}	Luz cam	Field woodrush	NP
Luzula hitchcockii [→]	Luz hit	Smooth woodrush	NP
Luzula parviflora	Luz par	Smallflowered woodrush	NP
Melica bulbosa [→]	Mel bul	Oniongrass	NP
Melica spectabilis	Mel spe	Showy oniongrass	NP
Muhlenbergia richardsonis [→]	Muh ric [→]	Mat muhly	NP
Oryzopsis exigua [→]	Ory exi	Little ricegrass	NP
Phleum alpinum	Phl alp	Alpine timothy	NP
Phleum pratense	Phl pra	Common timothy	IP
Poa compressa	Poa com	Canada bluegrass	NP
Poa juncifolia [→]	Poa jun [→]	Big bluegrass	NP
Poa nervosa [→]	Poa ner	Wheeler's bluegrass	NP
Poa palustris [→]	Poa pal [→]	Fowl bluegrass	IP
Poa pratensis	Poa pra	Kentucky bluegrass	IP
Poa sandbergii	Poa san	Native bluegrass	NP
Poa species	Poa spp.	Bluegrass species	_P
Stipa comata [→]	Sti com [→]	Needle-and-thread	NP
Stipa occidentalis var. minor	Sti occ	Columbia needlegrass	NP
Stipa richardsonii [→]	Sti ric [→]	Richardson's needlegrass	NP
Stipa viridula [→]	Sti vir [→]	Green needlegrass	NP
Trisetum spicatum [→]	Tri spi	Spike trisetum	NP
FORBS			
Achillea millefolium	Ach mil	Common yarrow	NP
Aconitum columbianum	Aco col	Columbian monkshood	NP
Agoseris glauca	Ago gla	Pale agoseris	NP
Allium brevistylum ^{→*}	All bre [→]	Short-style onion	NP
Allium cernuum	All cer	Nodding onion	NP
Anaphalis margaritacea	Ana mar	Pearly-everlasting	NP
Androsace septentrionalis	And sep	Northern rockjasmine	NA
Anemone multifida [→]	Ane mul	Ball anemone	NP
Angelica arguta [*]	Ang arg [*]	Sharptooth angelica	NP
Antennaria microphylla	Ant mic	Rose pussytoes	NP
Antennaria racemosa	Ant rac	Raceme pussytoes	NP
Antennaria umbrinella	Ant umb	Umber pussytoes	NP
Apocynum androsaemifolium [*]	Apo and [*]	Spreading dogbane	NP
Aquilegia flavescens [→]	Aqu fla	Yellow columbine	NP
Arabis divaricarpa	Ara div	Spreading-pod rockcress	NB
Arabis holboellii	Ara hol	Holboell's rockcress	NB
Arabis nuttallii	Ara nut	Nuttall rockcress	NP

Supplement A. (continued)

