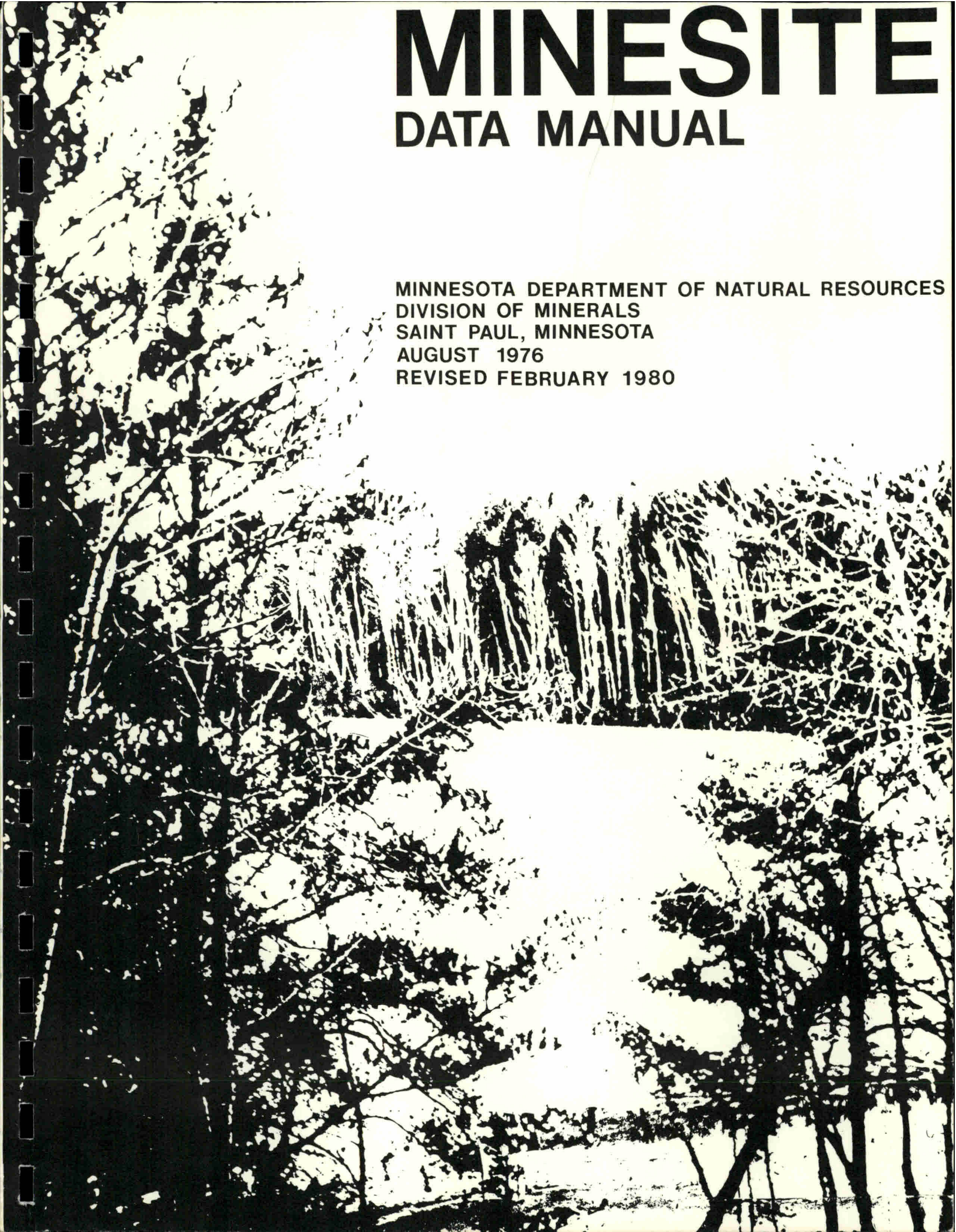


MINESITE

DATA MANUAL

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINERALS
SAINT PAUL, MINNESOTA
AUGUST 1976
REVISED FEBRUARY 1980



MINESITE

Data Manual

Division of Minerals
Minnesota Department of Natural Resources
St. Paul, Minnesota
August 1976
Revised February 1980

TABLE OF CONTENTS

Acknowledgments

MINESITE Project

Study Area

Description of Variables

V01 Site Map

V02 Slope

V03 Slope Orientation

V04 Bedrock Geology

V05 Surface Hydrology

V06 Watersheds

V08 Surface Ownership

V09 Elevation

V10 Soil Landscape Units

V11 Depth to Duluth Complex Basal Contact

V12 Land Use

V13 Shipstead Newton Nolan--Superior National Forest Boundary

V14 Recreational-Historical-Archeological Sites

V15 Taconite Reserves and Potential Taconite Resources

V16 Vegetation

V17 Timber Cutting History

V18 Crown Density

V19 Forest Size Classes

V20 Forest Height Classes

V21 Natural Resource Sites

V22 Lake and Stream Surveys (Fish Habitat)

V23 Mineral Leasing

V24 Soil Associations
V25 Highways, Roads, and Trails
V26 Railroads and Utilities
V29 Mineral Resource Polygons
V30 Watershed Areas
V31 Proposed Recreation Area and Research Areas
V32 Wolf, Moose, Pine Marten Areas - Potential Caribou Release
Site
V91 Units Within the MINESITE Area
V95 MINESITE Area
V133 Fish Classification

Appendix A - Definition of Slope Categories (V02)

Appendix B - Description of Soil Landscape Units (V10)

Appendix C - Taconite Reserves and Potential Resources (V15)

Appendix D - Vegetation Inventory (V16)

Appendix E - Timber Cutting History (V17)

Appendix F - Vegetation Size and Density Classes (V18, V19)

Appendix G - Summary: Lake and Stream Surveys (Fish Habitat) (V22)

Appendix H - Soil Association Survey Sheets (V24)

Appendix I - Mineral Resource Polygons (V29)

Appendix J - Statistical Check

ACKNOWLEDGMENTS

Financial support and resource data for this project has been provided primarily by the Department of Natural Resources. Additional funding has been received from the Legislative Committee on Minnesota's Resources, Land Exchange Review Board, and the Environmental Quality Council. Numerous private and public organizations have provided significant input. Many DNR student workers have contributed to the project since its conception.

Consultants

Bather, Ringrose, Wolsfeld, Inc.
Edina, Minnesota

Earth System Research, Inc.
Minneapolis, Minnesota

Limnological Research Center
University of Minnesota

Minnesota Land Management Information System (MLMIS)
Center For Urban and Regional Affairs
University of Minnesota

Remote Sensing Laboratory
College of Forestry
University of Minnesota

St. Anthony Falls Hydraulic Laboratory
Department of Civil and Mineral Engineering
University of Minnesota

Other Information Sources

Environmental Planning Division
Minnesota State Planning Agency

Environmental Services Section
Minnesota Highway Department

North Central Forest Experiment Station
U.S. Forest Service
Department of Agriculture

Soil Conservation Service
Department of Agriculture

Superior National Forest
U.S. Forest Service
Department of Agriculture

MINESITE PROJECT

The MINESITE study, under development by the Division of Minerals, Department of Natural Resources, is designed to serve as a resource management tool in a portion of Northeastern Minnesota. This area is known to contain significant copper-nickel resources and harbors the potential for significant resource and land use conflicts.

MINESITE, through this resource data manual and a systematic computer technique, combines the existing land use resources and environmental sensitivities into a framework for evaluating certain regional environmental trade-offs of potential copper-nickel development.

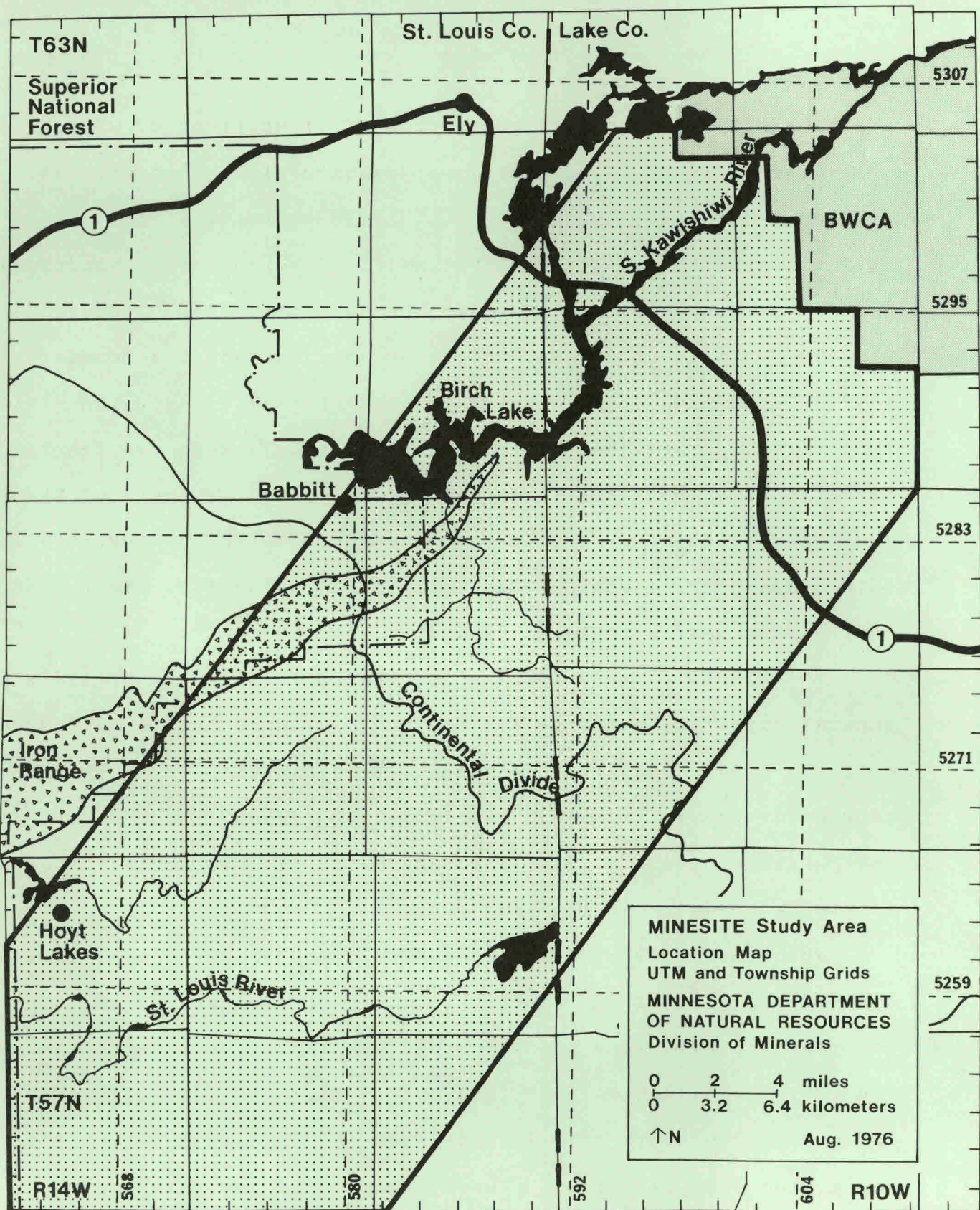
This data manual should be used with the "MINESITE Status Report" which further describes the study.

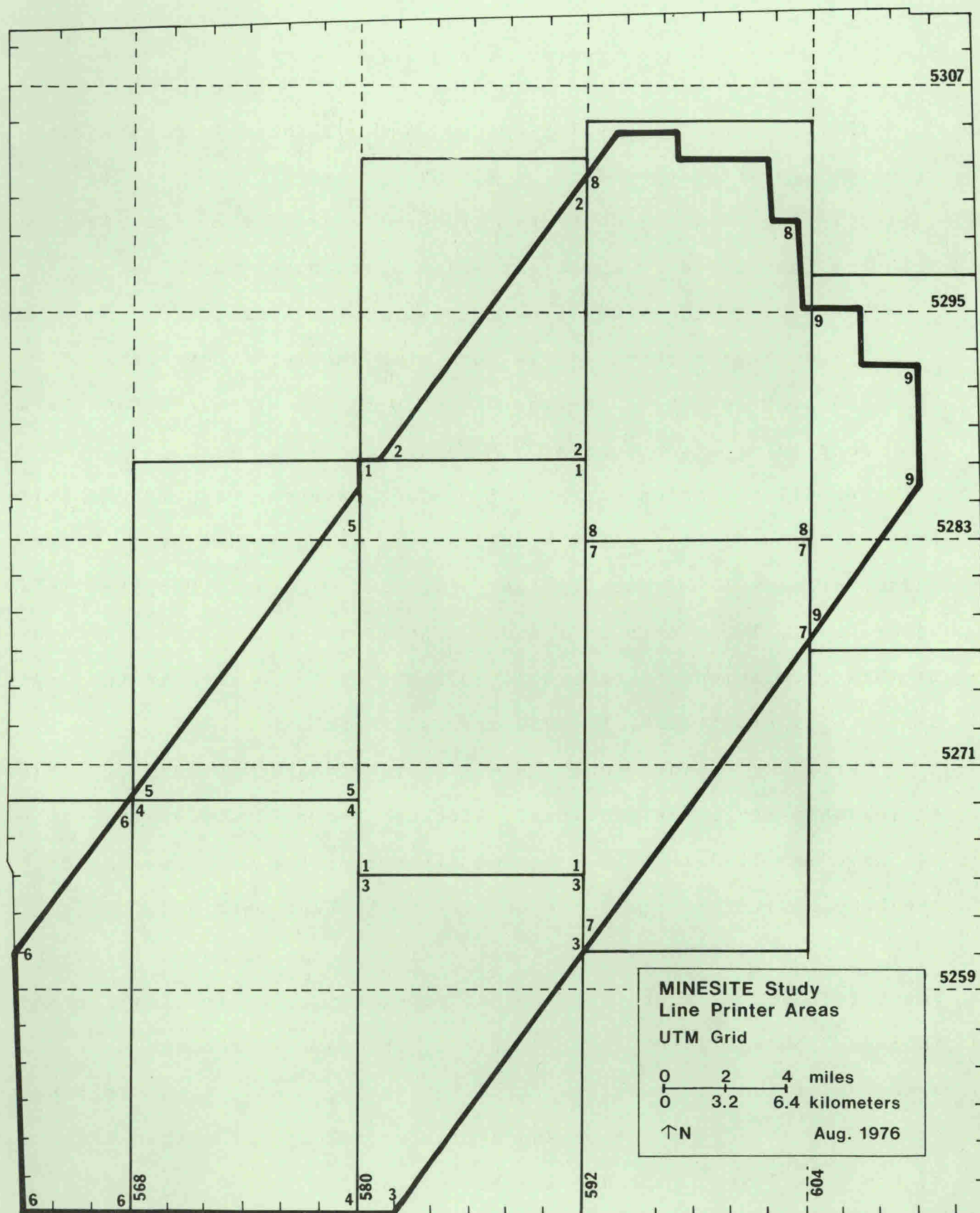
STUDY AREA

The MINESITE study area is composed of portions of 23 townships and contains approximately 560 square miles. Located in St. Louis and Lake counties, the MINESITE boundaries inclose the area of highest copper-nickel potential in Northeastern Minnesota and the extreme eastern end of the Mesabi Iron Range. Important management units in or near the study area include the Boundary Waters Canoe Area (BWCA), the Superior National Forest, and state forests and parks. Waters in the study area flow in two general directions. Northeast of the continental divide, waters of the South Kawishiwi River system flow through the BWCA and eventually into Hudson Bay. Waters southwest of the divide flow via the St. Louis River system to Lake Superior.

