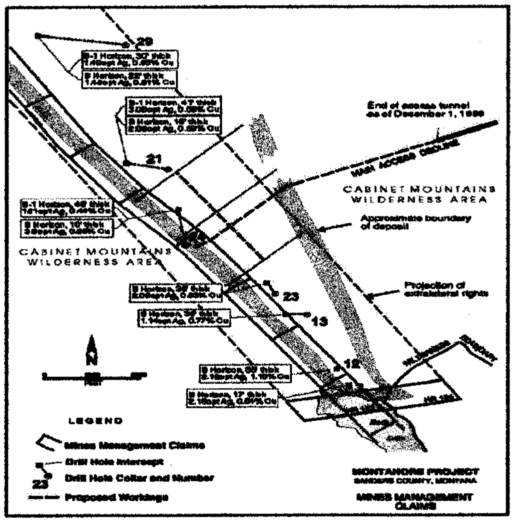
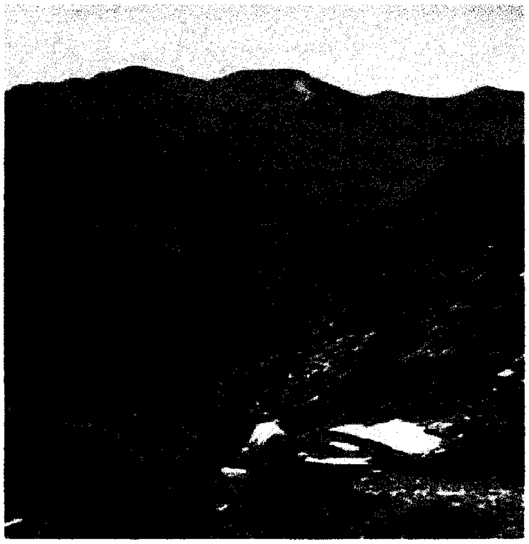
MONTANORE PROJECT

AMENDED APPLICATION

HARD ROCK OPERATING PERMIT

AMENDED PLAN OF OPERATIONS





Appendix F

Soils

December 2004

Mines Management, Inc.

SOILS

ADDENDUM

BASELINE SOILS STUDY

Montana Project

LINCOLN & SANDERS COUNTIES, MONTANA

prepared for

Noranda Minerals Corp.
65 N. Edison Way Suite 4 P.O. Box 7176 Reno, Nevada 89510

prepared by

Western Resource Development Corporation
711 Walnut St. P.O. Box 467 Boulder, Colorado 80306

August 1989

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SEP 13 1989
STATE LANDS

ADDENDUM

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1.0 INTRODUCTION

1.0 INTRODUCTION

1.1 Background

Following completion of the baseline soils study report in February 1989, the project planning process identified developments for areas not studied during the 1988 field season. Specifically, the Bear Creek Road (U.S. Forest Service Road 278) was identified as the major transportation access to the project site; the Cherry Creek impoundment site was expanded both to the east and west, but reduced in its southern limit; two percolation sites were added; the Ramsey Creek mine/mill site was slightly enlarged; the Libby Creek surface facilities site was moved down valley; and access corridors connecting the tailings impoundment, percolation sites, and the Ramsey and Libby Creek facilities were delineated.

Soil mapping for the areas not mapped in the original baseline soils study (Western Resource and Development, 1989), as well as description and sampling of some additional soil profiles, were conducted in July and August of 1989. This report provides the soil maps, supplemental soil and map unit descriptions, interpretations, lab data and map legends for the new areas. All the soil interpretations, descriptions and classification information provided in the original soil report are not repeated here; the reader is referred to that document for a complete soil inventory report.

1.2 Study Area Locations

The transportation access corridor extends from U.S Highway 2 for about 10 miles southwest to the tailings impoundment. The corridor then proceeds from the south side of the tailings impoundment about one and one-half miles farther south to the two percolation sites. From the south end of percolation site no. 1, the corridor divides with one branch extending about two and one-quarter miles south across a low ridge and then southwest up Libby Creek to the surface facilities site and the other branch extends west up Ramsey Creek. The width of the transportation corridor mapped for this study is 2000 feet. Figure 1 illustrates the location of the transportation corridor, tailings impoundment, percolation sites, and Ramsey and Libby Creek facilities.

The elevation of the transportation corridor is about 2,600 feet at U.S. Highway 2, and about 3,600 feet at the north entrance to the tailings impoundment. The terminus of the corridor in Ramsey and Libby Creek is at an elevation of 4,200 feet and 3,800 feet, respectively. The corridor crosses tributaries to Big Cherry Creek, Bear Creek, Poorman

Creek, Ramsey Creek, and parallels Libby Creek. Little Cherry Creek is crossed within the tailings impoundment.

The 1818 acre tailings impoundment is in the Little Cherry Creek drainage. The area studied in 1989 is about 1,205 acres in size. The west portion of the tailings impoundment area (181 acres) includes a section of Bear Creek and a gentle east sloping ridge at about 4,200 feet. The additional area (432 acres) to the east includes some land east and west of Libby Creek, areas along Little Cherry Creek, and the relatively flat ridges between these streams. The elevation of this region extends from about 3,100 feet to 3,500 feet.

Both percolation sites are located on a gentle east-sloping ridge between Poorman and Ramsey Creek. Site No. 1, the western-most is 218 acres in size, and ranges in elevation from 3,800 feet to 4,200 feet. Site No. 2, at about 3,600 feet, is 199 acres in size and has a gentler topography with steep slopes to the south along a short section of Ramsey Creek.

All but 124 acres of the 164 acre Ramsey Creek mine/mill site were studied in 1988. The 1989 study area included steep north and south facing slopes on the sides of the valley and the valley bottom.

The 202 acre Libby Creek surface facilities site is located in Libby Creek valley immediately down stream of the area studied in 1988. This site includes relatively gentle topography along Libby Creek at about 4,000 feet elevation and steep valley sideslopes.

1.3 Study Objectives

The objective of this study was to provide baseline soils information in the project facilities areas not studied in 1988. It will be the responsibility of other workers to provide information on impacts and mitigation measures. Each of the new areas (not including the corridors) were mapped in detail, extending the existing mapping into the new areas and using the existing map units to the extent possible. Since new terrain was encountered additional map units were added. Five new map units are described in this report in Section 3.6. In this study eight soil profiles were described and six were sampled by horizon and analyzed in the lab. The soils described and sampled in this study were found to be similar to those mapped in the original study.

The corridors for this project were treated in the same manner as the corridors in the original study (Western Resource and Development, 1989). The objective was simply to compile the existing land type mapping of the U.S.F.S

(Kuennen and Gerhardt 1984) and describe the soils and physiography of the corridors.

2.0 METHODS

2.0 METHODS

The existing soil mapping from the original soil baseline study (Western Resource and Development, 1989) was used as the basis for this study. The mapping was performed by traversing, surface observations, hand dug holes and observation of backhoe pits. A number of backhoe pits were excavated to 5 feet and eight were described in detail. Pedon descriptions are in Appendix A. Six pedons were sampled by horizon for laboratory analysis. The field methods used were the same as described in the original soil baseline study and are the methods of the National Cooperative Soil Survey (Soil ConServation Service 1983, Soil Survey Staff 1975, 1981, and 1987).

Laboratory analyses were performed to assess selected physical and chemical attributes of the soils. Particle size analysis including percent very fine sand, textural class, percent rock fragments (>2mm), organic matter percent, saturated soil paste extract, and percent water at saturation were determined. The procedures for determining the physical and chemical properties are referenced in Appendix B. The analyses were performed by Colorado Analytical Labs in Brighton, Colorado and the results are in Appendix C.

The methods used for classification and interpretation of soil properties are described in the original soil report (Western Resource Development Corp. 1989).

3.0 RESULTS AND DISCUSSION

3.0 RESULTS AND DISCUSSION

3.1 Bear Creek and Other Access Roads

The land type mapping of the Bear Creek access road corridor and the corridors to the Percolation and Libby and Ramsey Creek sites is shown in Figure 1 (in map pocket). The mapping is taken from Kuennen and Gerhardt (1984). Table 1 Map Unit Descriptions for Bear Creek Road and Other Access Roads provides a description of the Forest Service land type map units.

The first mile of the corridor heads southwest from state highway 2 and crosses Hoodoo Flats, an alluvial terrace of Big Cherry Creek. The soils (land type 103) along the road are deep, well-drained and well suited to road construction.

The next mile and one-half of the corridor crosses an area of well drained soils on knolls and poorly drained soils in concave depressions (land type 104). The high water table limits construction in depressional areas. The material exposed in road cuts tends to slump, but few cuts will be necessary in this area. Un-surfaced roads are dusty when dry and become rutted when wet (Kuennen and Gerhart 1984).

The rest of the corridor to the tailings area is almost exclusively within a single unit (land type 322). The soils were formed in dense, old, fine textured glacial till with ash-influenced surface layers. For about six miles the corridor is on moderately steep and steep west-facing hill-slopes above Big Cherry Creek. The soils are moderately suited to road construction although the material exposed by road construction tends to slump on roadcuts, and the bear-ing strength of these soils is low. Un-surfaced roads are dusty and become rutted when wet. The corridor crosses a major, unnamed tributary to Big Cherry Creek at elevation 3310 feet. Sediment hazard from road construction due to slumping and highly erodible soils is a concern (Kuennen and Gerhardt, 1984). The proximity of Big Cherry Creek increases that concern.

The corridor crosses a low pass about a mile north of the Little Cherry Creek tailings impoundment area. From that point to the tailings area the corridor is on gently sloping terrain on the same type of soils (land type 322). The corridor crosses Bear Creek at the north boundary of the tailings area.

The corridor from the tailings area south to the perco-lation sites is also dominated by land type 322. This is an old till plain and slopes in this section are rolling. Land type 352 occupies a portion of the western edge of the

Table 1. Map Unit Descriptions for Bear Creek Road and Other Line Corridors Montana Project (Adapted from Kuennen and Gerhardt 1984).

Map Unit Symbol	Map Unit Name	Physiography	Slope % Elev ft	Parent Material	Soil Components Classification	Family	Rock Outcrop %
103	Andic Dystrochrepts, alluvial terraces	Alluvial Terraces	0-15% 200-3500 ft	Glacial Lake Deposits	Andic Dystrochrepts	loamy-skeletal, mixed, frigid	0%
104	Andic Dystrochrepts-Andaquic Haplumbrepts somewhat poorly drained complex, glacial till substratum	Knolls and Sinkholes	5-35% 220-4200 ft	Glacial Drift Precambrian Belt Group	Andic Dystrochrepts Andaquic Haplumbrepts	loamy-skeletal, mixed, frigid fine-silty, mixed frigid	5%
110	Typic Eutrochrepts, coarse-silty mixed frigid	Sandy Alluvial Deposits	0-15% 2000-3500 ft	Alluvial Undifferentiated	Typic Eutrochrepts Deposits	coarse-silty mixed frigid	<5%
112	Eutric Glossoboralfs, clayey, lacustrine substratum	Clayey Lacustrine Terraces	0-25% 2200-3600 ft	Glacial Lake	Eutric Glossoboralfs Deposits	fine, illitic,	0%
322	Typic Glossoboralfs, volcanic ash surface	Glaciated Mountain Slopes	15-35% 2500-4500 ft	Tertiary and	Typic Glossoboralfs Precambrian Rock	fine, illitic	<5%

Table 1. Map Unit Descriptions for Extensive Study Areas and Transmission Line Corridors Montana Project (Adapted from Kuennen and Gerhardt 1984).

Map Unit Symbol	Map Unit Name	Physiography	Slope % Elev ft	Parent Material	Soil Components Classification	Family	Rock Outcrop %
352	Andic Dystrochrepts, glacial till substratum	Glaciated Low Relief Mountain Sideslopes	20-60 2200-5200	Precambrian Belt Group	Andic Dystrochrepts	loamy-skeletal, mixed, frigid	<5
401	Andic Dystrochrepts-Lithic Cryochrepts-Rock Outcrop complex, glacial trough walls headwalls	Glacially Scoured Trough Walls	>60 4200-7000	Precambrian Belt Group	Andic Cryochrepts Lithic Cryochrepts	loamy-skeletal, mixed loamy-skeltal, mixed	>40
407	Andic Cryochrepts, glacial till substratum	Alpine Glacial Moraines	5-20 3500-5500	Precambrian Belt Group	Andic Cryochrepts	loamy-skeletal, mixed	0-10
408	Andic Cryochrepts, glacial till substratum, steep	Steep Valley Sideslopes and Truncated Spurs	>60 2500-5500	Precambrian Belt Group	Andic Cryochrepts	loamy-skeletal, mixed	5-20

corridors in this section; the soils are deep, well drained and have few constraints to development.

The corridor from percolation site 1 to the Ramsey Creek site includes land type unit 401 and 407. Map unit 401 contains deep to shallow soils on steep slopes and rock outcrops. Map unit 407 includes well drained soils on glacial moraines formed in loamy and gravelly materials.

The corridor from percolation site 2 to Libby Creek includes map units 322, 352, 401 and 407. The soils have the same constraints and characteristics as described above.

3.2 Little Cherry Creek Tailings Impoundment Area

The soils of the newly proposed tailings area are shown on the soil map of the tailings impoundment area (figure 2 in map pocket). The soil types and map unit descriptions are in the original soil baseline report (Western Resource Development Corp. 1989) except for five new map units (AcD, AdB, AdC, AdF and DHU) which are described in this report. The map legend is Table 2, Map Unit Legend.

The expanded area on the east side of the tailings area includes lacustrine terraces, steep slopes on either side of Libby Creek and the creek bottom of Libby Creek. The expanded area on the west side of the tailings impoundment area includes sloping ridges, old till plains and (in the northwest corner of the site) the valley of Bear Creek.

3.3 Percolation Sites

The percolation sites occur on a sloping till plain. Both sites slope to the east and drop off steeply on their south sides toward Ramsey Creek. Figure 3 is the soil map of the percolation sites (in map pocket).

3.4 Ramsey Creek Mine/Mill Site

The Ramsey Creek mine and mill site has been expanded to include the steep valley sideslopes and the bottom of Ramsey Creek. Figure 4 is the soil map of the Ramsey Creek Mine and Mill Site.

3.5 Libby Creek Surface Facilities Site

The soils of the Libby Creek Site are very similar to the Ramsey Creek site. Figure 5 is a map showing the extent of soils in the Libby Creek surface facility site.

3.6 Map Unit Descriptions

The following are five new map unit descriptions for units added to supplement the existing mapping. All other

Table 2
Map Unit Legend

AcC	Andic Cryochrepts colluvial slopes, 10-35% slopes.
AcD	Andic Cryochrepts colluvial slopes, 35-60% slopes.
AcG	Andic Cryochrepts glacial moraine, 0-15% slopes.
AdA	Andic Dystrochrepts lacustrine terraces, 0-10% slopes.
AdB	Andic Dystrochrepts deep, 0-10% slopes.
AdC	Andic Dystrochrepts deep, 10-25% slopes
AdD	Andic Dystrochrepts deep, 25-60% slopes.
AdF	Andic Dystrochrepts, moderately deep, 45-90% slopes.
AdR	Andic Dystrochrepts moderately deep and deep complex, 0-25% slopes.
AdS	Andic Dystrochrepts alluvial terraces, 0-15% slopes.
AdW	Dystrochrepts-Humaquepts complex, 0-15% slopes.
CbC	Cryochrepts-Cryumbrepts complex, bouldery surface, 0-15% slopes.
CbD	Cryochrepts-Cryumbrepts complex, bouldery surface, 15-60% slopes.
CuB	Typic Cryumbrepts bouldery surface, 0-15% slopes.
DHU	Cryochrepts-Humaquepts-Udifluvents Association, 0-10% slopes.
ROC	Rock outcrop-Rubble land complex, 15-90% slopes.
TcA	Typic Cryorthents avalanche chutres, 15-35% slopes.
TcB	Typic Cryochrepts bouldery surface, 0-15% slopes.
TgC	Typic Glossoboralfs family, 0-15% slopes.
TgD	Typic Glossoboralfs family, 15-40% slopes.
ThA	Cumulic Humaquepts family, 0-3% slopes.
TpC	Typic Paleboralfs family, 0-15% slopes.

map unit descriptions are in the original site report (Western Resource Development 1989).

AcD Andic Cryochrepts Colluvial Slopes, 35-60% Slopes

This map unit consists of deep, well drained soil formed in gravelly, medium textured colluvium till and wind-deposited materials. It is composed of loamy-skeletal, mixed Andic Cryochrepts with gravelly and very gravelly silt loam surface horizons. The slopes are linear and dissected by drainage incisions and debris avalanche chutes and range in steepness from 35 to 60 percent. Andic Cryochrepts colluvial slopes (see Section 3.5.2(a) in the original soils report) is the major component for this map unit, 70 percent of the area. Typic Cryumbrepts are a major similar soil inclusion (10%) and occupy drainage incision positions. Loamy-skeletal Typic Cryochrepts occur as inclusions where the loess cap has been removed or mixed. Typic Cryorthents occur in the area affected by debris avalanching. Rock outcrop occurs in approximately 10 percent of the area. Where this unit is mapped on the north-facing slopes of Libby and Ramsey Creek, they are wetter than typical. Slope stability and water control on these slopes is a major concern.

See Section 3.5.2(a) in the original soils report for more information.

AdB Andic Dystrochrepts deep, 0-10% slopes and
AdC Andic Dystrochrepts deep, 10-25% slopes

These map units consist of deep well drained soils formed in gravelly, medium textured glacial drift and colluvium with volcanic ash influenced surface horizons. They are composed of loamy-skeletal, mixed, frigid Andic Dystrochrepts with silt loam and gravelly silt loam surface horizons. These units are mapped on the till plain between the mouths of the Libby and Ramsey Creek canyons. The map units are differentiated based on slope gradient. These map units are extensive in percolation sites 1 and 2.

See Section 3.5.2(d) in the original soils report for more information.

AdF Andic Dystrochrepts, moderately deep, 45-90% slopes

This map unit consists of moderately deep soils formed in colluvium. The soils in this map unit are similar to the soil described for the AdR map unit except soils less than 20 inches deep may occupy about 10% of the unit. Many of the soils in this map unit lack ash influenced surface horizons. Rock outcrop occupies about 20 percent of the map unit and commonly occurs as cliffs. This unit is mapped in the steep ravines of Libby and Little Cherry Creek in the tailings impoundment area. Inclusions of sandy-skeletal Udifluvents occur in the recent floodplain positions and occupy about 10% of the map unit.

See Section 3.5.2(e) in the original soils report for more information.

DHU Cryochrepts-Humaquepts-Udifluvents association, 0-10% slope

This map unit consists of deep, well to poorly drained soils formed in alluvium and wind deposited materials. It is comosed of loamy-skeletal, mixed Andic Cryochrepts, fine-silty, mixed Typic Humaquepts and sandy-skeletal, mixed Typic Udifluvents. This unit is mapped in the toeslopes, alluvial terraces and floodplains of Upper Libby and Ramsey Creek. The Andic Cryochrepts occupy the toeslope and upper terrace position and account for 50 percent of the map unit. The Typic Humaquepts occupy 30 percent of the map unit and occur in low terrace positions with restricted drainage. Some Humaquepts in these areas contain more coarse fragments than the typical pedon. The Udifluvents occur in floodplain positions and occupy approximately 20 percent of the map unit. Minor areas of Cumulic Humaquepts occur as inclusions.

See Section 3.5.2(a) and 3.5.2(m) in the original soils report for more information.

3.7 Map Unit Interpretations

Map unit interpretations were made for the five new detailed map units developed for the areas surveyed for this study. The interpretations were made using the same methodologies described in the original report (Western Resource Development 1989). The supplemental map unit interpretations are provided in Table 3.

Table 4 gives topsoil suitability for the five new soil map units.

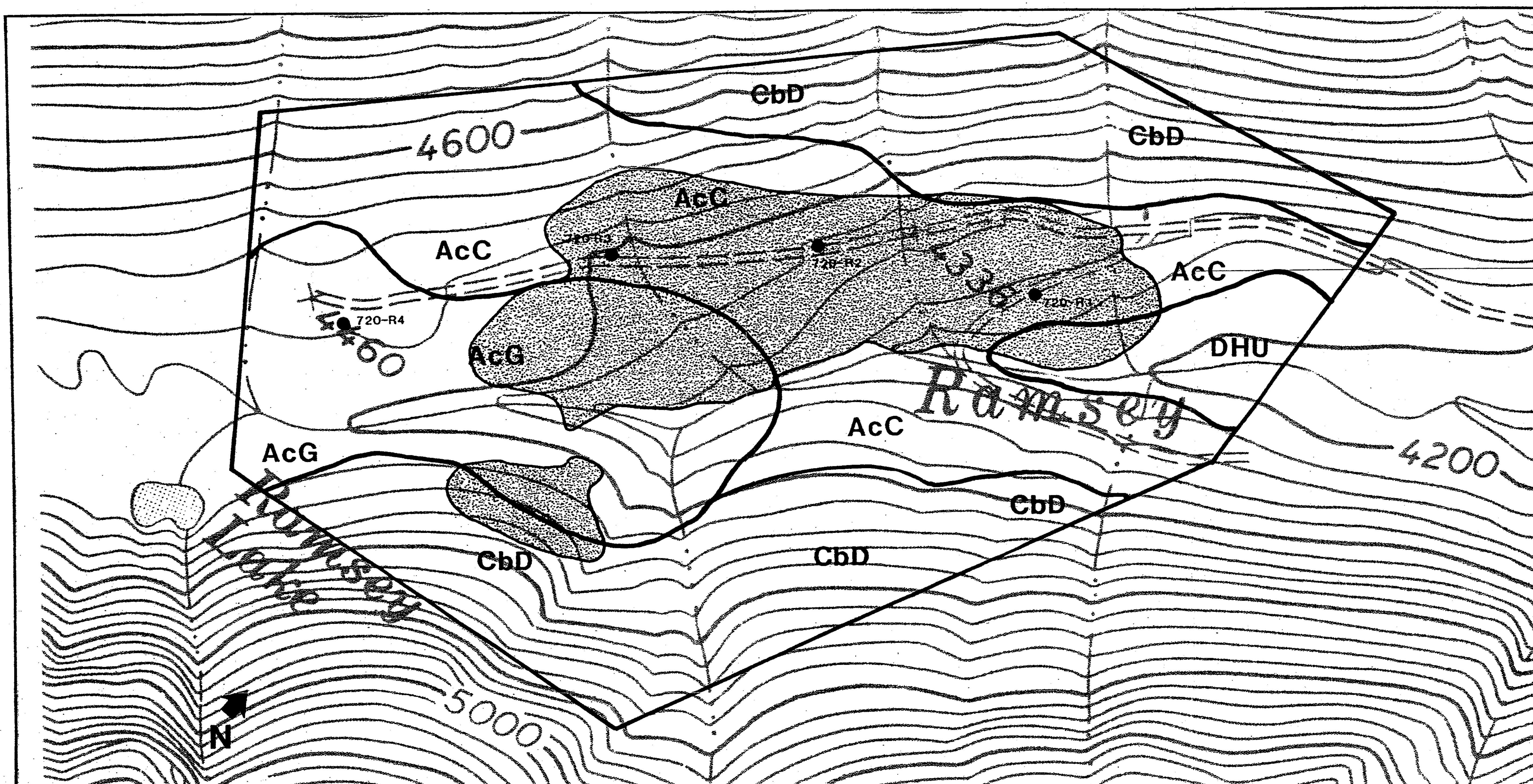
Table 3. Map Unit Interpretations, Montana Project

Map Unit Symbol	Hydrologic Group	AWHC Class	Permeability (in/hr)	Soil Erodibility Index (KLS)		Potential Slope Stability	Depth (in) to	
				Surf.	Subsurf.		Ground Water	Restrictive Layer
AdB	B	low	1.4-14.0	53	14	high	>60	>60
AdC	B	low	1.4-14.0	152	40	high	>60	>60
AdF	B	low	1.4-14.0	250	60	low	0-40	<40
AcD	B	moderate	1.4-14.0*	250	90	low	>60	>60*
DHU	D	high	0.14-14.0	1	1	high	0-40	>60*

*Compacted glacial till, stratified layers of coarse fragments or high water table may be restrictive and occur at less than 60 inches.

Table 4. Topsoil Suitability, Montana Project

Map Unit Symbol	Soil Composition Component (T)	Topsoil Suitability (depth)	Location	Constraints
AcD	Andic Cryochrepts colluvial slopes (70%)	moderate (25")	Libby Creek	excessive coarse fragments below 29"
	Typic Cryumbrepts (10%)	moderate (20")		excessive coarse fragments below 20"
	Typic Cryochrepts (10%)	moderate (29")		excessive coarse fragments below 20"
	Rock Outcrop (10%)	unsuitable		
AdB	Andic Dystrochrepts deep	moderate (9")	Percolation Site	excessive coarse fragments below 9"
AdC	Andic Dystrochrepts deep	moderate (9")	Percolation Site	excessive coarse fragments below 9"
AdF	Andic Cryochrepts moderately deep (60%)	moderate (11")	Tailings Area	excessive coarse fragments below 11"
	Andic Cryochrepts less than 20" deep (10%)	moderate (11")		excessive coarse fragments below 11"
	Rock Outcrop (20%)	unsuitable		
	Udifluvents (10%)	unsuitable		flooding
DHU	Andic Cryochrepts (50%)	moderate (29")	Libby Creek	excessive coarse fragments below 29"
	Typic Humaquepts (30%)	high (15")	Ramsey Creek	high water table below 15"
	Udifluvents (20%)	unsuitable		flooding



NORANDA MINERALS CORP.	
MONTANA PROJECT Lincoln County, Montana	
AUG. 1989	SCALE 1"=400'
prepared by Western Resource Development Corp.	

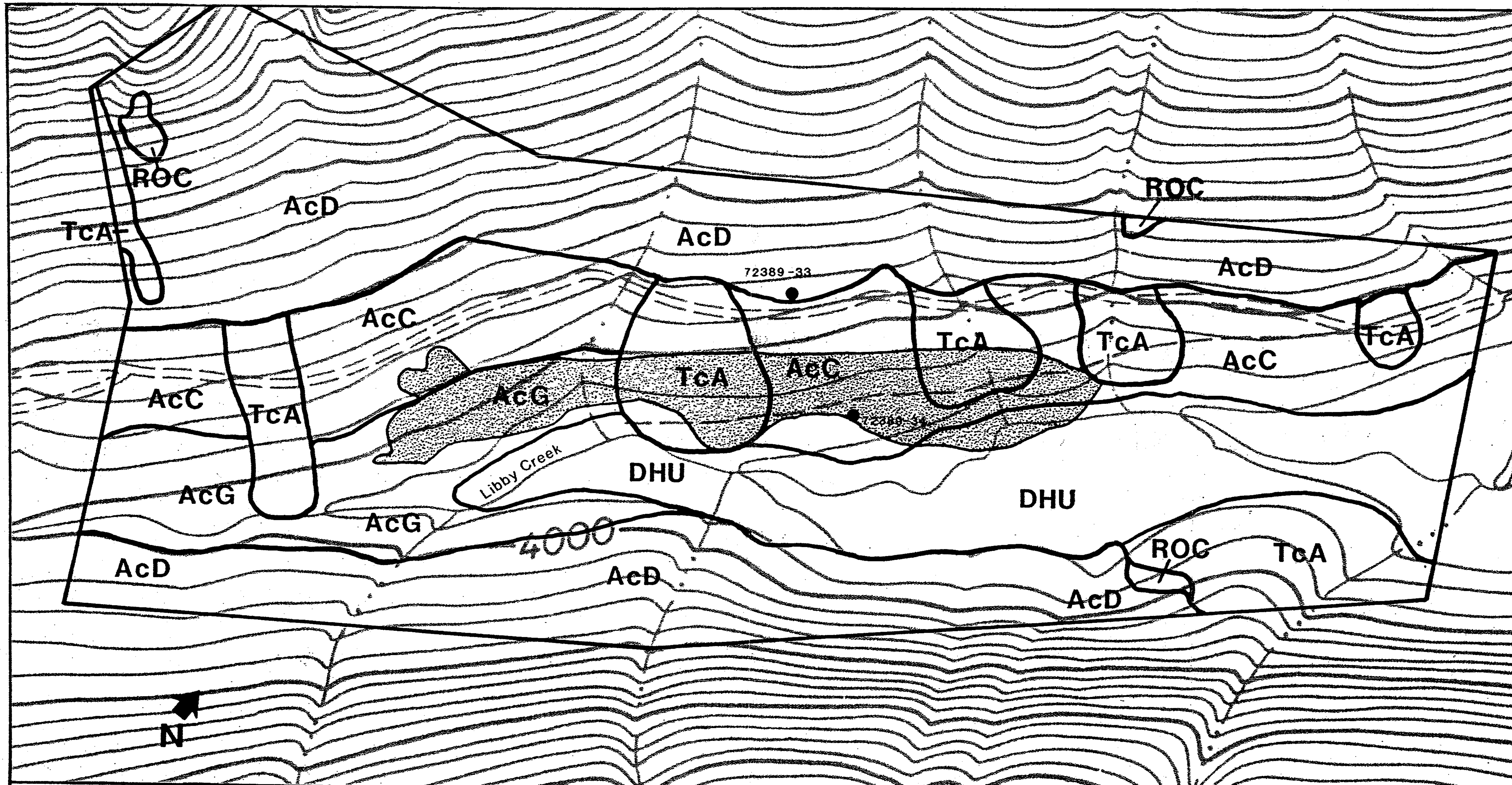
LEGEND

- Affected Area
- ● 72389-34 Soil observation site

AcC	Andic Cryochrepts colluvial slopes, 10-35% slopes.
AcG	Andic Cryochrepts glacial moraine, 0-15% slopes.
CbD	Cryochrepts-Cryumbrepts complex, bouldery surface, 15-60% slopes.
DHU	Cryochrepts-Humaquepts-Udifluvents Association, 0-10% slopes.

FIGURE 4

SOIL MAP-RAMSEY CREEK MINE /MILL SITE



NORANDA MINERALS CORP.

MONTANA PROJECT
Lincoln County, Montana

AUG. 1989 SCALE 1"=400'

prepared by
Western Resource Development Corp.

LEGEND

Affected Area

● 72389-3 Soil observation site

AcC	Andic Cryochrepts colluvial slopes, 10-35% slopes.
AcD	Andic Cryochrepts colluvial slopes, 35-60% slopes.
AcG	Andic Cryochrepts glacial moraine, 0-15% slopes.
DHU	Cryochrepts-Humaquepts-Udifluvents Association, 0-10% slopes.
TcA	Typic Cryorthents avalanche chutes, 15-35% slopes.
ROC	Rock outcrop-Rubble land complex, 15-90% slopes.

FIGURE 5

SOIL MAP_LIBBY CREEK SURFACE FACILITIES SITE

4.0 LITERATURE CITED

4.0 LITERATURE CITED

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APPENDICES

Appendix A
Additional Pedon Descriptions

Additional Soil Pedon Descriptions

PROFILE DESCRIPTION

Soil Type: Andic Dystrochrepts Lacustrine Terrace		Job: Noranda	Legal Description: --
Classification: Andic Dystrochrepts, coarse-silty, mixed frigid		Date: 7-22-89	Site No. 72289-24
Area/location: Tailings Impoundment Area	Elevation: 3345	Runoff:	Surf. Rck. Class: 0
Climate: frigid and udic	Slope: 3%	Moisture: dry to 21" moist to 55" wet to 55-60"	% Coarse Frag: 0
Vegetation: cedar-hemlock, clearcut/clover, mixed grasses	Aspect: S	Groundwater: water in bottom of pit	% Clay: <18
Parent material: lacustrine	Relief:	Hydr. Cond.: moderate	% Coarser V.F.S.: 5
Physiograpy: lacustrine terrace	Salt/Alkali: none	Erosion Type: sheet	Control section depth: 10-40"
Current use: woodland	Drainage: somewhat poorly	Wtr. eros. class: 1	Temperature: --

Additional Comments: This profile is wetter than is typical. The ash influenced layer is poorly expressed. Pedon is located 100 yds west of where road drops off terrace.

1-0 undecomposed root mat.
1-6 --
6-15 --
15-30 --
30-60 mottles are 7.5YR5/4; water in bottom of pit

Horizon	Depth	Color Dry	Color Moist	Mottles	Texture	Structure	Consistency Dry	Consistency Moist	Consistency Wet	Reaction	Boundary	Roots	Pores	Clay Films	% Gravel	% Cobbles	% Stones & Boulders
E	0-1	10YR 7/3	10YR 4/3	0	SiL	1,f,gr	so	vfr	so,po	eo	s	3,f	3,f,T	0	0	0	0
Bw1	1-6	10YR 6/3	10YR 5/3	1,f,f	SiL	1,m,sbk	so	vfr	so,po	eo	s	2,f,c	1,vf,T	0	0	0	0
Bw2	6-15	10YR 7/2	10YR 6/3	1,f,f	SiL	2,m,abk	sh	vfr	s,p	eo	s	1,f	1,f,T	0	0	0	0

PROFILE DESCRIPTION- Page 2

Site No. 72289-24

		Color					Consistency								Clay	%	%	% Stones &
Horizon	Depth	Dry	Moist	Mottles	Texture	Structure	Dry	Moist	Wet	Reaction	Boundary	Roots	Pores	Films	Gravel	Cobbles	Boulders
Bw3	15-30	-	10YR 5/4	2,m,d	SiL	2,m,abk	sh	vfr	ss,p	eo	gs	1,vf	1,f,T	0	0	0	0
C	30-60	-	2.5Y 6/2	3,c,p	SiL	m	sh	vfr	ss,po	eo	--	1,f	2,f,T	0	0	0	0

SOIL PROFILE DESCRIPTION

Soil Type: Andic Dystrochrept Family		Job: Noranda	Legal Description: --
Classification: Andic Dystrochrept, loamy-skeletal, mixed frigid		Date: 7-22-89	Site No. 72289-28
Area/location: Tailings Impoundment Area	Elevation: 3450	Runoff: rapid	Surf. Rck. Class: 0
Climate: Frigid/Udic	Slope: 25%	Moisture: sl moist to 40"	% Coarse Frag: 40
Vegetation: cedar-hemlock	Aspect: N	Groundwater: none	% Clay: <18
Parent material: till	Relief: convex	Hydr. Cond.: low	% Coarser V.F.S.: 5
Physiograpy: nose of ridge	Salt/Alkali: none	Erosion Type: sheet	Control section depth: 10-40
Current use: clearcut	Drainage: well	Wtr. eros. class: 0	Temperature: --
		Wind eros. class: 0	

Additional Comments: 1-0 0 horizons - mostly destroyed by logging. Litter, pine needles, bark. 0-1 disturbed
40+ hard argillites, with cracks, bedding not obvious, too hard to backhoe.