<u>Binomial</u>	<u>Code</u>	<u>Common Name</u>	<u>Life Habit</u>
FORBS (continued)			
<i>Arenaria congesta</i>	Are con	Ballhead sandwort	NP
<i>Arnica cordifolia</i>	Arn cor	Heartleaf arnica	NP
<i>Arnica fulgens</i>	Arn ful	Orange arnica	NP
<i>Artemisia ludoviciana</i> †	Art lud*	Cudweed sagewort	NP
<i>Aster chilensis</i> *	Ast chi†	Creeping aster	NP
<i>Aster conspicuus</i>	Ast con	Showy aster	NP
<i>Aster falcatus</i> *	Ast fal†	Creeping white prairie aster	NP
<i>Aster foliaceus</i>	Ast fol	Leafybract aster	NP
<i>Aster species</i>	Ast spp.	Aster species	NP
<i>Astragalus adsurgens</i> †	Ast ads†	Prairie milkvetch	NP
<i>Astragalus bisulcatus</i> †	Ast bis†	Two-grooved milkvetch	NP
<i>Astragalus canadensis</i> †	Ast can†	Canada milkvetch	NP
<i>Astragalus drummondii</i> †	Ast dru†	Drummond milkvetch	NP
<i>Astragalus miser</i>	Ast mis	Weedy milkvetch	NP
<i>Balsamorhiza sagittata</i>	Bal sag	Arrowleaf balsamroot	NP
<i>Berteroa incana</i> **	Eer inc	Hoary false alyssum	IA
<i>Besseya wyomingensis</i>	Bes wyo	Kittentail	NP
<i>Calochortus nuttallii</i> **	Cal nut	Nuttall's sego lily	NP
<i>Calochortus species</i>	Cal spp.	Mariposa species	NP
<i>Caltha leptosepala</i> **	Cal lep	Elkslip	NP
<i>Camelina microcarpa</i> †	Cam mic*	Littlepod falseflax	IA
<i>Carduus nutans</i> †	Car nut*	Musk thistle	IB
<i>Castilleja cusickii</i>	Cas cus	Cusick's paintbrush	NP
<i>Castilleja linariifolia</i> **	Cas lin	Narrow-leaved paintbrush	NP
<i>Castilleja miniata</i> **	Cas min	Scarlet Indian paintbrush	NP
<i>Castilleja pallescens</i>	Cas pal	Pale Indian paintbrush	NP
<i>Centaurea maculosa</i>	Cen mac	Spotted knapweed	IP
<i>Cerastium arvense</i>	Cer arv	Field chickweed	NP
<i>Chaenactis douglasii</i> *	Cha dou*	Douglas dusty maiden	NB
<i>Cirsium arvense</i>	Cir arv	Canada thistle	IP
<i>Cirsium scariosum</i>	Cir sca	Elk thistle	NP
<i>Cirsium undulatum</i> *	Cir und*	Wayleaf thistle	NP
<i>Cirsium vulgare</i>	Cir vul	Bull thistle	IB
<i>Clematis columbiana</i>	Cle col	Rock clematis	NP
<i>Collinsia parviflora</i>	Col par	Blue-eyed Mary	NA
<i>Collomia linearis</i>	Col lin	Narrow-leaved collomia	NA
<i>Comandra umbellata</i>	Com umb	Pale bastard toadflax	NP
<i>Corallorrhiza maculata</i> **	Cor mac	Spotted coral-root	NP
<i>Corallorrhiza trifida</i>	Cor tri	Early coral-root	NP
<i>Crepis atribarba</i> **	Cre atr	Slender hawksbeard	NP
<i>Crepis intermedia</i> **	Cre int	Gray hawksbeard	NP
<i>Crepis species</i>	Cre spp.	Hawksbeard species	NP

Supplement A. (continued)