The MINESITE Study Area map on the following page provides a general orientation to the area. Two grids have been superimposed over the study area, the traditional Township-Range grid and the metric Universal Transverse Mercator (UTM) grid. The UTM grid is the predominant system used for data plotting in the study. Data is plotted using a metric cell system.

When the study was initiated, the computer's storage system limited the size of the areas that could be evaluated, and output was restricted to line printer maps. Therefore, the MINESITE study area was initially divided into 9 smaller areas each 120 cells wide and of varying lengths (160 to 220 cells). Area 1 was designated the pilot area. These study areas are shown on the MINESITE Study Line Printer Areas map following the orientation map.





DESCRIPTION OF VARIABLES

Thirty separate compilations of data, or variables, have been computerized and mapped for the MINESITE area. These variables are listed in the Table of Contents. Twenty seven of the variables are resource inventories. Three variables serve other purposes:

V30 divides the study area into watershed areas.

V91 divides the study area into nine smaller study areas.

V95 provides access and orientation to the Minnesota Land Management Information System (MLMIS) 40-acre data base.

For all variables except V08 Surface Ownership and V95 MINESITE Area, data is plotted using a cell system based on Universal Transverse Mercator (UTM) coordinates. Each cell in the UTM system is a square cell, 100 meters on a side. The metric definition for an area of this size is one hectare. It corresponds to an area in the English system of approximately two and one-half acres.

Variables 8 and 95 use the MLMIS standardized 40-acre grid based on Township-Range designations. Although the grid scale difference may have resulted in some internal distortion for these variables, the best possible fit for the two grids has been obtained.

In this Data Manual, each data variable has an identification sheet followed by a photographed computer map. The information sheet includes the variable name and number, the data source and date, names of persons responsible for interpreting the data, a description of the variable, the method and date of final verification, and a list of the data levels included in the inventory.

The verification method refers to the system used to locate errors that might have occurred as data was transferred from a base map to the final computer map. Two techniques, an individual cell check and a statistical check, were used to verify data. The method of statistical checking is described in Appendix J. Both techniques refer only to the computerization process and are no reflection on the reliability of the original data source.

The data maps which follow the identification sheets are dot-plots of the resource inventories in the computer files. The title block for each map includes a list of the data levels identified for the variable, the map symbol associated with each data level, and the cell frequency count for each data level. In most cases, the map symbols are tones which create the appearance of shading. When many levels occur on a map, the data levels are grouped and the shading follows a logical sequence. For example, for V02 Slope, shades become more intense as slope increases. An overlay system is included on each map in order to provide visual orientation.

In several instances, a variable required description beyond that provided on the identification sheet. These detailed descriptions are provided in the section of Appendices.

**DATA BIOGRAPHY**

SOURCE: MINESITE Study, Division of Minerals, DNR

INTERPRETATION: MINESITE Staff, DNR

SOURCE DATE: June 1973

DESCRIPTION

The site map represents the MINESITE study boundaries. These boundaries contain the area in Northeastern Minnesota assessed to have the greatest potential for the development of copper-nickel resources found in the Duluth Complex formation.

VERIFICATION

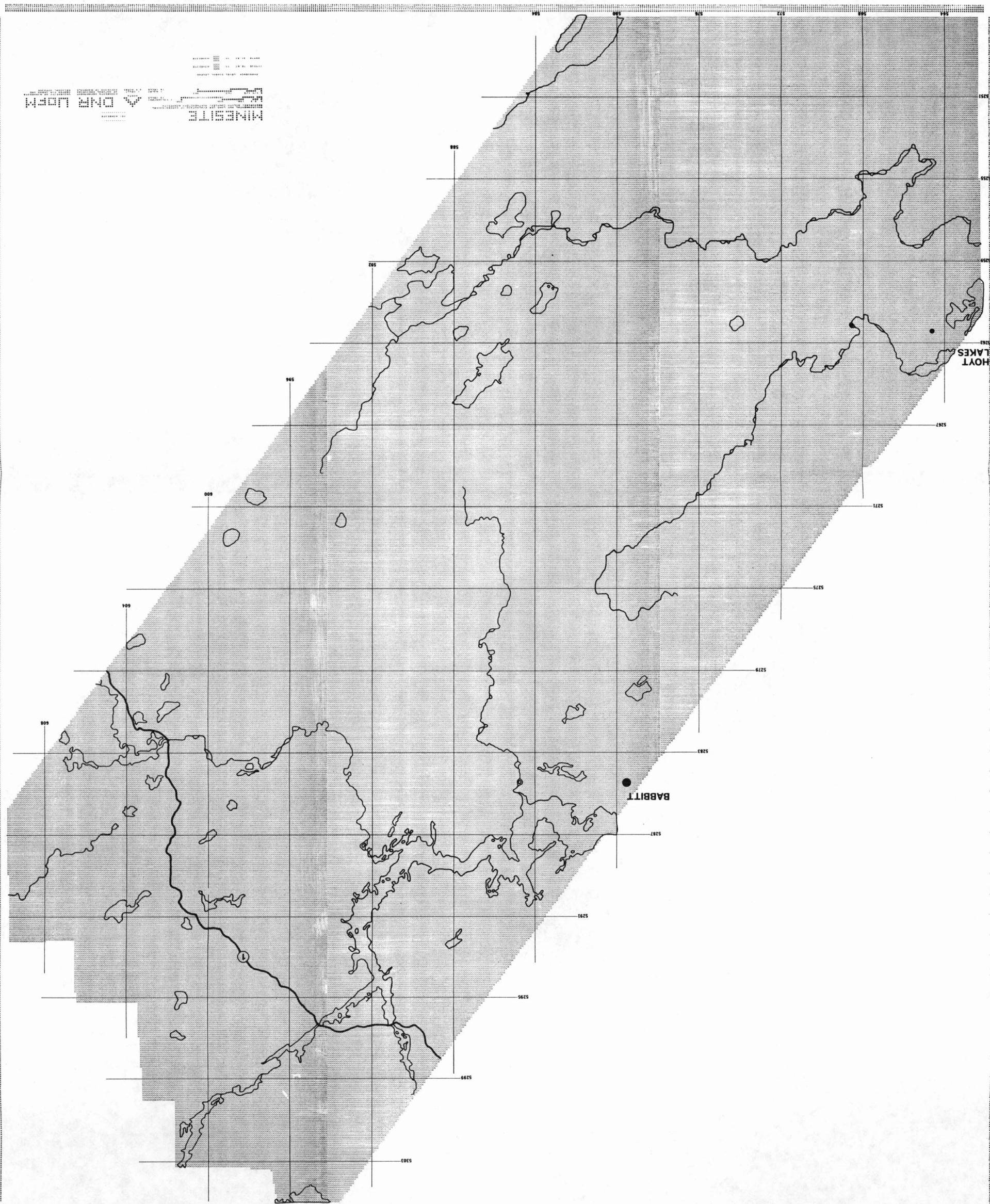
TECHNIQUE: All cells checked

FINAL DATE VERIFIED: August 16, 1976

LEVELSData LevelLegend

44
45

MINESITE
MINESITE





Slope

(V02)

DATA BIOGRAPHY

SOURCE: USGS Topo Maps: Greenwood Lake (1954); Gabbro Lake, Markham, Brimson (1957); Bear Island, Kangas Bay (1965); Babbitt (NW,NE,SW,SE), Allen, Isaac Lake, Aurora (1969PR*).

INTERPRETATION:

MINESITE Staff, DNR

SOURCE DATE:

See map dates listed above

DESCRIPTION

The predominant slope range for each cell is determined based on the most current elevation contour interval data (Appendix A - Definition of Slope Categories).

VERIFICATION

TECHNIQUE: Statistical Check - Appendix I

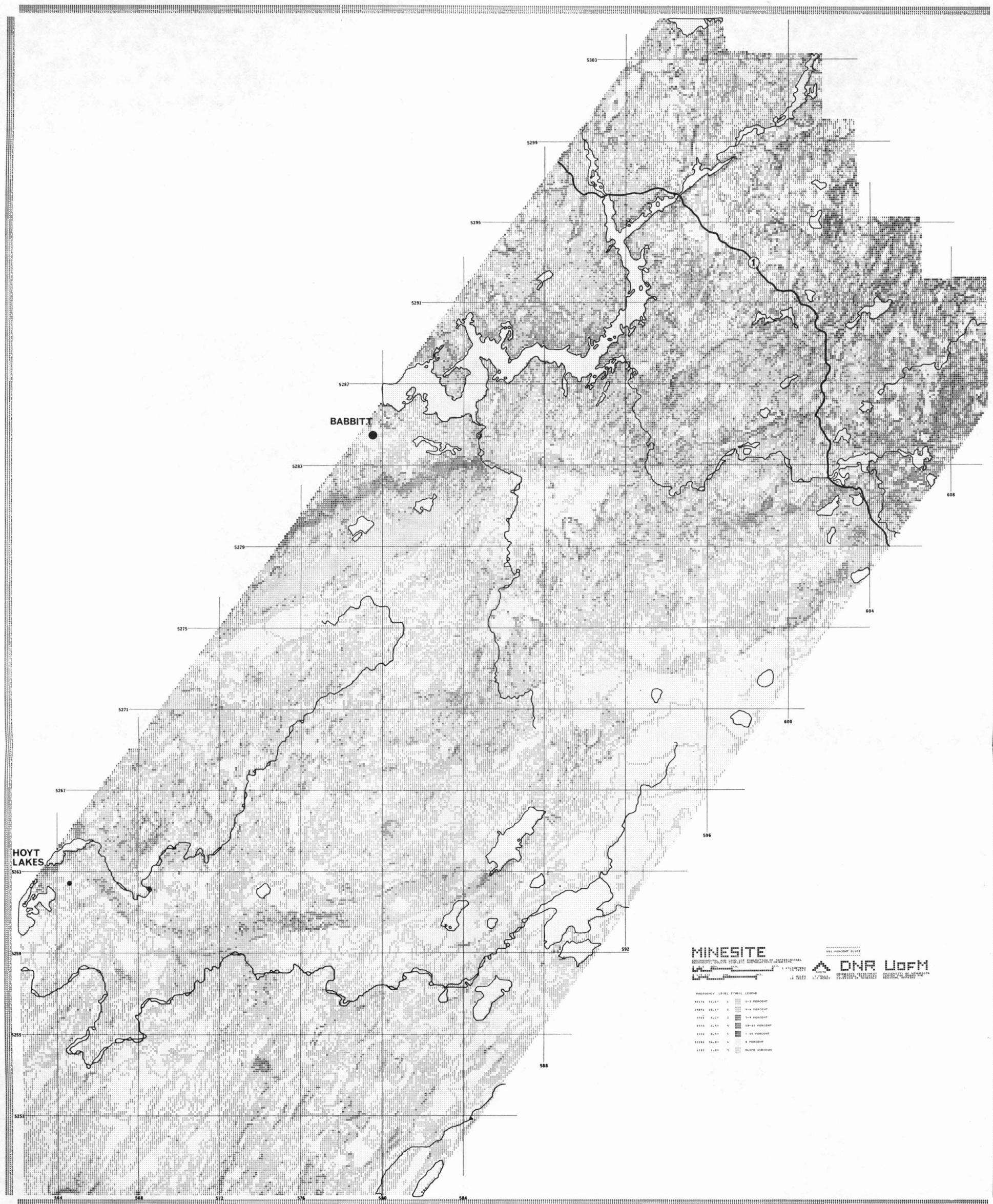
FINAL DATE VERIFIED: October 12, 1976

*photo revised

LEVELS

<u>Data Level</u>	<u>Legend</u>
1	1-3%
2	4-6%
3	7-9%
4	10-15%
5	> 15%
6	0%
7	Slope Unknown*

*areas recently disturbed, usually by mining activities



**DATA BIOGRAPHY**

SOURCE: See maps listed in V02

INTERPRETATION: MINESITE Staff, DNR

SOURCE DATE: See map dates listed in V02

DESCRIPTION

Predominant slope orientation is based on the direction that contour lines cross a given cell. The orientation direction is determined by the direction one would be facing if looking directly down a slope. On a contour map the orientation is found by drawing a down slope line perpendicular to the predominant alignment of the contour lines.

VERIFICATION

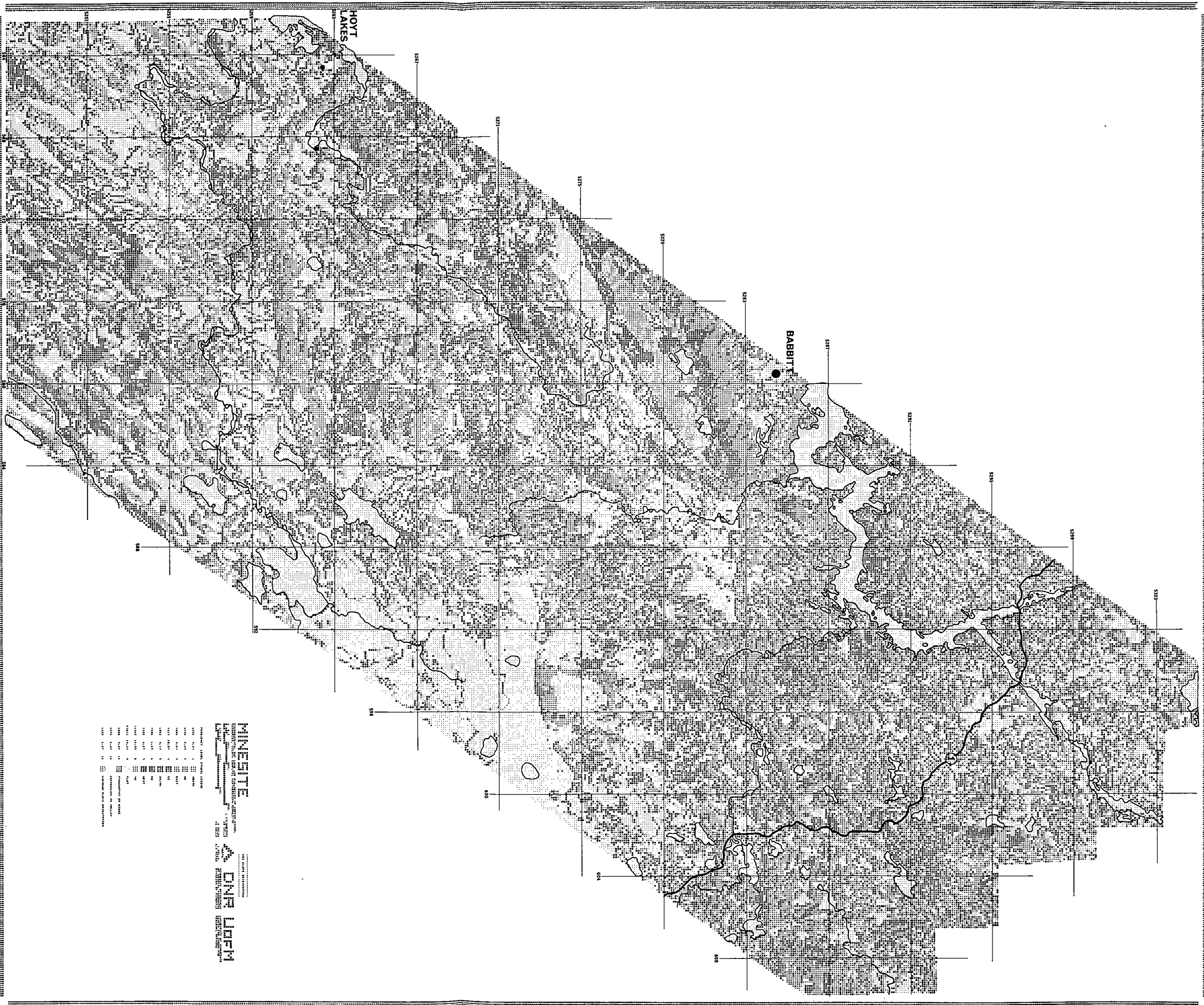
TECHNIQUE: Statistical Check - Appendix I