Horizon	Depth	Color Dry	Color Moist	Mottles	Texture	Structure	Consistency Dry	Consistency Moist	Consistency Wet	Reaction	Boundary	Roots	Pores	Clay Films	% Gravel	% Cobbles	% Stones & Boulders
E	0-1	10YR 6/4	2.5Y 6/2	0	SiL	1,f,gr	so	vfr	ss,ps	eo	a,w	2,vf	3,f,V	0	0	0	0
Bw	1-10	-	7.5YR 4/4	0	SiL	2,m,abk	sh	vfr	ss,ps	eo	a,w	1,vf	1,vf,T	0	0	0	0
2E	10-18	-	10YR 6/4	0	VGr Sil	2,m,abk	sh	vfr	ss,s,p	eo	c,w	1,vf	1,vf,T	0	30	5	5

SOIL PROFILE DESCRIPTION - Page 2

Site No. 72285-28

		Color					Consistency							Clay	%	%	% Stones &
Horizon	Depth	Dry	Moist	Mottles	Texture	Structure	Dry	Moist	Wet	Reaction	Boundary	Roots	Pores	Films	Gravel	Cobbles	Boulders
2B/E	18-30	-	10YR 6/4	0	VGr SiL	2,m,abk	h	fr	s,p	eo	a,i	1,vf	1,vf,T	1,mk	30	5	5
2Bt	30-40+	-	10YR 5/6	0	VGr SiL	3,f,abk		fi	s,p	eo	c,w	1,m	1,f,T	3,mk	30	5	5
R	40+	-															

SOIL PROFILE DESCRIPTION

Soil Type: Andic Dystrochrepts Family		Job: Noranda	Legal Description: --
Classification: Andic Dystrochrepts, loamy-skeletal, mixed, frigid		Date: 7-22-89	Site No. 72289-29
Area/location: Percolation Site 2	Elevation: 3345	Runoff: medium	Surf. Rck. Class: 0
Climate: frigid/udic	Slope: 5%	Moisture: dry to 47 sl moist to 55	% Coarse Frag: 60
Vegetation: cedar-hemlock	Aspect: S	Groundwater: none	% Clay: <18
Parent material: till	Relief: concave	Hydr. Cond.: moderate	% Coarser V.F.S.: 15
Physiograpy: rolling glacial plain	Salt/Alkali: none	Erosion Type: sheet	Control section depth: 10-40"
Current use: woodland	Drainage: moderately well	Wtr. eros. class: 0	Temperature: --
		Wind eros. class: 0	

Additional Comments:

Horizon	Depth	Color Dry	Color Moist	Mottles	Texture	Structure	Consistency Dry	Consistency Moist	Consistency Wet	Reaction	Boundary	Roots	Pores	Clay Films	% Gravel	% Cobbles	% Stones & Boulders
E 0	0-1	10YR 7/2	10YR 4/2	0	SiL	1,f,gr	sh	vfr	so,ps	eo	c,w	3,f	2,f,V	0	5	0	0
Bw	1-7	7.5YR 5/4	7.5YR 5/6	0	SiL	2,m,abk	sh	vfr	so,po	eo	c,i	3,f	2,f,T	0	5	0	0

Site No. 72289-29

Horizon	Depth	Color Dry	Color Moist	Mottles	Texture	Structure	Consistency Dry	Consistency Moist	Consistency Wet	Reaction	Boundary	Roots	Pores	Clay Films	% Gravel	% Cobbles	% Stones & Boulders
2Bw1	7-19	10YR 7/2	10YR 6/4	0	VGr SiL	2,f,sbk	sh	vfr	ss,ps	eo	c,i	1,vf	1,vf,T	0	45	0	0
2Bw2	19-29	10YR 6/4 7/2	10YR 5/4 6/4	0	VGr SiL	2,m,sbk	sh	vfr	ss,ps	eo	c,i	1,vf	1,f,T	0	45	0	0
2C1	29-47	10YR 6/4	10YR 5/4	0	VGr SiL	m	sh	vfr	s,p	eo	c,s	1,f	2,f,T	0	50	10	0
2C2	47-55	-	10YR 5/4	0	VGr SiL	m	sh	vfr	ss,ps	eo		1,vf	1,vf,T	0	50	0	0

SOIL PROFILE DESCRIPTION

Soil Type: Andic Dystrochrepts Deep		Job: Noranda	Legal Description: --
Classification: Andic Dystrochrepts, lo-s, mixed, frigid		Date: 7-23-89	Site No. 72389-30
Area/location: Perc Site 2	Elevation: 3660	Runoff: rapid	Surf. Rck. Class: 0
Climate: frigid/udic	Slope: 20%	Moisture: dry to 28 sl moist to 60	% Coarse Frag: 38
Vegetation: cedar-hemlock	Aspect: S	Groundwater: none	% Clay: 20
Parent material: colluvium and till	Relief: concave	Hydr. Cond.: moderate	% Coarser V.F.S.: 30
Physiograpy: side slope	Salt/Alkali: none	Erosion Type: sheet	Control section depth: 10-40"
Current use: woodland	Drainage: moderate	Wtr. eros. class: 0	Temperature: --
		Wind eros. class: 0	

Additional Comments: Steep colluvial slope derived from till

Horizon	Depth	Color Dry	Color Moist	Mottles	Texture	Structure	Consistency Dry	Consistency Moist	Consistency Wet	Reaction	Boundary	Roots	Pores	Clay Films	% Gravel	% Cobbles	% Stones & Boulders
E	0-1	10YR 7/2	10YR 4/2	0	SiL	1,f,gr	sh	vfr	so,ps	eo	c,w	2,f	2,f,V	0	10	2	0
BW	1-5	7.5YR 5/6	7.5YR 5/4	0	SiL	2,m,sbk	sh	vfr	so,ps	eo	c,w	2,f	1,f,T	0	10	2	0
2C1	5-28	10YR 7/2	10YR 6/4	0	GrV SiL	1,m,sbk	sh	vfr	so,ps	eo	c,s	1,m	2,vf,T	0	35	5	2
2C2	28-60	10YR 6/4	10YR 5/4	2,m,d	GrV SL	m	--	vfr	so,po	eo	--	1,m	2,vf,T	0	30	5	5

SOIL PROFILE DESCRIPTION

Soil Type: Andic Dystrochrepts		Job: Noranda	Legal Description:
Classification: Andic Dystrochrepts, coarse-silty, mixed, frigid		Date: 7-23-89	Site No. 72389-31
Area/location: Percolation Site 2	Elevation: 3360	Runoff: slow	Surf. Rck. Class: 0
Climate: frigid/udic	Slope: 1%	Moisture: moist to 40 wet to 60	% Coarse Frag: 15
Vegetation: cedar-hemlock	Aspect: SE	Groundwater: 60"	% Clay: 10
Parent material: till	Relief: concave	Hydr. Cond.: moderate	% Coarser V.F.S.: 10
Physiograpy: swale	Salt/Alkali: none	Erosion Type: sheet	Control section depth: 10-40"
Current use: woodland	Drainage: somewhat poorly	Wtr. eros. class: 0	Temperature:
		Wind eros. class: 0	

Additional Comments: 5-40 heavy iron staining, bands, swirls, mottles are 7.5YR 5/6
This soil is similar to Andic Dystrochepts deep - component of AdW - but lacks the coarse fragments in the E

Horizon	Depth	Color Dry	Color Moist	Mottles	Texture	Structure	Consistency Dry	Consistency Moist	Consistency Wet	Reaction	Boundary	Roots	Pores	Clay Films	% Gravel	% Cobbles	% Stones & Boulders
Bw	0-5		7.5YR 4/4	0	SiL	2,m,sbk	--	vfr	so,po	eo	c,w	1,vf	1,vf,T	0	5	0	0
E	5-40		10YR 7/2	3,c,p	Gr SiL	2,m,abk	--	vfr	so,po	eo	c	1,vf	1,vf	0	15	0	0
C2	40-60		7.5YR 4/6	3,c,p	VGr SiL	2,m,abk	--	vfr	so,po	eo	--	0	0	0	35	10	0

SOIL PROFILE DESCRIPTION

Soil Type: Andic Cryochrepts colluvial slopes		Job: Noranda	Legal Description: T4N R10W Sec 12,7,11,12,13 T4N R11W Sec 14,18,23,24
Classification: Andic Cryochrepts loamy-skeletal mixed		Date: 7-22-89	Site No. 72389-33
Area/location: Libby Ck Rd	Elevation: 4060	Runoff: rapid	Surf. Rck. Class: 2
Climate: frigid/udic	Slope: 50%	Moisture: dry to 60"	% Coarse Frag: 40
Vegetation: cedar-hemlock	Aspect: S	Groundwater: none	% Clay: 15
Parent material: colluvium	Relief: concave	Hydr. Cond.: moderate	% Coarser V.F.S.: -
Physiograpy: valley sideslope	Salt/Alkali: none	Erosion Type: sheet	Control section depth: 10-40"
Current use: woodland	Drainage: well	Wtr. eros. class: 0	Temperature: --
		Wind eros. class: 0	

Additional Comments: 0 1-0" coniferous needles, litter
On steep hillside just above road cut; undisturbed profile.

		Color					Consistency										
Horizon	Depth	Dry	Moist	Mottles	Texture	Structure	Dry	Moist	Wet	Reaction	Boundary	Roots	Pores	Clay Films	% Gravel	% Cobbles	% Stones & Boulders
Bw1	0-7	7.5YR 5/4	7.5YR 3/4	0	SiL	1,f,gr	so	lo	ss,po	eo	cs	2,f,m	2,f,V	0	10	2	0
Bw2	7-26	7.5YR 5/4	7.5YR 3/4	0	GrV ScL	1,m,sbk	so	lo	so,po	eo	c,w	3,f,m,c	3,m,T	0	30	2	2
C	26-60	--	10YR 4/3	0	GrV SL	sg	10	lo	so,po	eo	--	1,f,m	3,m,V	0	40	5	5

SOIL PROFILE DESCRIPTION

Soil Type: Andic Cryochrepts colluvial slopes		Job: Noranda	Legal Description: --
Classification: Andic Cryochrept,loamy-sk,mixed		Date: 7-23-89	Site No. 72389-34
Area/location: Libby Ck fac.	Elevation: 3930	Runoff: medium	Surf. Rck. Class: 0
Climate: cryic/udic	Slope: 10%	Moisture: sl moist to 50+	% Coarse Frag: 40
Vegetation: clearcut	Aspect: S	Groundwater: none	% Clay: 5
Parent material: ash over till	Relief: concave	Hydr. Cond.: moderate	% Coarser V.F.S.: 55
Physiograpy: toe slope	Salt/Alkali: none	Erosion Type: sheet	Control section depth: 10-40"
Current use: facilities area	Drainage: well	Wtr. eros. class: 0	Temperature: --
		Wind eros. class: 0	

Additional Comments: 3-0 0 horizon, roots, charcoal, litter

		Color					Consistency										
Horizon	Depth	Dry	Moist	Mottles	Texture	Structure	Dry	Moist	Wet	Reaction	Boundary	Roots	Pores	Clay Films	% Gravel	% Cobbles	% Stones & Boulders
A	0-3	-	7.5YR 3/2	0	Gr SiL	1,f,sbk	so	vfr	so,ps	eo	c,w	3,f,c	3,f,V	0	15	2	0
Bw	3-20	7.5YR 5/4	7.5YR 4/4	0	Gr SiL	1,f,sbk	so	vfr	so,ps	eo	a,w	3,f,m,c	2,f	0	15	5	2
C	20-41	-	2.5Y 5/4	0	GrV SL	sg	sh	vfr	so,ps	eo	c,s	1,vf	3,f,V	0	40	5	5
2C	41-50+	-	2.5Y 5/4	0	SiL	m	sh	vfr	so,ps	eo	--	0	1,f,V	0	0	0	0

SOIL PROFILE DESCRIPTION

Soil Type: Andic Dystrochrept Family		Job: Noranda	Legal Description: --
Classification: Andic Dystrochrept, loamy-skeletal, mixed, frigid		Date: 7-23-89	Site No. 72389-35
Area/location: Perc Site 1	Elevation: 3830	Runoff: medium	Surf. Rck. Class: 0
Climate: frigid/udic	Slope: 15%	Moisture: sl moist to 60"	% Coarse Frag: 47
Vegetation: cedar-hemlock	Aspect: NE	Groundwater: none	% Clay: 40
Parent material: till	Relief: concave	Hydr. Cond.: moderate	% Coarser V.F.S.: 5
Physiograpy: till plain	Salt/Alkali: none	Erosion Type: sheet	Control section depth: 40-60"
Current use: woodland/ wildlife	Drainage: well	Wtr. eros. class: 0	Temperature: --
		Wind eros. class: 0	

Additional Comments: 0-7
7-20 brittle

Horizon	Depth	Color Dry	Color Moist	Mottles	Texture	Structure	Consistency Dry	Consistency Moist	Consistency Wet	Reaction	Boundary	Roots	Pores	Clay Films	% Gravel	% Cobbles	% Stones & Boulders
A	0-7	-	10YR 3/4	2	SiL	2,m,sbk		vfr	ss,ps	eo	c,w	2,f,m	1,vf,T	0	5	0	0
BW	7-20	-	10YR 5/4	1	SiL	2,m,sbk		vfr	ss,ps	eo	c,i	1,vf	2,vf,T	0	10	0	0
BW2	20-40	-	10YR 5/4	2,m,f	Gr SiL	2,f,sbk		vfr	ss,ps	eo	c,w	1,vf	2,vf,T	0	15	0	0
C	40-60	-	10YR 5/4	2,m,d	VGr SiL	m		fi	s,p	eo	--	1,vf	1,vf,T	2,k	35	5	2

Appendix B

Laboratory Methods

Laboratory Methods
Sources of Methods for Determining Soil
Physical and Chemical Properties

Parameter	Source
Saturated Paste pH	ASA # 9-2, section 12-2
Electrical Conductivity of Saturation Extract (EC)	ASA # 9-2, section 10-3
Organic Matter (OM)	ASA # 9-2, section 29-4
Particle Size Analysis	ASA # 9-1, section 43.5
>2mm	ASA # 9-1, section 43.5

Appendix C
Additional Lab Data

Appendix C Additional Laboratory Data
Soil Chemical and Physical Properties, Montana Project

Soil Name (MU Symbol) Depth	pH	EC[1] (mmhos/cm)	O.M.[2] (%)	Particle Size Analysis (%) Sand	Silt	Clay	VFS	Texture Class	>2 mm Gravel (%)	Sat[3] (%)
072289-24										
Andic Dystrochrepts										
Lacustrine terrace (AdA)										
(0-6)	5.4	0.30	1.86	<1	86	14	<1	SIL	<1	52.5
(6-15)	5.7	0.18	0.13	10	82	8	8	SI	<1	33.6
(15-30)	5.7	0.15	0.11	<1	82	18	<1	SIL	<1	42.3
(30-60)	5.5	0.13	0.09	20	76	4	17	SIL	<1	33.3
072289-28										
Andic Dystrochrept Family (AdD)										
(0-10)	5.9	0.08	2.77	25	71	4	8	SIL	10	59.3
(10-18)	5.2	0.20	0.45	18	72	10	11	SIL	56	34.5
(18-30)	5.0	0.10	0.26	32	52	16	6	SIL	37	36.2
(30-40)	5.2	0.07	0.19	26	56	18	5	SIL	27	39.2
072289-30										
Andic Dystrochrept Deep (AdD)										
(0-5)	6.0	0.05	2.81	23	69	8	12	SIL	31	53.4
(5-29)	5.9	0.06	0.41	29	65	6	10	SIL	35	34.3
(29-60)	5.9	0.05	0.18	37	59	4	20	SIL	32	25.8
072289-31										
Andic Dystrochrept Deep (AdD)										
(0-5)	5.8	0.09	3.15	14	78	8	12	SIL	9	74.3
(5-40)	5.6	0.05	0.23	14	82	4	12	SI	42	34.2
(40-60)	5.8	0.09	0.04	37	59	4	12	SIL	37	25.8
072389-34										
Andic Dystrochrept										
(0-3)	4.9	0.18	22.00	41	51	8	15	SIL	67	106.0
(3-20)	5.9	0.05	2.57	40	56	4	10	SIL	37	51.6
(20-41)	6.1	0.05	0.32	54	42	4	10	SL	77	58.9
(41-50+)	6.3	0.04	0.26	34	62	4	13	SIL	1	38.0

Appendix C Additional Laboratory Data

Soil Name (MU Symbol) Depth	pH	EC[1] (mmhos/cm)	O.M.[2] (%)	Particle Size Analysis Sand (%)	Silt (%)	Clay (%)	VFS (%)	Texture Class	>2 mm Gravel (%)	Sat[3] (%)
072389-35										
Typic Glossoboralf Family										
(0-7)	5.6	0.08	2.74	16	66	18	9	SIL	28	67.2
(7-20)	6.0	0.05	0.12	43	53	4	18	SIL	52	30.0
(20-40)	5.8	0.03	0.10	27	69	4	11	SIL	33	29.5
(40-60)	5.9	0.06	0.06	23	65	12	14	SIL	55	36.7
Duplicates										
072289-30 (5-29)	6.0	0.05	0.37	27	69	4	7	SIL	-	31.4
072389-35 (7-20)	5.9	0.05	0.14	38	52	10	30	SIL	-	29.4

BASELINE SOILS STUDY

Montana Project

LINCOLN & SANDERS COUNTIES, MONTANA

prepared for

Noranda Minerals Corp.
65 N. Edison Way Suite 4 P.O. Box 7176 Reno, Nevada 89501

prepared by

Western Resource Development Corporation
711 Walnut St. P.O. Box 467 Boulder, Colorado 80306

February 1989

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SUMMARY

INTRODUCTION

A soils investigation of the Montana Mining Project site was conducted in the summer of 1988 by Western Resource Development Corporation. Soils of the area were mapped, described and sampled using methods detailed in the Baseline Soils Study (WRDC 1989). The objectives of the study included:

1. Description and characterization of the landscape, including the physical and chemical attributes of the soils.

2. Evaluation of basic soil and landscape data to provide interpretations important to use, management and reclamation.

3. Mapping the distribution of the soils in the intensive study areas.

This report presents soil information for the intensive and extensive study areas and the transmission line corridors. A detailed soil survey was performed in the intensive study area including the tailings disposal area, plant sites and evaluation adit areas. The Land System Inventory of the Kootenai National Forest (Kuennen and Gerhardt 1984) was used as the primary source of information for the extensive study area and the transmission corridors. Some additional field investigations were conducted for the transmission line corridors.

SOILS AND SOIL FORMING FACTORS IN THE EXTENSIVE STUDY AREA

Geology and Parent Materials

The project area is underlain by a great thickness of Precambrian meta-sedimentary rocks of the Belt series, composed of hard, fine-grained, clastic rocks, which are generally resistant to weathering (Veseth and Montagne 1980). Most of the soils formed in deposits derived from Belt series rocks. The deposits were transported by water (alluvial and lacustrine), ice (glacial) and slope (colluvial) processes. Wind-deposited (aeolian) materials containing volcanic ash mantle much of the project area (Nimlos 1980).

The soils formed in alluvial and lacustrine materials are weakly to moderately developed. Soils formed on lacustrine deposits are medium to fine textured with few coarse fragments. Soils formed on alluvial deposits are well-sorted, coarse to medium textured and stony.

Soils formed on alpine glacial deposits are minimally developed and are medium textured with abundant angular coarse fragments. Soils on continental glacial deposits in the tailings area are extensively weathered, have strong soil structure and thick weathering rinds on rocks. These soils are fine textured and vary widely in coarse fragment contents.

Colluvial soils are medium textured and weakly developed with abundant coarse fragments.

Physiography

The landforms of the project area have been shaped by alluvial and glacial processes acting within the structural constraints of the bedrock. There are nearly level to gently sloping flood plains, terraces and escarpments. Alpine glacial features, high in the Cabinet Mountains, include sloping marginal and recessional moraines and gently sloping valley bottoms. The valley bottoms are dissected by streams. Debris fans are associated with snow avalanche chutes.

Landforms in the tailings area are structurally controlled hills and ridges with a veneer of glacial drift. Slopes are moderately to very steep, convex and slightly dissected. Areas of glacial drift have hummocky topography suggesting a water-reworked glacial plain with a poorly integrated drainage network.

Time

The youngest soils in the study area are formed on recent alluvial and colluvial deposits. They have surface horizons with organic accumulation and little development in the subsurface. Soil age ranges from less than a hundred to several thousand years old.

Intermediate aged soils have weathered surface horizons affected by volcanic ash. These soils range in age from at least 6600 years old to early Wisconsin age.

The oldest soils in the intensive study area occur in the tailings area on deposits related to one of the pre-Wisconsin glacial advances which occurred in the Pleistocene over the last 2 million years.

Climate

Mean annual precipitation in the vicinity of the project area varies from 20 to 100 inches (Montagne et al 1982). Low intensity, long duration storms are common with the most of the precipitation falling as snow in the higher elevations.

The mean annual temperature of the surrounding valley stations is near 45°F (Kuennen and Gerhardt 1984). The frost free period is around 30 to 50 days (Montagne et al 1982).

The soil moisture regime of the well drained soils is assumed to be udic. Inadequately drained soils have aquic moisture regimes. Lower elevation soils have frigid soil temperature regimes; higher soils and those in cold air drainages are assumed to be cryic.

Biologic Influences

The dominant vegetation in the project area is coniferous forest. Shrubfields occur in areas of repeated disturbance, such as avalanche chutes. Small areas of hydric vegetation dominated by sedges, rushes and shrubs occur in bogs. The forest vegetation, with closed canopies and sparse understories, has resulted in soils with thin A horizons. Thick, dark colored surface horizons occur under grass and shrub vegetation.

SOILS OF THE INTENSIVE STUDY AREA

The intensive study area includes the Poorman and Little Cherry Creek disposal sites, the upper Libby Creek, Libby Creek and Ramsey Creek plant sites on the east slope of the Cabinet Mountains and the Rock Creek plant and adit sites on the west slope. The Baseline Soil Study contains maps showing the distribution of the seventeen (17) map units in the intensive study area.

The soil physical and chemical properties for the typical pedons for each major soil in the intensive study area are described in this report. The soils range from extremely acid to moderately alkaline. The soils have relatively high organic matter contents due to volcanic ash (Nimlos 1980; Fosberg et al. 1979a). The soils are predominantly medium textured, though both coarse and fine textured soils occur. Many of the soils contain significant amounts of rock fragments. The saturation percents of the soils are abnormally high in the surface soils indicating the presence of volcanic ash and in some cases high levels of organic matter; the subsoil horizons are within the normal range for mineral soils.

Important soil properties were estimated based on field and laboratory data and published relationships. The estimated parameters include hydrologic properties and those relevant to erosion, revegetation and engineering uses of the soils.

The suitability of the soils for topsoil salvage was evaluated for each map unit. The limiting parameter for many of the soils is excessive coarse fragments.

1.0 INTRODUCTION

BASELINE SOIL STUDY
MONTANA MINING PROJECT

Lincoln and Sanders
County, Montana

1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

This baseline study was initiated by U.S. Borax as part of the licensing requirements for the development and mining of a copper/silver deposit located underneath the Cabinet Mountain Wilderness Area in the Kootenai National Forest, Sanders and Lincoln Counties, Montana (Figure 1). Whereas the State of Montana, Department of State Lands, and the Kootenai National Forest have primary responsibility for permitting these activities, the two agencies and U.S. Borax developed a Plan of Study that defined the nature and extent of the baseline work. This work was initiated in the spring of 1988 and has been conducted in accordance with the terms of the Plan of Study (Appendix A).

A number of alternative sites were identified for portals, processing plant, tailings disposal and ancillary facilities. The area encompassing and adjacent to these sites then became the focus of the baseline work.

In September of 1988 Noranda Minerals Corporation and Montana Reserves formed a venture and purchased the silver/copper deposit from U.S. Borax and continued with project development under the "Montana Project" name. Noranda Minerals Corporation (Noranda) was designated the project manager.

Noranda continued to build from the data and information that had been generated by U.S. Borax and after reviewing the many alternative sites developed the proposed mining program detailed in the Application for a Hard Rock Operating Permit from the Montana Department of State Lands. The application also serves as a proposed Plan of Operation to the Kootenai National Forest. Basically, the application describes a 20,000 ton per day operation accessed from two (twin) portals in Ramsey Creek, a mill site located adjacent to the Ramsey portals, a portal in Libby Creek, two portals in the Rock Creek drainage for ventilation and emergency access, and a tailing impoundment in the Little Cherry Creek drainage. Access to the Ramsey Creek mine site would be

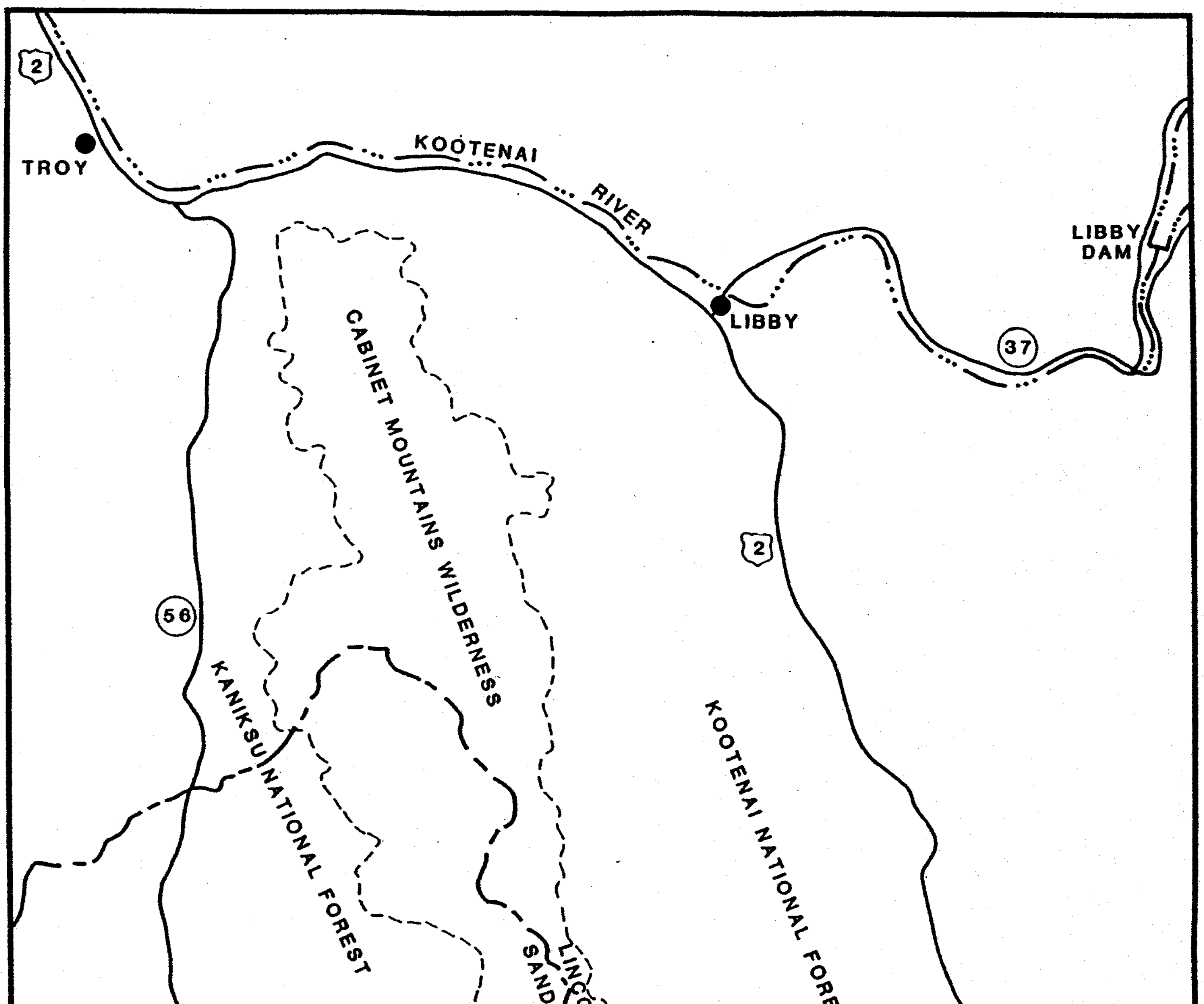


FIGURE 1. PROJECT LOCATION
NORANDA MINERALS CORP.
LINCOLN & SANDERS COUNTIES, MONTANA

over the existing Bear Creek Road. A new transmission line from Pleasant Valley to the mine site would provide electrical energy for the operation. The total labor force is expected to number approximately 400 people. These positions would be filled by hiring locally as much as possible.

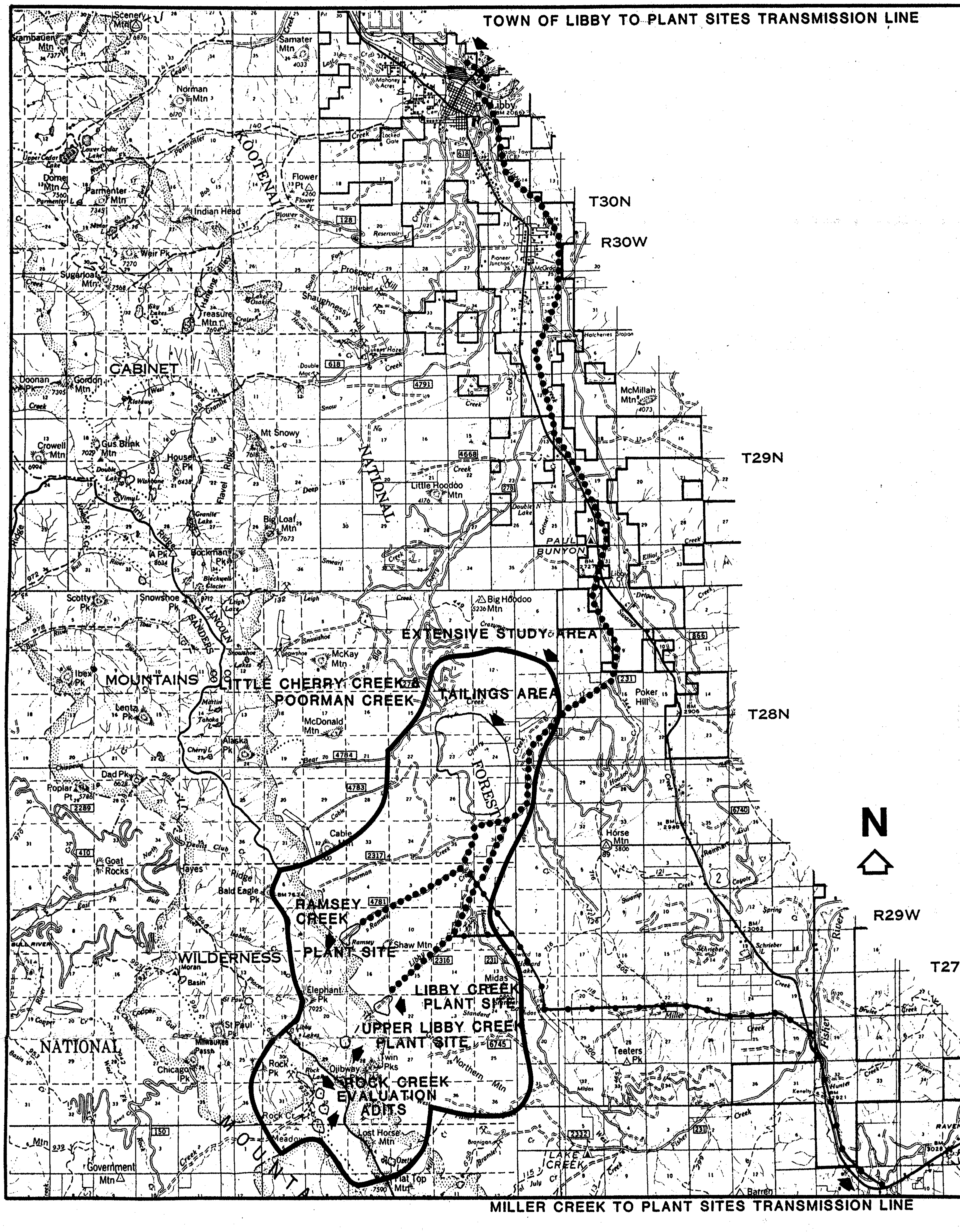
1.2 BASELINE SOIL STUDY

The Baseline Soil Study presents information about the soils of the study area at three different levels of detail, depending on the proposed degree of disturbance and land use. They are: the extensive study area, the transmission line corridors and the intensive study areas (Figure 2). The intensive study areas include the proposed tailings areas, plant and adit sites.

The Land System Inventory of the Kootenai National Forest (Kuennen and Gerhardt 1984) was the primary information source for the extensive study area. The information for the transmission line corridors was derived from the Land System Inventory and additional field investigations. The intensive study areas were mapped and characterized in detail using standard soil survey methods. This report includes a discussion of methods and results, interpretations of the soils and map units for various uses and soil maps and appendices.

Prior to conducting the field work, soil scientists from Western Resource Development met with Lou Kuennen, soil scientist with the USFS in Libby, Montana, to discuss the scope of work and get his input into soil characteristics in the areas of interest. Soil scientists at Montana DSL were notified that the field work was being conducted.

The goal of this study was to summarize and when necessary supplement existing soils information in the project areas. A detailed soil survey was performed in the tailings areas and plant sites since the activities proposed there require more specific soil information than the Land System Inventory was designed to provide. This investigation was initiated in response to the need for baseline data to support environmental evaluations and mine development and reclamation plans. The specific objectives include:



MILLER CREEK TO PLANT SITES TRANSMISSION LINE

FIGURE 2.
PROJECT ALTERNATIVES LOCATION MAP

NORANDA MINERALS CORP.
MONTANA PROJECT
Lincoln & Sanders Counties, Montana
JAN. 1989 SCALE 1″ = 2 MILES

1. Description and characterization of the landscape, including the physical and chemical attributes of the soils.

2. Evaluation of basic soil and landscape data to provide interpretations important to use, management and reclamation.

3. Determination and mapping of the distribution of the soils in the intensive study areas.

A glossary of soil terms used in this report is presented in section 6.0.

2.0 METHODS

2.0 METHODS

2.1 COMPILATION OF EXISTING SOIL INFORMATION

The principal source of soil information for the study area was the Land System Inventory of the Kootenai National Forest (Kuennen and Gerhardt 1984).

Soils information for the transmission line corridors were obtained from the land system inventory (Kuennen and Gerhardt 1984) and augmented by an on-site investigation. In addition, interpretations were summarized and developed for the corridor map units.

2.2 SOIL MAPPING

The soil inventory in the intensive study areas proceeded in two stages. The first comprised the identification, description and characterization of the dominant soils and the design of appropriate map units for the project. The second involved mapping the distribution of the soils.

The soils were identified and described using the procedures and nomenclature outlined in the Soil Survey Manual (Soil Survey Staff 1981). The investigation in the intensive study area involved the examination and detailed description of about thirty (30) soil profiles in backhoe excavated pits, and ten (10) from hand-dug pits and roadcut exposures. Soils were described and sampled to a depth of five feet. In addition, numerous observations were made about the soils and landscape in the process of traversing the study sites. Samples from the soil horizons of twenty (20) soil profiles were collected for laboratory characterization. The samples were collected so that cross contamination from other horizons was avoided. The soils were sealed in plastic bags in the field and shipped to the laboratory field moist. Soil sample locations are shown on Figures 3, 4, 5, 6 and 10. The field investigations were performed by Lewis P. Munk and James P. Walsh. The soils were classified in the field to the family level using Soil Taxonomy (Soil Survey Staff 1975).

Map units were designed to support the specific interpretations and uses of the soil survey for environmental impact assessment and mine planning. For example, soil and landscape properties which potentially influence plant growth, soil erosion, hydrology, slope stability and mined land reclamation were considered in developing the map units. Most map units were consociations of phases of soil families (e.g. Andic Cryochrepts bouldery surface, 0-15% slopes). However, map units composed of complexes (e.g. Cryochrepts-Cryumbrepts bouldery surface complex, 0-15% slopes) were used where the pattern of soils was intricate and delineating the soils would needlessly complicate the map. Miscellaneous landtypes were included as components in some map units (e.g. Rock outcrop-Rubble land complex, 15-90% slopes).

The second stage of the soil survey involved mapping the distribution of the soils (Soil Survey Staff 1981). This task was accomplished by making observations about the soils, vegetation,slope characteristics and physiography. The locations of soil observations were selected to represent the range of geomorphic positions occurring in the study area. This method is a standard soil survey procedure (Soil Survey Staff 1981) and was used in this investigation since soil boundaries in the project area corresponded well with changes in landscape position. This procedure allowed the development of a qualitative, location sensitive model relating soils to landscape position and vegetation. This conceptual model was tested and corrected for geographic variation as the survey progressed. Aerial photographs were used in conjunction with the ground investigations and as a mapping base.