1

<u>Binomial</u>	<u>Code</u>	<u>Common Name</u>	<u>Life Habit</u>
FORBS (continued)			
Delphinium bicolor	Del bic	Low larkspur	NP
Descurainia pinnata*	Des pin*	Pinnate tansymustard	NA
Descurainia richardsonii	Des ric	Mountain tansymustard	NA
Descurainia sophia*	Des sop*	Flixweed tansymustard	IA
Dodecatheon conjugens	Dod con	Shooting star	NP
Douglasia montana	Dou mon	Rocky Mountain douglasia	NP
Draba stenoloba	Dra ste	Slender draba	NA
Epilobium angustifolium	Epi ang	Fireweed	NP
Epilobium ciliatum*	Epi cil*	Glandular willow-herb	NP
(E. glandulosum)			
Epilobium minutum	Epi min	Small-flowered willow-herb	NA
Epilobium paniculatum*	Epi pan*	Autumn willow herb	NA
Equisetum arvense	Equ arv	Common horsetail	NP
Erigeron compositus	Eri com	Fernleaf fleabane	NP
Erigeron peregrinus**	Eri per	Wandering daisy	NP
Erigeron speciosus**	Eri spe	Showy fleabane	NP
Eriogonum ovalifolium	Eri ova	Cushion buckwheat	NP
Eriogonum umbellatum	Eri umb	Sulfur buckwheat	NP
Eriophyllum lanatum	Eri lan	Common eriophyllum	NP
Erysimum cheiranthoides**	Ery che	Treacle mustard	IA
Erysimum repandum	Ery rep	Spreading wallflower	NP
Erythronium grandiflorum	Ery gra	Glacier-lily	NP
Fragaria virginiana	Fra vir	Virginia strawberry	NP
Frasera speciosa	Fra spe	Giant frasera	NP
Gaillardia aristata*	Gai ari*	Common gaillardia	NP
Galium bifolium	Gal bif	Thinleaf bedstraw	NA
Galium triflorum	Gal tri	Sweet-scented bedstraw	NP
Gaura coccinea*	Gau coc*	Scarlet gaura	NP
Gentiana affinis	Gen aff	Pleated gentian	NP
Gentiana amarella	Gen ama	Annual gentianella	NA
Geranium viscosissimum	Ger vis	Sticky geranium	NP
Geum macrophyllum*	Geu mac*	Large leaf avens	NP
Geum triflorum	Geu tri	Prairiesmoke	NP
Goodyera oblongifolia	Goo obl	Rattlesnake plantain	NP
Grindelia squarrosa*	Gri squ*	Curcup gumweed	NP
Hackelia micrantha**	Hac mic	Blue stickseed	NP
Haplopappus acaulis*	Hap aca*	Stemless goldenweed	NP
Haplopappus lanuginosus	Hap lan	Woolly goldenweed	NP
Helianthella uniflora	Hel uni	Rocky Mountain helianthella	NP
Heracleum lanatum	Her lan	Cow parsnip	NP
Heterotheca villosa*	Het vil*	Hairy golden aster	NP
Heuchera cylindrica**	Heu cyl	Roundleaved allumroot	NP

Supplement A. (continued)

