Appendix 3.7-A to 4.3-A. Volume 6 1989

Green Bay, Wisconsin: Foth and Van Dyke, 1989

Foth & Van Dyke

REPORT

Environmental Impact Report for the Kennecott Flambeau Project

Scope I.D.: 87K10

Volume VI - Appendix 3.7-A to 4.3-A

Kennecott Minerals Company
Ladysmith, Wisconsin

April 1989

VOLUME 6
APPENDIX 3.7-A TO 4.3-A
ENVIRONMENTAL IMPACT REPORT
FOR THE
KENNECOTT FLAMBEAU PROJECT

Prepared for:

KENNECOTT MINERALS COMPANY

Prepared by:

FOTH & VAN DYKE and Associates Inc.
and Consultants
2737 S. Ridge Road
P. O. Box 19012
Green Bay, Wisconsin 54307-9012

APRIL 1989

Foth & Van Dyke
2737 S. Ridge Road
P. O. Box 19012
Green Bay, Wisconsin 54307-9012
414/497-2500

APPENDIX 3.7-A

Flambeau River Flood Study
March 1, 1989

Engineers
Architects
Planners
Scientists
Economists

Foth & Van Dyke

2737 S. Ridge Road
P. O. Box 19012
Green Bay, WI 54307-9012
414/497-2500

March 1, 1989

TO: Jerry W. Sevick 87K10

FR: Mike D. Liebman MDL

RE: Report on Kennecott Flambeau Project
Flambeau River Flood Study

GENERAL

Last spring, a detailed hydraulic study was begun on the Flambeau River along the Kennecott site to assess the site's relationship to the regional (100-year) floodplain. Preliminary results delineated the floodplain boundaries coinciding with the 100-year flood elevation of 1,095.53 feet above mean sea level (MSL) at the site. Additional study was needed following survey and contour verification. Having completed those tasks, the hydraulic model has been modified to reflect the actual, updated contours. This report summarizes the results of the final floodplain analysis.

METHODOLOGY

As explained in the Flambeau River flood study memorandum memo dated March 9, 1988, an existing Flood Insurance Study (FIS) had been completed for nearby Ladysmith in 1978. Data from this study, including flow values and upstream cross sections, were used in this expanded reach modeling. The model output is attached (Table 1), along with a map of the area showing the various valley cross sections (Figure 1).

RESULTS

The effect of the model modifications was a small decrease in the 100-year flood elevation at the Kennecott site to an elevation of 1,095.44 feet MSL. Any point along the river lower than 1,095.44 feet is therefore in the regional floodplain of the Flambeau River. The floodplain ends on the east bank, about 210 feet landward from the normal river edge.

An intermittent stream or large swale runs eastward from the river up into the Kennecott site. This swale remains below an elevation of 1,095.44 feet MSL until about 100 feet east of the local floodplain line creating a "finger" of floodplain along the swale. This "finger" will not convey the Flambeau River flood waters and, as such, is considered to be a flood fringe. The storage capability of the flood fringe "finger" is clearly insignificant.

MDL:mms

50 years

```
T1      FLAMBEAU RIVER BELOW LADYSMITH                          FOTHERAN DYKE, MSC
T2      KENNECOT DEVELOPMENT                                    OCTOBER, 1988
T3      100-YEAR FLOOD - EXISTING CONDITIONS                    FILE 'KENNEC'
J1 -10     5.                    0.0004                            1092.
NC .065    .065     .027     .1      .3
QT     5   9960    17200    23800   26800   33800
X1 3.      19.      42.      419.                                    - 9
GB1100.0     -77  1095.7      -26  1092.6       0  1091.       23  1087.8      42
GB1084.5      49  1083.2       75  1083.5      93  1083.5      125  1082.7     163
GB1082.4     236  1082.0      290  1081.7     310  1081.7      326  1082.0     340
GB1083.2     373  1084.5      392  1089.4     419  1100.0      560
X1 4.                             1400.   1400.   1400.          0.6
X1 5.                             860.    720.    760.           0.3
X1 5.3   19.      256.    570.    700.    700.    700.
GB 1100.  120.    1096.    143.   1092.    190.   1088.    256.    1084.8   257.
GB 1084.  265.    1082.5   275.   1082.2   293.   1083.2   330.    1083.3   370.
GB1082.8  446.    1081.9   492.   1082.1   540.   1082.2   560.    1085.7   565
GB1085.   570.    1088.    580.   1104.    630.   1106.    678.
NE 3.     .065    18.      .027   433.     .080   540.
X1 6.      17.     18.     433.    1780.   1780.   1780.
GB1100.0     -90  1094.0      -46  1092.0      67  1088.0      100  1086.1     110
GB1084.3     120  1083.6      128  1083.0     153  1083.2      188  1084.3     179
GB1094.3     195  1085.0      216  1085.7     414  1089.7      433  1094.2     449
GB1100.0     480  1120.0      520
NE     3   .070      14     .026     382    .080     450
X1     7     33       14     382     2580    2580    2580
GB1106.0    -410  1104.0     -410  1103.5     -380  1103.0     -355  1102.0    -310
GB1100.0    -290  1098.0     -230  1095.2      -30  1087.7      -20  1086.2      14
GB1087.2      26  1087.0       48  1086.2       53  1085.8       83  1085.4     108
GB1086.1     132  1086.1      148  1085.2      161  1085.1      195  1085.3     215
GB1085.8     229  1085.8      255  1085.6      269  1085.8      284  1085.8     299
GB1086.3     327  1086.1      373  1085.3      360  1089.7      382  1092.7     409
GB1096.2     428  1100.0      430  1102.0      450
NE 3.       .09     0.0     .026     285.    .085     420.
X1 7.5      22.      1.0     285.    1540.   1540.    1540.
GB1106.0    -280  1104.0     -280  1103.0     -215  1102.0     -145  1101.0    -102
GB 1100.    -97.    1098.    -88.   1094.    -32.    1093.7    -23.    1090.2     1.0
GB1088.0      23  1087.3       42  1086.0       71  1085.2       82  1084.8     110
GB1094.2     126  1084.1      194  1085.9      275  1087.4      282  1089.7     285
GB1094.1     317  1106.0      420
NE 3.       .070     0.0     .026     277.    .080     355.
X1     8     22        1     277     1690    1690    1690
GB1108.0    -320  1106.0     -300  1104.0     -280  1103.0     -270  1102.0    -260
GB1100.0    -240  1098.0     -215  1093.7      -54  1092.3      -25  1090.2      1.
GB1085.6      68  1084.6       93  1083.5      113  1083.7      137  1084.2     153
GB1084.7     178  1087.2      208  1087.6      232  1091.4      251  1093.7     277
GB1100.0     315  1102.0      355
NE     3   .070      10     .027     345    .060     470
X1   8.5      8       10     345     520     520     520
GB1105.0     -90  1087.6       10  1087.0      70  1086.0      280  1087.6     345
GB1096.0     394  1098.0      414  1105.0     470
NE 3.       .07      8.      .026     340.    .060     480.
X1     9     25        8     340     1340    1340    1340
GB1100.0     -50  1095.3        8  1089.8      25  1088.9       40  1088.5      55
GB1088.5      85  1089.1      100  1088.7     115  1088.3      135  1087.4     144
GB1086.6     155  1086.6      166  1086.1     180  1086.2      198  1086.8     210
GB1088.3     225  1087.8      240  1087.7     255  1087.8      270  1087.8     285
GB1086.8     315  1088.8      330  1094.8     340  1100.0      365  1110.0     400
NE 3.       .07     28.      .027     423.    .075     595.
X1    10     24       28     423     2340    2340    2340
GB1110.0     -50  1100.0      -10  1094.2      20  1092.5       28  1091.4      37
GB1089.7      57  1087.1      146  1089.7     168  1087.5      188  1088.5     208
GB1087.5     251  1087.0      261  1086.0     272  1087.2      292  1087.9     322
GB1087.9     360  1087.2      380  1087.8     392  1090.0      404  1095.8     423
GB1100.0     460  1104.0      500  1106.0     555  1110.0      595
NE 3.       .07      0.      .028     418.    .09     560.
X1    11     24        0     418     1700    1700    1700
GB1110.0     -50  1098.5        0  1096.0       8  1093.7       23  1092.5      25
GB1090.4      42  1089.2       63  1088.6      98  1089.3      142  1088.8     177
GB1087.8     212  1086.5      233  1087.0     254  1087.7      290  1089.1     325
GB1089.8     343  1089.7      366  1090.3     363  1092.0      380  1102.2     418
GB1102.8     432  1104.0      447  1106.0     510  1110.0      560
NE 3.       .07     15.      .026     348.    .08     444.
X1  12.     19.      15.     348.    1850.   1850.   1850.
GB1110.0     -45  1106.3      -22  1100.8       0  1094.8       15  1092.7      17
GB1090.7      33  1091.0       78  1090.9     131  1091.3      168  1090.1     198
GB1089.2     228  1088.4      243  1088.4     275  1090.2      306  1092.8     337
GB1096.7     348  1100.0      352  1108.0     422  1110.0      444
EJ
```

Table 3.7-A1
100-Year Flood Plain Model

EE

39000 N
39500 N
40000 N
40500 N
41000 N
41500 N
38000 E
38500 E

FLAMBEAU RIVER

CROSS SECTION 5.3
100 YEAR ELEVATION = 1095.44

CROSS SECTION 5.0
100 YEAR ELEVATION = 1095.23

CROSS SECTION 6.0
100 YEAR ELEVATION = 1096.51

NOTES:

1. SITE LOCATION: SECTIONS 9, 10, 15 & 16, T34N, R6W, RUSK COUNTY, WISCONSIN.
2. TOPOGRAPHIC BASE MAP PREPARED FROM AERIAL SURVEY BY SURDEX CORPORATION, CHESTERFIELD, MISSOURI. DATE OF PHOTOGRAPHY - APRIL 24, 1970. ROADS, TREES AND BUILDINGS WERE UPDATED AS PER AERIAL PHOTOGRAPH TAKEN BY MARKHURD CORPORATON, MINNEAPOLIS, MINNESOTA. DATE OF PHOTOGRAPHY - SEPTEMBER 14, 1987.
3. ELEVATIONS BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS TWO FEET.
4. HORIZONTAL DATUM BASED ON WISCONSIN STATE PLANE COORDINATE SYSTEM, NORTH ZONE. SITE GRID COORDINATES DERIVED AS FOLLOWS:

SITE GRID-CONTROL MONUMENT F-1	STATE PLANE
40000 N =	587,357.8087 N
40000 E =	1,713,516.1229 E

THE ANGULAR ROTATION FROM STATE PLANE BEARINGS TO SITE GRID BEARINGS IS 359°-13'-23" RIGHT WITH CONTROL POINT F-1 AS THE BASE POINT.

N

0 100' 200'
SCALE

LEGEND

- EXISTING GROUND CONTOUR
- DEPRESSION
- TREES AND/OR BRUSH
- EXISTING ROADWAY
- EXISTING TRAIL
- EXISTING FENCE
- 100 YEAR FLOODPLAIN BOUNDRY
- 100 YEAR FLOODWAY LINE
- PROPOSED PIT PERIMETER

FOTH & VAN DYKE
GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION
GREEN BAY, WISCONSIN

FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

KENNECOTT MINERALS COMPANY
515 MINERAL SQUARE
SALT LAKE CITY, UTAH
84112

FIGURE NO. 3.7-A 1
FLAMBEAU RIVER
FLOODPLAIN INFORMATION

MICROFILM | JOB
DRAWING NO. | REV.
DIVISION DRAWING NO.
SCALE | SEE BAR SCALE

REFERENCES

DWG. NO.	DESCRIPTION

REFERENCES

DWG. NO.	DESCRIPTION

NO.	DATE	REVISIONS	BY	CHK'D	ENG'R	ENG'R MGR.

NO.	DATE	REVISIONS	BY	CHK'D	ENG'R	ENG'R MGR.

	BY	DATE
PROJ. ENG'R		
MGR. PROCESS ENG'G.		
ENG'R MGR.		

	BY	DATE
DESIGN		
DRAWN	MJO	3/22/89
CHK'D	MDL	3/22/89
DES. ENG'R		
SECT ENG'R		

APPENDIX 3.8-A

Fish Lengths and Abundances

APPENDIX 3.8-A

Fish Lengths and Abundances

Species	No.	Size Range
Rock Bass	3	5.5-07.0"
Smallmouth Bass	14	6.5-12.0"
Walleye Pike	2	14.0-20.0"
Northern Pike	6	16.5-28.4"
Muskellunge	1	32.0"
Yellow Perch	30	<3.0-08.0"
Sunfish	1	4.5"
Crappie	1	5.0"
Silver Redhorse	4	12.0-18.0"
Shorthead Redhorse	2	15.5-19.0"
White Sucker	5	7.5-18.0"
Emerald Shiner	3	4.0"
Lake Sturgeon	4	20.0-41.0"

Source: Foth & Van Dyke, 1987-1988

SUMMARY FISHING RECORD

DEPARTMENT

BEST COPY AVAILABLE

FORM 3600-63*

*First one hour panfish/rough fish intensive effort.

COUNTY	WATERS
Rusk	Thornapple Flowage (Flambeau River)
SAMPLING OBJECTIVE: Length and numbers survey.	NUMBER AND LOCATION OF STATIONS (HABITAT): Starting at dam and going two miles upstream to section 19 border, and return on opposite shore line.
PERIOD FISHED (DATES): 5-16-88	

GEAR

BOOM SHOCKER (HOURS)	TIME
3 hours (Panfish/rough fish intensive - first hr. only)	8:00 pm NIGHT 11:00 pm

VISUAL HOURS	TIME OF DAY	HAUL SEINE (LENGTH)	MESH	AREA COVERED
ANGLING (HOURS)	TIME OF DAY	TRAP NET (NO. OF NET LIFTS)	MESH	DEPTH
MINNOW SEINE (NO. HAULS)	AREA COVERED	GILL NET (NO. OF FEET X NO. OF LIFTS)	MESH SIZE	DEPTH

OTHER (HOURS OR LIFTS)	CHARACTERISTICS
VV AC Boomshocker.	Dark water flowage.

FISHING RESULTS

SPECIES	NO.	MODAL SIZE(S)	SIZE RANGE	1 Hr. CATCH/UNIT	Total Hrs
Musky	3		10.0-23.4		1.0
Smallmouth Bass	2		7.0-9.4		0.67
Northern Pike	20	12.0	8.5-23.7		6.67
Walleye	76	9.9	5.8-16.8		25.33
Bluegill	2		2.0-2.4	2	0.67
Pumpkinseed	3		2.3-3.3	3	1.0
Yellow Perch	1		3.5	1	0.33
Rock Bass	1		6.6	1	0.33
W. Sucker	11		1.8-15.2	11	3.67
Golden Redhorse	2	23.0	23.0	2	0.67
Shorthead Redhorse	18		2.4-16.2	18	6.0

OBSERVATIONS

Many small (6-9") walleye observed.

Common shiner -3.2"

Johny darter - 2.0"

Sturgeon -20.2"

	SIGNED (COMPILER)	DATE
	James Moore	5-25-88

BEST COPY AVAILABLE

GAME FISH LENGTH FREQUENCY

FORM 3600-65 REV. 3-80

INCHES

COUNTY	WATER	DATE	GEAR
Rusk COUNTY CODE — —	Thornapple Flo. WATER CODE — — — —	5-16-88	VV AC Boom Shocker

SIZE RANGE — INCHES	SPECIES				SIZE RANGE — INCHES	SPECIES		
	Walleye	SMB	Musky	NP		Sturgeon		
<3.0					27.0-27.4	20.2		
3.0- 3.4					27.5-27.9			
3.5- 3.9					28.0-28.4			
4.0- 4.4					28.5-28.9			
4.5- 4.9	2				29.0-29.4			
5.0- 5.4	2				29.5-29.9			
5.5- 5.9	2				30.0-30.4			
6.0- 6.4	5				30.5-30.9			
6.5- 6.9	5				31.0-31.4			
7.0- 7.4	1	1			31.5-31.9			
7.5- 7.9	5				32.0-32.4			
8.0- 8.4	5				32.5-32.9			
8.5- 8.9	6			1	33.0-33.4			
9.0- 9.4	6	1			33.5-33.9			
9.5- 9.9	7			1	34.0-34.4			
10.0-10.4	3		1		34.5-34.9			
10.5-10.9	7				35.0-35.4			
11.0-11.4	3			1	35.5-35.9			
11.5-11.9	2			1	36.0-36.4			
12.0-12.4	4			2	36.5-36.9			
12.5-12.9	5			1	37.0-37.4			
13.0-13.4	2			2	37.5-37.9			
13.5-13.9					38.0-38.4			
14.0-14.4	1				38.5-38.9			
14.5-14.9				1	39.0-39.4			
15.0-15.4	1				39.5-39.9			
15.5-15.9				1	40.0-40.9			
16.0-16.4					41.0-41.9			
16.5-16.9	2		1	1	42.0-42.9			
17.0-17.4				1	43.0-43.9			
17.5-17.9					44.0-44.9			
18.0-18.4					45.0-45.9			
18.5-18.9					46.0-46.9			
19.0-19.4				1	47.0-47.9			
19.5-19.9				1	48.0-48.9			
20.0-20.4				1	49.0-49.9			
20.5-20.9					50.0-50.9			
21.0-21.4				2	51.0-51.9			
21.5-21.9					52.0-52.9			
22.0-22.4					53.0-53.9			
22.5-22.9				1	54.0-54.9			
23.0-23.4			1		55.0-55.9			
23.5-23.9				1	56.0-56.9			
24.0-24.4					57.0-57.9			
24.5-24.9					58.0-58.9			
25.0-25.4					59.0-59.9			
25.5-25.9					60.0+			
26.0-26.4								
26.5-26.9				3.8-A-3				
TOTAL	76	2	2	20	TOTAL	1		

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

PANFISH LENGTH FREQUENCY
FORM 3600-64 REV

INCHES

COUNTY	WATER	DATE	GEAR
Rusk COUNTY CODE — —	Thornapple Flo. WATER CODE — — — —	5-16-88	VV AC Boom Shocker

SIZE RANGE INCHES	SPECIES				SIZE RANGE INCHES	SPECIES				
	BG	Pumpkinseed	RB	YP		SHRH	GRH	WS	CS	JD
1.0-1.4					7.0	12.9	23.0	14.2	3.2	2.0
1.5-2.0	1				7.1	16.2	23.0	7.7		
2.1					7.2	7.7		5.2		
2.2					7.3	15.0		15.2		
2.3		1			7.4	6.7		2.0		
2.4	1				7.5	6.6		4.3		
2.5					7.6	6.8		1.8		
2.6					7.7	16.0		6.2		
2.7					7.8	7.6		3.6		
2.8					7.9	14.5		3.1		
2.9					8.0	15.8		2.2		
3.0					8.1	8.0				
3.1					8.2	5.5				
3.2		1			8.3	3.2		-		
3.3		1			8.4	7.4				
3.4					8.5	7.3				
3.5				1	8.6	7.1				
3.6					8.7	2.4				
3.7					8.8					
3.8					8.9					
3.9					9.0					
4.0					9.1					
4.1					9.2					
4.2					9.3					
4.3					9.4					
4.4					9.5					
4.5					9.6					
4.6					9.7					
4.7					9.8					
4.8					9.9					
4.9					10.0					
5.0					10.2					
5.1					10.4					
5.2					10.6					
5.3					10.8					
5.4					11.0					
5.5					11.2					
5.6					11.4					
5.7					11.6					
5.8					11.8					
5.9					12.0					
6.0					12.2					
6.1					12.4					
6.2					12.6					
6.3					12.8					
6.4					13.0					
6.5					13.2					
6.6			1		13.4					
6.7					13.6					
6.8				3.8-A-4	13.8					
6.9					14.0+					
TOTALS	2	3	1	1	TOTALS	18				

APPENDIX 3.8-B

Stream Navigability

(AD-75)

CORRESPONDENCE/MEMORANDUM

NOV 25 1988

STATE OF WISCONSIN

Date: November 23, 1988 *File Ref:* 3500
NW-P191

To: Bob Ramharter - EZ/6

From: Roger Jasinski

Subject: Navigability of Flambeau River Tributary Streams in the Kennecott Project Area, Rusk County

There are four small streams flowing through or in the immediate vicinity of the Kennecott proposed mine site adjacent to the Flambeau River in Rusk County. The streams are labeled A, B, C and D on the attached map.

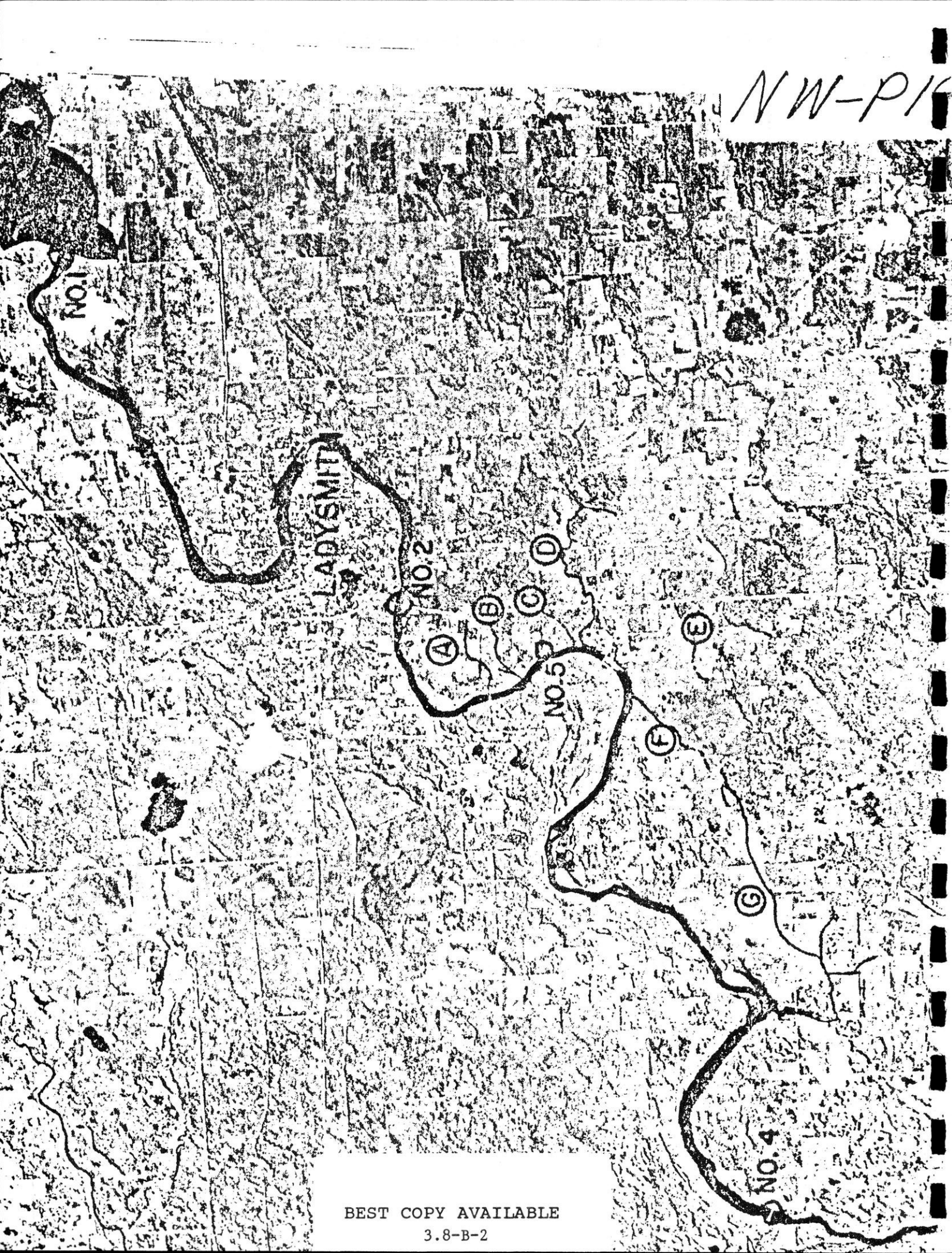
Stream A enters the Flambeau River north of the proposed mine site. Stream B flows through the proposed open pit. Stream C and stream D (Meadowbrook Creek) are south of the site. Navigability determinations were made based on site visits April 6, 1988, May 12, 1988 and June 14, 1988. In addition topographic maps were used to compare drainage areas and 1973 peak flow measurements were reviewed and compared to 1973 flood flows for other streams in the basin.

Streams A and B are not navigable under Wisconsin Law. These streams could not be physically navigated during any of my site visits. The small channel dimensions and drainage areas make it unlikely that flow in these streams is ever sufficient to permit navigation. Peak flows of 1.0 cfs and 1.4 cfs measured in 1973 confirm this conclusion.

Stream D appeared to be physically navigable during each of my site visits. Considering that this was a drought year, stream D is probably navigable in fact at practically all times and is definitely a navigable stream under Wisconsin Law.

Stream C was not navigable during any of my site visits, however it does have a larger drainage area and higher peak measured flow (6.2 cfs) than either streams A or B. The stream channel was barely discernable where it crosses highway 27. This is probably the result of past channelization and also this year's drought which allowed the stream to become overgrown with marsh grasses. Stream channel dimensions increase steadily as you go downstream. Based on stream channel dimensions and measured flows, I am confident the lower 1000 feet to 1500 feet of stream thread could be navigated on a recurring basis although numerous deadfalls and areas of steep gradient would make portages necessary. It is quite possible that the entire reach of stream from highway 27 to the Flambeau River could be navigable, however, this year's drought conditions made this impossible to verify.

RLJ:smw
cc: NWD
Foth and Van Dyke and Associates, Inc.



BEST COPY AVAILABLE

APPENDIX 3.8-C

Wetlands Inventory and Assessment

WETLAND INVENTORY AND ASSESSMENT
KENNECOTT FLAMBEAU PROJECT

Prepared for:

KENNECOTT MINERALS COMPANY

Prepared By:

FOTH & VAN DYKE and Associates Inc.
2737 S. Ridge Road
P. O. Box 19012
Green Bay, Wisconsin 54307-9012

MARCH 1989

Foth & Van Dyke
2737 S. Ridge Road
P. O. Box 19012
Green Bay, Wisconsin 54307-9012
414/497-2500

TABLE OF CONTENTS

87K10

TABLE OF CONTENTS (Cont.)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

87K10

1.0 INTRODUCTION

1.1 Background

In 1987, Kennecott Minerals Company (Kennecott) notified the U.S. Army Corps of Engineers, St. Paul District, U.S. Environmental Protection Agency (USEPA) - Region V, U.S. Fish and Wildlife Services, and the Wisconsin Department of Natural Resources (WDNR), of its intention to seek permits for the Flambeau Project, a proposed copper mine to be located near Ladysmith, Wisconsin.

In 1988, a report entitled *Preliminary Wetland Inventory and Assessment* was issued by Foth & Van Dyke on behalf of Kennecott to identify potential wetlands of the project area based on Corps of Engineer and Wisconsin NR 132 criteria. In May 1988, a site reconnaissance of all potential wetlands was carried out by representatives from the U.S. Army Corps of Engineers, USEPA-Region V, the WDNR, the Public Intervenor's office, Kennecott, Foth & Van Dyke, and other parties.

As a result of that meeting and subsequent field investigations, a final wetland inventory and assessment was prepared.

1.2 Purpose

The purpose of this document is to describe and evaluate the wetlands in the area of the proposed Kennecott Flambeau Project in Ladysmith, Wisconsin. The proposed mining project includes an open pit and facilities required to size and ship ore to a processing plant located out-of-state. The wetlands assessment provides an inventory of the potential wetlands in the study area and evaluates the relative importance of those areas according to methods and functions prescribed in Wisconsin Administrative Code NR 132 and the *Corps of Engineers Wetlands Delineation Manual* (Dept. of Army, 1987).

1.3 Criteria for Inclusion in Inventory

"Wetlands" is a term that can refer to a wide variety of ecosystems. The term implies a system that supports hydrophytic communities, whether they be classified as water bodies, marshes, swamps, or any other of many categories of "wet" lands. The definition used here to comply with State of Wisconsin requirements is provided in Wisconsin Administrative Code NR 132, and reads as follows:

> "Wetlands" means an area where water is at, near, or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation and which has soils indicative of wet conditions.

The inventory of wetlands for the study area was developed using these criteria.

The U.S. Army Corps of Engineers technical guidelines does not constitute a classification system; rather, it provides a basis for delineating wetlands for the purposes of implementing Section 404. The U.S. Fish and Wildlife Service has developed a classification system for wetlands which the Corps of Engineers recognizes for the purposes of wetland mapping. The Fish and Wildlife Service definition of a wetland is similar to that developed by the WDNR and differs from the Corps of Engineers definition. Not all of the wetlands identified in the Fish and Wildlife Service System are included in the wetlands delineated under the Corps of Engineers guidelines. The difference is as follows:

> "The FWS system requires that a positive indicator of wetlands be present for any one of the three parameters, while the technical guideline for wetlands requires that a positive wetland indicator be present for each parameter (vegetation, soils, and hydrology), except in limited instances identified in the manual" (Dept. of Army, 1987).

1.3.1 Wetland Habitats

The following definition, diagnostic environmental characteristics, and technical approach compose a guideline for the identification and delineation of wetlands according to the U.S. Army Corps of Engineers (Dept. of Army, 1987) for purposes of complying with section 404 of the Clean Water Act:

- "Definition - The Corps of Engineers and the USEPA jointly define wetlands as: Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamp, marshes, bogs, and similar areas.

- Diagnostic Environmental Characteristics - Wetlands have the following general diagnostic environmental characteristics:

  - Vegetation. The prevalent vegetation consists of macrophytes that are typically adapted to areas having hydrologic and soil conditions described above. Hydrophytic species, due to morphological, physiological, and/or reproductive adaptation(s), have the ability to grow, effectively compete, reproduce, and/or persist in anaerobic soil conditions.

  - Soil. Soils are present and have been classified as hydric, or they possess characteristics that are associated with reducing soil conditions.

- Hydrology. The area is inundated either permanently or periodically at mean water depths ≤6.6 ft, or the soil is saturated to the surface at some time during the growing season of the prevalent vegetation.

· Technical Approach for the Identification and Delineation of Wetlands - Except in certain situations defined in this manual, evidence of a minimum of one positive wetland indicator from each parameter (hydrology, soil, and vegetation) must be found in order to make a positive wetland determination."

1.3.2 Deepwater Aquatic Habitats

The following definition, diagnostic environmental characteristics, and technical approach compose a guideline for deepwater aquatic habitats (Dept. of Army, 1987):

· "Definition - Deepwater aquatic habitats are areas that are permanently inundated at mean annual water depths >6.6 ft or permanently inundated areas ≤6.6 ft in depth that do not support rooted-emergent or woody plant species.

· Diagnostic Environmental Characteristics - Deepwater aquatic habitats have the following diagnostic environmental characteristics:

- Vegetation - No rooted-emergent or woody plant species are present in these permanently inundated areas.

- Soil - The substrate technically is not defined as a soil if the mean water depth is >6.6 ft or if it will not support rooted emergent or woody plants.

- Hydrology - The area is permanently inundated at mean water depths >6.6 ft.

· Technical Approach for the Identification and Delineation of Deepwater Aquatic Habitats - When any one of the diagnostic characteristics is present, the area is a deepwater aquatic habitat."

1.3.3 Nonwetlands

The following definition, diagnostic environmental characteristics, and technical approach compose a guideline for the identification and delineation of nonwetlands:

· "Definition. Nonwetlands include uplands and lowland areas that are neither deepwater aquatic habitats, wetlands, nor other special aquatic sites. They are seldom or never inundated, or if frequently inundated, they have saturated soils for only brief periods during the growing season, and, if vegetated, they normally

support a prevalence of vegetation typically adapted for life only in aerobic soil conditions.

- Diagnostic environmental characteristics. Nonwetlands have the following general diagnostic environmental characteristics:

  - Vegetation - The prevalent vegetation consists of plant species that are typically adapted for life only in aerobic soils. These mesophytic and/or xerophytic macrophytes cannot persist in predominantly anaerobic soil conditions.

  - Soil - Soils, when present, are not classified as hydric, and possess characteristics associated with aerobic conditions.

  - Hydrology - Although the soil may be inundated or saturated by surface water or groundwater periodically during the growing season of the prevalent vegetation, the average annual duration of inundation or soil saturation does not preclude the occurrence of plant species typically adapted for life in aerobic soil conditions.

- Technical approach for the identification and delineation of nonwetlands. When any one of the diagnostic characteristics identified in Diagnostic Environmental Characteristics above is present, the area is a nonwetland" (Dept of Army, 1987).

1.4 Study Area

The study area selected for the wetlands assessment includes all areas that may directly or indirectly be affected by the proposed project. This includes areas immediately upgradient of the proposed facilities from the perspective of both surface water and groundwater.

The study area is presented on Figure No. 1 (Map following this appendix). Field investigations and preliminary groundwater studies have indicated that wetlands other than those included in this inventory will not be affected by the proposed project. With the careful siting of the project and after impact analysis, it was determined that most of the wetlands in the study area will not be affected by the project.

In addition to field and aerial reconnaissance of the study area wetlands, other wetlands in Rusk County were reviewed, and existing wetland information gathered. This was done in order to put the wetlands of the study area into a regional perspective from both a quantitative and qualitative viewpoint.

1.5 Regional Setting

The study area is in northwestern Wisconsin. It is located in Rusk County, in the Town of Grant, just south of the City of Ladysmith. The study area is rural in character, with scattered residential sites and farmsteads. It includes portions of Sections 9 and 10, T34N, R6W. The primary economy is agricultural.

The major surface water feature is the Flambeau River, which is a broad, shallow, meandering river with an average gradient of one to two feet per mile. Flow is controlled four miles upstream of the study area by the Dairyland Dam and about seven miles downstream of the study area by the Thornapple Dam. Flow records taken downstream of the proposed mine site at the Thornapple Dam indicate a mean discharge of 1,855 cfs based on a 36-year period of records. The river is currently controlled for hydroelectric purposes at points above and below the site. The river supports a diverse aquatic community.

Rusk County has about 50,000 acres of wetlands, a considerable portion of which is relatively unaffected by cultural activities. In contrast, most of the wetlands in the study area are affected by cultural activities.

Plant communities vary locally depending on soils and land uses during the past century, and on surface and groundwater conditions. Much of the upland areas and many of the local, small depressions have been logged and farmed.

2.0 INVENTORY OF WETLANDS

Criteria for including a given area in the wetlands inventory have been discussed. In order to delineate those areas meeting these criteria, two figures were prepared. Figure No. 2 presents soils and Figure No. 3 presents plant communities. Soils were mapped by the USDA Soil Conservation Service. Hydric soils are identified on Figure 2. Vegetation was mapped by Foth & Van Dyke using full-spectrum color and color-infrared aerial photography flown in 1987. A site reconnaissance and vegetation survey completed during autumn of 1987 and during the spring and summer of 1988 verified the limits of each wetland.

For initial inventory and descriptive purposes, potential wetland areas were identified in a preliminary inventory. Figure No. 4 is a final presentation of project wetlands as defined in NR 132 which are described on Table No. 2-1. It was prepared as a result of the mapping and field investigations at the site, and an application of the criteria.

In the preliminary assessment, the Flambeau River floodplain was included as a potential wetland because it had been so designated in the State of Wisconsin *Wetlands Inventory Map for Rusk County* prepared in 1978. Field investigations in 1987 and 1988 have revealed that the portion of this old field community to be affected by the project does not support hydrophytic vegetation and shows no evidence of being inundated in many years. Local residents report that this "abandoned" floodplain has not been covered with water since the Port Arthur Dam was removed in 1968. The area is currently in a successional stage that supports this observation. In addition, the soils in this entire area are not hydric according to the Rusk County Soil Conservation Service as presented on Figure 2. Therefore, it is not included in the final inventory. All other areas identified in the preliminary inventory are included in the final inventory.

Seven major wetland types have been identified on the study area using the U.S. Fish and Wildlife (Cowardin, 1979) classification scheme. U.S. Army Corps of Engineers guidelines from the St. Paul District require that this scheme be employed to describe wetland types. The structure of this classification scheme is hierarchical, progressing from systems and classes to more specific subclasses. The systematic breakdown of wetlands on the environmental study area from system to class to subclass, and how this relates to the state classification, can be found in Table No. 2-2.

Listed in descending order, palustrine, riverine, and lacustrine are the major systems identified in the study area. The palustrine system identifies nontidal wetlands bounded by uplands and dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. Further breakdown of classes and subclasses identifies more specific characteristics of each

TABLE NO. 2-1

Wetlands of Study Area

No.	Size (1) (Acres)	Description	Vegetation	Soils
1	5.4	Low Wooded Area North of Road (40,450N) & Northwest of Pit Area	Mixed Forest	Seeleyville
2	2.5	Low Wooded Area South of Road (40,450N) & Over West End of Pit	Mixed Forest, Drainageway	Seeleyville
3a b c	0.3 0.1 0.5	Depressions & Dug Pond North of Entrance Road West of STH 27, Over East End of Pit	(Variable Cattails, Willows, Sedges)	Auburndale
4a b c	0.3 0.1 0.1	Depressions & Dug Pond South of Entrance Road & North of 40,450N, West of STH 27	(Variable Cattails, Aspen, Willows, Sedges)	Auburndale,
5a b c	0.2 0.2 8.7	Drainageway, Depressions South of 40,450N, West of STH 27	(Variable Willow, Sedges, Cattails, Tag Alder, Juncus)	Auburndale

TABLE NO. 2-1 (Cont.)

No.	Size (1) (Acres)	Description	Vegetation	Soils
6a	.2	Drainageway North of Jansen Road, East of STH 27	(Variable Grasses, Sedges, Mountain Holly, Black Ash)	Cable
b	3.7			
c	1.3			
d	.2			
e	.5			
f	.6			
g	.1			
7	17.8	Shrub Bog North of Jansen Road from 43,000E to 43,800E	Willow, Tag Alder, Sphagnum	Seeleyville Cable
8	1.4	Depression Northwest of Jansen/Meadowbrook Road Intersection	Deciduous Forest	Seeleyville Cable
9a	.4	Depressions along Soo Line RR	Willow, Birch, Alder, Sedges (Variable)	Auburndale Seeleyville
b	.3			
c	.3			
d	4.4			
e	.8			
f	.5			
g	.7			
10a	58.0	Shrub and Grassy Area East of Meadowbrook Road	Willow, Birch, Alder, Sedges	Auburndale Seeleyville
b	10.3			

1) These areas are defined and sized based on plant community and hydric soil distribution. See wetlands map.

2) Coordinates refer to site grid.

TABLE NO. 2-2

Wetland Classification

Wetland No.		Federal Category (Cowardin, 1979)	State Category
T8K	1	Palustrine/forested wetland/needle leaved evergreen	Forested/needle leaved evergreen/wet soil
T8K	2	Palustrine/forested wetland/needle leaved evergreen	Forested/needle leaved evergreen/wet soil
S3K	3a	Palustrine/scrub-shrub wetland/broad leaved deciduous	Scrub-shrub/broad leaved deciduous/wet soil
W3	3b	Palustrine/unconsolidated bottom/mud	Open water/mud
E1Ka	3c	Palustrine/emergent wetland/persistent	Emergent/persistent/wet soil/abandoned
W3X	4a	Lacustrine/unconsolidated bottom/mud	Open water/mud/excavated
S3K	4b	Palustrine/scrub-shrub wetland/broad leaved deciduous	Scrub-shrub/broad leaved deciduous/wet soil
S3K	4c	Palustrine/scrub-shrub wetland/broad leaved deciduous	Scrub-shrub/broad leaved deciduous/wet soil
E1Ka	5a	Palustrine/emergent wetland/persistent	Emergent/persistent/wet soil/abandoned
E1Ka	5b	Palustrine/emergent wetland/persistent	Emergent/persistent/wet soil/abandoned

TABLE NO. 2-2 (Cont.)

Wetland No.		Federal Category (Cowardin, 1979)	State Category
E1Ka	9a	Palustrine/emergent wetland/persistent	Emergent/persistent/wet soil/abandoned
E1Ka	9b	Palustrine/emergent wetland/persistent	Emergent/persistent/wet soil/abandoned
E1Ka	9c	Palustrine/emergent wetland/persistent	Emergent/persistent/wet soil/abandoned
S3K	9d	Palustrine/scrub-shrub wetland/broad leaved deciduous	Scrub-shrub/broad leaved deciduous/wet soil
E2K	9e	Palustrine/emergent wetland/persistent	Emergent/narrow leaved persistent/wet soil
E2K	9f	Palustrine/emergent wetland/persistent	Emergent/narrow leaved persistent/wet soil
S3K	9g	Palustrine/scrub-shrub wetland/broad leaved deciduous	Scrub-shrub/broad leaved deciduous/wet soil
S3K	10a	Palustrine/scrub-shrub wetland/broad leaved deciduous	Scrub-shrub/broad leaved deciduous/wet soil
E1K	10a	Palustrine/emergent wetland/persistent	Emergent/persistent/wet soil
E1Ka	10a	Palustrine/emergent wetland/persistent	Emergent/persistent/wet soil
T3/S3K	10a	Palustrine/forested, scrub-shrub wetland/ broad leaved deciduous	Forested, scrub-shrub/broad leaved deciduous/ wet soil
S3K	10b	Palustrine/scrub-shrub wetland/broad leaved deciduous	Scrub-shrub/broad leaved deciduous/wet soil
W1	River	Riverine/unconsolidated bottom/cobble-gravel	Open water/cobble-gravel

*Meets FWS criteria for wetland. Not technically a wetland by Corps of Engineer definition which requires positive indicator of wetlands for soil, vegetation and hydrology.