The inventory of the intensive study areas meets the requirements of an Order 1 soil survey as defined in the Soil Survey Manual (Soil Survey Staff 1981) An Order 1 soil survey restricts the maximum proportion of limiting dissimilar soil inclusions in map units to about 10 percent. A limiting dissimilar soil is one which varies in properties from the mapped soil, to the extent that management or interpretations are significantly effected.

The map units used in this part of the inventory were consociations and complexes of phases of soil families and miscellaneous landtypes. Spot symbols were used where limiting dissimilar soils were too small to delineate. A typical pedon of each major soil was described in detail with accompanying laboratory data in this report. Soil and map unit interpretations were developed based on local, regional and national guidelines.

The field investigations of the transmission line corridors involved traversing the proposed corridors. Observations of soils and landforms were made along the route in order to identify potential problem areas not recognized in the Land System Inventory. The soil mapping in the land type inventory was field checked by observing land forms and profiles at selected locations along the corridors. The mapping was found to be accurate within the limits of that survey, a generalized Order III survey. The physiography along the corridor alignments, the major soils and constraints to siting at specific locations are briefly are described in Section 3.5, Description of Transmission Line Corridors.

2.3 LABORATORY PROCEDURES

Laboratory analysis were performed to assess selected physical and chemical attributes of the soils. The following parameters were determined: particle size analysis, percent very fine sand, percent rock fragments (>2mm), organic matter percent, saturated soil paste pH, electrical conductivity of the saturated soil paste extract, and percent water at saturation. The 1500 Kpa water contents were determined for selected surface horizons. The procedures for determining the physical and chemical properties are referenced in Appendix B. The analyses were performed by the Colorado State University soil testing laboratory, Ft. Collins, Colorado.

2.4 INTERPRETATION METHODS

Interpretations were made for each soil and map unit in the intensive study area. Soil interpretations were derived using soil properties from field and laboratory data and established relationships. Available water holding capacity and hydraulic conductivity are examples of soil interpretations. Map unit interpretations were based on the properties of the dominant or most restrictive soil(s) in combination with other landscape parameters. Revegetation potential for example, was estimated by considering several soil and landscape parameters.

Local, state and federal guidelines were consulted in making the interpretations for the intensive study areas (Soil Conservation Service 1983, Wischmeier and Smith 1978, Soil Survey Staff 1983, Soil Staff 1980). The map unit interpretations for the transmission line corridors were extracted primarily from the land system inventory. The methods used to make the interpretations are listed in Appendix C.

3.0 RESULTS AND DISCUSSION

3.0 RESULTS AND DISCUSSION

3.1 ENVIRONMENTAL SETTING

3.1.1 Study Area Locations

The extensive and intensive study areas are all located in the Cabinet Mountains south of Libby. The Cabinet Mountains generally trend north-south in direction, have U-shaped valleys to the east and west, and an elevation of 7,900 feet. The three evaluation adits are located in the Rock Creek drainage on a steep west-facing slope and range in elevation from 4,000 feet (near the base of the slope) to 4,600 feet, to 5,000 feet near Rock Lake. The three sites have an area of 72 acres. Rock Lake and runoff from these sites drain to Rock Creek Meadows, a wetlands area, and then to Rock Creek, a perennial stream.

Libby Creek on the east side of the Cabinet Mountains has two alternative plant sites named Libby Creek and Upper Libby Creek. The Libby Creek site is at an elevation of 4,200 feet and the Upper Libby Creek site is at an elevation of 4,400 feet. The Libby Creek Valley which trends northeast is generally less than 500 feet wide and has steep slopes which rise to surrounding peaks in excess of 7,000 feet. Avalanche chutes are common in the drainage from the side slopes. The Libby Creek site is approximately 96 acres in size while the Upper Libby Creek site which has two small ponds is about 51 acres in size.

The 54 acre Ramsey Creek plant site is located in Ramsey Creek, the stream valley just north of Libby Creek. The elevation of the plant site is about 4,400 feet. Like Libby Creek Valley, the Ramsey Creek Valley is narrow, surrounded by steep slopes and trends gently northeast.

The Little Cherry and Poorman Creek tailings areas are located about three and one-half miles northeast of the Libby and Ramsey Creek plant sites. The 2296 acre study area for these two sites ranges in elevation from 3,400 to 3,800 feet. Little Cherry Creek bisects the northern portion of this study area and Poorman Creek is just south of this area. The entire site contains numerous small ridges, has intermittent drainages, and drains to the northeast. Past continental glacial activity has created a hummocky, poorly drained topography in some areas.

All of the above intensive study areas are encompassed by the extensive study area (Figure 2). The only development planned for this area is a utility corridor connecting the preferred plant site with the preferred tailings alternative.

The town of Libby to plant sites transmission line is about 22 miles in length considering the terminus at either Libby or Ramsey Creek plant site. The line begins at the Pacific Power and Light substation north of the town of Libby and proceeds south, crossing the Kootenai River and follows private roads which parallel Libby Creek. Approximately 13 miles south of town the transmission line crosses U.S. Highway 2 and follows U.S. Forest Service Road 231 along Libby Creek to a point just south of the tailings sites. From this point one alternative proceeds up Libby Creek to a plant site and another up Ramsey Creek to a plant site.

The Miller Creek to plant sites transmission line begins at the Bonneville Power Authority transmission line which crosses U.S. Highway 2 southeast of the study area near Pleasant Valley. This transmission line proceeds north along U.S. Highway 2 for about 4.5 miles to Miller Creek where it turns west and follows a dirt road along Miller Creek. When the road ends, the transmission line proceeds further west crossing a 4,600 foot mountain and then heads northwest past Howard Lake and then has alternative branches that proceed up Libby and Ramsey creeks. This line is about 18 miles in length with either the Libby or Ramsey creek alternative.

3.1.2 Geology

The study area is within the Northern Rocky Mountain physiographic province, an area characterized by mountain ranges and intermountain valleys. This area is underlain by Precambrian meta-sedimentary rocks of the belt series, clastic rocks generally resistant to weathering (Veseth and Montagne 1980). Continental and alpine glaciation have influenced the project area (Kuennen and Gerhardt 1984). During the Pleistocene epoch of the Quaternary period, continental glaciers covered most of the lower elevations of the Cabinet Mountains and alpine glaciers formed on high peaks and in stream valleys. During post-glacial time, volcanic ash covered the landscape, presumably from the Mt. Mazama eruption 6600 years ago in what is now Oregon (Nimlos 1980). The ash affects soil productivity and moisture holding capacity and influences the type and productivity of vegetation on a site.

3.1.3 Soils

The soils of the study area vary in age and degree of development. Young soils associated with recent alluvial and slope processes have little or no development and surface horizons have varying accumulations of organic matter. They may or may not be mantled by ash. These soils generally have a sandy texture, abundant coarse fragments, a pH of 5 to 6, and are infertile. Intermediate aged soils have horizons which exhibit alteration of the parent material through soil forming processes. They are silt loams, infertile, have coarse fragments and a pH of 5 to 6. The tailings area has old soils which are probably related to one of the pre-Wisconsin glacial advances. These infertile soils have a clay to silty clay texture and a pH towards the high end of the 5 to 6 range.

3.1.4 Climate

The study area is characterized by a Pacific maritime climate modified by the inland continental location (Kuennen and Gerhardt 1984). The prevailing westerlies carry moist Pacific air masses inland, creating cloudy, warm, wet winters. During summer, dry air masses of the prevailing westerlies create dry and warm days with cool nights. The continental location of the study area results in occasional cold periods in winter and hot intervals in the summer (Kuennen and Gerhardt 1984).

Elevation has a major influence on both temperature and precipitation of the study area. Precipitation at 3,600 feet at the tailings area is approximately 30 inches but may range to 80-90 inches on 7,303 foot Ojibway Peak near Rock Lake which is above the adit sites (Kuennen and Gerhardt 1984). The majority of the precipitation falls in the November through January period. Most summer precipitation is associated with convectional storms.

The mean annual temperature for Libby is 45^{o}F (Kuennen and Gerhardt 1984). About half the days in July and August have maximum temperatures of 90^{o}F or warmer. Summer nighttime lows are commonly in the mid-40^{o}F. Temperature inversions are common in this area, which has a growing season of 30 to 50 days (Montagne et al. 1982). Extremely cold temperatures occur when arctic air masses from Canada move into the region. December and January are the coldest months of the year.

Both temperature and precipitation affect the vegetation pattern. At lower elevations, moisture is the dominant controlling factor influencing the presence of a forest type and at upper elevations temperature is the major factor (Daubenmire 1956).

3.1.5 Vegetation

The vegetation of the Kootenai National Forest has been mapped by forest habitat types by the U.S. Forest Service in the late 1970's and early 1980's. The area was mapped according the classification of Pfister et al. (1977) as presented in Forest Habitat Types of Montana. The Baseline Vegetation Study (WRDC 1989) for this project presents the forest habitat mapping for the extensive study area and describes the habitat types.

Five climax series with 15 habitat types occur within the extensive study area. Climax series present include:

- Douglas fir (Pseudotsuga menziesii)
- Grand fir (Abies grandis)
- Western red cedar (Thuja plicata)
- Western hemlock (Tsuga heterophylla)
- Subalpine fir (Abies lasiocarpa)

Each of the climax series are described below from publications of Pfister (1974, 1977) and Cooper et al. (1987).

The Douglas fir climax series in northwestern Montana is bordered on the warm side by the ponderosa pine (Pinus ponderosa) series and on the cool side by the grand fir series or the subalpine fir series at high elevations. The Douglas fir series occupies a broad ecological amplitude from the lower elevations of forest growth up to about 5,500 feet on southern exposures. This series occurs on all aspects, slope, and landforms but has a tendency to occupy the warm-dry moderately steep south-southwest aspects at midslope on minor ridges. Major trees in the series include Douglas fir, ponderosa pine, western larch and lodgepole pine (Pinus contorta).

Ponderosa pine, the predominant seral species, occurs on warm, dry slopes. Lodgepole pine and western larch occur in the early seral stage on moist sites. All four tree species are adapted to fire. Wildfires help to maintain seral species in the Douglas fir climax series. The natural fire frequency in this climax is 10 to 30 years.

The three Douglas fir climax series habitat types in the extended study area include: Douglas fir/bluebunch wheatgrass (Agropyron spicatum), Douglas fir/dwarf huckleberry (Vaccinium caespitosum) and Douglas fir/ninebark (Physocarpus malvaceus).

The grand fir climax series occurs on relatively warm exposures and excessively drained substrates in elevations just above the drier Douglas fir series. The series occur under mild and rather moist conditions but not sufficiently moist for western red cedar, the next series in the elevation gradient. The grand fir series generally occurs near or below 5000 feet elevation.

Douglas fir is the major seral species on nearly all grand fir habitat types. Engelmann spruce (Picea engelmannii) and lodgepole pine occur on the colder habitat types, whereas ponderosa pine is prevalent on warmer types.

Western larch is a major component where fire has had a significant influence and western white pine (<u>Pinus monticola</u>) is seldom a dominant.

Grand fir/queencop beadlily (<u>Clintonia uniflora</u>) and grand fir/bear grass (<u>Xerophyllum tenax</u>) are the two habitat types of the grand fir climax series.

The western red cedar climax series occurs on all aspects and slopes at elevations of 1,500 to 5,500 feet, but is best developed on toeslopes and bottomlands. On the upper elevation and cooler gradient, western red cedar is bordered by the western hemlock climax series. Western hemlock is common in western red cedar habitat types and on very wet sites is the climax codominant with western red cedar. Major seral tree species include Douglas fir, grand fir, western white pine and Engelmann spruce on colder, wetter sites and western larch on drier sites. Western red cedar/queencup beadlily is the most common habitat type of this series.

Western hemlock climax series can dominate all exposures and landforms in the elevation gradient from 2,500 to 5,500 feet. At the upper elevation limits, this series transcends to either the mountain hemlock or subalpine fir series. Most of the endemic trees are seral species with western hemlock habitat types. Western red cedar/queencup beadlilyis the most common habitat type in the extensive study area.

The subalpine fir climax series includes all forests potentially dominated at climax by subalpine fir, mountain hemlock, whitebark pine, or subalpine larch. At lower elevations, the subalpine fir series borders either western hemlock, western red cedar, or grand fir series. Alpine tundra and sometimes subalpine grasslands represent the upper elevation limit of the series.

Elevational subdivisions to the subalpine fir series are recognized. Lower elevation habitat types are generally warm enough to support Douglas fir, western larch, and western white pine occur up to elevations of 6,200 to 6,500 feet.

Upper elevation habitat types occur from about 6,500 to 7,200 feet. Subalpine fir is the dominant tree and whitebark pine is a persistent dominant seral tree on all but the moist sites.

Timberline habitat types occur in the transition zone between contiguous forest and alpine tundra at an elevation of 7,200 to 8,000 feet.

The extended study area has five habitat types in the lower subalpine habitat type grouping, one in the upper subalpine and two in the timberline. The lower subalpine includes: subalpine fir/queencup beadlily, subalpine fir/menziesia (Menziesia ferruginea), mountain hemlock/menziesia, subalpine fir/beargrass, and mountain hemlock/beargrass. Subalpine fir/smooth woodrush (Luzula hitchockii) occur in the upper subalpine and whitebark pine/subalpine fir and alpine larch/subalpine fir occur at timberline.

3.1.6 Land Use

Major land uses of the study area include timbering, mining, recreation, and agriculture. Timbering, the most observant of the land uses, began in this region in the late 1800's due to demands created by the railroad and mining industries (Kuennen and Gerhardt 1984). Timbering on the lower elevation of the study area began in the 1960's and continues to present. Mining is also a historic land use. Placer mining for gold occurred in several locatoins along Libby Creek in the late 1800's and resulted in the development of a few dwellings and ancillary facilities. Silver was mined at the Heidelberg Mine in the Rock Creek drainage in the 1950's. The principal recreation uses of the study area include hunting, fishing, hiking, backpacking, campingk, and cross-country skiing and snowmobiling in the winter. Livestock grazing is the only agricultural land use. Grazing occurs only at lower elevations and is quite limited.

3.2 SOIL FORMING FACTORS

3.2.1 Geology and Parent Materials

The soils of the project area formed in deposits composed primarily of Belt series rocks that were transported by alluvial, lacustrine, glacial and colluvial processes. The argillites and quartzites of the Belt series are generally resistant and exposures of these rocks occur throughout the project area. The aeolian materials containing volcanic ash mantle much of the project area and significantly influence soil genesis and classification. The ash is mainly from Mt. Mazama, but eruptions from other areas and times have probably contributed (Nimlos 1980). The differential deposition of volcanic ash, combined with redistribution by precipitation, results in soil profiles with variable depths of ash.

The water deposited materials include glaciofluvial, alluvial, and lacustrine sediments (Kuennen and Gerhardt 1984). The glaciofluvial and alluvial deposits are difficult to differentiate since they are composed of similar materials and were deposited by similar processes.

These alluvial deposits are well-sorted, coarse to medium textured and contain significant quantities of coarse fragments. The lacustrine deposits are medium to fine textured and contain little or no coarse fragments. These soils are weakly to moderately developed.

Alpine glaciation in the study area occurred in the higher elevations and valleys of the Cabinet Mountains. The soils that formed in these deposits exhibited only minimal weathering and development. They are medium textured and contain large amounts of angular coarse fragments. Evidence of continental glaciation was restricted to the lower elevations and was found in the Poorman and Cherry Creek tailings areas. The soils formed on these deposits are extensively weathered, as evidenced by the translocation of clay, development of strong soil structure and thick weathering rinds on coarse fragments. These soils are fine textured and vary widely in coarse fragment contents.

Slope or gravitational processes operate throughout the project area, but were most obvious in the high elevation sites. Soil creep and snow avalanche are dominate processes operating in the plant site areas. The soils formed in conjunction with these processes are medium textured and weakly developed with a high proportion of coarse fragments.

3.2.2 Physiography

The land surface of the project area has been largely shaped by fluvial and glacial processes acting within the structural constraints of the bedrock (Kuennen and Gerhardt 1984). The alluvial processes have resulted in the nearly level to gently sloping flood plains and alluvial terraces and associated steeper sloped terrace escarpments. Fluvial systems were also responsible for modifying landforms originally resulting from other geomorphic processes.

The evidence of past glaciation is obvious in the alpine features of the upper drainages and along the crest of the Cabinet Mountains. Landforms in the higher elevation project sites include strongly sloping to very steep marginal and recessional moraines and gently sloping valley bottoms. The sideslope deposits are commonly dissected by vertical drainages. The valley bottoms are dissected by streams with associated flood plains, small terraces and ravines. Conical, debris fans associated with snow avalanche chutes occur in the lower slope positions.

Portions of the lower elevation tailings areas retain evidence of continental glaciation. The area consists mainly of structurally controlled hills and ridges with a veneer of glacial drift. The slopes are moderately to very steep, convex and slightly dissected. A transition zone exists between the toeslopes and the alluvial and lacustrine terraces where the glacial drift has a hummocky topography suggestive of a water-reworked glacial plain with a poorly integrated drainage network.

3.2.3 Time

The soils in the project area vary in age as evidenced by their various degrees of development. The youngest soils are associated with recent fluvial and colluvial activity. They have subsurface horizons with little or no development and surface horizons which have accumulated various amounts of organic matter. These soils may or may not be mantled by volcanic ash-influenced materials. They range in age from less than a hundred to several thousand years old. The Orthents, Fluvents, Umbrepts and some Ochrepts are included with the younger soils.

Intermediate aged soils have horizons which exhibit alteration of the parent material through soil forming processes. Alteration may include the accumulation, loss or translocation of soil constituents and the development of soil structure. Most of the intermediate aged soils have surface horizons affected by volcanic ash. Weathering in the ash layer accounts for most of the perceivable development in these soils, since the Belt rock parent materials are so resistant to weathering. These soils range in age from at least 6600 years old (Nimlos 1980) to early Wisconsin age. The Mt. Mazama eruptions and the retreat of the glaciers associated with the last ice age bracket the formative period for these soils. Most of the Ochrepts and Aquepts and some of the Umbrepts are included with this group of soils.

The oldest recognizable soils in the intensive study areas occur in the Poorman and Cherry Creek tailings areas, where the soils have thick subsurface horizons in which silicate clays have accumulated through the process of illuviation. In addition, they have developed strong soil structure and distinct horizon boundaries and contain coarse fragments with substantial weathering rinds. These attributes are indicative of soils which have been forming over a relatively long period of time. The specific age of these soils is problematic, but they are likely related to one of the pre-Wisconsin glacial advances which have occurred in the Pleistocene over the last 2 million years. The surface horizons of these soils are related to the much younger Mazama ash fall.

3.2.4 Climate

The climate of the study area is described in section 3.1.4 above. The soil moisture regime of well drained soils in the project area is assumed to be udic. Aquic soil moisture regimes occur in soils with inadequate drainage. The lower elevation soils have frigid soil temperature regimes, whereas the higher elevation soils and those in cold air drainages are assumed to be cryic. The mean annual temperatures of the surrounding valley stations is near 45^{O}F (Kuennen and Gerhardt 1984). The frost free period is around 30 to 50 days (Montagne et al 1982).

3.2.5 Biologic Influences

The dominant vegetation in the project area is coniferous forest. Shrubfields occur in areas of repeated disturbance, such as avalanche chutes. Small areas of hydric vegetation dominated by sedges, rushes and shrubs occur in bogs.

The forest vegetation with closed canopies and sparse understories has resulted in soils which lack or have only thin A horizons (Ochrepts and Boralfs). Umbrepts, soils with thick dark colored surface horizons, occur in areas with grass and shrub vegetation and where materials from upslope have accumulated. Burrowing and grazing animals and soil insects and micro-organisms also affect soil formation, but their influence is difficult to gauge.

3.3 DESCRIPTION OF EXTENSIVE STUDY AREA

Kuennen and Gerhardt (1984) mapped three classes of landtypes in the extensive study area, including water influenced (100 series), alpine (400 series) and continentally glaciated landforms (300 series). The largest portion of the area was mapped as alpine glaciated landforms. The continentally glaciated landforms were the next most abundant map units and the water influenced landforms occupied a minor extent of the area. Table 1 is a list of the map units found in the extensive study area and along the transmission line corridors. This table also contains a number of important characteristics describing the landtype map units. Figure 7 is a map of the extensive study area and shows the extent and distribution of the map units. For more detailed information the reader is referred to the Land Systems Inventory report (Kuennen and Gerhardt 1984).

Table 1. Map Unit Descriptions for Extensive Study Areas and Transmission Line Corridors Montana Project (Adapted from Kuennen and Gerhardt 1984).

Map Unit Symbol	Map Unit Name	Physiography	Slope % Elev ft	Parent Material	Soil Components Classification	Family	Rock Outcrop %
101	Fluvents, flood plains	Alluvial lands	0-10 1800-4200	Alluvial Deposits	Fluvents	NA	0
102	Andic Dystrochrepts, lacustrine substratum	Lacustrine Terraces	0-15 2000-3000	Glacial Lake Deposits	Andic Dystrochrepts	fine-silty, mixed, frigid	0
103	Andic Dystrochrepts, alluvial terraces	Alluvial Terraces	0-15 200-3500	Glacial Lake Deposits	Andic Dystrochrepts	loamy-skeletal, mixed, frigid	0
104	Andic Dystrochrepts-Andaquic Haplumbrepts somewhat poorly drained complex, glacial till substratum	Knolls and Sinkholes	5-35 220-4200	Glacial Drift Precambrian Belt Group	Andic Dystrochrepts Andaquic Haplumbrepts	loamy-skeletal, mixed, frigid fine-silty, mixed frigid	5
105	Fluventic Umbric Dystrochrepts, wet meadows	Alluvial Lands	0-10 2000-4500	Alluvial Deposits	Fluventic Umbric Dystrochrepts	loamy-skeletal, mixed, frigid	0
106	Andic Dystrochrepts, glacial outwash substratum	Outwash Terraces	0-15 2000-4000	Outwash Deposits	Andic Dystrochrepts	sandy-skeletal, mixed, frigid	0
108	Andic Dystrochrepts and Typic Dystrochrepts, lacustrine and alluvial substratum	Lacustrine and Alluvial Terraces	0-15 2200-3700	Glacial Lake and Alluvial Deposits	Andic Dystrochrepts Typic Dystrochrepts	fine-silty, mixed, frigid fine-silty, mixed, frigid	0

7.1 APPENDIX A

APPROVED SCOPE OF WORK

Section 8

SOILS

A detailed plan of study for a soils baseline inventory is presented in the following sections. The plan represents present understanding of state and federal requirements for mine development. Specifically, the plan is based upon the National Environmental Policy Act (NEPA), Montana Environmental Policy Act (MEPA), Montana Metal Mine Reclamation Act (MMMRA), guidelines to these acts, interactions with Kootenai National Forest and Montana Department of State Lands (MDSL), and MDSL guidelines for metal mines.

The purpose of the soil investigation is to evaluate available soil information for the alternative development areas and to provide a detailed soil inventory for affected areas. The soil information will be used by U.S. Borax in site selection, reclamation planning, environmental impact assessment, and to prepare a mine permit application for the Forest Service and MDSL.

8.1 GENERAL SOIL INFORMATION

The U.S. Forest Service Land System Inventory of the Kootenai National Forest Area (Kuennen and Gerhardt 1984) at a scale of 1:63380 will be the principal source of general soil information for the study area. The report describes the vegetation and physiography of land-type map units and the types of soils that occur in the units. Detailed descriptions, analytical data, and classifications are provided for typical pedons.

The Land System Inventory will be used for site location studies. A detailed soils inventory is proposed for all areas to be disturbed. The mapping and data in the Land System Inventory will be compiled in a format suitable for evaluating the reclamation suitability, soil stability, and susceptibility to impacts from development.

8.2 DETAILED SOIL INVENTORY

Major tasks of the proposed detailed soils inventory are discussed below.

8.2.1 Task 1 - Agency Meetings

The soils specialist will meet with the soil scientists from the USFS Kootenai National Forest and from the Montana Department of State Lands prior to beginning field work. The purpose of the meeting will be to confirm the details of the soil inventory to be conducted, to be sure that the soil scientists' concerns will be adequately addressed by the study, and to take advantage of the agency specialists' knowledge of the soil characteristics in this area.

8.2.2 Task 2 - Mapping

A detailed soil inventory of affected areas will be conducted in accordance with the National Cooperative Soil Survey as described in the National Soils Handbook (USDA 1983), The Soil Survey Manual (USDA 1951), and Soil Taxonomy (USDA 1973). The USFS land type inventory will serve as the basis for the detailed inventory. Mapping of affected areas will be conducted on topographic base maps or air photo enlargements at a scale of between 1:4800 to 1:6000. Stereo aeral photographs at a smaller scale may also be provided.

Map units will consist primarily of consociations and their surface phases with some complexes and miscellaneous land types. Mapping will be at the family level with surface phases. To a certain extent, map units will be designed with the ultimate objective of topsoil salvage in mind. For example, slope classes will be divided at a slope angle where salvage becomes impractical.

The soil inventory is to approximate an Order 1 soil survey. The minimum size delineation for soils that are highly contrasting (for the purposes of this inventory) will be about two acres. Easily defined bodies of highly contrasting soils less than two acres should also be delineated; spot symbols can be used wherever practical. The minimum size delineation for similar soils is five acres. Soils that are on slopes that are too steep or too rocky to salvage need not be separated with this degree of precision. Steep slopes that are not practical to separate into consociations can be mapped as complexes or associations but each component must be carefully described, sampled, and evaluated as described below.

8.2.3 Task 3 - Sampling

Each major component of each map unit should be described and sampled in at least at one location in the field. Major components are dissimilar soils that comprise more than 15% of a map unit or similar soils that comprise more than 25% of a map unit. Very shallow soils (<6 inches), rocky soils (cobbles, stones, and boulders exceeding 50%), or steep slopes (slopes >50%) need not be sampled but must be described.

Detailed pedon descriptions and samples should be collected in backhoe pits excavated to 5 feet or to unsuitable material. Hand-dug pits to 40" or unsuitable material can be used in inaccessible areas. Suitable material between 40 to 60 inches should be sampled with an auger if possible. Pedon locations would be plotted on the maps.

Pedon site characteristics such as location, parent material, physiography, relief, elevation, slope, aspect, drainage, depth to groundwater, and current use and soil characteristics such as soil moisture, temperature, runoff, hydraulic conductivity, and water erosion class should be noted. The detailed profile descriptions should include horizon, depth, color, mottles, texture, structure, consistence, reaction, boundary, roots, clay films, and percent gravels, cobbles, stones, and boulders. A SCS form 232 or similar form would be appropriate for this study.

Each genetic horizon of each suitable soil should be sampled except that subsoil horizons less than 3" thick can be sampled with similar adjacent horizons. Each sample material should be collected so that a split can be made by the lab (at least 1000 g, more in stony soils).

8.2.4 Task 4 - Lab Analysis

Soils should be analyzed for the following parameters at a minimum: pH; organic matter; particle size class; texture (including sands coarser than vfs, vfs, silt, clay); saturation percent; salinity; and percent coarse fragments.

The method of analysis should be according to standard methods for establishing topsoil suitability for mine reclamation. The laboratory methods should be referenced and explained in soils report.

8.2.5 Task 5 - Interpretations

The major interpretations for this inventory are for reclamation and environmental impact assessment. Each horizon of soil should be rated suitable or unsuitable as a source of topsoil salvage material according to criteria that are standard in the industry for mine reclamation. Soil suitability should be incorporated into a table with map unit information so that volumes of soil material available for reclamation from each map unit can be calculated. The table should describe percent composition of each map unit, depth of each component, salvage depth for each component, and limiting factors (where salvage depth is less than soil depth).

The hydrologic characteristics of the soils are of critical concern in this project area due to high precipitation and flood events. The soil scientist should coordinate with the project surface water hydrologist to provide as much useful soil information as possible. At a minimum, soil drainage, water retention differences, runoff, and hydraulic conductivity should be estimated for the described pedons according to Chapter 4.0 of the draft Soil Survey Manual

(USDA SCS 1981) and hydrologic soil groups should also be provided.

The erodibility (K factors) should be calculated for each horizon of each soil and erodibility could be considered as part of suitability for salvage. The erodibility of each map unit should be evaluated using the modified USLE (EPA 1980) and each unit should be rated low, moderate, and high erosion potential for the purposes of environmental impact assessment.

Soil stability is also a concern in this project. Some factors that affect soil stability are slope, parent materials, physiography, soil horizon, and ground water tables. The presence of land forms indicative of soil instability should be noted and mapped if possible. The soil scientist should develop a set of criteria for evaluating soil stability in this study area and each map unit should be rated low, moderate, and high potential for soil slumping hazard.

The suitability of the soils for roads and facilities should be rated according to USFS criteria (USDA USFS 1974) or other criteria if appropriate. Engineering classification of the soils of the site should be estimated in the field, estimated based on lab textures, or taken from SCS soil interpretation records for the series (if available).

8.3 REPORT

The soil baseline report should contain the following information: a section on the purpose of the survey; a description of the persons contacted in the agencies and their input into the study; a methods section that contains a description of sources of information; field, laboratory, and interpretation methods; a discussion of pertinent soil forming factors in this inventory; and a section on conclusions.

The soil inventory will contain a description of soil map units, soil series, soil classification, analytical data, detailed profile descriptions, suitability criteria, and depth of suitable soils by soil type. A table that describes each map unit for calculation of the volumes of soil material available for reclamation will be prepared. Any soil inventory information that can be tabulated (such as map unit descriptions, series descriptions) to minimize verbiage will be acceptable.

An impacts and mitigation section will identify and quantify all potential impacts to soil resources. Mitigation alternatives for impacts will be presented and discussed.

REFERENCES

Kuennen, D. and N. Gerhardt. 1984. Land system inventory of the Kootenai National Forest Area. USFS.

Soil Survey Staff. 1951. Soil survey manual. USDA Agriculture Handbook No. 18.

Soil Survey Staff. 1975. Soil taxonomy - a basic system of soil classification for making and interpreting soil surveys. USDA Agriculture Handbook No. 436.

United States Department of Agriculture (USDA), U.S. Forest Service. 1974. Guidelines for making soil interpretations. Branch of Soils, Division of Watershed Management, Rocky Mountain Region.

United States Department of Agriculture (USDA). Soil survey manual, Chapter 4, examination and description of soils in the field. Manuscript (430-V-SSM, May 1981).

United States Department of Agriculture (USDA), Soil Conservation Service. National soils handbook (430-VI-NSH, July 1983).

United States Department of Agriculture (USDA), U.S. Forest Service (USFS). 1980. An approach to water resources evaluation: non-point sources silvaculture (WRENS). USFS-EPA amended interagency agreement EPA-IAG-D6-0660. GPO, Washington, D.C.

WESTERN RESOURCE DEVELOPMENT CORP.
P.O. Box 467
711 Walnut Street
Boulder, Colorado 80306
(303) 449-9009

August 15, 1988

Mr. Kenneth M. Reim
Manager, Mining Development
U.S. Borax
3075 Wilshire Boulevard
Los Angeles, CA 90010-1294

Re: Plans of Study

Dear Ken:

We have reviewed the Plans of Study Section 5 (Wildlife and Aquatic Biology), Section 6 (Vegetation), and Section 8 (Soils) as provided in your letter of July 11, 1988. Since development of the Plans of Study numerous changes have occurred. The U.S. Forest Service and the Montana Department of Fish, Wildlife, and Parks have modified details of the wildlife and aquatic biology. Field conditions of the area have resulted in minor changes to all Plans of Study.

These changes have been incorporated into the Plans of Study and they have been retyped. The enclosed document now represents what the agencies would like implemented.

Please call if you have questions.

Sincerely,

David

David L. Johnson
Ecologist

DLJ:ei
Enclosures

cc:
Gary Fletcher

FLETCHER
ASSOCIATES

17740 East Hinsdale Avenue
Aurora, Colorado 80016
(303) 693-2516

November 15, 1988

Jim Rathbun
Forest Supervisor
Kootenai National Forest
506 U.S. Highway 2 West
Libby, MT 59923

Kit Walther, Chief
Hard Rock Bureau
Montana Dept. of State Lands
1625 Eleventh Avenue
Helena, MT 59620

Re: Montana Mining Venture

Gentlemen:

Enclosed are the modified sections of the Plan of Study for:
1. Section 5 - Wildlife and Aquatic Biology
2. Statement of Work - Fisheries, Section 5.1.1
3. Section 6 - Vegetation

The Wildlife, Aquatic Biology, and Fisheries sections were prepared, modified, and completed in the field after consultations with the following agency personnel:
1. U.S. Forest Service - Al Bratkovich, Doug Perkinson
2. Water Quality Bureau - Gary Ingman
3. Fish, Wildlife & Parks - Terry Hightower, Joe Huston, Jim Vashro

Also enclosed are the "marked up" sections of Wildlife, Aquatic Biology, and Vegetation, enabling you to see the changes, as well as have clean copies of the finals.

Briefly, the changes were:
1. completed fish study
2. increased number of reaches and techniques for aquatic biology, and
3. reduction of area for birds and small mammals.

If you have any questions, please contact me.

Sincerely,

Gary J. Fletcher
GJF:af
Enclosures
cc: Joe Scheuering (w/o enclosures)
Brent Bailey (w/o enclosures)

United States Department of Agriculture

Forest Service

Kootenai NF

506 US Highway 2 West
Libby, MT 59923

Reply to: 2810

Date: January 9, 1989

Joe Scheuering
Noranda Minerals Corp.
P.O. Box 7176
Reno, NV 89510

Re: Plan of Study (POS) - Wildlife, Vegetation and Soils

Dear Joe,

Per letter of November 15 from Gary Fletcher, the agencies accept your proposed modifications/additions to the following sections:

a. Section 5, Wildlife and Aquatic Biology,
b. Section 6, Vegetation,
c. Section 8, Soils.

The agencies request that the proposed modifications be reflected as an addendum to the POS. The addendum should be revised Sections 5, 6 and 8 with appropriate signature page and cover.

If you have any questions, please contact either Kit or me.

Sincerely,

Ron Erickson

Ron Erickson
FS Project Coordinator

cc: Kit Walther, DSL
Brent Bailey
Gary Fletcher

7.2 APPENDIX B

LABORATORY METHODS

7.2 APPENDIX B. SOURCES OF METHODS FOR DETERMINING SOIL PHYSICAL AND CHEMICAL PROPERTIES

Parameter	Source
Saturated Paste pH	ASA # 9-2, section 12-2
Electrical Conductivity of Saturation Extract (EC)	ASA # 9-2, section 10-3
Organic Matter (OM)	ASA # 9-2, section 29-4
Particle Size Analysis	ASA # 9-1, section 43.5
1500 Kpa Water Content	ASA # 9-1, section 8-2

ASA # 9-1 Black et al, (ed.) 1965. Methods of Soil Analyses. Part I. Agronomy 5. American Society of Agronomy, Madison, WI..

ASA # 9-2 Page et al, (ed.) 1982. Methods of Soil Analysis. Part 2. Second Edition. Agronomy 5. American Society of Agronomy, Madison, WI.

7.3 APPENDIX C

INTERPRETATION METHODS

7.3 APPENDIX C. SOURCES OF METHODS FOR MAKING INTERPRETATIONS

Interpretation	Source
Soil Erodibility/Water	Universal Soil Loss Equation KLS factors multiplied by 100 to remove decimal numbers. Agric. Handbook No. 537.
K Factors	Agricultural Handbook No. 537
Hydrologic Groups	NSHB Part 603.02-2(f)
Available Water Holding Capacity	USDA-FS, R3, Soil Manual, Section 2550-13, 1980.
Hydraulic Conductivity	NSHB Part 603.02-1(h)
Permeability Class	NSHB Part 603.02-1(h)
Shrink/Swell Potential	NSHB Part 603.02-1(l)
Topsoil Suitability	USDA-FS Methods for Making Soil Interpretations
Slope Stability	Ryder and Howes (1982)

National Soil Handbook (Soil Conservation Service, 1983). National Soil Handbook, USGPO, Washington, D.C.