1

<u>Binomial</u>	<u>Code</u>	<u>Common Name</u>	<u>Life Habit</u>
FORBS (continued)			
<i>Heuchera parvifolia</i>	Heu par	Littleleaf allumroot	NP
<i>Hieracium cynoglossoides</i>	Hie cyn	Houndtongue hawkweed	NP
<i>Hieracium gracile</i> **	Hie gra	Slender hawkweed	NP
<i>Hyoscyamus niger</i> *	Hyo nig*	Henbane	IB
<i>Hypopitys monotropa</i> **	Hyp mon	Fringed pinesap	NP
<i>Iris missouriensis</i> *	Iri mis*	Rocky Mountain iris	NP
<i>Kochia scoparia</i> *	Koc sco*	Summer cypress	IA
<i>Lepidium densiflorum</i> *	Lep den*	Prairie pepperweed	NA
<i>Lepidium perfoliatum</i> *	Lep per*	Clasping pepperweed	IA
<i>Lesquerella alpina</i>	Les alp	Alpine bladderpod	NP
<i>Lewisia pygmaea</i>	Lew pyg	Dwarf lewisia	NP
<i>Lewisia rediviva</i> **	Lew red	Bitterroot	NP
<i>Linanthus septentrionalis</i>	Lin sep	Northern linanthus	NA
<i>Linaria vulgaris</i> *	Lin vul*	Butter-and-eggs	IP
<i>Linum perenne</i> **	Lin per	Blue flax	NP
<i>Listera borealis</i>	Lis bor	Northern twayblade	NP
<i>Lithophragma parviflorum</i>	Lit par	Smallflower woodlandstar	NP
<i>Lithospermum ruderale</i>	Lit rud	Western gromwell	NP
<i>Lomatium cusickii</i> **	Lom cus	Cusick's lomatium	NP
<i>Lomatium triternatum</i>	Lom tri	Nineleaf lomatium	NP
<i>Lomatium species</i>	Lom spp.	Lomatium species	NP
<i>Lupinus sericeus</i>	Lup ser	Silky lupine	NP
<i>Melilotus officinalis</i> *	Mel off*	Yellow sweetclover	IB
<i>Mertensia ciliata</i>	Mer cil	Broadleaf bluebells	NP
<i>Mertensia oblongifolia</i>	Mer obl	Oblongleaf bluebell	NP
<i>Microseris nutans</i>	Mic nut	Nodding microseris	NP
<i>Mitella pentandra</i>	Mit pen	Alpine mitrewort	NP
<i>Musineon divaricatum</i>	Mus div	Leafy musineon	NP
<i>Oenothera cespitosa</i> *	Oen ces*	Rock-rose	NP
<i>Oenothera subcaulis</i>	Oen sub	Northern evening primrose	NP
<i>Osmorhiza chilensis</i>	Osm chi	Mountain sweetroot	NP
<i>Osmorhiza occidentalis</i>	Osm occ	Western sweetroot	NP
<i>Oxytropis campestris</i> **	Oxy cam	Slender crazyweed	NP
<i>Oxytropis sericea</i>	Oxy ser	White pointloco	NP
<i>Pedicularis contorta</i>	Ped con	Coiled pedicularis	NP
<i>Pedicularis cystopteridifolia</i>	Ped cys	Fern-leaved lousewort	NP
<i>Pedicularis racemosa</i>	Ped rac	Leafy lousewort	NP
<i>Penstemon albertinus</i>	Pen alb	Alberta penstemon	NP
<i>Penstemon aridus</i> *	Pen ari*	Stiffleaf penstemon	NP
<i>Penstemon diphyllus</i> *	Pen dip*	Diphyllus penstemon	NP
<i>Penstemon eriantherus</i> *	Pen eri*	Fuzzytongue penstemon	NP
<i>Penstemon procerus</i>	Pen pro	Littleleaf penstemon	NP
<i>Penstemon rydbergii</i> **	Pen ryd	Rydberg's penstemon	NP

Supplement A. (continued)