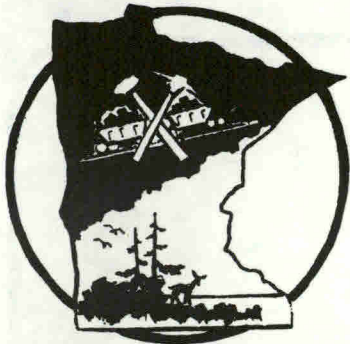
FINAL DATE VERIFIED: October 12, 1976

LEVELS

<u>Data Level</u>	<u>Legend</u>	<u>Data Level</u>	<u>Legend</u>
1	North	7	West
2	Northeast	8	Northwest
3	East	9	Flat
4	Southeast	10	Promontory or Ridge
5	South	11	Depression or Valley
6	Southwest	12	Slope Orientation
			Unknown*

*areas recently disturbed, usually by mining activities



**DATA BIOGRAPHY**

MGS Publications: Open file geologic maps Allen, Babbitt
SOURCE: (NW, NE, SW, SE), Ely, Kangas Bay; SP-8; M-2; M-11; Hibbing Sheet. DNR Two Harbors Geologic Map. MGS Bedrock Geologic Map, Hoyt Lakes - Kawishiwi Area, St. Louis and Lake Counties,
INTERPRETATION: Division of Minerals, Northeastern Minnesota.
DNR

SOURCE DATE: MGS Open file Maps (1970); SP-8 (1969); M-2 (1966); M-11 (1971); Hibbing Sheet (1970). DNR Two Harbors (1972). MGS Bedrock Geologic Map (1977).

DESCRIPTION Bedrock geology is most accurately mapped in areas where surface exposures are abundant. However, where bedrock is buried by surficial material, rock types are largely inferred by geophysical data. Additionally, continuity of certain contact relationships is resolved solely by interpretation. The legend gives the map symbol, followed by the name of the rock series or type represented.

VERIFICATION

TECHNIQUE: All cells checked

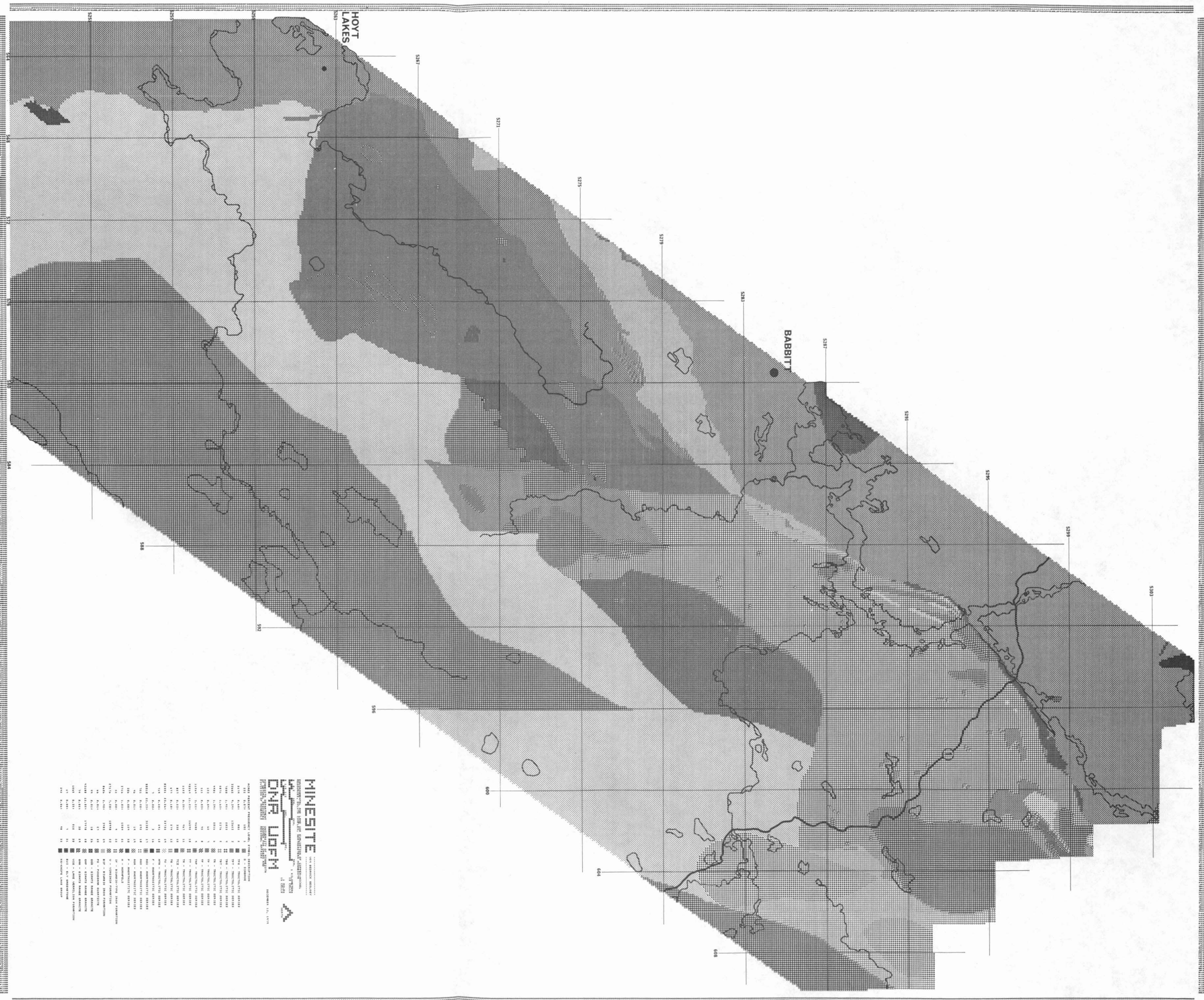
FINAL DATE VERIFIED: October 7, 1977

LEVELSData LevelLegend

1	d - Diabase
2	tpg - Troctolitic series
3	tpt - "
4	tbg - "
5	tbt - "
6	tr - "
7	tp - "
8	tf - "
9	tap - "
10	tt - "
11	ta - "
12	tcz - "
13	tg - "

Data LevelLegend

14	tu - "
15	mta - "
16	f - Anorthositic Series
17	agu - "
18	ago - "
19	aga - "
20	p - "
21	h - Hornfels
22	if - Biwabik-type Iron Formation
23	v - Virginia Formation
24	bif - Biwabik Iron Formation
25	pq - Pokegama Quartzite
26	ggb - Giants Range Granite
28	gap - "
29	gmh - "
30	vig - Lake Vermilion Formation
31	eui - Ely Greenstone
33	kg - Knife Lake Group



MINESITE
MINESITE SYMBOLS
1:50,000
CNR UORM
1983
REVISION 11, 1983

SYMBOLS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200

**DATA BIOGRAPHY**

USGS Topo. Maps: Aurora, Embarrass, Isacc L., Allen
SOURCE: (1950); Babbitt (SW, NW) (1951); Babbitt (SE, NE) (1952);
Greenwood L. (1954); Ely, Bear Island, Kangas Bay (1965);
Gabbro Lake, Markhan, Brimson (1957).

INTERPRETATION:

Division of Waters Staff, DNR

SOURCE DATE:

See map dates listed above

DESCRIPTION

Surface hydrology was plotted using two types of interpretation. When surface water is predominant within a cell, it is coded as a lake, marsh, tailings basin, or pond. A cell containing a river or stream is coded the appropriate data level regardless of whether the flowage occupies more than half of the cell.

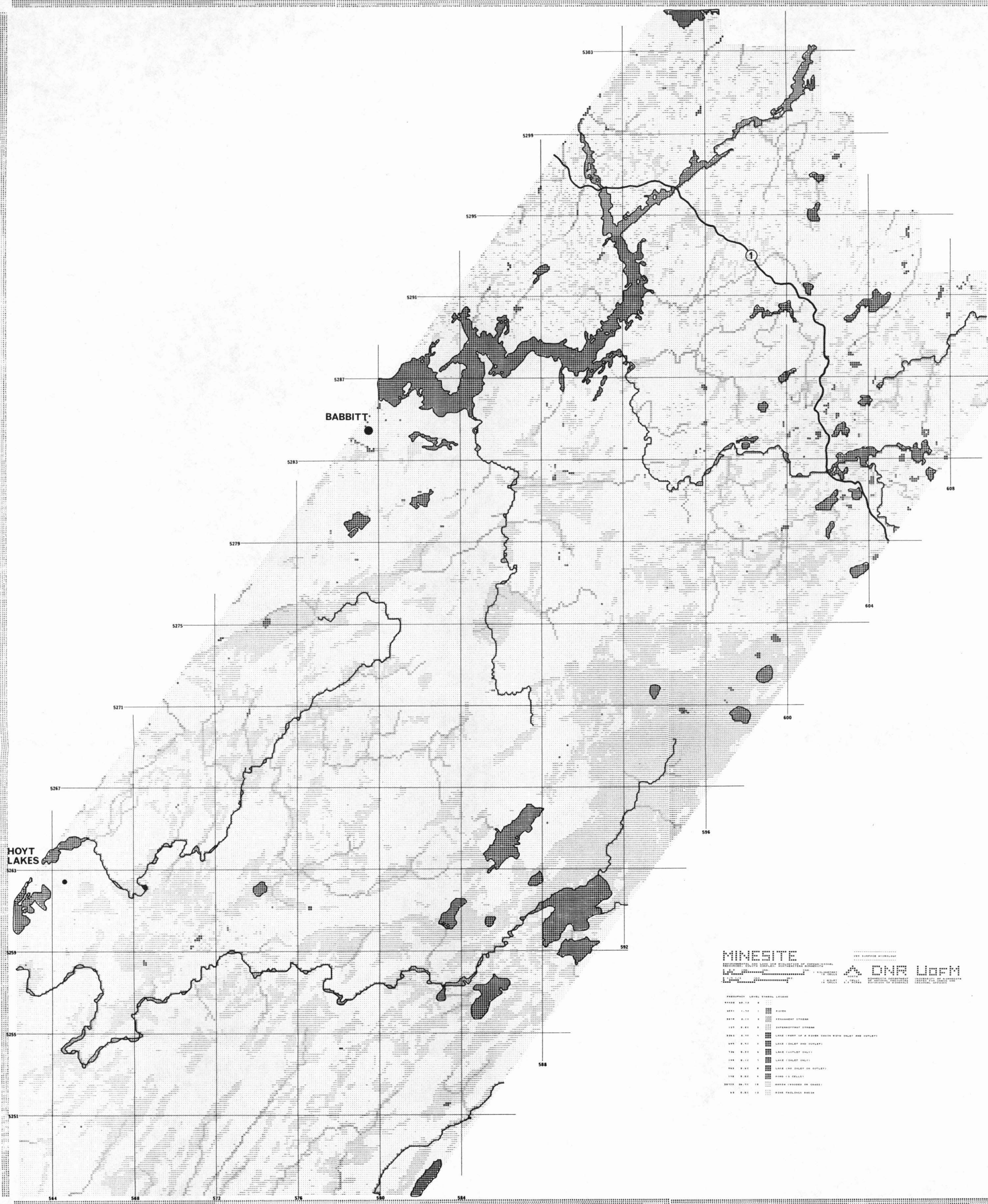
VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: September 2, 1976

LEVELS

<u>Data Level</u>	<u>Legend</u>
0	
1	River
2	Permanent Stream
3	Intermittant Stream
4	Lake (Part of a river chain with inlet and outlet)
5	Lake (Inlet and outlet)
6	Lake (Outlet only)
7	Lake (Inlet only)
8	Lake (No inlet or outlet)
9	Pond (2 cells)
10	Marsh (Wooded or grass)
12	Mine Tailings Basin



**DATA BIOGRAPHY**

USGS Topo Maps: Aurora, Embarrass, Isaac L., Allen
SOURCE: (1950); Babbitt (SW,NW) (1951); Babbitt (SE,NE) (1952);
Greenwood L. (1954); Ely, Bear Island, Kangas Bay (1965); Gabbro
Lake, Markham, Brimson (1957).

INTERPRETATION:

Division of Waters, DNR

SOURCE DATE:

See map dates listed above

DESCRIPTION

The watershed boundaries are based on the cells adjoining that boundary. Cells on each side of a watershed boundary were plotted with the appropriate name. Stream order drainage was established for rivers and streams, as well as lakes and ponds within a river system, with first order represented by the two main streams flowing out of the study area, the South Kawishiwi and St. Louis rivers. Stream branches were then numbered consecutively upstream as 2nd through 6th order. Levels are classified according to stream order or corresponding watershed boundary.