Agric. Handbook # 537 (Wischmeier and Smith, 1978. Predicting rainfall erosion losses. A guide to conservation planning. USDA SCS Ag. Handbk. 537. USGPO, Washington, D.C..

Soil Survey Manual (Soil Survey Staff, 1981. Soil Survey Manual. USDA Agricultural Handbook 18. USGPO, Washington, D.C.

USDA-FS (Soil Staff. Soil Manual. Region 3. 1980).

USDA-FS (Rocky MOuntain Tegion, Methods for Making Soil Interpretations. 1974)

TOPSOIL SUITABILITY

The following groups of ratings are indicators of the suitability of the soils for salvage and use as a reclamation material. The rating is based on soil chemical and physical properties and characteristics of the landscape.

Topsoil Suitability

Parameter	Unsuitable	Suitable	
	Low	Moderate	High
1. Texture	S, LS, SiC SCL (<18% & >40% clay)	CL, SiCL (27-40% clay)	L, SiL, SL, SCL (18-27% clay)
2. Hydraulic Conductivity	low	very high	moderate & high
3. AWHC (in/in)	<0.09	0.09-0.15	>0.15
4. Coarse fragment content (volume)	>50%	35-50%	<35%
5. Soil pH	<4.4	4.4-5.4	>5.4
6. Slope steepness	>50%	15-50%	<15%

This table has been adapted based on professional experience from USDA Forest Service, Methods for Making Soil Interpretations, 1974.

7.4 APPENDIX D

ADDITIONAL LABORATORY DATA

APPENDIX D. Soil Chemical and Physical Properties, Intensive Study Areas Montana Project

Soil Name depth	pH	EC[1] (mmhos/cm)	O. M.[2] (%)	Particle Size Analysis Sand	Silt (%)	Clay	VFS	Texture Class	> 2mm Gravel (%)	Sat[3] (%)	15 bar (%) H_2O
Andic Dystrochrepts #714-1											
0-4"	5.0	0.2	3.2	28	58	14	9	SiL	16	69.7	NA
4-15	5.5	0.1	1.8	33	57	10	12	SiL	19	63.3	
15-20	4.8	0.1	0.7	28	52	20	10	SiL	44	35.1	
20-29	4.9	0.1	0.2	45	45	10	16	L	46	21.5	
29-55	4.7	0.1	0.2	27	57	16	10	SiL	30	28.6	
Typic Glosssoboralfs #714-3											
0-6"	5.2	0.1	5.3	19	55	26	6	SiL	15	84.5	ND
8-13	5.0	0.2	0.8	26	56	18	1	SiL	41	31.9	
13-23	5.2	0.1	0.2	34	54	12	10	SiL	38	25.3	
23-39	4.9	0.1	0.3	25	53	22	10	SiL	28	34.2	
39-52	5.2	0.1	0.2	29	49	22	10	L	47	40.8	
Typic Paleboralfs #714-4											
0-5"	5.9	0.1	1.4	30	54	16	9	SiL	14	53.6	ND
5-29	4.7	0.1	0.2	19	61	20	8	SiL	14	23.5	
29-50	7.4	0.4	0.2	19	55	27	10	SiL/SiCL	40	34.2	
50-71	7.5	0.3	0.2	19	56	25	2	SiL	9	34.2	
Typic Glossoboralfs #714-5											
0-9"	5.8	0.1	2.2	29	58	13	10	SiL	31	60.9	13.7
9-19	5.9	0.1	0.4	29	52	19	3	SiL	59	26.4	
19-46	5.9	0.3	0.3	27	35	36	6	CL	54	34.1	

[1] Electrical Conductivity. [2] Organic Matter. [3] Saturation Percent.

APPENDIX D. Soil Chemical and Physical Properties, Intensive Study Areas. Montana Project

Soil Name depth	pH	EC[1] (mmhos/cm)	O. M.[2] (%)	Particle Size Analysis Sand	Silt (%)	Clay	VFS	Texture Class	> 2mm Gravel (%)	Sat[3] (%)	15 bar (%) H_2O
Typic Dystrochrepts #715-11											
0-4"	6.4	0.4	5.6	8	52	40	2	SiC/SiCL	1	58.1	ND
4-12	6.5	0.3	2.1	30	46	24	10	L	7	36.0	
12-21	6.4	0.2	1.1	43	41	16	10	L	4	32.5	
21-29	6.4	0.2	0.2	79	12	10	5	SL	2	26.5	
Typic Udifluvents #719-22											
1-6"	5.2	0.1	1.2	59	33	8	3	SL	56	29.8	3.6
6-40	5.6	0.1	0.9	76	18	6	4	LS/SL	76	26.0	
Andic Cryochrepts #720-L1											
0-13"	5.1	0.1	5.6	21	65	14	8	SiL	21	86.1	21.0
13-54	5.3	0.1	1.4	53	35	12	4	SL	66	32.5	
Andic Cryochrepts #720-L2											
0-12"	4.9	0.2	17.3	28	56	16	5	SiL	35	130.9	26.0
12-27	5.1	0.1	21.6	23	59	18	6	SiL	35	103.6	
27-51	5.5	0.1	5.1	21	74	5	14	SiL	<1	100.0	
51-60	5.2	0.1	2.9	24	55	21	8	SiL	31	57.2	
Typic Cryochrepts #720-R1											
0-9"	5.0	0.1	3.3	27	56	17	4	SiL	39	55.4	8.5
9-29	5.3	0.1	2.6	40	13	17	5	L	69	41.1	
40-56	5.6	0.1	1.8	39	46	15	2	L	45	54.7	

1 Electrical Conductivity. 2 Organic Matter. 3 Saturation Percent.

APPENDIX D. Soil Chemical and Physical Properties, Intensive Study Areas. Montana Project

Soil Name depth	pH	EC[1] (mmhos/cm)	O. M.[2] (%)	Particle Size Analysis Sand	Silt (%)	Clay	VFS	Texture Class	> 2mm Gravel (%)	Sat[3] (%)	15 bar (%) H_2O
Typic Cryumbrepts #929-L6											
0-18"	5.1	0.2	17.2	33	52	15	<1	SiL	41	78.6	19.3
18-28	5.3	0.1	14.2	30	50	20	7	SiL	41	71.1	17.0

[1] Electrical Conductivity. [2] Organic Matter. [3] Saturation Percent.

7.5 APPENDIX E

ADDITIONAL SOIL PEDON DESCRIPTIONS

SOIL PROFILE DESCRIPTION

Soil type: Map Unit TgC	Job: Noranda	Legal Description:	By: JPW
Classification: clayey - skeletal mixed, Typic Glossoboralf		Date: 7-14-88	Site No: 714-3
Area/Location: Little Cherry Ck. tailings area	Elevation: 3500'	Runoff: medium	Surf. Rck. Cl.: 0
Climate: frigid/udic	Slope: 10%	Moisture: sl. moist to 55"	% Coarse Frag: 37%
Vegetation: cedar/nev bck	Aspect: E	Groundwater: <5 feet	% Clay*: 3%
Parent material: ash over till	Relief: planar	Hydr. cond.: low	% Coarser than V.F.S.*: 20%
Physiography: disected till plain	Salt or Alkali: none	Erosion type: sheet	Control Section: 23-43:
Current Use: woodland	Drainage: mod. well	Water Erosion Class: 0	Temp.: ND
		Wind Erosion Class: 0	

Additional Comments: In clear cut area, disturbed surface; 0 horizon intermittent

0-8 ash

8-13 ashy

13-23 --

23-39 Tongues of overlying E horizon extend into this horizon and into underlying horizons; soft weathered gravels, mottles are 7.5 YR 4/4.

39-52 Manganese concretions and staining on ped faces. Tongues of E horizon extend into this horizon; soft weathered gravels.

Horizon	Depth (in)	Color Dry	Color Moist	Mottles	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reaction	Boundary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD
Bw1	0-8		7.5YR 3/2	0	SiL	2m,sbk	so	vfr	so po	eo	cw	2mc	2f	0	2	0	0	0
Bw2	8-13		7.5YR 4/2	0	SiL	2msbk	so	vfr	--	eo	cs	2mc	1f	0	2	5	0	0
2E	13-23		10YR 5/3	1cd	GrSCL	2msbk	--	fr	ss ps	eo	ci	1m	1f	1n	15	5	0	0
2Bt1	23-39		10YR 6/2	3mcd	GrCL	2msbk	--	fr	s p	eo	b	0	1f	1n	30	5	2	0
2Bt2	39-52		7.5YR 4/4	3mcd	GrC	2mabk	--	fr	s p	eo	--	0	1f	3mk	30	5	2	0

SOIL PROFILE DESCRIPTION

Soil type: Map Unit TpC	Job: Noranda	Legal Description:	By: LM
Classification: Typic Paleboralf, fine, mixed		Date: 7-14-88	Site No: 714-4
Area/Location: tailings area	Elevation: 3420'	Runoff:	Surf. Rck. Cl.: <5
Climate: frigid/udic	Slope: 3%	Moisture:	% Coarse Frag: 10%
Vegetation: Cedar - Hemlock	Aspect: NW	Groundwater: >5 feet	% Clay*: 42%
Parent material: glacial till	Relief: undulating	Hydr. cond.:	% Coarser than V.F.S.*: %
Physiography: dissected plain	Salt or Alkali:	Erosion type:	Control Section:
Current Use: clear cut	Drainage: well	Water Erosion Class:	Temp.: ND
		Wind Erosion Class:	

Additional Comments: Possibly lacustrine material but some cobbles are observed. E tounges into Bt, some pockets of B material in E.

MnO_2 in the Bt.

29-50 and 50-71 subdivided for sampling.

Horizon	Depth (in)	Color Dry	Color Moist	Mottles	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reac-tion	Boun-dary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD
O	2-0	7.5YR 5/4	7.5YR 4/4	--	needles	--	--	--	--	--	--	--	--	--	<5	--	--	--
Bw	0-5	7.5YR 5/4	7.5YR 4/4	--	SiL loess	1vf,gr	so	vfr	ss ps	eo	as	2vf,f mc	--	0	<5	<5	--	--
2E	5-29	10YR 7/3	10YR 6/3	--	SiL SiCL (26-29%)	m	h	fr	ss ps	eo	aw	1vf,f m,c	--	0	5	<5	--	--
2Bt	29-71+	7.5YR 6/6	7.5YR 5/6	--	C(SiC) (42%)	--	vh	vf	sv pv	eo	--	1vf	--	2mk PF-PO	5-10	<5	--	--

SOIL PROFILE DESCRIPTION

Soil type: Map Unit TgD | Job: Noranda | Legal Description: | By: LM

Classification: Typic Glossoboralf, c-s, mixed | Date: 7-14-88 | Site No: 714-5

Area/Location: Poorman Cr. tailings area | Elevation: 3540' | Runoff: | Surf. Rck. Cl.:

Climate: frigid/udic | Slope: 31% | Moisture: | % Coarse Frag: 55%

Vegetation: clear cut- THPL-SHE | Aspect: E | Groundwater: <5 feet | % Clay*: 44%

Parent material: till loess | Relief: convex | Hydr. cond.: | % Coarser than V.F.S.*: %

Physiography: sideslope | Salt or Alkali: | Erosion type: | Control Section: 19-39"

Current Use: clear cut | Drainage: well | Water Erosion Class: | Temp.: ND

Wind Erosion Class:

Additional Comments: small amount of tounging in 2Bt, on nose of till ridge, between minor dissections, described in clearcut, used backhoe excavated roadcut for sampling.

Disturbed surface.

Alder, Buffalo berry, reseeding looks good on cutslopes.

Horizon	Depth (in)	Color		Mottles	Texture	Structure	Consistence			Reac-tion	Boun-dary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD	
		Dry	Moist				Dry	Moist	Wet										
Bw	0-9	7.5YR 6/4	7.5YR 4/4	--	SiL loess	1vf,gr	so	vfr	ss ps	eo	as	3vf	--	0	<5	--	--		
2E	9-19	10YR 6/4	10YR 5/4	--	L (SCL) 26-28	m	sh	fr	ss ps	eo	as	1vf,f,m		--	0 Gr	45	5	5	--
2Bt	19-46	7.5YR 6/6	7.5YR 5/6	--	C 44%	2sbk	h	fi	sv pv	eo	--	1vf,f m,c	--	2k po	45 Gr	5	5	--	

SOIL PROFILE DESCRIPTION

Soil type: Map Unit TgC	Job: Noranda	Legal Description:	By: JPW
Classification: clayey - skeletal, mixed, frigid Typic Glossoboralf		Date: 7-15-88	Site No: 715-9
Area/Location: Poorman tailings area	Elevation: 3500'	Runoff: --	Surf. Rck. Cl.: 0
Climate: Frigid/udic	Slope: 2%	Moisture: dry to 60"	% Coarse Frag: --%
Vegetation: Cedar	Aspect: E	Groundwater: >5 feet	% Clay*: 45%
Parent material: ash over till	Relief: convex	Hydr. cond.: low	% Coarser than V.F.S.*: 15%
Physiography: gently sloping upland	Salt or Alkali: none	Erosion type: sheet	Control Section: 28-48
Current Use: woodland	Drainage: well	Water Erosion Class: 0	Temp.: ND
		Wind Erosion 0	

Additional Comments: 0 horizon 2-0", partially decomposed conifer needles.

28-60" MnO2 coatings abundant on ped faces.

Horizon	Depth (in)	Color Dry	Color Moist	Mottles	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reaction	Boundary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD
A	0-1	10YR 3/2	--	0	SiL	2fgr	so	lo	so ps	eo	cw	2m	1f	0	0	0	0	0
Bw	1-10	7.5YR 5/6	--	0	SiL	1msbk	so	lo	ss ps	eo	cw	2fmc	1f	0	0	0	0	0
2E	10-28	10YR 8/3	--	0	grCL	m	h	fi	s p	eo	cw	1m	2fT	0	25	10	2	0
2Bt	28-60	10YR 5/6	--	0	GrvC	3mabk	vh	vfi	sv pv	eo	--	1c	0	3mk	30	10	5	0

SOIL PROFILE DESCRIPTION

Soil type:	Job: Noranda	Legal Description:	By: JPW
Classification: sandy-skeletal, mixed, frigid Typic Dystrocherept		Date: 7-15-88	Site No: 715-11
Area/Location: Poorman	Elevation: 3220'	Runoff:	Surf. Rck. Cl.: 0
Climate: frigid/udic	Slope: 2%	Moisture:	% Coarse Frag: 40%
Vegetation: Cedar	Aspect: N	Groundwater: >5 feet	% Clay*: 5%
Parent material: alluvium	Relief: planar	Hydr. cond.: high	% Coarser than V.F.S.*: 70%
Physiography: terrace Libby Creek	Salt or Alkali: none	Erosion type: sheet	Control Section: 10-40
Current Use: woodland	Drainage: somewhat poorly	Water Erosion Class: 0	Temp.: ND
		Wind Erosion Class: 0	

Additional Comments: 2-0" litter

0-4": mottles are 10YR 5/6

4-12": roots 3f, 1c; mottles are 7.5YR 4/4

12-21": mottles are 10YR 4/4

21-29": --

29-52": did not sample; unsuitable, excess gravels

Horizon	Depth (in)	Color Dry	Color Moist	Mottles	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reaction	Boundary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD
A	0-4	--	10YR 4/3	0	L	3cgr	--	fr	s p	eo	cw	3f	3fT	0	5f	0	0	0
Bw	4-12	--	10YR 4/4	1ff	CL	2csbk	--	vfr	ss ps	eo	gs	see above	3vfT	0	2f	0	0	0
C	12-21	--	10YR 4/4	2cd	fSL	m	--	vfr	so po	eo	cs	2f	2f	0	2f	0	0	0
2C	21-29	--	10YR 4/3	2ff	S	sg	lo	lo	so po	eo	cs	1f	1f	0	15f	0	0	0
3C	29-52	--	10YR 4/4	0	GrX S	sg	lo	lo	so po	eo	--	1f	3fv	0	60	10	5	0

SOIL PROFILE DESCRIPTION

Soil type: Map unit AdR - mod. deep component	Job: Noranda	Legal Description:	By: LM
Classification: loamy-skeletal, mixed, frigid Andic Dystrochrept		Date: 7-18-88	Site No: 718-13
Area/Location: Tailings area	Elevation: 3880'	Runoff:	Surf. Rck. Cl.:
Climate: frigid/udic	Slope: 25%	Moisture:	% Coarse Frag: 50%
Vegetation: TSHE-THPL	Aspect: NW	Groundwater:	% Clay*: 28%
Parent material: loess/colluvium	Relief: convex	Hydr. cond.:	% Coarser than V.F.S.*: %
Physiography: ridgetop	Salt or Alkali:	Erosion type:	Control Section:10-24"
Current Use:	Drainage: well	Water Erosion Class:	Temp.: ND
		Wind Erosion Class:	

Additional Comments: Road cut, thin O horizons observed, loess over fractured residual bedrock with some colluvium and subrounded transported material on surface. Soils range from <20" to about 10 deep over bedrock on this ridge. Rock is highly fractured.

Horizon	Depth (in)	Color Dry	Color Moist	Mottles	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reaction	Boundary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD
Bw	0-11	7.5YR 6/4	7.5YR 4/4	--	SiL loess	--	--	--	--	--	--	--	--	--	5	--	--	--
C1	11-24	10YR 6/4	10YR 4/4	--	CL (28%)	--	--	--	--	--	--	--	--	--	40	10	--	--
Cr/R	Fractured R		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

SOIL PROFILE DESCRIPTION

Soil type: Map Unit TgD	Job: Noranda	Legal Description:	By: LM
Classification: clayey-skeletal, mixed, Typic Glossoboralf		Date: 7-19-88	Site No: 719-16
Area/Location: tailings area	Elevation: 3600'	Runoff:	Surf. Rck. Cl.: 2
Climate: frigid/udic	Slope: 24%	Moisture:	% Coarse Frag: 40% gravels/cobbles
Vegetation: TSHE	Aspect: SE	Groundwater:	% Clay*: 37%
Parent material: loess/till	Relief: convex	Hydr. cond.:	% Coarser than V.F.S.*: %
Physiography: glaciated sideslope	Salt or Alkali:	Erosion type:	Control Section:
Current Use:	Drainage: well	Water Erosion Class:	Temp.: ND
		Wind Erosion Class:	

Additional Comments: Ceonthus, PUTR, PILO, PIMO, BERE, Epilobium

Road cut - backhoe pit, not sampled

some evidence of bedrock in the roadcut, but soils are mostly deep - >10-15' thick

Similar to other C-S soils described in terms of color/structure.

Bt is highly oxidized and brittle, MnO2 stains.

Horizon	Depth (in)	Color Dry	Color Moist	Mottles	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reac-tion	Boun-dary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD
O	1-0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E	0-1	--	--	--	SiL loess	--	--	--	--	--	--	--	--	--	<5	--	--	--
Bw	1-11	--	--	--	SiL loess	--	--	--	--	--	--	--	--	--	<5	--	--	--
2E/Bt	11-39	--	--	--	SiCL 37	--	--	--	--	--	--	--	--	--	40	5	--	--
2Bt	39-60+	--	--	--	SiL C 45	--	--	--	--	--	--	--	--	PF-B	40	5	--	--

SOIL PROFILE DESCRIPTION

Soil type: Map Unit TgC (inclusion)	Job: Noranda	Legal Description:	By: LM
Classification: loamy-skeletal, mixed, frigid Andic Dystrochrept		Date: 7-19-88	Site No: 719-17
Area/Location: tailings area	Elevation: 3500'	Runoff: slow	Surf. Rck. Cl.:
Climate: frigid/udic	Slope: 7% (range 3-15%	Moisture:	% Coarse Frag: 50%
Vegetation: TSHE	Aspect: NE	Groundwater: >5	% Clay*: 18%
Parent material: alluvium from Bear Creek	Relief: undulating	Hydr. cond.:	% Coarser than V.F.S.*: %
Physiography: alluvial terrace	Salt or Alkali:	Erosion type:	Control Section: 10-40"
Current Use:	Drainage: well	Water Erosion Class:	Temp.: ND
		Wind Erosion Class:	

Additional Comments: PICO, Alnus, ARUV, SYAL, sedges, SHCA PPMY, UAGL, TSHE

Bumpy topography, ridges and mounds with discontinuous drainages; material, recent alluvium from Bear Creek - note channel (old) below hillslope to the SW. This is an old terrace which has been dissected then covered with loess, gravels and cobbles are poorly sorted and unweathered. Weak cambic in this sandy material. Compacted below 43", no roots. Limited extent, inclusion in TgC.

Horizon	Depth (in)	Color Dry	Color Moist	Mottles	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reaction	Boundary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD
	1-0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	0-1	10YR 7/3	10YR 6/3	--	SiL loess	1gr	so	vfr	ss ps	eo	as	3mc	--	0	<5	--	--	--
	1-13	7.5YR 6/4	7.5YR 4/4	--	SiL loess	1sbk	so	vfr	ss ps	eo	aw	3mc	--	0	<5	--	--	--
	13-65	10YR 6/3	10YR 5/3	--	SL 18%	sg	lo	lo	ss ps	eo	--	1vf	--	0	50GR	5	5	--

SOIL PROFILE DESCRIPTION

Soil type: Map Unit AdR - mod. deep component Job: Noranda		Legal Description:	By: LPM
Classification: loamy-skeletal, mixed, frigid Andic Dystrochrept		Date: 7-19-88	Site No: 719-18
Area/Location: Tailings area	Elevation: 3760'	Runoff:	Surf. Rck. Cl.:
Climate: frigid/udic	Slope: 5%	Moisture:	% Coarse Frag: 55%
Vegetation: TSHE	Aspect: E	Groundwater:	% Clay*: 19%
Parent material: loess/till over bedrock	Relief: convex	Hydr. cond.:	% Coarser than V.F.S.*: %
Physiography: ridgetop	Salt or Alkali:	Erosion type:	Control Section: 10-22"
Current Use:	Drainage: well	Water Erosion Class:	Temp.: ND
		Wind Erosion Class:	

Additional Comments: THPL, PIMO, LAOC, PSME, PILO, no understory, Undisturbed area.

Cr is weathered bedrock, highly fractured and fairly soft - colored by Fe_2O_3

Rock structure is evident MaO_2 stains, easily excavated with backhoe to 52"

C1 contains water worked gravels - alluvium over R with a loess cap.

Not sampled - R was observed in roadcut.

Horizon	Depth (in)	Color Dry	Color Moist	Mottles	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reaction	Boundary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD
O	2-0																	
E	0-1	7.5YR 6/4	7.5YR 4/4	--	SiL loess	m	so	vfr	ss ps	eo	as	3mc	0	0	<5	--	--	--
Bw	1-13	7.5YR 6/4	7.5YR 4/4	--	SiL loess	1sbk	so	vfr	ss ps	eo	as	3mc	--	0	<5	--	--	--
2C1	13-22	10YR 7/2	10YR 6/2	--	SiL 19	m	--	--	--	--	--	--	--	--	45	10	--	--
2CR	22+	7.5YR 5/6	7.5YR 4/6	--	--	m	--	--	--	--	--	--	--	--	90+	90+	90+	90+

SOIL PROFILE DESCRIPTION

Soil type: Map Unit TgC	Job: Noranda	Legal Description:	By: LM
Classification: Typic Glossboralf, c-s, mixed.		Date: 7-19-88	Site No: 719-20
Area/Location: Tailings area	Elevation: 3600'	Runoff:	Surf. Rck. Cl.:
Climate: frigid/udic	Slope: 18%	Moisture:	% Coarse Frag: 45%
Vegetation: TSHE	Aspect: E	Groundwater:	% Clay*: 38%
Parent material: old till	Relief: convex	Hydr. cond.:	% Coarser than V.F.S.*: %
Physiography: sideslope	Salt or Alkali:	Erosion type:	Control Section: 34-54"
Current Use:	Drainage: well	Water Erosion Class:	Temp.: ND
		Wind Erosion Class:	

Additional Comments: TSHE, ABGR, LAOC, THPL, PICO, PIMO, LIPO, VAGL, XETE

Toungues, interfingering of E into Bt.

Horizon	Depth (in)	Color Dry	Color Moist	Mottles	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reaction	Boundary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD
O-2	2-0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bw	0-13	7.5YR 6/4	7.5YR 4/4	--	SiL loess	2sbk	so	vfr	ss ps	eo	aw	3vf,f m,c	--	0	<5	--	--	--
2E	13-34	10YR 7/3	10YR 6/3	--	CL SiCL	m	h	fi	s p	eo	ai	0	--	0	35	5	--	--
2Bt	34-60	7.5YR 6/6	7.5YR 5/6	--	C	3abk	h	fi	s p	eo	--	0	--	3k PF-PO	40	5	--	--

SOIL PROFILE DESCRIPTION

Soil type: Map Unit TgC	Job: Noranda	Legal Description:	By: LM
Classification: Typic Glossoboralf, c-s, mixed		Date: 7-19-88	Site No: 719-21
Area/Location: Tailings area	Elevation: 3620'	Runoff:	Surf. Rck. Cl.: 1
Climate: frigid/udic	Slope: 4%	Moisture:	% Coarse Frag: >35%
Vegetation: TSHE	Aspect: SE	Groundwater:	% Clay*: >35%
Parent material: old till	Relief: convex	Hydr. cond.:	% Coarser than V.F.S.*: %
Physiography: sideslope, till, plane	Salt or Alkali:	Erosion type:	Control Section:
Current Use:	Drainage: well	Water Erosion Class:	Temp.: ND
		Wind Erosion Class:	

Additional Comments: see pedon 719-20, essentially the same soil. Higher stone content and slightly thicker.

Bw 0-9;

2E 9-38 SiCL-CL

2Bt 38-53+ C

E horizon prominent interfingering of E in Bt;

Old till, PICO, THPL, XETE, VASG, LIBO, Aluns, PIMO, ABGR, TSHE, PAMY

Horizon	Depth (in)	Color		Mottles	Texture	Structure	Consistence			Reac-tion	Boun-dary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD
		Dry	Moist				Dry	Moist	Wet									

SOIL PROFILE DESCRIPTION

Soil type: Map Unit AdS (inclusions)	Job: Noranda	Legal Description:	By: LM
Classification: sandy-skeletal, mixed, frigid Typic Udifluent		Date: 7-19-88	Site No: 719-22
Area/Location:	Elevation: 3500'	Runoff:	Surf. Rck. Cl.:
Climate: frigid/udic	Slope: 1%	Moisture:	% Coarse Frag: 80%
Vegetation: TSHE	Aspect: N	Groundwater:	% Clay*: 5%
Parent material: recent alluvium	Relief: concave	Hydr. cond.:	% Coarser than V.F.S.*: %
Physiography: terrace	Salt or Alkali:	Erosion type:	Control Section: 10-40"
Current Use:	Drainage: well	Water Erosion Class:	Temp.: ND
		Wind Erosion Class:	

Additional Comments: THPL, ACER, UASC, PICO, PIMO, TSHE, LIBO, SMST, COCA, Disporum, mitella, SYAL.

Recent alluvium from Poorman Cr.

1-6" appears to be ash influenced sandy material, stratified.

Pit is where 278 crosses Poorman Cr. in the s. side of Cr. E of road.

No cambic in the surface Bw since too sandy.

Horizon	Depth (in)	Color Dry	Color Moist	Mottles	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reaction	Boundary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD
O	0-3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
A1	0-1	10YR 7/3	10YR 6/3	--	SL	m,sg	lo	lo	so po	eo	as	3m,c	3	0	15	--	--	--
A2/Bw	1-6	7.5YR 6/4	7.5YR 4/4	--	SL	m,sg	lo	lo	so po	eo	aw	3vf, m,c	3	0	15	--	--	--
C1	6-44	10YR 6/4	10YR 4/4	--	LoS 1%	sg	lo	lo	so po	eo	--	3vf	--	0	70	10	10	--

SOIL PROFILE DESCRIPTION

Soil type: Map unit AdA	Job: Noranda	Legal Description:	By: LM
Classification: Andic Dystrochrept, fine, mixed, frigid		Date: 7-20-88	Site No: 720-23
Area/Location:	Elevation: 3420'	Runoff: slow	Surf. Rck. Cl.:
Climate: frigid/udic	Slope: 1-2%	Moisture:	% Coarse Frag: <5%
Vegetation: TSHE	Aspect: E	Groundwater:	% Clay*: >35%
Parent material: lacustrine	Relief: planer	Hydr. cond.:	% Coarser than V.F.S.*: %
Physiography: lacustrine terrace	Salt or Alkali:	Erosion type:	Control Section:
Current Use:	Drainage: somewhat poorly	Water Erosion Class:	Temp.: ND
		Wind Erosion Class:	

Additional Comments: End of road in clearcut north of gravel pit. ravel pit has alluvial ravels 6-15 feet thick.

Pit is in forest adjacent to clearcut, ABR, TSHE, LADC, PIMO, SMST, BERE, LIBO, AMAL, COCA, ROSA sp.

Varves in the lacustrine material have distorted and destroyed some evidence near the bottom of the pit - roots follows cracking ped surfaces and occur litearily down the profile.

Horizon	Depth (in)	Color Dry	Color Moist	Mottles	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reaction	Boundary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD
O	2-0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
E	0-1	10YR 7/3	10YR 6/3	--	SiL loess	m	so	vfr	ss ps	eo	aw	2vf,f m,c	--	0	<5	--	--	--
Bw	1-9	7.5YR 6/4	7.5YR 4/4	--	SiL loess	1sbk	so	vfr	ss ps	eo	as	2m,c	--	0	<5	--	--	--
2Bw1	9-24	10YR 7/2	10YR 6/2	--	SiC	1sbk	h	fi	sv p	eo	gs	1f	--	0	<5	--	--	--
2Bw2	24-60+	7.5YR 6/6	7.5YR 5/6	--	SiC	1sbk	h	fi	sv p	eo	--	1f	--	0	<5	--	--	--

iron stains and weak mottles in the 2Bw

SOIL PROFILE DESCRIPTION

Soil type: Map Unit AcC	Job: Noranda	Legal Description:	By: LM
Classification: Andic Cryochrept, l-s, mixed, frigid		Date: 7-20-88	Site No: 720-L1
Area/Location: Libby Creek	Elevation: 4180'	Runoff:	Surf. Rck. Cl.:
Climate: cryic/udic	Slope: 11%	Moisture:	% Coarse Frag: 60%
Vegetation: ABLA/TSHE	Aspect: NE	Groundwater:	% Clay*: 18%
Parent material: loess/till/alluvium	Relief: concave	Hydr. cond.:	% Coarser than V.F.S.*: %
Physiography: toeslope	Salt or Alkali:	Erosion type:	Control Section: 10-40"
Current Use:	Drainage:	Water Erosion Class:	Temp.: ND
		Wind Erosion Class:	

Additional Comments: MEFE, cady fern, VAGL, miatella

Adjacent to debris abalanche deposit.

Horizon	Depth (in)	Color Dry	Color Moist	Mottles	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reaction	Boundary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD
O	1-0																	
Bw	0-13	7.5YR 6/8	7.5YR 5/8	--	SiL loess	1sbk	so	vfr	ss ps	eo	aw	3m	--	0	5	--	--	--
2C	13-54	10YR 6/6	10YR 5/6	--	1-VfSL 18-20	m	so	vfr	ss ps	eo	--	1f	--	0	35	10	10	5

SOIL PROFILE DESCRIPTION

Soil type: Map Unit CuB - (inclusion)	Job: Noranda	Legal Description:	By: LM
Classification: Typic Cryumbrept, fine-silty, mixed.		Date: 7-20-88	Site No: 720-L2
Area/Location: Libby Creek	Elevation: 4140'	Runoff:	Surf. Rck. Cl.:
Climate: cryic/udic	Slope: 1-2%	Moisture:	% Coarse Frag: %
Vegetation: ABLA - grass	Aspect: N	Groundwater:	% Clay*: %
Parent material: avalanche/fluvial	Relief: planer	Hydr. cond.:	% Coarser than V.F.S.*: %
Physiography: level terrace	Salt or Alkali:	Erosion type:	Control Section:
Current Use:	Drainage: well	Water Erosion Class:	Temp.: ND
		Wind Erosion Class:	

Additional Comments: *Texture in 27-51 varies, layers of VFSL, LS and finer, possible glacier fluvial or lake. A and Bw1 are related to avalanche chute across valley, boulder in the pit and scattered on surface of site, A is fairly uniform, but Bw is slightly stratified and mixed, charcoal stratifications in 27-51 are 2mm to 75mm thick.

Possible waste rock disposal area. Needs more investigation.

Horizon	Depth (in)	Color Dry	Color Moist	Mottles	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reac-tion	Boun-dary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD
A	0-12	10YR 5/3	10YR 3/3	--	L hi om	3vfgr	so	vfr	so po	eo	si	3f	--	0	15	10	--	--
Bw1	12-27	10YR 5/4	10YR 3/4	--	L	1sbk	so	vfr	ss ps	eo	as	2vf	--	0	15	10	--	--
2Bw2	27-51	7.5YR 7/6	7.5YR 6/6	--	SiL/ L/SL	m	so	vfr	--	eo	as	1vf	--	0	0	--	--	--
3Ab	51-60	10YR 6/4	10YR 4/4	--	L	m	--	--	--	eo	--	0	--	0	15	--	5	10

SOIL PROFILE DESCRIPTION

Soil type: Map unit AcC	Job: Noranda	Legal Description:	By: LM
Classification: Andic Cryochrept, l-s, mixed, frigid		Date: 7-21-88	Site No: 721-L5
Area/Location: Libby Creek	Elevation: 4200'	Runoff:	Surf. Rck. Cl.:
Climate: cryic/udic	Slope: 16%	Moisture:	% Coarse Frag: %
Vegetation: ABLA/TSHE	Aspect: S	Groundwater:	% Clay*: %
Parent material: colluvium	Relief: concave	Hydr. cond.:	% Coarser than V.F.S.*: %
Physiography: sideslope	Salt or Alkali:	Erosion type:	Control Section:
Current Use:	Drainage:	Water Erosion Class:	Temp.: ND
		Wind Erosion Class:	

Additional Comments: PAMY, PIEN, PSME, VAGL, CLUN, Erithronium, ACER, XETE

Quick pit - sideslope on N side of Libby Creek - backhoe

8" loess or loess influenced layer at surface

8-43" L-FESL with cobbles and stones at about 35% Gr. 15%, See pedon 721-L3

Horizon	Depth (in)	Color Dry	Color Moist	Mottles	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reac-tion	Boun-dary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD

SOIL PROFILE DESCRIPTION

Soil type: Map Unit AcC	Job: Noranda	Legal Description:	By: JPW
Classification: loamy-skeletal, mixed, Typic Cryumbrept		Date: 7-29-88	Site No: 929-L6
Area/Location: Upper Libby	Elevation: 4400	Runoff: rapid	Surf. Rck. Cl.: see below
Climate: udic/cryic	Slope: 22%	Moisture: sl. moist to 18"	% Coarse Frag: NA
Vegetation: ABLA/TSHE	Aspect: S	Groundwater: >5 feet	% Clay*: NA
Parent material: colluvium, loess influenced	Relief: concave	Hydr. cond.: moderate	% Coarser than V.F.S.*: NA
Physiography: toeslope	Salt or Alkali: none	Erosion type: --	Control Section: 10-40?
Current Use: woodland	Drainage: well	Water Erosion Class: 0	Temp.: ND
		Wind Erosion Class: 0	

Additional Comments: Surface rocks (stones and boulders) none in this area; other areas are rockier but this gently sloping colluvial fan is well vegetated and has no rocks.