1

<u>Binomial</u>	<u>Code</u>	<u>Common Name</u>	<u>Life Habit</u>
FORBS (continued)			
<i>Perideridia gairdneri</i>	Per gai	Yampa	NP
<i>Phacelia hastata</i>	Pha has	Silverleaf phacelia	NP
<i>Phlox longifolia</i> †	Phl lon	Longleaf phlox	NP
<i>Phlox muscoides</i> †	Phl mus†	Moss phlox	NP
<i>Polemonium pulcherrimum</i> †	Pol pul†	Showy polemonium	NP
<i>Polygonum aviculare</i> †	Pol avi†	Prostrate knotweed	NA
<i>Polygonum bistortoides</i>	Pol bis	Bistort	NP
<i>Polygonum kelloggii</i>	Pol kel	Kellogg's knotweed	NA
<i>Potentilla arguta</i>	Pot arg	Tall cinquefoil	NP
<i>Potentilla diversifolia</i>	Pot div	Diverse-leaved cinquefoil	NP
<i>Potentilla glandulosa</i>	Pot gla	Glandular cinquefoil	NP
<i>Potentilla gracilis</i>	Pot gra	Northwest cinquefoil	NP
<i>Potentilla pensylvanica</i> †	Pot pen†	Prairie cinquefoil	NP
<i>Pyrola asarifolia</i> †	Pyr asa†	Common pink wintergreen	NP
<i>Pyrola secunda</i>	Pyr sec	Sidebells pyrola	NP
<i>Pyrola uniflora</i>	Pyr uni	Woodnymph	NP
<i>Ranunculus uncinatus</i>	Ran unc	Little buttercup	NP
<i>Rumex crispus</i> †	Rum cri†	Curly dock	IP
<i>Rumex patienta</i> †	Rum pat†	Patience dock	IP
<i>Rumex paucifolius</i>	Rum pau	Mountain sonnet	NP
<i>Rumex salicifolius</i> †	Rum sal†	Willowleaved dock	NP
<i>Saxifraga arguta</i>	Sax arg	Brook saxifrage	NP
<i>Saxifraga integrifolia</i>	Sax int	Swamp saxifrage	NP
<i>Sedum stenopetalum</i>	Sed ste	Wormleaf stonecrop	NP
<i>Selaginella densa</i>	Sel den	Clubmoss	NP
<i>Senecio canus</i> †	Sen can†	Woolly groundsel	NP
<i>Senecio hydrophilus</i> †	Sen hyd†	Alkali-marsh butterweed	NP
<i>Senecio integerrimus</i>	Sen int	Western groundsel	NP
<i>Senecio megacephalus</i> †	Sen meg†	Large-headed butterweed	NP
<i>Senecio pauperulus</i> †	Sen pau†	Balsam groundsel	NP
<i>Senecio pseud aureus</i>	Sen pse	Streambank butterweed	NP
<i>Senecio triangularis</i>	Sen tri	Arrowleaf groundsel	NP
<i>Sisymbrium altissimum</i> †	Sis alt†	Tumblemustard	IA
<i>Smilacina racemosa</i>	Smi rac	Feather solomon's seal	NP
<i>Solidago missouriensis</i> †	Sol mis†	Missouri goldenrod	NP
<i>Sphaeralcea coccinea</i> †	Sph coc†	Scarlet globemallow	NP
<i>Stellaria longipes</i> †	Ste lon†	Longstalk starwort	NP
<i>Streptopus amplexifolius</i>	Str amp	Clasping leaf twisted-stalk	NP
<i>Taraxacum officinale</i>	Tar off	Common dandelion	IP
<i>Thalictrum occidentale</i>	Tha occ	Western meadowrue	IP
<i>Thlaspi arvense</i>	Thl arv	Fanweed	IA

Supplement A. (continued)

1

<u>Binomial</u>	<u>Code</u>	<u>Common Name</u>	<u>Life Habit</u>
FORBS (continued)			
Townsendia parryi	Tow par	Parry's townsendia	NP
Tragopogon dubius	Tra dub	Common salsify	IB
Trifolium longipes	Tri lon	Long-stalked clover	NP
Trollius laxus [†]	Tro lax	Globeflower	NP
Urtica dioica	Urt dio	Stinging nettle	NP
Valeriana dioica	Val dio	Marsh valeriana	NP
Valeriana sitchensis	Val sit	Sitka valerian	NP
Veratrum viride	Ver vir	Green false hellebore	NP
Verbascum thapsus	Ver tha	Fiannel mullein	IB
Verbena bracteata [†]	Ver bra [†]	Bracted verbena	NP
Veronica americana	Ver ame	American speedwell	NP
Viola adunca	Vio adu	Western violet	NP
Viola orbiculata	Vio orb	Roundleaf violet	NP
Xerophyllum tenax	Xer ten	Beargrass	NP
Zigadenus elegans [†]	Zig ele	Glaucous zigadenus	NP
Zigadenus venenosus	Zig ven	Meadow death camas	NP
SUBSHRUBS			
Arctostaphylos uva-ursi [†]	Arc uva [†]	Kinikinnick	NP
Artemisia frigida [†]	Art fri [†]	Fringed sagewort	NP
Berberis repens	Eer rep	Creeping Oregon-grape	NP
Chimaphila umbellata	Chi umb	Common pipsissewa	NP
Gutierrezia sarothrae [†]	Gut sar [†]	Broom snakeweed	NP
Linnaea borealis	Lin bor	Western twinflower	NP
Rubus parviflorus	Rub par	Thimbleberry	NP
LOW SHRUBS			
Amelanchier alnifolia	Ame aln	Western serviceberry	NP
Chrysothamnus nauseosus [†]	Chr nau [†]	Rubber rabbitbrush	NP
Cornus stolonifera [†]	Cor sto [†]	Red osier dogwood	NP
Ledum glandulosum	Led gla	Smooth Labrador-tea	NP
Juniperus communis	Jun com	Common juniper	NP
Juniperus scopulorum	Jun sco	Rocky Mountain juniper	NP
Lonicera involucrata	Lon inv	Bearberry honeysuckle	NP
Lonicera utahensis	Lon uta	Utah honeysuckle	NP
Menziesia ferruginea	Men fer	Rusty menziesia	NP
Physocarpus malvaceus [†]	Phy mal [†]	Mallow ninebark	NP
Potentilla fruticosa	Pot fru	Shrubby cinquefoil	NP
Purshia tridentata [†]	Pur tri [†]	Antelope bitterbrush	NP
Prunus virginiana [†]	Pru vir [†]	Chokecherry	NP
Ribes cereum [†]	Rib cer [†]	Squaw currant	NP
Ribes lacustre	Rib lac	Swamp gooseberry	NP