VERIFICATION

TECHNIQUE: All cells checked

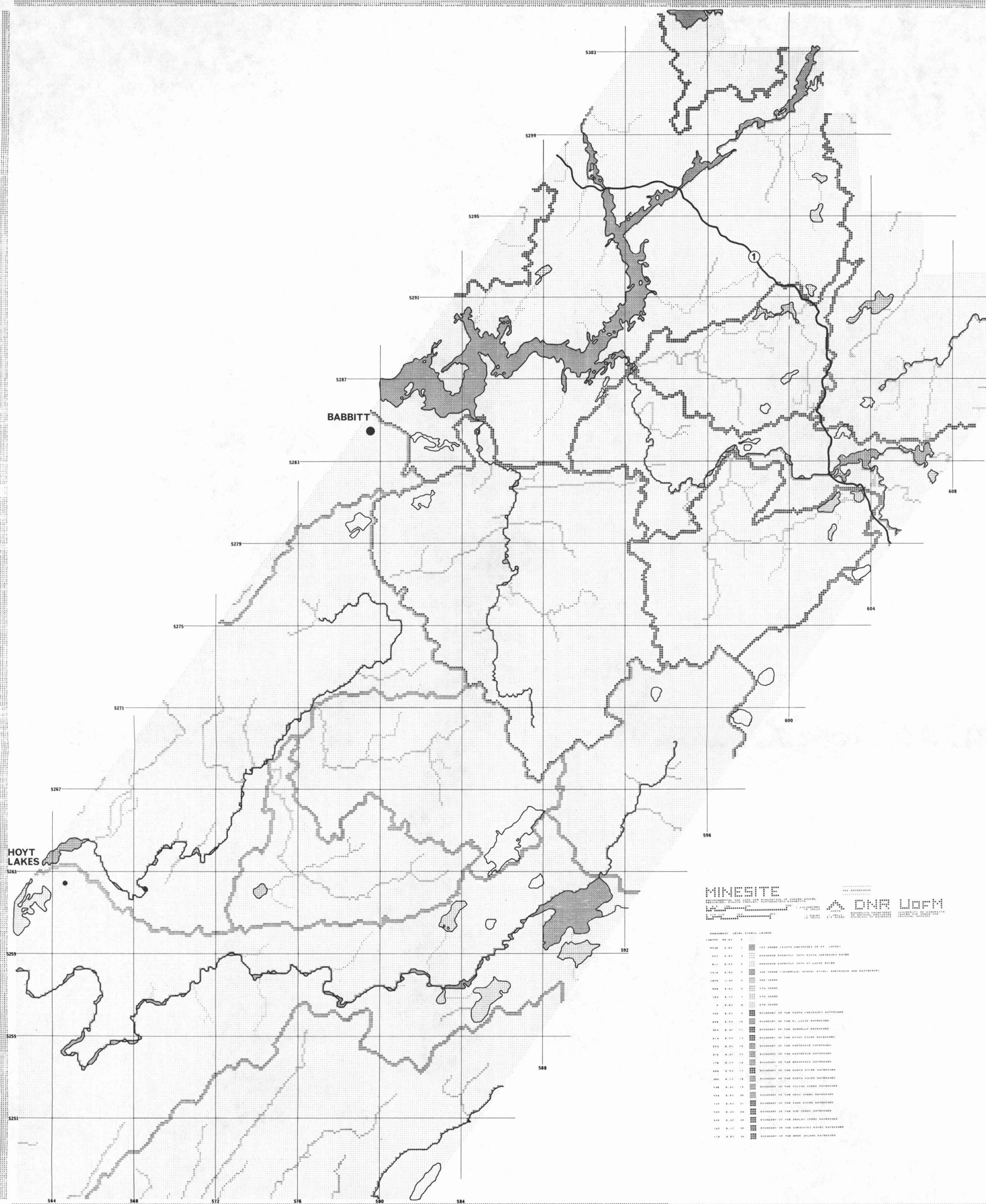
FINAL DATE VERIFIED: September 2, 1976

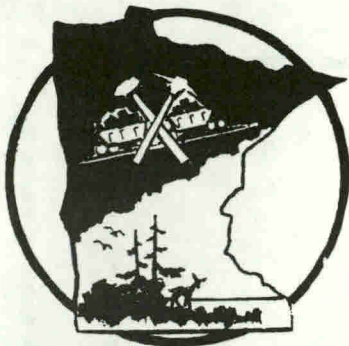
LEVELS

<u>Data Level</u>	<u>Legend</u>
0	
1	1st Order (South Kawishiwi or St. Louis)
2	Drainage Directly into South Kawishiwi River
3	Drainage Directly into St. Louis River
4	2nd Order (Isabella, Dunka, Stony, Partridge, and Whiteface)
5	3rd Order
6	4th Order
7	5th Order
8	6th Order
9	Boundary of the South Kawishiwi Watershed

Data LevelLegend

10	Boundary of the St. Louis Watershed
11	Boundary of the Isabella Watershed
12	Boundary of the Stony River Watershed
13	Boundary of the Partridge Watershed
14	Boundary of the Whiteface Watershed
16	Boundary of the Embarrass Watershed
17	Boundary of the Dunka River Watershed
18	Boundary of the North River Watershed
19	Boundary of the Colvin Creek Watershed
20	Boundary of the Argo Creek Watershed
21	Boundary of the Sand River Watershed
22	Boundary of the Nip Creek Watershed
23	Boundary of the Denley Creek Watershed
25	Boundary of the Kawishiwi River Watershed
26	Boundary of the Bear Island River Watershed



**DATA BIOGRAPHY**

Surface ownership was obtained from MLMIS regional data -
SOURCE: V05 Public Ownership: Federal, State, and County. MLMIS
used Agency Land Ownership Records; Department of Natural Re-
sources, Land Classification Study. Updated by data from Super-
INTERPRETATION: Minesite Staff. ior National Forest, USFS;
IRRRC; Division of Lands,
DNR.

SOURCE DATE: MLMIS (1973); USFS (1974); IRRRC - Lake County (1973)
and St. Louis County (1975); DNR (Sept. 1977).

DESCRIPTION The earlier version of this variable was based upon
a forty-acre MLMIS township - range cell fitted to the MINESITE UTM
grid and the one hectare cell. The current map is corrected to re-
flect more recent ownership information, as well as to adjust bound-
aries so that they more accurately represent ownership patterns.

VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: September 10, 1977

LEVELSData LevelLegend

2	Federal - National Forests
3	Multiple - Lands coded Federally owned, but show State ownership
4	Multiple - Federally owned lands sharing County Ownership
5	State - DNR Forestry Division lands with- in State Forests
6	State - DNR Forestry Division lands out- side State Forests
7	State - DNR Waters Division lands
14	State - DOT Rest Areas
15	No Public Ownership
16	State - DOT maintenance, storage and gravel pits

Data Level

Legend

18

County - Other County (tax forfeit)

19

County - Partial ownership





Elevation

(V09)

DATA BIOGRAPHY

SOURCE: See maps listed in V02

INTERPRETATION: MINESITE Staff, DNR

SOURCE DATE: See map dates listed in V02

DESCRIPTION Elevation is coded based on the predominant line passing through each cell. When multiple contour lines pass through a cell, the interpreter is required to select the most representative elevation for that cell.

VERIFICATION

TECHNIQUE: Statistical Check - Appendix I

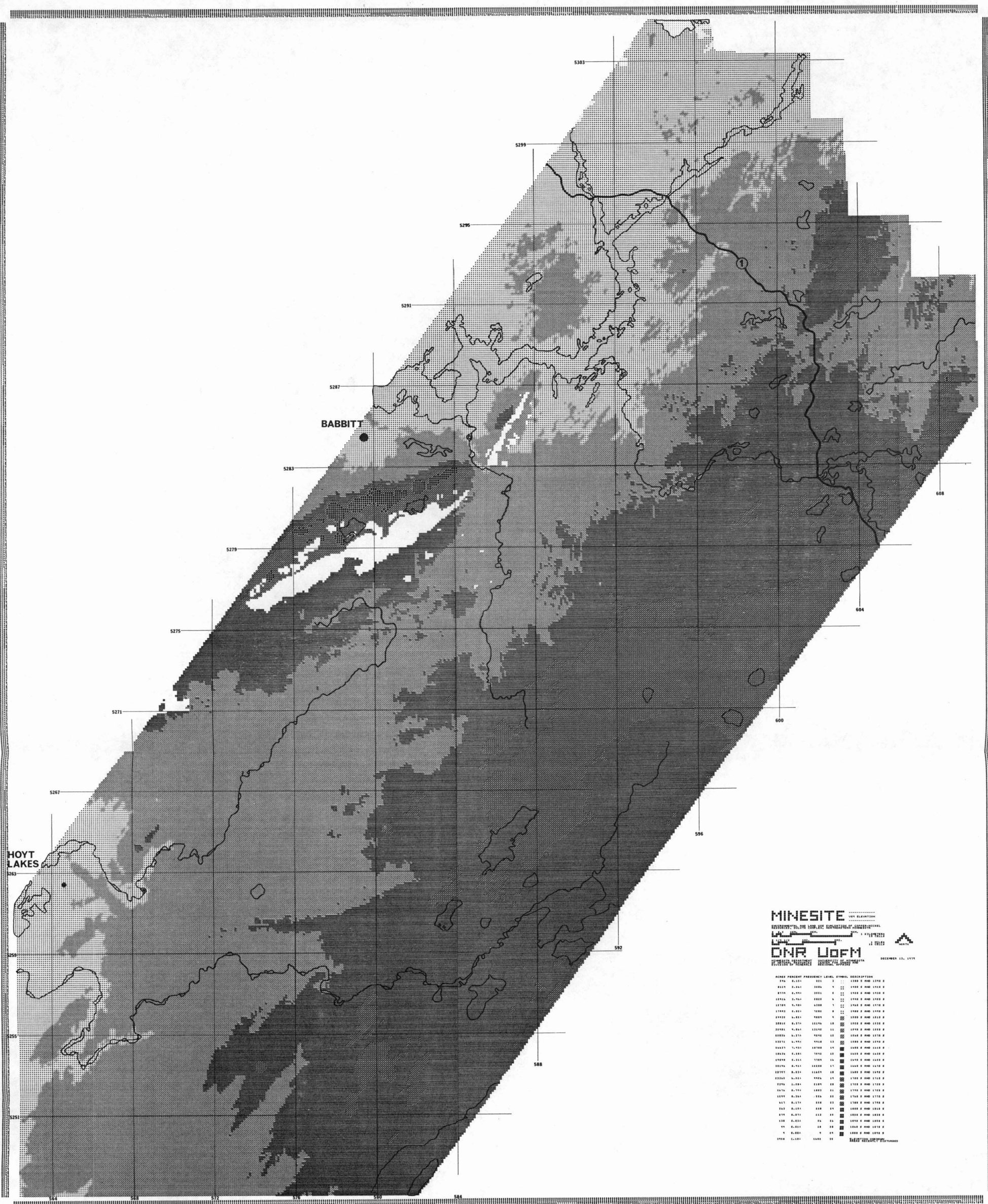
FINAL DATE VERIFIED: September 16, 1976

LEVELS

<u>Data Level</u>	<u>Legend</u>	<u>Data Level</u>	<u>Legend</u>
3	1380's and 1390's	12	1560's and 1570's
4	1400's and 1410's	13	1580's and 1590's
5	1420's and 1430's	14	1600's and 1610's
6	1440's and 1450's	15	1620's and 1630's
7	1460's and 1470's	16	1640's and 1650's
8	1480's and 1490's	17	1660's and 1670's
9	1500's and 1510's	18	1680's and 1690's
10	1520's and 1530's	19	1700's and 1710's
11	1540's and 1550's	20	1720's and 1730's

<u>Data Level</u>	<u>Legend</u>	<u>Data Level</u>	<u>Legend</u>
21	1740's and 1750's	26	1840's and 1850's
22	1760's and 1770's	28	1860's and 1870's
23	1780's and 1790's	29	1880's and 1890's
24	1800's and 1810's	35	Elevation unknown*
25	1820's and 1830's		

*areas recently disturbed, usually by mining activities



**DATA BIOGRAPHY**

SOURCE: Superior National Forest, U.S. Forest Service, U.S. Dept. of Agriculture.

INTERPRETATION: Donald Prettyman, Forest Soil Scientist, Superior National Forest

SOURCE DATE: July 1976

DESCRIPTION Soil Landscape Units were mapped based upon geology, drainage patterns, local relief, slope, vegetation, topographic patterns identified from aerial photographs and topographic maps, as well as from direct field observation. The smallest mapping unit shown on the soil map is 5-10 acres. See Appendix B for detailed information on soil units present in the MINESITE area.

VERIFICATION

TECHNIQUE: Statistical Check - Appendix I

FINAL DATE VERIFIED: September 15, 1977

LEVELS

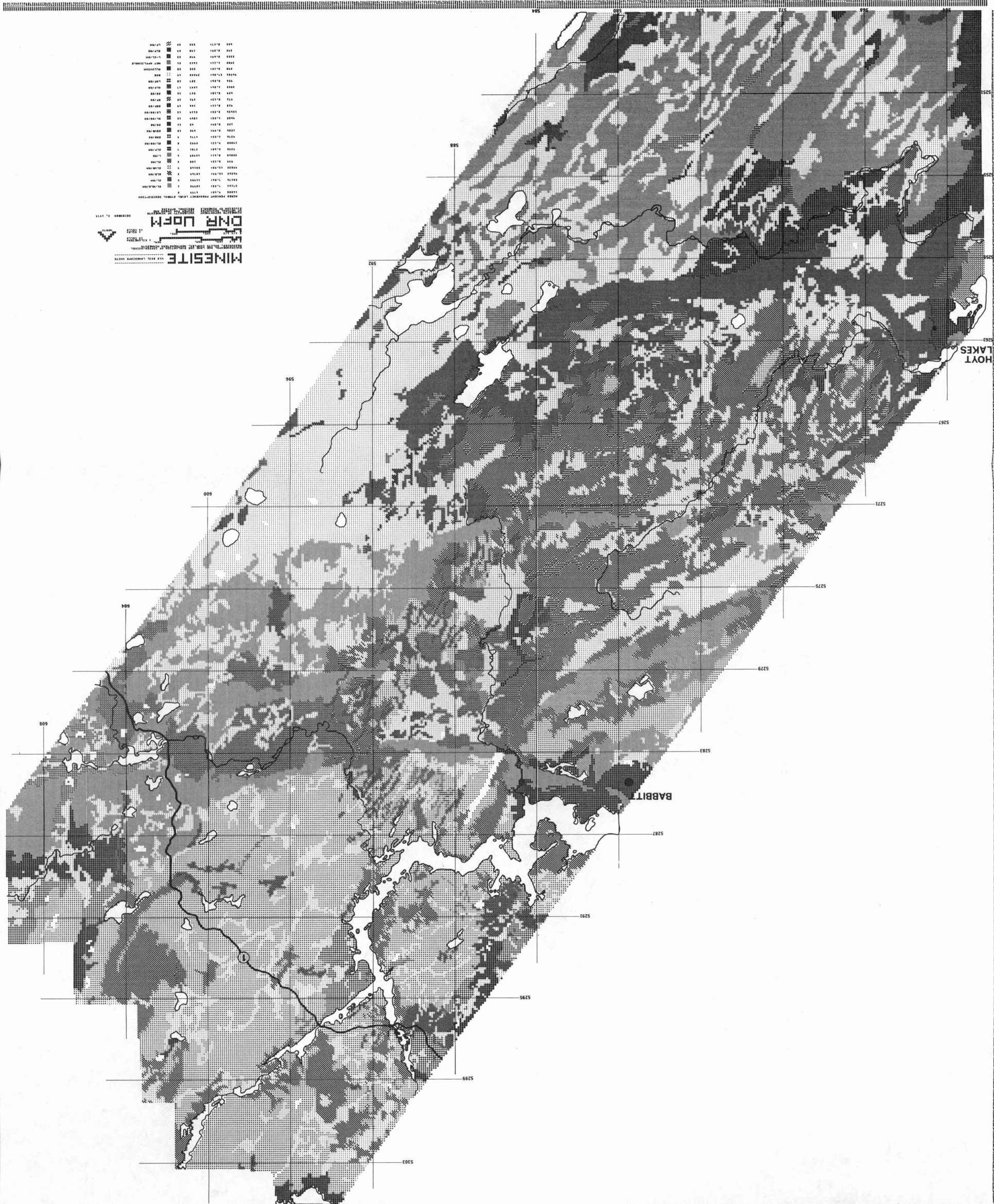
<u>Data Level</u>	<u>Legend</u>	<u>Data Level</u>	<u>Legend</u>
1	SL/GLS ✓ RM	6	L ✓ RD
2	SL ✓ RM	7	SLP ✓ RM
3	SLB ✓ RM	8	SL/SG ✓ RO
4	SLVB ✓ RM	9	SGB ✓ RO
5	SL ✓ RD	10	SGVB ✓ RO

Data Level Legend

✓ 11 SG
 RE
✓ 12 SL/SG
 SO
✓ 13 LS/SG
 SO
✓ 14 SGP
 SO
✓ 15 SP
 SO
✓ 16 SG
 SE

Data Level Legend

✓ 17 OLP
 DR
✓ 18 LOP
 DR
✓ 19 Bog
✓ 20 Alluvium
21 Not applicable
23 L-CL
 DM
24 SLP ✓
 RD
25 LP ✓
 RM





Depth to Duluth Complex Basal Contact (V11)

DATA BIOGRAPHY

SOURCE: Division of Minerals, DNR

INTERPRETATION: Division of Minerals, DNR

SOURCE DATE: June 1977.