O horizon litter and conifer needles

samples 9-29-04-00-18 and 9-29-04-18-28

Horizon	Depth (in)	Color Dry	Color Moist	Mottles	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reaction	Boundary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD
O	2-0	litter																
A	0-18	--	10YR 2/1	0	CbL	2mgr	--	vfr	ss ps	eo	c	2fm	2fT	0	10	20	5	--
C	18-28	--	10YR 2/2	0	CbL	1msbk	--	vfr	ss ps	eo	--	2m	--	0	20	20	5	--

SOIL PROFILE DESCRIPTION

Soil type: Map Unit AcC	Job: Noranda	Legal Description:	By: LM
Classification: Andic Cryochrept, l-s, mixed		Date: 7-20-88	Site No: 720-R1
Area/Location: Ramsey Creek	Elevation: 4240'	Runoff:	Surf. Rck. Cl.:
Climate: cryic/udic	Slope: 12%	Moisture:	% Coarse Frag: 60%
Vegetation: ABLA/TSHE	Aspect: SW	Groundwater:	% Clay*: 18%
Parent material: loess/steep wash	Relief: concave	Hydr. cond.:	% Coarser than V.F.S.*: %
Physiography: trough sideslope near toeslope of main valley wall	Salt or Alkali:	Erosion type:	Control Section: 10-40"
Current Use:	Drainage:	Water Erosion Class:	Temp.: ND
		Wind Erosion Class:	

Additional Comments: ABLA, TSHE, grasses, PICO, ALER, Epilobium, Alnus; poor reforest, max cover - 100% P

Colluvium slope wash; lots of mixing in the loess cap, also some areas with higher OM content; till, alluvium, slope wash, (minor dissections in c.c.) 2'X2' rills perpindicular to slope).

Backhoe pit about 10 feet off road.

Samples - no sample of the 29-40"

Horizon	Depth (in)	Color Dry	Color Moist	Mottles	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reaction	Boundary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD
O	1-0																	
Bw	0-9	7.5YR 6/4	7.5YR 4/4	--	SiL loess mixed	1sbk	so	vfr	ss ps	eo	aw	2vf,f m,c	--	0	10-15	--	--	--
2C1	9-29	10YR 6/4	10YR 4/4	--	L-SiL not loess	m	sh	fr	ss ps	eo	ai	2f	--	0	45	10	--	--
2C2	29-40	10YR 6/4	10YR 4/4	--	L-SiL	msg	lo	lo	ss ps	eo	aw	2f	--	0	55	10	--	--
2C3	40-56+	--	7.5YR 5/6	--	SiL/ SiCL?	m	sh	fr	ss ps	eo	--	1f	--	0	35	--	--	--

SOIL PROFILE DESCRIPTION

Soil type: Map Unit AcC (inclusion)	Job: Noranda	Legal Description:	By: LM
Classification: Typic Cryumbrept, l-s, mixed		Date: 7-20-88	Site No: 720-R2
Area/Location: Ramsey Creek	Elevation: 4420'	Runoff:	Surf. Rck. Cl.:
Climate: cryic/udic	Slope: 32%	Moisture:	% Coarse Frag: 60%
Vegetation: ABLA/TSHE	Aspect: SW	Groundwater:	% Clay*: 19%
Parent material: colluvium (till?)	Relief: concave	Hydr. cond.:	% Coarser than V.F.S.*: %
Physiography: sideslope/swale/dissection	Salt or Alkali:	Erosion type:	Control Section: 10-40"
Current Use:	Drainage: well	Water Erosion Class:	Temp.: ND
		Wind Erosion Class:	

Additional Comments: grasses, ACER, EPAN, Alnus

Inclusion within Andic Cryochrepts.

Some boulders in the main Dystrochrept unit; Libby Creek running on bedrock at the bridge (slopes up to 35%) No terraces (major) on creek.

Horizon	Depth (in)	Color Dry	Color Moist	Mottles	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reac-tion	Boun-dary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD
A	0-12	10YR 5/3	10YR 3/3	--	L	1sbk	so	vfr	ss ps	eo	aw	3vf	--	0	20	15	--	--
Bw	12-23	10YR 7/4	10YR 5/4	--	L	1sbk	so	vfr	ss ps	eo	gs	2vf	--	0	25	15	5	--
C	23-60	10YR 7/4	10YR 5/4	--	L/SL 19%	m	--	--	--	eo	--	1vf	--	0	35	15	10	--

SOIL PROFILE DESCRIPTION

Soil type: Map Unit AcC	Job: Noranda	Legal Description:	By: LM
Classification: Andic Cryochrept, l-s, mixed		Date: 7-20-88	Site No: 720-R6
Area/Location: Ramsey Ck.	Elevation: 4480'	Runoff:	Surf. Rck. Cl.:
Climate: cryic/udic	Slope: 18% (15-25%)	Moisture:	% Coarse Frag: 60%
Vegetation: ABLA/TSHE	Aspect: SE	Groundwater:	% Clay*: 19%
Parent material: loess/till	Relief: concave	Hydr. cond.:	% Coarser than V.F.S.*: %
Physiography: glaciated sideslope	Salt or Alkali:	Erosion type:	Control Section: 10-40"
Current Use:	Drainage: well	Water Erosion Class:	Temp.: ND
		Wind Erosion Class:	

Additional Comments: Clearcut, XETE, Amal, EPAN, Alnus, VAGL, Sanbucus, PSME, LAOU, Lonicera, PAMY

Weakly dissected sideslope. See pedon 720-4

Horizon	Depth (in)	Color Dry	Color Moist	Mottles	Texture	Structure	Consistence Dry	Consistence Moist	Consistence Wet	Reaction	Boundary	Roots	Pores	Clay Films	% GR	% CB	% ST	% BD
Bw	0-10	7.5YR 6/4	7.5YR 4/4	--	SiL loess	1fsbk	so	vfr	ss ps	eo	as	3vf,f m,c	--	0	5	5	--	--
2Bw1	10-37	7.5YR 7/4	7.5YR 5/4	--	SL/SCL 19%	1fsbk	so	vfr	ss ps	eo	gs	2f	--	0	30	20	5	--
2C1	37-57+	10YR 6/4	10YR 4/4	--	SL 19%	m	so	vfr	ss ps	eo	--	2f	--	0	45	10	10	--

Table 1. Map Unit Descriptions for Extensive Study Areas and Transmission Line Corridors Montana Project (Adapted from Kuennen and Gerhardt 1984).

Map Unit Symbol	Map Unit Name	Physiography	Slope % Elev ft	Parent Material	Soil Components Classification	Family	Rock Outcrop %
112	Eutric Glossoboralfs, clayey, lacustrine substratum	Clayey Lacustrine Terraces	0-25 2200-3600	Glacial Lake Deposits	Eutric Glossoboralfs	fine, illitic,	0
252	Andic Dystrochrepts, steep	Structural Fluvial Breaklands	>60 3100-4600	Precambrian Belt Group	Andic Dystrochrepts	loamy-skeletal, mixed, frigid	5-15
301	Typic Eutrochrepts, glacial till substratum	Glaciated Mountain Slopes	15-35 2400-3800	Precambrian Belt Group	Typic Eutrochrepts	loamy-skeletal, mixed, frigid	<5
302	Typic Eutrochrepts, glacial till substratum	Glaciated Mountain Slopes	20-60 3000-4200	Precambrian Belt Group	Typic Eutrochrepts	loamy-skeletal, mixed, frigid	5-15
303	Lithic Dystrochrepts-Rock Outcrop complex, south aspects	Glacially Scoured Ridge Tops and Ridge Noses	15-35 3500-4700	Precambrian Belt Group	Lithic Dystrochrepts	loamy-skeletal, mixed, frigid	>50
322	Typic Glossoboralfs, volcanic ash surface	Glaciated Mountain Slopes	15-35 2500-4500	Tertiary and Precambrian Rock	Typic Glossoboralfs	fine, illitic	<5
323	Typic Eutroboralfs, calcareous glacial till substratum	Glaciated Mountain Foothills	15-35 2500-4500	Precambrian Belt Group	Typic Eutroboralfs	fine-silty, mixed	<5

Table 1. Map Unit Descriptions for Extensive Study Areas and Transmission Line Corridors Montana Project (Adapted from Kuennen and Gerhardt 1984).

Map Unit Symbol	Map Unit Name	Physiography	Slope % Elev ft	Parent Material	Soil Components Classification	Family	Rock Outcrop %
351	Andic Dystrochrepts, glacial substratum, stream dissected slopes	Glaciated Drainage Heads and Mountain Sideslopes	30-60 3000-5000	Precambrian Belt Group	Andic Dystrochrepts	loamy-skeletal, mixed, frigid	10
352	Andic Dystrochrepts, glacial till substratum	Glaciated Low Relief Mountain Sideslopes	20-60 2200-5200	Precambrian Belt Group	Andic Dystrochrepts	loamy-skeletal, mixed, frigid	<5
353	Andic Cryochrepts-Lithic Cryochrepts-Rock Outcrop complex, rolling ridges	Glacially Scoured Ridge Tops	15-35 3500-5500	Precanbrian Bekt Group	Andic Cryochrepts Lithic Cryochrepts	loamy-skeletal, mixed loamy-skeletal, mixed	25-50
355	Andic Dystrochrepts-Rock Outcrop complex, very cobbly substratum	Glacially Scoured Valley Sideslopes	20-50 3000-5200	Precambrian Belt Group	Andic Dystrochrepts	loamy-skeletal, mixed, frigid	0-25
381	Andic Dystrochrepts, thin glacial till substratum, stream dissected slopes	Glaciated Drainageheads and Sideslopes	30-60 3000-5000	Precambrian Belt Group	Andic Dystrochrepts	loamy-skeletal, mixed, frigid	5-15
401	Andic Dystrochrepts-Lithic Cryochrepts-Rock Outcrop complex, glacial trough walls headwalls	Glacially Scoured Trough Walls	>60 4200-7000	Precambrian Belt Group	Andic Cryochrepts Lithic Cryochrepts	loamy-skeletal, mixed loamy-skeltal, mixed	>40

Table 1. Map Unit Descriptions for Extensive Study Areas and Transmission Line Corridors Montana Project (Adapted from Kuennen and Gerhardt 1984).

Map Unit Symbol	Map Unit Name	Physiography	Slope % Elev ft	Parent Material	Soil Components Classification	Family	Rock Outcrop %
403	Rock Outcrop-Andic Cryochrepts-Lithic Cryochrepts complex, cirque	Alpine Ridges and Glacial Headwalls	>60 5500-8000	Precambrian Belt Group	Andic Cryochrepts Lithic Cryochrepts	loamy-skeletal, mixed loamy-skeletal, mixed	50-80
404	Andic Cryochrepts, glacial till substratum	Alpine Basins and Sideslopes	>60 4500-6500	Precambrian Belt Group	Andic Cryochrepts	loamy-skeletal, mixed	50-80
405	Andic Cryochrepts-Lithic Cryochrepts complex, subalpine ridges and basins	Frosted Churned Alpine Slopes and Ridgetops	15-50 5500-8000	Precambrian Belt Group	Andic Cryochrepts Lithic Cryochrepts	loamy-skeletal, mixed loamy-skeletal, mixed	15-25
406	Andic Cryochrepts, warm	Frost Churned Alpine Slopes	15-50 5400-7000	Precambrian Belt Group	Andic Cryochrepts	loamy-skleltal, mixed	5-15
407	Andic Cryochrepts, glacial till substratum	Alpine Glacial Moraines	5-20 3500-5500	Precambrian Belt Group	Andic Cryochrepts	loamy-skeletal, mixed	0-10
408	Andic Cryochrepts, glacial till substratum, steep	Steep Valley Sideslopes and Truncated Spurs	>60 2500-5500	Precambrian Belt Group	Andic Cryochrepts	loamy-skeletal, mixed	5-20

3.4 DESCRIPTION OF TRANSMISSION LINE CORRIDORS

3.4.1 Libby Townsite to Libby and Ramsey Plant Sites

This power transmission corridor begins on a low terrace of the Kootenai River north of the town of Libby (Figures 8a and 8b). The transmission corridor is 25 miles long to the Ramsey Creek sites. The corridor crosses the river and runs southward for about 13 miles along the broad floodplain of Libby Creek. Near the Libby Creek Campground the transmission corridor follows the creek south and then southeast; in this segment Libby Creek is in the foothills and the valley is narrow and incised. For about 6 miles the corridor runs along steep sideslopes, mostly on the east side of Libby Creek. Near the site of Old Town, the corridor crosses Libby Creek and forks, the north fork running up the north side of Ramsey Creek, the south fork running up the north side of Libby Creek.

From Libby townsite to the Libby Creek Campground, the corridor is on bottomlands (map unit 101) and low terraces (map unit 103) of Libby Creek (Table 1). The bottomlands have stratified alluvial soils that are subject to flooding and high groundwater tables. At several locations the corridor crosses or is contiguous to small wetlands. The stream channel is subject to frequent course changes. Protection of streambanks, channels and wetlands and limiting sediment production are the major concerns on the bottomlands.

The low terraces (map unit 103) are just a few feet higher than the bottomlands, but they are well drained and not subject to frequent flooding. The subsoils are excessively cobbly and therefore difficult to revegetate, but there are few other limitations to power transmission line siting on the terraces.

There are some steep, exposed cut-banks of lacustrine deposits on the east side of Libby Creek. The corridor does not cross these deposits (map unit 102) but any disturbance of the unstable cut banks should be avoided.

From near Libby Creek Campground to the Old Town site, the corridor is alternately on steep, till-covered sideslopes or lacustrine terraces. Where the corridor first enters the foothills near Libby Creek Campground it is on steep slopes with talus and rock outcrops (map unit 322). For a few miles the corridor is on lacustrine terraces on the bottom of the Libby Creek valley (map units 108 and 102). The soils on the lacustrine deposits have low bearing strength and tend to slump on steep cuts. At several locations where steep cut banks of lacustrine deposits are exposed, there is evidence of slumping.

The corridor forks near the Old Town site, one fork goes up the north side of Ramsey Creek, the other up the north side of Libby Creek. In the first two or three miles above the fork, both corridors are on gentle slopes of dense glacial till overlain by ash-influenced surface horizons (map unit 322). The till has a gravelly, silty clay loam texture. This area has few constraints to the construction of power transmission corridors.

The last few miles of the corridors up Libby and Ramsey Creeks are in the bottoms of U-shaped glacial valleys. The soils have formed in volcanic ash-influenced loess overlying glacial till (map unit 407). The till is gravelly sandy loam in texture and tends to ravel on steep cut slopes, but there are few other limitations to construction of the power transmission corridors in these areas.

3.4.2 Pleasant Valley to Libby and Ramsey Plant Sites

The southern corridor runs from Sedlak Park on the Fisher River, north to the confluence of Miller Creek, west up Miller Creek, over a divide and down the Howard Creek drainage to near its confluence with Libby Creek (Figure 9). At that point the corridor forks, one fork going up Libby Creek and the other crossing a ridge between Libby and Ramsey Creek and continuing up (west) to the Ramsey site. The corridor to Ramsey Creek is about 17 miles long.

The first two miles of the power transmission corridor north of Sedlak Park crosses very steep sideslopes of silty glacial till (map units 301) and lacustrine deposits (map unit 112). The steep glacial till is poorly suited to transmission line construction because on these steep slopes it tends to slump and is erodible and difficult to revegetate. The lacustrine deposits are poorly suited to construction because they are subject to serious slumping on steep slopes.

The next few miles of the corridor are mostly on the bottomland alluvial soils of the Fisher River (map unit 101). The soils and constraints are similar to the northern corridor from the Libby townsite to Libby Creek Campground; the soils are subject to flooding and high groundwater tables and the subsoils are cobbly alluvium that is difficult to revegetate. There are wetlands in at least one location where the corridor crosses the Fisher River.

The corridor turns west and runs for four miles on gentle slopes on the north side of Miller Creek. The first mile is on a mixed unit of alluvial and lacustrine deposits overlain by volcanic ash-influenced loess (map unit

108). The soils are moderately suited to construction but are subject to slumping on steep slopes and the bearing strength of the lacustrine deposits is low. The next mile is on an upper terrace of Miller Creek (map unit 103) that has few constraints to development. The next two miles are again on lacustrine deposits (map unit 112), but the slopes are gentle and slumping hazard is lower.

From about the confluence of the North and South Fork of Miller Creek, over the divide and down to Howard Creek, the power transmission corridor is on steep mountain sideslopes (map units 355 and 352). These soils have volcanic ash-influenced surface layers overlying dense glacial tills; one map unit (355) has a component of rock outcrops that varies up to 25% which the other (352) lacks. Slope steepness will increase the amount of material to be excavated should a road be constructed along the powerline. Exposed subsoils will tend to slump on steep cut banks and the material is difficult to revegetate. Non-rippable bedrock limits excavation and the materials on and near rock outcrops may be difficult to revegetate.

For the last 2 to 3 miles, both corridor forks are in the same location as described in section 3.4.1 for the Libby townsite to Libby and Ramsey Creek plant sites.

3.5 DESCRIPTION OF INTENSIVE STUDY AREAS

The intensive study areas occur as discreet blocks within the extensive study area (Figure 2). They include the Poorman and Little Cherry creek disposal sites (2024 ac), the upper Libby Creek (50.8 ac), Libby Creek (95.5 ac) and Ramsey Creek (53.7 ac) plant sites on the east slope of the Cabinet mountains and the Rock creek plant and adit sites (71.9 ac) on the west slope.

The following section describes the soils and map units of the intensive study areas. Figures 3 through 6 and 10 are maps showing the distribution of the map units in the intensive study areas. Table 2 is a list of the soil map units which occur in the intensive study areas; a map legend is included with the soil maps at end of this report. Table 3 provides the acreages of each map unit by study area.

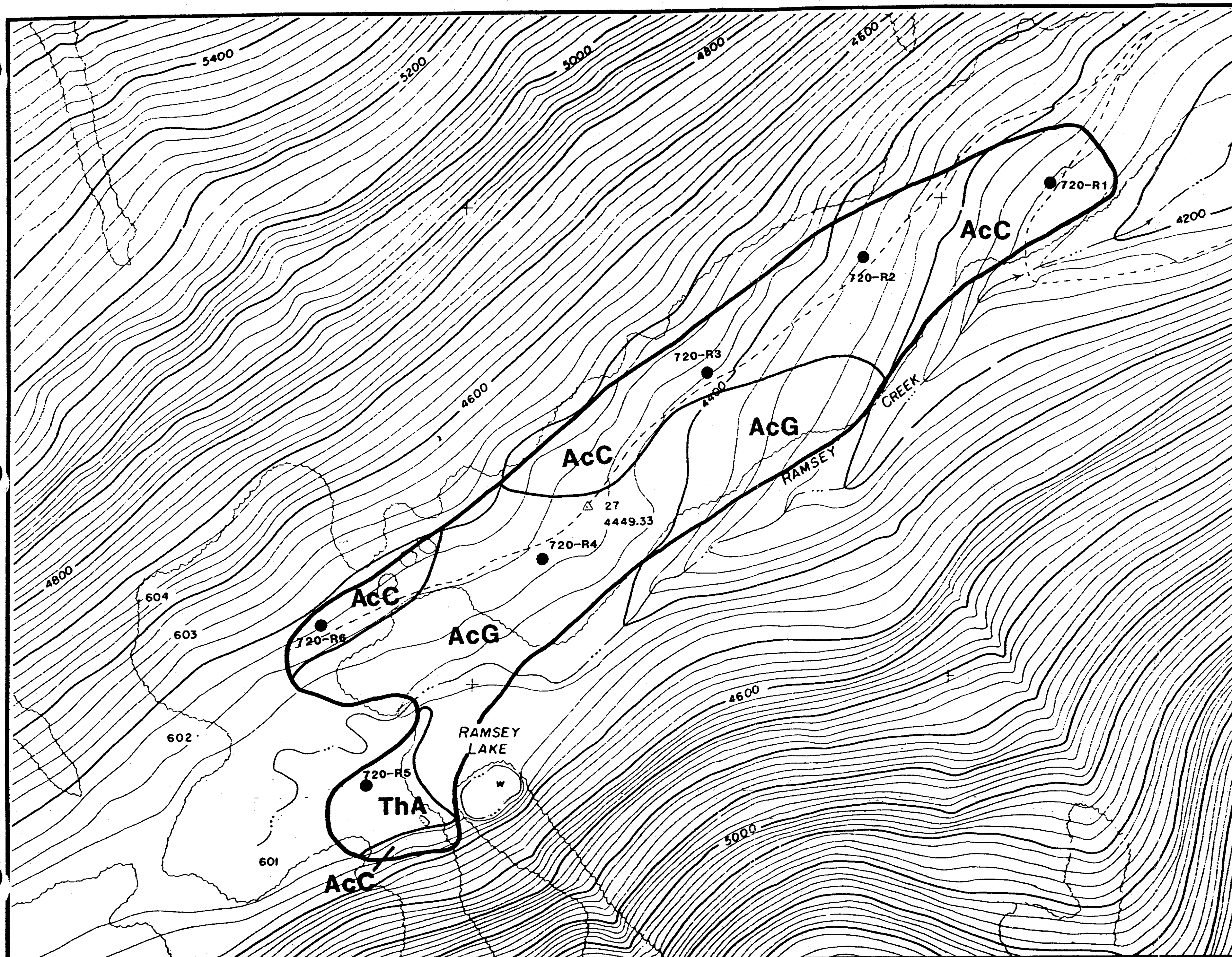


FIGURE 3.

SOIL MAP - RAMSEY CREEK

LEGEND

AcC	Andic Cryochrepts colluvial slopes, 10-35% slopes
AcG	Andic Cryochrepts glacial moraines, 0-15% slopes
ThA	Cumulic Humaquepts family, 0-3% slopes
● 720-4	Soil observation site

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MONTANA PROJECT
Lincoln County, Montana

N ⇧ JAN. 1989
SCALE 1"= 400'

prepared by
Western Resource Development Corporation

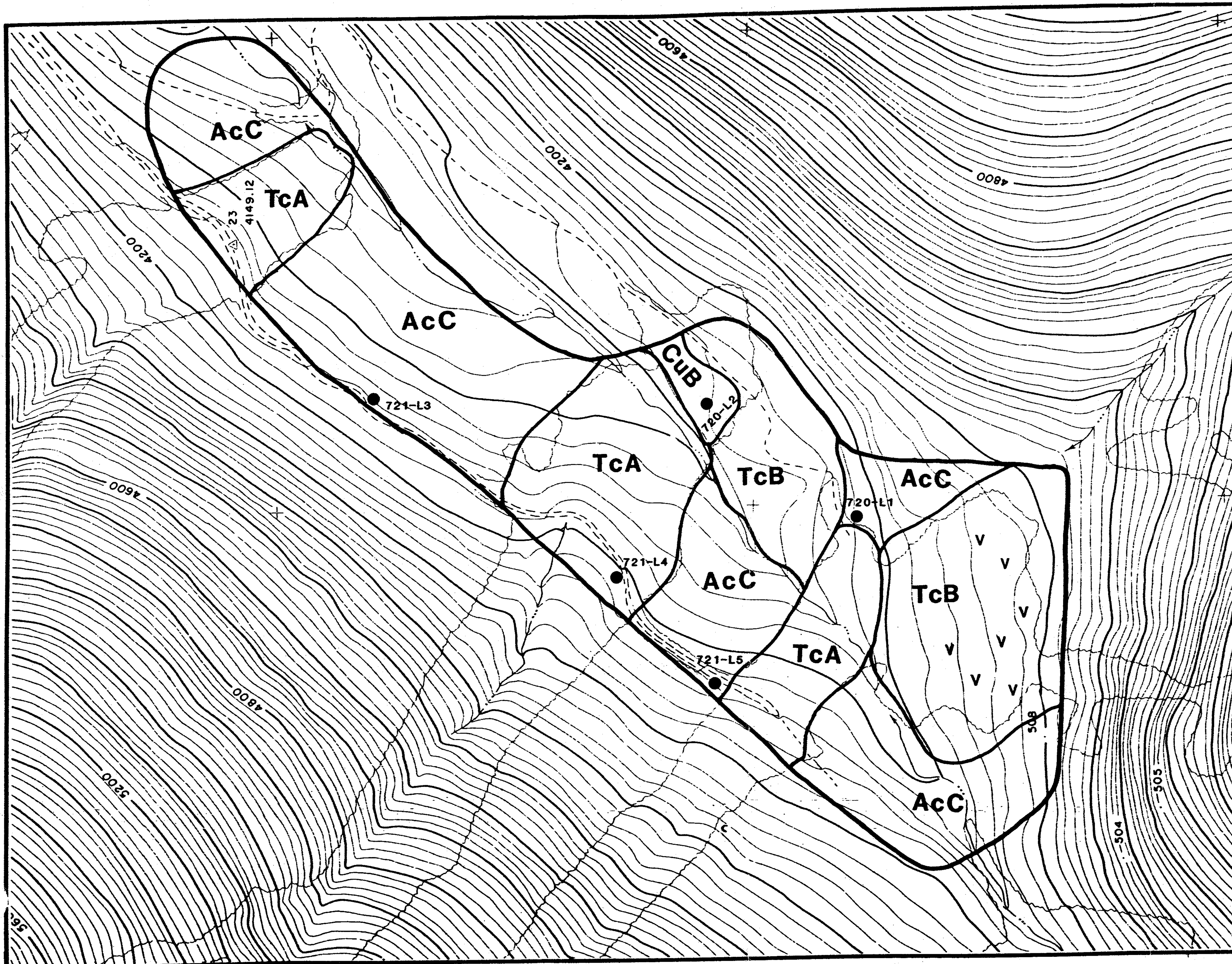

FIGURE 4.

SOIL MAP - LIBBY CREEK

LEGEND

AcC	Andic Cryochrepts colluvial slopes, 10-35% slopes
CuB	Typic Cryumbrepts, bouldery surface, 0-15% slopes
TcA	Typic Cryorthents avalanche chutes, 15-35% slopes
TcB	Typic Cryochrepts bouldery surface, 0-15% slopes
● 716-L1	Soil observation site
V V	Rock outcrop

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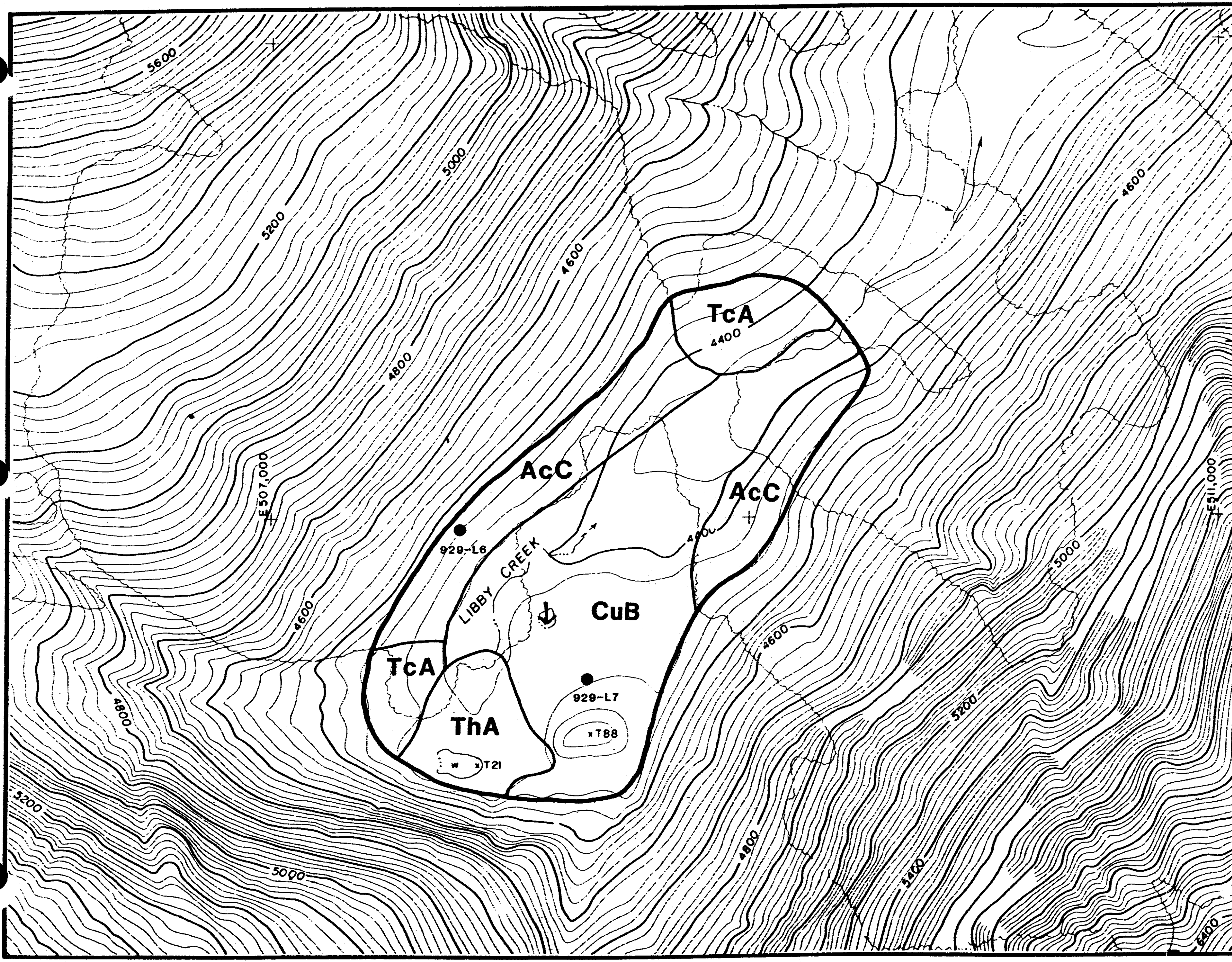

FIGURE 5.

SOIL MAP - UPPER LIBBY CREEK

LEGEND

AcC	Andic Cryochrepts colluvial slopes, 10-35% slopes
CuB	Typic Cryumbrepts, bouldery surface, 0-15% slopes
TcA	Typic Cryorthents avalanche chutes, 15-35% slopes
ThA	Cumulic Humaquepts family, 0-3% slopes
● 720-R2	Soil observation site
↓	Wet area

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MONTANA PROJECT
Lincoln County, Montana

N JAN. 1989
SCALE 1"= 400'

prepared by
Western Resource Development Corporation

FIGURE 6.

SOIL MAP - ROCK CREEK EVALUATION ADITS

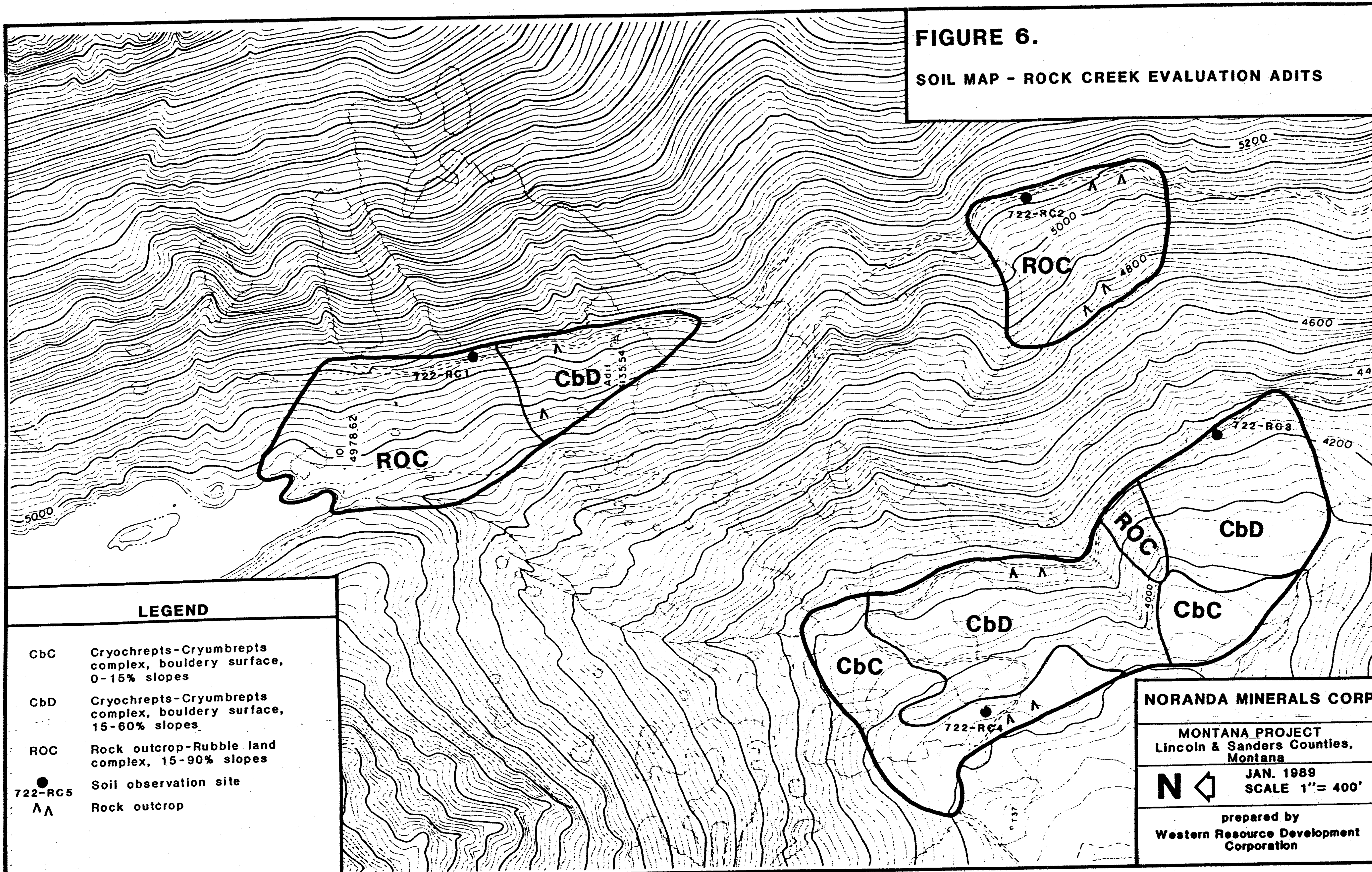

Table 2. List of Map Units, Intensive Study Areas. Montana Project

Map Unit Symbol	Map Unit Name
AcC	Andic Cryochrepts colluvial slopes, 10-35% slopes.
AcG	Andic Cryochrepts glacial moraine, 0-15% slopes.
AdA	Andic Dystrochrepts lacustrine terraces, 0-10% slopes.
AdD	Andic Dystrochrepts deep, 25-60% slopes.
AdR	Andic Dystrochrepts moderately deep and deep complex, 0-25% slopes.
AdS	Andic Dystrochrepts alluvial terraces, 0-15% slopes.
AdW	Dystrochrepts-Humaquepts complex, 0-15% slopes.
CbC	Cryochrepts-Cryumbrepts complex, bouldery surface, 0-15% slopes.
CbD	Cryochrepts-Cryumbrepts complex, bouldery surface, 15-60% slopes.
CuB	Typic Cryumbrepts bouldery surface, 0-15% slopes.
ROC	Rock outcrop-Rubble land complex, 15-90% slopes.
TcA	Typic Cryorthents avalanche chutes, 15-35% slopes.
TcB	Typic Cryochrepts bouldery surface, 0-15% slopes.
TgC	Typic Glossoboralfs family, 0-15% slopes.
TgD	Typic Glossoboralfs family, 15-40% slopes.
ThA	Cumulic Humaquepts family, 0-3% slopes.
TpC	Typic Paleboralfs family, 0-15% slopes.