TABLE NO. 2-2 (Cont.)

Wetland No.		Federal Category (Cowardin, 1979)	State Category
S3K	5c	Palustrine/scrub-shrub wetland/broad leaved deciduous	Scrub-shrub/broad leaved deciduous/wet soil
S3K	6a	Palustrine/scrub-shrub wetland/broad leaved deciduous	Scrub-shrub/broad leaved deciduous/wet soil
E2K	6b	Palustrine/emergent wetland/persistent	Emergent/narrow leaved persistent/wet soil
None	6c	Wetland soils*	Wet soils/abandoned
S3K	6d	Palustrine/scrub-shrub wetland/broad leaved deciduous	Scrub-shrub/broad leaved deciduous/wet soil
S3K	6e	Palustrine/scrub-shrub wetland/broad leaved deciduous	Scrub-shrub/broad leaved deciduous/wet soil
S3K	6f	Palustrine/scrub-shrub wetland/broad leaved deciduous	Scrub-shrub/broad leaved deciduous/wet soil
S3K	7	Palustrine/scrub-shrub wetland/broad leaved deciduous	Scrub-shrub/broad leaved deciduous/wet soil
S3K	8	Palustrine/scrub-shrub wetland/broad leaved deciduous	Scrub-shrub/broad leaved deciduous/wet soil

wetland. The riverine system refers to the Flambeau River and its banks.

The magnitude of potential impact on ten wetland areas within the study area boundary is assessed in Table No. 2.3 and presented on Figure No. 1. Total wetland acreages were determined by measurements from the outermost boundary of hydric soils and hydrophytic vegetation delineations on Figure No. 4. This is in accordance with WDNR and U.S. Fish and Wildlife Service guidelines. According to the U.S. Army Corps of Engineers, the extent of hydrophytic vegetation is evaluated in wetlands determination. In accordance with each agency's guidelines, wetland acreages affected on the site are shown on Table No. 2-3.

TABLE NO. 2-3

Wetland Acreage Affected Within Site Boundaries

Wetland Number	*Total Acreage in Wetland	Affected Acreage by Defined Guidelines	
		U.S. Corps of Engineers	Wisconsin DNR and U.S. Fish and Wildlife Services
2	2.5	2.1	2.5
3a	0.3	0.3	0.3
3b	0.1	0.1	0.1
4a	0.3	0.3	0.3
4b	0.1	0.1	0.1
4c	0.1	0.1	0.1
5a	0.2	0.2	0.2
5b	0.2	0.2	0.2
5c	8.7	3.3	4.1
6b	3.7	0.4	0.4
Total	16.2	7.1	8.3

*Total Wetland Acreage Inclusive of Hydric Soils and Hydrophytic Vegetation Boundaries.

3.0 FUNCTIONAL EVALUATION OF WETLANDS

3.1 Procedures

The literature has numerous references to methods and procedures that have been used to evaluate the relative "importance" of wetlands using wetland functions (Reppert, *et al.*, 1979, Schamberger, *et al.*, 1979; Golet, 1973). There exists also a comprehensive discussion of available evaluation models and their adaptability to wetlands in northern Wisconsin insofar as NR 132 criteria are applied (Normandeau Associates, Inc., 1982). After a careful review of the semi-quantitative and qualitative methods used in that study, it was determined that quantification of wetland values for comparative purposes would not be appropriate for this study for several reasons: 1) the areas involved in the study area are few in number; 2) they are relatively small in size; and 3) they are diverse in character. Therefore, it was concluded that a wetland evaluation procedure using a sound, comprehensive qualitative approach based on the NR 132 functional criteria would be sufficient to evaluate and characterize the wetlands in the study area.

The wetland areas have been characterized using existing environmental information available for the site and surrounding areas. This database includes descriptive information on plant communities, plant species inventory, terrestrial vertebrate inventories, and data on soils, surface water hydrology and groundwater hydrology.

A number of wells, pits, and borings have been located to provide a better understanding of the subsurface conditions within and adjacent to wetlands.

Piezometers PZ1A and PZ1B were installed in 1987 at the northern edge of Wetland Area 2 to determine upgradient seasonal water table elevations.

Wells MW-1006, 1006G, and 1006S were installed between the east end of the proposed open pit and Wetland Area 10 to obtain data on groundwater elevations and to determine the horizontal and vertical hydraulic conductivity at that location. Well PZ-1009 was installed immediately west of Wetland 10a to provide similar information at that location. Other soil borings and test pits have been installed at numerous locations around the proposed mine pit including around the periphery of the large wetland to the northeast of the project area.

Biological investigations addressing the occurrence and relative abundance of terrestrial vertebrates and plant species in these areas were conducted in the early 1970s. Field investigations during spring, summer, and autumn of 1987 and 1988 provide supplementary information on biological resources and the possible occurrence of endangered and threatened species in the

wetland areas, as well as in other habitats of the project area. No endangered or threatened species were found during the 1987 and 1988 field investigations.

3.2 Wetland Functions and Values

The following list of important functions and values associated with wetlands is taken from NR 132.06(g).

- Biological Functions
  - Spawning, breeding, nursery, and feeding uses.
  - Use by endangered or threatened species.
  - Plant and animal communities.
  - Primary production.
  - Wildlife production and use.
  - Energy transfer to other systems.
- Watershed Functions
  - Hydrologic support functions
    - Hydrologic relationship to entire aquatic ecosystem.
    - Cumulative benefit to regional hydrology.
    - Extent of wetland in associated system.
    - Connection and relative importance to waters of the state.
    - Hydrologic regime (velocity, depth, fluctuation, renewal rate, temporal patterns).
    - Role in nutrient transport in overall system.
  - Groundwater function
    - Connection and role in groundwater surcharge or recharge
    - Characteristics of associated aquifer (use, extent).
  - Storm and floodwater storage
  - Shoreline protection
  - Other watershed functions
    - Storage of heavy metals or other contaminants.
    - Accumulation of sediment or nutrients.
    - Release of harmful substances.
    - Other important characteristics.
    - Density distribution of plants.
    - Basin depth, shape, area.
    - Hydrologic regime.
    - Physical, chemical, biological properties of the water and soil.

- Relationship of wetland size to watershed size.
- Number and size of other wetlands in the watershed.
- Topography of the watershed.
- Position of wetland in watershed relative to springs, lakes, rivers, and other waters.
- Land use practices and trends within the watershed, or the likelihood of nutrient, sediment, or toxin loads increasing.

- Recreational, Cultural, and Economic Value

  - Hunting, canoeing, hiking, etc.
  - Cultural, economic base.

- Scarcity of Wetland Type

- Study Areas, Sanctuaries, Refuges

- Regional Values

The wetland functions defined above are divided into two groups. The first group consists of those functions which do not apply to any of the study area wetlands and will not be discussed as the individual wetland areas are described and evaluated. In this group are the following:

Biological Functions - use by endangered or threatened species

There is no evidence that any of these habitats are essential to or play a significant role in the life cycle of an endangered or threatened plant or animal species. No endangered or threatened species have been discovered in the study area.

Watershed Functions - shoreline protection

None of the study area wetlands border a navigable waterway; therefore, they do not serve in the dissipation of wave energy or in protection from erosion by water.

Recreational, Cultural, and Economic Value

Kennecott has a policy of not allowing hunting or any other form of recreation on their property; therefore, there are no current recreational uses to evaluate. None of the wetlands in the study area offer cultural or special economic values such as wild rice harvesting or cranberry production.

Study Areas, Sanctuaries, Refuges

The wetlands in the study area are not designated or used for any of these purposes.

Regional Values

All of the wetland types identified from the study area are abundant in the region. As Table No. 3-1 indicates, each wetland type is prevalent in Rusk County. The contribution of wetlands in the study area to wetland habitats of the region is judged to be in direct relationship to their size and percent of the county total by type. Using this comparative approach, the value of the wetlands in the study area with respect to the region is very minor, although each particular wetland can serve valuable functions at the local level. These functions are discussed below.

The second group of wetland functions are those that apply to one or more of the individual wetland areas in the study area. The following section of this report presents each of the ten wetland areas and discusses each in the context of the functions that apply to that particular area.

3.3 Wetland Area 1

Wetland Area 1 consists of a lowland mixed coniferous-deciduous forest area northwest of the proposed pit area and north of an earthen road.

3.3.1 General Description

The mixed coniferous-deciduous forest designated as Wetland Area 1 is approximately 5.4 acres in size and is separated from Wetland Area 2 by an earthen road embankment approximately three feet in height above original grade. The road was constructed across the original wetland and serves as a hydrological separation relative to surface flow. Surface water from Wetland Area 1 drains to the north and then west into the Flambeau River via intermittent Stream A. This area is separated from the river by a distance of about 500 to 800 feet. Wetland Area 2, on the other hand, drains south and then west via intermittent Stream B and extends to within 300 feet of the Flambeau River. This area was not included in the Wisconsin Wetlands Inventory for Rusk County in 1978.

The soils in Wetland Area 1 are gleyed and mottled and clearly hydric in nature. Prior to the field investigations conducted for this study, the Soil Conservation Service had not classified the soils in Wetland Areas 1 and 2 as hydric. After the field survey identified these areas as wetlands, a special study by the Soil Conservation Survey and Foth & Van Dyke in 1988 classified these soils as Seeleyville. The origin of the soils is probably colluvial, primarily from river sedimentation in a backwater area during the late Pleistocene. These sediments have been stranded as the river receded. Generally, the distribution of hydric soils corresponds closely to the distribution of hydrophytic vegetation in this wetland (Figure No. 4).

Currently, this area has small pockets of standing water year-round, with hummocks and large boulders distributed throughout the western three-quarters of the area. A free-flowing seep is located along the northeastern edge and a seepage zone exists on the slope along the eastern edge of the area corresponding approximately to the 1,110 foot contour line.

Using the methodology and classification system adapted by the WDNR for the Wisconsin Wetlands Inventory (Appendix A), which assigns wetland types an alphanumeric code, Wetland Area 1 is classified as a T8K wetland. It is a forested area, vegetated primarily with needle-leaved trees, that does not appear to have surface water for prolonged periods of time. Classification of this wetland using the U.S. Fish and Wildlife Service methodology identifies this area as a palustrine system, forested wetland class, and needle-leaved evergreen subclass.

3.3.2 Biological Functions

This area supports a relatively undisturbed biotic community characteristic of a wet-lowland, wet-mesic northern forest (after Curtis, 1959). Common tree species are hemlock (*Tsuga canadensis*), balsam fir (*Abies balsamia*) black ash (*Fraxinus nigra*), and red maple (*Acer rubrum*). The shrub layer is sparse, with infrequent occurrences of tag alder (*Alnus rugosa*) and young hemlock. Ground cover is typically goldthread (*Coptis trifolia*), sweet white violet (*Viola pallens*), marsh marigold (*Caltha palustris*) marsh bedstraw (*Gallium*) and sedges (*Carex*). Birds frequenting this habitat are included in Table C-1 in Appendix C. According to Curtis, (1959), this is a very stable community and is naturally succeeded by northern mesic forest.

A reconnaissance of the floral components of the wetland during spring, summer, and autumn indicate that there are no rare or endangered plant species which occur in this wetland (Appendix B). Together with Wetland Area 2, which occupies 2.5 acres, this wetland area is isolated from other wetlands in the region and is surrounded by northern mesic forest. Mammals, reptiles, and amphibians observed or expected to utilize this wetland during various stages of their life cycles are presented in Tables C-2 and C-3 in Appendix C. An anuran voice survey conducted in May 1988 revealed numerous spring peepers (*Hyla crucifer*) using Wetlands 1 and 2 (Casper 1988). It is not a spawning ground or nursery for aquatic life from the Flambeau River. Although no estimates of energy transfer to the Flambeau River are available, the transfer of detrital materials to the river is very likely during runoff events. Based on the relative size of this area to the Flambeau River watershed, and surface water flows from intermittent Stream A, the energy contribution is considered of minor significance.

3.3.3 Watershed Functions

Although this area may have been a backwater to the Flambeau River in prehistoric times, it is currently over ten feet above the high-water elevation of the Flambeau River and is about six feet above the 100-year flood elevation (1,096 feet MSL). At this time, under current controlled-flow conditions on the river, it does not function as a storage area for Flambeau River floodwaters.

Wetland Area 1 retains surface runoff and groundwater seepage for an extended period due to its relatively flat topography. The Flambeau River drainage basin (1,838 square miles) contributes an average flow of 1,855 cfs based on a 36-year period of record from the U.S. Geological Survey (USGS) gaging station located two and one-half miles downstream of the Thornapple Dam (approximately nine miles below the site). Surface water inflows to Wetland Area 1 include sheet flow along the eastern boundary and channel flow from intermittent Stream A, which drains about 90 acres east of the wetland. Intermittent Stream A has a total watershed of approximately 115 acres, and a recorded maximum flow of 1.0 cfs during 1973 (BCMC, 1974). The potential storage and retention of stormwaters in Wetland Area 1 is limited to the flow of intermittent Stream A's watershed. Because of the small relative size of Stream A's watershed, and the relatively low flow contribution, the benefits Wetland Area 1 may have as stormwater storage in the Flambeau Basin are judged to be insignificant in their effect on downstream flooding.

Along portions of the slope east of Wetland Area 1 is a groundwater seep at an approximate elevation of 1,110 feet MSL. At one point a short, vertical steel pipe was surcharging at a rate of about one gallon per minute. At this location surface water was evident throughout the 1987-88 field investigation. Surface water and groundwater inflows from the seep drain slowly to the northwest corner of this wetland and then west to the Flambeau River. Groundwater seeps along the eastern boundary appear to be important in maintaining wet surface conditions in these areas.

This wetland serves a role as a stormwater storage area within the intermittent Stream A watershed. It is, however, too far above the Flambeau to serve as a flood storage site.

There is a potential for storage and retention in Wetland Area 1 of heavy metals associated with the groundwater entering this area. In order to evaluate this potential, chemical analyses of artesian water and soils at the seep area were conducted. The test results are presented in Appendix D.

3.3.4 Other Watershed Functions

Based on these results, and comparing them to groundwater quality from other wells in the region, (Appendix D) the discharge to Wetland Area 1 from this seep is similar to regional groundwater quality. Comparing these data to the surface water chemistry taken from the Flambeau River during the 1987-1988 baseline study period, the heavy metal parameters analyzed for the seep are within the ranges reported for the surface water. Therefore, based on this comparison, there is no indication that Wetland Area 1 is serving as a significant storage site for heavy metals.

3.3.5 Scarcity of Wetland Type

Originally, northern wet-mesic forests accounted for approximately 560,000 acres or 25 percent of the northern lowland forest in Wisconsin. This community is found throughout glaciated regions of northeast North America, including the northern lake states and southern Canadian provinces. It is a diverse community with 253 identified species, including dominant tree species white cedar (*Thuja occidentalis*), balsam fir (*Abies balsamia*), hemlock (*Tsuga canadensis*), and black ash (*Fraxinus nigra*) (Curtis, 1959).

On a global and national scale, this community is not recognized as rare, endangered, or threatened. However, the state of Wisconsin ranks it between an uncommon (between 21 to 100 occurrences), and an apparently secure community with many occurrences in the state (Wisconsin Natural Heritage Inventory, 1988). A review of all wetlands for Rusk County based on Wisconsin wetland inventory maps is presented in Table No. 3-1. In Rusk County there are 7,322 acres of type T8K (i.e., forested, predominantly needle-leaved, wet soil unit). The study area supports 7.9 acres (or 0.1 percent) of the T8K wetlands in Rusk County.

An inventory of special "natural areas" in Rusk County identified three northern wet mesic forests outside of the study area. The Zelinski's Cedar Swamp, located in Sec. 25 of T34N,R9W, is the largest (77 acres); the remaining two areas (not in the study area) have insignificant acreage. The Wisconsin Bureau of Endangered Resources describes these areas as significant to local and county ecological relationships. Wetland Areas 1 and 2 is not included on the Wisconsin Natural Heritage Inventory.

3.4 Wetland Area 2

Wetland Area 2 consists of lowland mixed coniferous-deciduous forest area over the west end of the ore body, including portions of intermittent Stream B.

TABLE NO. 3-1

Wetlands of Rusk County and the Mine Site

Wetland Type	Wetland Description	Rusk County		Study Area			
		Total Acres (1)	Percent of Total	Wetland No.	Acres	Percent	Unavoidable Loss (Acres)
S3E	Shrub, Broad-Leaved, Wet soil	27,864	55.9%	3a	.3		.3
				4b	.1		.1
				4c	.1		.1
				5c	8.7		4.1
				6a	.2		0
				6d	.2		0
				6e	.5		0
				6f	.6		0
				6g	.1		0
				7	17.8		0
				8	1.4		0
				9d	4.4		0
				9g	.7		0
				10a part	16.1		0
				10b	10.3		0
					61.5	51.3%	4.6
E1K	Persistent Wet Meadow Wet Soil	1,716	3.4%	10a part	19.7	16.4%	0
T3/S3K	Broad-Leaved Forest With S3K	10,671	21.4%	10a part	12.5	10.5%	0
E1Ka	Persistent Wet Meadow Wet Soil/Disturbed	110	0.2%	3c -	.5		0
				5a -	.2		.2
				5b -	.2		.2
				9a -	.4		0
				9b -	.3		0
				9c -	.3		0
				10a -	9.7		0
					11.6	9.7%	.4

TABLE NO. 3-1 (Cont.)

Wetland Type	Wetland Description	Rusk County		Study Area			
		Total Acres (1)	Percent of Total	Wetland No.	Acres	Percent	Unavoidable Loss (Acres)
T8K	Forested, Needle-leaved Wet Soil	7,322	14.7%	1	5.4		0
				2	2.5		2.5
					7.9	6.6%	2.5
E2K	Persistent Wet Meadow Grasses, Wet Soil	2,191	4.4%				
				6b	3.7		.4
				9e	.8		0
				9f	.5		0
					5.0	4.1%	.4
W3X	Open Water	(2)		3b	.1		.1
				4a	.3	.4%	.3
					.4		.4
Other	Hydric Soils			6c	1.3	1.1%	0
		49,874	100.0%		119.9	100.0%	8.3

(1)The acreage for Rusk County was planimetered from Wetland Inventory Maps provided by the Wisconsin DNR.
(2)Open water acreage for Rusk County was not determined.

3.4.1 General Description

Wetland Area 2 is very similar in character and function to Wetland Area 1. The two forested wetlands are separated by a roadway constructed of local soils filled to approximately three feet above the surface of the wetland. Today this road is an effective barrier and prevents the interchange of surface flow between Wetland Areas 1 and 2.

This wetland includes a natural wet drainage swale that extends eastward from the southern portion of Wetland Area 2. This swale includes the intermittent stream designated as "B" which drains the area over the proposed pit. The total acreage of Wetland Area 2 is 2.5 acres.

3.4.2 Biological Functions

The biological functions of Wetland Area 2 are similar to Wetland Area 1. It is also vertically separated from the Flambeau River by about ten feet of elevation and is, therefore, not a spawning or nursery area for the river's aquatic communities. No rare or endangered species were identified from the area nor are any expected to utilize this wetland during any life cycle stage.

3.4.3 Storm & Floodwater Storage

This wetland serves a minor role as a storage area for stormwater from its watershed, but, like Wetland Area 1, is too far from the influence of the Flambeau River to serve as a backwater or floodwater storage area.

Wetland Area 2 receives surface flow from intermittent Stream B, which drains a total of 65 acres. According to data provided in the BCMC (1974), the maximum flow in Stream B during 1973 was 1.4 cfs. The drainage upgradient of Wetland Area 2 is approximately 55 acres. This wetland serves identical hydrological functions as Wetland Area 1.

Like Wetland Area 1, this area is a groundwater surcharge area but, based on extensive field observations, is apparently less influenced by seeps than Wetland Area 1. The aquifer discharging into both wetlands is a near-surface formation that flows westerly over a less permeable layer of soil that overlies the ore body.

3.4.4 Other Watershed Functions

Based on this evidence, the seepage discharge to Wetland Area 2 is likely to be similar in quality to Wetland Area 1. Based on this comparison, there is no indication that Wetland Area 2 is serving as a significant storage site for heavy metals.

3.4.5 Scarcity of Wetland Type

Originally, northern wet-mesic forests accounted for approximately 560,000 acres or 25 percent of the northern lowland forest in Wisconsin. This community is found throughout glaciated regions of northeast North America, including the northern lake states and southern Canadian provinces. It is a diverse community with 253 identified species, including dominant tree species white cedar (*Thuja occidentalis*), balsam fir (*Abies balsamia*), hemlock (*Tsuga canadensis*), and black ash (*Fraxinus nigra*) (Curtis, 1959).

On a global and national scale, this community is not recognized as rare, endangered, or threatened. However, the state of Wisconsin ranks it between an uncommon (between 21 to 100 occurrences), and an apparently secure community with many occurrences in the state (Wisconsin Natural Heritage Inventory, 1988). A review of all wetlands for Rusk County based on Wisconsin wetland inventory maps is presented in Table No. 3-1. In Rusk County there are 7,322 acres of type T8K (i.e., forested, predominantly needle-leaved, wet soil unit). The study area supports 7.9 acres (or 0.1 percent) of the T8K wetlands in Rusk County.

An inventory of special "natural areas" in Rusk County identified three northern wet mesic forests outside of the study area. The Zelinski's Cedar Swamp, located in Sec. 25 of T34N,R9W, is the largest (77 acres); the remaining two areas (not in the study area) have insignificant acreage. The Wisconsin Bureau of Endangered Resources describes these areas as significant to local and county ecological relationships. Wetland Area 2 is not included on the Wisconsin Natural Heritage Inventory.

3.5 Wetland Area 3

Wetland Area 3 consists of small, variable, disturbed, and isolated depressions at the east end of the proposed pit.

3.5.1 General Description

Three small isolated depressions comprise this wetland group. Subarea 3a is a small disturbed depression of about 0.3 acre. Dominant vegetation is willow (*Salix*) and alder, with sedges as groundcover. Due to recent disturbance, the present community cannot be classified as a specific wetland community according to the U.S. Fish and Wildlife Service (Cowardin, 1979) but does resemble an alder thicket as described by Curtis (1959). Under natural succession it will be replaced by northern mesic forest.

Subarea 3b is a small pond, about 0.1 acre in size, which was dug in the late 1960s. This depression frequently contains

water which enables it to support volunteer emergent vegetation; common cattail (*Typha latifolia*), bullrush (*Scirpus macrocarpus*), sedge (*Carex sp.*). During the summer of 1988, the pond was dry for a short period of time.

Subarea 3c is an extension of wetland subarea 10a, a larger wetland to the east separated from subarea 3c by State Highway 27 (STH 27). This subarea is abandoned farmland and is part of the headwaters of intermittent Stream A. It is an area, approximately 0.5 acre in size, that has naturally succeeded to a hummocky northern sedge meadow community. During 1987-1988 investigations, there was no standing water observed in either 3a or 3c at any time.

These palustrine depressions are recently-disturbed plant communities. Therefore, they do not represent the typical, natural wetlands found in Rusk County. Subarea 3b, the dug pond, is the only wetland identified by the Wisconsin Wetland Inventory (Appendix A). For the purpose of this report, Table No. 2-2 classifies these wetland areas according to the Wisconsin Wetland Inventory and Cowardin (1979). Table No. 3-1 quantifies these wetlands in relation to others on the site and in the county.

Subareas 3a and 3b are isolated and serve no apparent groundwater function nor are they significant storage areas for stormwater. Subarea 3c is part of the headwaters of intermittent Stream A. Due to their small size, ranging from 0.1 to 0.5 acres, these areas do not serve any significant biological or hydrological function except for the dug pond (3b), which was used by wildlife as a water source during the summer of 1988. The overall value of these areas to the region is minimal due to their small size and isolation.

3.6 Wetland Area 4

Wetland Area 4 consists of small, variable, disturbed, and isolated areas located southeast of the proposed pit.

3.6.1 General Description

Area 4a is a pond dug in the late 1960s that is bordered on two sides by pine trees planted in the late 1960s. The other two sides are early successional forest, where the prominent tree species is quaking aspen. The pond is used by green herons, wood ducks, and mallards as a feeding area and by anurans as a breeding location. It serves as a water source for local wildlife as evidenced by the tracks of deer, raccoon and other small mammals frequently observed around its perimeter. It is a deepwater habitat after the Corps of Engineers (1987) definition.

Aquatic or wetland vegetation identified during the 1988 field investigation includes:

Bullrush	*Scirpus sp.*
Arrowhead	*Sagittaria sp.*
Pondweed	*Potamogeton vaginatus*
Pondweed	*Potamogeton spirillus*
Reed Canary Grass	*Phalaris arundinacea*
Sedge	*Eleocharis panciflora*
Rush	*Juncus sp.*
Cattail	*Typha latifolia*
Willow	*Salix sp.*

Surface drainage enters the pond from the north and into a ditch serving Wetland Area 5. During high runoff events, the pond probably stores stormwater, and equalizes surface flow to Wetland Area 5. During 1988, which was a dry year, no discharges from the pond were noted.

The results of groundwater studies at well nest 1005, located about 300 feet to the east of Wetland Area 5, indicate a groundwater elevation ranging from 1,136.7 to 1,139.4 feet MSL during the October 1987 to September 1988 period. These levels are between 1.5 and 5.2 feet below the ground surface and correspond closely to the surface water level in the dug pond based on visual observation in the field. The soil borings at Well 1005 indicate sandy soils and an absence of a soil strata that could cause perched conditions at this location.

Subareas 4b and 4c are small, topographic depressions surrounded by early successional woodland dominated by aspen and elm. These areas do not represent a dominant wetland community, but contain species found in northern sedge meadow, alder thicket, and early successional woodland. The Wisconsin Wetland Inventory identifies these areas as small wetland spots less than two acres in size. Table No. 3-1 quantifies the acreages of these subareas in relation to other wetlands on the site and in the county. Their value and functions are insignificant from a local or regional perspective, primarily because of their small size (approximately 0.2 acres combined), minor storage volumes, recent disturbance, and nondominant wetland community. Table No. 2-2 identifies these subareas according to wetland classification systems adopted by the Wisconsin Wetland Inventory and Cowardin (1979).

3.7 Wetland Area 5

Wetland Area 5 consists of shrub, wet meadow areas west of STH 27.

3.7.1 General Description

This series of three wetlands consists of two small isolated depressions (5a and 5b), approximately 0.2 acres in size, in addition to a larger 8.7-acre shrub/grassland (5c). All three areas have been recently disturbed by agricultural practices. Subareas 5a and 5b are surrounded by row crops. The portion of 5c that borders STH 27 supports woody shrubs such as willow, tag alder, and pine trees planted in the 1970s to screen the proposed mine from STH 27.

3.7.2 Biological Functions

These plant communities cannot be easily classified as a specific wetland type because they contain a combination of wetland plant species found in two distinct communities, northern sedge meadow and alder thicket. These are palustrine-type wetlands containing the following dominant plant species: cattail, tag alder, willow, rushes, and sedges. The Wisconsin Wetland Inventory does not recognize subareas 5a and 5b, but identifies subarea 5c with three wet spot symbols. These scrub-shrub and wet meadow habitats are used by small mammals, songbirds, reptiles, and amphibians noted in Appendix C.

3.7.3 Watershed Functions

Wetland Area 5 is in the headwaters of a tributary to the intermittent stream designated as "C", and occupies about eight acres of its watershed, totaling about 272 acres. The watershed of Wetland Area 5c includes approximately 257 acres of natural areas and about 15 acres of rotation-cropped agricultural land located to the west. The water quality benefits of Wetland Area 5 to the intermittent Stream C watershed are minor based on its relative surface area.

Wetland Area 5c is probably at or near the groundwater table based on elevations taken from an adjacent groundwater monitoring well (MW-1005). Stormwater storage benefits are limited and, based on the watershed size and flows in intermittent Stream C, are regionally insignificant.

3.8 Wetland Area 6

Wetland Area 6 consists of isolated, disturbed, wet meadow and shrub areas east of STH 27.

3.8.1 General Description

The headwaters for intermittent Stream C extend east of STH 27 and transect a 3.7-acre wetland that is designated 6b. The other five subareas in this wetland series are isolated topographic depressions with a combined total of less than three acres.

3.8.2 Biological Functions

Subareas 6a, 6d, 6e, 6f, and 6g are wooded depressions in a lowland forest. They are dominated by Michigan holly (*Ilex*), black ash (*Fraxinus nigra*), tag alder, black locust (*Robinia seudoacacia*), black raspberry (*Rubus occidentalis*), and tussock sedge (*Carex stricta*). The surrounding woodland is predominantly aspen (*Populus tremuloides*). These subareas are classified as alder thickets by Curtis (1959). This plant community is not recognized as rare on a global scale. The Wisconsin Natural Heritage Inventory has determined this plant community to be secure within the state, and it will be naturally succeeded by northern wet mesic forest. The Wisconsin Wetland Inventory does not identify these subareas as wetlands but, for the purpose of this study, they have been classified according to the Wisconsin Wetland Inventory and Cowardin (1979) as shown in Table No. 2-2. Quantitatively, subareas in Wetland Area 6 have been compared to other wetlands on the site and in the county (Table No. 3-1).

Sedges, grasses, and emergents are the dominant groundcover in subarea 6b with a mixture of common early-successional species. This area was originally farmland, most likely used as pasture. A portion of this land has also been plowed recently. Because of these disturbances, mixture of early-successional, old-field, and sedge meadow species are present. Although wetland species are present, subarea 6b does not constitute a typical northern sedge meadow as described by Curtis (1959).

Subarea 6c is shown on Figure No. 2 as containing 1.3 acres of hydric soils. No hydrophytic vegetation was found. This area is primarily early successional woodland and abandoned farmland and does not meet the technical guideline for wetlands established by the U.S. Army Corps of Engineers (1987).

All subareas in series 6 are isolated palustrine depressions with indirect connections to intermittent Stream C. They serve as buffer areas, reducing the sediment load to intermittent Stream C during runoff events. The significance of these small wetland areas as stormwater storage is minimal due to their size and capacity relative to the entire intermittent Stream C watershed. They are not adjacent to the Flambeau River and serve no flood storage function. The habitat provided by these wetlands is of marginal value for terrestrial vertebrates due to

its relatively small size, isolation, and history of recent disturbance.

3.9 Wetland Area 7

Wetland Area 7 consists of alder thicket and sphagnum bog.

3.9.1 General Description

A five-acre mature sphagnum bog comprises the central portion of Wetland Area 7. There is no open water at this location, but the sphagnum forms floating mats in the central portion of the wetland. The alder thicket border surrounding the bog varies in width. The entire wetland is 17.8 acres in size.

Alder thickets and open bogs are not recognized as rare communities globally. The Wisconsin Natural Heritage Inventory states that these plant communities are not rare and appear to be secure throughout the state. In Wisconsin these areas are most numerous north of the tension zone (after Curtis, 1959) and are found throughout glaciated regions of northeast North America. Alder thickets are stable communities naturally succeeded by northern wet mesic forest. The open bog is a stable community naturally succeeded by northern wet forest (Curtis 1959). The Wisconsin Wetland Inventory identifies this entire area as scrub-shrub/broad-leaved deciduous/wet soil, and does not recognize the bog. In addition to the Wisconsin Wetland Inventory classification, Table No. 2-2 classifies Wetland Area 7 according to Cowardin (1979). Table No. 3-1 quantifies this wetland in relation to other wetlands on the site and within Rusk County.

3.9.2 Biological Functions

This palustrine wetland is approaching the latter stages of natural filling that have been described for northern glacial lakes that have minimal surface inflow/outflow. The central sphagnum bog is surrounded by an alder thicket community dominated by tag alder with occasional willow and red-osier dogwood (*Cornus stolonifera*). Mountain holly (*Nemopanthus mucronata*) is found along the edge, and transitions into an aspen birch association. In more open areas, sedges and solomon's seal (*Smilacina trifolia*) are common.

Terrestrial vertebrates observed during the 1987-1988 field investigations included whitetail deer (*Odocoileus virginianus*) and raccoon (*Procyon lotor*). Birds species observed include swamp sparrow, (*Melospiza georgiana*) clay-colored sparrow (*Spizella pallida*), redwing blackbird (*Ageleius phoenicus*), common yellow throat (*Geothlypis trichas*), and ruffed grouse (*Bonasa umbellus*). During the breeding bird survey in early

summer, yellow warblers (*Dendroica petechia*) were observed along the transition zone from shrub to trees. In addition, northern harrier (*Circus cyaneus*) were observed hunting in the open areas adjacent to Wetland Area 7.

An anuran voice survey conducted in May of 1988 along Jansen Road indicated that spring peepers (*Hyla crucifer*) were abundant. Red-backed salamanders (*Plethedon cinereus*) were collected in lowland mesic woodlands south of the study area and likely occur around the periphery of this area in wet forest habitats.

Wetland Area 7 is not connected to any natural surface outflow. There is a ditch along Jansen Road that contributes surface flow to the wetland from the south. Open-water habitat that could be used as a nursery or spawning area for fish does not exist at this location. The anurans recorded during the frog voice survey likely utilize seasonally wet areas for breeding.

3.9.3 Watershed Functions

Wetland Area 7 has a confined drainage area of approximately 17.8 acres. A ditch along the northern edge of Jansen Road contributes surface flow to this topographic low area. Its value for storm or flood storage is considered minor.

3.9.4 Other Functions

There are no other wetland functions attributable to Wetland Area 7 that are considered significant from a site or regional perspective.

3.10 Wetland Area 8

Wetland Area 8 consists of lowland, mesic forest.

3.10.1 General Description

Wetland Area 8, approximately 1.4 acres in size, is a palustrine depression in the woodland east of Wetland Area 7. It is connected hydrologically to surface drainage ditches along the west side of Meadowbrook Road. The Wisconsin Wetland Inventory classifies this area as an extension of Wetland Area 7, a scrub-shrub/broad-leaved deciduous/wet soil wetland (S3K). Using Curtis' (1959) classification system, Wetland Area 8 has been identified as a northern wet mesic forest. For quantitative purposes, we have elected to identify this area S3K as reported by the Wisconsin Wetland Inventory, although we believe a more accurate classification may be T8K (forested/broad leaved deciduous/wet soil). Table No. 2-2 relates Wisconsin Wetland Inventory and the Fish and Wildlife Service classification systems to Wetland Area 8. Table No. 3-1 quantifies this area in relation to other wetlands on the site and in Rusk County.

The major function of this wetland is that it provides diversity to the surrounding northern mesic forest. An anuran voice survey in May 1988, concluded that spring peepers were abundant in the wetland. There were no other flora or fauna field surveys done on this area because it became apparent during the field reconnaisance work that it would not be affected by the project.

3.11 Wetland Area 9

Wetland Area 9 consists of variable wet meadow and shrub areas in isolated topographic depressions.

3.11.1 General Description

The seven isolated wetland subareas in this series include five small topographic depressions ranging from 0.3 to 0.8 acres each (9a, 9b, 9c, 9e, 9f). They support a variety of wet soil herbs (sedges, grasses), and in some cases, willow and red-riser dogwood. Using the classification system developed by Curtis (1959), these subareas are classified as a combination of alder thicket and northern sedge meadow plant communities. Subareas 9a, 9b, and 9c show evidence of past disturbance--probably from agricultural uses. The Wisconsin Wetland Inventory identifies subareas 9a and 9f with small wetland symbols signifying areas less than two acres. The remaining subareas are part of a larger area of scrub-shrub/broad-leaved deciduous/wet soil delineation (Appendix A).

Subarea 9d is about 4.4 acres in size and is a mixture of grass/sedge areas and shrubs. It appears to be a relictual wetland from a much larger area of similar composition separated by the railroad right-of-way (R-O-W) on its eastern boundary. Subarea 9g is a narrow strip of wetland north of 9d along the same R-O-W and has a similar history. Both areas are a mixture of alder thicket and northern sedge meadow plant communities.

3.11.2 Biological Functions

This series of wetlands apparently serve no special or unique biological function from a regional perspective. In addition, the value of all of these small surface depressions for wildlife is marginal due to their small size and isolation. No biological or hydrological data was generated for this wetland because it will not be physically affected by the project.

3.12 Wetland Area 10

Wetland Area 10 consists of an emergent wet meadow/deciduous shrub/wet soil unit northeast of the proposed pit area.

3.12.1 General Description

The largest wetland in the study area is a 68.3-acre palustrine unit northeast of the mine site. It is divided by Meadowbrook Road into subarea 10a on the west (58.0 acres) and 10b on the east (10.3 acres). This wetland unit is part of a larger wetland east of the study area. The northern border of Wetland Area 10 has been ditched and drained to allow agricultural activity. Evidence of past farming activity is present in the north-central and northeast portion of subarea 10a. There is no open water associated with Wetland Area 10, but field surveys reveal the entire area has wet soil conditions throughout most of the year.

3.12.2 Biological Functions

Typical vegetation distribution for these wetlands is a centrally situated heath community dominated by ericads like leatherleaf (*Chamaedaphne calyculata*) and labrador tea (*Ledum groenlandicum*), as well as sedges (*Carex*), sphagnum, and Cottongrass (*Eriophorum spissum*). Using the classification system adopted by Curtis (1959), this area is classified an open bog. Bog areas are found primarily in northern Wisconsin and other glaciated regions of northeast United States and southern Canada. They are considered significant to the regional ecology but are not considered rare according to the Wisconsin Natural Heritage Inventory.

There are a few acres of wooded swamp dominated by tamarak (*Larix laricina*) in subarea 10a. Understory species are similar to those of the surrounding heath. This area is classified as northern wet forest (Curtis, 1959) which is a very stable community found in glaciated regions of United States and Canada. In Wisconsin this community was originally estimated to consist of 1,680,000 acres or 75 percent of the northern lowland forest. Under natural successional conditions, this community will proceed to a northern wet-mesic forest (Curtis, 1959). The Wisconsin Natural Heritage Inventory identifies this community as significant to the regional ecology but not as threatened or endangered in the state.

In many locations the perimeter of this wetland supports alder, willow, red-osier dogwood, and meadow sweet (*Spirea alba*), and is classified by Curtis (1959) as an alder thicket. This perimeter is fringed by old-field communities in the disturbed areas to the north and southeast. Northern mesic forests with aspen, black ash, white birch and red maple (*Acer rubrum*) are the predominant species along the southern border.

The Wisconsin Wetland Inventory delineates four areas within wetlands 10a and 10b. Wetland 10a contains:

T3/S3K - Combination of forested, broad-leaved deciduous; and scrub-shrub, broad-leaved deciduous with wet soil.

E1K - Emergent wet meadow with persistent vegetation in wet soil.

S3K - Scrub-shrub, broad-leaved deciduous with wet soil.

E1Ka - Emergent wet meadow with persistent vegetation in wet soil--abandoned land.

Subarea 10b is classified as S3K. Table No. 2-2 compares Wisconsin Wetland Inventory and Fish and Wildlife Service classification system of Wetland Area 10. Table No. 3-1 illustrates the relative abundances of these wetlands on the site and in Rusk County.

Terrestrial vertebrates, as depicted in Appendix C, use this area to nest and feed. Although the area is not adjacent to the Flambeau River and, therefore, is not a spawning or nursery area for aquatic species, it undoubtedly contributes important, naturally available nutrients as detritus to the river system via surface water outlets to the north during runoff periods of the year.

Northern harriers frequently utilize the area for hunting. Ruffed grouse and ring-necked pheasants (*Phasianus colchicus*) are common in the wooded and agricultural fields surrounding the wetland. The wetland habitat provides important winter habitat for the upland game birds.

An anuran voice survey conducted in May 1988 identified American toad (*Bufo terrestris*) and spring peepers utilizing Wetland Area 10 (Casper 1988).

3.12.3 Watershed Functions

Wetland Area 10a has two surface outlets. A drainage ditch channels runoff to a small, intermittent tributary on the northwest corner of the wetland. It runs due north and discharges into the Flambeau River. A small stream on the western boundary drains to the west. It is the headwaters of intermittent Stream A, which drains the northern portion of the mine site. Because of the flat topography throughout Subarea 10a, it is difficult to partition surface drainage areas between these two outlets. However, based on size and orientation, the north outlet probably carries the majority of the surface flow.

Subsurface information obtained at Well Nest 1006 indicates that Wetland Area 10 is a perched condition and is probably not connected hydrologically with the groundwater in the mine site area.

3.12.4 Other Wetland Functions

The role Wetland Area 10 plays in stormwater storage is locally significant because it occupies a major portion of the watershed that drains to the north. Past channelization to improve drainage along the northern border of 10a promotes flow in the northerly direction. Compared to the Flambeau River watershed, the area is relatively minor, and stormwater storage is considered insignificant.

Other wetland functions identified above are of minor significance for Wetland Area 10 due to its relative contribution to regional wetlands present in Rusk County. There are no special or unique functions or other values known for this area.

3.13 Summary of Functional Evaluation

Each wetland has been evaluated using wetland functions that are considered important and valuable. An assessment of the quality of each wetland by functional category is presented in Table No. 3-2. This summary assigns a high, moderate, or low valuation to each study area wetland for each particular function. The comparative basis for these values is the relative size, ecological role, etc. of each study area wetland in its regional setting.