DESCRIPTION The area within a few hundred feet of the basal contact of the Duluth Complex contains the majority of known sulfide mineralization and is therefore most likely to contain mineable ore deposits. The basal contact, or footwall, of the Duluth Complex occurs along the western margin of the formation between the complex and underlying rock units and dips to the southeast. Determination of the dip of this contact was made from bedrock outcrop mapping and available drill core. From this data, depth to the contact was projected and plotted.

VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: October 7, 1977

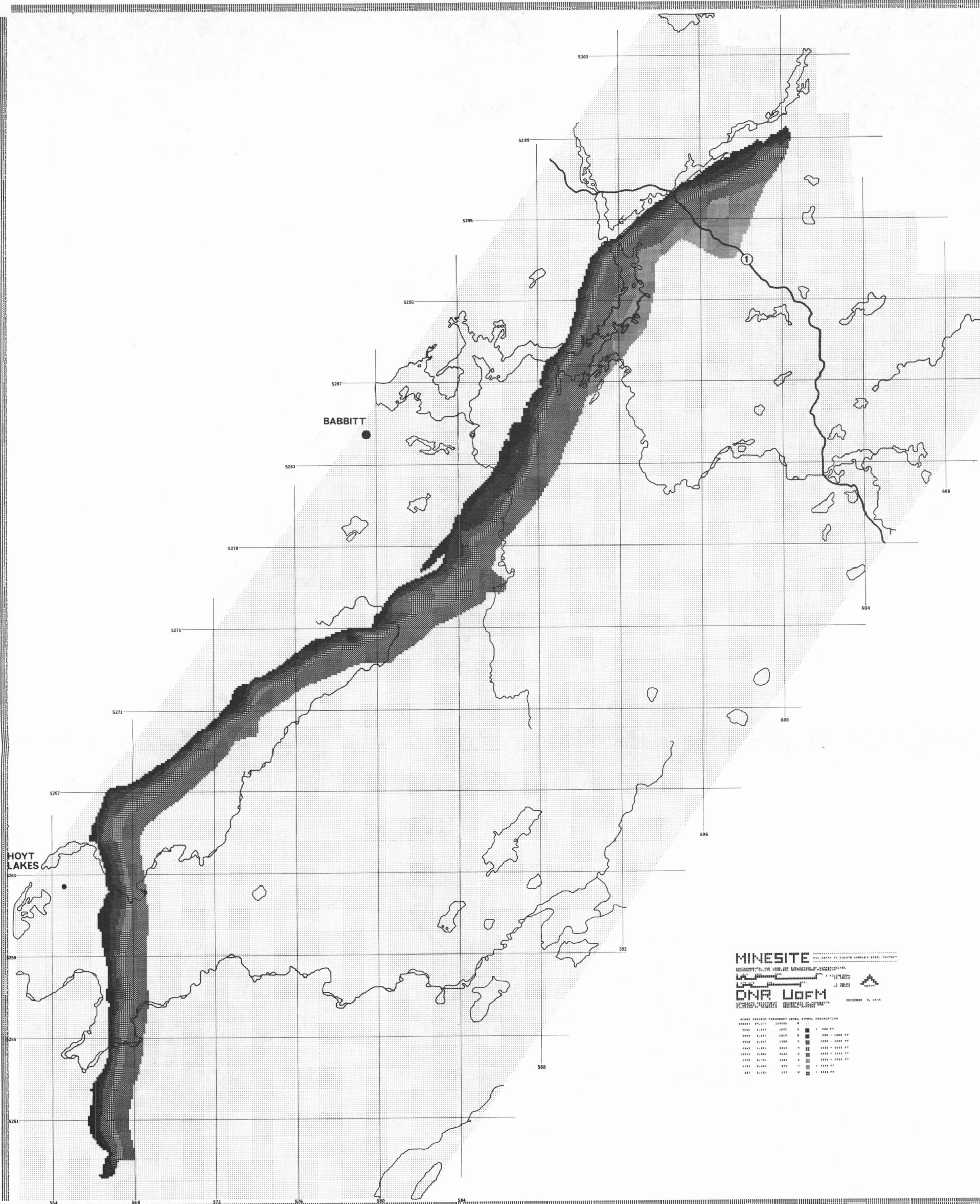
LEVELS

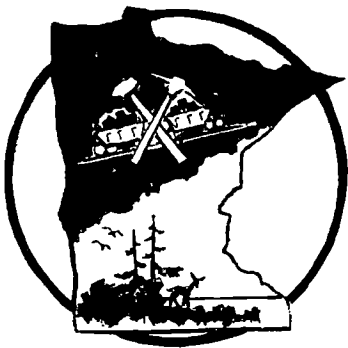
Data Level

0
1
2
3
4
5
6
7
8

Legend

<500 feet
500-1,000 feet
1,000-1,500 feet
1,500-2,000 feet
2,000-3,000 feet
3,000-4,000 feet
>4,000 feet
>3,000 feet





DATA BIOGRAPHY

SOURCE: DNR Reclamation Maps (1975); SCORP (State Comprehensive Outdoor Recreation Plan) Maps (July 1974); MLMIS Data Maps (January 1976); Aerial Photographs (1970); Quadrangle Maps;
INTERPRETATION: MINESITE Staff, DNR

SOURCE DATE: See map dates listed above

DESCRIPTION Existing man-made land use activities, with emphasis on mining activities, are shown. This variable does not include land uses covered in other variables.

VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: December 20, 1977

LEVELS

<u>Data Level</u>	<u>Legend</u>	<u>Data Level</u>	<u>Legend</u>
1	Mining - Open pit	12	Urban Residential
2	Surface Stockpiles	13	Non-Urban Residential and Resorts (Some possibly abandoned)
3	Lean Ore Stockpiles		
4	Waste Rock Stockpiles		
5	Tailings Basins		
6	Reservoirs	14	Commercial-Industrial & Residential
7	Mining Facilities		
8	Auxiliary Lands (Mine)	15	Exploration Shafts
10	Public Recreation Sites	16	Exploration Test Pits
11	Agriculture (Cultivated and pasture land)	17	Gravel or Borrow Pits
		18	Isolated Buildings (Some possibly abandoned)

*See following page

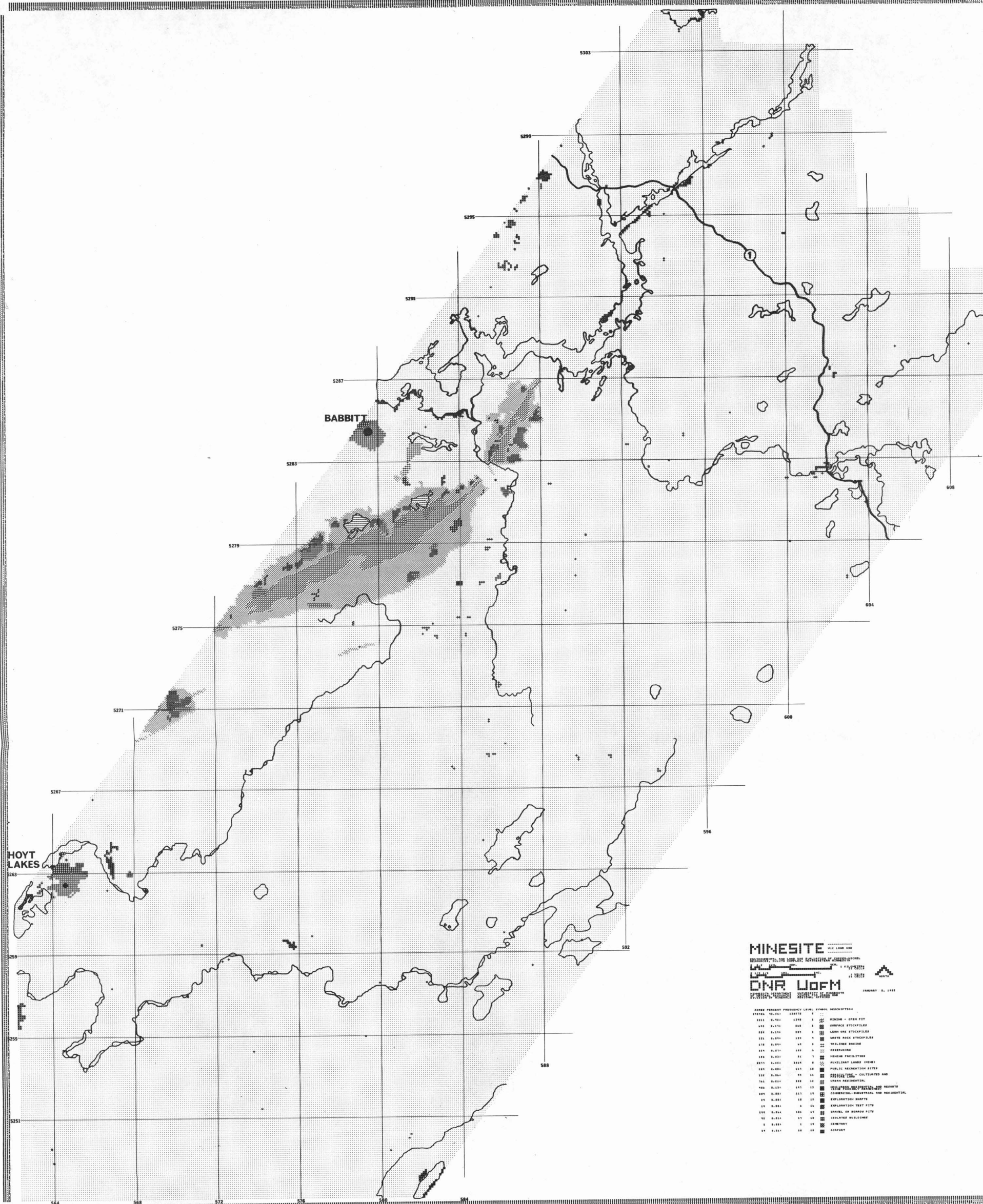
Data Level

19
20

Legend

Cemetary
Airport

*U.S. Forest Service Ownership Maps; Superior National Forest Map. Udata based on 1975 Traffic Map, St. Louis County, Minnesota, MN. DOT, Basic data 1968; 1973 Traffic Map, Lake County, Minnesota, MN. DOT, Basic data 1962.



MINESITE
 REVISION: 10-1-74
 1:50,000
 DNR UOPM
 JANUARY 8, 1975

SYMBOL	PERCENT FREQUENCY	LEVEL	SYMBOL DESCRIPTION
1	100	1	MINING - OPEN PIT
2	100	2	SURFACE STOCKPILE
3	100	3	LEAD AND ZINC STOCKPILE
4	100	4	WHITE ROCK STOCKPILE
5	100	5	TRAILER WAREHOUSE
6	100	6	WATER TOWER
7	100	7	WATER FACILITIES
8	100	8	AUXILIARY LINES (DRAIN)
9	100	9	PUBLIC RECREATION SITE
10	100	10	WATER TOWER
11	100	11	WATER TOWER
12	100	12	WATER TOWER
13	100	13	WATER TOWER
14	100	14	WATER TOWER
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96	100	96	WATER TOWER
97	100	97	WATER TOWER
98	100	98	WATER TOWER
99	100	99	WATER TOWER
100	100	100	WATER TOWER



Shipstead Newton Nolan--
Superior National Forest Areas

(V13)

DATA BIOGRAPHY

SOURCE: Superior National Forest Map (1972)
Shipstead Newton Nolan Act of 1930

INTERPRETATION: MINESITE Staff, DNR

SOURCE DATE: See map dates listed above

DESCRIPTION

The Superior National Forest is administered by the U.S. Forest Service, Dept. of Agriculture as a National Forest. One area within the Superior National Forest is regulated by the Shipstead Newton Nolan Act which imposes water level and shoreline restrictions.