Table 3. Extent of Map Units, Intensive Study Areas. Montana Project

Map Unit Symbol	Acres in Study Areas: Ramsey Creek	Libby Creek	Upper Libby Creek	Rock Creek	Tailings Area	Total: Area	Total: Percent
AcC	25.4	45.1	14.7	-	-	85.2	3.7
AcG	25.3	-	-	-	-	25.3	1.1
AdA	-	-	-	-	139.7	139.7	6.0
AdD	-	-	-	-	67.2	67.2	2.9
AdR	-	-	-	-	294.5	294.5	12.8
AdS	-	-	-	-	97.6	97.6	4.3
AdW	-	-	-	-	179.8	179.6	7.8
CbC	-	-	-	14.0	-	14.0	0.6
CbD	-	-	-	33.7	-	33.7	1.5
CuB	-	1.3	24.4	-	-	25.7	1.1
ROC	-	-	-	24.2	-	24.2	1.1
TcA	-	24.6	6.5	-	-	31.1	1.4
TcB	-	24.5	-	-	-	24.5	1.1
TgC	-	-	-	-	603.6	603.6	26.3
TgD	-	-	-	-	308.1	308.1	13.4
ThA	3.0	-	5.2	-	13.2	22.4	0.9
TpC	-	-	-	-	320.3	320.3	14.0
Total	53.7	95.5	50.8	71.9	2024.0	2295.9	100.0

3.5.1 Soil Classification

The soils were classified to the family level using Soil Taxonomy (Soil Survey Staff 1975) and local conventions. Table 4 lists the soils great group phase and provides their classification to the family level.

3.5.2 Soils and Map Units

This section provides a description of the soils and map units of the intensive study areas. The map unit descriptions are included with the narrative for the dominant or most limiting soil naming that map unit. For map units composed of more than one soil (e.g. complexes) the description of both soils should be consulted.

Table 4. Classification of Soils, Intensive Study Areas - Montana Project.

Subgroup	Family	Phase (Map unit occurrence)
Andic Cryochrepts	loamy-skeletal, mixed	colluvial slopes (AcC)
Andic Cryochrepts	loamy-skeletal, mixed	glacial moraines (AcG)
Andic Dystrochrepts	fine, mixed, frigid	lacustrine terraces (AdA,AdW)
Andic Dystrochrepts	loamy-skeletal, mixed, frigid	deep (AdD,AdR,AdW)
Andic Dystrochrepts	loamy-skeletal, mixed, frigid	moderately deep (AdR)
Andic Dystrochrepts	sandy-skeletal, mixed, frigid	alluvial terraces (AdS,AdW)
Cumulic Humaquepts	fine-silty, mixed, frigid	family (ThA)
Typic Cryochrepts	loamy-skeletal, mixed	bouldery surface (TcB,CbC,CbD)
Typic Cryorthents	loamy-skeletal, mixed	avalanche chutes (TcA)
Typic Cryumbrepts	loamy-skeletal, mixed	bouldery surface (CuB,CbC,CbD)
Typic Glossoboralfs	clayey-skeletal, mixed	family (TgC,TgD)
Typic Humaquepts	fine-silty, mixed, frigid	family (AdW)
Typic Paleboralfs	fine, mixed	family (TpC)

3.5.2(a) Andic Cryochrepts colluvial slopes.

The Andic Cryochrepts colluvial slopes are deep, well drained soils formed in gravelly medium textured colluvium, till and wind deposited materials. They occur on moderately steep and steep valley sideslopes and strongly sloping valley bottoms. These soils are extensive in Libby and Ramsey Creek.

Pedon # 721-L3 is a typical profile of the Andic Cryochrepts colluvial slopes and is located approximately 10 feet north of the road and 2000 feet east of the end of the Libby Creek road on the north side of Libby Creek. This soil is a member of the loamy-skeletal, mixed, Andic Cryochrepts.

O 1-0" discontinuous, conifer needles.

Bw 0-10" light brown (7.5YR 6/4) silt loam, brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; strongly acid (pH 5.4); gradual smooth boundary; common fine roots; common pores; about 10 percent gravel.

2Bw2 10-29" pink (7.5YR 7/4) very gravelly silt loam, brown (7.5YR 5/4) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; strongly acid (pH 5.4); clear smooth boundary; many very fine to fine roots; about 25 percent gravel and 10 percent cobbles.

2C1 29-60" very pale brown (10YR 7/3) very gravelly silt loam, pale brown (10YR 6/3) moist; massive; slightly hard, very friable, nonsticky and nonplastic; very strongly acid (pH 5.4); few very fine roots; about 35 percent gravel, 10 percent cobbles and 5 percent stones and boulders. Material is compacted and brittle in places.

This soil was described about 10 feet upslope of roadcut; soil surface was slightly disturbed. Soil material in 2Bw2 appears to be ash influenced. Compacted, brittle till in 2C1 restricts roots and possibly water.

AcC Andic Cryochrepts colluvial slopes, 10-35% slopes.

This map unit consists of deep, well drained soils formed in gravelly medium textured colluvium, till and wind-deposited materials. It is composed of loamy-skeletal, mixed Andic Cryochrepts with gravelly silt loam surface horizons. The slopes are concave and dissected by minor drainage incisions and range in steepness from 10 to 35 percent. Andic Cryochrepts colluvial slopes is the major component in this map unit and occupy 85 percent of the area. Typic Cryumbrepts are a major similar soil inclusion (< 10%) and occur in the drainage incisions. Loamy-skeletal Typic Cryochrepts occur as inclusions where the loess cap has been removed or mixed. Typic Cryorthents are included where this unit is mapped adjacent to avalanche chutes. Fluvents are minor inclusions in the low terrace and flood plain positions of Libby and Ramsey Creek. This map unit is extensive in Libby and Ramsey Creek.

3.5.2(b) Andic Cryochrepts glacial moraines.

The Andic Cryochrepts glacial moraines are deep, well drained soils formed in gravelly medium textured glacial drift and wind deposited materials. They occur on gently to strongly sloping recessional moraines and valley trains. These soils are extensive in Ramsey Creek.

Pedon # 720-R4 is a typical profile of the Andic Cryochrepts glacial moraines and is located 25 feet south and 2300 feet east of the end of the Ramsey Creek road. This soil is a member of the loamy-skeletal, mixed, Typic Cryochrepts.

O 1-0" discontinuous, conifer needles.

Bw 0-10" light brown (7.5YR 6/4) silt loam, brown (7.5YR 4/4) moist; weak subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; strongly acid (pH 5.5); clear smooth boundary; common very fine to coarse roots; less than 5 percent gravel.

2Bw2 10-14" strong brown (7.5YR 5/6) silt loam, moist; weak subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; strongly acid (pH 5.2); abrupt smooth boundary; many fine to medium roots; about 5-10 percent gravel.

2C1 14-20" brown (7.5YR 5/4) gravelly silt loam, moist; massive; slightly hard, friable, slightly sticky and slightly plastic; very strongly acid (pH 5.0); gradual smooth boundary; few fine roots; about 30 percent gravel.

2C2 20-45+" light yellowish brown (2.5Y 6/4) gravelly silt loam, reddish brown (2.5Y 4/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; very strongly acid (pH 5.1); few very fine roots; about 35 percent gravel, 10 percent cobbles and 15 percent stones and boulders.

This soil was near an old landing area and surface was slightly disturbed. 2C2 horizon is slightly compacted till and appears to be restricting roots.

AcG Andic Cryochrepts glacial moraines, 0-15% slopes.

This map unit consists of deep, well drained soils formed in gravelly medium textured glacial drift and wind-deposited materials. It is composed of loamy-skeletal, mixed Andic Cryochrepts with gravelly silt loam surface horizons. The slopes are undulating and slightly dissected with gradients of 0 to 15 percent. Andic Cryochrepts glacial moraines are the major component in this map unit and occupy about 90 percent of the area. Loamy-skeletal Typic Cryochrepts occur as inclusions where the loess cap has been removed or mixed. Aquepts occur as inclusions where this unit is mapped north and east of Ramsey Lake. Fluvents are minor inclusions in the low terrace and flood plain positions of Ramsey Creek. This map unit is extensive in Ramsey Creek.

3.5.2(c) Andic Dystrochrepts lacustrine terraces.

The Andic Dystrochrepts lacustrine terraces consist of deep, well drained soils formed in fine textured late-Wisconsin glacial lake sediments and Holocene wind-deposited materials. They occur on nearly level to strongly sloping (0 to 10 percent slopes) lacustrine terraces. These soils are moderately extensive in the Poorman and Little Cherry Creek tailings areas.

Pedon # 719-15 is a typical profile of an Andic Dystrochrepts lacustrine terraces and is located about 800 feet east and 1000 feet north of the southeast corner of section 24, R31W, T28N. This soil is a member of the fine, mixed, frigid, Andic Dystrochrepts.

O 1-0" Decomposed and partially decomposed conifer needles.

E 0-1" very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) moist; weak granular structure; soft, very friable, slightly sticky and slightly plastic; abrupt smooth boundary; common very fine to fine roots.

Bw1 1-7" light brown (7.5YR 6/4) silt loam, dark brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; moderately acid (pH 5.8); abrupt smooth boundary; common very fine to fine roots.

2Bw2 7-35" very pale brown matrix (10YR 7/3) silty clay, pale brown matrix (10YR 6/3) moist, strong brown (7.5YR 5/6) iron stains and small concretions; few medium distinct mottles; weak subangular blocky structure; hard, firm, very sticky and very plastic; strongly to moderately acid (pH 5.9); clear smooth boundary; few very fine roots.

2C 35-65" yellow (10YR 7/6) silty clay, brownish yellow (10YR 6/6) moist; platy massive structure; hard, firm, very sticky and very plastic; slightly acid (pH 6.2); few very fine roots.

This soil was described in a clearcut but did not appear to be disturbed. The surface horizon was ash influenced. Distinct 1 to 3 mm thick varves occur in the 2C horizons, but have been destroyed by pedogenesis in the 2Bw2.

AdA Andic Dystrochrepts lacustrine terraces, 0-10% slopes.

This map unit consists of relatively young soils formed in fine textured glacial lake sediments with a volcanic ash influenced surface horizon. It is composed of fine, mixed, frigid Andic Dystrochrepts with silt loam surface horizons. Slopes are dominantly planar with gradients of 0 to 3 percent however, some areas are undulating and range up to 10 percent. This unit is mapped on the high terraces above and to the west of Libby Creek in the Poorman and Little Cherry Creek tailings areas. Inclusions of sandy-skeletal Dystrochrepts and clayey-skeletal Glossoboralfs occur near the boundaries of the delineations. Small areas of fine-textured Aquepts are included and most have been marked with a spot symbol for wet areas.

AdW Dystrochrepts-Humaquepts complex, 0-15% slopes.

Andic Dystrochrepts are an important component in this map unit in the eastern part of the tailings disposal area. This unit is described in detail in section 3.5.2 (m).

3.5.2(d) Andic Dystrochrepts deep.

The Andic Dystrochrepts deep consist of deep, well drained soils formed in gravelly, medium textured residuum, colluvium, and wind-deposited materials. They occur on gently sloping to steep (0 to 50 percent slopes) rigdetops, backslopes and toeslopes of bedrock controlled ridges. These soils are moderately extensive in the Poorman and Little Cherry Creek tailings areas.

Pedon # 719-19 is a typical profile of the Andic Dystrochrepts deep and is located about 2200 feet south and 1000 feet west of the northeast corner of section 26, R31W, T28N. This soil is a member of the loamy-skeletal, mixed, frigid Andic Dystrochrepts.

O 2-0" Conifer needles in various states of decomposition.

Bw 0-9" light brown (7.5YR 6/4) silt loam, dark brown (7.5YR 4/4) moist; moderate subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; moderately acid (pH 6.0); abrupt wavy boundary; many fine to coarse roots; less than 5 percent gravel.

2E 9-16" very pale brown (10YR 7/3) very gravelly loam, pale brown (10YR 6/3) moist; massive; soft, very friable, slightly sticky and slightly plastic; moderately acid (pH 5.8); clear smooth boundary; common very fine to fine roots; about 60 percent gravel and 5 percent cobbles.

2C1 16-33" strong brown (7.5YR 5/6) moist extremely gravelly sandy loam; massive; soft, very friable, nonsticky and nonplastic; strongly acid (pH 5.2); gradual smooth boundary; few fine roots; few thin clay films; about 80 percent gravel and 5 percent cobbles.

2C2 33-56+" very pale brown (10YR 7/4) extremely gravelly sandy clay loam, light yellowish brown (10YR 6/4) moist; massive; soft, very friable, nonsticky and nonplastic; moderately acid (pH 6.0); few fine roots; about 80 percent gravel, 5 percent cobbles and 5 percent stones and boulders.

This soil was described in an undisturbed forest stand in the upper backslope position and had a volcanic ash surface horizon. The 2C1 horizon was stained and appeared to contain translocated clay as coating on gravels. Rock structure is evident in the C horizons. Where these soil occur in the lower slope positions they are deeper, lack rock structure and orientation of the coarse fragments and have silt loam textures.

AdD Andic Dystrochrepts deep, 25-60% slopes.

This map unit consists of deep, well drained soils formed in gravelly, medium textured colluvium, residuum and glacial drift with volcanic ash influenced surface horizons. It is composed of loamy-skeletal, mixed, frigid Andic Dystrochrepts with silt loam and gravelly silt loam surface horizons. This soil is mapped on the steeper slopes of the bedrock controlled ridges of the Poorman and Cherry Creek tailings areas. Small areas of Typic Glossoboralfs and Typic Paleboralfs are included the lower slope positions. Andic Dystrochrepts moderately deep occur as inclusion in upper slope positions. This unit is limited in extent and is restricted to the tailings areas.

AdR Andic Dystrochrepts moderately deep and deep complex, 0-25% slopes.

The Andic Dystrochrepts deep are a component of this unit map in the western half of the tailings area. This map unit is described in detail in section 3.5.2 (e).

AdW Dystrochrepts-Humaquepts complex, 0-15% slopes.

The Andic Dystrochrepts deep are an important component of this map unit in the western part of the tailings area. This map unit is described in detail in section 3.5.2 (m).

3.5.2(e) Andic Dystrochrepts moderately deep.

The Andic Dystrochrepts moderately deep soils consist of moderately deep, well drained soils formed in gravelly medium textured glacial till, meta-sedimentary residuum and wind-deposited materials. They occur on gently sloping to moderately steep (0 to 25 percent slopes) glacially scoured ridgetops and spurs. These soils are moderately extensive in the Poorman and Little Cherry Creek tailings areas.

Pedon # 714-6 is a typical profile of the Andic Dystrochrepts moderately deep and is located about 2000 feet north and 600 feet east of the southwest corner of section 25, R31W, T28N. This soil is a member of the loamy-skeletal, mixed, frigid Andic Dystrochrepts.

O 1-0" Conifer needles in various states of decomposition.

Bw1 0-11" pink (7.5YR 7/4) silt loam, dark brown (7.5YR 4/4) moist; weak fine granular structure; soft, loose, nonsticky and nonplastic; slightly acid (pH 6.1); clear smooth boundary; common fine to medium roots; many fine tubular pores; about 5 percent fine gravel.

2C 11-24" light yellowish brown (10YR 6/4) extremely cobbly sandy clay loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; moderately acid (pH 5.9); abrupt irregular boundary; common fine to medium roots; few fine pores; about 40 percent gravel, 20 percent cobbles and 10 percent stones and boulders.

R 24+" hard, fractured metasedimentary rock.

This soil was described in a clearcut area with minor surface disturbance. The surface horizon was influenced by volcanic ash and contained a small amount of gravel sized coarse fragments. Original rock bedding was observed in the 2C horizon.

AdR Andic Dystrochrepts moderatly deep and deep complex, 0-25% slopes.

This map unit consists of moderately deep and deep soils formed in gravelly, medium textured till, residuum and colluvium with volcanic ash influenced surface horizons. It is composed of loamy-skeletal, mixed, frigid Andic Dystrochrepts with silt loam and gravelly silt loam surface horizons. The moderately deep component of this unit is 20 to 40 inches deep over bedrock and occupies the ridgetop positions. The deep component occurs in the steeper sideslope positions and has a solum greater than 40 inches thick. The slopes are convex with gradients of 3 to

25 percent. This unit is mapped on the bedrock controlled ridges extending east and down from the western boundary of the Poorman and Little Cherry Creek disposal sites. The moderately deep component accounts for 60 percent and the deep component 40 percent of this map unit. Minor inclusions of Typic Glossoboralfs may occur near the boundaries of the delineations. Seeps and wet areas are common where these bedrock controlled ridges intersect the more gently sloping till and lacustrine map units. This map unit is moderately extensive in the Poorman and Little Cherry Creek tailings areas.

3.5.2(f) Andic Dystrochrepts alluvial terraces.

The Andic Dystrochrepts alluvial terraces consist of deep, well drained soils formed in coarse textured Holocene alluvium and wind-deposited materials. They occur on nearly level to strongly sloping (0 to 15 percent) alluvial and glaciofluvial terraces, terrace escarpments and flood plains. These soils are moderately extensive in the Poorman and Little Cherry Creek tailings areas.

Pedon # 715-10 is a typical profile the Andic Dystrochrepts alluvial terraces and is located 1700 feet south and 1800 west of the northeast corner of section 25, R31W, T28N. This soil is a member of the sandy-skeletal, mixed, frigid Andic Dystrochrepts.

A 0-3" dark yellowish brown (10YR 4/4) silt loam, dark yellowish brown (10YR 4/4) moist; moderate fine platy structure; slightly hard, friable, slightly sticky and slightly plastic; moderately acid (pH 5.7); abrupt wavy boundary; many very fine roots; about 5 percent gravel.

Bw 3-9" light brown (7.5YR 6/4) silt loam, dark brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; moderately acid (pH 5.7); abrupt wavy boundary; common very fine to medium roots; less than 5 percent gravel.

2C 9-16" pink (7.5YR 7/4) gravelly clay loam, brown (7.5YR 5/4) moist; massive; slightly hard, friable, sticky and plastic; very strongly acid (pH 4.5); abrupt smooth boundary; common very fine to medium roots; about 25 percent gravel.

3C 16-62"+ very pale brown (10YR 7/4) extremely gravelly sand, yellowish brown (10YR 5/4) moist; single grain; loose, loose, nonsticky and nonplastic; moderately acid (pH 5.9); few very fine roots; about 50 percent gravel, 30 percent cobbles and 5 percent stones and boulders.

This soil was described in a clearcut area. The soil surface was slightly disturbed and was not sampled for laboratory analysis. Thin clay bands and iron coatings on coarse fragments occur deep in the 3C horizon. Stratified lenses of sand and gravel occur in the substratum.

AdS Andic Dystrochrepts alluvial terraces, 0-15% slopes.

This map unit consists of relatively recent soils formed in gravelly and cobbly, coarse textured alluvium with volcanic ash influenced surface horizons. It is composed of sandy-skeletal, mixed, frigid Andic Dystrochrepts with silt loam and gravelly silt loam surface horizons. Slopes are dominantly planar with slope gradients of 0 to 5 percent; steeper concave slopes (up to 15%) occur on the terrace escarpments. This unit is mapped along the Poorman, Libby and Bear Creek drainages in the tailings areas. Minor inclusions of sandy-skeletal Udifluvents lacking ash influenced surfaces occur in the recent flood plain positions. Also included are Andic Dystrochrepts lacustrine terraces on the higher terraces.

AdW Dystrochrepts-Humaquepts complex, 0-15% slopes.

Andic Dystrochrepts alluvial terraces occur as an important component of this map unit in the eastern and southern part of the tailings area. This map unit is described in detail in section 3.5.2(m).

3.5.2(g) Cumulic Humaquepts family.

The Cumulic Humaquepts family consists of deep, very poorly drained soils formed in medium textured glacial drift, lake deposits and alluvium. They occur in nearly level (0 to 3 percent slopes) concave depressions and old lake beds. These soils are of minor extent in Poorman and Little Cherry Creek tailings areas. Their cold (cryic) counterparts occupy small areas in the Ramsey and Upper Libby Creek project areas.

Pedon # 715-8 is a typical profile the Cumulic Humaquepts family and is located 650 feet south and 1200 feet east of the northwest corner of section 36, R31W, T28N. This soil is a member of the fine-silty, mixed, frigid Cumulic Humaquepts.

A/O 0-9" very dark grayish brown (10YR 3/2) loam moist; very strongly acid (pH 4.9), partially decomposed plant materials in mineral soil matrix.

Bwg 9-39" very dark grayish brown (10YR 3/2) silty clay loam moist; moderate medium to coarse subangular blocky structure; sticky and plastic; very strongly acid (pH 4.8); clear smooth boundary; less than 5 percent gravel.

Cg 39-60+" light olive brown (2.5Y 5/6) silt loam moist; medium many distinct mottles (2.5YR 3/4); massive; slightly sticky and slightly plastic; strongly acid (pH 5.1); abrupt wavy boundary; many very fine to medium roots; less than 5 percent gravel.

This soil was described near the edge of a large bog in the tailings areas. Free water flowed from the interface of A/O and Bw horizons. Soils in Upper Libby and Ramsey Creek may have colder soil temperatures and higher coarse fragment contents than typical.

ThA Cumulic Humaquepts family, 0-3% slopes.

This map unit consists of soils that are saturated with water during most of the year. It is composed of fine-silty, mixed, frigid Cumulic Humaquepts with loam and silt loam surface horizons. Slopes are concave and planar with gradients of 0 to 3 percent. The water table ranges from the surface to about 12 inches, and open water occurs in some delineations most of the year. Soils with cryic soil temperature regimes and higher coarse fragment contents were included in this map unit in the Upper Libby and Ramsey Creek sites. These soils were not named and mapped separately since the high water table is the limiting characteristic of this unit. Inclusions of Typic Humaquepts occur in the drier upland positions. This map unit is very limited in extent and occurs in the tailings area and in Upper Libby and Ramsey Creek.

3.5.2(h) Rock outcrop and Rubble land.

The Rock outcrop and Rubble land miscellaneous landtypes consist of areas of non-soil. They are composed of hard, competent bedrock and unconsolidated rock debris. They occur on moderately steep and very steep (15 to 65 percent slopes) glacially scoured sideslopes, talus and upper avalanche chutes.

ROC Rock outcrop-Rubble land complex, 15-65% slopes.

This map unit consists of competent Precambrian meta-sedimentary bedrock and scree. The Rock outcrop and Rubble land components occur in approximately equal proportions. This unit is mapped on glacially scoured mountain sideslopes, nivation basins, talus and the upper part of avalanche chutes. The slopes range from linear and cliffy to concave with gradients of 15 to 65 percent. The cliff areas have slopes near vertical. Small areas of fragmental Typic Cryorthents occur and support scattered vegetation. Coarse fragments cover nearly 100 percent of the surface and range up to "Volkswagon" size. This unit is moderately extensive and restricted to the Rock Creek site.

3.5.2(i) Typic Cryochrepts bouldery surface.

The Typic Cryochrepts bouldery surface consists of deep, well drained soils formed in cobbly, medium textured colluvium, high energy alluvium, old debris flow and avalanche debris deposits and wind-deposited materials. They occur on gently sloping to very steep (5 to 65 percent) slopes. These soils are moderately extensive in Libby and Rock Creek sites.

Pedon # 722-RC3 is a typical profile of the Typic Cryochrepts bouldery surface and is located 1300 feet east and 400 feet north of the southwest corner of section 30, R31W, T27N, on the exploration road in upper Rock Creek. This soil is a member of the loamy-skeletal, mixed Typic Cryochrepts.

A 0-9" pale brown (10YR 6/3) very gravelly silt loam, brown (10YR 4/3) moist; moderate very fine granular structure; soft, very friable, slightly sticky and slightly plastic; moderately acid (pH 5.6); clear smooth boundary; common very fine roots; about 35 percent gravel and 10 percent cobbles.

Bw 9-29" very pale brown (10YR 7/4) very gravelly silt loam, yellowish brown (10YR 5/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; strongly acid (pH 5.3); gradual smooth boundary; many very fine to fine roots; about 35 percent gravel and 10 percent cobbles.

C 29-51" very pale brown (10YR 7/4) extremely gravelly silt loam, light yellowish brown (10YR 6/4) moist; massive; soft, very friable, nonsticky and nonplastic; strongly acid (pH 5.4); few very fine roots; about 50 percent gravel, 15 percent cobbles and 10 percent stones and boulders.

This soil was described in a roadcut on a 60 percent slope. It lacked evidence of an ash influenced surface horizon. Other pedons of this soil, particularly those with lower slope gradients have ash influenced surfaces. The soil surface has 35 to 50 percent rock cover with fragments ranging in size from gravel to boulders.

TcB Typic Cryochrepts bouldery surface, 0-15% slopes.

This map unit consists of deep, well drained soils formed in very gravelly medium textured colluvium, high energy alluvium and old debris flow deposits. It is composed of loamy-skeletal, mixed Typic Cryochrepts with gravelly and very gravelly silt loam surface horizons. Boulders and stones are common surface cover components. Slopes are mostly convex, benchy and incised by drainages. This unit is mapped primarily on old debris flow deposits in the Libby Creek Plant site. Outcrops of bedrock or large blocks occupy about 5 percent of this unit. Typic Cryumbrepts are included in mapping where the ash cap has been removed or significantly mixed. This map unit is of minor extent and is restricted to the Libby Creek Plant site.

CbC Cryochrepts-Cryumbrepts bouldery surface complex, 0-15% slopes.

This map unit consists of deep, well drained soils formed in very gravelly medium textured colluvium, glacial till, avalanche deposits and wind-deposited materials. It is composed of Typic Cryochrepts bouldery surface in the backslope position and Typic Cryumbrepts bouldery surface in swales, toeslopes and depositional positions. The surface textures are gravelly and very gravelly silt loams with varying degrees of ash influence. Boulders and large stones are common surface cover components. The Cryochrepts component occupies 60 percent and the Cryumbrept component about 30 percent of the unit. Typic Cryorthents and rock outcrop constitute about 10 percent of the area. Slopes are concave and dissected with gradients of 5 to 15 percent. Seeps and wet areas occur in the lowest slope positions. This map unit is of minor extent and is restricted to the Rock Creek site.

CbD Cryochrepts-Cryumbrepts bouldery surface complex, 15-65% slopes.

This map unit consists of deep, well drained soils formed in very gravelly colluvium, avalanche debris and wind-deposited materials. It consists of Typic Cryochrepts bouldery surface on steep dissected colluvial slopes and Typic Cryumbrepts bouldery surface in concave dissections and depositional areas where water and slopewash accumulate. The surface textures are gravelly and very gravelly silt loam with varying degrees of ash-influence. Boulders and stones are common surface cover components. The Cryochrept component occupies about 70 percent and the Cryumbrepts about 20 percent of the unit. The slopes are convex and dissected with gradients of 15 to 65 percent. Rock outcrop and scree are included in this unit. Typic Cryorthents avalanche chutes are similar soil inclusions and may occupy up to 20 percent of the area. The drainage incisions contain running water during much of the year. This unit is of minor extent and is restricted to the Rock Creek site.

3.5.2(j) Typic Cryorthents avalanche chutes.

The Typic Cryorthents avalanche chutes consist of deep, well drained soils formed in cobbly, medium textured colluvium. They occur on moderately steep to steep (10 to 35 percent slopes) snow avalanche chutes and debris fans. These soils are moderately extensive in the Libby and Upper Libby Creek Plant sites.

Pedon # 721-L4 is a typical profile of the Typic Cryorthents avalanche chutes and is located on the Libby Creek road 800 feet east of the end of the road. This soil is a member of the loamy-skeletal, mixed Typic Cryorthents.

A 0-5" brown (10YR 5/3) very cobbly silt loam, dark brown (10YR 3/3) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; abrupt irregular boundary; about 25 percent gravel, 20 percent cobbles and 15 percent stones and boulders.

C1 5-46" light yellowish brown (10YR 6/4) extremely cobbly silt loam, dark yellowish brown (10YR 4/4) moist; soft, very friable, slightly sticky and slightly plastic; about 25 percent gravel, 20 percent cobbles and 15 percent stones and boulders.

C2 46+" unsorted, angular cobbles and stones with soil partially filling voids.

This soil was described in an excavated roadcut. The C horizon is composed of fine materials in a matrix of unoriented cobbles and stones. Stones and boulders cover 25 to 35 percent of soil surface.

TcA Typic Cryorthents avalanche chutes, 10-35% slopes.

This map unit consists of deep, well drained soils formed in colluvium transported partly by snow avalanches. It is composed of loamy-skeletal, mixed Typic Cryorthents with gravelly silt loam surface horizons. The slopes are convex with gradients of 10 to 35 percent. This unit is mapped on cone-shaped avalanche debris fans in the lower slopes of Libby Creek. The area delineated does not include the maximum extent of the avalanche path, only the major depositional area. Stones and boulders are common on the surface of this unit. Typic and Andic Cryochrepts are similar soil inclusions. Typic Cryumbrepts occur in areas where water and slope wash accumulate and near the base of the fans. This map unit is moderately extensive in Libby Creek.

3.5.2(k) Typic Cryumbrepts bouldery surface.

The Typic Cryumbrepts bouldery surface consists of deep, well drained soils formed in gravelly and cobbly, medium textured colluvium, glacial till and wind-deposited materials. They occur on gently sloping to very steep (3 to 65 percent slopes) cirque basins, colluvial and glacial sideslopes and avalanche debris deposits. These soils are moderately extensive in the Rock Creek and Upper Libby Creek study sites.

Pedon # 929-L7 is a typical profile of the Typic Cryumbrepts bouldery surface and is located about 200 feet east and 900 feet south of the northwest corner of section 20, R31W, T27N, in upper Libby Creek. This soil is a member of the loamy-skeletal, mixed Typic Cryumbrepts.

A 0-17" dark brown (7.5YR 3/2) very cobbly loam, moist; moderate medium granular structure; very friable, slightly sticky and slightly plastic; clear smooth boundary; extremely acid (pH 4.4); many medium roots; about 15 percent gravel, 10 percent cobbles and 20 percent stones and boulders.

AC 17-20" dark brown (7.5YR 3/2) very cobbly loam, moist; very friable, slightly sticky and slightly plastic; very strongly acid (pH 4.6); many fine roots; about 15 percent gravel, 10 percent cobbles and 20 percent stones and boulders.

This soil was described and sampled in a hand-dug pit in the Upper Libby Creek plant site. The material below 20 inches was not sampled because it was extremely cobbly. Properties of this material is expected to similar to the other subsoils in this general area.

CbC Cryochrepts-Cryumbrepts bouldery surface complex, 0-15% slopes.

The Typic Cryumbrepts bouldery surface are a minor component in this map unit. See map unit description in section 3.5.2(i).

CbD Cryochrepts-Cryumbrepts bouldery surface complex, 15-65% slopes.

The Typic Cryumbrepts bouldery surface are a minor component in this map unit. See map unit description in section 3.5.2(i).

CuB Typic Cryumbrepts bouldery surface, 0-15% slopes.

This map unit consists of deep, well drained soils formed in glacial till, colluvium and wind-deposited materials. It is composed of loamy-skeletal, mixed Typic Cryumbrepts with ash influenced, cobbly and very cobbly silt loam surface horizons. Stones and boulders occur on and in the surface horizon. The slopes are concave with gradients mostly between 0 and 5 percent, though steeper, convex slopes up to 15 percent are included. Where this unit is mapped in the Lower Libby Creek Plant site it contains less coarse fragments than typical and may have formed in materials deposited in a marginal glacial lake. Poorly drained Cumulic Humaquepts occur as inclusions in the lowest landscape positions in the Upper Libby Creek Plant site. Andic and Typic Cryochrepts bouldery surface are included where this unit is mapped adjacent to steep slopes.

3.5.2(1) Typic Glossoboralfs family.

The Typic Glossoboralfs family consists of deep, well drained soils formed in gravelly, fine textured glacial drift, colluvium and wind-deposited materials. They occur on nearly level to steep (0 to 40 percent slopes) glaciated ridges and sideslopes. These soils are extensive in the Poorman and Little Cherry Creek tailings areas.

Pedon # 719-14 is a typical profile of the Typic Glossoboralfs family and is located 1000 feet north and 800 feet east of the southeast corner of section 24, R31W, T28N. This soil is a member of the clayey-skeletal, mixed Typic Glossoboralfs.

O 1-0" discontinuous, conifer needles.

E 0-1" light gray (10YR 7/2) silt loam, light brownish gray (10YR 6/2) moist; massive; soft, very friable, slightly sticky and slightly plastic; abrupt discontinuous boundary.

Bw 1-8" light brown (7.5YR 6/4) silt loam, light brownish gray (7.5YR 4/4) moist; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; strongly acid (pH 5.3); abrupt wavy boundary; many very fine to coarse roots; less than 5 percent gravel.

2E 8-22" light gray (10YR 7/2) gravelly clay loam, light brownish gray (10YR 6/2) moist; massive; hard, firm, sticky and plastic; strongly acid (pH 5.1); abrupt wavy boundary; few very fine roots; about 35 percent gravel.

2B/E 22-33" reddish yellow (7.5YR 6/6) gravelly silty clay, light, strong brown (7.5YR 5/6) moist, gray (10YR 7/2), light brownish gray (10YR 6/2) moist; moderate medium subangular blocky structure; hard, firm, sticky and plastic; very strongly acid (pH 5.0); clear wavy boundary; few very fine roots; few moderately thick clay films on ped faces and in pores; about 15 percent gravel.

2Bt 33-60+" reddish yellow (7.5YR 6/6) very gravelly clay, strong brown (7.5YR 5/6) moist; strong medium angular blocky structure; very hard, very firm, sticky and plastic; strongly acid (pH 5.4); common thick clay films on ped faces and in pores; about 35 percent gravel and 5 percent cobbles.

This soil was described in a clearcut and the O and E horizon were disturbed and discontinuous. Tongues of gray (10YR 7/2), and light brownish gray (10YR 6/2) moist, 2E material interfinger into and occur as pockets in the upper argillic horizon.

TgC Typic Glossoboralfs family, 0-15% slopes.

This map unit consists of gravelly fine textured soils formed in old glacial drift with ash influenced surface horizons. It is composed of clayey-skeletal, mixed Typic Glossoboralfs with silt loam and gravelly silt loam surface horizons. The slopes are undulating with gradients of 0 to 15 percent. Hummocky topography with discontinuous and poorly integrated drainage systems are common in this map unit. The lower areas contain soils that are wetter than those in the upland positions. This unit is mapped on continentally glaciated mountain sideslopes and plains in the Poorman and Little Cherry Creek tailings areas. Included in the mapping are Andic Dystrochrepts lacustrine terraces and alluvial terraces in the eastern portion of the tailings area. Loamy-skeletal Dystrochrepts are inclusions on the steeper upland slopes. This map unit is extensive in the Poorman and Little Cherry Creek tailings areas.

TgD Typic Glossoboralfs family, 15-40% slopes.

This map unit consists of gravelly fine textured soils formed in glacial drift and colluvium with ash influenced surface horizons. It is composed of clayey-skeletal, mixed Typic Glossoboralfs with silt loam and gravelly silt loam surface horizons. The slopes are convex and slightly dissected with gradients of 15 to 40 percent. This unit is mapped on glaciated mountain sideslopes. Andic Dystrochrepts and Typic Paleboralfs are inclusions on the steeper upland slopes. This unit is extensive in the Poorman and Little Cherry Creek tailings areas.

3.5.2.(m) Typic Humaquepts family.

The Typic Humaquepts family consists of deep, somewhat poorly and poorly drained soils formed in medium textured alluvium, slopewash and wind-deposited materials. They occur on gently to strongly sloping (0-15 percent slopes) drainages bottoms and swales. These soils are moderately extensive in the Poorman and Little Cherry Creek tailings areas.

Pedon # 715-7 is a typical profile of the Typic Humaquepts family and is located 1000 east and 250 north of the southwest corner of section 25, R31W, T28N. This soil is a member of the fine-silty, mixed, frigid Typic Humaquepts.

O 3-0" Decomposed plant materials.

A 0-6" brown (10YR 5/3) gravelly loam, dark brown (10YR 3/3) moist; moderate medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; neutral (pH 6.6); clear smooth boundary; common medium roots; common fine pores; about 25 percent gravel and 5 percent cobbles.

Bw 6-15" brown (10YR 4/3) silty clay loam moist; few fine distinct mottles (10YR 5/6); moderate medium angular blocky structure; friable, sticky and plastic; slightly acid (pH 6.5); clear wavy boundary; few medium roots; few fine pores: about 10 percent gravel and 5 percent cobbles.