TABLE NO. 3-2

Kennecott Flambeau Project
Summary of Wetland Functions

Function	1	2	3	4	5	6	7	8	9	10
Geological Functions	H	H	L	L	M/L	M	H	H	L	H
Watershed Functions										
Hydrologic	M	M	L	L	M/L	M	L	L	L	M
Groundwater	L	L	L	L	L	L	L	L	L	L
Storm/Flood Water	L	L	L	L	L	L	L	L	L	M
Shoreline Protection	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other	L	L	L	L	L	L	L	L	L	L
Recreational, etc.	L	NA	NA	NA	L	L	L	L	L	L
Quality	L	L	L	L	L	L	L	L	L	L
Study Area, Sanctuary, etc.	L	L	L	L	L	L	L	L	L	L
Regional Values	L	L	L	L	L	L	L	L	L	L

Qualitative Value
High - H
Moderate - M
Low - L
NA - Not Applicable

4.0 PROJECT IMPACTS ON WETLANDS OF THE STUDY AREA

There are 10 wetland areas identified on the environmental study area. Five of these wetlands will be preserved in their natural state, and five will be affected in some manner by the proposed project activities. The following discussion is a summary, wetland by wetland, of the decisions made by the project team to minimize effects on the ten wetland areas and to protect to the maximum degree possible their integrity as functional ecosystems.

Approximately 8.0 acres, or six percent of the total wetlands in the study area, will be adversely affected. During site layout and design, careful consideration was given to preserving as much of the wetland areas as possible. Therefore, the proposed project represents a plan that will cause the least overall adverse affect on wetlands in the study area. Further, the wetland assessment was used to evaluate minor siting considerations to preserve the highest-value wetlands in the area. None of the wetland areas to be affected are of types considered scarce in Rusk County. Also, the majority of the wetland areas to be affected are of low relative value as biological, hydrological and recreational resources.

4.1 Wetland Area 1

The project features (Figure No. 1) have been located so there will be no filling or dredging of Wetland Area 1. The fence, settling ponds, and discharge pipes are outside of the perimeter of this area. Construction activities upslope of the wetland, including the stormwater ditch that is necessary to drain noncontact surface water from the site, will be managed to minimize sediment transport into the wetland.

These measures include maintaining the maximum buffer zone possible within which natural vegetation will not be disturbed, using straw and silt fences to retain sediment within the disturbed area, and protecting bare soils on slopes with appropriate stabilization measures. These measures will be utilized during construction, operation, and reclamation to reduce or eliminate off-site impacts of the project. Surface modifications proposed to the south of Wetland Area 1 will not affect surface drainage patterns north of the existing road. Surface inflow and groundwater infiltration to Wetland Area 1 will be maintained by means of controlled discharge of treated water from the sedimentation pond, wastewater treatment pond, or the Flambeau River (Figure No. 1).

Along the eastern border of Wetland Area 1 is a groundwater seep that contributes flow to the area. Construction of project facilities upgradient of this area and excavation of the pit to the south is expected to reduce groundwater inflow and probably lower the groundwater table on the southern end of Wetland Area 1 unless certain measures are installed. Kennecott is committed

to preventing adverse effects on biological function on Wetland Area 1 by maintaining adequate soil moisture and water levels in this area and will implement surface inflow and/or groundwater control measures to accomplish this objective. The topography of Wetland 1 will not be affected by the project so its function as stormwater storage will be retained.

Although this is a small percent of total T8K in Rusk County, Kennecott is committed to maintaining the wetland in its present form by artificial mechanisms as necessary.

4.2 Wetland Area 2

The entire 2.5 acres in Wetland Area 2 will be taken, either by dewatering or excavation, when the pit and perimeter road are constructed. Inflow to the pit from groundwater and Wetland Area 2 has been considered in the pit design for slope stability purposes. It is not feasible to maintain that portion of Wetland Area 2 not directly above the pit by adding water through artificial means.

Further reduction of the affected wetland area by steepening the pit slopes, would jeopardize the safety of mine employees and would, therefore, make the proposed project infeasible. According to the pit design consultants and Kennecott engineers, the pit has been designed with interior sideslopes that are the maximum allowable given geotechnical, operational, and safety considerations within acceptable margins.

4.3 Wetland Area 3

Of the three subareas of this area, 3c is the most valuable. It will be preserved by the proposed site layout. Orientation of the ore body and pit design criteria are such that 3a and 3b, both of low value as wetlands, will be filled as the area is used for stockpiling waste material. No regional hydrology or groundwater function will be interrupted because of this action. Subarea 3b has been used by wildlife as a water source during drought periods; however, additional sources of water such as other wetlands and the Flambeau River are available as an alternative to subarea 3b. Therefore, there will be no significant biological impact.

4.4 Wetland Area 4

The layout of the Type II Stockpile, within the constraints of transport distances and site operations and overall environmental considerations requires that these four small, low-value, wetland subareas be taken by the project. Water sources for wildlife will be available from the other wetlands and the Flambeau River. Stormwater control will be maintained artifically during operation of the mine.

4.5 Wetland Area 5

The proposed project layout preserves the moderate-quality portion of subarea 5c along STH 27. It requires the loss of subareas 5a and 5b, which are very small, isolated pockets of low-value wetland totaling approximately 0.4 acres, plus 4.1 acres of the disturbed western portions of 5c. Considerable site planning, within the environmental constraints of setbacks from the river and STH 27 and the areal requirements of project features, has resulted in the proposed layout which minimizes the loss of Wetland Area 5. The higher-quality portions of subarea 5c will be preserved. No long-term hydrologic functions or water quality benefits will be lost.

4.6 Wetland Areas 6 and 7

The proposed layout of the railroad spur east of STH 27 was designed to weave through wetland areas and particularly to avoid high-quality Wetland 7. This route will entirely avoid affecting Wetland Area 7, minimize the effects on Wetland Area 6, and still provide a safe and functional railroad spur. This spur will cross STH 27, possess proper curve radii, and connect to the main line on the east end of the spur. This option required the filling of a portion of subarea 6c, which is a recently disturbed, low-value wetland area. The proposed layout will present no significant adverse impact on the stormwater retention or other hydrologic functions served by subarea 6b.

4.7 Other Wetland Areas

The railroad right-of-way (R-O-W) will affect a small area of hydric soils at its eastern end where it joins the main railroad line. This R-O-W will be approximately 24 feet wide by 100 feet long and will fill about 0.05 acres of hydric soils. A portion of these soils has already been disturbed by filling for the construction of the existing mainline. Drainage will be provided beneath this fill so existing surface hydrology will not be affected.

Other than this necessary connection point, which was located so as to preserve Wetland Areas 8, 9, and 10 in their current condition, there will be no dredging, filling, or other effects on Wetlands 8, 9, and 10.

The large contiguous acreage of Wetland Area 10 has been completely avoided by site planning. Preliminary groundwater and subsurface studies indicate that there will be no dewatering of Wetland Area 10 due to the dewatering of the pit. Water level information at MW-1006 and PZ-1009, as well as test pits that were dug around the periphery of Wetland 10a support the conclusion that this area is perched.

REFERENCES

Bear Creek Mining Company. 1974. Preliminary Environmental Impact Report: Mining the Flambeau Copper Deposit. Flambeau Mining corporation.

Casper, G. 1988. Milwaukee Public Museum, Vertebrate Zoologist. Personal Communication and Anuran Voice Identification. December 1988.

Cowardin, L.M., V. Carter, and F.C. Golet. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Government Printing Office., Washington, D.C., 103 p.

Curtis, J.T. 1959. The Vegetation of Wisconsin: The University of Wisconsin Press. Madison, Wisconsin, 675 p.

Golet, F.C. 1973. Classification and Evaluation of Freshwater Wetlands as Wildlife Habitat in the Glaciated Northeast: Trans. Northeast Fish Wildlife Conference, 22 p.

Normandeau Associates, Inc., and Interdisciplinary Environmental Planning, Inc. 1982. Wetlands Assessment Report, Crandon Project: Prepared for Exxon Minerals Company.

Reppert, R.T. et al. 1979. Wetland Values: Concepts and Methods for Wetland Evaluation: U.S. Army Corps of Engineers, Fort Belvoir, Virgina, 109 p.

Schamberger, M.L., C. Short, and A. Farmer. 1979. Evaluating Wetlands as Wildlife Habitat: American Water Resources Association. Minneapolis, Minnesota, 9 p.

Weihrouch, B. 1988. Soil Conservation Service, Soil Scientist, Personal Communications and Soil Mapping. Summer 1988.

Wisconsin Natural Heritage Inventory. 1988. Endangered and Threatened Species List: Office of Bureau of Endangered Resources, Wisconsin Department of Natural Resources. Madison, Wisconsin, 20 p.

U.S. Department of the Army, Corps of Engineers. 1987. Corps of Engineers Wetland Delineation Manual. Environmental Laboratory, Vicksburg, MS. Ted. Rpt. Y-87-1.

FIGURES

NOTES:

1. SITE LOCATION: SECTIONS 9, 10, 15 & 16, T34N, R6W, RUSK COUNTY, WISCONSIN.
2. TOPOGRAPHIC BASE MAP PREPARED FROM AERIAL SURVEY BY SURDEX CORPORATION, CHESTERFIELD, MISSOURI. DATE OF PHOTOGRAPHY - APRIL 24, 1970. ROADS, TREES AND BUILDINGS WERE UPDATED AS PER AERIAL PHOTOGRAPH TAKEN BY MARKHURD CORPORATON, MINNEAPOLIS, MINNESOTA. DATE OF PHOTOGRAPHY - SEPTEMBER 14, 1987.
3. ELEVATIONS BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS TWO FEET.
4. HORIZONTAL DATUM BASED ON PROJECT SITE GRID SYSTEM. SITE GRID COORDINATES CORRELATION TO STATE PLANE COORDINATES DERIVED AS FOLLOWS:

SITE GRID COORDINATES CONTROL MONUMENT F-1	STATE PLANE COORDINATES
40000 N =	587,357.8087 N
40000 E =	1,713,516.1229 E

THE ANGULAR ROTATION FROM STATE PLANE BEARINGS TO SITE GRID BEARINGS IS 359°-13'-23" RIGHT WITH CONTROL POINT F-1 AS THE BASE POINT.

5. MINE FACILITIES DESIGN BY FORD, BACON & DAVIS, INCORPORATED, SALT LAKE CITY, UTAH AND PINCOCK, ALLEN & HOLT, INCORPORATED, LAKEWOOD, COLORADO.

LEGEND

- 1100 — EXISTING CONTOUR
- EXISTING PAVED ROADWAY
- EXISTING TRAIL/GRAVEL SURFACE
- TREES AND/OR BRUSH
- FENCE
- F-1 CONTROL MONUMENT
- WETLANDS

N

0 300' 600'
SCALE

FOTH & VAN DYKE
GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION
GREEN BAY, WISCONSIN

FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

KENNECOTT MINERALS COMPANY
155 MINERAL SQUARE
SALT LAKE CITY, UTAH 84112

FIGURE NO. 1
SITE PLOT PLAN

MICROFILM | JOB
DRAWING NO. | REV.
DIVISION DRAWING NO.
SCALE SEE BAR SCALE

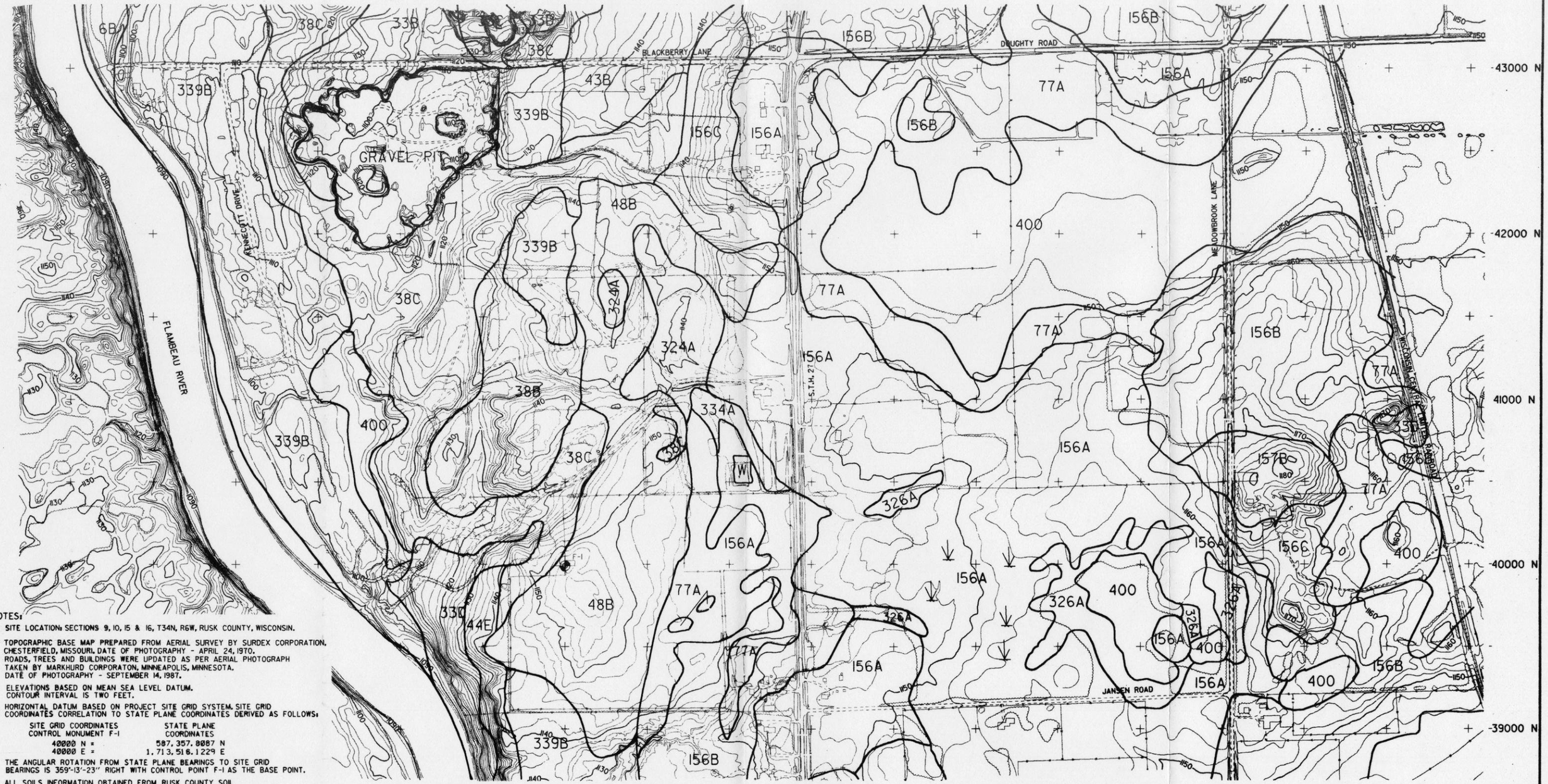
REFERENCES DWG. NO.	DESCRIPTION

REFERENCES DWG. NO.	DESCRIPTION	NO.	DATE	REVISIONS	BY	CH'D	ENG'R	ENG'R MGR.

NO.	DATE	REVISIONS	BY	CH'D	ENG'R	ENG'R MGR.

	BY	DATE
PROJ. ENG'R		
MGR. PROCESS ENG'R.		
ENG'R MGR.		

	BY	DATE
DESIGN		
DRAWN	SJL	FEB. 89
CH'D	TJW	Feb 89
DES. ENG'R		
SECT ENG'R		



NOTES:

1. SITE LOCATION: SECTIONS 9, 10, 15 & 16, T34N, R6W, RUSK COUNTY, WISCONSIN.
2. TOPOGRAPHIC BASE MAP PREPARED FROM AERIAL SURVEY BY SURDEX CORPORATION, CHESTERFIELD, MISSOURI. DATE OF PHOTOGRAPHY - APRIL 24, 1970. ROADS, TREES AND BUILDINGS WERE UPDATED AS PER AERIAL PHOTOGRAPH TAKEN BY MARKHURD CORPORATON, MINNEAPOLIS, MINNESOTA. DATE OF PHOTOGRAPHY - SEPTEMBER 14, 1987.
3. ELEVATIONS BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS TWO FEET.
4. HORIZONTAL DATUM BASED ON PROJECT SITE GRID SYSTEM. SITE GRID COORDINATES CORRELATION TO STATE PLANE COORDINATES DERIVED AS FOLLOWS:

SITE GRID COORDINATES CONTROL MONUMENT F-1	STATE PLANE COORDINATES
40000 N =	587,357.8087 N
40000 E =	1,713,516.1229 E

THE ANGULAR ROTATION FROM STATE PLANE BEARINGS TO SITE GRID BEARINGS IS 359°-13'-23" RIGHT WITH CONTROL POINT F-1 AS THE BASE POINT.

5. ALL SOILS INFORMATION OBTAINED FROM RUSK COUNTY SOIL CONSERVATION SERVICE AND LAND CONSERVATION DEPARTMENT, LADYSMITH, WISCONSIN.
   - SOIL MAP BOUNDARIES OBTAINED FROM STATE SOILS MAPS DEVELOPED 1964 - 1966
   - UPDATED MAPPING CONDUCTED JUNE 1988 BY USDA, SOIL CONSERVATION SERVICE.
   - SOIL UNIT NAMES CURRENT AS OF JUNE 20, 1988.
   - HYDRIC SOIL DATA PREPARED BY K. LUBICH OF SOIL CONSERVATION SERVICE - NOVEMBER 1986.
6. SLOPE GROUPS ARE DESIGNATED BY THE FOLLOWING LETTERS:
   A = 0-2%
   B = 2-6%
   C = 6-12%
   D = 12-20%
   E = 20-30%
   F = 30% AND OVER

LEGEND

- —1100— EXISTING CONTOUR
- EXISTING PAVED ROADWAY
- EXISTING TRAIL/GRAVEL SURFACE
- TREES AND/OR BRUSH
- FENCE
- F-1 CONTROL MONUMENT
- 77A SOIL UNIT BOUNDARY
- 156B SOIL UNIT SYMBOL - % SLOPE
- ISOLATED WET SOIL AREA

N

0 300' 600'
SCALE

SOIL LEGEND

6	STURGEON FINE SANDY LOAM, SOMEWHAT POORLY DRAINED
33	CHETEK SANDY LOAM, SOMEWHAT EXCESSIVELY DRAINED
38	ROSHOLT SANDY LOAM, WELL DRAINED
43	ANTIGO SILT LOAM, WELL DRAINED
44	TERRACE ESCARPMENT, WELL DRAINED
48	BRILL SILT LOAM, MODERATELY WELL DRAINED
77	*AUBURNDALE SILT LOAM, POORLY DRAINED
156	MAGNOR SILT LOAM, SOMEWHAT POORLY DRAINED
157	FREEON SILT LOAM, MODERATELY WELL DRAINED
324	POSKIN VARIENT SILT LOAM, SOMEWHAT POORLY DRAINED
326	*CABLE SILT LOAM, VERY POORLY DRAINED
334	PLOVER SANDY LOAM, SOMEWHAT POORLY DRAINED
339	BEVENT LOAMY FINE SAND, WELL DRAINED
400	*SEELYVILLE, MARKEY AND CATHRO-MUCKS, VERY POORLY DRAINED *HYDRIC SOIL

FOTH & VAN DYKE
GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION
GREEN BAY, WISCONSIN

FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

KENNECOTT MINERALS COMPANY
155 MINERAL SQUARE
SALT LAKE CITY, UTAH
84112

FIGURE NO. 2
SOILS OF THE STUDY AREA

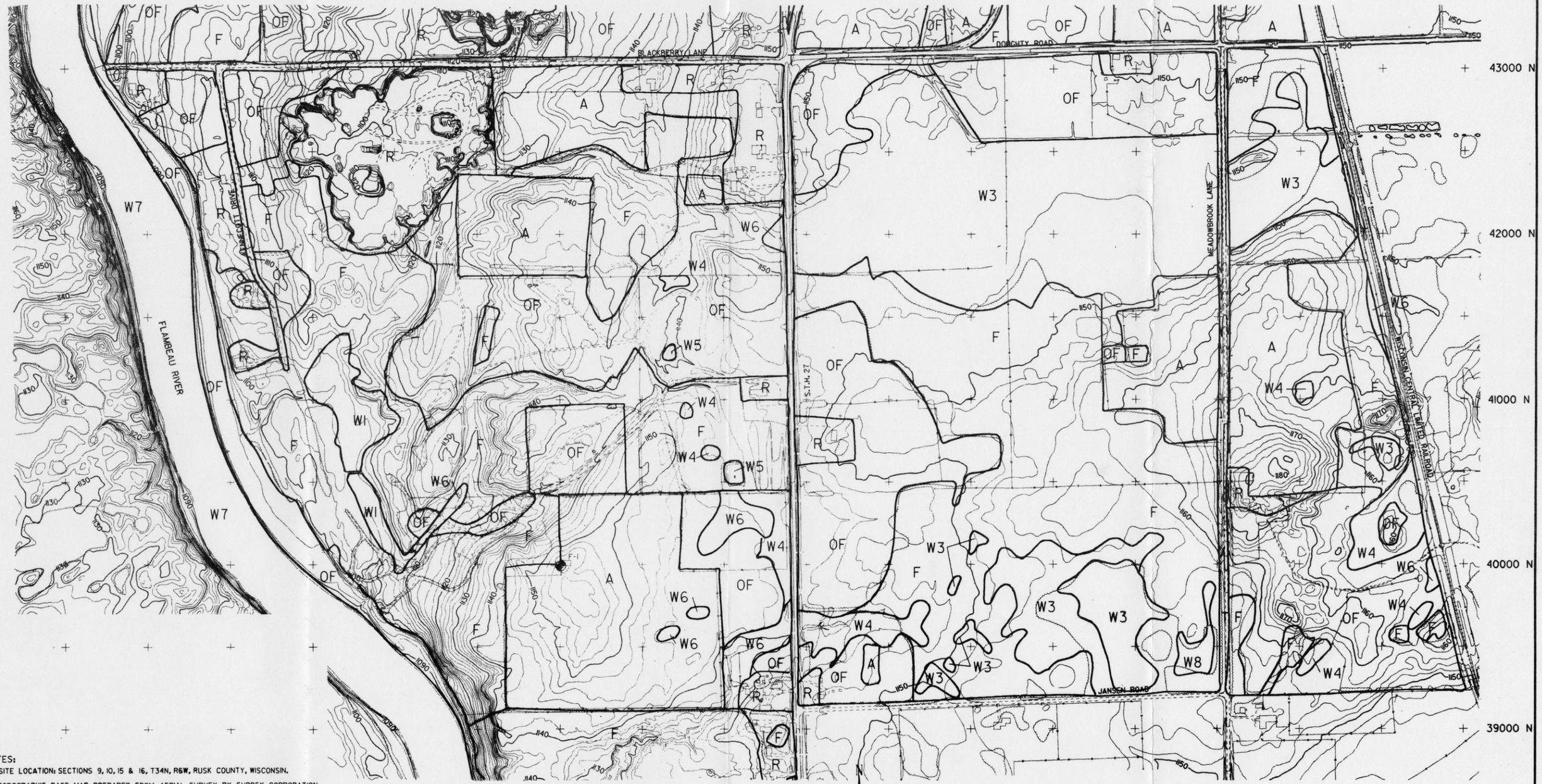
MICROFILM | JOB
DRAWING NO. | REV.
DIVISION DRAWING NO.
SCALE | SEE BAR SCALE

	BY	DATE
PROJ. ENG'R		
MGR. PROCESS ENG'R		
ENG'R MGR.		
DESIGN		
DRAWN	M.R.S.	FEB 89
CHK'D	TJW	Feb 89
DES. ENG'R		
SECT ENG'R		

REFERENCES

DWG. NO.	DESCRIPTION

NO.	DATE	REVISIONS	BY	CHK'D	ENG'R	ENG'R MGR.



NOTES:

1. SITE LOCATION: SECTIONS 9, 10, 15 & 16, T34N, R6W, RUSK COUNTY, WISCONSIN.
2. TOPOGRAPHIC BASE MAP PREPARED FROM AERIAL SURVEY BY SURDEX CORPORATION, CHESTERFIELD, MISSOURI. DATE OF PHOTOGRAPHY - APRIL 24, 1970. ROADS, TREES AND BUILDINGS WERE UPDATED AS PER AERIAL PHOTOGRAPH TAKEN BY MARKHURD CORPORATON, MINNEAPOLIS, MINNESOTA. DATE OF PHOTOGRAPHY - SEPTEMBER 14, 1987.
3. ELEVATIONS BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS TWO FEET.
4. HORIZONTAL DATUM BASED ON PROJECT SITE GRID SYSTEM. SITE GRID COORDINATES CORRELATION TO STATE PLANE COORDINATES DERIVED AS FOLLOWS:

SITE GRID COORDINATES CONTROL MONUMENT F-1	STATE PLANE COORDINATES
40000 N =	587,357.8087 N
40000 E =	1,713,516.1229 E

THE ANGULAR ROTATION FROM STATE PLANE BEARINGS TO SITE GRID BEARINGS IS 359°-13'-23" RIGHT WITH CONTROL POINT F-1 AS THE BASE POINT.

5. REFER TO TEXT FOR DETAIL DESCRIPTION OF PLANT COMMUNITIES.

LEGEND

1100	EXISTING CONTOUR
	EXISTING PAVED ROADWAY
	EXISTING TRAIL/GRAVEL SURFACE
	TREES AND/OR BRUSH
	FENCE
F-1	CONTROL MONUMENT

A	AGRICULTURE
F	UPLAND MIXED FOREST
OF	PASTURE/OLD FIELD/EARLY SUCCESSIONAL
R	RESIDENTIAL/DISTURBED
T	TRANSPORTATION
W	WETLANDS
- W1	NORTHERN WET MESIC FOREST
- W2	RIVERINE FLOODPLAIN MEADOW
- W3	ADLER THICKET; BOG
- W4	NORTHERN SEDGE MEADOW, ADLER THICKET
- W5	DUG PONDS
- W6	NORTHERN SEDGE MEADOW
- W7	RIVERINE
- W8	NORTHERN MESIC FOREST

REFERENCES

DWG. NO.	DESCRIPTION

REFERENCES

DWG. NO.	DESCRIPTION

NO.	DATE	REVISIONS	BY	CH'K'D	ENG'R	ENG'R MGR.

NO.	DATE	REVISIONS	BY	CH'K'D	ENG'R	ENG'R MGR.

	BY	DATE
PROJ. ENG'R		
MGR. PROCESS ENG'G.		
ENG'R MGR.		

	BY	DATE
DESIGN		
DRAWN	MJD	Feb 89
CH'K'D	TWD	Feb 89
DES. ENG'R		
SECT. ENG'R		

FOTH & VAN DYKE
GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION
GREEN BAY, WISCONSIN

FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

KENNECOTT MINERALS COMPANY
136 MINERAL SQUARE
SALT LAKE CITY, UTAH 84102

FIGURE NO. 3
PLANT COMMUNITIES OF THE STUDY AREA

MICROFILM	JOB
DRAWING NO.	REV.
DIVISION DRAWING NO.	
SCALE	SEE BAR SCALE

37000 E | 38000 E | 39000 E | 40000 E | 41000 E | 42000 E | 43000 E | 44000 E | 45000 E

43000 N | 42000 N | 41000 N | 40000 N | 39000 N

BLACKBERRY LANE | DOUGHTY ROAD | MEADOWBROOK LANE | JANSEN ROAD | S.T.H. 27 | FLAMBEAU RIVER | KENNECOTT DRIVE | WISCONSIN CENTRAL LIMITED RAILROAD

INTERMITTENT STREAM "A" | INTERMITTENT STREAM "B" | INTERMITTENT STREAM "C"

10a | 10b | 9a | 9b | 9c | 9d | 9e | 9f | 9g | 8 | 7 | 6a | 6b | 6c | 6d | 6e | 6f | 6g | 5a | 5b | 5c | 4a | 4b | 4c | 3a | 3b | 3c | 2 | 1

MW-1005P
MW-1005
MW-1005S
PZ-1006P
PZ-1006
PZ-1006S
PZ-1A
PZ-1B
F-1

NOTES:

1. SITE LOCATION: SECTIONS 9, 10, 15 & 16, T34N, R6W, RUSK COUNTY, WISCONSIN.
2. TOPOGRAPHIC BASE MAP PREPARED FROM AERIAL SURVEY BY SURDEX CORPORATION, CHESTERFIELD, MISSOURI. DATE OF PHOTOGRAPHY - APRIL 24, 1970. ROADS, TREES AND BUILDINGS WERE UPDATED AS PER AERIAL PHOTOGRAPH TAKEN BY MARKHURD CORPORATON, MINNEAPOLIS, MINNESOTA. DATE OF PHOTOGRAPHY - SEPTEMBER 14, 1987.
3. ELEVATIONS BASED ON MEAN SEA LEVEL DATUM. CONTOUR INTERVAL IS TWO FEET.
4. HORIZONTAL DATUM BASED ON PROJECT SITE GRID SYSTEM. SITE GRID COORDINATES CORRELATION TO STATE PLANE COORDINATES DERIVED AS FOLLOWS:

SITE GRID COORDINATES CONTROL MONUMENT F-1	STATE PLANE COORDINATES
40000 N =	587,357.8087 N
40000 E =	1,713,516.1229 E

THE ANGULAR ROTATION FROM STATE PLANE BEARINGS TO SITE GRID BEARINGS IS 359°-13'-23" RIGHT WITH CONTROL POINT F-1 AS THE BASE POINT.

LEGEND

- —1100— EXISTING CONTOUR
- EXISTING PAVED ROADWAY
- EXISTING TRAIL/GRAVEL SURFACE
- TREES AND/OR BRUSH
- FENCE
- F-1 CONTROL MONUMENT
- HYDRIC SOILS
- HYDROPHYTIC VEGETATION
- ISOLATED WET SOIL AREA
- 7 WETLAND AREA DESIGNATION REFER TO TEXT FOR DETAIL DESCRIPTIONS OF WETLAND COMMUNITIES
- MW-1005 GROUNDWATER MONITORING WELL
- PZ-1A PIEZOMETER

0 300' 600
SCALE

FOTH & VAN DYKE
GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION
GREEN BAY, WISCONSIN

FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

KENNECOTT MINERALS COMPANY
155 MINERAL SQUARE
SALT LAKE CITY, UTAH
8412

FIGURE NO. 4
WETLANDS OF THE STUDY AREA

MICROFILM | JOB
DRAWING NO. | REV.
DIVISION DRAWING NO.
SCALE SEE BAR SCALE

BY	DATE
MRS	FEB. 89
JW	Feb. 89

REFERENCES

DWG. NO.	DESCRIPTION

REFERENCES

DWG. NO.	DESCRIPTION

NO.	DATE	REVISIONS	BY	CHK'D	ENG'R	M.G.

NO.	DATE	REVISIONS	BY	CHK'D	ENG'R	M.G.

APPENDIX A

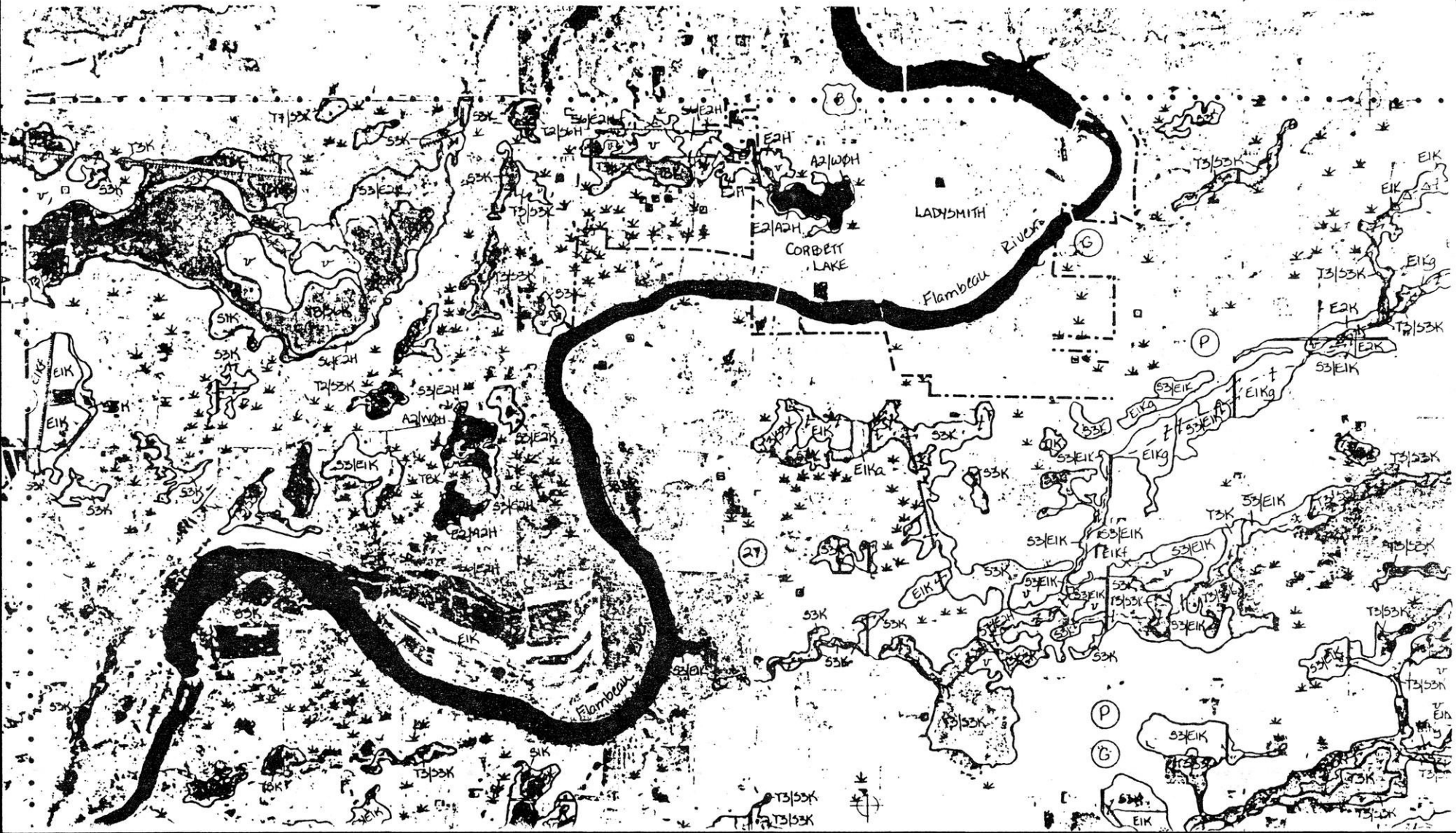
Wisconsin Wetland Inventory Information

INVENTORY

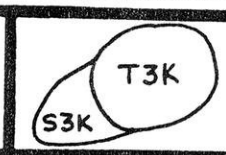
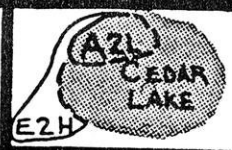
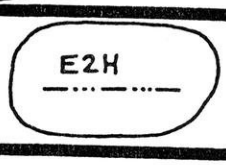
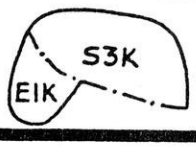
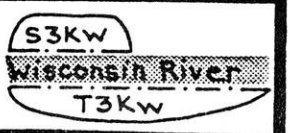
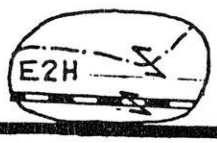
DNR Bureau of Planning

County RUSK

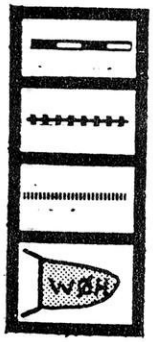
Ladysmith



WISCONSIN WETLANDS INVENTORY MAP LEGEND

Symbol	Example of Use	Description
———		Wetland-upland boundary; boundaries between cover types.
— — —		Boundary between wetland and deep water lake. A deep water lake is greater than 6 feet deep and does not support any wetland vegetation except submergents. (Shaded portion represents the lake).
—···—		Level ditch constructed within a wetland for wildlife management.
—·—·—		Stream or drainage ditch less than 100 feet wide within or adjacent to a wetland. The dot-dash line is drawn down the center of the stream or ditch.
—·—·—		Boundary between wetland and a primary river channel. A primary river channel is 100 feet wide or more and does not support any wetland vegetation except submergents.
⇆		Indicates the classification for the wetland mapping unit is the same on both sides of the linear feature.

MAN-MADE FEATURES



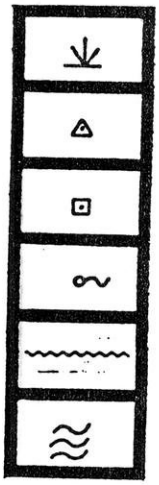
Road

Railroad

Dike, man-made levee or abandoned railroad grade

Man-made dam

POINT SYMBOLS



Wetland smaller than 2 or 5 acres depending on the county

Dammed artificial pond smaller than 2 or 5 acres depending on the county

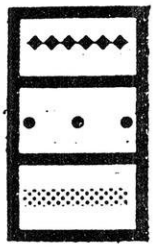
Excavated or blasted pond smaller than 2 or 5 acres depending on the county

Spring within a wetland

Beaver Dam

Areas of filled land adjacent to wetlands

MAP BOUNDARIES

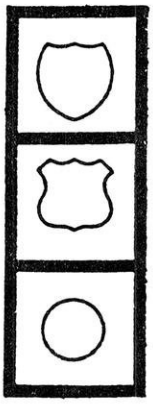


County Boundary

Township Boundary

Indicates the overlap of an orthophotoquad on a township base map

HIGHWAY SYMBOLS



Interstate Highway

U.S. Route

State or County Highway

MAP REVISIONS

Area may no longer be wetland; not field verified

Area no longer wetland; field verified.

CLASSIFICATION SYSTEM FOR THE WISCONSIN WETLANDS INVENTORY

This wetland classification system is based on the new U.S. Fish and Wildlife Service "Classification of Wetlands and Deep-Water Habitats of the United States", but with a few simplifications to make it easier to use and understand.

Mapping Units

All wetlands which can be identi ied on the aerial photographs are mapped as follows:

--- Wetlands larger than 2 or 5 acres, depending on the county, will be mapped and classified. A delineated wetland having only one classification is considered one mapping unit. Larger wetlands may be divided into small mapping units. Minor inclusions of other cover types (less than 30%) may exist within a mapping unit. Wetland classifications and boundaries are based on conditions present as of the aerial photograph date (1978-1980).

--- Wetlands smaller than 2 or 5 acres, depending on the county, will be indicated by a point symbol (⊻). Man-made ponds smaller than the minimum size are also indicated by a point symbol (⊡ or ⍙).

--- The following counties were mapped using 2 acres as the minimum mapping unit: Adams, Barron, Brown, Chippewa, Dane, Dodge, Green, Jackson, Jefferson, Juneau, Kenosha, Kewaunee, Manitowoc, Marathon, Milwaukee, Monroe, Ozaukee, Portage, Racine, Rock, St. Croix, Walworth, Washington, Waukesha, Waushara and Wood. The remainder of the counties are being mapped using 5 acres as the minimum mapping unit.

Components of the Classification System

The classification codes describe the class (Table 1), subclass (Table 1), and general hydrologic characteristics (Table 2) of a wetland mapping unit. Some classification codes will also have a "special modifier" (Table 3). The classification code will usually contain 3 or 4 letters and digits:

When small patches of different covertypes (at least 30% of the cover) are intermingled within the wetland mapping unit, a mixed classification code will be used. Mixed classes are separated by a slash (e.g., T3/S3K), with the taller form of vegetation listed first.

TABLE 1. COVERTYPE CLASSES FOR THE WISCONSIN WETLANDS INVENTORY

Vegetated mapping units are classified by the uppermost layer of vegetation which covers 30% or more of the area. Vegetated classes take precedence over unvegetated classes if a choice has to be made. Subclasses in parentheses are only used where the information can be easily obtained from existing soil surveys, lake survey maps, or other data sources.