VERIFICATION

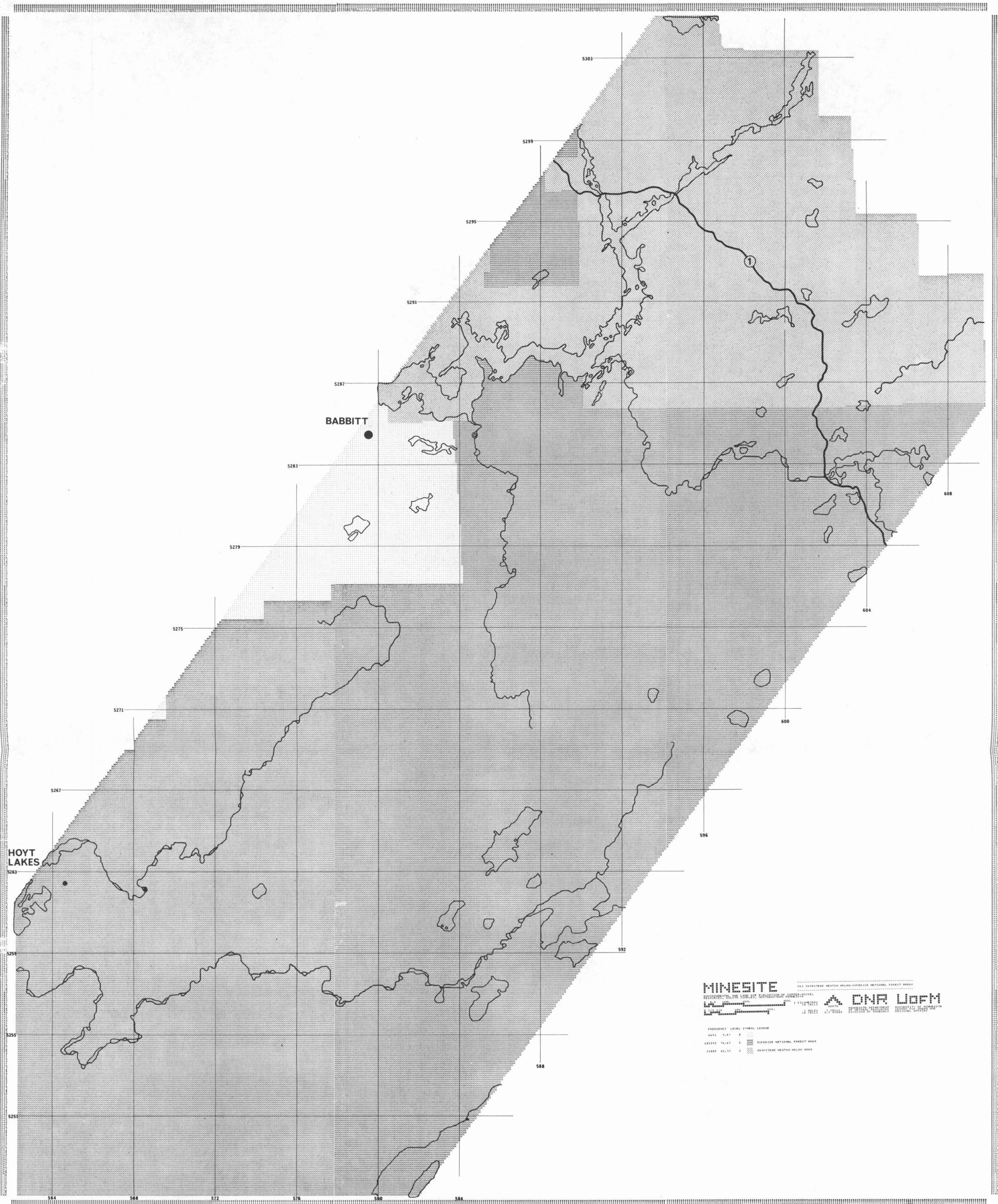
TECHNIQUE: All cells checked

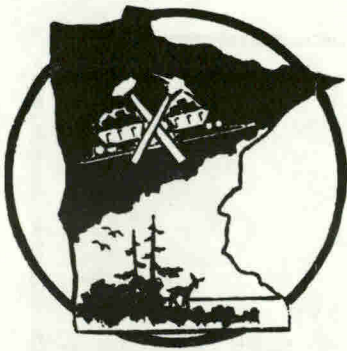
FINAL DATE VERIFIED: September 24, 1976

LEVELS

<u>Data Level</u>	<u>Legend</u>
0	
1	Superior National Forest Area
2	Shipstead Newton Nolan Area*

*Also within the Superior National Forest





Recreational-Historical- Archeological Sites

(V14)

DATA BIOGRAPHY DNR; USFS; Superior Nat'l Forest Maps; Project 80
Natural & Historical Areas of MN (1971); USGS Maps;

SOURCE: "Exploring St. Louis Co. Historical Sites" (1971); MN
Outdoor Recreation Area Inventory, DNR (1976); Background to the
General Plan, Lake Co.; Trygg Map, Sheet 17 (1966).

INTERPRETATION:

MINESITE Staff, DNR

SOURCE DATE: September 1976

DESCRIPTION This inventory includes existing or potential historical sites and cultural land uses that are traditionally associated with recreational-educational activities. The data levels have been mapped as either areas or boundaries. In several cases, such as with the historical site data levels, the location of the sites is approximate, based upon the best available information.

VERIFICATION

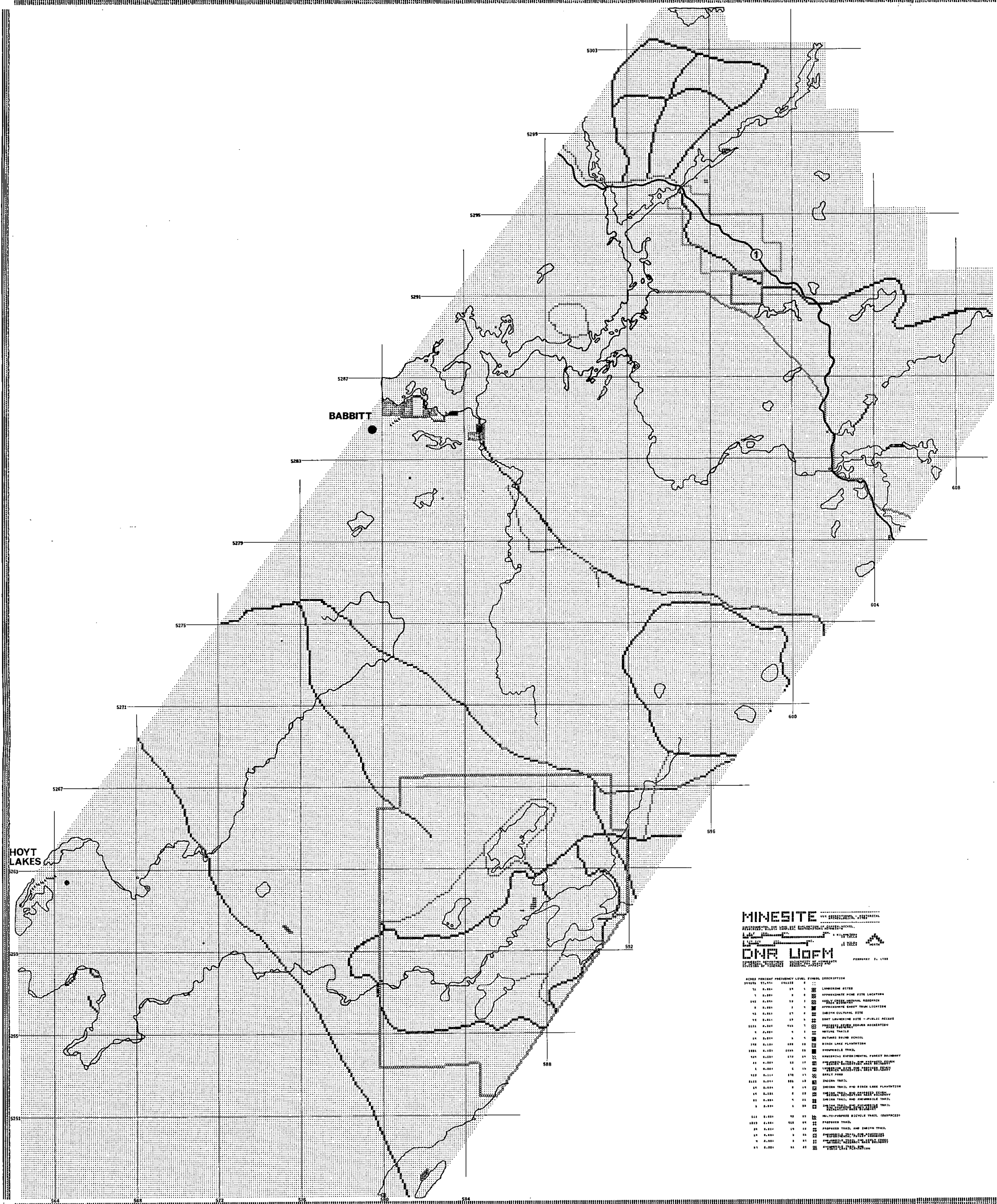
TECHNIQUE: All cells checked

FINAL DATE VERIFIED: July 19, 1979

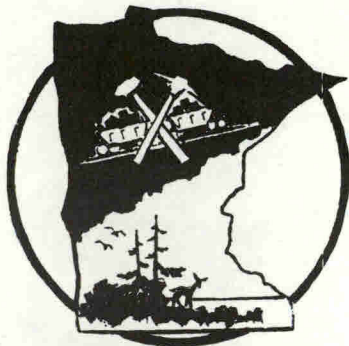
LEVELS

<u>Data Level</u>	<u>Legend</u>
0	
1	Lumbering Site
2	Approximate Mine Site Location
3	Keeley Creek Natural Research Area Boundary
4	Approximate Ghost Town Location
5	Indian Cultural Site
6	Boat Launching Site - Public Access
7	Proposed Seven Beaver Recreation Area Boundary
8	Nature Trails
9	Outward Bound School
10	Birch Lake Plantation

<u>Data Level</u>	<u>Legend</u>
12	Snowmobile Trail
14	Kawishiwi Experimental Forest Boundary
15	Snowmobile Trail and Proposed Seven Beaver Recreation Area Boundary
16	Lumbering Site and Proposed Seven Beaver Recreation Area Boundary
17	Early Road
18	Indian Trail
19	Indian Trail and Birch Lake Plantation
20	Indian Trail and Proposed Seven Beaver Recreation Area Boundary
21	Indian Trail and Snowmobile Trail
22	Indian Trail and Snowmobile Trail and Proposed Seven Beaver Recreation Area Boundary
23	Multi-Purpose Bicycle Trail (surfaced)
24	Proposed Trail
25	Proposed Trail and Indian Trail
26	Snowmobile Trail and Kawishiwi Experimental Forest Boundary
27	Snowmobile Trail and Keeley Creek Natural Research Area Boundary
28	Snowmobile Trail and Birch Lake Plantation



MINESITE			
APPROXIMATE 1:250,000 SCALE MAP OF THE MINESITE AREA			
DNR LIDRM			
FEBRUARY 2, 1988			
ACRES PERCENT FREQUENCY LEVEL SYMBOL DESCRIPTION			
SYMBOL	SYMBOL	SYMBOL	SYMBOL
1	0.001	1	1
2	0.001	2	2
3	0.001	3	3
4	0.001	4	4
5	0.001	5	5
6	0.001	6	6
7	0.001	7	7
8	0.001	8	8
9	0.001	9	9
10	0.001	10	10
11	0.001	11	11
12	0.001	12	12
13	0.001	13	13
14	0.001	14	14
15	0.001	15	15
16	0.001	16	16
17	0.001	17	17
18	0.001	18	18
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25	0.001	25	25
26	0.001	26	26
27	0.001	27	27
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99	0.001	99	99
100	0.001	100	100



Taconite Reserves and Potential Taconite Resources

(V15)

DATA BIOGRAPHY

SOURCE: See Appendix C References

INTERPRETATION: MINESITE Staff, DNR

SOURCE DATE: April 1976

DESCRIPTION

Taconite reserves and potential resources are delineated based on the mining type (Open Pit or Underground), the dip of the mineral layers, the depth of the mineral layers, the thickness of the upper and lower cherty horizons and the southerly extent of the potential mineral layers. Appendix C, Definition of Taconite Reserves and Potential Resources, provides the criteria for this interpretation.

VERIFICATION

TECHNIQUE: All cells checked

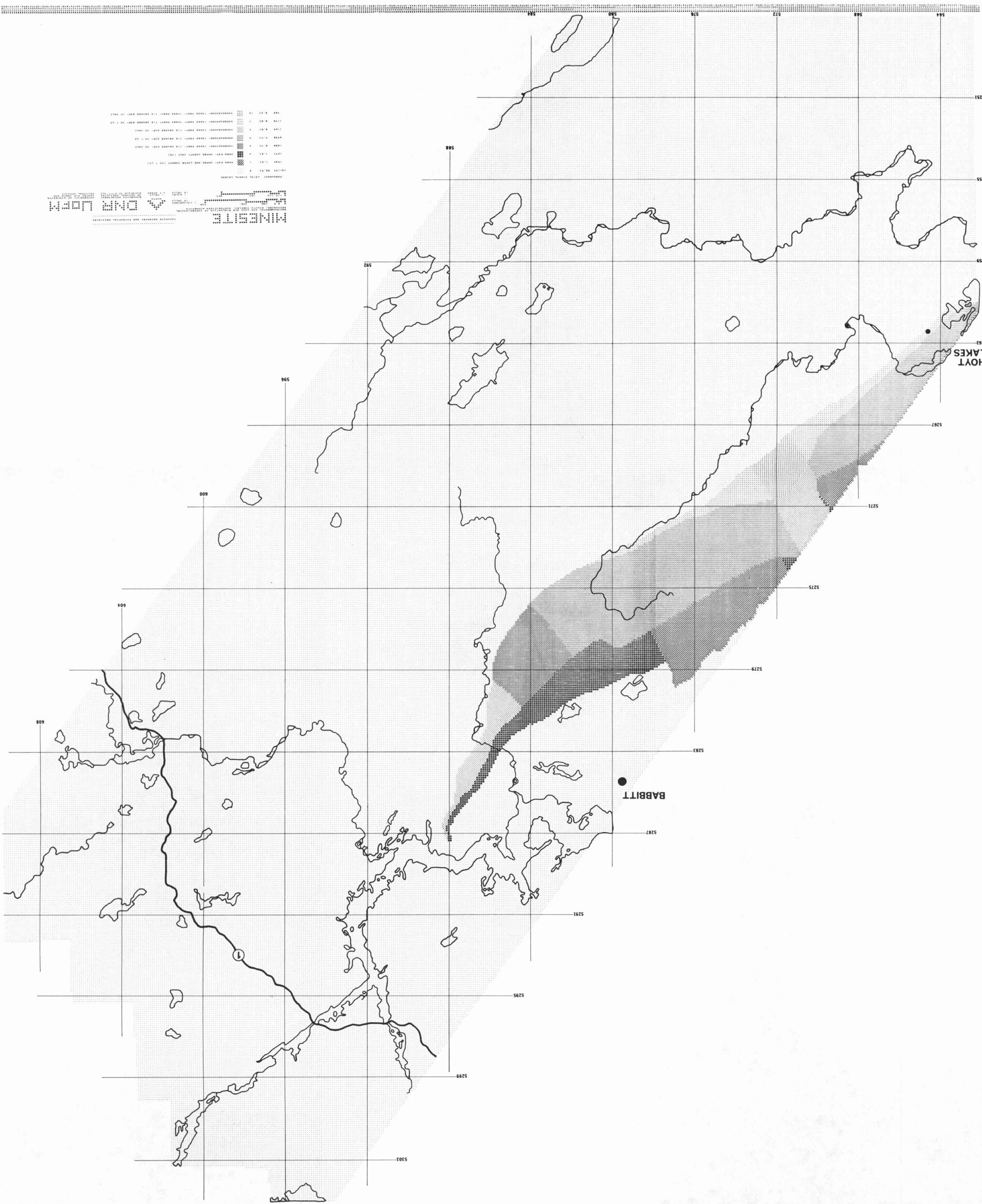
FINAL DATE VERIFIED: August 20, 1976

LEVELS

<u>Data Level</u>	<u>Legend</u>
0	
1	Open Pit - Upper and Lower Cherty (UC & LC)
2	Open Pit - Upper Cherty only (UC)
3	Underground (UG) - $<10^{\circ}$, ≤ 3000 ft. Max. Depth, UC only
4	UG - $<10^{\circ}$, ≤ 3000 ft. Max. Depth, UC & LC
5	UG - $>10^{\circ}$, ≤ 3000 ft. Max. Depth, UC only
6	UG - $>10^{\circ}$, ≤ 3000 ft. Max. Depth, UC & LC
7	UG - $<10^{\circ}$, >3000 ft. but <5000 ft., UC & LC
8	UG - $>10^{\circ}$, >3000 ft. but <5000 ft., UC & LC
9	UG - $<10^{\circ}$, >3000 ft. but <5000 ft., UC only
10	UG - $>10^{\circ}$, >3000 ft. but <5000 ft., UC only

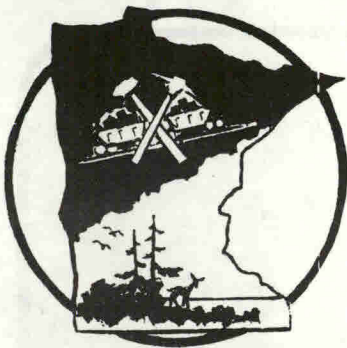
MINESITE
A ONE MILE
SCALE

Legend:
1. 100' X 100' AREA
2. 100' X 100' AREA
3. 100' X 100' AREA
4. 100' X 100' AREA
5. 100' X 100' AREA
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40. 100' X 100' AREA
41. 100' X 100' AREA
42. 100' X 100' AREA
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99. 100' X 100' AREA
100. 100' X 100' AREA



HOYT
LAKES

BABBITT



DATA BIOGRAPHY Superior National Forest, Forest Compartment Records, May, 1977; "Vegetation Mapping, Inventory and
SOURCE: Analysis for MINESITE Project", Remote Sensing Laboratory, College of Forestry, University of Minnesota, February 1975; Wright, H.E., "Vegetation Mapping in the Copper-Nickel Mining Area",
INTERPRETATION: Report to All-University Council
Same as source. on Environmental Quality, Aug. 1973.
V16, V18, V19, and V20 interpreted concurrently.
SOURCE DATE:
See above.