Cg1 15-26" light gray (5Y 7/1) silt loam moist; few coarse prominent mottles (7.5YR 5/6); massive; hard, firm, very sticky and very plastic; neutral (pH 6.7); gradual smooth boundary; no roots observed; few very fine pores; about 5 percent gravel.

Cg2-- 26-50" light gray (5Y 7/1) silty clay loam moist; many coarse prominent mottles; moderate coarse angular blocky structure; firm; very sticky and very plastic; neutral (pH 7.3); about 10 percent gravel and 2 percent cobbles.

This soil was described near the bottom of a low energy drainage. Standing water was observed on the surface in the vicinity of the soil pit. The Cg1 and Cg2 horizons were both seeping water following excavation. The properties and horizonation are expected to be variable in this soil given its alluvial nature.

AdW Dystrochrepts-Humaquepts complex, 0-15% slopes.

This map unit consists of well drained soils formed in colluvium and poorly drained soils formed in alluvium and slopewash. It is composed of Andic Dystrochrepts in the well drained toeslope positions and Typic Humaquepts in the poorly drained bottom positions. The Dystrochrepts occupy 70 percent of the unit and the Humaquepts about 30 percent. Slopes are concave with gradients of 0 to 15 percent. This unit is mapped as long, narrow delineations dissecting the Poorman and Little Cherry Creek tailings area from west to east. Consequently, the Andic Dystrochrepts component includes members of the deep, lacustrine terraces and alluvial terraces phases depending on the dominant soil of the map unit dissected by the AdW delineation. Minor areas of Cumulic Humaquepts and Typic Glossoboralfs occur as inclusions. This map unit is moderately extensive in the Poorman and Little Cherry Creek tailings areas.

3.5.2(n) Typic Paleboralfs family.

The Typic Paleboralfs family consists of deep, well drained soils formed in fine textured glacial drift and wind-deposited materials. They occur on gently to strongly sloping (0 to 15 percent slopes) glaciated ridges and sideslopes. These soils are extensive in the Poorman and Cherry Creek disposal sites.

Pedon # 719-2 is a typical profile of the Typic Paleboralfs family and is located 1000 feet north and 2100 feet east of the southwest corner of section 23, R31W, T28N. This soil is a member of the fine, mixed Typic Paleboralfs.

Bw 0-9" strong brown (7.5YR 5/6) gravelly silt loam, strong brown (7.5YR 5/8) moist; weak fine subangular blocky, platy structure; slightly hard, very friable, slightly sticky and slightly plastic; strongly acid (pH 5.2); clear wavy boundary; common very fine to fine and few medium and coarse roots; about 15 percent gravel and 5 percent cobbles.

2E 9-24" very pale brown (10YR 7/3) gravelly loam, light yellowish brown (10YR 6/4) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; strongly acid (pH 5.3); clear smooth boundary; few very fine to medium roots; about 25 percent gravel.

2B/E 24-36" light brown (7.5YR 6/4) clay, strong brown (7.5YR 5/6) moist; moderate subangular blocky structure; hard, friable, sticky and plastic; extremely acid (pH 4.3); gradual smooth boundary; few very fine to coarse roots; few thin clay films on ped faces; about 10 percent gravel.

2Bt 36-65" reddish brown (2.5YR 5/4) clay, reddish brown (2.5YR 4/4) moist; strong medium angular blocky structure; hard, firm, very sticky and very plastic; extremely acid (pH 4.3); clear wavy boundary; few very fine roots; common thick clay films on ped faces and in pores. This horizon was subdivided for sampling at 36-50 and 50-65 inches.

This soil was described in a clearcut and the surface horizon was mixed. Tongues of E material extend along ped surfaces to 65 inches. About 35 percent of the 2B/E is composed of E materials in pockets in the Bt matrix. Weathering rinds on coarse fragments 2 to 5mm thick occur in the 2Bt horizon. Common, small (1 to 2mm dia.) MnO_2 stains occur on ped faces in the 2Bt horizon.

TpC Typic Paleboralfs family, 0-15% slopes.

This map unit consists of fine textured soils formed in glacial drift with volcanic ash influenced surface horizons. It is composed of fine, mixed Typic Paleboralfs with silt loam and gravelly silt loam surface horizons. The slopes are convex and slightly dissected with gradients ranging from 0 to 15 percent. This unit is mapped in large delineations in the northwest part of the Poorman and Little Cherry Creek tailings area. Typic Glossoboralfs family and Andic Dystrochrepts deep are inclusions in this map unit along Little Cherry Creek. Small areas of soils with high water tables are included and are marked with spot symbols. This map unit is extensive in the northern part of the tailings area.

3.5.3 Soil Chemical and Physical Properties

Soil physical and chemical properties for most of the typical pedons for each major soil are presented in Table 5. The data contained in this table were generated in Colorado State University Soil Testing Laboratory using standard methods. Appendix E contains chemical and physical data for ten additional soils that were described, collected and analyzed but not used for typical profiles during this investigation. Appendix B contains references to the methods used in the laboratory. Descriptions of these soils and others are included in Appendix D. The chemical and physical properties of all the soils tested are discussed below.

The soils range from extremely acid to moderately alkaline. The saturated soil paste pH ranged from 4.3 to 7.5. Most soils were in the pH 5.0 to 6.0 range. These data showed no particular trend with depth, although the highest pH values occurred in the subsoil of soils in the tailings areas. This may reflect the influence of glacially transported calcareous Belt rocks as opposed to local non-calcareous Belt rocks. Surface soils were in the 4.9 to 6.6 pH range for the study area.

All the soils were non-saline. The electrical conductivity (EC) of the saturated soil paste extract ranged from 0.1 to 0.4 mmhos/cm. Based on pH of less than 8.4, the soils are non-sodic as well.

The soils had relatively high organic matter contents. This may be accounted for by the presence of volcanic ash (Nimlos 1980; Fosberg et al. 1979a) and relatively low ambient air and soil temperatures reducing the rate of decomposition. The surface soils ranged from 1.2 to greater than 54 percent organic matter. The highest values were in soils with ash surface layers, umbric epipedons and/or less than adequate drainage. The subsoils of well drained non-umbric soils ranged from about 0.1 to 1.4 percent.

The soils were predominantly medium textured with silt loam being the most common texture, though both coarse and fine textured soils occurred. The surface horizons were mostly silt loam in texture. Most of the soils contained rock fragments greater than 2mm in mean diameter and many contained significant amounts (>35%).

The saturation percent and 15 bar water content of the soils were abnormally high in the surface soils indicating the presence of volcanic ash and in some cases high levels of organic matter. The 15 bar water:clay ratio of many of the surface horizons was near or greater than 1.0 which is indicative of volcanic ash influenced soils (Soil Survey Staff 1987). The subsoil horizons fell within the normal range for mineral soils (Brady 1974).

Several important soil properties were estimated based on field and laboratory data and published relationships. The estimated parameters include soil hydrologic properties and those relevant to soil erosion, revegetation and engineering uses of the soil. The data are presented in Table 6. Appendix C contains references to the methods used in their determination.

Table 5. Soil Chemical and Physical Properties, Intensive Study Areas Montana Project

Soil Name (MU symbol) depth	pH	EC[1] (mmhos/cm)	O. M.[2] (%)	Particle Size Analysis Sand	Silt (%)	Clay	VFS	Texture Class	> 2mm Gravel (%)	Sat[3] (%)	15 bar (%) H_2O
Andic Cryochrepts colluvial slopes #721-L3 (AcC)											
0-10"	5.4	0.1	3.1	30	57	13	9	SiL	37	66.3	13.0
10-29	5.4	<0.1	1.4	32	56	12	4	SiL	45	52.3	
29-60	5.4	0.1	0.2	43	53	4	11	SiL	54	31.4	
Andic Cryochrepts glacial moraines #720-R4 (AcG)											
0-10"	5.5	0.1	21.9	26	65	9	9	SiL	18	108.1	25.9
10-14	5.2	0.1	4.5	29	60	11	8	SiL	39	73.1	16.6
14-20	5.0	0.1	2.2	32	54	14	6	SiL	47	43.5	
20-45	5.1	0.1	0.6	37	55	8	3	SiL	62	32.3	
Andic Dystrochrepts lacustrine terraces #719-15 (AdA)											
1-7"	5.8	0.1	3.1	19	59	22	4	SiL	6	73.6	18.7
7-10	5.3	0.1	0.3	12	58	30	4	SiCL	<1	33.6	
10-35	5.9	0.1	0.1	1	53	46	<1	SiC	<1	39.3	
35-65	6.2	0.1	0.1	0	59	41	<1	SiC	10	45.3	

1 Electrical Conductivity. 2 Organic Matter. 3 Saturation Percent.

Table 5. Soil Chemical and Physical Properties, Intensive Study Areas Montana Project

Soil Name (MU symbol) depth	pH	EC[1] (mmhos/cm)	O. M.[2] (%)	Particle Size Analysis (%) Sand	Silt	Clay	VFS	Texture Class	> 2mm Gravel (%)	Sat[3] (%)	15 bar (%) H_2O
Andic Dystrochrepts deep, family #719-19 (AdD,AdR,AdW)											
0-9"	6.0	0.1	3.3	34	54	12	8	SiL	49	58.0	12.1
9-16	5.8	0.1	0.6	46	40	14	9	L	75	27.4	
16-33	5.2	0.1	0.3	57	25	18	6	SL	69	23.7	
33-56	6.0	0.2	0.4	53	26	21	10	SCL	70	27.0	
Andic Dystrochrepts moderately deep #714-6 (AdR)											
0-11"	6.1	0.1	1.8	27	59	14	8	SiL	29	58.2	11.4
11-24	5.9	0.2	0.7	35	43	22	8	L	59	30.7	
Andic Dystrochrepts alluvial terraces #715-10 (AdS)											
0-9"	5.7	0.2	3.2	23	55	22	8	SiL	6	60.8	12.9
9-16	4.5	0.1	0.3	21	56	23	7	SiL	22	26.9	
16-62	5.9	0.1	0.1	81	11	8	4	LS	77	22.8	

[1] Electrical Conductivity. [2] Organic Matter. [3] Saturation Percent.

Table 5. Soil Chemical and Physical Properties, Intensive Study Areas Montana Project

Soil Name (MU symbol) depth	pH	EC[1] (mmhos/cm)	O. M.[2] (%)	Particle Size Analysis (%) Sand	Silt	Clay	VFS	Texture Class	> 2mm Gravel (%)	Sat[3] (%)	15 bar (%) H_2O
Cumulic Humaquepts family #715-8 (ThA)											
0-9"	4.9	0.2	54.2	33	47	20	5	L	1	313.6	58.7
9-39	4.8	0.2	43.5	10	54	36	3	SiCL	3	235.2	
39-60	5.1	0.1	4.9	17	69	14	13	SiL	<1	90.3	9.7
Typic Cryochrepts bouldery surface #722-RC3 (TcB, CbC, CbD)											
0-9	5.6	0.2	5.8	24	62	14	6	SiL	80	63.8	
9-29	5.5	0.1	3.3	33	54	13	9	SiL	72	54.0	
29-51	5.4	0.2	1.8	40	52	8	3	SiL	87	40.3	
Typic Cryumbrepts bouldery surface #929-L7 (CuB)											
0-17	4.4	0.4	15.8	35	51	14	2	SiL	44	68.3	18.6
17-20	4.6	0.2	8.7	35	51	14	7	SiL	46	49.2	8.4

[1] Electrical Conductivity. [2] Organic Matter. [3] Saturation Percent.

Table 5. Soil Chemical and Physical Properties, Intensive Study Areas Montana Project

Soil Name (MU symbol) depth	pH	EC[1] (mmhos/cm)	O. M.[2] (%)	Particle Size Analysis (%) Sand	Silt	Clay	VFS	Texture Class	> 2mm Gravel (%)	Sat[3] (%)	15 bar (%) H_2O
Typic Glossoboralfs family #719-14 (TgC, TgD)											
1-8"	5.3	0.3	3.4	24	48	28	6	CL	19	53.8	
8-22	5.1	0.3	0.3	30	44	26	9	L	50	23.7	
22-33	5.0	0.2	0.3	14	48	38	4	SiCL	23	35.8	
33-60	5.4	0.1	0.1	21	43	36	10	CL	56	37.7	
Typic Humaquepts family #715-7 (AdW)											
0-6"	6.6	0.4	4.1	20	49	31	6	SCL/CL	49	55.8	
6-15	6.5	0.3	1.4	18	54	28	8	SCL	28	34.3	
15-26	6.7	0.3	0.3	20	55	25	1	SiL	31	31.2	
26-50	7.3	0.3	0.2	16	54	30	7	SiCL	16	35.3	
Typic Paleboralfs family #714-2 (TpC)											
0-9"	5.2	0.1	3.0	23	55	22	9	SiL	6	78.5	22.9
9-24	5.3	0.4	0.3	40	50	10	14	SiL/L	69	26.2	
24-36	4.3	0.1	0.4	17	58	25	8	SiL	8	34.7	
36-50	4.3	0.1	0.4	2	37	61	2	C	17	69.3	
50-65	4.4	0.1	0.4	4	35	61	3	C	27	72.9	

[1] Electrical Conductivity. [2] Organic Matter. [3] Saturation Percent.

Table 6. Estimated Soil Properties, Intensive Study Areas Montana Project

Soil Name (MU symbol) depth	Available Water Holding Capacity (in/in)	Hydraulic Conductivity (in\hr)	Shrink/ Swell Potential	Unified Class.	K Factor
Andic Cryochrepts colluvial slopes #721-L3 (AcC)					
0-10"	0.17	1.4-14.0	low	SM	0.36
10-29	0.13	1.4-14.0*	low	GM	0.19
29-60	0.10	1.4-14.0*	low	GM	0.17
Andic Cryochrepts glacial moraines #720-R4 (AcG)					
0-10"	0.18	1.4-14.0	low	SM	0.18
10-14	0.17	1.4-14.0	low	SM	0.30
14-20	0.13	1.4-14.0*	low	GM	0.20
20-45	0.09	1.4-14.0*	low	GM	0.11
Andic Dystrochrepts lacustrine terraces #719-15 (AdA)					
1-7"	0.18	1.4-14.0	low	SM	0.34
7-10	0.18	1.4-14.0	medium	ML-MH	0.42
10-35	0.18	0.10-0.01	medium	ML-MH	0.25
35-65	0.18	0.001-0.01	medium	ML-MH	0.25

Table 6. **Estimated Soil Properties, Intensive Study Areas Montana Project**

Soil Name (MU symbol) depth	Available Water Holding Capacity (in/in)	Hydraulic Conductivity (in\hr)	Shrink/ Swell Potential	Unified Class.	K Factor
Andic Dystrochrepts deep, family #719-19 (AdD,AdR,AdW)					
0-9"	0.18	1.4-14.0	low	SM	0.38
9-16	0.09	1.4-14.0	low	GM	0.10
16-33	0.07	1.4-14.0	low	GM	0.05
33-56	0.06	1.4-14.0	low	GM	0.05
Andic Dystrochrepts moderately deep #714-6 (AdR)					
0-11"	0.18	1.4-14.0	low	SM	0.42
11-24	0.08	1.4-14.0	low	GM	0.10
Andic Dystrochrepts alluvial terraces #715-10 (AdS)					
0-9"	0.18	1.4-14.0	low	SM	0.38
9-16	0.15	1.4-14.0	low	GM	0.24
16-62	0.03	>14.0	low	GW-GP	0.05
Cumulic Humaquepts family #715-8 (ThA)					
0-9"	0.19	1.4-14.0	medium	ML-MH	0.12
9-39	0.19	0.14-1.4	medium	ML-MH	0.12
39-60	0.19	0.14-1.4	medium	ML-MH	0.18

Table 6. Estimated Soil Properties, Intensive Study Areas Montana Project

Soil Name (MU symbol) depth	Available Water Holding Capacity (in/in)	Hydraulic Conductivity (in\hr)	Shrink/ Swell Potential	Unified Class.	K Factor
Typic Cryochrepts bouldery surface #722-RC3 (TcB,CbC,CbD)					
0-9	0.10	1.4-14.0	low	GM	0.10
9-29	0.10	1.4-14.0	low	GM	0.10
29-51	0.08	>14.0	low	GM	0.05
Typic Cryorthents avalanche chutes # 721-L4					
0-5"	0.09	1.4-14.0	low	GM	0.10
5-46	0.09	>14.0	low	GM-GP	0.05
46+	0.07	>14.0	low	GM-GP	0.05
Typic Cryumbrepts bouldery surface #929-L7 (Cbc,CbD)					
0-17"	0.12	1.4-14.0	low	GM	0.12
17-20	0.12	1.4-14.0	low	GM	0.12
20+	0.10	1.4-14.0*	low	GM	0.05
Typic Glossoboralfs family #719-14 (TgC,TgD)					
1-8"	0.18	1.4-14.0	low	SM	0.25
8-22	0.13	0.01-0.14	medium	GM	0.16
22-33	0.17	0.01-0.14	medium	GM-GC	0.29
33-60	0.11	0.01-0.14	medium	GM-GC	0.16

Table 6. Estimated Soil Properties, Intensive Study Areas Montana Project

Soil Name (MU symbol) depth	Available Water Holding Capacity (in/in)	Hydraulic Conductivity (in\hr)	Shrink/ Swell Potential	Unified Class.	K Factor
Typic Humaquepts family #715-7 (AdW)					
0-6"	0.18	1.4-14.0	medium	ML-MH	0.12
6-15	0.13	1.4-14.0	medium	ML-MH	0.12
15-26	0.19	0.14-1.4	medium	ML-MH	0.12
26-50	0.19	0.14-1.4	medium	ML-MH	0.18
Typic Paleboralfs family #714-2 (TpC)					
0-9"	0.17	1.4-14.0	low	SM-GM	0.32
9-24	0.16	0.14-1.4	medium	GM-GC	0.28
24-36	0.16	0.01-0.14	medium	ML-MH	0.45
36-50	0.18	0.01-0.14	medium	ML-MH	0.25
50-65	0.18	0.01-0.14	medium	ML-MH	0.25

* The occurrence of compacted till layers will decrease the hydraulic conductivity.

4.0 MAP UNIT INTERPRETATIONS

4.0 MAP UNIT INTERPRETATIONS

4.1 EXTENSIVE STUDY AREA AND TRANSMISSION LINE CORRIDORS

Map unit interpretations for the extensive study area and transmission line corridors were taken from the land systems inventory report. The interpretations were selected for their relevance to environmental assessment, mitigation and general project planning and are presented in Table 7. Additional information about the map units and interpretations may be obtained from the land systems inventory report (Kuennen and Gerhardt 1984).

4.2 INTENSIVE STUDY AREAS

Map unit interpretations were made for each detailed map unit in the intensive study area based on soil and landscape properties. The interpretations were made using guidelines from published sources, field observations and laboratory data. The methods for making these interpretations are referenced in appendix C, Interpretation Methods. The properties of the most limiting or dominant soil in the map unit were used in making the interpretations. The map units were assessed in terms of their hydrologic properties and erosion and revegetation potential (Table 8).

The suitability of the soils for topsoil salvage was evaluated for each map unit. The criteria used to evaluate soil profiles is in appendix C, Interpretation Methods. The suitability of each map unit for topsoil salvage is shown in Table 9. The first column gives the map unit, the second gives the soil components and the percent of the unit they comprise. The third column gives the suitability of the surface layer to be salvaged (high or moderate) and recommended salvage depth. The fourth and fifth columns give the acreages and location where the units occur. The last column desc ribes the depth to unsuitable material and the parameter(s) that eliminates the material from use.

The most common constraint is excessive coarse fragments. A few subsoils are eliminated on the basis of unsuitable texture, low pH or high ground water table. A few map units include slopes steeper than 50% which are not recommended for salvage.

Table 7. Map Unit Interpretations, Extensive Study Area and Transmission Line Corridors Montana Project (Adapted from Kuennen and Gerhardt 1984).

Map Unit Symbol	Soil Erodibility		Roads		Sediment Delivery Efficiency	Regeneration		Revegetation Potential
	Surface	Subsurface	Suitability	Limitation		Potential	Limitation	
101	high	moderate	fair	excess water	low	high	frost, gravelly	fair
102	high	high	poor	slumping	low	high	---	good
103	high	moderate	good	---	low	high	shallow soil	fair
104	high	moderate	fair	high water table	moderate	high	---	good
105	high	moderate	poor	excess water	low	NA	NA	very poor
106	high	moderate	good	---	low	high	shallow soil	fair
108	high	high	fair	slumping	low	high	---	good
112	high	high	poor	slumping	low	high	boggy areas	good
252	high	moderate	poor	steep slopes	high	moderate	wet soils	fair
301	moderate	moderate	good	---	moderate	moderate	soil moisture	fair
302	moderate	moderate	fair	slumping	moderate	moderate	soil moisture	fair
303	moderate	moderate	fair	non-rippable	NA	poor	NA	poor
322	high	high	good	---	moderate	high	---	good
323	moderate	moderate	fair	steep slopes	moderate	moderate	---	good
351	high	moderate	poor	slope stability	high	high	---	fair
352	high	moderate	good	steep slopes	moderate	high	---	good

Table 7. Map Unit Interpretations, Extensive Study Area and Transmission Line Corridors Montana Project (Adapted from Kuennen and Gerhardt 1984).

Map Unit Symbol	Soil Erodibility		Roads		Sediment Delivery Efficiency	Regeneration		Revegetation Potential
	Surface	Subsurface	Suitability	Limitation		Potential	Limitation	
353	moderate	moderate	fair	bedrock	low	moderate	short growing season, shallow and rocky soils	poor
355	high	moderate	fair	rock outcrop	moderate	high	---	good
381	high	moderate	fair	slumping	high	high	---	good
401	high	low	poor	steep slopes	high	slight	shallow, rocky soil;	very poor
403	high	low	poor	slope stability	high	very poor	shallow, rocky soil; short growing season; frost heave	very poor
404	high	moderate	good	---	moderate	high	short growing season;frost heave; high rock content	fair-low
405	high	low	fair	bedrock	moderate	very poor	short growing season; frost heave;high rock content	fair
406	high	moderate	good	---	moderate	moderate	short growing season;frost heave; high rock content	fair
407	high	moderate	good	---	moderate	slight	---	poor
408	high	moderate	poor	steep slopes, non-rippable	high	moderate	short growing season	poor

Table 8. Map Unit Interpretations, Intensive Study Areas Montana Project

Map Unit Symbol	Hydrologic Group	AWHC Class	Permeability (in\hr)	Soil Erodibility Index (KLS) Surf.	Soil Erodibility Index (KLS) Subsurf.	Potential Slope Stability	Depth (in) to Ground water	Depth (in) to Restrictive layer
AcC	B	moderate	1.4-14.0 *	144	76	high	>60	>60 **
AcG	B	moderate	1.4-14.0 *	25	28	high	>60	>60 **
AdA	C	high	0.001-0.01	5	6	high ***	>60	>60
AdD	B	low	1.4-14.0	230	28	moderate	>60	>60
AdR	B	low	1.4-14.0	93	22	high	>40	<40
AdS	A	low	1.4-14.0	11	3	high	>40	>60 **
AdW	D	high	0.14-1.4	10	10	high	0-40	>60
CbC	B	low	1.4-14.0	14	14	high	>60	>60 **
CbD	B	low	1.4-14.0	80	80	moderate ***	>60	>60
CuB	B	moderate	1.4-14.0	30	30	high	>40	>60 **
ROC	NA	NA	NA	NA	NA	high ***	NA	0
TcA	A	moderate	1.4-14.0	100	50	moderate ***	>60	>60 **

Table 8. Map Unit Interpretations, Intensive Study Areas
Montana Project

Map Unit Symbol	Hydrologic Group	AWHC Class	Permeability (in\hr)	Soil Erodibility Index (KLS)		Potential Slope Stability	Depth (in) to	
				Surf.	Subsurf.		Ground water	Restrictive layer
TcB	B	low	1.4-14.0	14	14	high	>60	>60
TgC	B	moderate	0.01-0.14	20	10	high	>60	>60
TgD	B	moderate	0.01-0.14	200	100	high ***	>60	>60
ThA	D	high	0.14-1.4	1	1	high	0-12	>60
TpC	B	high	0.01-0.14	20	17	high	>60	>60

* - Occurence of compacted glacial till may reduce permiability rating.

** - Compacted glacial till, stratified layers of coarse fragments or high water table may be restrictive and occur at less than 60 inches.

*** - For steep slopes or areas with compacted glacial till reduce rating one class.

NA - Not applicable

TABLE 9. TOPSOIL SUITABILITY, INTENSIVE STUDY AREAS MONTANA PROJECT

Map Unit Symbol	Soil Composition Component(%)	Topsoil Suitability (depth*)	Total Area		Constraints
			Acres	Location	
AcC	Andic Cryochrepts colluvial slopes	moderate (29")	85.2	Ramsey, Libby Upper Libby	excessive coarse fragments below 29"
AcG	Andic Cryochrepts glacial moraines	moderate (20")	25.3	Ramsey	excessive coarse fragments belows 20"
AdA	Andic Cryochrepts lacustrine terraces	high (65")	139.7	Tailings area	
AdD	Andic Dystrochrepts deep	moderate (9")	67.2	Tailings area	excessive coarse fragments below 9", unsuitable on slopes >50%
AdR	Andic Cryochrepts moderately deep (60%)	moderate (11")	294.5	Tailings area	excessive coarse fragments below 11"
	Andic Cryochrepts deep (40%)	moderate (9")	- - -	- - -	excessive coarse fragments below 9"

* Recommended salvage.

TABLE 9. TOPSOIL SUITABILITY, INTENSIVE STUDY AREAS
MONTANA PROJECT

Map Unit Symbol	Soil Composition Component (%)	Topsoil Suitability (depth*)	Total Area: Acres	Total Area: Location	Constraints
AdS	Andic Cryochrepts	moderate alluvial terraces (9")	97.6	Tailings area	very strongly acid at 9" excessive coarse fragments and sand below 16"
AdW	Typic Humaquepts family (30%)	high (15")	179.6	Tailings area	high water table below 15"
	AdA component (15%)	high (65")	- - -	- - -	
	AdD component (40%)	moderate (9")	- - -	- - -	see AdD above
	AdS component (15%)	moderate (9")	- - -	- - -	see AdS above

* Recommended salvage.

TABLE 9. TOPSOIL SUITABILITY, INTENSIVE STUDY AREAS MONTANA PROJECT

Map Unit Symbol	Soil Composition Component(%)	Topsoil Suitability (depth*)	Total Area Acres	Location	Constraints
CbC	Typic Cryochrepts bouldery (60%)	moderate unsuitable	14.0	Rock Creek	excessive coarse fragments throughout; boulders
	Typic Cryumbrepts bouldery (30%)	moderate unsuitable	- - -	- - -	excessive coarse fragments throughout; boulders
	Rock outcrop/ Rubble land (10%)	unsuitable	- - -	- - -	- - -
CbD	Typic Cryochrepts bouldery (70%)	moderate unsuitable	33.7	Rock Creek	see above CbC, unsuitable on slopes >50%
	Typic Cryumbrepts bouldery (20%)	moderate unsuitable	- - -	- - -	see above CbC
	Rock outcrop/ Rubble land (10%)	unsuitable	- - -	- - -	- - -

* Recommended salvage.

TABLE 9. TOPSOIL SUITABILITY, INTENSIVE STUDY AREAS MONTANA PROJECT

Map Unit Symbol	Soil Composition Component (%)	Topsoil Suitability (depth*)	Total Area Acres	Location	Constraints
CuB	Typic Cryumbrepts bouldery	moderate (20")	25.7	Upper Libby, Libby	excessive coarse fragments below 20"; boulders will require special handling
ROC	Rock outcrop/ Rubble land	unsuitable	24.2	Rock Creek	- - -
TcA	Typic Cryorthents avalanche chutes	unsuitable	31.1	Upper Libby, Libby	excessive coarse fragments
TcB	Typic Cryochrepts bouldery	moderate unsuitable	24.5	Libby	excessive coarse fragments throughout; boulders
TgC	Typic Glossoboralfs family	moderate (33")	603.6	Tailings area	excessive coarse fragments below 33"

* Recommened salvage.

TABLE 9. TOPSOIL SUITABILITY, INTENSIVE STUDY AREAS MONTANA PROJECT

Map Unit Symbol	Soil Composition Component(%)	Topsoil Suitability (depth*)	Total Area Acres	Total Area Location	Constraints
TgD	Typic Glossoboaralfs family	moderate (33")	308.1	Tailings area	excessive coarse fragments below 33"
ThA	Cumulic Humaquepts family	high (9")	22.4	Tailings area Ramsey, Upper Libby	high water table below 9"
TpC	Typic Paleboralfs family	moderate (24")	320.3	Tailings area	extremely acid below 24" clay below 36" (excessive coarse fragments from 9-24", but this coarse material is needed for the dike faces)

* Recommended salvage.

5.0 LITERATURE CITED

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6.0 GLOSSARY

6.0 GLOSSARY

acid soil - Soil with a pH value <7.0. See reaction, soil.

acidic cations - Hydrogen ions or cations that, on being added to water, undergo hydrolysis resulting in an acidic solution. Examples in soil are H^+, Al^{3+}, and Fe^{3+}.

acidity, residual - Soil acidity that is neutralized by lime or other alkaline materials, but which cannot be replaced by an unbuffered salt solution.

aggregate - A unit of soil structure, usually formed by natural processes in contrast with artificial processes, and generally <10 mm in diameter.

air dry - (i) The state of dryness at equilibrium with the water content in the surrounding atmosphere. The actual water content will depend upon the relative humidity and temperature of the surrounding atmosphere. (ii) To allow to reach equilibrium in water content with the surrounding atmosphere.

albic horizon - A mineral soil horizon from which clay and free iron oxides have been removed or in which the oxides have been segregated to the extent that the color of the horizon is determined primarily by the color of the primary sand and silt particles rather than by coatings on these particles.

Alfisols - Mineral soils that have umbric or ochric epipedons, argillic horizons, and that hold water at <1.5 MPa tension during at least 90 days when the soil is warm enough for plants to grow outdoors. Alfisols have a mean annual soil temperature of <8^{o}C or a base saturation in the lower part of the argillic horizon of 35% or more when measured at pH 8.2. (An order in the U.S. system of soil taxonomy.)

allophane - An aluminosilicate with primarily short-range structural order. Occurs as exceedingly small spherical particles especially in soils formed from volcanic ash. Also, it occurs in podzolic soils formed on weathered granite in a cool moist climate.

alluvial - Pertaining to processes or materials associated with transportation or deposition by running water.

alluvium - Sediments deposited by running water of streams and rivers. It may occur on terraces well above present streams or in the normally flooded bottom land of existing streams.

altithermal - Pertaining or belonging to a climate characterized by rising or high temperatures; e.g., altithermal soil of postglacial time.

amorphous material - Noncrystalline constituents that either do not fit the definition of allophane or it is not certain if the constituent meets allophane criteria.

Andepts - Inceptisols that have formed either in vitric pyroclastic materials, or have low bulk density and large amounts of amorphous materials, or both. Andepts are not saturated with water long enough to limit their use for most crops. (A suborder in the U.S. system of soil taxonomy.)

Aquepts - Inceptisols that are saturated with water for periods long enough to limit their use for most crops other than pasture or woodland unless they are artificially drained. Aquepts have either a histic or umbric epipedon and gray colors within 50 cm of the surface, or an ochric epipedon underlain by a cambic horizon with gray colors, or have sodium saturation of 15% or more. (A suborder in the U.S. system of soil taxonomy.)

aquic - A mostly reducing soil moisture regime nearly free of dissolved oxygen due to saturation by groundwater or its capillary fringe and occurring at periods when the soil temperature at 50 cm below the surface is $>5^{\circ}C$.

argillic horizon - A mineral soil horizon that is characterized by the illuvial accumulation of layer-lattice silicate clays. The argillic horizon has a certain minimum thickness depending on the thickness of the solum, a minimum quantity of clay in comparison with an overlying eluvial horizon depending on the clay content of the eluvial horizon, and usually has coatings of oriented clay on the surface of pores or peds or bridging sand grains.

Aridic - A soil that has an aridic soil moisture regime.

available nutrients - (i) Nutrient ions or compounds in forms which plants can absorb and utilize in growth, and (ii) contents of legally designated "available" nutrients in fertilizers determined by specified laboratory procedures which in most states constitute the legal basis for guarantees.

available water - The portion of water in a soil that can be absorbed by plant roots. It is the amount of water released between in situ field capacity and the permanent wilting point (usually estimated by water content at soil matric potential of -1.5 MPa).

backslope - The slope component that is the steepest, straight then concave, or merely concave middle portion of an erosional slope.

badland - An area generally devoid of vegetation and broken by an intricate maze of narrow ravines, sharp crests, and pinnacles resulting from serious erosion of soft geologic materials. Most common in arid or semiarid regions. See miscellaneous land area.

bar - A term used in a generic sense to include various types of submerged or exposed embankments of sand and gravel built on a sea or lake floor by waves and currents. Or a mass of sand, gravel, or alluvium deposited on the bed of a stream, sea, or lake, or at the mouth of a stream, forming an obstruction in navigation.

base saturation percentage - The extent to which the adsorption complex of a soil is saturated with alkali or alkaline earth cations expressed as a percentage of the cation exchange capacity measured at pH 7.0, which may include acidic cations such as H^+ and Al^{3+}.

bedrock - The solid rock underlying soils and the regolith in depths ranging from zero (where exposed by erosion) to several hundred centimeters.

bentonite - Layer silicates, largely composed of smectite minerals, produced by the alteration of volcanic ash in sites.

bisequum - One sola above another in the same profile.

blown-out - Areas from which all or almost all of the soil and soil material has been removed by wind erosion. Usually barren, shallow depressions with a flat or irregular floor consisting of a more resistant layer and/or an accumulation fo pebbles, or a wet zone immediately above a water table. Usually unfit for crop production. See miscellaneous land areas.

Boralfs - Alfisols that have formed in cool places. Boralfs have frigid or cryic but not pergelic temperature regimes and have udic moisture regimes. Boralfs are not saturated with water for periods long enough to limit their use for most crops. (A suborder in the U.S. system of soil taxonomy.)

bulk density, soil (ρ_b) - The mass of dry soil per unit bulk volume. The bulk volume is determined before drying to constant weight at 105°C. The value is expressed in grams per cubic centimeter.