Class and Subclass	Description	Subclass Examples
A Aquatic bed	Plants growing entirely on or in a water body	--
(1) (Submergent)	(Aquatic bed plants growing entirely under water)	(Milfoil, coontail, pondweeds)
2 Floating	Aquatic bed plants having structures which float at the water surface	Rooted or free floating
3 Rooted floating	Rooted aquatic bed plants which have floating leaves	Pond lilies, water shield
4 Free floating	Aquatic bed plants which float freely on the water surface	Duckweed, water meal, surface algae
M Moss	Wetlands where the uppermost layer of vegetation is moss	Sphagnum moss
E Emergent/wet meadow	Herbaceous plants which stand above the surface of the water or soil	--
1 Persistent	Plant remains persist into next year's growing season	Narrow- or broad-leaved
2 Narrow-leaved persistent	Persistent emergents having grass-like leaves without petioles	Cattail, most sedges and grasses
3 Broad-leaved persistent	Persistent emergents with wide leaf blades	Stinging nettle, some asters
4 Nonpersistent	Emergents which fall beneath the water and decompose over winter	Narrow- or broad-leaved
5 Narrow-leaved nonpersistent	Nonpersistent emergents with grass-like leaves without petioles	Wild rice, some bulrush stands
6 Broad-leaved nonpersistent	Nonpersistent emergents with wide leaf blades	Arrowhead, pickerel weed

S Scrub/shrub	Woody plants less than 20 feet tall	--
1 Deciduous	Shrubs which drop their leaves in the fall	Needle- or broad-leaved
2 Needle-leaved deciduous	Stunted tamaracks	Stunted tamaracks
3 Broad-leaved deciduous	Deciduous shrubs other than tamarack	Willows, alder, young green ash
4 Evergreen	Shrubs which keep their leaves over winter	Needle- or broad-leaved
5 Needle-leaved evergreen	Evergreen shrubs with needle-like or scale-like leaves	Stunted black spruce
6 Broad-leaved evergreen	Evergreen shrubs with wide leaf blades	Labrador tea, leatherleaf
7 Dead	Dead shrubs	Shrubs killed by flooding
8 Needle-leaved	Any coniferous shrubs	Deciduous or evergreen
9 Broad-leaved	Any broad-leaved shrubs	Deciduous or evergreen
T Forested	Woody plants taller than 20 feet	--
1 Deciduous	Trees which drop their leaves in the fall	Needle- or broad-leaved
2 Needle-leaved deciduous	Tamaracks	Tamaracks
3 Broad-leaved deciduous	Deciduous trees other than tamarack	Black ash, elm, silver maple
5 Needle-leaved evergreen	Evergreen trees with needle-like or scale-like leaves	White cedar, black spruce, balsam
7 Dead	Dead trees	Trees killed by flooding
8 Needle-leaved	Any coniferous tree	Deciduous or evergreen
F Flats/unvegetated wet soil	Exposed wet soils which do not support vegetation	--
Ø Subclass unknown	Soil characteristics undetermined	--
(1) (Cobble/gravel)	(Flats composed of gravel and larger stones)	(Gravel bar in a fast flowing river)
(2) (Sand)	(Flats composed of sand)	(Sand flats in the Wisconsin R.)
(3) (Mud)	(Flats composed of silt and clay-sized mineral particles)	(Mud flats in the Mississippi R.)
(4) (Organic)	(Exposed muck)	(Organic flats exposed by drawdown)
(5) (Vegetated pioneer)	(Flats supporting herbaceous pioneer vegetation which is killed by rising water levels before the next growing season)	(Cocklebur growing on a sand flat)
W Open water	Lakes and ponds less than 20 acres in size, all lakes with a maximum depth of 6 feet or less, and unvegetated river sloughs	--
Ø Subclass unknown	Bottom characteristics undetermined	--
(1) (Cobble/gravel)	(Cobble or gravel bottom)	--
(2) (Sand)	(Sand bottom)	--
(3) (Mud)	(Mud bottom)	--
(4) (Organic)	(Muck bottom)	--
U Upland	Upland areas surrounded by wetland	Also used as a subclass to indicate small inclusions of upland (TU/E1Kj)

TABLE 2. HYDROLOGIC MODIFIERS FOR THE WISCONSIN WETLANDS INVENTORY

Hydrologic modifier	Situation applied to:	Used with the following subclasses
L Standing water, Lake	Lakes of 20 acres or more having a maximum depth of 6 feet or less (smaller lakes and ponds receive the "H" hydrologic modifier)	A1-A4, E4, E5, E6, S7, T7 FØ-F5, WØ-W4
R Flowing water, River	The abandoned and secondary channels of rivers and streams	A1-A4, E4, E5, E6, S7, T7, FØ-F5, WØ-W4
H Standing water, Palustrine	Wetlands which are not in a lakebed or river channel, but which have surface water present for much of the growing season	All subclasses
K Wet soil, Palustrine	Areas which are wetlands, but do not appear to have surface water for prolonged periods of time	MØ, E1, E2, E3, S1-S9, T1-T8, FØ-F5

TABLE 3. SPECIAL MODIFIERS FOR THE WISCONSIN WETLANDS INVENTORY

a Abandoned - Areas which appear to have been cultivated in the past, but which have since been abandoned from cultivation and have reverted to wetland vegetation.

c Cranberry bog - Used to indicate all artificially constructed cranberry bogs.

e Exposed flats complex - Wetland mapping units bearing this modifier are a combination of exposed flats (e.g., sand flats in the Wisconsin River) and secondary river channels which are too small to delineate individually.

f Farmed - Land cultivated only during drought years and periods of low water table, and which also has soils classified by the National Cooperative Soil Survey as poorly drained or very poorly drained.

g Grazed - Wetlands which are used for pasturing livestock.

j Central Sands complex - wetland mapping units bearing this modifier occur mainly in Central Wisconsin where small areas of peat, wet sand, and dry sand ridges are so intermingled that they cannot be delineated individually.

m Mats - Used to indicate areas where wetland vegetation is floating on water as a mat, rather than being rooted in soil.

r Red clay complex - Wetland mapping units bearing this modifier occur mainly on old lake plains adjoining Lake Superior, where small areas of wet and dry red clay soils are so intermingled that they cannot be delineated individually.

s Ridge and swale complex - This landform occurs mainly along the Lake Michigan coast, where narrow beach ridges (strand lines) were formed parallel to the shore as the water in Lake Michigan receded during post-glacial times. Depressions (swales) between the beach ridges contain wetland vegetation, but the ridges themselves are dry. The complex is used to indicate areas where the swales are too small to delineate individually.

v Vegetation recently removed - Used to indicate areas where the vegetation has recently been totally or partially removed by clearing, shearing, logging, or other means.

w Floodplain complex - This modifier describes the floodplains of rivers and streams which are composed of small areas of seasonally flooded wetlands, wet meander scars, oxbow lakes, and/or small inclusions of upland, all of which are too small to delineate individually.

x Excavated - Used to indicate wetlands which have been artificially excavated, usually for the purpose of creating ponds. Gravel pit ponds and other ponds created by mining are not considered to be wetlands unless they support wetland vegetation.

z Evidence of muskrat activity - When muskrat lodges and eat-out areas can be detected on the aerial photographs, this modifier is used.

0028Y

APPENDIX B

Endangered or Threatened Species List

Endangered and threatened species[a] including Federal species listed for Wisconsin

---

PLANTS

Endangered

Carolina Anemone	*Anemone caroliniana*
Hudson Bay Anemone	*Anemone multifida*
Large-leaved Sandwort	*Arenaria macrophylla*
Lake Cress	*Armoracia aquatica*
Purple Milkweed	*Asclepias purpurascens*
Green Spleenwort	*Asplenium viride*
Alpine Milk Vetch	*Astragalus alpinus*
Prairie Plum	*Astragalus crassicarpus*
Cooper's Milk Vetch	*Astragulus neglectus*
Moonwort	*Botrychium lunaria*
Goblin Fern	*Botrychium mormo*
Marsh Marigold	*Caltha natans*
Wild Hyacinth	*Camassia scilloides*
Crow-spur Sedge	*Carex crus-corvi*
Hoplike Sedge	*Carex lupuliformis*
Intermediate Sedge	*Carex media*
Brook Grass	*Catabrosa aquitica*
Stoneroot	*Collinsonia canadensis*
Hemlock-parsley	*Conioselinum chinense*
Beak Grass	*Diarrhena americana*
Lanceolate Whitlow-cress	*Draba lanceolata*
a Spike-rush	*Eleocharis quadrangulata*
Harbinger-of-spring	*Erigenia bulbosa*
Chestnut Sedge	*Fimbristylis puberula*
Umbrella Sedge	*Fuirena pumila*
Northern Commandra	*Geocaulon lividum*
Pale False Foxglove	*Gerardia skinnerana*
Dotted Blazing Star	*Liatris punctata*
Auricled Twayblade	*Listera auriculata*
Smith Melicgrass	*Melica smithii*
a Grass-of-Parnassus	*Parnassia parviflora*
Smooth Phlox	*Phlox glaberrima*
Butterwort	*Pinguicula vulgaris*
Heart-leaved Plantain	*Plantago cordata*
Pink Milkwort	*Polygala incarnata*
Spotted Pondweed	*Potamogeton pulcher*
Rough White Lettuce	*Prenanthes aspera*
Great White Lettuce	*Prenanthes crepidinea*
Pine-drops	*Pterospora andromedea*
Small Shinleaf	*Pyrola minor*
Seaside Crowfoot	*Ranunculus cymbalaria*
Small Yellow Water Crowfoot	*Ranunculus gmelinii*
Lapland Rosebay	*Rhododendron lapponicum*
Wild Petunia	*Ruellia humilis*
Sand Dune Willow	*Salix cordata*

Tussock Bulrush	*Scirpus cespitosus*
Netted Nut-rush	*Scleria reticularis*
Small Skullcap	*Scutellaria parula*
Selago-like Spikemoss	*Selaginella selaginoides*
Blue-stemmed Goldenrod	*Solidago caesia*
Lake Huron Tansy	*Tanacetum huronense*
Hairy Meadow Parsnip	*Thaspium barbinodce*
Foamflower	*Tiarella cordifolia*
Dwarf Bilberry	*Vaccinium cespitosum*
Mountain Cranberry	*Vaccinium vitis-idaea*
Squashberry	*Viburnum edule*
a Violet	*Viola fimbriatula*

PLANTS

Threatened

Northern Monkshood[b]	*Aconitum noveboracense*
Muskroot	*Adoxa moschatellina*
Yellow Giant Hyssop	*Agastache nepetoides*
Thickspike Wheatgrass	*Agropyron dasystachyum*
Wooly Milkweed	*Asclepias lanuginosa*
Prairie Milkweed	*Ascelpias sullivantii*
Forked Aster	*Aster furcatus*
Kitten Tails	*Besseya bullii*
Prairie Indian Plantain	*Cacalia tuberosa*
Sand Reed	*Calamovilfa longifolia*
Beautiful Sedge	*Carex concinna*
Garber's Sedge	*Carex Garberi*
Lenticular Sedge	*Carex lenticularis*
Michaux's Sedge	*Carex michauxiana*
Dune Thistle[b]	*Cirsium pitcheri*
Ram's-head Lady's-slipper	*Cypripedium arietinum*
White Lady's-slipper	*Cypridedium candidum*
a Sundew	*Drosera anglica*
a Sundew	*Drosera linearis*
Purple ConeFlower	*Echinacea pallida*
Beaked Spike-rush	*Eleocharis rostellata*
Western Fescue	*Festuca occidentalis*
Blue Ash	*Fraxinus quadrangulata*
Yellowish Gentian	*Gentiana alba*
Round-stemmed False Foxglove	*Gerardia gattingeri*
Round-fruited St. John's Wort	*Hypericum sphaerocarpum*
Dwarf Lake Iris	*Iris lacustris*
Prairie Bush-clover[b]	*Lespedeza leptostachya*
Broad-leaved Twayblade	*Listera convallaroides*
Brittle Prickly-Pear	*Opuntia fragilis*
Small Round-leaved Orchid	*Orchis rotundifolia*
Clustered Broomrape	*Orobanche fasciculata*
Fassett's Locoweed	*Oxytropis campestris var.*
a Grass-of-Parnassus	*Parnassia palustris*
Wild Quinine	*Parthenium integrifolium*
Sweet Coltsfoot	*Petasites sagittatus*
Tubercled Orchid	*Platanthera flava*
Prairie White-fringed Orchid	*Platanthera leucophaea*
Braun's Holly Fern	*Polystichum braunii*
Prairie-parsley	*Polytaenia nuttallii*
Algal-leaved Pondweed	*Potamogeton confervoides*
Sheathed Pondweed	*Potamogeton vaginatus*
Bald Rush	*Psilocarya scirpoides*
Hawthorn Leaved Gooseberry	*Ribes oxyacanthoides*
Dune Goldenrod	*Solidago spathulata*
False Asphodel	*Tofieldia glutinosa*
Snow Trillium	*Trillium nivale*
Spike Trisetum	*Trisetum spicatum*
Marsh Valerian	*Valeriana sitchensis*
a Violet	*Viola novae-angliae*

MOLLUSCS	*Lampsilis higginsi*
Endangered	
Higgins Eye Pearly Mussel[C]	
Threatened	
None	
FISHES	
Endangered	
Gravel Chub	*Hybopsis x-punctata*
Striped Shiner	*Notropis chrysocephalus*
Slender Madtom	*Noturus exilis*
Starhead Topminnow	*Fundulus notti*
Crystal Darter	*Ammocrypta asprella*
Bluntnose Darter	*Etheostoma chlorosomum*
Goldeye	*Hiodon alosoides*
Pallid Shiner	*Notropis amnis*
FISHES	
Threatened	
Speckled Chub	*Hybopsis aestivalis*
Blue Sucker	*Cycleptus elongatus*
Black Buffalo	*Ictiobus niger*
Longear Sunfish	*Lepomis megalotis*
Ozark Minnow	*Notropis nubilus*
Gilt Darter	*Percina evides*
AMPHIBIANS	
Endangered	
Blanchard's Cricket Frog	*Acris crepitans blanchardi*
Threatened	
Tremblay's Salamander	*Ambystoma tremblayi*

REPTILES

Endangered

Queen Snake	*Regina septemvittata*
Western Ribbon Snake	*Thamnophis proximus*
Eastern Ribbon Snake	*Thamnophis sauritus*
Massasauga	*Sistrurus catenatus*
Western Box Turtle	*Terrapene ornata*
Western Slender Glass Lizard	*Ophisaurus attenuatus*

Threatened

Wood Turtle	*Clemmys insculpta*
Blanding's Turtle	*Emydoidea blandingi*

BIRDS

Endangered

Bald Eagle[bc]	*Haliaeetus leucocephalus*
Osprey	*Pandion haliaetus*
Peregrine Falcon[c]	*Falco peregrinus*
Piping Plover	*Charadrius melodus*
Forster's Tern	*Sterna forsteri*
Common Tern	*Sterna hirundo*
Barn Owl	*Tyto alba*
Red Necked Grebe	*Podiceps Grisegena*
Loggerhead Shrike	*Lanius ludovicianus*

Threatened

Great Egret	*Casmerodius albus*
Greater prairie Chicken	*Tympanuchus cupido*
Cooper's Hawks	*Accipiter cooperii*
Red-shouldered Hawk	*Buteo lineatus*

MAMMALS

Endangered

Pine Marten	*Martes americana*
Canada Lynx	*Lynx canadensis*
Timber Wolf[c]	*Canis lupus*

Threatened

None

---

[a]Endangered and Treatened Species WDNR List
[b]Threatened Species Federal List
[c]Endangered Species Federal List

APPENDIX C

Aquatic and Terrestrial Vertebrates of the Study Area

KENNECOTT FLAMBEAU PROJECT

Reptiles and Amphibians of Rusk County

	Documented Occurrences	Observed on Study Area	Probable in Rusk County
Reptiles			
Turtles			
◦ Wood turtle (*Clemmy's insculpta*)			X
Map turtle (*Graptemys geographica*)			X
◦ Blandings turtle (*Emdoidea blandingi*)	X		
E. spiny softshell (*Trionyx spinifer*)			X
Snapping turtle (*Chelydra serpentina*)	X	X	
Painted turtle (*Chrysemys picta*)	X	X	
Skinks			
N. prairie skink (*Eumeces Septentroinalis*)			X
Snakes			
Red-bellied snake (*Storeria occipitomaceulata*)			X
Hognose snake (*Heterodon playtyrhinos*)			X
Ringneck snake (*Diadophis punctatus*)			X
Smooth green snake (*Opheodrys vernalis*)			X
E. garter snake (*Thamnophis sirtalis*)		X	X
N. water snake (*Nerodia sipedon*)	X		
W. fox snake (*Elaphe vulpina*)			X
Brown snake (*Storeria dekayi*)			X
Amphibians			
Mudpuppies			
Mudpuppy (*Necturus maculosus*)			X
Salamanders			
Spotted salamander (*Ambystoma maculatum*)	X		
Central newt (*Notophthalmus viridescens*)			X
Four-toed salamander (*Hemidactylum scutatum*)			X
Tiger salamander (*Ambystoma tigrinum*)		X	X
Blue-spotted salamander (*A. laterale*)		X	X
Redbacked salamander (*Plethodon cinereus*)		X	X

	Documented Occurrences	Observed on Study Area	Probable in Rusk County
Frogs			
Copes grey tree frog (*Hyla Chrysoscelis*)			X
Western chorus frog (*Pseudacris triseriata*)			X
Spring peeper (*Hyla crucifer*)		X	X
Grey tree frog (*Hyla versicolor*)	X	X	
Pickerel frog (*Rana palustris*)	X	X	
Mink frog (*Rana septentrionalus*)		X	X
Bullfrog (*Rana catesbiana*)	X		
Green frog (*Rana clamitans*)	X		
Leopard frog (*Rana pipiens*)	X		
Wood frog (*Rana sylvatica*)			X
American toad (*Bufo terrestris*)		X	X

Documented occurrences (Vogt 1981)
Study area observations from 1973-1974 and 1987-1988 field work
Probable occurrences in Rusk County (Casper 1988)
◦Threatened species, Wisconsin Natural Heritage Inventory November 1988

Mammal List
Kennecott Flambeau Project
Mammals Known from the Region

A = Abundant (Frequently Observed)
C = Common (Occassionally Observed)
R = Rare (Only Rarely Observed)

Common Name	Species Name	(1) Observed In 1972/73	Observed In Region 1987/88	Preferred Habitat
Starnose Mole	Condylura cristata	X		Wet Meadows
Masked Shrew	Sorex cinereus	X	R	Woods, Grassland
Acrtic Shrew	Sorex arcticus			Spruce Swamps
N. Water Shrew	Sorex palustris		R	Streams, Bogs
Pigmy Shrew	Microsorex hoyi			Woods, Grassland
Shorttail Shrew	Blarina brevicauda	X	C	Woods, Swamps
Little Brown Bat	Myotis lucifugus			Woods, Buildings
Keen Myotis	Myotis keeni			Woods
Silver-haired Bat	Lasionycterus noctivagans			Woods, Streams
Eastern Pipistrelle	Pipistrellus subflavus			Caves. Trees
Big Brown Bat	Eptesicus fuscus			Woods, Buildings
Red Bat	Lasiurus borealis			Woods
Hoary Bat	Lasiurus cinereus			Woods
Black Bear	Ursus americanus			Woods, Swamps
Racoon	Procyon Lotor	X	C	Woods, Along Stream
Shorttail Weasel	Mustela erminea	X		Woods, Grassland
Longtail Weasel	Mustela frenata			Woods, Grassland
Least Weasel	Mustela rixosa			Meadows, Fields
Mink	Mustela vison	X		Along Shorelines
River Otter	Lutra canadensis	X		Along Shorelines
Badger	Taxidea taxus	X		Grassland
Striped Skunk	Mephitis mephitis	X		Woods, Grassland
Red Fox	Vulpes fulva	X	C	Open Areas, Edge

Gray Fox	Urocyon cinereoargenteus			Woods, Brushland
Coyote	Canis latrans			Open Areas, Woods
Bobcat	Lynx rufus	X		Large Forest Tracts
Woodchuck	Marmota monax			Forest Edge, Brush
Thirteen lined Ground Squirrel	Spermophilus tridecemlineatus	X		Grassland
Franklin Ground Squirrel	Spermophilus franklini	X	C	Grassland, Edge
Least Chipmunk	Eutamias minimus			Coniferous Forest
Eastern Chipmunk	Tamias striatus	X	A	Hardwood Forest
Red Squirrel	Tamiasciurus hudsonicus	X	C	Coniferous Forest
Gray Squirrel	Sciurus carolinensis	X	C	Hardwood Forest
Fox Squirrel	Sciurus niger			Hardwood Forest
Southern Flying Squirrel	Glaucomys volans	X	R	Wooded Areas
Northern Flying Squirrel	Glaucomys sabrinus	X		Wooded Areas
Plains Pocket Gopher	Geomys bursarius			Grassland
Beaver	Castor canadensis		C	Along Shorelines
Deer Mouse	Peromyscus maniculatus	X	A	Woodland
White-footed Mouse	Peromyscus leucopus	X	A	Woodland, Brush
Southern Bog Lemming	Synaptomys cooperi			Bogs
Boreal Redback Vole	Clethrionomys gapperi	X	C	Lowland Forest
Meadow Vole	Microtus pennsylvanicus	X	A	Grassland, Swamps
Muskrat	Ondatra zibethicus	X	C	Along Shorelines
Norway Rat	Rattus norvegicus			Buildings, Sewers
House Mouse	Mus musculus			Buildings

Meadow Jumping Mouse	Zapus hudsonius	X		Low meadows
Woodland Jumping Mouse	Napaeozapus insignis	X		Woods, Stream Edge
Porcupine	Erethizon dorsatum			Woods
Snowshoe Hare	Lepus americanus	X		Coniferous Swamps
Eastern Cottontail	Sylvilagus floridanus		C	Brush, Forest Edge
Whitetail Deer	Odocoileus virginianus	X	A	Brush, Woods, Edge

(1) - PEIR, 1974 Note: Project area was much larger in 1974 than is currently proposed.

Bird List
Kennecott Flambeau Project
Field Observations and Checklist for Wetland Inventory

X = Observed
H = Habitat Avaiable

	Wetland Area								
	1 & 2	3	4	5	6	7	8	9	10
Common Loon									
Grebe, Horned									
Grebe, Pied Billed									
Heron, Green Backed		H	X						
Heron, Grt Blue									
Crane, Sandhill									H
Bittern, Am.						H			H
Bittern, Least						H			N
Swan, Tundra									
Swan, Mute									
Goose, Snow									
Goose, Canada									
Duck, Wood	H		X						H
Duck, Amer. Black									
Mallard			H						

Northern Pintail				
Redhead				
Duck, Ring,necked				
Bufflehead				
Scaup, Lesser				
Goldeneye, Common				
Merganser, Hooded				
Merganser, Common				
Duck, Ruddy				
Teal, Blue Winged				
Vulture, Turkey				H
Osprey				
Eagle, Bald				
Hawk, Sharp-shinned	H			H
Hawk, Cooper's	H			H
Goshawk, Northern				H
Hawk, Red shouldered				H
Hawk, Broad winged	H	H		H
Hawk, Red Tailed	H	H		H
Hawk, Rough legged				H
Northern Harrier	H	H	X	X
Kestrel, American	H	H		
Merlin				H
Partridge, Gray				
Pheasant, Ring-necked				X

Grouse, Sharp-tailed								
Grouse, Ruffed	X		X	X			H	H		H
Sora										H
Coot, American				H						
Crane, Sandhill										H
Killdeer										
Yellowlegs, Lessor										
Sandpiper, Spotted										
Sandpiper. Least										
Sandpiper, Baird's										
Snipe, Common					H	H				
Woodcock, American	H		X	X			H	H		H
Gull, Herring										
Tern, Common										
Tern, Black										H
Dove, Rock										
Dove, Mourning							H			H
Cuckoo, Blackbillied										
Cuckoo, Yellowbilled										
Owl, Great horned	X						H			H
Owl, Snowy										H
Owl, Barred	H									
Owl, Great Gray	H									
Owl, Northern Saw-whet	H									
Nightwawk										

Whip-poor-will	H				
Swift, Chimney					
Hummingbird, Ruby-throated					
Kingfisher, B.					
Woodpecker, Redheaded	H				
Woodpecker, Redbellied	H				
Sapsucker, Yellowbellied					X
Woodpecker, Hairy	H				
Woodpecker, Downy	H				
Flicker, Northern	H				
Woodpecker, Pileated	H				
Wood-pewee, Eastern	H				
Flycatcher, Yellowbellied					
Flycatcher, Alder					
Flycatcher, Least					
Phoebe, Eastern	H				
Flycatcher, Great Crested					
Kingbird, Eastern					
Lark, Horned		H	H		
Martin, Purple		H	H		
Swallow, Tree		H	H		H
Swallow, N. Roughwinged		H	H		
Swallow, Bank					
Swallow, Barn		H	H		H
Swallow, Cliff					

Blue Jay	X					H			H
Gray Jay									
Crow	X	X		X	X	X	X	X	X
Raven, Common									
Chickadee, Blackcapped	X			X	X	X	X	X	X
Chickadee, Boreal									H
Nuthatch, Whitebreasted	H								
Nuthatch, Redbreasted	X								
Creeper, Brown	H								
Wren, House									
Wren, S-b Marsh				H	H	H			H
Wren, Sedge				H	H	H			
Wren, Winter									
Wren, Marsh				H	H	H			
Kinglet, Goldencrowned									
Kinglet, Rubycrowned									
Bluebird, East.				X	H				H
Veery	H		X						H
Thrush, Swainson's	H								
Thrush, Hermit	H								
Thrush, Wood	H								
Robin				X	X				
Grey Catbird		X	X	H	H	H	H		H
Mockingbird, Northern									
Brown Thrasher				H	H				

Water Pipit				
Waxwing, Cedar				H
Waxming, Bohemian				
Shrike, Northern				H
Starling				
Vireo, Yellowthroated				
Vireo, Redeyed				
Vireo, Warbling				
Vireo, Philadelphia				
Warbler, Goldenwinged				
Warbler, Tennessee				
Warbler, Orangecrowned				
Warbler, Nashville				
Warbler, Yellow			X	H
Warbler, C-nut-sided				
Warbler, Magnolia	H			
Warbler, Cape May				
Warbler, Blackthr. Blue				
Warbler, Yellow rmpd		X	H	H
Warbler, Blk-Th Green		X		
Warbler, Blackburnian				
Warbler, Pine	H			
Warbler, Palm				
Warbler, Bay-breasted				
Warbler, Blackpoll				

Warbler, Blk & White		X					
American Redstart							
Ovenbird	X						
Waterthrush, Northern							
Yellowthroat, Common	X						H
Warbler, Canada							
Scarlet Tanager							
Northern Cardinal							
Grosbeak, Rosebreasted			X				H
Bunting, Indigo				H	H		
Dickisssel							
Rufus sided Towhee							
Sparrow, Tree							
Sparrow, Chip.							H
Sparrow, Claycolored						H	X
Sparrow, Field				X	X		
Sparrow, Vesper							
Sparrow, Savannah							
Sparrow, Grasshopper							
Sparrow, Fox							
Sparrow, Song				X	X	X	X
Sparrow, Lincoln's							
Sparrow, Swamp				X		X	X
Sparrow, Whitethroated			H	H			
Sparrow, Whitecrowned			H	H			

Sparrow, Harris'								
Junco, Darkeyed						X		X
Snow Bunting								
Bobolink								
Blackbird, Redwinged		X	X	X	X	X		X
Meadowlark, East.				H	H			
Meadowlark, West.				H	H			
Blackbird, Yellowheaded								
Blackbird, Rusty								
Blackbird, Brewer's								
Grackle	X	X	X	X	X	X		X
Cowbird				H	H			
Oriole, Orchard								
Oriole, Northern						H		H
Grosbeak, Pine								
Finch, Purple								
Crossbill, Red								
Crossbill, whitewinged								
Common Redpoll								
Siskin, Pine								
Goldfinch				X	X			
Grosbeak, Eve.	H					X		H
Sparrow, House								

APPENDIX D

Artesian Seep Geochemistry

KENNECOTT FLAMBEAU PROJECT
BASELINE GROUNDWATER MONITORING
NOVEMBER 1987

Primary Drinking Water Standards

Well ID	Date	As	Ba	Cd	Cr	Pb	Hg	NO2+NO3-N	Se	Ag	Na
MW-1000	11/05/87	<0.005	<0.5	<0.0010	<0.005	<0.005	<0.0005	0.27	<0.005	<0.005	3.70
MW-1000P	11/05/87	<0.005	<0.5	0.0037	<0.005	<0.005	<0.0005	0.11	<0.005	<0.005	14.00
MW-1001	11/05/87	<0.005	<0.5	0.0021	<0.005	<0.005	<0.0005	0.91	<0.005	<0.005	4.50
MW-1001G	11/05/87	<0.005	<0.5	<0.0010	<0.005	<0.005	<0.0005	0.91	<0.005	<0.005	7.00
MW-1001P	11/05/87	<0.005	<0.5	0.0041	<0.005	<0.005	<0.0005	0.22	<0.005	<0.005	10.00
MW-1002	11/05/87	<0.005	<0.5	0.0023	<0.005	<0.005	<0.0005	1.10	<0.005	<0.005	20.00
MW-1002G	11/05/87	<0.005	<0.5	0.0031	<0.005	<0.005	<0.0005	1.30	<0.005	<0.005	6.50
MW-1003	11/05/87	<0.005	<0.5	<0.0010	<0.005	<0.005	<0.0005	0.59	<0.005	<0.005	4.10
MW-1003P	11/05/87	<0.005	<0.5	0.0027	<0.005	<0.005	<0.0005	0.11	<0.005	<0.005	10.00
MW-1004	11/05/87	0.021	<0.5	<0.0010	<0.005	<0.005	<0.0005	0.33	<0.005	<0.005	3.90
MW-1004S	11/05/87	<0.005	<0.5	0.0030	<0.005	<0.005	<0.0005	0.20	<0.005	<0.005	4.60
MW-1004P	11/05/87	<0.005	<0.5	0.0022	<0.005	<0.005	<0.0005	0.35	<0.005	<0.005	8.80
MW-1005	11/05/87	<0.005	<0.5	0.0017	<0.005	<0.005	<0.0005	0.38	<0.005	<0.005	16.00
MW-1005G	11/05/87	<0.005	<0.5	<0.0010	<0.005	<0.005	<0.0005	0.16	<0.005	<0.005	6.00
MW-1005P	11/05/87	<0.005	<0.5	0.0031	<0.005	<0.005	<0.0005	0.19	<0.005	<0.005	15.00
BLANK	11/05/87	<0.005	<0.5	<0.0010	<0.005	<0.005	<0.0005	0.13	<0.005	<0.005	<0.5
ARTESIAN	11/05/87	<0.005	<0.5	0.0011	<0.005	<0.005	<0.0005	0.25	<0.005	<0.005	4.60

Secondary Drinking Water Standards

Well ID	Date	Cl	Cu	Fl	Fe	Mn	pH(fld)	SO4	TDS	Zn
MW-1000	11/05/87	<1	0.010	<0.1	<0.10	0.10	6.05	15	250	<0.05
MW-1000P	11/05/87	1	0.061	0.2	0.15	0.46	5.78	28	350	0.11
MW-1001	11/05/87	6	<0.005	0.1	0.12	0.15	6.16	8	170	<0.05
MW-1001G	11/05/87	1	<0.005	<0.1	<0.10	0.09	5.97	16	140	<0.05
MW-1001P	11/05/87	<1	<0.005	0.4	<0.10	0.39	6.21	10	220	<0.05
MW-1002	11/05/87	4	<0.005	0.2	<0.10	0.21	6.40	20	200	<0.05
MW-1002G	11/05/87	15	<0.005	<0.1	<0.10	0.12	6.32	10	250	<0.05
MW-1003	11/05/87	2	<0.005	0.2	<0.10	0.45	6.00	7	190	<0.05
MW-1003P	11/05/87	1	<0.005	0.3	<0.10	0.34	6.26	8	320	<0.05
MW-1004	11/05/87	<1	<0.005	<2.0	0.26	0.28	5.74	<5	400	<0.05
MW-1004S	11/05/87	3	<0.005	0.1	<0.10	0.09	6.06	10	180	<0.05
MW-1004P	11/05/87	1	<0.005	0.3	<0.10	0.13	6.47	<5	220	<0.05
MW-1005	11/05/87	220	<0.005	0.1	6.10	1.10	5.60	16	610	<0.05
MW-1005G	11/05/87	<1	<0.005	0.3	3.10	0.28	6.35	<5	300	<0.05
MW-1005P	11/05/87	4	<0.005	0.2	0.56	0.24	6.38	6	330	<0.05
BLANK	11/05/87	1	<0.005	<0.1	<0.10	<0.05	N/A	<5	55	<0.05
ARTESIAN	11/05/87	4	<0.005	<0.1	<0.10	<0.05	6.24	10	150	<0.05

All values in milligrams per liter unless indicated otherwise

"N/A" is "Not Applicable" or "Not Available"

KENNECOTT FLAMBEAU PROJECT
BASELINE GROUNDWATER MONITORING
NOVEMBER 1987 (continued)

Indicator Parameters

Well ID	Date	Alk	Ca	COD	Hard	SpCnd (u-mhos/cm)	Mg	Temp (deg C)
MW-1000	11/05/87	43	11.0	<5	39	238	3.10	8.0
MW-1000P	11/05/87	96	23.0	85	93	129	9.90	8.0
MW-1001	11/05/87	53	13.0	25	49	172	4.50	8.0
MW-1001G	11/05/87	64	17.0	90	70	168	6.10	8.0
MW-1001P	11/05/87	110	24.0	30	100	232	9.80	8.0
MW-1002	11/05/87	110	24.0	10	93	292	7.50	8.0
MW-1002G	11/05/87	96	28.0	10	120	252	11.00	8.0
MW-1003	11/05/87	53	13.0	25	56	131	3.80	8.0
MW-1003P	11/05/87	180	36.0	80	170	341	17.00	8.0
MW-1004	11/05/87	53	11.0	50	49	125	6.00	8.0
MW-1004S	11/05/87	53	15.0	15	62	149	5.40	8.0
MW-1004P	11/05/87	170	34.0	15	150	345	15.00	8.0
MW-1005	11/05/87	74	91.0	30	380	816	38.00	8.0
MW-1005G	11/05/87	170	42.0	75	160	330	14.00	8.0
MW-1005P	11/05/87	250	56.0	50	210	449	21.00	8.0
BLANK	11/05/87	<10	<1.0	<5	<1	N/A	<0.05	N/A
ARTESIAN	11/05/87	53	15.0	<5	52	152	4.40	7.0

Other Parameters

Well ID	Date	Al	Be	Co	Mo	Ni	Th	Sn	Ti	U	SWL
MW-1000	11/05/87	0.042	0.001	<0.05	0.030	0.027	<0.005	<0.067	0.005	<0.001	1,088.10
MW-1000P	11/05/87	0.090	<0.001	<0.05	0.040	0.010	<0.005	<0.067	<0.004	<0.001	1,087.66
MW-1001	11/05/87	0.070	<0.001	<0.05	<0.029	<0.007	<0.005	<0.067	<0.004	<0.001	1,114.51
MW-1001G	11/05/87	0.102	<0.001	<0.05	0.034	0.016	<0.005	<0.067	0.005	<0.001	1,113.79
MW-1001P	11/05/87	0.046	<0.001	<0.05	<0.029	0.008	<0.005	<0.067	<0.004	<0.001	1,114.11
MW-1002	11/05/87	0.046	<0.001	<0.05	0.050	<0.007	<0.005	<0.067	<0.004	0.002	1,089.86
MW-1002G	11/05/87	0.074	<0.001	<0.05	<0.029	0.021	<0.005	<0.067	<0.004	0.003	1,089.89
MW-1003	11/05/87	0.076	<0.001	<0.05	<0.029	0.033	<0.005	<0.067	<0.004	<0.001	1,110.87
MW-1003P	11/05/87	0.038	<0.001	<0.05	<0.029	<0.007	<0.005	<0.067	<0.004	0.004	1,110.90
MW-1004	11/05/87	0.131	<0.001	<0.05	<0.029	<0.007	<0.005	<0.067	<0.004	<0.001	1,108.66
MW-1004S	11/05/87	0.058	<0.001	<0.05	0.046	<0.007	<0.005	<0.067	<0.004	<0.001	1,108.49
MW-1004P	11/05/87	0.034	<0.001	<0.05	0.042	<0.007	<0.005	<0.067	<0.004	0.002	1,106.41
MW-1005	11/05/87	0.086	<0.001	<0.05	0.042	0.040	<0.005	<0.067	<0.004	0.004	1,138.89
MW-1005G	11/05/87	0.070	<0.001	<0.05	<0.029	0.017	<0.005	<0.067	<0.004	<0.001	1,138.17
MW-1005P	11/05/87	0.070	<0.001	<0.05	<0.029	<0.007	<0.005	<0.067	<0.004	0.006	1,138.47
BLANK	11/05/87	0.044	<0.001	<0.05	<0.029	<0.007	<0.005	<0.067	<0.004	<0.001	N/A
ARTESIAN	11/05/87	0.038	<0.001	<0.05	<0.029	0.022	<0.005	<0.067	<0.004	<0.001	N/A

All values in milligrams per liter unless indicated otherwise

"N/A" is "Not Applicable" or "Not Available"

APPENDIX 3.9-A

Plant Species List

Legend

DA =	Disturbed Area
OF =	Old Field
UF =	Upland Forest
LF =	Lowland Forest
BG =	Bog
AT =	Alder Thicket
NS =	Northern Sedge Meadow

Plant Species Known in the Environmental Study Area

		HABITAT
Aceraceae		
* *Acer negundo*	Box elder	DA-OF
* *Acer rubrum*	Red maple	UF-BG-LF
* *Acer saccharinum*	Silver maple	OF-LF-UF
* *Acer saccharum*	Sugar maple	UF-OF
* *Acer spicatum*	Mountain maple	UF-LF
Alismaceae		
* *Sagittaria latifolia*	Broad leaved arrowhead	OF-DA
Anacardiaceae		
* *Rhus radicans*	Poison ivy	UF-OF
* *Rhus typhina*	Staghorn sumac	UF-OF-DA
Aquifoliaceae		
Ilex verticillata	Northern winterberry	BG
* *Nemopanthus mucronatus*	Mountain holly	AT-OF-LF
Araceae		
* *Acorus calamus*	Sweet flag	NS
* *Arisaema triphyllum*	Jack-in-the-pulpit	LF-UF-AT
* *Calla palustris*	Water arum	AT-LF

Araliaceae			
*	*Aralia nudicaulis*	Wild sarsaparilla	UF-LF
*	*Panax trifolius*	Dwarf ginseng	UF-LF-AT
Aristolochiaceae			
	Asarum canadense	Wild ginger	UF-LF
Asclepiadaceae			
	Asclepias incarnata	Swamp milkweed	OF-NS
*	*Asclepias syriaca*	Common milkweed	OF-DA-UF
Balsaminaceae			
*	*Impatiens biflora*	Jewelweed	UF-OF-AT-NS
Berberidaceae			
*	*Caulophyllum thalictroides*	Blue cohosh	UF
	Berberis thundergii	Barberry	UF
Betulaceae			
*	*Alnus rugosa*	Tag alder	UF-OF-AT LF-BG-NS
	Betula grandulosa	Scrub birch	BG
	Betula lutea	Yellow birch	UF
*	*Betula nigra*	River birch	AT-LF
*	*Betula papyrifera*	White birch	OF-UF-DA
*	*Betula alleghaniensis*	Yellow birch	UF

*	*Carpinus caroliniana*	Ironwood	UF
	Corylus americana	Hazelnut	UF
*	*Corylus cornuta*	Beaked hazelnut	UF-OF
*	*Ostrya virginiana*	Hop-hornbeam	UF
Caesalpiniaceae			
*	*Gleditsia triacanthos*	Black locust	DA
Caprifoliaceae			
	Diervilla Lonicera	Bush honeysuckle	OF
	Lonicera hirsuta	Hairy honeysuckle	UF-AT
	Lonicera tatarica	Tartarian bush honeysuckle	UF-OF
	Sambucus canadensis	American elder	UF-OF-AT-NS
*	*Sambucus pubens*	Red-berried elder	LF
	Viburnum dentatum	Arrowwood	UF
	Viburnum Lentago	Sweet viburnum	UF-AT
	Viburnum Rafinesquianum	Viburnum	OF
Caryophyllaceae			
	Cerastium vulgatum	Mouse-ear chickweed	LF
	Dianthus Armeria	Grass pink	
*	*Lychnis alba*	White cockle	OF-UF-DA
*	*Stellaria graminea*	Lessor stichwart	OF

Celastraceae			
	Celastrus scandens	Climbing bittersweet	UF
Chenopodiaceae			
	Chenopodium urbicum	Upright goosefoot	
Compositae			
*	*Ambrosia artemissifolia*	Ragweed	OF
*	*Anchillea millefolium*	Yarrow	OF-DA
*	*Anaphalis margaritacea*	Pearly everlasting	OF-DA-UF
*	*Antennaria plantaginifolia*	Field pussytoes	OF
*	*Arctium Lappa*	Burdock	UF
*	*Aster macrophyllus*	Large-leaved aster	AT-OF-UF
*	*Aster sagittifolius*	Arrow-leaved aster	UF
*	*Bidens laevis*	Smooth bur marigold	NS
*	*Chrysanthemum leucanthemum*	Ox-eye daisy	OF-DA
*	*Cirsium arvense*	Thistle	OF-DA
	Erigeron philadelphicus	Philadelphia fleabane	
*	*Erigeron strigosus*	Daisy fleabane	OF-DA
	Eupatorium maculatum	Spotted joe-pye weed	OF-AT
*	*Eupatorium perfoliatum*	Boneset	OF-NS-UF