Supplement A. (continued)

1

<u>Binomial</u>	<u>Code</u>	<u>Common Name</u>	<u>Life Habit</u>
LOW SHRUBS (continued)			
Ribes setosum*	Rib set [†]	Redshoot gooseberry	NP
Ribes viscosissimum	Rib vis	Sticky currant	NP
Rosa acicularis	Ros aci	Prickly rose	NP
Rosa woodsii*	Ros woo [†]	Wood's rose	NP
Rosa species	Ros spp.	Rose species	NP
Rubus idaeus	Rub ida	Red raspberry	NP
Sambucus racemosa	Sam rac	Black elderberry	NP
Shepherdia canadensis	She can	Canada buffaloberry	NP
Symphoricarpos albus	Sym alb	Common snowberry	NP
Tetradymia canescens [†]	Tet can [†]	Gray horsebrush	NP
Vaccinium caespitosum	Vac cae	Dwarf huckleberry	NP
Vaccinium globulare	Vac glo	Blue huckleberry	NP
Vaccinium myrtillus?	Vac myr	Dwarf bilberry	NP
Vaccinium scoparium	Vac sco	Grouse whortleberry	NP

TALL SHRUBS AND TREES

Abies lasiocarpa	Abi las	Subalpine fir	NP
Alnus sinuata	Aln sin	Sitka alder	NP
Betula occidentalis	Bet occ	Water birch	NP
Picea engelmannii	Pic eng	Engelmann spruce	NP
Pinus albicaulis	Pin alb	Whitebark pine	NP
Pinus contorta	Pin con	Lodgepole pine	NP
Populus tremuloides	Pop tre	Quaking aspen	NP
Populus trichocarpa	Pop tri	Black cottonwood	NP
Pseudotsuga menziesii	Pse men	Douglas-fir	NP
Salix drummondiana [†]	Sal dru [†]	Drummond willow	NP
Salix exigua	Sal exi	Slender willow	NP
Salix fragilis [†]	Sal fra [†]	Crack willow	IP
Salix myrtillifolia [†]	Sal myr [†]	Blueberry willow	NP
Salix scouleriana [†]	Sal sco [†]	Scouler willow	NP
Salix species	Sal spp.	Willow species	NP

1 N = Native F = Perennial A = Annual
 I = Introduced B = Biennial

Scientific nomenclature follows Hitchcock and Cronquist (1973) and Hitchcock et al. (1955-1969). Common names were mostly taken from these sources.

Supplement A. (continued)

* taxa identified only for access corridor options; many of these taxa can be expected to also occur in the permit area, but weren't documented there. Most taxa identified for the permit area (no *) were also documented in the access options.

**taxa identified by Richard Producers for the High Rye area (John Joy, pers. comm.) which were not included on the list for the Beal Mountain Project permit area and access options.