C horizon - See soil horizon.

calcic horizon - A mineral soil horizon of secondary carbonate enrichment that is >15 cm thick, has a $CaCO_3$ equivalent of >150 g kg^{-1}, and has at least 50 g kg^{-1} more $CaCO_3$ equivalent than the underlying C horizon.

cambric horizon - A mineral soil horizon that has a texture of loamy very fine sand or finer, has soil structure rather than rock structure, contains some weatherable minerals, and is characterized by the alteration or removal of mineral material as indicated by mottling or gray colors, stronger chromas or redder hues than in underlying horizons, or the removal of carbonates. The cambic horizon lacks cementation or induration and has too few evidences of illuviation to meet the requirements of the argillic or spodic horizon.

cation exchange capacity (CEC) - The sum of exchangeable cations that a soil, soil constituent, or other material can absorb at a specific pH. It is usually expressed in centimoles of charge per kilogram of exchanger ($cmol_c$ kg^{-1}).

cemented - Indurated; having a hard, brittle consistency because the particles are held together by cementing substances such as humus, $CaCO_3$, or the oxides of silicon, iron, and aluminum. The hardness and brittleness persist even when wet. See consistence.

classification, soil - The systematic arrangement of soils into groups or categories on the basis of their characteristics. Broad groupings are made on the basis of general characteristics and subdivisions on the basis of more detailed differences in specific properties. The USDA soil classification system (Soil Taxonomy) was adapted for use in publications by the National Cooperative Soil Survey on 1 January 1965. Abridged statements of diagnostic features, orders, and suborders are listed alphabetically. The outline of the system is shown in Appendix II (Table 1). Great groups are named by adding a prefix to the suborder name. A list of the connotations of these prefixes is shown in Appendix II (Table 2). For complete definitions of taxa see: Soil Survey Staff, 1975, Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys (Agric. Handbook 436). See also Appendix I.

clay films - Coatings of clay on the surfaces of soil peds and mineral grains and in soil pores. (Also called clay skins, clay flows, illuviation cutans, argillans or tonhautchen.)

climax - The most advanced successional community of plants capable of development under, and in dynamic equilibrium with, the prevailing environment.

clinal - Varied in form (e.g., morphologic or physiologic variations) within a group of closely related (usually conspecific) organisms, generally developing as a result of environmental, geographic, chronological, or stratigraphic transition.

coarse fragments - Rock or mineral particles >2.0 mm in diameter.

coarse texture - The texture exhibited by sands, loamy sands, and sandy loams except very fine sandy loam.

colluvium - A general term applied to deposits on a slope or at the foot of a slope or cliff that were moved there chiefly by gravity. Talus and cliff debris are included in such deposits.

component soil - The soil (or soils) formally named and described as comprising the delineations of a map unit and for which the map unit is named. Simple or complex names for the component soils are formed from a class name (taxon name) from some categorical level of the U.S. system of soil taxonomy, with or without an additional phase identification for utilitarian features. See inclusion and map unit.

concretion - A local concentration of a chemical compound, such as calcium carbonate or iron oxide, in the form of a grain or nodule of varying size, shape, hardness, and color.

consistence - The attributes of soil material as expressed in its degree of cohesion and adhesion or in its resistance to deformation or cupture. Terms used in soil survey for describing consistence at various soil-water contents are:

wet soil - nonsticky, slightly sticky, sticky, very sticky, nonplastic, slightly plastic, plastic, and very plastic.

moist soil - loose, very friable, friable, firm, very firm, and extremely firm.

dry soil - loose, slight, softly hard, hard, very hard, and extremely hard.

cementation - weakly cemented, strongly cemented, and indurated.

crest - The slope component that is commonly at the top of an erosional ridge, hill, mountain, etc. See summit.

cryic - A soil temperature regime that has mean annual soil temperatures of $>0^{o}C$ but $<8^{o}C$, $>5^{o}C$ difference between mean summer and mean winter soil temperatures at 50 cm, and cold summer temperatures.

delineation - A portion of a landscape shown by a closed boundary on a soil map that defines the area, shape, and location of one or more component soils plus inclusions, and/or miscellaneous area. See map unit.

EC - The electrolytic conductivity of an extract from saturated soil, normally expressed in units of siemens per meter at $25^{o}C$.

eluviation - Downward movement of soluble or suspended materials in a soil, from the A horizon to the B horizon, by groundwater percolation. Adjective: eluvial.

Entisols - Mineral soils that have no distinct subsurface diagnostic horizons within 1 m of the soil surface. (An order in the U.S. system of soil taxonomy.)

eolian - Pertaining to the wind; esp. said of such deposits as loess and dune sand, of sedimentary structures such as wind-formed ripple marks, or of erosion and deposition accomplished by wind.

erodibility - The state or condition of being erodible.

erodible - Susceptible to erosion. (Expressed by terms such as highly erodible, slightly erodible, etc.)

erosion potential (EI) - A numerical value expressing the inherent erodibility of a soil or maximum potential erosion. In the Universal Soil Loss Equation (under clean tillage, up and down slope) EI = RKLS/T.

exchange capacity - The total ionic charge of the adsorption complex active in the adsorption of ions. See anion exchange capacity and cation exchange capacity.

fan - A gently sloping, fan-shaped mass of sediment forming a section of a very low cone commonly at a place where there is a notable decrease in the gradient of the drainageway or stream; specifically an alluvial fan.

fine texture - Consisting of or containing large quantities of the fine fractions, particularly of silt and clay. (Includes all clay loams and clays; that is, clay loam, sandy clay loam, silty clay loam, sandy clay, silty clay, and clay textural classes. Sometimes subdivided into clayey texture and moderately fine texture.) See soil texture.

flood plain - The land bordering a stream, built up of sediments from overflow of the stream and subject to inundation when the stream is at flood stage.

footslope - A slope that is concave-upward in profile and below the steepest portion of the hillslope. Occurs just below the backslope and above the toeslope. A zone of sediment transportation and deposition on the hillslope.

Fluvents - Entisols that form in recent loamy or clayey alluvial deposits, are usually stratified, and have an organic carbon content that decreases irregularly with depth. Fluvents are not saturated with water for periods long enough to limit their use for most crops. (A suborder in the U.S. system of soil taxonomy.)

glacial drift - Rock debris that has been transported by glaciers and deposited, either directly from the ice or from the melt-water. The debris may or may not be heterogeneous.

glaciers - Large masses of ice that formed, in part, on land by the compaction and recrystallization of snow. They may be moving downslope or outward in all directions because of the stress of their own weight or they may be retreating or be stagnant.

glaciofluvial deposits - Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers, and kame terraces. See glacial drift and till (i).

gravelly - Containing appreciable or significant amounts of gravel. (Used to describe soils or lands.)

Haplargids - A soil that is an Argid and does not have a silicate or calcite-cemented horizon or a sodic, clay-enriched B (natric) horizon. A great group in the USDA soil taxonomy.

Holocene - An epoch of the Quaternary period from the end of the Pleistocene, approximately 8,000 years ago to the present time; also the corresponding series of rocks and deposits.

horizon, soil - A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming (pedogenic) processes.

illuvial horizon - A soil layer or horizon in which material carried from an overlying layer has been precipitated from solution or deposited from suspension. The layer of accumulation. See eluvial horizon.

Inceptisols - Mineral soils that have one or more pedogenic horizons in which mineral materials other than carbonates or amorphous silica have been altered or removed but not accumulated to a significant degree. Under certain conditions, Inceptisols may have an ochric, umbric, histic, plaggen or mollic epipedon. Water is available to plants more than half of the year or more than 90 consecutive days during a warm season. (An order in the U.S. system of soil taxonomy.)

inclusion - A soil or miscellaneous land area within a delineation of a map unit that is not identified by the map unit name; i.e., is not one of the named component soils or named miscellaneous area components. Such soils or areas are either too small to be delineated separately without creative excessive map or legend detail, or occur too erratically to be considered a component, or are not identified by practical mapping methods.

indicator plants - Plants characteristic of specific soil or site conditions.

iron oxides - Group name for the oxides and hydroxides of iron. Includes the minerals goethite, hematite, lepidocrocite, ferrihydrite, maghemite, and magnetite. Sometimes referred to as "free iron oxides," "sesquioxides," or "hydrous oxides."

lacustrine deposit - Material deposited in lake water and later exposed either by lowering of the water level or by the elevation of the land.

landform - A three-dimensional part of the land surface, formed of soil, sediment, or rock that is distinctive because of its shape, that is significant for land use or to landscape genesis, that repeats in various landscapes, and that also has a fairly consistent position relative to surrounding landforms.

lithic contact - A boundary between soil and continuous, coherent, underlying material. The underlying material must be sufficiently coherent to make hand-digging with a spade impractical. If mineral, it must have a hardness of 3 or more (Mohs scale), and gravel size chunks that can be broken out do not disperse within 15 hours shaking in water or sodium hexametaphosphate solution.

litter - The surface layer of the forest floor consisting of freshly fallen leaves, needles, twigs, stems, bark, and fruits.

map unit - (i) A conceptual group of one to many delineations identified by the same name in a soil survey that represent similar landscape areas comprised of either: (1) the same kind of component soil, plus inclusions, or (2) of two or more kinds of component soils, plus inclusions, or (3) of component soils and miscellaneous area, plus inclusions, or (4) of two or more kinds of component soils that may or may not occur together in various delineations but all have similar, special use and management, plus inclusions, or (5) of a miscellaneous area and included soils. (ii) A loose synonym for a delineation. See declinational, component soil, inclusion, soil consociation, soil complex, soil association, undifferentiated group, miscellaneous areas.

medium-texture - Intermediate between fine-textured and coarse-textured (soils). (It includes the following textural classes: very fine sandy loam, loam, silt loam, and silt.)

mesic - A soil temperature regime that has a mean annual soil temperature of 8 degrees centigrade or more but less than 15 degrees centigrade, and more than 5 degrees centigrade difference between mean summer and mean winter soil temperatures at 50 centimeters.

metamorphic rock - Rock derived from preexisting rocks but that differ from them in physical, chemical, and mineralogical properties as a result of natural geologic processes, principally heat and pressure, originating within the earth. The preexisting rocks may have been igneous, sedimentary, or another form of metamorphic rock.k miscellaneous areas - A kind of map unit used in soil surveys comprised of delineations, each of which shows the size, shape, and location of a landscape unit within which little or no vegetation occurs because there either is little or no soil, there are very unfavorable soil conditions, active erosion, washing by water, or man's activities prevent vegetation growth. Miscellaneous areas are named for the limiting conditions, such as beaches, dumps, rock outcrop, and badlands.

mollic epipedon - A diagnostic soil horizon that is dark and thick and at least 0.6% organic carbon, a base saturation of at least 50% when measured at a pH of 7, and less than 250 ppm P_2O_5 soluble in citric acid. They are normally formed under grass vegetation.

Munsell color system - A color designation system that specifies the relative degrees of the three simple variables of color: hue, value, and chroma. For example: 10YR 6/4 is a color (of soil) with a hue = 10YR, value = 6, and chroma = 4. These notations can be translated into several different systems of color names as desired.

Ochrepts - Inceptisols formed in cold or temperate climates and that commonly have an ochric epipedon and a cambic horizon. They may have an umbric or mollic epipedon <25 cm thick or a fragipan or duripan under certain conditions. These soils are not dominated by amorphous materials and are not saturated with water for periods long enough to limit their use for most crops. (A suborder in the U.S. system of soil taxonomy.)

ochric epipedon - A surface horizon of mineral soil that is too light in color, too high in chroma, too low in organic carbon, or too thin to be a plagen, mollic, umbric, anthropic or histic epipedon, or that is both hard and massive when dry.

Orthents - Entisols that have either textures of very fine sand or finer in the fine earth fractions, or textures of loamy fine sand or coarser and a coarse fragment content of 35% or more and that have an organic carbon content that decreases regularly with depth. Orthents are not saturated with water for periods long enough to limit their use for most crops. (A suborder in the U.S. system of soil taxonomy.)

Orthids - In USDA taxonomy, a suborder of Aridisols characterized by the presence of a cambic, calcic, petrocalcic, gypsic, or salic horizon or a duripan and by the absence of an argillic or natric horizon. They form in sediments or on erosion surfaces of late Pleistocene or younger age and are products of the present environment.

outwash - Stratified glacial drift deposited by meltwater streams beyond active glacier ice.

oven-dry soil - Soil that has been dried at 105^{o}C until it reaches constant mass.

parent material - The unconsolidated and more or less chemically weathered mineral or organic matter from which the solum of soils is developed by pedogenic processes.

particle size - The effective diameter of a particle measured by sedimentation, sieving, or micrometric methods.

permanent wilting point - The largest water content of a soil at which indicator plants, growing in that soil, wilt and fail to recover when placed in a humid chamber. Often estimated by the water content at -1.5 MPa soil matric potential.

pH, soil - The negative logarithm of the hydrogen ion activity of a soil. The degree of acidity (or alkalinity) of a soil as determined by means of a glass, quinhydrone, or other suitable electrode or indicator at a specified moisture content in soil-water ratio, and expressed in terms of the pH scale.

phase, soil - A subdivision of a soil unit (usually a soil series) based upon characteristics significant to the use and management of the soils. Such characteristics typically include surface texture and slope group.

Pleistocene - An epoch of the Quaternary period before the Holocene. It began two to three million years ago and lasted until the start of the Holocene (8,000 years ago); also the corresponding series of rocks and deposits.

reaction, soil - The degree of acidity or alkalinity of a soil, usually expressed as a pH value. Descriptive terms commonly associated with certain ranges in pH are: extremely acid, <4.5; very strongly acid, 4.5-5.0; strongly acid, 5.1-5.5; moderately acid, 5.6-6.0; slightly acid, 6.1-6.5; neutral, 6.6-7.3; slightly alkaline, 7.4-7.8; moderately alkaline, 7.9-8.4; strongly alkaline, 8.5-9.0; and very strongly alkaline, >9.1.

relict - Adj. said of a topographic feature that remains after other parts of the feature have been removed or disappeared.

residuum - Mineral soil material that accumulates by disintegration of bedrock in place.

rock outcrop - Consists of exposures of base bedrock, other than lava flows and rock-lined pits. Most rock outcrops are of hard rock, but some are soft rock.

saturated soil paste - A particular mixture of soil and water. At saturation, the soil paste glistens as it reflects light, flows slightly when the container is tipped, and the paste slides freely and cleanly from a spatula.

saturation extract - The solution extracted from a soil at its saturation water content.

soil association - A kind of map unit used in soil surveys comprised of delineations, each of which shows the size, shape, and location of a landscape unit composed of two or more kinds of component soils or component soils and miscellaneous areas, plus allowable inclusions in either case. The bodies of component soils and miscellaneous areas are large enough o be delineated individually at the sale of 1:24,000. Several to numerous bodies of each kind of component soil or miscellaneous area are apt to occur at each delineation and they occur in a fairly repetitive and describable pattern. The proportions of the components may vary appreciably from one delineation to another and all of the components need not occur in every delineation though they will be present in most delineations.

soil compaction - Increasing the soil bulk density, and concomitantly decreasing the soil porosity, by the application of mechanical forces to the soil.

soil complex - (i) A kind of map u7nit used in soil surveys comprised of delineations, each of which shows the size, shape and location of a landscape unit composed of two or more kinds of components oils, or component soils and a miscellaneous area, plus allowable inclusions in either case. The bodies of component soils and the miscellaneous area are too small to be individually delineated at the scale of 1:24,000. Several numerous bodies of each kind of component soil or the miscellaneous area are apt to occur in each delineation. The proportions of the components may vary appreciably from one delineation to another and all of the components need not occur in every delineation though they will be present in most delineations. (ii) Formerly defined as in (i) but the scale of mapping was not specified. See component soil, soil consociation, soil association, undifferentiated group, miscellaneous areas.

soil consociation - A kind of map unit comprised of delineations, each of which shows the size, shape, and location of a landscape unit composed of one kind of component soil, or one kind of miscellaneous area, plus allowable inclusions in either case. The size, shape, and location of each component-soil body or miscellaneous area is shown as exactly as mapping intensity and inclusions permit. See component soil, soil complex, soil association, undifferentiated group, miscellaneous areas.

soil formation factors - The variable, usually interrelated natural agencies that are active in and responsible for the formation of soil. The factors are usually grouped into five major categories as follows: parent rock, climate, organisms, topography, and time.

soil horizon - A layer of soil or soil material approximately parallel to the land surface and differing from adjacent genetically related layers in physical, chemical, and biological properties or characteristics such as color, structure, texture, consistency, kinds and number of organisms present, degree of acidity or alkalinity, etc. See Appendix I for obsolete definitions of horizon designations, and Appendix IV, "New Designations for Soil Horizons and Layers."

soil interpretations - Predictions of soil behavior in response to specific uses or management based on inferences from soil characteristics and qualities (e.g., trafficability, erodibility, productivity, etc.). They are either qualitative or quantitative estimates or ratings of soil productivities, potentials, or limitations.

soil map - A map showing the distribution of soils or other soil map units in relation to the prominent physical and cultural features of the earth's surface.

soil sample - A representative sample taken from an area, a field, or portion of a field from which the physical and chemical properties can be determined.

soil series - The lowest category of U.S. system of soil taxonomy; a conceptualized class of soil bodies (polypedons) that have limits and ranges more restrictive than all higher taxa. Soil series are commonly used to name dominant or codominant polypedons represented on detailed soil maps. The soil series serve as a major vehicle to transfer soil information and research knowledge from one soil area to another.

subsoil - The soil below the surface soil and above the substratum. It includes the B horizon and other horizons in the equivalent vertical position.

substratum - Any layer lying beneath the soil solumn, either conforming or unconforming.

talus - Fragments of rock and other soil material accumulated by gravity at the foot of cliffs or steep slopes.

taxadjunct - A soil whose classification differs from the soil series giving the taxadjunct its name, but whose properties and behavior are very similar. A term used by the National Cooperative Soil Survey.

till - Unstratified glacial drift deposited by ice and consisting of clay, silt, sand, gravel, and boulders, intermingled in any proportion.

Torriorthents - A soil that is an Orthent with an aridic soil moisture regime and/or accumulated salts. A great group in the USDA soil taxonomy.

truncated - Having lost all or part of the upper soil horizon or horizons.

udic - A soil moisture regime that is neither dry for as long as 90 cumulative days nor for as long as 60 consecutive days in the 90 days following the summer solstice at periods when the soil temperature at 50 cm below the surface is above $5^{o}C$.

Umbrepts - Inceptisols formed in cold or temperate climates that commonly have an umbric epipedon, but they may have a mollic or an anthropic epipedon 25 cm or more thick under certain conditions. These soils are not dominated by amorphous materials and are not saturated with water for periods long enough to limit their use for most crops. (A suborder in the U.S. system of soil taxonomy.)

umbric epipedon - A surface layer of mineral soil that has the same requirements as the mollic epipedon with respect to color, thickness, organic carbon content, consistence, structure, and phosphorous content, but that has a base saturation <50% when measured at pH 7.

undifferentiated group - A kind of map unit used in soil surveys comprised of delineations each of which shows the size, shape, and location of a landscape unit composed of one or the others, or all of two or more component soils that have the same or very similar use and management for specified common uses. Inclusions may occur up to some allowable limit. The locations, shapes, or size of individual bodies of a component soil in a delineation cannot be known exactly, even ignoring inclusions, because one or all of the component soils may occur in any delineation. See component soil, soil consociation, soil complex, soil association, miscellaneous areas.

Ustic - In great groups of the USDA soil taxonomy it means soils that have a moisture regime transitional to an ustic soil moisture regime. For the aridic soils at the project site this means they are slightly moister than typical aridic soils.

Ustoll - A suborder of Mollisol, characterized by formation in an ustic moisture regime and in a mesic or warmer temperature regime. They are soils of mid to low latitudes with subhumid to semiarid climates. Because summer rainfall is erratic, drought is frequent and often severe. Productivity without irrigation is limited. Most Ustolls have a cambic, argillic, or natric horizon of lime acccumulation. Adjective: Ustollic.

varve - A distinct band representing the annual deposit in sedimentary materials regardless of origin and usually consisting of two layers, one a thick, light-colored layer of silt and fine sand and the other a thin, dark-colored layer of clay.

variant - A soil whose morphology or composition differs from the soils series giving the variant its name, but whose properties and behavior are similar. A term used by the National Cooperative Soil Survey.

water table - The upper surface of ground water or that level in the ground where the water is at atmospheric pressure.

water table, perched - The water table of a saturated layer of soil which is separated from an underlying saturated layer by an unsaturated layer (vadose water).

Xerolls - Mollisols that have a xeric soil moisture regime. Xerolls may have a calcic, petrocalcic, or hypsic horizon, or a duripan. (A suborder in the U.S. system of soil taxonomy.)

7.0 APPENDICES

LEGEND

102	Andic Dystrochrepts, lacustrine substratum
103	Andic Dystrochrepts, alluvial terraces
105	Fluventic Umbric Dystrochrepts, wet meadows
108	Andic Dystrochrepts and Typic Dystrochrepts, lacustrine and alluvial substratum
322	Typic Glossoboralfs, volcanic ash surface
351	Andic Dystrochrepts, glacial substratum, stream dissected slopes
352	Andic Dystrochrepts, glacial till substratum
355	Andic Dystrochrepts-Rock Outcrop complex, very cobbly substratum
381	Andic Dystrochrepts, thin glacial till substratum, stream dissected slopes
401	Andic Cryochrepts-Lithic Cryochrepts-Rock Outcrop complex, glacial trough walls
403	Rock Outcrop-Andic Cryochrepts-Lithic Cryochrepts complex, cirque headwalls
404	Andic Cryochrepts, glacial till substratum
403	Andic Cryochrepts-Lithic Cryochrepts complex, subalpine ridges and basins
406	Andic Cryochrepts, warm
407	Andic Cryochrepts glacial till substratum
408	Andic Cryochrepts, glacial till substratum, steep

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Lincoln & Sanders Counties, Montana

FIGURE 7.

LANDTYPE MAP - EXTENSIVE STUDY AREA

N ⇧ | JAN. 1989 | SCALE 1" = 2000'

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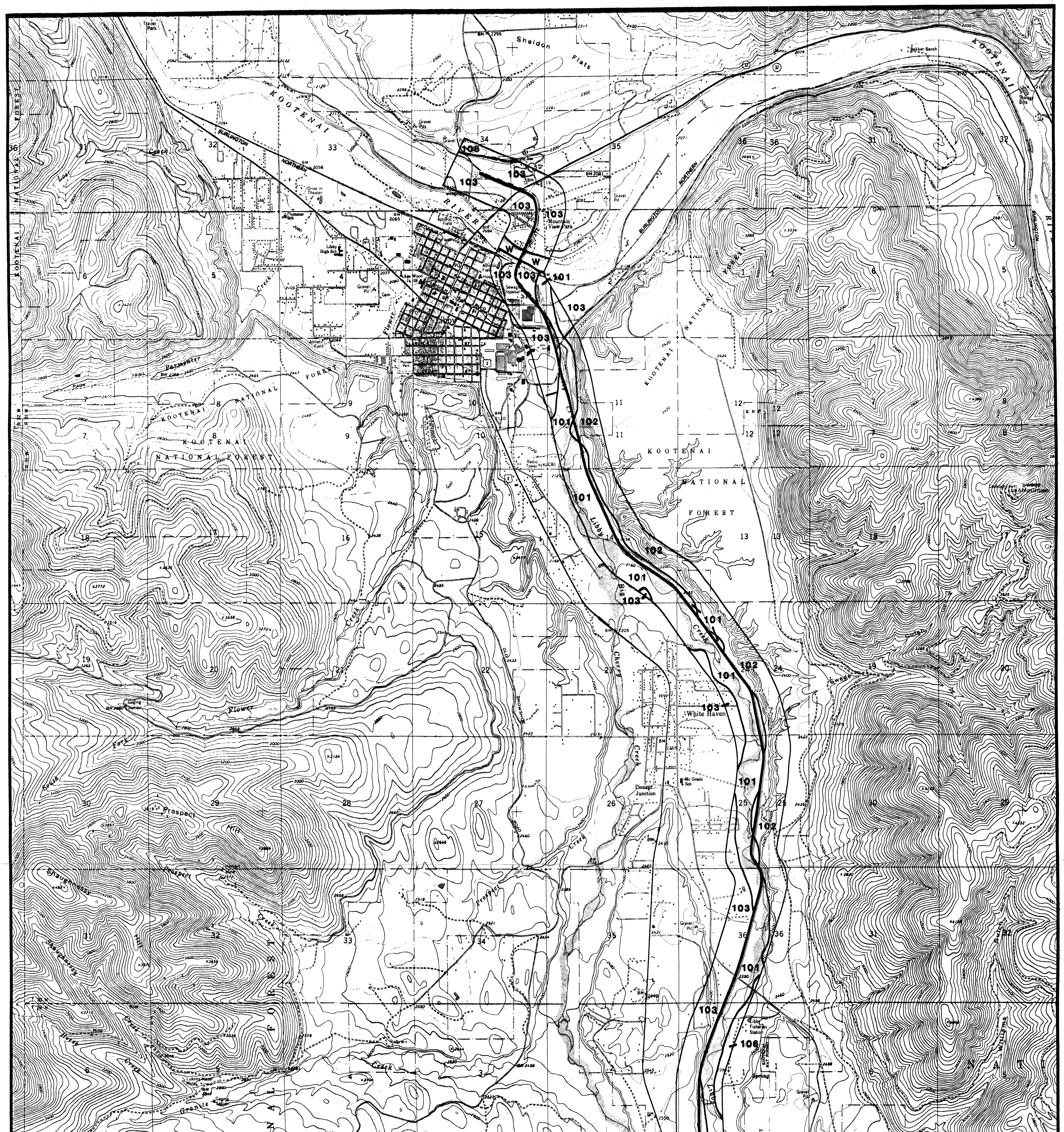
LEGEND
101 Fluvents, flood plains
102 Andic Dystrochrepts, lacustrine substratum
103 Andic Dystrochrepts, alluvial terraces
104 Andic Dystrochrepts–Andaquic Haplumbrepts somewhat poorly drained complex, glacial till substratum
106 Andic Dystrochrepts, glacial outwash substratum
108 Andic Dystrochrepts and Typic Dystrochrepts, lacustrine and aluvial substratum
W Water
NORANDA MINERALS CORP.
MONTANA PROJECT
Lincoln County, Montana
TOWN OF LIBBY TO PLANT SITES
ALTERNATIVE TRANSMISSION LINE
FIGURE 8a.
LANDTYPE MAP
MAP 1 OF 2
N
JAN. 1989
SCALE 1"=2000'
MAP 1 OF 2
2
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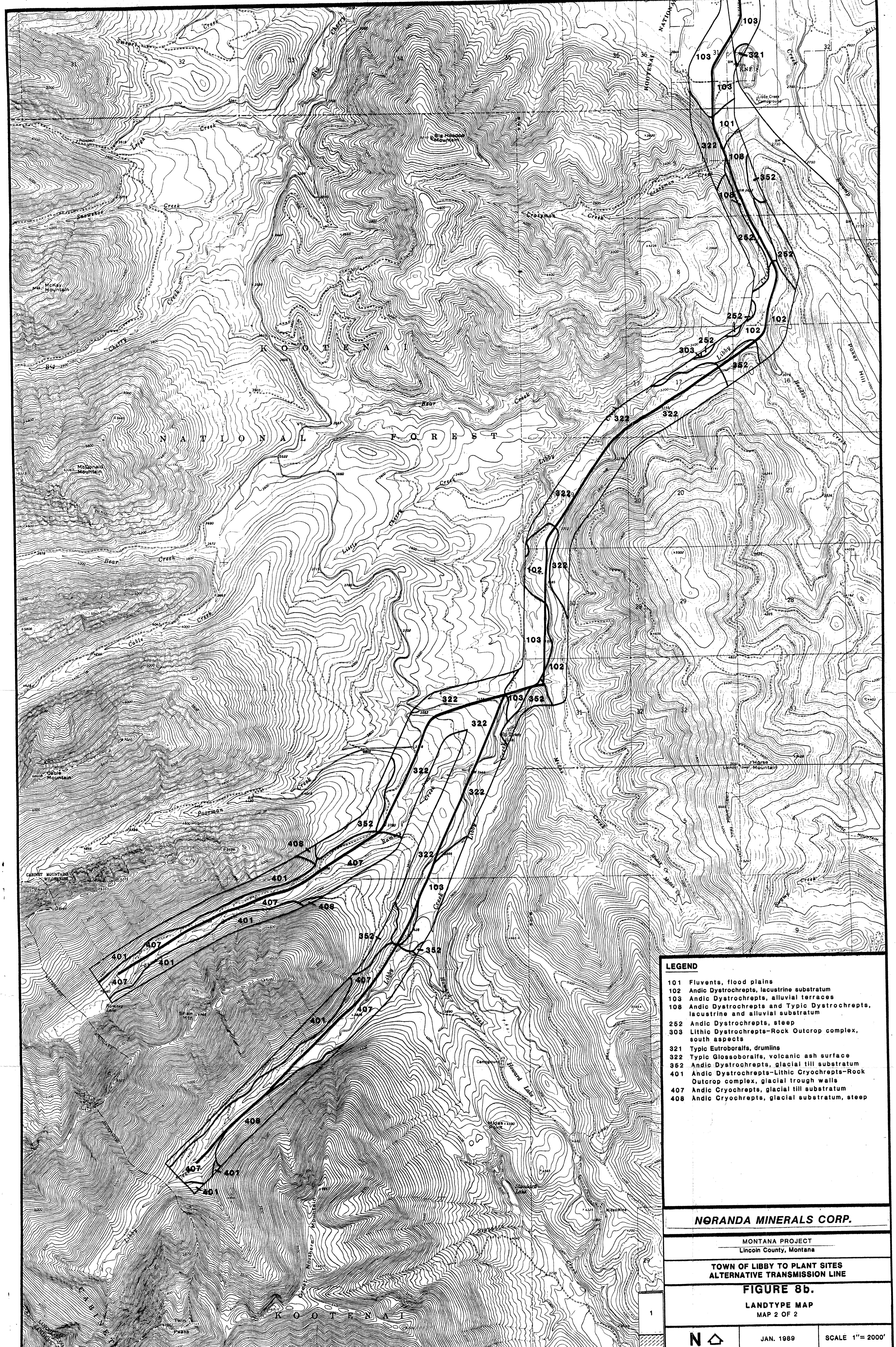
KOOTENAI RIVER
KOOTENAI NATIONAL FOREST
Sheldon Flats
White Haven
Little Hoodoo Mountain
McMillan Mountain
Prospect Hill
Flower Creek
Big Cherry Creek
Libby Creek


KOOTENAI NATIONAL FOREST
Libby Creek
Big Cherry Creek
Bear Creek
Little Cherry Creek
Poorman Creek
Howard Creek
Midas Creek
Crazyman Creek
McKay Mountain
McDonald Mountain
Cable Mountain
Big Horsley Mountain
Shaw Mtn
Howard Lake
Snowshoe Creek
Cable Creek
Libby Creek Campground
KOOTENAI
CABINET MOUNTAINS WILDERNESS
101
102
103
108
252
303
321
322
352
401
407
408
LEGEND
101 Fluvents, flood plains
102 Andic Dystrochrepts, lacustrine substratum
103 Andic Dystrochrepts, alluvial terraces
108 Andic Dystrochrepts and Typic Dystrochrepts, lacustrine and alluvial substratum
252 Andic Dystrochrepts, steep
303 Lithic Dystrochrepts–Rock Outcrop complex, south aspects
321 Typic Eutroboralfs, drumlins
322 Typic Glossoboralfs, volcanic ash surface
352 Andic Dystrochrepts, glacial till substratum
401 Andic Dystrochrepts–Lithic Cryochrepts–Rock Outcrop complex, glacial trough walls
407 Andic Cryochrepts, glacial till substratum
408 Andic Cryochrepts, glacial substratum, steep
NORANDA MINERALS CORP.
MONTANA PROJECT
Lincoln County, Montana
TOWN OF LIBBY TO PLANT SITES
ALTERNATIVE TRANSMISSION LINE
FIGURE 8b.
LANDTYPE MAP
MAP 2 OF 2
1
MAP 2 OF 2
N
JAN. 1989
SCALE 1"= 2000'
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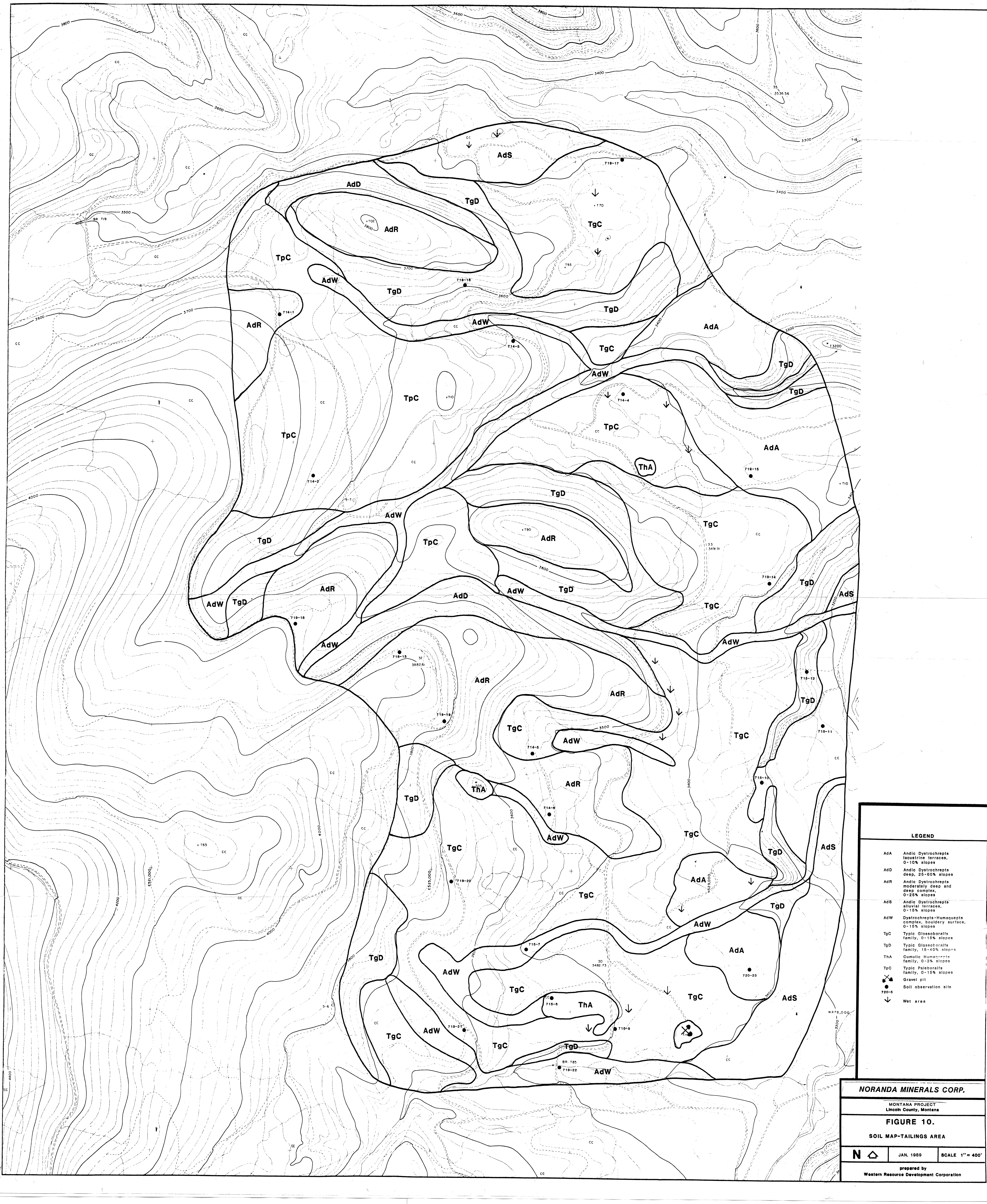
NORANDA MINERALS CORP.
MONTANA PROJECT
Sanders & Lincoln Counties, Montana
MILLER CREEK TO PLANT SITES
ALTERNATIVE TRANSMISSION LINE
FIGURE 9.
LANDTYPE MAP
N
JAN. 1989
SCALE 1"= 2000'
prepared by
Western Resource Development Corporation
LEGEND
101 Fluvents, flood plains
103 Andic Dystrochrepts, alluvial terraces
105 Fluventic Umbric Dystrochrepts, wet meadows
108 Andic Dystrochrepts and Typic Dystrochrepts, lacustrine and alluvial substratum
112 Eutric Glossoboralfs, clayey, lacustrine substratum
252 Andic Dystrochrepts, steep
301 Typic Eutrochrepts, glacial till substratum
302 Typic Eutrochrepts, glacial till substratum
303 Lithic Dystrochrepts-Rock Outcrop complex, south aspects
322 Typic Glossoboralfs, volcanic ash surface
352 Andic Dystrochrepts, glacial till substratum
353 Andic Cryochrepts-Lithic Cryochrepts-Rock Outcrop complex, rolling ridges
355 Andic Cryochrepts-Rock Outcrop complex, very cobbly substratum
401 Andic Dystrochrepts-Lithic Cryochrepts-Rock Outcrop complex, glacial trough walls
407 Andic Cryochrepts, glacial till substratum
408 Andic Cryochrepts, glacial till substratum steep
KOOTENAI
NATIONAL FOREST



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MONTANA PROJECT
Lincoln County, Montana

FIGURE 10.

SOIL MAP-TAILINGS AREA

N | JAN. 1989 | SCALE 1" = 400'

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