	Gnaphalium obtusifolium	Fragrant life everlasting	OF
*	*Helenium autumnale*	Swamp sunflower	LF
	Helianthus grosseserratus	Saw-tooth sunflower	UF-OF
*	*Helianthus divaricatus*	Woodland sunflower	UF
*	*Hieracium aurantiacum*	Orange hawkweed	UF-OF-DA
*	*Hieracium seabrum*	Rough hawkweed	OF-DA-UF
*	*Hieracium umbellatum*	Narrow-leaved hawkweed	DA
*	*Kuhnia eupatorioides*	False boneset	UF
	Lactuca canadensis	Wild lettuce	
*	*Rudbeckia hirta*	Blackeyed susan	OF-UF
	Rudbeckia triloba	Thin-leaved cone flower	UF-OF
	Senecio aureus	Golden ragwort	LF
	Solidago flexicaulis	Zig-zag goldenrod	
	Solidago juncea	Early goldenrod	OF
*	*Solidago sp.*	Goldenrod	OF-AT-NS-DA
	Sonchus asper	Spiny sow-thistle	OF
*	*Taraxacum officinale*	Dandelion	LF-OF-AT-DA-UF

Convallariaceae		
* *Clintonia borealis*	Yellow clintonia	LF
Convolvulaceae		
* *Convolvulus sepium*	Hedge bindweed	OF-DA
* *Convolvulus spithamaeus*	Upright bindweed	OF
Cornaceae		
* *Cornus alternifolia*	Alternate leaved dogwood	UF
* *Cornus canadensis*	Bunchberry	LF
* *Cornus stolonifera*	Red osier dogwood	UF-LF-OF-AT-BG-NS
Crassulaceae		
* *Cratagegus sp.*	Hawthorn	OF-UF
Penthorum sedoides	Ditch stonecrop	
Cruciferae		
Arabis Drummondii	Drummond's rock-cress	OF
Barbarea vulgaris	Yellow rocket	UF
* Berteroa incana	Hoary alyssum	OF-DA
Capsella Bursa-pastoris	Sheperd's purse	OF
Cyperaceae		
Carex comosa	Bristly sedge	OF
Carex Crawfordii	Crawford's sedge	OF

	Carex lacustris	Lake bank sedge	NS
	Carex lupulina	Hop sedge	UF
	Carex miliaris	Northeastern sedge	BG
*	*Carex pennsylvania*	Pennsylvania sedge	AT-UF
	Carex projecta	Necklace sedge	OF
*	*Carex rostrata*	Yellowish sedge	BG-NS
*	*Carex stricta*	Tussock sedge	NS-AT-OF-DA
	Cyperus sp.	Cyperus	OF
	Cyperus strigosus	Straw-colored cyperus	OF
	Eleocharis obtusa	Blunt spike rush	OF
	Eleoharis ovata	Ovoid spikerush	
	Eriophorum angustifolium	Cotton grass	LF-BG
	Rhynchospora capitellata	Capillary beaked-rush	OF
	Scirpus atrovirens	Dark-green bulrush	OF
*	*Scirpus cyperinus*	Wool grass	OF-LF
*	*Scirpus microcarpus*	Bullrush	LF-NS
	Scirpus pedicellatus	Wood grass	BG
	Scirpus validus	American great bulrush	OF-DP

Droseraceae			
	Drosera rotundifolia	Round-leaved sundew	BG
Equisetaceae			
*	Equisetum arvense	Field horsetail	OF-DA
*	Equisetum fluviatile	Swamp horsetail	LF
	Equisetum hyemale var. affine	Stout scouring rush	UF-OF
*	*Equisetum sylvaticum*	Wood horsetail	UF-OF
Ericaceae			
	Andromeda glaucophylla	Wild rosemary	BG
*	*Chamaedaphne calyculata*	Leather leaf	LF-BG
*	*Gaultheria hispidula*	Creeping snowberry	LF
	Gaultheria procumbens	Creeping wintergreen	
*	*Kalmia polifolia*	Pale laurel	LF
*	*Ledum groenlandicum*	Labrador tea	LF-BG
	Pyrola elliptica	Shin-leaf	UF
	Pyrola rotundifolia	Bog wintergreen	UF
	Vaccinium myrtilloides	Thin-leaved bilberry	LF
	Vaccinium oxycoccus	Small cranberry	BG

Fagaceae			
*	*Quercus alba*	White oak	UF-DA
*	*Quercus macrocarpa*	Bur oak	UF
*	*Quercus rubra*	Red oak	UF
Fumariaceae			
*	*Dicentra Cucullaria*	Dutchman's breeches	UF
Gentianaceae			
*	*Dasystephana andrewsii*	Blind gentian	LF
Geraniaceae			
	Geranium maculatum	Spotted crane's-bill	UF
Gramineae			
*	*Agropyron repens*	Quackgrass	DA
	Agropyron trachycaulum	Wheatgrass	OF
	Agrostis gigantea	Redtop	OF
	Argostis stolonifera	Bentgrass	OF-NS
	Aristida ramosissima	Branched aristida	UF
*	*Bromus inermis*	Smooth brome	OF-DA
	Echinochloa pungens var. wiegandii	Barnyard grass	OF
*	*Festuca elatior*	Meadow fescue	OF-DA
*	*Glyceria borealis*	Northern managrass	LF-NS
	Glyceria canadensis	Rattlesnake grass	BG

	Glyceria striata	Mangrass	LF
	Leersia oryzoides	Rice cut-grass	OF
*	*Panicum capillare*	Panicum	OF
	Panicum oliogosanthes	Few-flowered panic grass	OF-DA
*	*Phalaris arundinacea*	Reed canary grass	OF-BG-NS-DP-LF
*	*Phleum pratense*	Timothy	OF-DA-UF
*	*Poa pratensis*	Kentucky bluegrass	OF-DA
*	*Setaria lutescens*	Foxtail	OF
	Sphenopholis intermedia	Slender wedgegrass	OF-NS
Grossulariaceae			
*	*Ribes gladulosum*	Fedit currant	LF
Hydrophyllaceae			
*	*Hydrophyllum virginianum*	Virginia waterleaf	UF
Hypericaceae			
	Hypericum mutilum	Slender St. Johnswort	
	Hypericum punctatum	Spotted St. Johnswort	UF
*	*Hyparicum pyramidatum*	Great St. Johnswort	OF
Iridaceae			
	Iris versicolor	Blue flag	NS
Juglandaceae			
	Carya cordiformis	Hickory	UF
	Juglans cinerea	Butternut	UF

Juncaceae			
	Juncus acuminatus	Sharp-fruited rush	OF
*	*Juncus effusus var. solutus*	Common rush	OF-LF-NS-DP
	Juncus interior	Inland rush	OF
Labiatae			
	Blephilia ciliata	Downy blephilia	OF
	Lycopus americanus	Cut-leaved water hoarhound	OF-AT
	Mentha arvemsis var. glabrata	Field mint	OF
	Monarda clinopodia	Basal balm	OF
	Monarda fistulosa	Wild bergamot	UF
	Monarda sp.	Bergamot	UF
	Nepeta cataria	Catnep	UF
	Prunella vulgaris	Self heal	OF
	Scutellaria galericulata	Hooded willow-herb	AT-NS
	Stachys palustris	Hedge nettle	OF
Leguminosae			
*	*Lotus corniculatus*	Birdsfoot trefoil	OF-DA
	Trifolium hybridum	Alsike clover	OF
*	*Trifolium pratense*	Red clover	OF-DA
*	*Trifolium repens*	White clover	OF-DA-UF
	Vicia americana	Purple vetch	OF

Liliaceae			
	Allium tricoccum	Wild leek	UF-LF
*	*Clintonia borealis*	Yellow clintonia	UF-LF
*	*Erythronium albidum*	White adder's-tongue	UF
	Erythronium americanum	Yellow adders-tongue	UF
*	*Maianthenum canadense*	Canada mayflower	UF-LF
*	*Polygonatum biflorum*	Solomon's seal	UF
	Smilacina racamosa	False spikenard	UF
*	*Smilacina trifolia*	Three-leaved false solomons seal	BG
*	*Streptopus amplexifolius*	Twisted stalk	UF
	Streptopus roseus	Yellow adders-tongue	UF
*	*Trillium cernuum*	Nodding trillium	UF-LF
*	*Trillium grandiflorum*	White trillium	UF-LF
	Uvularia grandiflora	Large flowered bellwort	UF-LF
*	*Uvularia sessilifolia*	Sessile bellwort	UF-LF
Lobeliaceae			
	Lobelia inflata	Indian tobacco	UF

Lycopodiaceae		
* *Lycopodium annotinum*	Stiff clubmoss	UF
Lycopodium clavatum	Running pine clubmoss	UF
* *Lycopodium complanatum*	Trailing christmas tree	UF-LF
* *Lycopodium lucidulum*	Shining clubmoss	UF-LF
* *Lycopodium sp.*	Clubmoss	LF
* *Lycopodium obscurum*	Ground pine	UF-LF
* *Selaginella sp.*	Selaginella	LF
Lythraceae		
Lythrum salicaria	Purple loosestrife	
Najadaceae		
Potamogeton gramineus	Spatulate-leaved pondweed	OF
Oleaceae		
* *Fraxinus nigra*	Black ash	UF-AT-LF
* *Fraxinus pennsylvanica*	Green ash	UF-DA
Onagraceae		
Circaea quadrisulcata	Enchanters nightshade	UF
Epilobium adenocaulon	Northern willow herb	UF
Epilobium anqustifolium	Willow herb	OF-BG
Epilobium coloratum	Purple-leaved willow herb	AT

	Epilobium leptophyllum	Willow herb	NS
	Epilobium palustre	Swamp willow herb	BG
*	*Oenothera biennis*	Evening primerose	OF-DA
	Ophioglossaceae		
	Botrychium virginianum	Virginia grape-fern	UF
	Orchidaceae		
	Cypripedium acaule	Moccasin flower	LF
	Habenaria hyperborea	Tall leafy green orchis	AT
	Habenaria psycodes	Smaller purple-fringed orchis	OF
	Osmundaceae		
*	*Osmunda cinnamomea*	Cinnamon fern	UF-AT-OF
	Osmunda Claytoniana	Clayton's fern	UF
	Osmunda regalis var. spectabilis	Royal fern	AT-BG
	Oxalidaceae		
	Oxalis europa	Wood sorrel	OF
	Papaveraceae		
*	*Sanquinaria canadensis*	Bloodroot	UF-LF
	Phrymaceae		
	Phryma Leptostachya	Lopseed	UF

Pinaceae			
*	*Abies balsamea*	Balsam fir	UF-LF
*	*Larix laricina*	Tamarack	BG
*	*Picea glauca*	White spruce	OF-UF
*	*Picea mariana*	Black spruce	BG
*	*Pinus banksania*	Jack pine	OF-DA
*	*Pinus resinosa*	Red pine	UF-OF
*	*Pinus strobus*	White pine	BG-UF-LF-DA
*	*Thuja occidentalis*	White cedar	UF
*	*Tsuga canadensis*	Hemlock	UF-LF
Plantaginaceae			
*	*Plantago major*	Common plantain	OF-DA
	Plantago Rugelii	Pale plantain	UF
Polemoniaceae			
*	*Phlox divaricata*	Wild blue phlox	UF
Polygonaceae			
	Polygonum cilinode	Fringed black bindweed	UF
	Polygonum lapathifolium	Pale persicaria	OF
	Polygonum pensylvanicum	Pennsylvania persicaria	OF
	Polygonum Persicaria	Lady's thumb	OF

	Rumex Acetosella	Field sorrel	OF
*	*Rumex crispus*	Curled dock	UF-OF-DA
	Rumex verticillatus	Swamp dock	NS
Polypodiaceae			
*	*Adiantum pedatum*	Maidenhair fern	UF-PF-LF
*	*Athyrium felix-femina*	Lady fern	UF-PF-LF
	Dryopteris cristata	Crested shield-fern	UF-AT-BG-NS
	Dryopteris disjuncta	Fern	UF
	Dryopteris Goldiana	Goldie's fern	UF
*	*Dryopteris intermedia*	American shield fern	OF
	Dryopteris Phegopteris	Longbeech fern	UF
*	*Dryopteris spinulosa*	Evergreen wood fern	UF-AT
*	*Matteuccia pensylvanica*	Ostrich fern	UF
*	*Onoclea sensibilis*	Sensitive fern	UF-OF-AT-NS-LF
*	*Pteridium aquilinum*	Bracken fern	UF-OF
Portulacaceae			
*	*Claytonia virginica*	Spring beauty	UF-LF
*	*Portulaca oleracea*	Purslane	DA

Primulaceae			
	Lysimachia quadrifolia	Whorled loosestrife	
	Lysimachia terrestris	Bulbbearing loosestrife	
	Steironema ciliatum	Fringed loosestrife	OF
*	*Trientalis borealis*	Starflower	LF-UF
Ranunculaceae			
*	*Actaea alba*	White baneberry	LF
	Anemone canadensis	Round-leaved anemone	UF
*	*Anemone quinquefolia*	Wood anemone	UF-LF
	Anemone virginiana	Tall anemone	UF
	Aquilegia canadensis	Wild Columbine	UF
*	*Caltha palustris*	Marsh marigold	AT-LF
	Clematis virginiana	Virginia virgin's bower	UF
*	*Coptis trifolia*	Gold thread	UF-LF
*	*Hepatica acutiloba*	Round-lobed hepatica	UF-LF
	Isopyrum biternatum	False rue anemone	UF-LF
*	*Ranunculus arbortivus*	Kidney leaf buttercup	UF-LF
*	*Ranunculus acris*	Common buttercup	Uf-OF-DA

	Ranunculus pensylvanicus	Crowfoot	UF-LF-OF
	Ranunculus recurvatus	Rough crowfoot	UF-LF
*	*Ranunculus septentrionalis*	Swamp buttercup	UF-LF-OF
*	*Thalictrum dioicum*	Meadow rue	UF
Rhamnaceae			
	Rhamnus alnifolius	Dwarf alder	
	Rhamnus Frangula	Alder buckthorn	LF
Rosaceae			
	Agrimonia gryposepela	Tall hairy agrimony	UF
*	*Amelanchier arborea*	Service berry	OF
*	*Fragaria virginiana*	Wild strawberry	UF-LF-OF-DA
	Geum canadense	White avens	UF-LF
*	*Potentilla argentea*	Silvery cinquefoil	DA
*	*Potentilla norvegica*	Rough cinquefoil	OF
	Potentilla recta	Rough-fruited cinquefoil	OF
	Potentilla simplex	Decumbent five-finger	
	Prunus pensylvanica	Wild red cherry	UF-OF
	Prunus pumila	Dwarf cherry	
	Prunus serotina	Wild black cherry	UF

*	*Prunus virginiana*	Choke cherry	UF-NS-LF
	Rubus allegheniensis	Mountain Blackberry	UF-OF
	Rubus flagellaris	Northern dewberry	AT
*	*Rubus hispidus*	Swamp raspberry	LF
*	*Rubus idaeus*	Red raspberry	UF-OF-AT-NS-DA
*	*Rubus occidentalis*	Black raspberry	UF
*	*Rubus pubescens*	Dwarf raspberry	UF-AT-BG
*	*Spirea alba*	Meadow sweet	UF-OF-BG-NS
	Spirea tomentosa	Hard hack	OF-AT-BG
*	*Waldsteinia fragariodes*	Barren strawberry	OF-UF
Rubiaceae			
*	*Galium asprellum*	Rough bedstraw	
	Galium boreale	Northern bedstraw	
*	*Galium labradoricum*	Labrador marsh bedstraw	LF
	Galium palustre	Marsh bedstraw	OF
	Galium tinctorium	Stiff marsh bedstraw	NS
Rutaceae			
	Xanthoxylum americanum	Prickly ash	OF

Salicaceae			
*	*Populus deltoides*	Cottonwood	OF-UF-DA
*	*Populus grandidentata*	Big tooth aspen	UF
	Populus Tacamahacca	Poplar	LF
*	*Populus tremuloides*	Quacking aspen	UF-LF-OF-BG-NS-AT-DA
*	*Salix babylonica*	Weeping willow	OF-NS-DP
	Salix Bebbiana	Beaked willow	OF
*	*Salix discolor*	Silver willow	UF-LF-OF
	Salix fragilis	Snap willow	LF-OF-AT-BG
	Salix interior	River bank willow	UF
*	*Salix nigra*	Black willow	LF-OF
	Salix petiolaris	Slender willow	AT
	Salix serissima	Autumn willow	UF
Sarraceniaceae			
*	*Sarracenia purpurea*	Pitcher plant	LF
Saxifragaceae			
*	*Mitella diphylla*	Mitre-wort	UF-LF
	Ribes americanum	Wild black currant	LF-AT-NS
*	*Ribes Cynosbati*	Wild gooseberry	UF-BG

Ribes glandulosum	Fedit currant	AT
Ribes gracile	Missouri gooseberry	UF
Ribes sativum	Gooseberry	NS
Scrophulariaceae		
Gerardia purpurea	Large purple agalinis	
* *Linaria vulgaris*	Butter and eggs	OF
Mimulus ringens	Square stemmed monkeyflower	
Verbascum Blattaria	Moth mullen	OF
Veronica Anagallis-aquatic	Water speedwell	LF-OF
Veronica serpyllifolia	Thyme-leaved speedwell	LF-OF
Solanaceae		
Physalis pruinosa	Tall hairy ground cherry	OF
Solanum Dulcamara	Bittersweet	AT
Sphagnaceae		
* *Sphagnum sp.*	Sphagnum moss	BG
Taxaceae		
Taxus canadensis	Ground hemlock	UF
Thymelaeceae		
Dirca palustris	Leatherwood	UF
Tiliaceae		
* *Tilia americana*	Basswood	UF

Typhaceae			
*	*Typha angustifolia*	Narrow-leaved cattail	OF-AT-DP
*	*Typha latifolia*	Broad-leaved cattail	AT-BG-NS-LF
Ulmaceae			
*	*Ulmus americana*	American elm	UF
	Ulmus rubra	Red elm	UF-LF
	Ulmus Thomasi	Rock elm	UF
Umbelliferae			
*	*Cicuta maculata*	Water hemlock	UF-OF-NS
*	*Osmorhiza claytonii*	Sweet cicely	LF
Urticaceae			
	Laportea canadensis	Wood nettle	UF
	Pilea fontana	Clearweed	UF-OF
Verbenaceae			
	Verbena Engelmanii	Vervain	OF
	Verbena hastata	Wild hyssop	OF
Violaceae			
	Viola adunca	Hooked violet	OF
	Viola conspersa	American dog violet	UF-LF
	Viola cuncullata	Marsh blue violet	UF
	Viola eriocarpa	Smoothish yellow violet	UF-LF
*	*Viola pallens*	Northern white violet	UF-LF-AT

*	*Viola pubescens*	Downy yellow violet	UF
*	*Viola selkirkii*	Great spurred violet	LF
*	*Viola sororia*	Woolly blue violet	UF-LF-AT
Vitaceae			
	Parthenocissus quinquefolia	American ivy	UF
Zannichelliaceae			
*	*Potamogeton spirillus*	Spiral pondweed	DP

Note: Habitat rererences are as follows:

DA = Disturbed Area
OF = Old Field
LF = Lowland Forest
UF = Upland Forest
BG = Bog
NS = Northern Sedge Meadow
AT = Alder Thicket

° Endangered species reported from larger study area in 1974. Not found in smaller project area in 1987-1988.

* Identified in 1987-1988 field work

APPENDIX 3.9-B

Lee S. Forest Inventory & Wetlands Inventory

FOREST INVENTORY, APPRAISAL, & MANAGEMENT RECOMMENDATIONS

for

KENNECOTT FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

PREPARED BY
DAVID A. LEE
CONSULTING FORESTER
LADYSMITH, WISCONSIN

OCTOBER, 1988

TABLE OF CONTENTS

1. INTRODUCTION

The purpose of this report is to provide a forestry inventory, timber appraisal, and forest management recommendations for the Kenncott Flambeau Project at Ladysmith, Wisconsin It was prepared under the terms of a contract between Foth & Van Dyke, Engineers / Architects, Milwaukee, Wisonsin, and David A. Lee, Consulting Forester, Ladysmith, Wisconsin.

The report covers areas indicated on a Preliminary Project Plot Plan provided by Foth & Van Dyke as being the project area and railroad spur. In addition, it provides similar information on several off-site areas ("Comparable Areas") selected by the consulting forester as being similar in nature to the timber stands on the project site. These comparable areas are to be used as long-term reference areas.

Included are maps of these areas, acreage by timber and/or land use type, timber inventory, timber appraisal, forest management plans for all of the areas, and additional information felt to be of use.

The forests and other vegetative cover of this area is the result of a combination of factors, including climate, soils, and past and current land use.

The first European explorers foung this area covered by a variety of timber types. Northern Hardwoods, principally maple, ash, basswood, and hemlock, dominated the glacial till uplands. White pine was common on alluvial soils along rivers and streams and on sandy outwash plains. Poorly drained lowlands were occuppied by stands of black ash, tamarack (eastern larch), and black spruce.

Logging of the pine along the rivers and streams began in the mid to late 1800's and was completed by about 1900. The arrival of the Soo Line railroad in the first decade of the 20th century signalled the beginning of an era of logging which stripped the remaining forests of most of their marketable timber. The lumberjacks were followed by settlers who attempted to clear the land for farms. Wildfires, some started by nature, but most by settlers clearing land, raced through much of the area, destroying what was left of the forests in their path. With the initiation of state fire control efforts in the 1930's the area's forests began a long period of recovery which is still continuing today.

Today's Northern Hardwood stands generally occupy areas that were heavily cut over, but were not cleared and were burned only lightly, if at all. Aspen stands are found mostly on areas that were heavily burned and/or cleared. Most pine stands are red pine that was planted in the last 30 years, but some naturally occurring white pine patches can be found. Some poorly drained lowlands support second growth stands of their original species, while others are covered by dense growths of brush, grass, and herbs. Many upland areas on which farming has been abandoned area now being reclaimed by forests. On these areas, aspen and other "pioneer" species are slowly replacing the brush and ground vegetation.

The kinds of forests growing here today are largely the result of natural factors; their condition: of decades of mistreatment and abuse. Their future value will be determined by their treatment in the next few years. Those forest areas disturbed for mine related activities can never be exactly duplicated, any more than the original forests that were "logged off" and/or cleared for agriculture can be duplicated. Whether they are eventually replaced with new forests, either of similar or different composition, will depend on conditions and regulations existing when the mining activity is completed.

In the meantime, and in addition to any new forests that may be created upon completion of mining activity, the contribution of other forests on Kennecott land in the area to the local environment, i.e. growth of forest products, wildlife habitat, scenic values, release of oxygen to the atmosphere and

absorption of carbon dioxide, etc., can be enhanced by careful and proper management of those forests.

One of the goals of professional foresters is to leave the forests with which they are involved in better condition than they found them. Hopefully, this will be Kennecott's goal also.

3. FOREST INVENTORY

3.1 Methods

3.11 Selection of Areas to be Inventoried:

Project Area: All of the area indicated as being within the Project Area on the map provided was examined and an inventory made of forest products growing there, except that no inventory was made of trees growing in yards of residences.

Comparable Areas for Project Area:These areas were selected based on the following criteria:

1. On land owned by Kennecott
2. Near, but not within, the project area
3. Having vegetative species composition, stocking, age distribution, and terrain similar to that of areas within the project area.

Railroad Spur & Comparable Areas:

The area ecompassed by the railroad spur was considered to be an area 1 chain (66 feet) wide along the route shown on a map provided by Foth & Van Dyke in September 1988. Comparable areas are areas lying within 2 chains (132 feet) on either side of the railroad spur.

3.12 Preliminary Mapping of the project area, railroad spur, and much of the comparable areas was done from color aerial photos with a scale of 1 inch = 500 feet, and which were dated September, 1987. For comparable areas not covered by these photos, copies of panchromatic photos, dated 1980, were obtained from the Rusk County Agricultural Stabalization and Conservation Service (ASCS). These photos have a scale of 8 inches = 1 mile. Different vegetative cover types were identified on the photos as being productive forest, non-productive forest, or non-forest. A preliminary map was prepared on frosted acetate delineating the areas so identified.

3.13 Field Examination was largely completed during the period of April 20 - May 7, 1988. The balance was completed in September, 1988, following signing of the local agreement. Prior to entering the field, the acetate maps were superimposed on a grid on which the distance between lines represents a ground distance of 1 chain (66 feet) and each square covers an area of .01 acre. The grid provides a base for "navigation" in the field and is a means of determining the area occupied by each forest or non-forest cover type.

As the field examination progressed, the maps were changed and additional features and information added as appropriate.

3.14 Acreage Determination was accomplished by counting the .01 acre squares covered by each cover type. Squares covered partly by two or more cover types were credited to the type covering the largest portion of the square.

3.15 Volume Estimates were made using the Bitterlich, or "Point Sampling" method of timber volume estimating. Points at which stand data was to be collected were located on the map prior to the field examination. Frequency of points varied with stand size and other factors, but overall, averaged about 1 point per acre of productive forest land.
Data collected in the field was processed on a computer program designed by the consulting forester on Lotus 1-2-3 software.

3.2 Results

3.21 Cover Type Maps of the project site, railroad spur, and comparable areas will be found in Appendix A, Cover Type Maps.

3.22 An Acreage Summary of forest and non-forest cover types on the project site, railroad spur, and comparable areas will be found in Appendix B. Acreage Summaries.

3.23 Volume Estimates, by species and product, for the project site, railroad spur, and comparable areas wil be found in Appendix C. Volume Estimates.

4.TIMBER APPRAISAL

Appraisal of standing timber is very subjective at best. Prices offered or bid on a particular stand of timber will vary with the quality, volume, and accessibility of the timber stand, operating (cutting) requirements and/or limitations, current market conditions, weather, a prospective purchaser's perceptions of what the timber will be worth when he delivers it to a wood-using mill and what it will cost him to get it there, and how much similar timber he already has available to him. When timber is offered for sale by sealed bids, it is not uncommon for the highest bid to exceed the lowest bid by 50% or more.

4.1 Methods: Appraisal of the timber on the project area, railroad spur, and comparable areas was completed using data from the following sources:

4.11 Volume data obtained as described in 3.INVENTORY.

4.12 Wisconsin Department of Natural Resources (WDNR) Administrative Code N.R. 46.03(2) Stumpage Values for Calculation of Severance or Yield Taxes Under the Forest Crop Law and Managed Forest Law.

4.13 WDNR Timber Sale Handbook, Page 43-1, Stumpage Values, Park Falls Area.

4.14 Private timber sales of which the Consulting Forester has records and/or knowledge.

4.15 Consultation with local WDNR foresters regarding timber values and trends.

4.16 WDNR form 2460-1, Stumpage Appraisal

4.2 Results: Timber value appraisal data will be found in Appendix D: Timber Appraisal.

5. FOREST MANAGEMENT PLAN

5.1 Methods:

5.11 Based on data collected during the forest inventory phase, and on guidelines prepared and used by both the Wisconsin Department of Natural Resources (WDNR) and the U.S. Forest Service, forest management plans were prepared for each timber stand or land use category in the Project Area, Railroad Spur, and Comparable Areas.

5.12 The plans contain the following:
Stand No. - For identification and location on maps
Timber (or Cover) Type - List of major species of vegetation, age in years and site index (for even aged stands) DBH of the average tree in the stand, stocking class, average volume per acre in cords and board feet, and descriptive remarks.
Management Objective - The kinds of trees and products to be grown on the land, or other uses.
Managaement Recommendations - Measures to accomplish the first steps in meeting the objectives.

5.2 Results:
Management plans for the areas listed above will be found in Appendix E, Management Plans.
Summaries of the guidelines for three of the major timber types, Northern Hardwood, Aspen, and Red Pine, are found at the beginning of the Appendix, along with an index showing which Comparable Stands relate to their counterparts in the Project Area or Railroad Spur.

FOREST INVENTORY, APPRAISAL,
& MANAGEMENT RECOMMENDATIONS

KENNECOTT FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

APPENDIX A
COVER TYPE MAPS

FOREST TYPE CLASSIFICATION

INDEX MAP

MAP A
PROJECT AREA
STANDS P-1 THROUGH P-19

MAP B
STANDS C-1, C-2, C-7
C-10, C-12, C-13

MAP C
STANDS C-5, C-6

FOREST TYPE CLASSIFICATION

A FOREST TYPE is defined as a tract of forest land characterized by the predominance of one or more key species which make up 50 percent or more of the volume of saw-timber or pole-timber stands or of the number of trees in seedling and sapling stands. Forest land less than 10 percent stocked with commercial tree species is classified as upland brush, grass, or lowland brush.

Following are the symbols used to identify the various forest types found on the subject areas.

Type	Symbol	Description
Red Pine	PR	More than 50% pine with red pine outweighing white or jack pine.
Aspen	A	More than 50% bigtooth and/or quaking aspen
Northern Hardwood	NH	More than 50% northern hardwood species; hard maple, soft maple, basswood, ash, etc.
White Spruce	SW	More than 50% white spruce
Mixed Conifers	CX	More than 50% conifers, with no species being predominant.
Grass	GG	Ground cover predominantly true grasses.
Herbaceous Vegetation	GH	Ground cover predominantly herbaceous vegetation such as golden rod, upland aster, ragweed, etc.
Low Growing Shrubs	GLS	Ground cover predominantly low shrubs such as raspberry, blackberry, sumac, etc.
Lowland Brush	LB	Lowland brush, such as alder, willow, etc., often including grasses and herbs as well.
Field	F	Land actively used for agriculture.
Industrial & Residential	I&R	Industrial, business, or residential areas.

FOREST TYPE CLASSIFICATION

SIZE CLASSES - The predominant stand of each classified type is designated according to the following size classes: (The division between pole-timber and small saw-timber is 9 inches for conifers and 11 inches for hardwoods).

Symbol	Class	DBH
0-5	Seedling-sapling	Less than 5"
5-11 or 5-9	Pole-timber	5-11" or 5-9"
11-15 or 9-15	Small Saw-timber	11-15" or 9-15"
15+	Large Saw-timber	Over 15"

STOCKING CLASSES - Forest land is classified by percent of growing space effectively utilized by trees as indicated by number of trees, net volume, or basal area.

Symbol	Stocking	Percent
'''	Good or Fully Stocked	70-100+
''	Medium	40-69
'	Poorly Stocked	10-39
	Unstocked	Less than 10

TYPE CLASSIFICATION - Each distinctive forest stand (type) is given a type symbol showing type, size class, and stocking.

FOREST INVENTORY, APPRAISAL,
& MANAGEMENT RECOMMENDATIONS

KENNECOTT FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

APPENDIX B
ACREAGE SUMMARIES

ACRES BY TIMBER TYPE - PROJECT AREA

NAME: KENNECOTT
COUNTY: Rusk SECTION: 9 TOWN: 34N RANGE: 6W DATE: 4/22/88

STAND NO.	TMBR. TYPE	NENE	NWNE	LOT 7	SENE	TOTAL	NENW	NWNW	SWNW	SENW	TOTAL	NESW	NWSW	SWSW	SESW	TOTAL	NESE	LOT 6	LOT 5	SESE	TOTAL	TOTAL
P-1	NH 15+'''				10.9	10.9					0					0					0	10.9
P-2	NH 5-11'''			4.9	1.2	6.1					0					0	1.2	25.7	8.3		35.2	41.3
P-3	NH 5-11'''			0.5	0.6	1.1					0					0	1.4	12.0	6.0		19.4	20.5
P-4	A 5-11'''			3.7		3.7					0					0		2.8			2.8	6.5
P-5	A 5-11''					0					0					0	11.4				11.4	11.4
P-6	A 5-11'			12.3		12.3					0					0		0.6			0.6	12.9
P-7	ANH 0-5'''					0					0					0			9.4		9.4	9.4
P-8	PR 5-9'''			3.3		3.3					0					0	3.2	0.5	2.0	0.1	5.8	9.1
P-9	PR 0-5'''			1.1	0.5	1.6					0					0					0	1.6
P-10	SW 0-5'''					0					0					0	0.2	2.1	0.6		2.9	2.9
P-11	CX 0-5'''					0					0					0	2.6			11.6	14.2	14.2
P-12	GLS			9.2	1	10.2					0					0	10.3	12.6	2.3	2.3	27.5	37.7
P-13	GH				7	7					0					0	5.6	5.0			10.6	17.6
P-14	GG			2.4		2.4					0					0		4.3	4.4		8.7	11.1
P-15	LB					0					0					0	0.9			1	1.9	1.9
P-16	F			14.2	10.2	24.4					0					0			10.5	22.2	32.7	57.1
P-17	ROW				3.0	3.0					0					0	2.0	0.4		2.0	4.4	7.4
P-18	I&R 1			2.3	5.6	7.9					0					0	1.2	2.3		0.8	4.3	12.2
P-19	I&R 2			20.0		20.0					0					0					0	20.0
TOTAL		0	0	73.9	40	113.9	0	0	0	0	0	0	0	0	0	0	40	68.3	43.5	40.0	191.8	305.7

ACRES BY TIMBER TYPE - PROJECT AREA COMPARABLE AREAS

NAME: KENNECOTT
COUNTY: Rusk SECTION: 16 TOWN: 34N RANGE: 6W DATE: 4/22/88

STAND NO.	TMBR. TYPE	NENE	NWNE	LOT 7	SENE	TOTAL	NENW	NWNW	SWNW	SENW	TOTAL	NESW	NWSW	SWSW	SESW	TOTAL	NESE	NWSE	SWSE	SESE	TOTAL	TOTAL
C-1	NH 5-11'''			0.7	26.2	26.9					0					0					0	26.9
C-2	A 5-11'''			1.6	4.4	6.0					0					0					0	6
C-7	CX 0-5''					0					0					0	2.4				2.4	2.4
C-10	GG			2.5	1.4	3.9					0					0					0	3.9
C-12	F					0					0					0	20.0				20	20
C-13	I&R 1				2.1	2.1					0					0					0	2.1
TOTAL			252	4.8	34.1	38.9					0					0	22.4				22.4	61.3

COUNTY: Rusk SECTION: 9 TOWN: 34N RANGE: 6W DATE: 4/22/88

STAND NO.	TMBR. TYPE	NENE	NWNE	LOT 7	SENE	TOTAL	LOT 8	NWNW	SWNW	SENW	TOTAL	NESW	NWSW	SWSW	SESW	TOTAL	NESE	NWSE	SWSE	SESE	TOTAL	TOTAL
C-3	A 5-11'					0	4.5				4.5					0					0	4.5
C-9	GLS					0	5.6				5.6					0					0	5.6
C-14	I&R 2		6.3			6.3					0					0					0	6.3
TOTAL			6.3			6.3	10.1				10.1					0					0	16.4

SUBTOTAL 77.7

3.9-B-15

ACRES BY TIMBER TYPE - PROJECT AREA COMPARABLE AREAS
(CONTINUED)

NAME: KENNECOTT
COUNTY: Rusk SECTION: 10 TOWN: 34N RANGE: 6W DATE: 4/22/88

STAND NO.	TMBR. TYPE	NENE	NWNE	SWNE	SENE	TOTAL	NENW	NWNW	SWNW	SENW	TOTAL	NESW	NWSW	SWSW	SESW	TOTAL	NESE	NWSE	SWSE	SESE	TOTAL	TOTAL
C-4	ANH 0-5''			3.7		3.7					0					0					0	3.7
C-8	GH			2.4		2.4					0					0					0	2.4
C-11	LB			3.3		3.3					0					0					0	3.3
TOTAL				9.4	0	9.4					0					0	0				0	9.4

COUNTY: Rusk SECTION: 21 TOWN: 34N RANGE: 6W DATE: 4/22/88

STAND NO.	TMBR. TYPE	NENE	NWNE	LOT 7	SENE	TOTAL	LOT 8	NWNW	SWNW	SENW	TOTAL	NESW	NWSW	SWSW	SESW	TOTAL	NESE	NWSE	SWSE	SESE	TOTAL	TOTAL
C-5	A 5-11'					0					0					0	1.4				1.4	1.4
C-6	GLS					0					0					0	2.0				2.0	2.0
TOTAL						0					0					0	3.4				3.4	3.4

SUBTOTAL 12.8
GRAND TOTAL 90.5

ACRES BY TIMBER TYPE - RAILROAD SPUR

NAME: KENNECOTT
COUNTY: RUSK SECTION: 10 TOWN: 34 RANGE: 6W DATE: 9/24/88

STAND NO.	TMBR. TYPE	NENE	NWNE	SWNE	SENE	TOTAL	NENW	NWNW	SWNW	SENW	TOTAL	NESW	NWSW	SWSW	SESW	TOTAL	NESE	NWSE	SWSE	SESE	TOTAL	TOTAL
S-1	GG					0.0					0.0			1.0		1.0					0.0	1.0
S-2	A 5-11'''					0.0					0.0			0.8		0.8					0.0	0.8
S-3	NH 5-11'''					0.0					0.0			1.0		1.0					0.0	1.0
S-4	A 0-5'''					0.0					0.0	0.3			0.7	1.0					0.0	1.0
S-5	NH 5-11'''					0.0					0.0	0.6				0.6					0.0	0.6
S-6	NH 0-5''					0.0					0.0	0.4				0.4					0.0	0.4
S-7	F		1.2			1.2					0.0					0.0					0.0	1.2
S-8	NHA 0-5''		0.5			0.5					0.0					0.0					0.0	0.5
TOTAL		0.0	1.7	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	1.3	0.0	2.8	0.7	4.8	0.0	0.0	0.0	0.0	0.0	6.5

ACRES BY TIMBER TYPE - RAILROAD SPUR COMPARABLE STANDS

STAND NO.	TMBR. TYPE	NENE	NWNE	SWNE	SENE	TOTAL	NENW	NWNW	SWNW	SENW	TOTAL	NESW	NWSW	SWSW	SESW	TOTAL	NESE	NWSE	SWSE	SESE	TOTAL	TOTAL
SC-1	GG					0.0					0.0			4.0		4.0					0.0	4.0
SC-2	A 5-11'''					0.0					0.0			3.5		3.5					0.0	3.5
SC-3	NH 5-11'''					0.0					0.0			3.4		3.4					0.0	3.4
SC-4	A 0-5'''					0.0					0.0	0.4			4.0	4.4					0.0	4.4
SC-5	NH 5-11'''					0.0					0.0	2.6				2.6					0.0	2.6
SC-6	NH 0-5''					0.0					0.0	0.9				0.9					0.0	0.9
SC-7	F		6.0			5.8					0.0	0.3				0.3					0.0	6.1
SC-8	NHA 0-5''		2.4			2.4					0.0					0.0					0.0	2.4
TOTAL		0.0	8.4	0.0	0.0	8.2	0.0	0.0	0.0	0.0	0.0	4.2	0.0	10.9	4.0	19.1	0.0	0.0	0.0	0.0	0.0	27.3

FOREST INVENTORY, APPRAISAL,
& MANAGEMENT RECOMMENDATIONS

KENNECOTT FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

APPENDIX C
VOLUME SUMMARIES
TIMBER INVENTORY

C-1
PROJECT AREA

C-2
PROJECT AREA
COMPARABLE STANDS

C-3
RAILROAD SPUR

C-4
RAILROAD SPUR
COMPARABLE STANDS

KENNECOTT FLAMBEAU PROJECT

TIMBER INVENTORY
PROJECT AREA

Stand No.	Type Symbol	Acres	Pulpwood Volume (Cords) Mixed Hardwood	Aspen	Pine	Other Conifer	Total	Sawtimber Volume (M. Bd. Ft.) Hard Maple	Soft Maple	Basswood	Ash	Other Hardwoods	Pine	Other Conifer	Total
P-1	NH 15+'''	10.9	164	0	0	0	164	58.4	4.4	0.0	11.1	0.8	0.0		74.7
P-2	NH 5-11''	41.3	602	0	10	130	742	3.4	4.4	20.9	3.3	14.5	0.0	12.7	59.2
P-2	NH5-11'''	20.5	292	0	0	0	292	4.1	NIL	6.1	NIL	19.6	0.0	0.0	29.8
P-4	A 5-11'''	6.5	35	49	33	0	117	0.0	0.0	0.0	0.0	1.0	12.3	0.0	13.2
P-5	A 5-11''	11.4	11	73	2	0	86	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P-6	ANH 0-5''	12.9	10	34	22	0	66	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P-7	ANH 0-5''	11.0	23	0	0	0	23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P-8	PR 5-9'''	8.5	0	1	196	0	197	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL, ALL FOREST LAND		123	1137	157	263	130	1687	65.9	8.8	27.0	14.4	36.0	12.3	12.7	177.0

ALL OTHER COVER TYPES HAVE NO MARKETABLE TIMBER VOLUME

KENNECOTT FLAMBEAU PROJECT

TIMBER INVENTORY
PROJECT AREA COMPARABLE STANDS

Stand No.	Type Symbol	Acres	Pulpwood Volume (Cords) Mixed Hardwood	Aspen	Pine	Other Conifer	Total	Sawtimber Volume (M. Bd. Ft.) Hard Maple	Soft Maple	Basswood	Ash	Other Hardwoods	Pine	Other Conifer	Total
C-1	NH 5-11''	26.9	617	0	0	0	617	17.3	16.9	3.8	2.3	0.1	14.0	0.4	54.8
C-2	A 5-11'''	6.0	50	123	5	14	192		0.7				2.7		3.4
C-3	A5-11''	4.5	5	32	9	0	46								0
C-4	NHA 0-5''	3.0	17	3	0	0	20								0
C-5	SW 0-5'''	1.4	0	0	0	9	9								0
C-6	PR 5-9'''	2.0	0	0	76	1	77								0
TOTAL, ALL FOREST Total		43.8	689	158	90	24	961	17.3	17.6	3.8	2.3	0.1	16.7	0.4	58.2

ALL OTHER COVER TYPES HAVE NO MARKETABLE TIMBER VOLUME

KENNECOTT FLAMBEAU PROJECT

TIMBER INVENTORY
RAILROAD SPUR

Stand No.	Type Symbol	Acres	Pulpwood Volume (Cords) Mixed Hardwood	Aspen	Pine	Other Conifer	Total	Sawtimber Volume (M. Bd. Ft.) Hard Maple	Soft Maple	Basswood	Ash	Other Hardwoods	Pine	Other Conifer	Total
S-2	A 5-11''	0.8	4.6	9.7			14.3								0.0
S-3	NH5-11'''	1.0	14.7	2.0			16.7								0.0
S-4	A 0-5'''	1.0	4.7	0.8		0.1	5.6								0.0
S-5	NH 5-11''	0.6	12.7	2.6			15.3								0.0
S-8	NHA 0-5''	0.5	0.9	0.7			1.6								0.0
TOTAL, ALL FOREST LAND		3.9	37.6	15.8	0.0	0.1	53.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OTHER COVER TYPES HAVE NO MARKETABLE TIMBER VOLUME

3.9-B-21

KENNECOTT FLAMBEAU PROJECT

TIMBER INVENTORY
RAILROAD SPUR
COMPARABLE STANDS

Stand No.	Type Symbol	Acres	Pulpwood Volume (Cords)					Sawtimber Volume (M. Bd. Ft.)							
			Mixed Hardwood	Aspen	Pine	Other Conifer	Total	Hard Maple	Soft Maple	Basswood	Ash	Other Hardwoods	Pine	Other Conifer	Total
SC-2	A 5-11'''	3.0	18.7	38.6			57.3								0.0
SC-3	NH5-11'''	3.2	47.0	6.4			53.4								0.0
SC-4	A 0-5'''	4.0	18.9	3.1		0.4	22.4								0.0
SC-5	NH 5-11''	2.8	35.5	7.4			42.9								0.0
SC-8	NHA 0-5''	2.4	3.2	4.5			7.7								0.0
TOTAL. ALL FOREST LAND		15.4	123.3	60.0	0.0	0.4	183.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

OTHER COVER TYPES HAVE NO MARKETABLE TIMBER VOLUME

FOREST INVENTORY, APPRAISAL,
& MANAGEMENT RECOMMENDATIONS

KENNECOTT FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

APPENDIX D
TIMBER APPRAISAL

D-1
PROJECT AREA, PULPWOOD VALUE

D-2
PROJECT AREA, SAWTIMBER VALUE & SUMMARY

D-3
PROJECT AREA COMPARABLE STANDS,
PULPWOOD VALUE

D-4
PROJECT AREA COMPARABLE STANDS,
SAWTIMBER VALUE & SUMMARY

D-5
RAILROAD SPUR, PULPWOOD VALUE

D-6
RAILROAD SPUR, SAWTIMBER VALUE & SUMMARY

D-7
RAILROAD SPUR, COMPARABLE STANDS
PULPWOOD VALUE

D-8
RAILROAD SPUR, COMPARABLE STANDS
SAWTIMBER VALUE & SUMMARY

KENNECOTT FLAMBEAU PROJECT

TIMBER APPRAISAL
PROJECT AREA

			PULPWOOD VALUE												
			Mixed Hardwood			Aspen			Pine			Other Conifers			TOTAL PULPWOOD
Stand No.	Type Symbol	Acres	Cords	Rate	Value	Cords	Rate	Value	Cords	Rate	Value	Cords	Rate	Value	VALUE
P-1	NH 15+'''	10.9	164	$4.30	$705.20			0			0			0	873.5
P-2	NH 5-11''	41.3	602	$4.00	$2,408.00			0	10	$5.00	$50.00	140	$4.00	$560.00	3783
P-2	NH5-11'''	20.5	292	$4.00	$1,168.00			0			$0.00			$0.00	1464
P-4	A 5-11'''	6.5	35	$4.10	$143.50	49	$4.90	$240.10	33	$5.10	$168.30			$0.00	683
P-5	A 5-11''	11.4	11	$1.70	$18.70	73	$2.00	$146.00	2	$4.20	$8.40			$0.00	267
P-6	ANH 0-5''	12.9	10	$1.70	$17.00	34	$2.00	$68.00	22	$4.20	$92.40			$0.00	251.3
P-7	ANH 0-5''	11.0	23	$1.70	$39.10			$0.00			$0.00			$0.00	63.8
P-8	PR 5-9'''	8.5			$0.00			$0.00	196	$8.10	$1,587.60			$0.00	1791.7
TOTAL, ALL FOREST LAND		123	1137		$4,499.50	156		$454.10	263		$1,906.70	140		$560.00	$9,177.30

OTHER PROJECT AREA COVER TYPES HAVE NO MARKETABLE TIMBER.