DESCRIPTION Standard methods of aerial photo interpretation and vegetation type classification are used to classify the cover types by predominant species, and are related to a previously developed ecosystem classification. Types delineated are commonly used timber management classes that can be assigned marketing and pricing factors and can be distinguished on black and white infrared aerial photographs (Appendix D - Vegetation Survey).

VERIFICATION

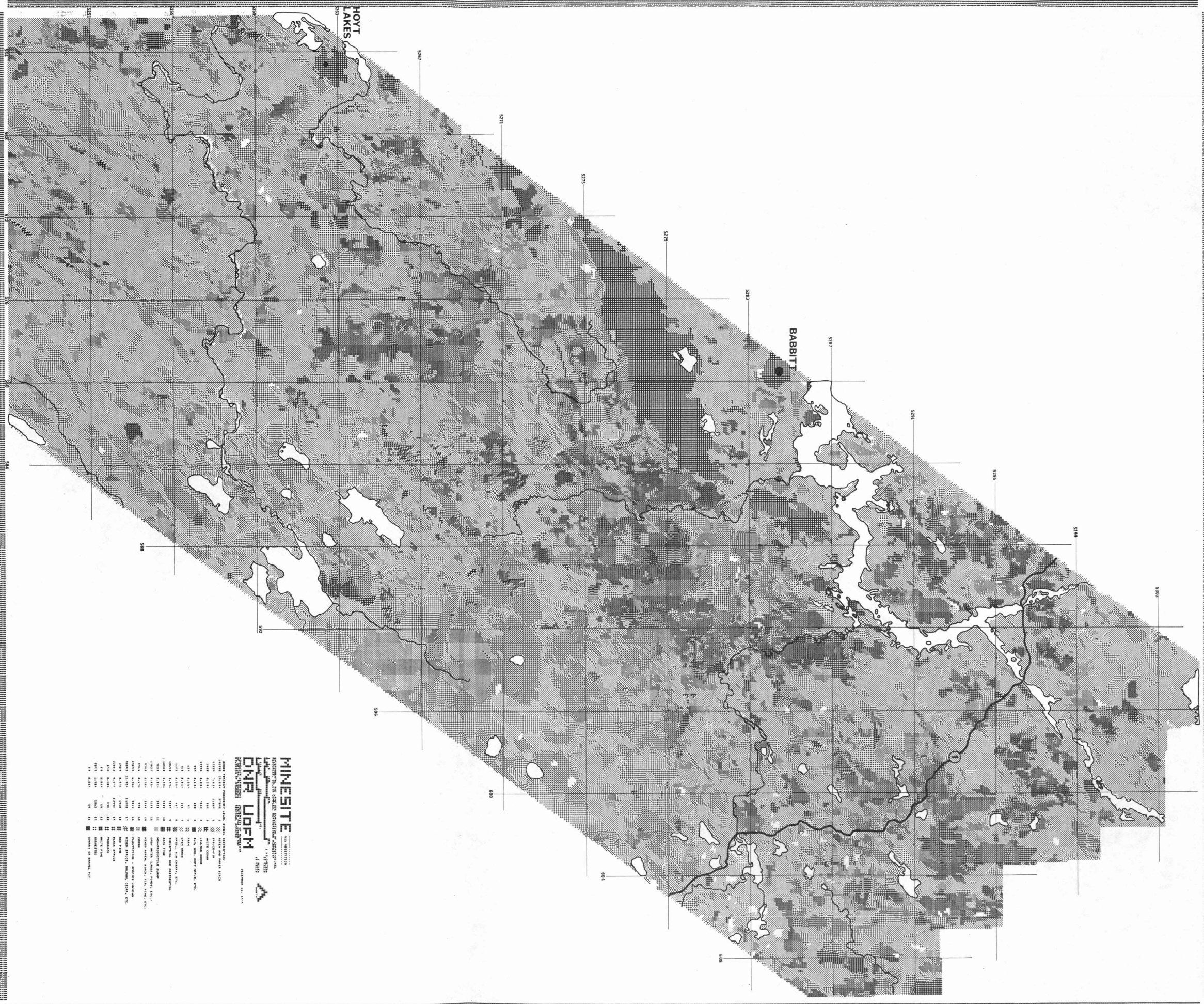
TECHNIQUE: Statistical Check - Appendix I
FINAL DATE VERIFIED: August 25, 1977.

LEVELS

<u>Data Level</u>	<u>Legend</u>
1	Aspen and paper birch
2	Spruce-fir
3	White cedar
4	Lowland shrub
5	Elm, ash, soft maple, etc.
6	Farm
7	Open grass
8	Hazel, pin cherry, etc.
9	Industrial and residential
10	Jack pine
11	Non-productive swamp

Data LevelLegend

12	Open water (lakes, ponds, etc.)
14	Mixed aspen, birch, fir, pine, etc.
15	Marsh
16	Plantations - Species unknown
17	Mixed spruce, balsam, cedar, etc.
18	Red pine
19	Black spruce
20	Tamarack
23	White pine
24	Harvested
26	Quarry or gravel pit



**DATA BIOGRAPHY**

SOURCE: Limnological Research Center, University of Minnesota

INTERPRETATION: Limnological Research Center

SOURCE DATE: July 1975

DESCRIPTION

Using aerial photographs from the period 1934 (or 1937) to 1970, several map units depicting cutting history are detailed. Logging occurring after 1970 is not shown because it is reflected in the forest cover-type inventory (V16) that has been corrected to 1975 by Earth Resource Technology Satellite (ERTS) imagery (Appendix E).

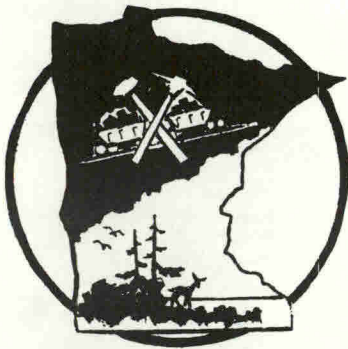
VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: October 27, 1977

LEVELS	<u>Data Level</u>	<u>Legend</u>
	1	1970 +
	2	1962-1970
	3	1949-1961
	4	1937-1948
	5	Cut prior to 1937
	6	Uncut
	7	Fire on 1961 aerial photos
	8	Cultural features
	9	Data not available
	10	Probably cut
	11	Probably uncut
	12	Dunka River Forest Fire - 1976





Crown Density

(V18)

DATA BIOGRAPHY

SOURCE: See references for Appendix D - Vegetation Inventory

INTERPRETATION: Same as source. V16, V18, V19, and V20 interpreted concurrently

SOURCE DATE: February 1975

DESCRIPTION

Vegetation units delineated in V16 are interpreted into density classes as poor, medium, or good. Density classes for poles and saw timber are based upon percentage crown closure; classes for seedlings and saplings are based upon number of trees per acre (Appendix F - Vegetation Size and Density Classes (V18 and V19)).

VERIFICATION

TECHNIQUE: Statistical check - Appendix I

FINAL DATE VERIFIED: September 12, 1976

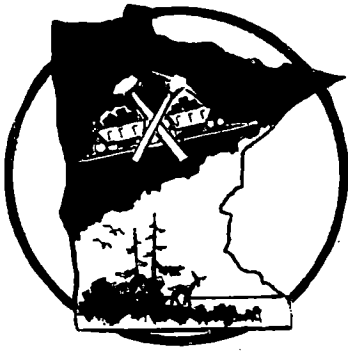
LEVELS

Data Level

Legend

0	Water
2	Low - 10 to 40 percent
3	Medium - 41 to 70 percent
4	High - 71 percent or greater
5	Not applicable - no overstory
6	Plantation



**DATA BIOGRAPHY**

SOURCE: See references for Appendix D - Vegetation Inventory

INTERPRETATION: Same as source. V16, V18, V19 and V20 interpreted concurrently

SOURCE DATE: February 1975

DESCRIPTION

Vegetation units delineated in V16 are interpreted into size classes from seedling size to large sawtimber. Size classes are interpreted using the dbh (diameter at breast height) which is defined as the diameter 4½ feet above ground (Appendix F).

VERIFICATION

TECHNIQUE: Statistical check-Appendix I

FINAL DATE VERIFIED: September 15, 1976

LEVELSData LevelLegend

1	Seedlings - 0 to 1 inch dbh
2	Saplings - 1 to 5 inches dbh
3	Pole Timber - 5 to 9 inches dbh
4	Small Saw Timber - 9 to 15 inches dbh
5	Large Saw Timber - over 15 inches dbh
6	Not applicable - no overstory
7	Plantation



**DATA BIOGRAPHY**

SOURCE: See references for Appendix D - Vegetation Inventory

INTERPRETATION: Same as source. V16, V18, V19 and V20 interpreted concurrently.

SOURCE DATE: February 1975

DESCRIPTION

Vegetation units delineated in V16 are identified by the height of the dominant tree species. Data levels are, for the most part, identified in 20-ft. height class intervals.

VERIFICATION

TECHNIQUE: Statistical check - Appendix I

FINAL DATE VERIFIED: September 15, 1976

LEVELSData LevelLegend

1	0-10 feet
2	11-30 feet
3	31-50 feet
4	51-70 feet
5	71-90 feet
7	Not applicable - no overstory
8	Plantation



**DATA BIOGRAPHY**

Division of Game & Fish, DNR; Dr. David Mech, US Fish & Wildlife Service; Dr. Lynn Rogers, North Central Forest Experiment Station, USFS; Project 80 Natural and Historic Areas of Minnesota (September 1971).

INTERPRETATION:

MINESITE Staff, DNR

SOURCE DATE: September 1976

DESCRIPTION

The inventory consists of identified natural resource sites. As additional surveys are conducted and other natural resource sites are located, map updating will be necessary. Data levels are plotted either as areas or boundaries. Mapped data levels show approximate boundaries based upon the best information available. In some cases, unique wildlife species areas have been expanded when mapped so that specific sites are not readily locatable. The Caribou Release Site should be considered an area potentially suitable for reintroduction of caribou.

VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: November 29, 1977

LEVELSData LevelLegend

0	
1	Area of Mature White Pine
2	Area of Mature Ash Swamp
4	Scenic Timber Area
5	Area of Mature Red Pine
6	Potential Ruffed Grouse Winter Cover Type
7	Wolf Denning Boundary
8	Area of Mature Paper Birch
9	Area of Mature Black Spruce Swamp with rare or large numbers of orchids.
10	Area of Shrub and Marsh cover bordering the Stony River
11	Area of Mature Black Spruce Bog
12	Narrow Alder strips surrounded by Aspen- Birch Uplands

Data LevelLegend

- | | |
|----|--|
| 13 | Area of Grassland dating back to 1920's |
| 14 | Area of rare or large number of orchid plants |
| 16 | Rapids |
| 17 | Caribou Release Site Boundary |
| 18 | High Density Moose Range Boundary |
| 19 | Approximate Eagle Nest Location |
| 20 | Approximate Osprey Nest Location |
| 21 | Pine Marten Distribution Boundary |
| 22 | Area of Wild Rice |
| 23 | Deer Yarding Area |
| 24 | Deer Habitat Improvement Project |
| 25 | Deer Exclosure since 1948 - Known Location |
| 26 | Deer Exclosure since 1948 - Approximate Location |
| 28 | Waterfowl Lake |
| 29 | High Density Moose Range Boundary and Approximate Osprey Nest Location |
| 30 | High Density Moose Range Boundary and Wolf Denning Boundary |
| 31 | High Density Moose Range Boundary and Narrow Alder strips surrounded by Aspen-Birch Uplands |
| 32 | Wolf Denning Boundary and Pine Marten Distribution Boundary |
| 33 | Pine Marten Distribution Boundary and area of Shrub and Marsh cover bordering the Stony River |
| 34 | Rapids and area of Shrub and Marsh cover bordering the Stony River |
| 35 | Waterfowl Lake and area of Wild Rice |
| 36 | Deer Yarding Area and Wolf Denning Boundary and Pine Marten Distribution Boundary |
| 37 | Caribou Release Site Boundary and Approximate Eagle Nest Location |
| 38 | Caribou Release Site Boundary and Pine Marten Distribution Boundary |
| 39 | Caribou Release Site Boundary and Scenic Timber Area |
| 40 | Caribou Release Site Boundary and Wolf Denning Boundary |
| 41 | Scenic Timber Area and Pine Marten Distribution Boundary |
| 42 | High Density Moose Range Boundary and Pine Marten Distribution Boundary |
| 43 | Caribou Release Site Boundary and Wolf Denning Boundary and Pine Marten Distribution Boundary |
| 44 | Caribou Release Site Boundary and Deer Yarding Area |
| 46 | Beaver Pond Location |
| 47 | Wolf Denning Boundary and Approximate Osprey Nest Location |
| 48 | Approximate Osprey Nest Location and Pine Marten Distribution Boundary |
| 49 | Wolf Denning Boundary and Pine Marten Distribution Boundary and Approximate Osprey Nest Location |
| 50 | Narrow Alder Strips Surrounded by Aspen-Birch Uplands, and Beaver Pond Location |
| 51 | Wolf Denning Boundary and Beaver Pond Location |