KENNECOTT FLAMBEAU PROJECT

TIMBER APPRAISAL
PROJECT AREA

			SAWTIMBER VALUE																					
			Hard Maple			Soft Maple			Basswood			Ash			Other Hardwoods			Pine			Other Conifers			TOTAL
Stand No.	Type Symbol	Acres	MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	SAWTIMBER VALUE
P-1	NH 15+'''	10.9	58.4	$78.00	$4,555.20	4.4	$58.00	$255.20			$0.00	11.1	$78.00	$865.80	0.8	$91.00	$72.80			$0.00			$0.00	5964.1
P-2	NH 5-11''	41.3	3.4	$77.00	$261.80	4.4	$58.00	$255.20	20.9	$83.00	$1,734.70	3.3	$77.00	$254.10	14.5	$90.00	$1,305.00			$0.00	12.7	$36.00	$457.20	2832.8
P-2	NH5-11'''	20.5	4.4	$77.00	$338.80			$0.00	6.1	$83.00	$506.30			$0.00	19.4	$90.00	$1,746.00			$0.00			$0.00	1015.6
P-4	A 5-11'''	6.5			$0.00			$0.00			$0.00			$0.00			$0.00	12.3	$52.00	$639.60			$0.00	0
P-5	A 5-11''	11.4			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00	0
P-6	ANH 0-5''	12.9			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00	0
P-7	ANH 0-5''	11.0			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00	0
P-8	PR 5-9'''	8.5			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00	0
TOTAL, ALL FORES LAND		123	66.2		$5,155.80	8.8		$510.40	27		$2,241.00	14.4		$1,119.90	34.7		$3,123.80	12.3		$639.60	12.7		$457.20	9812.5

ALL OTHER COVER TYPES HAVE NO MARKETABLE TIMBER VOLUME

PROJECT AREA SUMMARY:

PRODUCT	VOLUME	UNITS	VALUE
HARDWOOD LOGS	151.1	MBF	$12,150.90
SOFTWOOD LOGS	25.0	MBF	$1,096.80
HARDWOOD PULPWOOD	1293	CORDS	$4,953.60
SOFTWOOD PULPWOOD	403	CORDS	$2,466.70
			$20,668.00

KENNECOTT FLAMBEAU PROJECT

TIMBER APPRAISAL
PROJECT AREA
COMPARABLE STANDS

Stand No.	Type Symbol	Acres	PULPWOOD VALUE												
			Mixed Hardwood			Aspen			Pine			Other Conifers			TOTAL PULPWOOD VALUE
			Cords	Rate	Value	Cords	Rate	Value	Cords	Rate	Value	Cords	Rate	Value	
C-1	NH 5-11''	26.9	617	$4.00	$2,468.00			0			0			0	$3,089.00
C-2	A 5-11'''	6.0	50	$4.00	$200.00	123	$4.80	$590.40	5	$5.00	$25.00	14	$5.00	$70.00	$1,096.20
C-3	A 5-11''	4.5	5	$1.70	$8.50	32	$2.00	$64.00	9	$5.00	$45.00			$0.00	$172.20
C-4	NHA 0-5''	3.0	17	$1.70	$28.90	3	$2.00	$6.00			$0.00			$0.00	$58.60
C-5	SW 0-5'''	1.4			$0.00			$0.00			$0.00	9	$1.00	$9.00	$19.00
C-6	PR 5-9'''	2.8			$0.00			$0.00	76	$8.10	$615.60	1	$1.00	$1.00	$702.70
TOTAL, ALL FOREST LAND		44.6	689		$2,705.40	158		$660.40	90		$685.60	24		$80.00	$5,137.70

ALL OTHER COVER TYPES HAVE NO MARKETABLE TIMBER VOLUME

KENNECOTT FLAMBEAU PROJECT

TIMBER APPRAISAL
PROJECT AREA
COMPARABLE AREAS

Stand No.	Type Symbol	Acres	SAWTIMBER VALUE																					TOTAL SAWTIMBER VALUE
			Hard Maple			Soft Maple			Basswood			Ash			Other Hardwoods			Pine			Other Conifers			
			MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	
C-1	NH 5-11''	26.9	17.3	$77.00	$1,332.10	16.9	$58.00	$980.20	3.8	$83.00	$315.40	2.3	$77.00	$177.10	0.1	$60.00	$6.00	14.0	$52.00	$728.00	0.4	$36.00	$14.40	3140.1
C-2	A 5-11'''	6.0			$0.00			$0.00			$0.00			$0.00			$0.00	2.7	$52.00	$140.40			$0.00	0
C-3	A 5-11''	4.5			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00	0
C-4	NHA 0-5''	3.0			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00	0
C-5	SW 0-5'''	1.4			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00	0
C-6	PR 5-9'''	2.0			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00	0
TOTAL. ALL FORES LAND		43.8	17.3		$1,332.10	16.9		$980.20	3.8		$315.40	2.3		$177.10	0.1		$6.00	16.7		$868.40	0.4		$14.40	3140.1

ALL OTHER COVER TYPES HAVE NO MARKETABLE TIMBER VOLUME

PROJECT AREA
COMPARABLE STANDS
SUMMARY:

PRODUCT	VOLUME	UNITS	VALUE
HARDWOOD LOGS	40.4	MBF	$2,810.80
SOFTWOOD LOGS	17.1	MBF	$882.80
HARDWOOD PULPWOOD	847	CORDS	$3,365.80
SOFTWOOD PULPWOOD	114	CORDS	$765.60
			$7,825.00

3.9-B-27

KENNECOTT FLAMBEAU PROJECT

TIMBER APPRAISAL
RAILROAD SPUR

			PULPWOOD VALUE												
			Mixed Hardwood			Aspen			Pine			Other Conifers			TOTAL PULPWOOD
Stand No.	Type Symbol	Acres	Cords	Rate	Value	Cords	Rate	Value	Cords	Rate	Value	Cords	Rate	Value	VALUE
S-2	A 5-11'''	0.8	4.6	$2.80	$12.88	9.7	$3.30	$32.01			0			0	$65.29
S-3	NH5-11'''	1.0	14.7	$3.60	$52.92	2.8	$4.30	$12.04			0			0	$90.36
S-4	A 0-5'''	1.0	4.7	$1.90	$8.93	0.8	$2.30	$1.84			0			0	$20.47
S-5	NH 5-11''	0.6	12.7	$4.40	$55.88	2.6	$5.30	$13.78			0			0	$94.66
S-8	NHA 0-5''	0.5	0.9	$1.90	$1.71	0.7	$2.30	$1.61			0			0	$9.12
TOTAL, ALL FOREST LAND		3.9	37.6		$132.32	16.6		$61.28	0			0			$279.90

ALL OTHER COVER TYPES HAVE NO MARKETABLE TIMBER VOLUME

KENNECOTT FLAMBEAU PROJECT

TIMBER APPRAISAL
RAILROAD SPUR

Stand No.	Type Symbol	Acres	SAWTIMBER VALUE																					TOTAL SAWTIMBER VALUE
			Hard Maple			Soft Maple			Basswood			Ash			Other Hardwoods			Pine			Other Conifers			
			MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	
S-2	A 5-11'''	0.8			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00		$36.00	$0.00	0
S-3	NH 5-11''	1.0			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00	0
S-4	A 0-5'''	1.0			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00	0
S-5	NH 5-11''	0.6			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00	0
S-8	NHA 0-5''	0.5			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00	0
TOTAL, ALL FOREST LAND		3.9	0		$0.00	0		$0.00	0		$0.00	0		$0.00	0		$0.00	0		$0.00	0		$0.00	0

ALL OTHER COVER TYPES HAVE NO MARKETABLE TIMBER VOLUME

RAILROAD SPUR SUMMARY:

PRODUCT	VOLUME	UNITS	VALUE
HARDWOOD LOGS	0.0	MBF	$0.00
SOFTWOOD LOGS	0.0	MBF	$0.00
HARDWOOD PULPWOOD	45.2	CORDS	$193.60
SOFTWOOD PULPWOOD	0.0	CORDS	$0.00
			$193.60

3.9-B-29

KENNECOTT FLAMBEAU PROJECT

TIMBER APPRAISAL
RAILROAD SPUR
COMPARABLE AREAS

Stand No.	Type Symbol	Acres	PULPWOOD VALUE												TOTAL PULPWOOD VALUE
			Mixed Hardwood			Aspen			Pine			Other Conifers			
			Cords	Rate	Value	Cords	Rate	Value	Cords	Rate	Value	Cords	Rate	Value	
S-2	A 5-11'''	3.0	18.7	$2.80	$52.36	38.6	$3.30	$127.38			0			0	$243.14
S-3	NH5-11'''	3.2	47.0	$3.60	$169.20	6.4	$4.30	$27.52			0			0	$258.02
S-4	A 0-5'''	4.0	18.9	$1.90	$35.91	3.1	$2.30	$7.13			0	0.4	$1.00	$0.40	$71.04
S-5	NH 5-11''	2.8	35.5	$4.40	$156.20	7.4	$5.30	$39.22			0			0	$248.02
S-8	NHA 0-5''	0.9	3.2	$1.90	$6.08	4.5	$2.30	$10.35			0			0	$28.33
TOTAL, ALL FOREST LAND		13.9	123.3		$419.75	60		$211.60	0			0.4			$848.55

ALL OTHER COVER TYPES HAVE NO MARKETABLE TIMBER VOLUME

KENNECOTT FLAMBEAU PROJECT

TIMBER APPRAISAL
RAILROAD SPUR
COMPARABLE STANDS

Stand No.	Type Symbol	Acres	SAWTIMBER VALUE																					TOTAL SAWTIMBER VALUE
			Hard Maple			Soft Maple			Basswood			Ash			Other Hardwoods			Pine			Other Conifers			
			MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	MBF	Rate	Value	
SC-2	A 5-11'''	3.0			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00		$36.00	$0.00	0
SC-3	NH 5-11''	3.2			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00	0
SC-4	A 0-5'''	4.0			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00	0
SC-5	NH 5-11''	2.8			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00	0
SC-8	NHA 0-5''	2.4			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00			$0.00	0
TOTAL. ALL FOREST LAND		15.4	0		$0.00	0		$0.00	0		$0.00	0		$0.00	0		$0.00	0		$0.00	0		$0.00	0

ALL OTHER COVER TYPES HAVE NO MARKETABLE TIMBER VOLUME

RAILROAD SPUR
COMPARABLE AREAS
SUMMARY:

PRODUCT	VOLUME	UNITS	VALUE
HARDWOOD LOGS	0.0	MBF	$0.00
SOFTWOOD LOGS	0.0	MBF	$0.00
HARDWOOD PULPWOOD	183.3	CORDS	$631.35
SOFTWOOD PULPWOOD	0.4	CORDS	$0.40
			$631.75

FOREST INVENTORY, APPRAISAL,
& MANAGEMENT RECOMMENDATIONS

KENNECOTT FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

APPENDIX E
FOREST MANAGEMENT PLAN

E-1
MANAGEMENT GUIDE
NORTHERN HARDWOOD

E-2
MANAGEMENT GUIDE
ASPEN

E-3
MANAGEMENT GUIDE
RED PINE

E-4
INDEX OF STANDS
& COMPARABLE STANDS

E-5
FOREST MANAGEMENT PLAN
STANDS P-1 THROUGH P-19

E-13
FOREST MANAGEMENT PLAN
C-1 THROUGH C-14

E-19
FOREST MANAGEMENT PLAN
RAILROAD SPUR &
COMPARABLE AREAS

MANAGEMENT SUMMARY,
PROJECT AREA

MANAGEMENT SUMMARY,
PROJECT AREA COMPARABLE STANDS

MANAGEMENT SUMMARY,
RAILROAD SPUR &
COMPARABLE STANDS

NORTHERN HARDWOOD

The northern hardwood timber type is the second most extensive in Wisconsin, occupying 3.5 million acres, or 24% of the state's forest area.

Composed mainly of hard (sugar) maple, red (soft) maple, basswood, and ash, but often containing several other species, northern hardwood presents an almost endless variety of stocking and stand conditions, depending on the proportions of the various species, soil, terrain, and past treatment of the stand.

Most of our current northern hardwood stands originated from heavy cutting of the old growth stands during the 1920's, 30's and 40's and tend to be quite even-aged, pole sized, but with increasing amounts of sawtimber. Unmanaged stands usually have a high proportion of defective trees. Stocking varies from poor to overstocked.

Most northern hardwood stands are capable of producing quality hardwood sawtimber, with annual growth rates of 2-300 board feet per acre per year being common in well managed, fully stocked stands.

The first step in bringing previously unmanaged northern hardwood stands under management should be a timber stand improvement cut, made when stocking reaches 110 to 120 square feet of basal area and reducing it to 60 to 65 feet by removing the most defective and poorest quality trees and releasing the best "crop" trees from competition of their nearest neighbors to allow them to grow to sawtimber size in the shortest possible time.

Additional cuts should be made when basal area again reaches 110-120 feet, usually 15 to 20 years after the first cut. However, these cuts should reduce basal area only to 80 to 85 feet, and should be made at about 10 year intervals.

Northern hardwood stands can be managed either as uneven-aged stands, under the selection system, or as even-aged stands to be regenerated by shelterwood cutting.

Selection leads to many sized stands but eventually results in a stand dominated by hard maple and a few other very tolerant species. One means of keeping a somewhat larger proportion of less tolerant trees in an uneven-aged stand is by the use of group selection cutting. This creates small openings scattered throughout the forest in which less tolerant trees can find suitable conditions for growth.

Shelterwood can also be used to maintain a larger number of less tolerant species in a stand, but it does have the undesireable visual impact of the final removal cuts.

Seed tree or clearcutting rarely if ever have a place in northern hardwood regeneration.

Northern hardwood stands, especially those with better than average amounts of sawtimber, are favorite targets of loggers or timber buyers, who offer the owner a seemingly good price to be allowed to "log it off", "select cut" it, or some similar phrase. For a landowner to allow this to happen would be like a dairy farmer inviting a cattle buyer into his barn and saying "help yourself". In most cases, the buyer will take the best, leaving the landowner or dairyman with the rest, and that's no way to improve the future productivity of either a forest or a dairy herd. Wise management is the best course in both forest and farm.

Northern hardwood is on of the timber types in which there is little conflict between timber production and scenic values, because the selection system is well suited to both.

ASPEN

The aspen timber type, covering 3.7 million acres (26%) of Wisconsin's forests, is the most extensive timber type in the state.

Once considered a weed tree, aspen is now recognized as one of Wisconsin's most important timber trees. Its light colored, medium density wood is well suited to production of a wide variety of consumer goods, including paper, reconstituted wood panels, excelsior, and lumber.

Aspen is sometimes called the "Phoenix" tree after the mythical Egyptian bird, the Phoenix, which was supposed to have lived for 500 years, then burned itself and arose from its own ashes. Aspen's tiny, tufted seeds, which can travel for miles on wind currents, and rapid juvenile growth, frequently make it the first tree established on recently burned or denuded areas. Most of our current aspen stands litteraly arose from the ashes of the wildfires that ravaged northern Wisconsin in the 1930's. For this reason, and because it is very intolerant of shade, aspen stands are usually even aged.

The aspen timber type is dominated by either quaking aspen, bigtooth aspen, or a mixture of the two. While some stands are almost pure aspen, most contain a mixture or an understory of red maple, white birch, oak, pine, balsam fir, or other trees and shrubs.

Aspen is a relatively short lived tree and most stands mature at ages of 40 to 60 years. An average mature aspen will be 8 to 14 inches DBH, and 50 to 70 feet tall. After maturity, aspen trees begin to deteriorate rather rapidly, and very few aspen trees live to be 100 years of age.

Due to its extreme intolerance, aspen is managed by the clearcutting system of silviculture. It is one of the easiest of the timber types of this area to regenerate. When an aspen stand is clearcut, its root systems quickly send up thousands of fast growing sprouts. With full sunlight, these sprouts will reach 5 to 8 feet in height by the end of their first growing season. A 15 year old aspen stand should average 30-35 feet in height and 3 to 5 inches DBH.

Since clearcutting causes such a drastic change in the appearance of an area, many landowners prefer to try alternatives which leave the area looking better. One of these is to cut only the aspen from the stand, leaving the other trees. if the trees that remain form a well stocked stand of good quality, longer lived trees, this may well be the best management. However, it more often leaves a poorly stocked stand of poor quality red maple and other trees with aspen sprouts struggling to grow in their shade. The remaining red maple and other trees are then essentially weeds, and they do what weeds the world over do: reduce the growth of the more desireable aspen trees by competing with them for sunlight, moisture, and nutrients. Unless the stand is "weeded" by cutting them down, the next crop of aspen on the area will produce substantially less volume (and value) than the site is capable of producing.

A second alternative is to do nothing, allowing nature to take its course. In these cases, the aspen eventually dies, leaving whatever longer lived trees were mixed with it or in an understory, or if there were none, brush.

Aspen stands are a favored habitat for two of Wisconsin's favorite game species, ruffed grouse and deer, as well as a multitude of small birds and animals. Limiting clearcuts to 40 acres or less with a few years time lapse between adjacent clearcuts enhances the wildlife values of the type.

RED PINE

Red pine occupies nearly one-half million acres in Wisconsin. Much of it is in plantations, but some areas of the state have extensive natural stands as well.

Red pine, also widely known as Norway pine, is a versatile and fast growing tree. It grows naturally on sandy soils, but has been planted successfully on a wide range of soil types. It is relatively free from insect and disease problems.

Red pine is commonly used for Christmas trees, pulpwood, posts, poles, piling, and lumber, and is the species most often planted to reforest old fields and other open areas.

Ideally, managament of red pine should start as soon as the trees are planted (or before, if site preparation is called for). For the first few years, management consists of weed and brush control to insure that the growth of young trees is not hindered by competition.

By the time a red pine stand, either a plantation or a naturally regenerated stand, is 15 to 20 years old, it should be ready for pruning. Pruning involves cutting the lower limbs from 100 to 150 of the best trees per acre. This results in the production of more valuable, knot free lumber on the pruned part of the tree. The first pruning usually removes limbs to a height of 9 feet, with later pruning to 17 feet or higher.

At 20 to 25 years, the stand should be ready to be thinned. In plantations, the first thinning often removes every second or third row. In natural stands, trees should be marked individually for cutting. Further thinnings should be done at about 10 year intervals until the stand is 60 to 120 years old. The final harvest will probably be either by the shelterwood system or clear-cutting followed by replanting.

INDEX OF STANDS & COMPARABLE STANDS

PROJECT AREA			COMPARABLE STANDS		
STAND NO.	TIMBER TYPE	ACRES	STAND NO.	TIMBER TYPE	ACRES
P-1	NH 15+'''	10.9	C-1	NH 5-11'''	26.9
P-2	NH 5-11'''	41.3	C-1	NH 5-11'''	
P-3	NH 5-11'''	20.5	C-1	NH 5-11'''	
P-4	A 5-11'''	6.5	C-2	A 5-11'''	6.0
P-5	A 5-11''	11.4	SC-2	A 5-11''	3.5
P-6	A 5-11'	12.9	C-3	A 5-11'	4.5
P-7	ANH 0-5''	9.4	C-4	ANH 0-5''	3.7
P-8	PR 5-9'''	9.1	C-6	PR 5-9'''	2.0
P-9	PR 0-5''	1.6	C-7	CX 0-5''(Part)	
P-10	SW 0-5'''	2.9	C-5	SW 0-5'''	1.4
P-11	CX 0-5''	14.2	C-7	CX 0-5''	2.4
P-12	GLS	37.7	C-9	GLS	5.6
P-13	GH	17.6	C-8	GH	2.4
P-14	GG	11.1	C-10	GG	3.9
P-15	LB	1.9	C-11	LB	3.3
P-16	F	57.1	C-12	F	20.0
P-17	ROW	7.4	NONE		
P-18	I&R 1	12.2	C-13	I&R 1	2.1
P-19	I&R 2	20.0	C-14	I&R 2	6.3
	TOTAL	305.7		TOTAL	94.0

FOR THE RAILROAD SPUR AND COMPARABLE STANDS, THE NUMBERS ARE THE SAME, WITH THE LETTER "C" ADDED TO THE NUMBER FOR THE COMPARABLE STAND, I.E., THE COMPARABLE STAND FOR STAND S-1 IS SC-1.

FOREST MANAGEMENT PLAN

For: KENNECOTT FLAMBEAU PROJECT
Section 9, T34N, R6W
Date: Oct. 3, 1988

STAND NO. P-1 TIMBER TYPE: Northern Hardwood Large sawtimber. ACRES: 10.9

STAND DESCRIPTION:
Species Composition: Hard maple, Ash, Red maple, others
Age: Uneven Site Index: N/A DBH of Average Tree: 16"
Stocking: Fully stocked Average Volume/Acre: 6,850 bd. ft.+ 15 cords
Remarks: This stand is unusual because of the large size of the trees. It appears to have been pastured for many years. The combination of large trees, heavy stocking, and pasturing has resulted in very few small trees being present. Probably its most valuable attribute is its appearance.

MANAGEMENT OBJECTIVE:
Production of hardwood (primarily hard maple) sawtimber under the single tree selection system, with emphasis on maintaining the "large tree" appearance of the stand.

MANAGEMENT RECOMMENDATIONS:
Light selection cuts at 8 to 12 year intervals, harvesting the most devective and/or mature trees and providing small openings in which seedlings can become established. The first cut should occur about 1993.

STAND NO. P-2 TIMBER TYPE: Northern Hardwood Pole timber ACRES: 41.3

STAND DESCRIPTION:
Species Composition: Soft maple, basswood, hard maple, hemlock, ash, birch, and others.
Age: Uneven Site Index: N/A DBH of Average Tree: 9.8"
Stocking: Fully stocked Average Volume/Acre: 18 cords + 1,400 board feet.
Remarks: Quality and growth appear average. The stand has a large variety of species, with none being dominant.

MANAGEMENT OBJECTIVE:
Production of hardwood sawtimber under the selection system, using group selection to maintain intolerant species.

MANAGEMENT RECOMMENDATIONS:
The first selection cut in this stand should be made about 1999.

For: KENNECOTT FLAMBEAU PROJECT
Section 9, T34N, R6W
Date: Oct. 3, 1988

STAND NO. P-3 TIMBER TYPE: Northern Hardwood Pole timber ACRES: 20.5

STAND DESCRIPTION:
Species Composition: Hard maple, basswood, oak, and others.
Age: Uneven Site Index: N/A DBH of Average Tree: 10.8"
Stocking: Fully stocked Average Volume/Acre: 14 cords + 1,400 board feet.
Remarks: This stand has about the same species composition as stand P-2, but with somewhat more hard maple. It is also somewhat less heavily stocked than either stand P-1 or P-2.

MANAGEMENT OBJECTIVE:
Hardwood sawtimber, under the selection system.

MANAGEMENT RECOMMENDATIONS:
This stand will not be ready for its first selection cut until about 2005.

STAND NO. P-4 TIMBER TYPE: Aspen Pole timber ACRES: 6.5

STAND DESCRIPTION:
Species Composition: Aspen, white birch, white pine, & others.
Age: 35 years Site Index: 84 DBH of Average Tree: 9.3"
Stocking: Fully stocked Average Volume/Acre: 18 cords + 2,000 board feet.
Remarks: This stand is primarily aspen with an admixture of white birch, and red maple, and a patch of white pine at the northwest corner.

MANAGEMENT OBJECTIVE:
Aspen pulpwood and saw bolts, with pine sawtimber as a secondary product, under even aged management with a rotation age of about 50 years.

MANAGEMENT RECOMMENDATIONS:
Regenerate by clearcutting in 2004.

For: KENNECOTT FLAMBEAU PROJECT
Section 9, T34N, R6W
Date: Oct. 2, 1988

STAND NO. P-5 TIMBER TYPE: Aspen Pole timber ACRES: 11.4

STAND DESCRIPTION:
Species Composition: Aspen, white birch, pine.
Age: 22 years Site Index: 90 DBH of Average Tree: 5.7
Stocking: Medium stocked Average Volume/Acre: 7.5 cords
Remarks: Site index is unreliable at this age. The true SI is probably somewhat less than shown. It can be more accurately determined in the next 10-15 years.

MANAGEMENT OBJECTIVE:
Production of aspen pulpwood under even aged management.

MANAGEMENT RECOMMENDATIONS:
Regenerate by clearcutting at an age to be determined later. Present indicators point to a rotation age of 50+ years, but that may be excessive.

STAND NO. P-6 TIMBER TYPE: Aspen Pole and Saplings ACRES: 12.9

STAND DESCRIPTION:
Species Composition: Aspen, white birch, oak, pine.
Age: 30 years Site Index: 68 DBH of Average Tree: 9.3
Stocking: Poor to Med. Average Volume/Acre: 5.1 cords
Remarks: A poorly stocked mixture of short pole sized trees and saplings. The stand should be managed for the older trees.

MANAGEMENT OBJECTIVE:
Production of aspen pulpwood under even aged management on about a 45 year rotation.

MANAGEMENT RECOMMENDATIONS:
Regenerate by clearcutting about 2002.

STAND NO. P-7 TIMBER TYPE: Aspen & Northern Hardwood saplings ACRES: 11

STAND DESCRIPTION:
Species Composition: Aspen, birch, oak, ironwood, etc.
Age: 15 years Site Index: Medium DBH of Average Tree: 3.5"
Stocking: Medium Average Volume/Acre: 2 cords
Remarks: An old pasture that has been invaded by trees in recent years. The east end is mostly northern hardwoods, the west, aspen.

MANAGEMENT OBJECTIVE:
Eventual production of the best products the site is capable of producing.

MANAGEMENT RECOMMENDATIONS:
Let grow until a need for thinning, etc. becomes evident.

FOREST MANAGEMENT PLAN

For: KENNECOTT FLAMBEAU PROJECT
Section 9, T34N, R6W
Date: Oct. 2, 1988

STAND NO. P-8 TIMBER TYPE: Red Pine poles ACRES: 8.5

STAND DESCRIPTION:
Species Composition: Red pine with a few white pine and aspen.
Age: 18 years Site Index: 92 DBH of Average Tree: 6.5"
Stocking: Overstocked Average Volume/Acre: 23 cords
Remarks: These are planted stands ranging in age from 15 to 20. Site index is not reliable at this early age and may be overstated.

MANAGEMENT OBJECTIVE:
Red pine sawtimber, with pulpwood, poles, and piling as earlier products. Even aged management with thinnings as needed.

MANAGEMENT RECOMMENDATIONS:
Thin by removing every other row at age 25 (1995)

STAND NO. P-9 TIMBER TYPE: Red Pine seedlings ACRES: 1.6

STAND DESCRIPTION:
Species Composition: Red pine with some brush.
Age: 8 years Site Index: Good DBH of Average Tree: <1"
Stocking: Medium to good Average Volume/Acre: None
Remarks: These also are planted stands, appearing to have been 3 year old seedlings planted about 1983.

MANAGEMENT OBJECTIVE:
Red pine sawtimber, with pulpwood, poles, and piling as earlier products.

MANAGEMENT RECOMMENDATIONS:
Thin by removing every other row at age 25 (2005).

STAND NO. P-10 TIMBER TYPE: White Spruce saplings. ACRES: 2.9

STAND DESCRIPTION:
Species Composition: White spruce
Age: 15 years Site Index: Good DBH of Average Tree: 1"+/-
Stocking: Good Average Volume/Acre: None
Remarks: These also are planted stands, appearing to have been 3 year old seedlings planted about 1973.

MANAGEMENT OBJECTIVE:
Spruce sawtimber, with pulpwood, poles, and piling as earlier products.

MANAGEMENT RECOMMENDATIONS:
Thin by removing every other row at age 35 (2008). Spruce take somewhat longer than red pine to reach marketable size.

FOREST MANAGEMENT PLAN

For: KENNECOTT FLAMBEAU PROJECT
Section 9, T34N, R6W
Date: Oct. 2, 1988

STAND NO. P-11 TIMBER TYPE: Mixed Conifer seedlings & saplings ACRES: 14.2

STAND DESCRIPTION:
Species Composition: White spruce, red pine, jack pine, white cedar, and a few cottonwood.
Age: 15 years Site Index: Good DBH of Average Tree: 1"+/-
Stocking: Fair to good Average Volume/Acre: None
Remarks: These stands were first planted about 1973 to provide a vegetative screen for the proposed mine and facilities. More trees were added about 5 years ago.

MANAGEMENT OBJECTIVE:
To provide a screen between Hwy. 27 and the mine and associated buildings.

MANAGEMENT RECOMMENDATIONS:
Thin only as necessary to prevent overcrowding and maintain vigorous trees.

The following areas are not presently forested. However, they have been forest in the past, and could be forest again, if that were deemed to be their best use.

STAND NO. P-12 COVER TYPE: Low Growing Shrubs ACRES: 37.7

STAND DESCRIPTION:
Species Composition: Sumac, blackberry, grasses and herbs, and a few "pioneer" trees such as aspen and pine.
Remarks: These areas have been cultivated and/or pastured in the past. Their vegetation represents an early stage of a return to a forested condition.

MANAGEMENT OBJECTIVE:
These areas have several potential uses including cropland, pasture, wildlife (pheasant and other open land species) habitat, or forest.

MANAGEMENT RECOMMENDATIONS:
If the decision is made to return these areas to a forested condition, they could be machine planted, using 3 year old red pine seedlilngs. These trees have demonstrated that they do well on the area and they are a relatively versatile and pest free timber producer, but produce relatively poor wildlife habitat. If the areas are to be used for agriculture or wildlife habitat, persons with more expertise in those areas should be consulted.

FOREST MANAGEMENT PLAN

For: KENNECOTT FLAMBEAU PROJECT
Section 9, T34N, R6W
Date: Oct. 2, 1988

STAND NO. P-13 COVER TYPE: Grass & Herbs ACRES: 17.6

STAND DESCRIPTION:
Species Composition: Various grasses and herbs such as goldenrod, aster, and others.
Remarks: These areas have been cultivated and/or pastured in the past. Their vegetation represents the first stages of a return to a forested condition.

MANAGEMENT OBJECTIVE:
These areas have several potential uses including cropland, pasture, wildlife (pheasant and other open land species) habitat, or forest.

MANAGEMENT RECOMMENDATIONS:
If the decision is made to return these areas to a forested condition, they could be machine planted, using 3 year old red pine seedlilngs. These trees have demonstrated that they do well on the area and they are a relatively versatile and pest free timber producer. but produce relatively poor wildlife habitat. If the areas are to be used for agriculture or wildlife habitat. persons with more expertise in those areas should be consulted.

STAND NO. P-14 COVER TYPE: Grass ACRES: 11.1

STAND DESCRIPTION:
Species Composition: Dense tall grasses with a few aspen and silver maple growing on alluvial soil along the river bank.
Remarks: These areas are subject to being inundated during periods when the Flambeau River is high. The dense grass makes it very difficult for tree seeds to germinate and survive.

MANAGEMENT OBJECTIVE:
Allow changing river levels and the accompanying scouring and soil deposition to control the destiny of these areas.

MANAGEMENT RECOMMENDATIONS:
No management should be undertaken on these areas.

FOREST MANAGEMENT PLAN

For: KENNECOTT FLAMBEAU PROJECT
Section 9, T34N, R6W
Date: Oct. 2, 1988

STAND NO. P-15 COVER TYPE: Lowland Brush ACRES: 1.9

STAND DESCRIPTION:
Species Composition: Dense tall grasses, alder, willow, lowland herbaceous plants. Some of the same trees planted in stand 11 were planted here, but survival has been poor.
Remarks: Competition from the dense vegetation makes it very difficult for trees to become established in areas such as this difficult for tree seeds to germinate and survive. However, this does provide habitat for a number of species of small birds and animals not found elsewhere.

MANAGEMENT OBJECTIVE:
Allow the area to remain as it is.

MANAGEMENT RECOMMENDATIONS:
No management should be undertaken on these areas.

STAND NO. P-16 COVER TYPE: Fields ACRES: 57.1

STAND DESCRIPTION:
Species Composition: These areas are primarily devoted to hay production.

MANAGEMENT OBJECTIVE:
These areas have several potential uses including cropland, pasture, wildlife (pheasant and other open land species) habitat, or forest.

MANAGEMENT RECOMMENDATIONS:
If the decision is made to return these areas to a forested condition, they could be machine planted, using 3 year old red pine seedlilngs. These trees have demonstrated that they do well on the area and they are a relatively versatile and pest free timber producer, but produce relatively poor wildlife habitat. If the areas are to be used for agriculture or wildlife habitat, persons with more expertise in those areas should be consulted.

STAND NO. P-17 COVER TYPE: Right-of-Way ACRES: 6.8

STAND DESCRIPTION:
Species Composition: These areas are occupied Hwy. 27, Blackberry Lane, and Kennecott Drive.

MANAGEMENT OBJECTIVE:
None

MANAGEMENT RECOMMENDATIONS:
None

FOREST MANAGEMENT PLAN

For: KENNECOTT FLAMBEAU PROJECT
Section 9, T34N, R6W
Date: Oct. 2, 1988

STAND NO. P-18 COVER TYPE: Residential ACRES: 7.41

STAND DESCRIPTION:
Species Composition: These areas residential sites along Hwy. 27 and Kennecott Drive. No inventory of their trees was conducted, because no wood using mill will knowingly buy trees from such a site due to the spikes, etc. which they often contain. This classification also includes the former H & H Haulers office building.

MANAGEMENT OBJECTIVE:
Maintain these areas in their present condition.

MANAGEMENT RECOMMENDATIONS:
No management of the forest resources of these areas is recommended.

STAND NO. P-19 COVER TYPE: Industrial ACRES: 20.0

STAND DESCRIPTION:
Species Composition: This is a former county gravel pit, now used in part for burning brush and other combustible waste. The vegetative cover is a sparse growth of mosses, xeric grasses and herbs, and a few pioneer trees such as pin cherry, white birch, aspen, and red pine.

MANAGEMENT OBJECTIVE:
To return this area to a productive condition, either for forest or wildlife.

MANAGEMENT RECOMMENDATIONS:
How to accomplish the objective is beyond the expertise of this consultant. Perhaps someone experienced in reclaiming mine spoil banks, highway cuts and fills, or similar environments can help.

FOREST MANAGEMENT PLAN

For: KENNECOTT FLAMBEAU PROJECT
PROJECT AREA COMPARABLE STANDS
Date: Oct. 3, 1988

STAND NO. C-1 TIMBER TYPE: Northern Hardwood Pole timber ACRES: 26.9

STAND DESCRIPTION:
Species Composition: Hard maple, soft maple, basswood, ash,birch, and others.
Age: Uneven Site Index: N/A DBH of Average Tree: 10.0"
Stocking: Fully stocked Average Volume/Acre: 23 cords + 2,040 board feet.
Remarks: Quality and growth appear average. This stand is used as a comparable to stands P-1, P-2, and P-3. It does not truly duplicate any of them, but has all of the species and most of the stand conditions represented in those stands, including a small patch of large sawtimber, similar to stand P-1.

MANAGEMENT OBJECTIVE:
Production of hardwood sawtimber under the selection system, using group selection to maintain intolerant species.

MANAGEMENT RECOMMENDATIONS:
The first selection cut in this stand should be made about 1995.

STAND NO. C-2 TIMBER TYPE: Aspen Pole timber ACRES: 6.0

STAND DESCRIPTION:
Species Composition: Aspen, white birch, white pine, & others.
Age: 42 years Site Index: 74 DBH of Average Tree: 8.8"
Stocking: Fully stocked Average Volume/Acre: 32 cords + 440 board feet.
Remarks: This stand is somewhat older than, but otherwise quite comparable to, stand P-4. It does not have a patch of white pine as stand P-4 does, but there is such a patch in stand C-1, just south of this stand.

MANAGEMENT OBJECTIVE:
Aspen pulpwood and saw bolts, with pine sawtimber as a secondary product, under even aged management with a rotation age of about 50 years.

MANAGEMENT RECOMMENDATIONS:
Regenerate by clearcutting in 1996.

For: KENNECOTT FLAMBEAU PROJECT
PROJECT AREA COMPARABLE STANDS
Date: Oct. 2, 1988

STAND NO. C-3 TIMBER TYPE: Aspen Pole timber ACRES: 4.5

STAND DESCRIPTION:
Species Composition: Aspen, white birch, pine.
Age: 31 years Site Index: 69 DBH of Average Tree: 8.3
Stocking: Medium. Average Volume/Acre: 11.2 cords
Remarks: Somewhat better stocked than its project area counterpart, but otherwise quite similar.

MANAGEMENT OBJECTIVE:
Production of aspen pulpwood under even aged management on about a 45 year rotation.

MANAGEMENT RECOMMENDATIONS:
Regenerate by clearcutting about 2002.

STAND NO. C-4 TIMBER TYPE: Aspen & Northern Hardwood saplings ACRES: 3.7

STAND DESCRIPTION:
Species Composition: Aspen, birch, oak, ironwood, etc.
Age: 15 years Site Index: Medium DBH of Average Tree: 5.1"
Stocking: Medium Average Volume/Acre: 6.6 cords
Remarks: An old pasture that has been invaded by trees in recent years.

MANAGEMENT OBJECTIVE:
Eventual production of the best products the site is capable of producing.

MANAGEMENT RECOMMENDATIONS:
Let grow until a need for thinning, etc. becomes evident.

STAND NO. C-5 TIMBER TYPE: White Spruce saplings. ACRES: 1.4

STAND DESCRIPTION:
Species Composition: White spruce
Age: 15 years Site Index: Good DBH of Average Tree: 2.3"
Stocking: Good Average Volume/Acre: 6.5 cords
Remarks: These also are planted stands, appearing to have been 3 year old seedlings planted about 1973.

MANAGEMENT OBJECTIVE:
Spruce sawtimber, with pulpwood, poles, and piling as earlier products.

MANAGEMENT RECOMMENDATIONS:
Thin by removing every other row at age 35 (2008). Spruce take somewhat longer than red pine to reach marketable size.

FOREST MANAGEMENT PLAN

For: KENNECOTT FLAMBEAU PROJECT
PROJECT AREA COMPARABLE STANDS
Date: Oct. 2, 1988

STAND NO. C-6 TIMBER TYPE: Red Pine poles ACRES: 2.0

STAND DESCRIPTION:
Species Composition: Red pine with a few white pine and spruce.
Age: 21 years Site Index: 116 DBH of Average Tree: 7.7"
Stocking: Overstocked Average Volume/Acre: 38 cords
Remarks: Site index is not reliable at this early age and may be overstated. The stand appears very similar to stand P-8.

MANAGEMENT OBJECTIVE:
Red pine sawtimber, with pulpwood, poles, and piling as earlier products. Even aged management with thinnings as needed.

MANAGEMENT RECOMMENDATIONS:
Thin by removing every other row at age 25 (1992)

STAND NO. C-7 TIMBER TYPE: Mixed Conifers ACRES: 2.4

STAND DESCRIPTION:
Species Composition: White spruce, red pine, jack pine, white cedar, and a few cottonwood.
Age: 15 years Site Index: Good DBH of Average Tree: 1"+/-
Stocking: Fair to good Average Volume/Acre: None
Remarks: These stands were first planted about 1973 to provide a vegetative screen for the proposed mine and facilities. More trees were added about 5 years ago. The red pine added in these later plantings can serve as a comparable for stands P-9.

MANAGEMENT OBJECTIVE:
To provide a screen between Hwy. 27 and the mine and associated buildings.

MANAGEMENT RECOMMENDATIONS:
Thin only as necessary to prevent overcrowding and maintain vigorous trees.

FOREST MANAGEMENT PLAN

For: KENNECOTT FLAMBEAU PROJECT
PROJECT AREA COMPARABLE STANDS
Date: Oct. 2, 1988

The following areas are not presently forested. However, they have been forest in the past, and could be forest again, if that were deemed to be their best use.

STAND NO. C-8 COVER TYPE: Grass & Herbs ACRES: 2.4

STAND DESCRIPTION:
Species Composition: Various grasses and herbs such as goldenrod, aster, and others.
Remarks: These areas have been cultivated and/or pastured in the past. Their vegetation represents the first stages of a return to a forested condition.

MANAGEMENT OBJECTIVE:
These areas have several potential uses including cropland, pasture, wildlife (pheasant and other open land species) habitat, or forest.

MANAGEMENT RECOMMENDATIONS:
If the decision is made to return these areas to a forested condition, they could be machine planted, using 3 year old red pine seedlilngs. These trees have demonstrated that they do well on the area and they are a relatively versatile and pest free timber producer. If the areas are to be used for agriculture or wildlife habitat, persons with more expertise in those areas should be consulted.

STAND NO. C-9 COVER TYPE: Low Growing Shrubs ACRES: 5.6

STAND DESCRIPTION:
Species Composition: Sumac, blackberry, grasses and herbs, and a few "pioneer" trees such as aspen and pine.
Remarks: These areas have been cultivated and/or pastured in the past. Their vegetation represents an early stage of a return to a forested condition.

MANAGEMENT OBJECTIVE:
These areas have several potential uses including cropland, pasture, wildlife (pheasant and other open land species) habitat, or forest.

MANAGEMENT RECOMMENDATIONS:
If the decision is made to return these areas to a forested condition, they could be machine planted, using 3 year old red pine seedlilngs. These trees have demonstrated that they do well on the area and they are a relatively versatile and pest free timber producer. If the areas are to be used for agriculture or wildlife habitat, persons with more expertise in those areas should be consulted.

For: KENNECOTT FLAMBEAU PROJECT
PROJECT AREA COMPARABLE STANDS
Date: Oct. 2, 1988

STAND NO. C-10 COVER TYPE: Grass ACRES: 3.9

STAND DESCRIPTION:
Species Composition: Dense tall grasses with a few aspen and silver maple growing on alluvial soil along the river bank.
Remarks: These areas are subject to being inundated during periods when the Flambeau River is high. The dense grass makes it very difficult for tree seeds to germinate and survive.

MANAGEMENT OBJECTIVE:
Allow changing river levels and the accompanying scouring and soil deposition to control the destiny of these areas.

MANAGEMENT RECOMMENDATIONS:
No management should be undertaken on these areas.

STAND NO. C-11 COVER TYPE: Lowland Brush ACRES: 3.3

STAND DESCRIPTION:
Species Composition: Dense tall grasses, alder, willow, lowland herbaceous plants.
Remarks: Competition from the dense vegetation makes it very difficult for tree seeds to germinate and survive. However, this does provide habitat for a number of species of small birds and animals not found elsewhere.

MANAGEMENT OBJECTIVE:
Allow the area to remain as it is.

MANAGEMENT RECOMMENDATIONS:
No management should be undertaken on these areas.

STAND NO. C-12 COVER TYPE: Fields ACRES: 20.0

STAND DESCRIPTION:
Species Composition: In the summer of 1988, this was a clover field.

MANAGEMENT OBJECTIVE:
These areas have several potential uses including cropland, pasture, wildlife (pheasant and other open land species) habitat, or forest.

MANAGEMENT RECOMMENDATIONS:
Same as stand P-16.

FOREST MANAGEMENT PLAN

For: KENNECOTT FLAMBEAU PROJECT
PROJECT AREA COMPARABLE STANDS
Date: Oct. 2, 1988

STAND NO. C-13 COVER TYPE: Residential ACRES: 2.1

STAND DESCRIPTION:
Species Composition: These areas residential sites along Hwy. 27 and Kennecott Drive. No inventory of their trees was conducted, because no wood using mill will knowingly buy trees from such a site due to the nails, etc. which they often contain. This classification also includes the former H & H Haulers office building.

MANAGEMENT OBJECTIVE:
Maintain these areas in their present condition.

MANAGEMENT RECOMMENDATIONS:
No management of the forest resources of these areas is recommended.

STAND NO. C-14 COVER TYPE: Industrial ACRES: 6.3

STAND DESCRIPTION:
Species Composition: This is a part of an active gravel pit being used at the present. If it is to provide a truly comparable area for stand P-19, it should be protected from futrther gravel removal.

MANAGEMENT OBJECTIVE:
To return this area to a productive condition, either for forest or wildlife.

MANAGEMENT RECOMMENDATIONS:
How to accomplish the objective is beyond the expertise of this consultant. Perhaps someone experienced in reclaiming mine spoil banks, highway cuts and fills, or similar environments can help.

For: KENNECOTT FLAMBEAU PROJECT
RAILROAD SPUR & COMPARABLE STANDS
Date: Oct. 2, 1988

Since the comparable areas for the railroad spur are adjacent to the spur, the same description is used for both in the following sections. The number and acreage for both the spur (S-*) and comparable area (SC-*) will be listed with each description.

STAND NO. S-1 SC-1 COVER TYPE: Grass ACRES: 1.0 4.0

STAND DESCRIPTION:
Species Composition: A former home site and field, now covered with a dense growth of grass and herbs.
Remarks: These areas have been cultivated and/or pastured in the past. Their vegetation represents an early stage of a return to a forested condition.

MANAGEMENT OBJECTIVE:
These areas have several potential uses including cropland, pasture, wildlife (pheasant and other open land species) habitat, or forest.

MANAGEMENT RECOMMENDATIONS:
If the decision is made to return these areas to a forested condition, they could be machine planted, using 3 year old red pine seedlilngs. These trees have demonstrated that they do well on the area and they are a relatively versatile and pest free timber producer. If the areas are to be used for agriculture or wildlife habitat, persons with more expertise in those areas should be consulted. Due to the dense ground cover on most of this area, herbicide or mechanical cultivation would have to be used to insure survival of planted trees.

STAND NO. S-2 SC-2 TIMBER TYPE: Aspen pole timber ACRES: 0.8 3.5

STAND DESCRIPTION:
Species Composition: Aspen, white birch, red maple, and others.
Age: 34 years Site Index: 76 DBH of Average Tree: 8.2"
Stocking: Fully stocked Average Volume/Acre: 18.9 cords
Remarks: Quality and growth appear average. This stand is also used as a comparable for stand P-5.

MANAGEMENT OBJECTIVE:
Production of aspen pulpwood under even aged management on about a 45 year rotation.

MANAGEMENT RECOMMENDATIONS:
Regenerate by clearcutting about 1999.

For: KENNECOTT FLAMBEAU PROJECT
RAILROAD SPUR & COMPARABLE STANDS
Date: Oct. 2, 1988

STAND NO.	TIMBER TYPE:	ACRES:
S-3	Northern Hardwood	1.0
SC-3	pole timber	3.4

STAND DESCRIPTION:
Species Composition: Soft maple, ash, aspen, and others.
Age: Uneven Site Index: N/A DBH of Average Tree: 7.3"
Stocking: Fully stocked Average Volume/Acre: 16.7 cords
Remarks: Aspen, and some of the better maple and other trees, were cut about 15 years ago. The stand has an understory of ash seedlings which seem to be doing quite well. These will probably be the next generation of timber on the areas.

MANAGEMENT OBJECTIVE:
Production of hardwood sawtimber under the selection system, using group selection to maintain intolerant species.

MANAGEMENT RECOMMENDATIONS:
The first selection cut on this stand should be made about 2003.

STAND NO.	TIMBER TYPE:	ACRES:
S-4	Aspen saplings	1.0
SC-4		4.4

STAND DESCRIPTION:
Species Composition: Aspen, white birch, red maple, and others.
Age: 15 years Site Index: 76 DBH of Average Tree: 4.5"
Stocking: Fully stocked Average Volume/Acre: 5.6 cords
Remarks: This stand sprung up from the roots of a former aspen stand which was harvested about 15 years ago. The volume shown above consists of a few trees remaining from the prior stand.

MANAGEMENT OBJECTIVE:
Production of aspen pulpwood under even aged management on about a 45 year rotation.

MANAGEMENT RECOMMENDATIONS:
Regenerate by clearcutting about 2018.

FOREST MANAGEMENT PLAN

For: KENNECOTT FLAMBEAU PROJECT
RAILROAD SPUR & COMPARABLE STANDS
Date: Oct. 2, 1988

STAND NO. S-5 SC-5 TIMBER TYPE: Northern Hardwood pole timber ACRES: 0.6 2.6

STAND DESCRIPTION:
Species Composition: Soft maple, ash, aspen, and others.
Age: Uneven Site Index: N/A DBH of Average Tree: 6.4"
Stocking: Fully stocked Average Volume/Acre: 15.3 cords
Remarks: Aspen, and some of the better maple and other trees, were cut about 15 years ago. This stand lacks the understory of ash seedlings which are found in stand S-3. Otherwise it is similar to that stand.

MANAGEMENT OBJECTIVE:
Production of hardwood sawtimber under the selection system, using group selection to maintain intolerant species.

MANAGEMENT RECOMMENDATIONS:
The first selection cut in this stand should be made about 2003.

STAND NO. S-6 SC-6 S-8, SC-8 TIMBER TYPE: Aspen & Northern Hardwood saplings ACRES: 0.4 0.9 0.5, 2.4

STAND DESCRIPTION:
Species Composition: Aspen, birch, oak, ironwood, etc.
Age: 15 years Site Index: Medium DBH of Average Tree: 4.8"
Stocking: Medium Average Volume/Acre: 3.2 cords
Remarks: Old pastures that have been invaded by trees in recent years.

MANAGEMENT OBJECTIVE:
Eventual production of the best products the site is capable of producing.

MANAGEMENT RECOMMENDATIONS:
Let grow until a need for thinning, etc. becomes evident.

STAND NO. S-8 SC-8 COVER TYPE: Fields ACRES: 1.2 6.1

STAND DESCRIPTION:
Species Composition: In the summer of 1988, this was a corn field.

MANAGEMENT OBJECTIVE:
These areas have several potential uses including cropland, pasture, wildlife (pheasant and other open land species) habitat, or forest.

MANAGEMENT RECOMMENDATIONS:
Same as stand P-16.

MANAGEMENT SUMMARY

KENNECOTT FLAMBEAU PROJECT
LADYSMITH, WI

PROJECT AREA

STAND #	TYPE	MANAGEMENT PRACTICE RECOMMENDED	YEAR
P-1	NH 11-15''	Selection Cut	1993
P-2	NH 5-11''	Selection cut	1999
P-3	NH 5-11''	Selection cut	2005
P-4	A 5-11'''	Regeneration cut	2005
P-5	A 5-11''	Regeneration cut	2016
P-6	A 5-11'	Regeneration cut	2002
P-7	ANH 0-5''	Thinning	??
P-8	PR 5-9''	Thinning	1995
P-9	PR 0-5''	Thinning	2005
P-10	SW 0-5'''	Thinning	2008
P-11	CX 0-5''	Thinning	As Needed

OTHER AREAS IN PROJECT AREA HAVE NO SCHEDULED MANAGEMENT PRACTICES

MANAGEMENT SUMMARY

KENNECOTT FLAMBEAU PROJECT
LADYSMITH, WI

PROJECT AREA, COMPARABLE STANDS

STAND #	TYPE	MANAGEMENT PRACTICE RECOMMENDED	YEAR
C-1	NH 5-11''	Selection Cut	1995
C-2	A 5-11'''	Regeneration Cut	1996
C-3	A 5-11''	Regeneration Cut	2002
C-4	ANH 0-5''	Thinning	??
C-5	SW 0-5'''	Thinning	2008
C-6	PR 5-9'''	Thinning	1992
C-7	CX 0-5''	Thinning	??
C-8 - C-14	Several	No specific practices recommended	

MANAGEMENT SUMMARY

KENNECOTT FLAMBEAU PROJECT
LADYSMITH, WI

RAILROAD SPUR & COMPARABLE AREAS

STAND #	TYPE	MANAGEMENT PRACTICE RECOMMENDED	YEAR
S-2 & SC-2	A 5-11''	Regeneration cut	1999
S-3 & SC-3	NH 5-11''	Selection cut	2003
S-4 & SC-4	A 0-5'''	Regeneration Cut	2018
S-5 & SC-5	NH 5-11''	Selection cut	2003
S-6 & SC-6	ANH 0-5''	Thinning	??

OTHER RAILROAD SPUR & COMPARABLE AREAS HAVE NO SCHEDULED MANAGEMENT PRACTICES

FOREST INVENTORY, APPRAISAL,
& MANAGEMENT RECOMMENDATIONS

KENNECOTT FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

APPENDIX F
ESTHETIC CONSIDERATIONS
ETC.

F-1
GENERAL COMMENTS

EXCERPTS FROM WDNR SILVICUTURAL &
AESTHETICS HANDBOOK

CHAPTER 11
AESTHETIC MANAGEMENT

CHAPTER 12
BIG TREE SILVICULTURE

CHAPTER 18
FOREST MANAGEMENT POLICY

CHAPTER 90
GLOSSARY OF TERMS

FOREST INVENTORY, APPRAISAL, & MANAGEMENT RECOMMENDATIONS

FLAMBEAU KENNECOTT PROJECT
LADYSMITH, WIISCOSIN

ESTHETIC CONSIDERATIONS, GENERAL COMMENTS

The recent "environmental awareness" movement has included greater awareness of peoples' scenic environment as well as the problems of air, water, and ground water pollution and nuclear concerns. Zoning laws include controls on cutting trees or clearing land along lakes and waterways. Several western states have passed restrictive forest practice laws which include scenic regulations, and local governments have created a maze of logging-control regulations in some eastern states.

While no such laws have been adopted in Wisconsin, several townships have attempted to pass ordinances, so far unsuccessfully, to limit the size of clearcuts, or even to prohibit clearcuts entirely. Much of the "environmentalist" groups' efforts to change National Forest management is directed toward what they consider to be esthetic problems caused by forestry practices.

Wisconsin DNR has established guidelines for management of state and county forests which take esthetics into consideration. To put it simply, the guidelines divide a forest area into zones, based on the impact of forestry activities on the scenic values of the area, as viewed by "the public".

The following are exerpts from WDNR's "Silvicultural and Forest Aesthetics Handbook". They provide guidelines which should be considered in any management planning for the forested areas of Kennecott's property in the Ladysmith area. While no attempt has been made to zone the property along these lines in this report, some general observations can be made:

Areas along the Flambeau River and State Highway 27 would probably be considered Class A - Scenic Management zones, while areas along secondary roads might be Class B zones. Areas not generally visible from the River or primary or secondary roads could be zoned Class C. No areas are recommended for Class D zoning.

Esthetic management as it applies to forestry is a still-evolving subject. Since "beauty is in the eye of the beholder", there are few well defined rules to follow. However, it is clear, that if we are to avoid having rules imposed on us by legislation, we must consider esthetics in our forestry activities.

APPENDIX 3.9-C

WDNR Correspondence Dated 3/29/88

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES
Carroll D. Besadny
Secretary

BOX 7921
MADISON, WISCONSIN 53707

March 29, 1988

File Ref: 1650

Mr. Tim J. Weyenberg
FOTH & VAN DYKE
8528 West Lisbon Avenue
Milwaukee, Wisconsin 53222-3799

APR 8 1988

Dear Mr. Weyenberg:

The Bureau of Endangered Resources has reviewed the project area described in your letter of March 9, 1988 for the proposed copper mine, Rusk County.

We have no occurrence records of endangered or threatened animal or plant species, nor of any Natural Areas or communities on the project area, in Sections 2 - 5, 8 - 11, 14 - 16, T34N R6W.

Please be sure to include a legal description of the area for which you are requesting information in any future requests.

Your concern for endangered resources is greatly appreciated.

Sincerely,

Ronald F. Nicotera
Director, Bureau of Endangered Resources

cc: Gary Birch - BEAR/6
Michael Neuman - BEAR/6
William Clark - NWD
Bruce Moss - NWD

APPENDIX 3.10-A

Letter From Golder Associates, Ltd.
Regarding Air Blast Potential at the
Flambeau Mine
Dated March 23, 1989

Blasting and Vibration Impact
From Midwest Engineers
Dated March 1989

Golder Associates Ltd.
CONSULTING ENGINEERS

March 23, 1989

BP Minerals
1515 Mineral Square
Salt Lake City, Utah
U.S.A. 84112

ATTENTION: Mr. L.E. Mercando
Director Process Development

Re: Air Blast Potential at the Flambeau Mine

Dear Mr. Mercando:

Further to the verbal request from Mr. E. May of Askew Associates on February 23rd, 1989, this letter report presents an appraisal of the potential environmental impacts from air blasts at the proposed Flambeau open pit mine near Ladysmith, Wisconsin. This review, which is based upon the proposed blast designs incorporated in the Pincock, Allen and Holt Inc. feasibility study on the project, is intended to augment our previous report dated June 30, 1988 on the blasting, with particular reference to fly-rock and blast vibrations.

1.0 AIR BLASTS

The term "air blast" is generally used to describe the air pressure waves generated by explosions. In extreme cases these can result in physical damage due to overpressure and/or excessive noise. These two effects are directly related, see Figure 1.

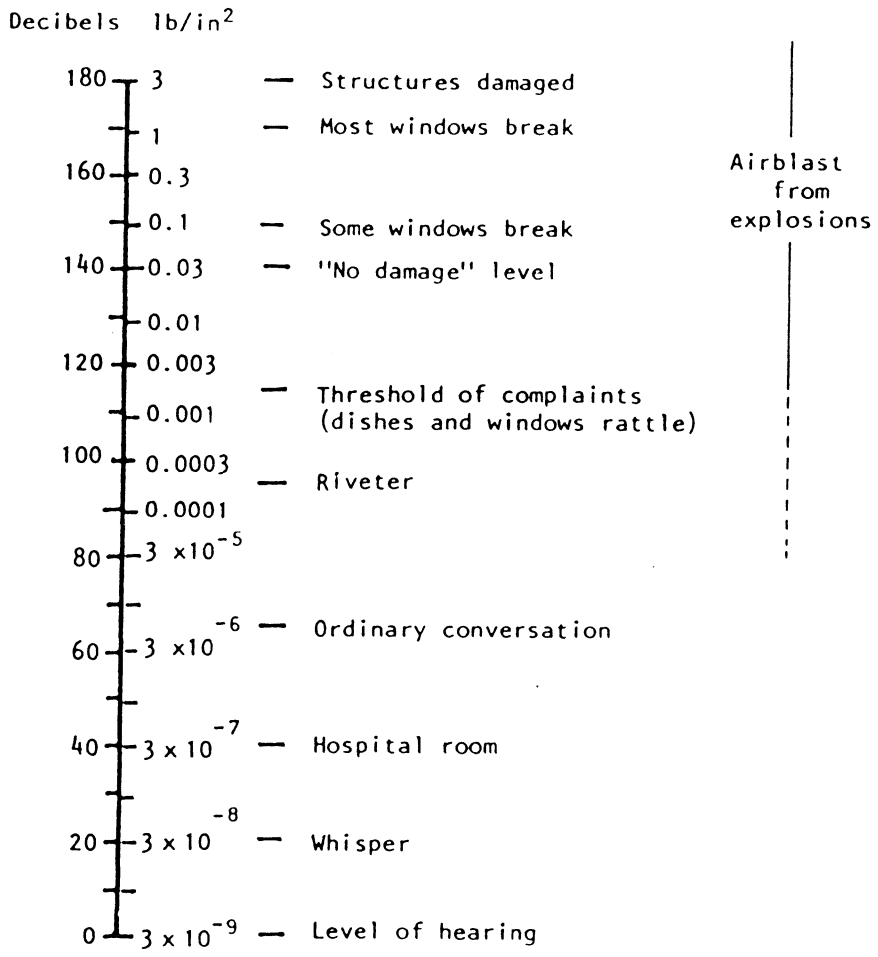
Factors that are likely to promote air blasts from open pit mines include:

- overcharged blast holes;
- poor stemming
- venting through cracks/unplugged holes; and,
- inadequate front row burden.

Many of these factors are similar to the basic causes of fly-rock.

HUMAN AND STRUCTURAL RESPONSE TO SOUND PRESSURE LEVEL

Figure 1



(After Ladegaard-Pedersen and Dally, 1975.)

PROJECT NO. 882/6028 DRAWN ..... REVIEWED ..... DATE .....

The impact of both overpressure and noise normally decreases with distance from the blast. However, atmospheric conditions such as cloud cover, wind and temperature inversions can reduce the attenuation, and in certain circumstances can even concentrate the sound in specific areas at some distance from the blast, see Figure 2.

The Wisconsin State Administrative Code (Chapter ILHR7) specifies maximum limits for air blasts "at the location of any dwelling, public building, place of employment, school, church or community or institutional building outside the controlled blasting site area". These are as follows:

Lower Frequency Limit of Measuring System	Maximum Noise Level, in dB
2 Hz or lower*	133 peak
6 Hz or lower*	129 peak

* flat response

These levels are similar to the maximum values recommended by the U.S. Bureau of Mines (USBM). It is also stipulated in the Wisconsin Code that the operator shall conduct periodic monitoring to ensure compliance with the above standards.

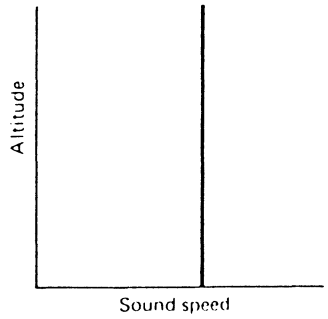
2.0 FLAMBEAU MINE BLASTING

It is proposed that mining operations in the Flambeau open pit would be conducted in 10 ft. benches in the ore and immediately associated waste, and 20 ft. benches for the major waste areas. The production blasts would involve the full bench height in both cases.

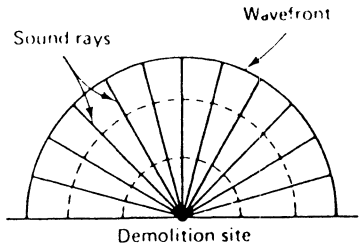
In order to meet production requirements, it is estimated that the blasts in the ore and associated waste would involve 20 to 30 small diameter (4 in.) holes each containing up to approximately 30 lb. of explosive. The waste stripping blasts would probably involve 50 to 60 holes of approximately 5 mm diameter, with average loads in the order of approximately 100 lb. of explosive per hole. Delays would be used in the blasts to

EFFECTS OF TEMPERATURE AND WIND SPEED ON SOUND WAVEFRONT PROPAGATION

Figure 2

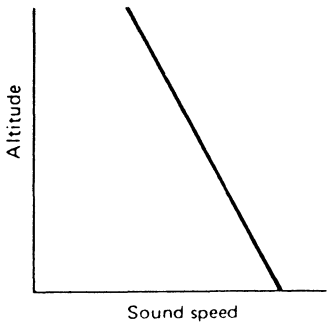


Sound speed vs. altitude

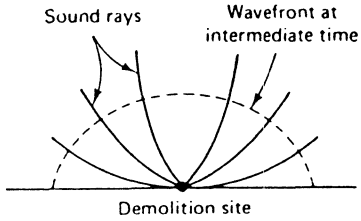


Vertical plane showing sound propagation

a) STILL, CONSTANT TEMPERATURE

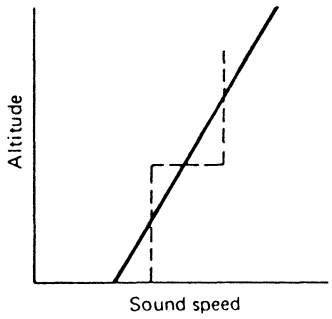


Sound speed vs. altitude

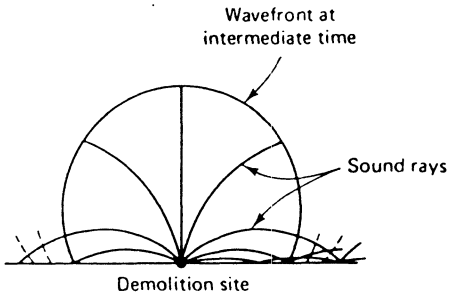


Vertical plane showing sound propagation

b) STILL, NORMAL DECREASING TEMPERATURE WITH ALTITUDE

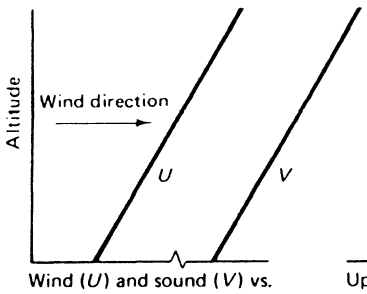


Sound speed vs. altitude



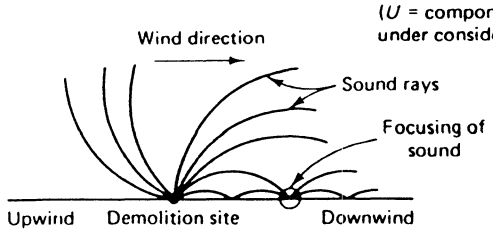
Vertical plane showing sound propagation

c) STILL, INVERSION, INCREASING TEMPERATURE WITH ALTITUDE



Wind (U) and sound (V) vs. altitude

Note: V is the velocity of the sound wave relative to the earth, i.e., $V = C + U$ (U = component of wind in direction under consideration).



Vertical plane of sound propagation

d) WINDY, INCREASING WIND SPEED WITH ALTITUDE

(From Cook, 1974.)

PROJECT NO. 882/608 DRAWN ..... REVIEWED ..... DATE .....

improve the fragmentation and minimize the potential for fly-rock, air blast and damage to the pit walls. For example, it can be assumed that in the waste production blasts a maximum of approximately five holes would be fired at any delay period.

3.0 AIR BLAST POTENTIAL

3.1 Introduction

Under normal atmospheric conditions sound/pressure levels decrease with distance from the blast in accordance with the following cube root scaling formula:

$$K_R = \frac{R}{\sqrt[3]{W}}$$

where

K_R is the scale distance function.
R is the radial distance from the blast.
W is the weight of explosive detonated.

Several empirical studies have been conducted in attempt to relate the scale distance function (K_R) to noise and overpressure levels through field monitoring of actual blasts. Most of these studies have been aimed at surface coal mines and quarries, see Figure 3. However, the actual values are very site specific due to such other factors as:

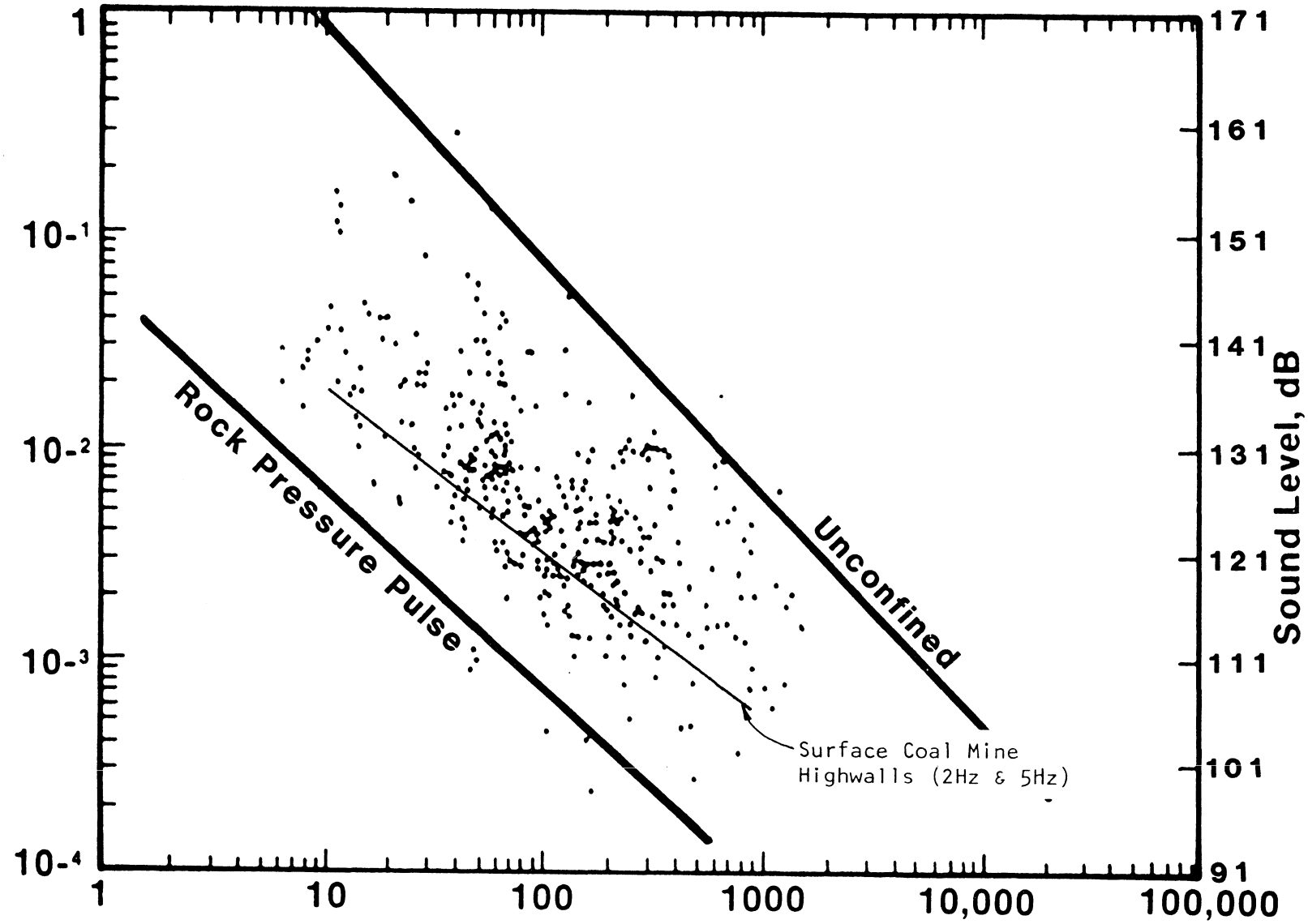
- type of blast and design variations;
- depth of blast below ground surface, i.e. local topography;
- orientation of blast relative to observation point; and,
- atmospheric conditions.

all of which can contribute to a relatively wide spread in the range of measurements even within a single operation.

However, using values established by Siskind et. al. (1980)*, it is possible to estimate the general range of potential noise levels under normal conditions. The line

* Siskind, D.E., Stachura, V.J., Stagg, M.S., & Kopp, J.W. (1980). *Structure Response and Data Produced by Air Blast From Surface Mining*, USBM, RI 8485.

PROJECT NO. ..... DRAWN ..... REVIEWED ..... DATE .....



COMBINED AIRBLAST MEASUREMENTS, ALL SITES (USBM, R18485, 1980)

Figure 3

Golder Associates

3.10-A-6

However, using values established by Siskind et. al. (1980)*, it is possible to estimate the general range of potential noise levels under normal conditions. The line used for this assessment, which approximately corresponds to the mean values for 2 and 5 Hz for coal highwalls, is shown on Figure 3.

3.2 Flambeau Blasts

A review of the proposed blast designs for the Flambeau operation suggests that the waste stripping blasts carry the largest potential for creating air blasts, since they will involve larger total quantities of explosive, and probably larger instantaneous charges (charge fired per delay). However, under certain, very specific atmospheric conditions, even the ore blasts could potentially result in local air blasts in the mine vicinity.

Assuming that 5 production waste blast holes (20 ft. bench) are fired per delay, i.e. an instantaneous charge of 500 lb., the following noise levels can be predicted in the **immediate vicinity of the blast**:

Distance from Blast	K_R	Estimated Noise Level (dB)
500 ft.	63	124
1,000 ft.	126	119

At some distance from the blast the delaying impact would tend to be reduced, and the blast would tend to merge to a single event. If this distance is conservatively assumed to be 1,500 ft., then the estimated distant field noise levels based upon 60 holes (approximately 6,000 lb.) would be as follows:

Distance from Blast	K_R	Estimated Noise Level (dB)
1,500 ft.	83	122
2,000 ft.	110	120
5,000 ft. (south Ladysmith)	276	114
10,000 ft.	552	109

* Siskind, D.E., Stachura, V.J., Stagg, M.S., & Kopp, J.W. (1980). *Structure Response and Data Produced by Air Blast From Surface Mining*, USBM, RI 8485.

All of the above estimated noise levels fall well below the corresponding overpressure levels at which physical damage could be expected, see Figure 1. For this reason, the remaining discussions relate mainly to the potential for excessive noise generation.

The above estimated values of noise levels from the blasts fall well below the maximum levels required in the Wisconsin Administrative code.

3.3 Impact of Atmospheric Conditions

Under certain atmospheric conditions, the normal attenuation rate in noise level with distance from the blast can be reduced. In fact, it is possible to have actual concentrations of reduced noise in local areas at some distance from the blast, see Figure 2.

3.3.1 Wind

The empirical studies have shown that the decay of sound levels away from the blast is in the order of 7.7 dB for each doubling of distance. However, this rate is reduced by the wind according to the following formula:

$$7.7 - 0.16\ V.\ \text{Cos}\ \theta\ \text{dB}$$

where

V is wind speed in miles per hour.
θ is the angle between the line connecting the blast and observer, and the wind direction.

Basically, the rate of noise attenuation is decreased downwind, and increased upwind, as is shown schematically in Figure 2d). For example, directly downwind in a 20 mph wind the noise attenuation is reduced to 4.4 dB for each doubling distance.

In the Flambeau context, it is of note that southerly winds, i.e. from the pit towards Ladysmith, occur for about 10% of the total time, and that these winds are in excess of 10 mph for only approximately 2% of the time. Similarly, winds in the

Because of the relatively low wind speeds involved, it is considered unlikely that the noise levels experienced in Ladysmith would approach the regulated maximum levels, provided blasts are not detonated when wind speeds are in excess of 20 mph from the southerly quadrant. However, in the light of the above comments related to complaints, it might be appropriate to restrict the blasting to a maximum permissible wind speed level from the southerly quadrant to 10 mph until a reasonable body of experience has been developed on the local impact of wind on blast noise attenuation.

3.3.2 Temperature Inversions and Low Cloud

Temperature inversions and low dense cloud can have extremely unpredictable impacts on noise levels both in the vicinity of mines and at some distance. Both tend to reflect the sound back to earth, and can result in focussing of sound at considerable distances from the mine site. Temperature inversions are particularly bad in this respect, see Figure 2c).

For this reason, it is recommended that blasts not be fired when a temperature inversion exists in the mine area. Similarly, blasting should be avoided when there is low cloud, and particularly if there is a combination of low cloud and a southerly wind.

4.0 SUMMARY

In summary, it would appear that the proposed blast designs for the Flambeau operation will result in overpressure and noise levels beyond the mine boundary that are well below those required by state regulations, provided that blasting is avoided during periods of high southerly wind, low cloud cover and temperature inversions.

There is some potential for perceived "high" noise levels, particularly between Flambeau and the river, and possibly even in south Ladysmith. In consequence, it is recommended that a careful public awareness campaign be mounted prior to the initiation of blasting operations. Further, the initial blasts should be kept relatively small, with a high degree of delaying so that experience can be gained as to the impact of local terrain, etc. This assessment should include physical monitoring of noise levels at various locations around the mine area, including the south side of city.

The monitoring will also form a basis for field optimization of the preliminary blast designs, in order to maximize mine productivity, while meeting environmental criteria.

We trust that this letter report meets your current requirements. If you have any questions, or require further assistance, please do not hesitate to contact me.

Yours very truly,

GOLDER ASSOCIATES LTD.

P.F. Stacey, P. Eng.
Principal

PFS/mk
882-1608
3/PS-1608

MEI

MIDWEST ENGINEERS, INC.

3149 VENARD ROAD
DOWNERS GROVE, IL 60515
(312) 969-4307

BLASTING AND VIBRATION IMPACTS

KENNECOTT FLAMBEAU PROJECT
RUSK COUNTY, WISCONSIN

INTRODUCTION

Midwest Engineers, Inc. was requested to assess the blasting and vibration impacts for the Kennecott Flambeau Project in accordance with Section 3.6 of the October 1987 document entitled "Scope of Study for the Flambeau Project," prepared pursuant to NR 132.05(7)(a), the Golder Associates Report (1988) on Blasting at the Flambeau Project, and the Draft Narrative for the Project's Mine Permit Application Addressing Blasting, dated December 1988. Dr. Rajaram completed a site survey and obtained ambient seismograph readings during October 26 and 27, 1987. The Wisconsin blasting regulations and U.S. Bureau of Mines guidelines related to vibrations from surface mine blasting were reviewed to determine the blast design criteria. Based on the review and site survey, a pre-blast survey plan and recommendations for minimizing the blasting impacts are provided in this report.

STRUCTURES AND DISTANCES

There are a few homes and businesses within 3000 feet of the edge of the proposed pit. These are located along State Highway (STH) 27 and Gokey road, just south of Ladysmith, WI. The STH 27 bridge crossing the Flambeau river is 3600 feet, and the hospital, convent, and Mt. Senario college facilities are between 4200 and 4300 feet from the edge of the pit. At its nearest point, STH 27 is about 500 feet from the eastern edge of the pit. (See Fig. 1).

WISCONSIN INDUSTRY, LABOR AND HUMAN RELATIONS CODE

The Wisconsin Administrative Code, Industry, Labor and Human Relations (ILHR) Subchapter VII, establishes uniform limits on permissible levels of blasting resultants to reasonably assure that blasting resultants do not cause injury, damage or unreasonable annoyance to persons or property outside any controlled blasting site area (Wisconsin Register, May 1987).

ILHR 7.61 deals with pre-blasting notification of all residents or owners of affected dwellings or other structures. At least 24 hours before initiation of blasting, Kennecott should notify those residing within a distance (D) determined by the scaled-distance equation. This equation is $D = D_S (W)^{1/2}$, where

D_S = scaled distance factor = 100,
W = weight per delay, pounds.

The Golder Associates Report (1988) suggests that although an instantaneous charge of 150 pounds per delay is possible by firing one hole per delay, it is likely that two and possibly more holes could be fired without generating excessive flyrock, or exceeding regulated vibration levels (p. 9). Hence, using two holes per delay or 300 pounds per delay, the distance D given by the scaled-distance equation is 1,732 feet. If the holes per delay is varied from one to four holes per delay to suit production requirements, the distance D will vary from 1,225 to 2,450 feet.

As noted in the previous section, most of the dwellings and structures in the vicinity of the proposed pit are located at a distance greater than 1,732 feet. However, in order to avoid liability, the dwellings and structures shown on the pre-blast survey plan (Fig. 1) should be inspected before blasting, and the owners of the dwellings and structures notified of the blasting schedule.

ILHR 7.62 restricts all surface blasting to between sunrise and sunset, unless otherwise stated by the Department.

ILHR 7.64 states that blasting shall be conducted so as to prevent injury and unreasonable annoyance to persons and damage to public or private property outside the controlled blasting site area. It limits airblast at the location of any dwelling, public or private property to a maximum of 133 dB at 2 Hz or lower, and to a maximum of 129 dB at 6 Hz or lower (frequency refers to the lower limit of the measuring system). Periodic monitoring is necessary to ensure compliance with this standard.

Flyrock shall remain within the controlled blasting site area, and shall not be cast from the blasting site more than one-half of the distance to the nearest inhabited building within or without the controlled blasting site area. The maximum ground vibration at the location of any structure outside the controlled blasting area shall be established in accordance with one of the following:

1. Peak Particle Velocity

Type of Structure	Max. Allowable Peak Particle Velocity (in/s)	
	At Freq. <40 Hz	>40 Hz
Modern homes with drywall interiors	0.75	2.0
Older homes with plaster on wood lath for interior walls	0.50	2.0

(Peak particle velocity measurements should be recorded in three mutually perpendicular directions).

2. Scaled-Distance Equation

A scaled-distance equation $W = (D/D_S)^2$, is suggested to determine the allowable charge-weight of explosives to be detonated in any 8-millisecond period, without seismic monitoring, where D = distance in feet from the blasting site to the nearest structure, D_S = scaled-distance factor (dependent on distance) D, in our case $D_S = 55$ since D is 2100 (between 301 and 5,000)), and W = maximum weight per delay of explosives, in pounds. For D = 2,100 feet and $D_S = 55$, $W = (2,100/55)^2 = 1,458$ lbs.

The charge per delay planned for the project is well under the 1,458 pounds allowed by the scaled-distance equation.

3. Blasting Level Chart

A blasting level chart (Fig. 2) as developed by the U.S. Bureau of Mines, has been suggested to relate the allowable peak particle velocity to the frequency of the vibration. This chart is similar to the criteria provided under 1, Peak Particle Velocity.

U.S. BUREAU OF MINES GUIDELINES

The Bureau of Mines has reanalyzed the blast damage problem since 1974, and conducted several field and laboratory studies. At a recently conducted Technology Transfer Seminar, the Bureau of Mines (1987) summarized the results of their work as follows:

1. Cracking of plaster and wallboard is not likely below about 0.5 in/s peak particle velocity for the worst case of structure condition and typical vibration frequency.
2. This safe-level criterion also appears to be independent of the number of blasting events and their durations.
3. High strains are produced in structure walls by normal weather conditions such as wind, temperature, and humidity cycling.
4. Human activities such as door slams can be equivalent to blast vibrations of up to 0.5 in/s.
5. Local cracking (block-length) may not be noticeable until particle velocities reach up to 3.0 in/s.
6. Delays between holes in each row or echelon should be greater than 1 ms/ft. of spacing in order to prevent reinforcing of the airblast wave fronts from the individual holes (tests on shale with intermixed sandstone.)
7. Delay intervals that can cause airblast frequencies equal to the natural frequencies of midwalls of nearby structures (about 11 to 25 Hz) should be avoided. Delay intervals of less than 40 ms will usually not present a problem (tests on shale with intermixed sandstone.)

8. Orientation of the blast and direction of initiation has a noticeable effect on the magnitude of vibrations. Vibration levels in the direction of initiation are about twice the level of those away from the direction of initiation. Vibration levels across the pit from the blast are also lower.

9. Delay interval between rows should be as long as practical for the burden involved. The longest burden relief value, 4.3 ms/ft, gave the lowest vibration levels (tests on shale with intermixed sandstone.)

10. The predominant frequencies of ground vibrations are controlled by the geology, and not by the timing of delay intervals between rows.

Based on these findings by the Bureau of Mines, the following guidelines can be established for blasting at the Kennecott mine:

1. Test blasts should be conducted to optimize the density of explosive (type, grade, distribution in the blasthole, size of hole and coupling), the geometry (spacing, burden, bench height, collar, subgrade drilling), and hookup (parallel or angled firing, delays) which will maximize the frequency of vibration. A frequency of 40 Hz or more is desirable so that a peak particle velocity of 2.0 in/s will be allowed by the Wisconsin Department of ILHR.

2. The orientation of the blast and direction of initiation should, if practical, be away from STH 27 and the city of Ladysmith.

3. Delay intervals between rows should be as long as practical for the burden involved, to minimize vibration levels, and delays between holes in each row should be greater than 1 ms/ft of spacing to prevent reinforcing of the airblast wavefronts. The Golder Associates Report (1988) suggests a minimum delay of 25 ms, and I concur with this recommendation.

AMBIENT VIBRATION INTENSITIES AND SOURCES

Ambient vibration intensities in the vicinity of the Kennecott property were recorded using a GMS 4 seismograph on October 26, and 27, 1987. Sources of vibration included traffic on STH 27, the then Soo Line railroad, and traffic in and out of Rusk County Memorial Hospital and Mt. Senario College (See Fig. 1). Attempts to measure the vibrations from the gravel loading operation at the Olynick sand and gravel pit were not successful due to interference from a CB radio or some other similar disturbance. The three components of vibration (longitudinal, vertical, and transverse) were measured by the seismograph. The second intensity was also measured. A summary of the readings obtained is given in the table below.

VIBRATION AND SOUND MEASUREMENTS
KENNECOTT FLAMBEAU PROJECT, LADYSMITH, WISCONSIN

Measuring Loc. (See Fig. 1)	Max. Sound (dB)	Max. Ground Velocity (in/s)
Mt. Senario College	118	L=0.04, V=0.04, T=0.05
Rusk County Memorial Hospital (Photo 1)	118	L=0.04, V=0.05, T=0.05
Blackberry Lane/STH 27	114	L=0.04, V=0.04, T=0.04
Soo Line Railroad/ STH 27	119	L=0.07, V=0.10, T=0.06
Flambeau River Bridge/STH 27 (Photo 2)	118	L=0.04, V=0.04, T=0.05
Jansen Road/STH 27 (Photo 3)	114	L=0.06, V=0.07, T=0.06

The maximum vibration and sound intensities were noted at the intersection of STH 27 and then Soo Line railroad. The average ambient vibration intensity is about 0.05 in/s, and the sound intensity is about 117 dB.

VIBRATION IMPACTS FROM MINE BLASTING

The U.S. Bureau of Mines funded a study of geologic factors affecting vibrations from surface mine blasting in which production tests were carried out at two limestone quarries (VibraTech Engineers, Inc., 1985). The findings of this study are relevant to impacts from blasting at the Kennecott mine,, and are summarized below.

1. Delay times intended to create constructive interference produced a higher vibration level than those intended to create destructive interference. Hence, vibration effects from blasting can be reduced if the geology and precise delay times are known.
2. At delay corresponding to a relief of 2 ms/ft between holes in a row, the gas pressures die down to the extent that strain waves may be propagated across fractures which were extended by the gas pressure pulse. Hence, a delay of 2 ms/ft results in optimum fragmentation.
3. Single-hole blast tests can be used to characterize vibration and fragmentation at a mine.

Work on ground vibrations from blasting in hard rock conducted in Scandinavian countries demonstrates the significant impact of geology on particle velocity (Vuolio, 1986). The particle velocity that resulted in insignificant cracking (threshold value) varied from 1.18 in/s in sand and clay formations under groundwater to 4.3 in/s in hard limestone, quartzy sandstone, gneiss and diabase. This means that particle velocities in hard rock formations such as the sulfides in the Kennecott pit - higher than those suggested by the Wisconsin Department of ILHR - will result in insignificant damage to structures in the vicinity of the mine.

Test blasts conducted during mining of the upper portion of the west end of the deposit using four-inch-diameter holes ten feet deep will assist in optimizing the blasting operation. The supervision of the blasting operation to ensure that all holes are carefully loaded and stemmed, use of millisecond delays, and use of an electrical initiating system will prevent any fly rock and result in the desired fragmentation.

Blast variables such as blast round size, use of millisecond delay caps, time of initiation, and method of initiation can be varied during mining in the western portion of the pit to determine a propagation law that relates the level of vibration to distance and weight of the charge. This propagation law will assist in the prediction of impacts from blasting vibrations.

PRE-BLAST SURVEY PLAN

A pre-blast survey plan is presented in Figure 1. The distance of the structures to be surveyed is greater than the distance guidelines provided by the Wisconsin Department of ILHR regulations. However, to minimize public concern and avoid potential liability, some of the following steps should be taken:

1. Inform local property owners that steps have been taken to minimize vibrations and damage, and that any legitimate claims of damage will be settled expeditiously.
2. Complete a pre-blast survey of structures shown in Fig. 1, observing evidence of settling, poor construction, and plaster cracks, and taking photographs of the existing condition of the property.
3. Measure vibrations from blasting at the structures shown in Fig. 1 to establish that the damage criteria values given in the ILHR regulations are not being exceeded.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions:

1. There will be no damage to structures in the vicinity of the pit since the charge-weight per delay of explosives is below the 1,458 pounds allowed by the Wisconsin guidelines (scaled-distance equation).
2. Blasting in the upper portion of the west end of the open pit using four-inch-diameter holes, ten feet deep will assist in optimizing the blast design. Proper loading and stemming of the holes and the use of millisecond delays will prevent flyrock generation. Using the optimized blast design, waste production blasts using larger diameter holes to approximately 20 feet deep will not pose any fly rock generation problems.
3. Ambient vibrations in the vicinity of the Kennecott property are at or below 0.1 in/s, and sound intensities (measured) with a GMS 4 seismograph) are at or below 119 dB.
4. The Wisconsin Department of ILHR regulations can be complied with by following the recommendations provided in this report, and in the Golder Associates Report (1988).

Recommendations:

1. An effective pre-blast survey procedure should be established for the structures shown in Fig. 1.
2. Test blasts should be conducted during the mining in the upper portion of the west end of the open pit to optimize blast design, and to establish a propagation law that relates the level of vibration to distance and weight of charge.
3. The orientation of the blast and direction of initiation, if practical, should be away from STH 27 and to the northwest or northeast in the westend of the pit.
4. In order to minimize vibrations and airblasts, delay intervals between rows should be as long as practicle for the burden involved, and the delay between holes in each row should be 1 ms/ft or greater. The 25 ms delay suggested in the Golder Associates Report (1988) is a good number to use during the mining of the western portion of the open pit.

REFERENCES

Foth & Van Dyke Associates (1988), Draft Narrative for the Project's Mine Permit Application Addressing Blasting, Dec. 8.

Golder Associates (1988), Report on Blasting at the Flambeau Project, June 30.

Siskind, D.E. (1973), Ground and air vibrations from blasting, Mining Engineering Handbook, SME-AIME, N.Y., N.Y., Vol. 1 pp. 11-99 to 11-111.

Staff, Bureau of Mines (1987), Surface mine blasting - IC 9135, Proc. Bureau of Mines Technology Transfer Seminar, Chicago, IL, April 15, US GPO, Washington, DC, 114 p.

VibraTech Engineers, Inc. (1985), Geologic factors affecting vibrations from surface mine blasting, Final Report, Bureau of Mines Contract No. HO222009, NTIS, Springfield, VA, 191 p.

Vuolio, R. (1986), Excavation of large rock caverns taking into account the integrity of rock structures, surrounding buildings, and delicate instruments in surrounding buildings, Proc. of the Int'l Symposium on Large Rock Caverns, Helsinki, Finland, Ed. K. Saari, Pergamon Press, N.Y., N.Y., pp. 1629-1646.

Wisconsin Department of Industry, Labor and Human Relations. (1987), Subchapter VII, Blasting resultants, Wisconsin Register, May 1987, No. 377, pp. 43-44.

APPENDIX 3.13-A

Railroad Noise Modeling Study

APPENDIX 3.13-A

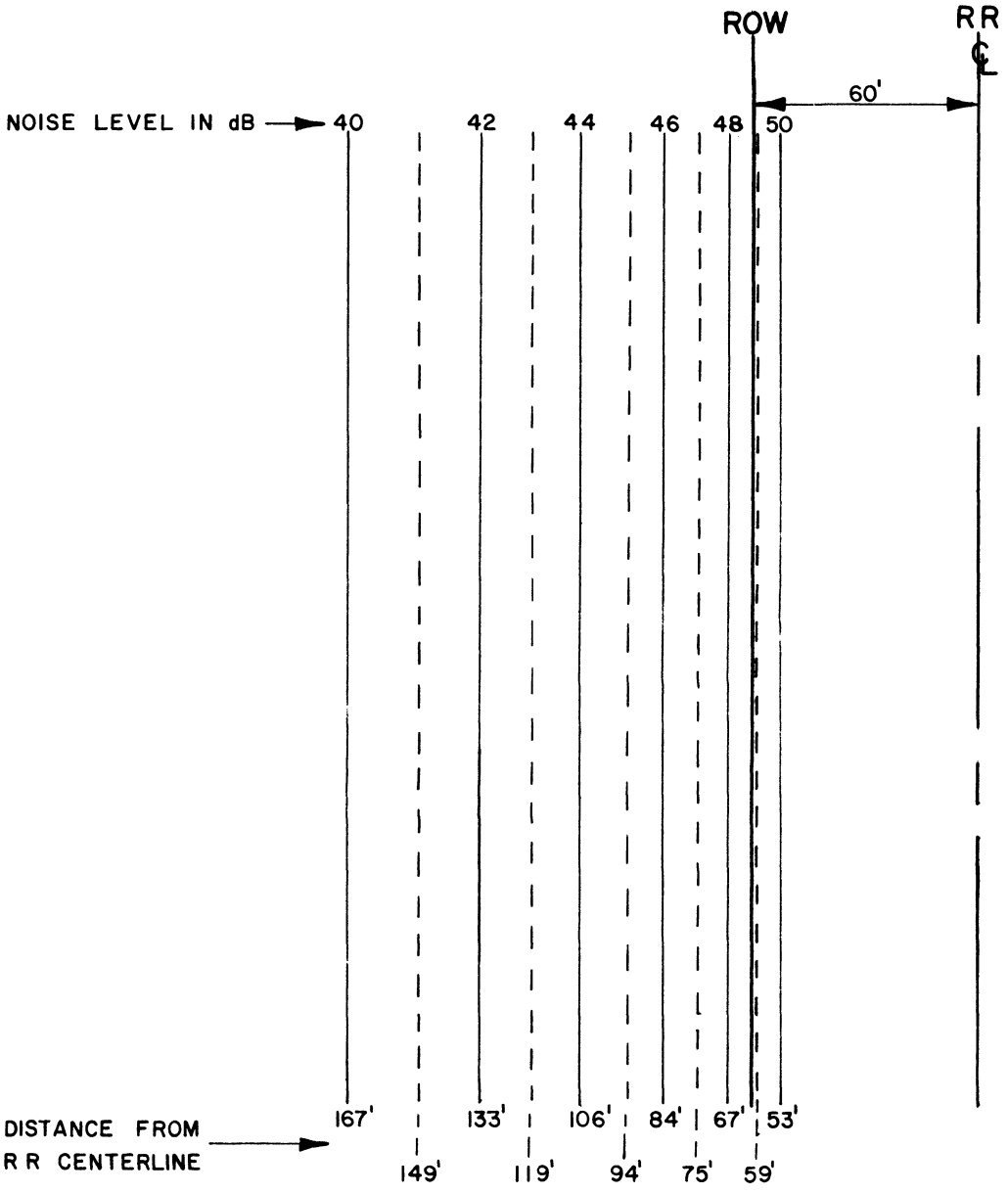
KENNECOTT FLAMBEAU MINING PROJECT

Railroad Noise Modeling Study

A study was conducted at typical railroad locations in Wisconsin to develop baseline noise conditions along railroad right-of-ways. This data will be used to assist in assessing the environmental impacts of future railroad operations in the vicinity of the proposed Kennecott Mine near Ladysmith, Wisconsin. This report summarizes the results of that study.

Noise monitoring of rail operations was conducted at several representative locations in Wisconsin. Data collection was conducted in accordance with the standards of ASTM E-1014, *Standard Method for Measurement of Outdoor A-Weighted Sound Levels,* and employed a sound meter which meets Type 2 standards for ANSI S1.4, *Specifications for Sound Level Meters.* A wind screen was used for testing. The meter was located approximately 50 feet away from the centerline of the tracks. Using the data collected at various railroad sites, typical noise levels at distance from mainline railroads were developed and are presented on Figure 3.13-A1.

The A-weighted scale of measurement offers a nonuniform response to sound intensity. Within an overall frequency range of 30 Hz to 8 KHz, the A scale has considerably reduced response at low frequencies, thus approximating the response of the human ear. The A scale has been found to be useful in expressing both the annoyance factor and the hazard (danger of hearing loss) of a



FOTH & VAN DYKE GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION GREEN BAY, WISCONSIN			KENNECOTT MINERALS COMPANY FLAMBEAU PROJECT LADYSMITH, WISCONSIN		
NOTES	APPROVAL	DATE	FIGURE NO. 3.13-A1 TYPICAL NOISE LEVELS AT ACTIVE RAILROADS IN WISCONSIN		
	DESIGNED BY				
	DRAWN BY MWB	1/89			
	CHECKED BY				
	APPROVED BY				
	CAD No. SCALE 1" = 50'		Job No	Dwg No	REV

wide variety of noises. It is commonly used to assess the impact of other transportation-related noise sources.

Prior to the conduct of the actual noise monitoring, it was hypothesized that the following factors could influence noise generation:

1. Haul weight
2. Length of train (an indirect function of haul weight)
3. Locomotive horsepower (an indirect function of haul weight)
4. Speed
5. Track gradient
6. Track condition
7. Equipment condition

Because of the difficulty of quantifying some of these factors, it was decided to simplify the modeling process to employ only three factors:

1. Length of train
2. Speed
3. Gradient

The intention of the noise modeling procedure was to provide a convenient method to forecast the day/night average sound level (L) for a typical 24-hour period in the project vicinity. The method involved summing, on an energy basis, the noise contributions from each railroad operation occurring in one day, with an adjustment of 10 decibels for each nighttime operation (to account for the increased disruption of sleep). The resulting calculation was then compared to ambient noise levels and to accepted noise exposure standards to provide a useful measure of noise impact.

The noise exposure contribution from each rail operation has been described in terms of sound exposure level (SEL). The SEL is a function of the number of cars, distance, and track gradient as presented on Figure 3.13-A2. The SEL is the A-weighted sound level integrated over the entire noise event associated with a railroad train passby, normalized to a reference duration of one second. Thus, the SEL gives the level of a continuous one-second signal which contains the same amount of energy as the full noise event. The SEL will generally be somewhat higher than the maximum A-weighted sound level occurring during the same event.

The calculation of an SEL for a single-rail operation has been accomplished using the worksheets illustrated in Tables 3.13-A1 and 3.13-A2. First, a basic SEL was found using two factors--the approximate number of cars in the train and its average speed maintained while passing over the track segment which was to be analyzed. Second, the SEL was adjusted according to the average track gradient in the segment.

The calculation of the day/night average sound level (L) associated with the SEL was done in accordance with the following formula:

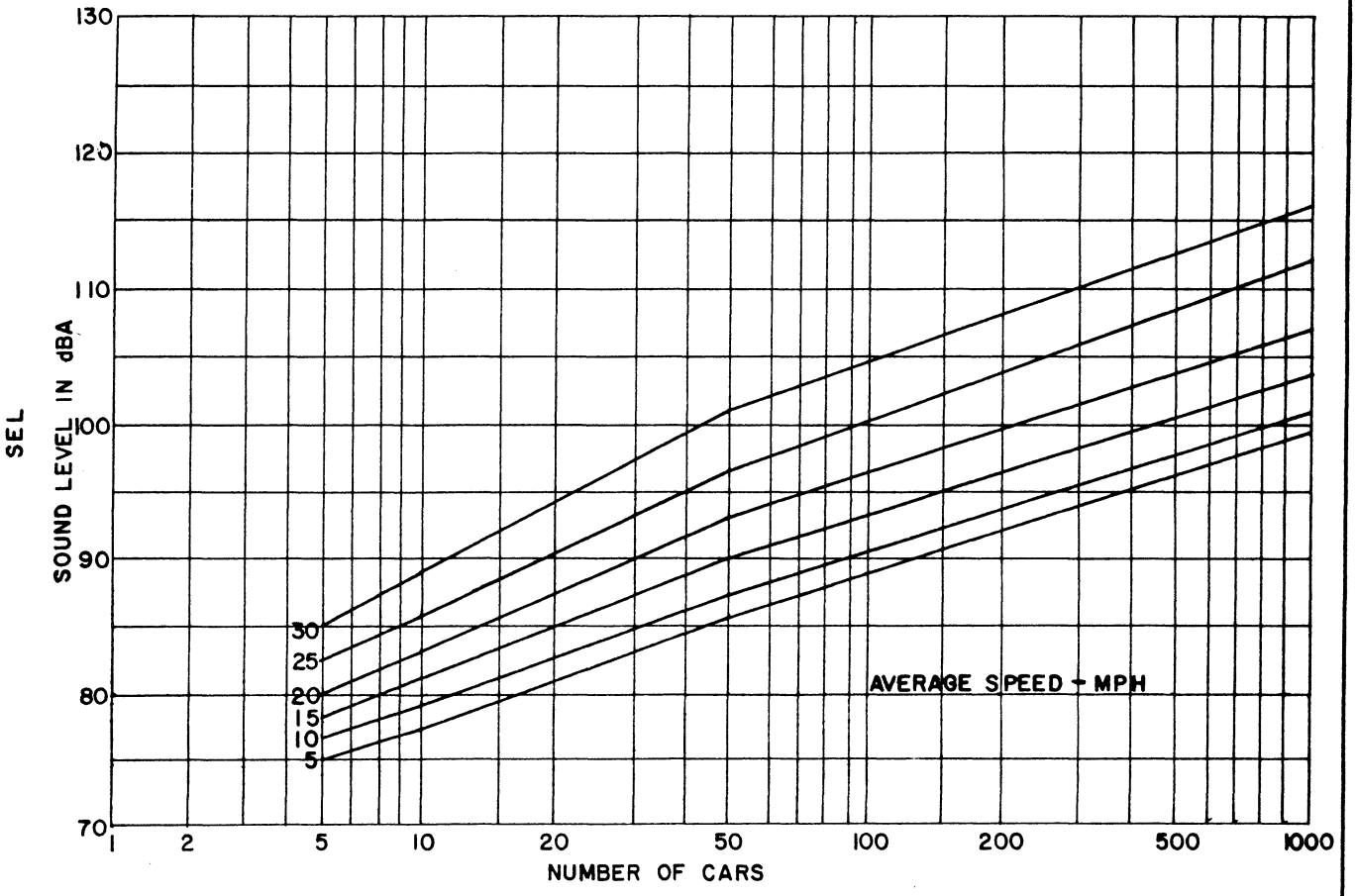
$$L = SEL + 10 \log (N^D + 10\ N) - 49.4$$

Where N = the number of daytime operations

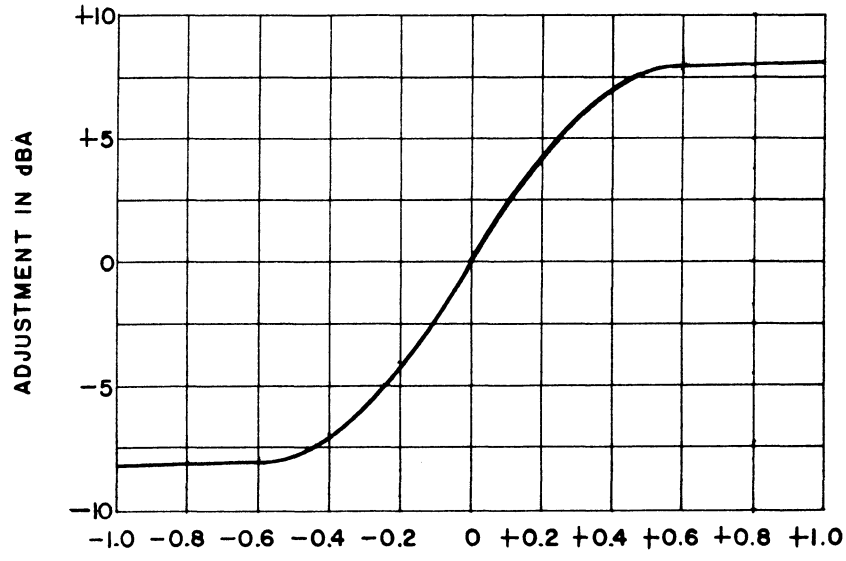
N = the number of nighttime operations (11:00 p.m. to 7:00 a.m.)

A separate SEL and L were used for each condition of operation (i.e., for each combination of train length and speed). The

SEL DETERMINATION



GRADIENT ADJUSTMENT



FOTH & VAN DYKE GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION GREEN BAY, WISCONSIN			KENNECOTT MINERALS COMPANY FLAMBEAU PROJECT LADYSMITH, WISCONSIN
NOTES	APPROVAL	DATE	FIGURE NO. 3.13-A2 SOUND EXPOSURE LEVELS AT ACTIVE RAILROADS IN WISCONSIN
	DESIGNED BY		
	DRAWN BY MWB	1/89	
	CHECKED BY		
	APPROVED BY		
	CAD No. / SCALE AS SHOWN		Job No / Dwg No / REV

TABLE NO. 3.13-A1

Railroad Noise Worksheet - L_{dn} Calculation

Operating Conditions	Speed/Train Length Combination								
	1	2	3	4	5	6	7	8	
No. of Cars									
Speed, mph									
SEL, dBA									
Daytime operations									
Nighttime operations									
L_{dn}, dBA									
Composite L_{dn}, dBA									

TABLE NO. 3.13-A2

Railroad Noise Worksheet - Decibel Addition

Combination Number	L_{dn}, dB	Antilog Columns-Left Digit of Sound Level						Antilog Table	
		11	10	9	8	7	6	Right Digit of Sound Level	Antilog
1								0	1000
2								1	1259
3								2	1585
4								3	1995
5								4	2512
6								5	3162
7								6	3981
8								7	5013
TOTALS								8	6311
								9	7944

final L, then, is the total of the level calculated for each condition of operation.

Calculation forms and graphs are attached. Note that an additional adjustment may be required in some locations where the rail track is raised or depressed from the observer's location.

Research Notes:

1. The speeds and gradients selected were based upon the conditions anticipated in the Kennecott study area.

2. The decision to exclude track and equipment condition from the modeling process was justified in part by the findings of the study. In general, these two factors are significant only at speeds of 20 mph or greater, and with very long trains (200 or more cars).

3. The values are believed to be accurate for trains loaded to an average of 80 to 85 percent of maximum haul weight. Varying loading conditions may produce slightly different results.

APPENDIX 4.3-A

Groundwater Inflow Into Open Pit

1.0 ESTIMATED GROUNDWATER INFLOW INTO THE MINE EXCAVATION

The permeability values obtained from the 1987-1988 field investigations, and permeability data obtained in 1973 by STS Consultants, Ltd., were used to estimate groundwater flow into the pit that could be expected in the final excavation based on the mine phasing plan contained in the report titled *Mining Feasibility Study of the Flambeau Deposit* prepared by Pincock, Allen & Holt, Inc. Methodology and results are discussed below.

1.1 Methodology

The following steps were taken to calculate groundwater inflow into the mine excavation.

1.1.1 Development of Panoramic Cross Section

A panoramic geologic cross-section (Figure No. 4.3-A1) was constructed using information provided by available soil boring logs (i.e., Foth & Van Dyke and STS). The geologic cross-section provides an approximation of the stratigraphy along the outside of the mine excavation. Actual boring locations are shown on Drawing No. 1.

1.1.2 Development of Flow Sectors

The water table elevations shown on Figure No. 4.3-A1 are typical for a section located 200 feet outside of the mine excavation. The pit area beneath the estimated water table was divided into flow sectors. The extent of each flow sector was dependent on mine geometry and hydrogeologic characteristics. These flow sectors are indicated on Figure No. 4.3-A1 and numbered 1 through 17.

1.1.3 Assignment of Permeabilities

Based on the results of permeability testing, including bail/slug tests, pump tests, packer tests, and drilling observations, each flow sector was assigned the highest measured value of permeability for that stratum. The permeability was determined by tests conducted on wells or piezometers located in or near the designated flow sector. Well locations and corresponding permeabilities are shown on the panoramic cross section.

No permeabilities were obtained from Sector 11A. The range of permeabilities used for Sector 11A is based on permeabilities obtained from nearby wells TW-K4 and PZ-S4. The permeability used for Sector 11 is based on TW-K4 values.

1.1.4 Calculation of Inflow

The Prickett Lonnquist Aquifer Simulation Model (PLASM) was used to estimate the steady state pit inflow originating from each flow sector in Figure No. 4.3-A1. The code was modified to allow for seepage face formation at the excavation wall. In the model, pit inflow was calculated using Darcy's Law and the model-generated heads (see Bear, 1970, pp. 361-366).

Each model was two-dimensional in plan view. In most instances, no-flow boundary conditions were assigned on three sides of the model. The fourth side of the model was constant head, representing the base elevation of the pit. For flow sectors which are immediately downgradient of the Flambeau River, the boundary opposite the pit (i.e., the Flambeau River) was also set at a constant head. The head in the aquifer was initially set at the top of the sector. At time = 0, the head at the constant head boundary representing the base pit elevation was dropped to the bottom of the sector. The model was then stepped through time until steady state conditions were attained. After

each time step, the permeability and hydraulic gradient (from nodes adjacent to seepage face) were used with Darcy's Law to estimate pit inflow from the sector. The model was considered at steady state when this flow did not vary by more than five percent.

The flow sector area was converted into an equivalent rectangular area. First, the actual area was calculated from the cross section on Figure no. 4.3-A1. This area was then divided by the thickness of the sector to determine the sector width. This width corresponded to the width of the two-dimensional model at the constant head boundary. With the exception of flow sectors immediately downgradient of the Flambeau River, the length was chosen such that drawdown would not reach the boundary opposite the constant head boundary at steady state.

Table No. 4.3-A-1 summarizes the following data input information for each model:

- Width and depth of average flow sector.
- The highest measured values of permeability and storativity for the stratum.
- Model length.
- Whether the model is linked to the Flambeau River.
- Number of model rows and columns.

The output of the models consisted of head declines and pit inflow rate versus time.

TABLE NO. 4.3-A-1

Estimate of Pit Inflow
Model Parameters and Results

Flow Sector	Depth (ft)	Width (ft)	Flow Path Length (ft)	Permeability (cm/sec)	River Link	Model Rows	Model Columns	Flow (gpm)	Strata
1	35	130	200	8.0E-03	Yes	10	13	71.0*	SP
2&3	100	914	500	1.0E-06	Yes	20	18	1.5	RK
2a	170	535	150	1.0E-05	Yes	8	13	10.9	RK
2b	170	54	150	1.0E-03	Yes	15	6	130.0	RK
4								1.0	SS
5								1.3	SS
6&8	20	1000	4000	1.0E-03	No	40	5	7.2	SS
7								1.7	RK
9								2.2	SS
10	19	358	4000	1.0E-03	No	20	7	2.1	SS
11	100	1183	4000	6.0E-05	No	20	6	9.4	RK
11a	135	540	4000	6.0E-05	No	20	11	6.2	RK
11b	132	72	4000	1.0E-03	No	40	6	3.8	RK
12								0.5	SS
13								0.2	SS
14								>0.1	SM
15								>0.1	SS
16	130	1049	4000	4.0E-04	No	20	5	114.0	RK
17								2.0	RK
				Total Flow - Precambrian (RK)				279.5	gpm
				- Sandstone (SS)				14.5	gpm
				- Glacial (SP,SM)				(71.0)*	gpm
				Total w/o slurry wall				365.0	gpm
				Total w/slurry wall				294.0	gpm

*The slurry wall will stop this flow and is thus not included in the 294 gpm figure.

1.2 Results

Estimates of steady state groundwater inflow into the mine are provided in Table No. 4.3-A-1. Flow rates for each sector are listed as well as flow rate totals for each geologic unit (i.e., SP = sand, SM = silty sand, SS = sandstone, RK = Precambrian rock).

The estimated steady state groundwater inflow to the final mine excavation is 294 gpm. Approximately 95 percent of the inflow (280 gpm) is derived from the Precambrian rock, with the remaining 5 percent (15 gpm) originating from the sandstone and glacial sediments. Of the Precambrian rock inflow, about one-half originates from Sector 2b, the river pillar. This sector has high permeability rates parallel to the northeast-southwest axis of the mine. About 13 percent of the pit inflow (35.5 gpm) is derived from upgradient sources of both Precambrian and sandstone deposits.

Based upon the model runs the pit inflows are expected to be higher than the above rates (no more than 588 gpm) during the early stages of mining activities (first few months) as water from storage is depleted along the way to steady-state conditions.

2.0 SUMMARY AND CONCLUSIONS

Based on the data collected to date and the analyses completed as part of this document, the following conclusions and summary comments.

1. The permeability of the glacial-fluvial sediment (SP, GP) ranges from 1 x 10^{-5} to 1 x 10^{-1} cm/sec. The glacial fluvial sediment is the most permeable geologic unit in the pit area.

2. The glacial-fluvial sediment is most coarsely grained at the northwest pit perimeter and thickest at the river pillar in the area of boring ST-9-17.

3. The till (SM) has permeabilities in the range of 1 x 10^{-5} to 6 x 10^{-3} cm/sec.

4. The till is absent at the northwest pit perimeter, but occurs over most of the pit area and ranges from three to 23 feet thick. South of the pit the till is more than 35 feet thick.

5. The sandstone has the second-highest permeabilities observed. The permeabilities obtained from the sandstone ranged from 1 x 10^{-4} to 2 x 10^{-3} cm/sec.

6. The sandstone is absent at the southwest end of the pit but thickens to the northeast to about 20 feet thick at Section 422.

7. Rocks on the hanging wall side of the pit are less permeable than the ore body or footwall rocks. Permeabilities in the hanging wall rocks ranged from 8 x 10^{-8} to 2 x 10^{-4} cm/sec. Permeabilities obtained from rocks on the footwall side of the pit ranged from 3 x 10^{-7} to 6 x 10^{-4} cm/sec.

8. The highest permeability observed in the Precambrian rock was from the ore body contact. Permeabilities obtained from the ore horizon as a whole ranged from 9×10^{-7} to 1×10^{-3} cm/sec.

9. Core logs and field observations made while drilling and pumping, and pump test results, indicate that the massive sulfide, semimassive sulfide, and metachert units are potentially the most permeable rock units.

10. As indicated by bail and pump tests, and field observations including poor core recovery and caving of bore holes, the rocks on the hanging wall are the least permeable. This is probably due to the high degree of alteration to clay.

11. Sand and gravel occurs at the river pillar. The sand and gravel thins to the southeast and northwest with a maximum of about 45 feet of thickness at ST-9-17A.

12. The extent and thickness of the glacial-fluvial gravel and sand outside the pit perimeter from MW-1004 to PZ-S1 is based on an extrapolation of data obtained from within the pit area.

13. Quantitative information regarding the permeability of the ore body has been obtained at the river pillar in the upper part of the ore body.

14. Core logs indicate fault zones that may have secondary permeability where the faults intersect brittle units such as the metachert.

15. The steady-state pit inflow is estimated to be about 294 gpm. The pit inflow may be as high as 588 gpm during the very early stages of mining as water is being removed from storage in the first months of activity.

16. Most of the till and glacial-fluvial sediment in the pit wall will be dewatered at the completion of Final Phase excavation. The exception is flow Sector 1, which is located at the river pillar. Without the slurry wall, this sector would provide approximately 71 gpm during steady-state flow for the Final Phase excavation. The purpose of the slurry wall is to cut this flow off.

17. Most of the sandstone in the pit wall will be dewatered at the completion of the Final Phase excavation. The sandstone will provide approximately 14 gpm at steady-state conditions for the Final Phase excavation.

18. The quantification of flow from the sandstone at the northeast end of the pit is based on an extrapolation of data from Section 422. The volume of water entering the pit from the sandstone at the northeast end of the pit will be greater if the sandstone is thicker than 20 feet or will be less if the sandstone layer is thinner.

19. After Final Phase excavation, 87 percent (244 gpm) of the pit inflow would come from Precambrian flow Sectors 2b and 16 located at the river pillar and the southwest end of the pit, respectively.

20. Most of the water from the rock in Sectors 2b and 11b will enter the pit through the ore body, and ore body/footwall contact.

21. Inflow calculations indicate that the majority of inflow originates in a number of key flow sectors. Therefore, if necessary, engineering techniques such as grouting can be applied to control or eliminate inflow in these key flow sectors, thus significantly reducing total inflow into the pit.

110527

BASELINE AT NORTEAST END OF PROPOSED PIT

BASELINE AT SOUTHWEST END OF PROPOSED PIT

PZ-S1 TW-K1 ST-18 ST-17A ST-58 TW-K6R ST-60 ST-61 ST-63 ST-65 ST-67 MW-1003P TW-K5R B-S5 ST-22 PZ-S4 TW-K4 ST-23 TW-K3R PZ-S3 ST-4 ST-5 ST-24 ST-26 39 PZ-S2 TW-K2 MW-1000P ST-29 ST-17A

1145 1125 1105 1085 1065 1045 1025 1005 985 965 945 925 905

PHASE I

PHASE I

FINAL

FINAL

$\frac{3\times10^{-5}}{(2c)}$ $\frac{1\times10^{-6}}{(5)}$ $\frac{2\times10^{-6}}{(2c,2a)}$ $\frac{1\times10^{-6}}{(3a)}$ $\frac{5\times10^{-6}}{(2b)}$ $\frac{6\times10^{-4}}{(5)}$ $\frac{1\times10^{-3}}{(STS)}$ $\frac{3\times10^{-5}}{(5,2c)}$ $\frac{1\times10^{-3}}{(STS)}$ $\frac{1\times10^{-4}}{(SS)}$ $\frac{2\times10^{-5}}{(2c,2a)}$ $\frac{5\times10^{-6}}{(STS)}$ $\frac{4\times10^{-4}}{(3a)}$ $\frac{4\times10^{-5}}{(STS)}$ $\frac{6\times10^{-4}}{(1a)}$ $\frac{1\times10^{-3}}{(STS)}$ $\frac{8\times10^{-5}}{(1b,1c,2a)}$

LEGEND

(7) FLOW SECTOR

PHASE I – APPROX. EXTENT OF PIT AT COMPLETION OF PHASE I EXCAVATION

FINAL – APPROX. EXTENT OF PIT AT COMPLETION OF FINAL PHASE EXCAVATION

PZ-S4 BORING/WELL DESIGNATION AND LOCATION, OTHER DESIGNATIONS: TW-K4, ST-18, MW-1000P

WATER TABLE – ESTIMATED ELEVATION DURING STEADY STATE CONDITIONS AT COMPLETION OF THE PHASE I AND FINAL PHASE EXCAVATION

$\frac{3\times10^{-5}}{(5,2c)}$ ← HYDRAULIC CONDUCTIVITY IN cm./sec. ← ROCK UNIT(S) IN WHICH WELLS ARE SCREENED

$\frac{1\times10^{-3}}{(STS)}$ HYDRAULIC CONDUCTIVITY IN cm./sec., TEST BY STS IN 1973

PRECAMBRIAN ROCK UNIT

1a	SERICITE – QUARTZ SCHIST
1b	METACHERT
1c	MASSIVE SULPHIDE
2a	BIOTITE – SERICITE – QUARTZ – CHLORITE SCHIST (LOCAL ANDALUSITE)
2b	BIOTITE – CHLORITE – QUARTZ – SERICITE SCHIST (LOCAL ANDALUSITE)
2c	BIOTITE – QUARTZ – CHLORITE SCHIST
3a	QUARTZ – AUGEN SCHIST
5	METADACITE

CAMBRIAN UNIT

SS	SANDSTONE

PLEISTOCENE UNIT

SM	SILTY SAND TILL WITH SOME WIND BLOWN SILTY SAND AND SILT
GP	POORLY GRADED GRAVEL AND SAND
SP	POORLY GRADED SAND WITH GRAVEL

40' 20' 10' 0' 0' 100' 200' 400'

FOTH & VAN DYKE
GEOSCIENCES & ENVIRONMENTAL MANAGEMENT DIVISION
GREEN BAY, WISCONSIN

FLAMBEAU PROJECT
LADYSMITH, WISCONSIN

KENNECOTT MINERALS COMPANY
1515 MINERAL SQUARE
SALT LAKE CITY, UTAH
84112

FIGURE NO. 4.3-A1
PANORAMIC X-SECTION

MICROFILM | KECC-JOB
KECC-DRAWING NO. 2 | REV
DIVISION DRAWING NO.
SCALE: SEE BAR SCALE

REFERENCES

DWG. NO.	DESCRIPTION

NO	DATE	REVISIONS	BY	CHK'D	ENG'R	ENG'R MGR.

	BY	DATE
PROJ. ENG'R		
MGR. PROCESS ENG'R		
ENG'R MGR.		
DESIGN		
DRAWN		
CHK'D		
DES. ENG'R		
SECT ENG'R		