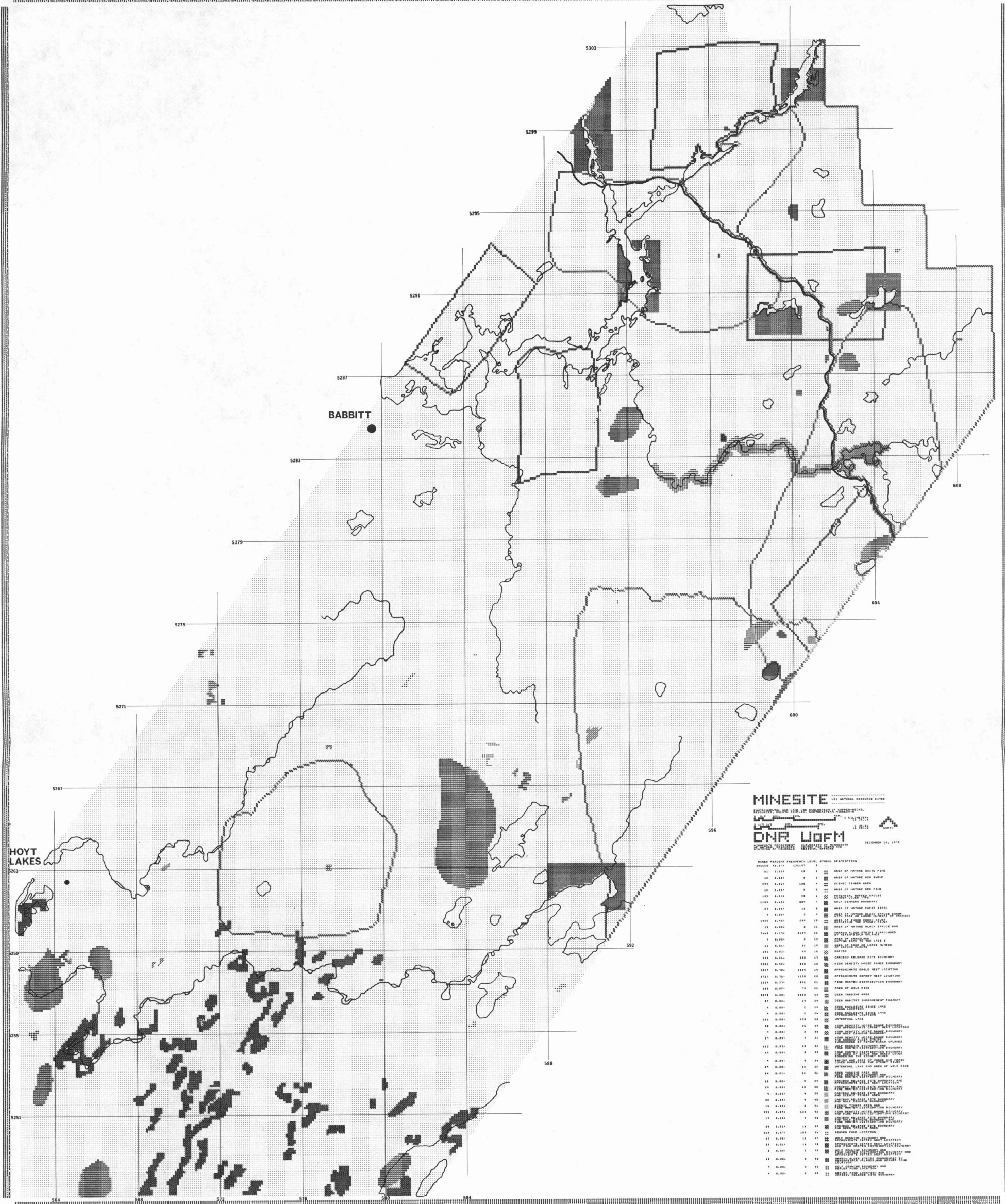
Natural Resource Sites (V21), continued

Data Level

52

Legend

Beaver Pond Location and Caribou Release
Site Boundary



MINESITE
DEPARTMENT OF THE INTERIOR, BUREAU OF LAND MANAGEMENT
1:50,000
1982
DNR UOFM
DECEMBER 11, 1978

SYMBOL	PERCENT	DESCRIPTION
1	1	AREA OF MOUNTAIN WHITE PINE
2	2	AREA OF MOUNTAIN RED JUMP
3	3	SCENIC TIMBER AREA
4	4	AREA OF MOUNTAIN RED PINE
5	5	AREA OF MOUNTAIN RED PINE
6	6	AREA OF MOUNTAIN RED PINE
7	7	AREA OF MOUNTAIN RED PINE
8	8	AREA OF MOUNTAIN RED PINE
9	9	AREA OF MOUNTAIN RED PINE
10	10	AREA OF MOUNTAIN RED PINE
11	11	AREA OF MOUNTAIN RED PINE
12	12	AREA OF MOUNTAIN RED PINE
13	13	AREA OF MOUNTAIN RED PINE
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97	97	AREA OF MOUNTAIN RED PINE
98	98	AREA OF MOUNTAIN RED PINE
99	99	AREA OF MOUNTAIN RED PINE
100	100	AREA OF MOUNTAIN RED PINE



Lake and Stream Surveys
(Fish Habitat)

(V22)

DATA BIOGRAPHY

SOURCE: Lake and Stream Surveys, Division of Fisheries, DNR

INTERPRETATION: Division of Fish and Wildlife, DNR

SOURCE DATE: September 1977

DESCRIPTION

Streams and lakes are classified based upon a combination ecological/management classification prepared by the DNR. The lake classification denotes the basic lake type, which is described in terms of the natural and characteristic fish populations best adapted to the physical, chemical, and biological characteristics of the lake. The stream classification system used has not been officially adopted by the DNR, but is representative of the system expected to be adopted (Appendix G - Lake and Stream Surveys).

VERIFICATION

TECHNIQUE: All cells checked

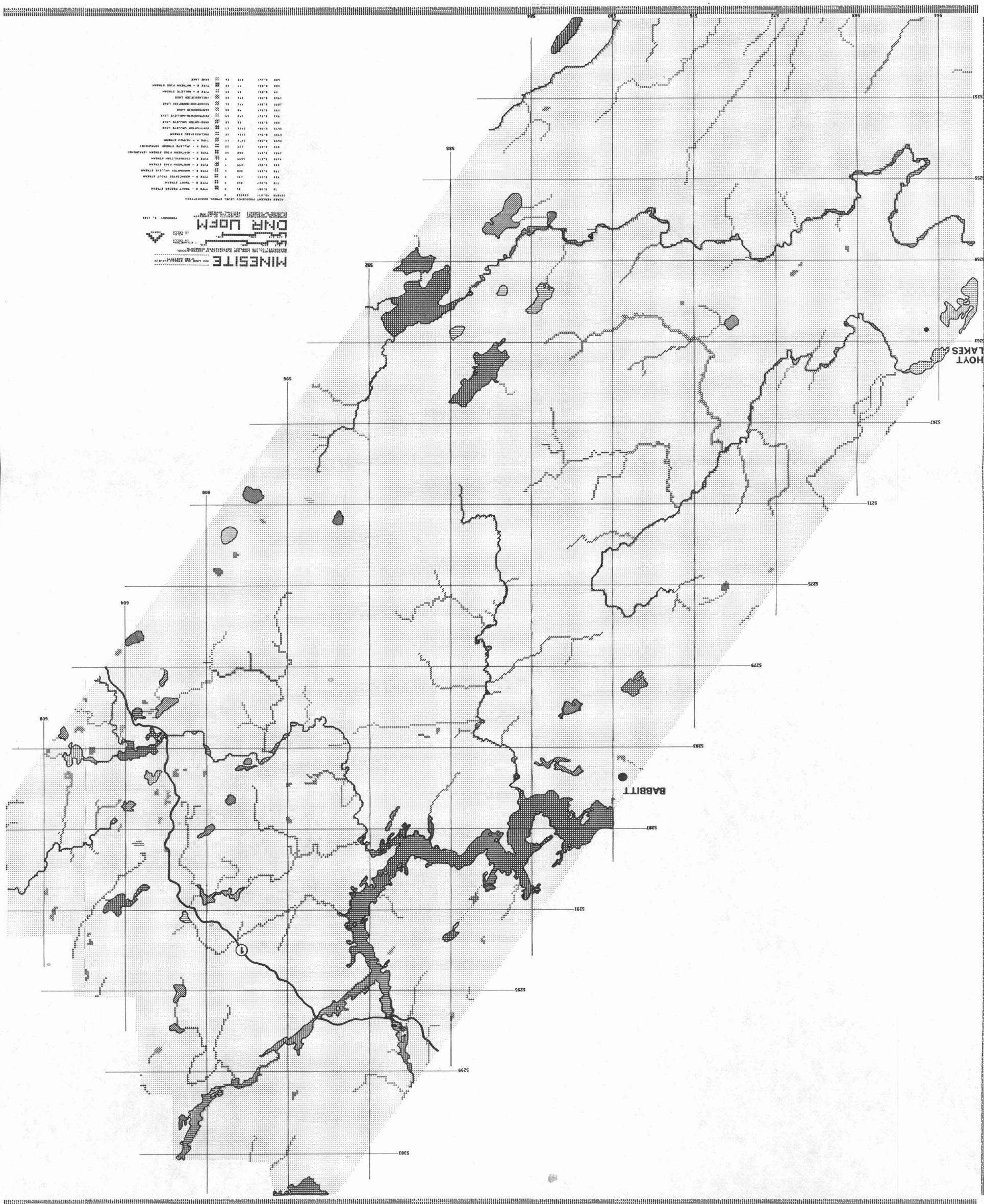
FINAL DATE VERIFIED: January 14, 1978

LEVELS	<u>Data Level</u>	<u>Legend</u>
	2	Type A - Feeder Trout Stream
	3	Type B - Trout Stream
	5	Type D - Associated Trout Stream
	6	Type E - Warmwater Walleye Stream
	7	Type E - Northern Pike Stream
	9	Type E - Cosmopolitan Stream
	12	Type H - Northern Pike Stream (Spawning)
	13	Type H - Walleye Stream (Spawning)
	14	Type H - Minnow Stream
	15	Unclassified Stream
	17	Soft-Water Walleye Lake
	18	Hard-Water Walleye Lake
	19	Centrarchid-Walleye Lake
	20	Centrarchid Lake
	21	Roughfish-Gamefish Lake

Data level

Legend

23	Unclassified Lake
24	Type G - Walleye Stream
25	Type G - Northern Pike Stream
26	Game Lake



**DATA BIOGRAPHY**

SOURCE: Division of Minerals, DNR; and Bureau of Land Management, U.S. Dept. of the Interior.

INTERPRETATION: Division of Minerals, DNR

SOURCE DATE: January 1976

DESCRIPTION

Active State mineral leases are shown for both iron ore and copper-nickel. Cu-Ni leases active for greater than five years are listed separately because they reflect longer-term company interest, probably because of mineral discovery. Federal prospecting permit applications, prospecting permits, preferential rights, mineral leases, and private iron ore and Cu-Ni leases are also represented.

VERIFICATION

TECHNIQUE: All cells checked

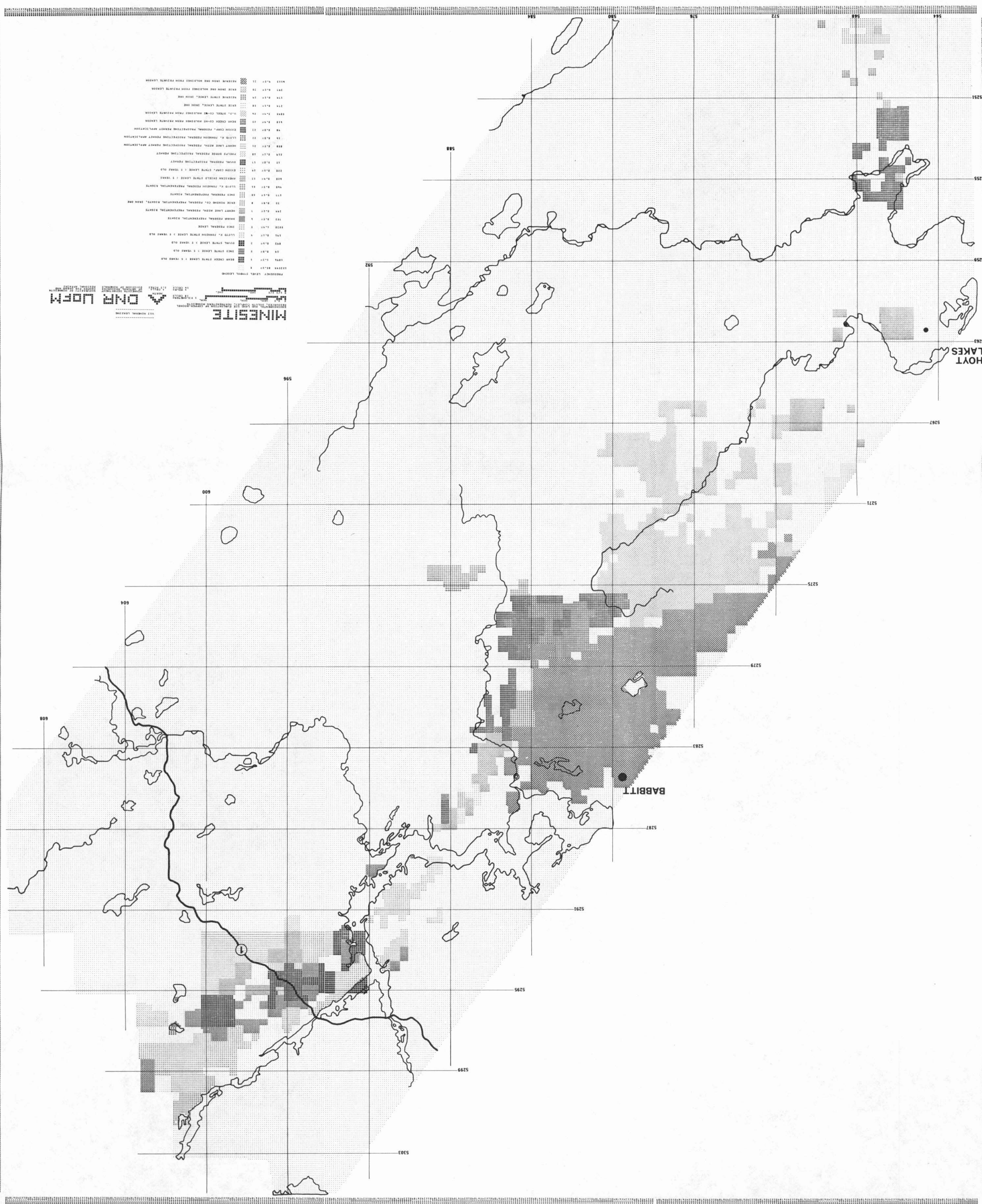
FINAL DATE VERIFIED: September 27, 1976

LEVELS

<u>Data Level</u>	<u>Legend</u>
0	
1	Bear Creek State Lease, >5 years old
2	Inco State Lease, >5 years old
3	Duval State Lease, >5 years old
4	Lloyd K. Johnson State Lease, >5 years old
5	Inco Federal Lease
6	Hanna Federal Preferential Rights
7	Heart Lake Association Federal Preferential Rights
8	Erie Mining Co. Federal Preferential Rights, Iron Ore
10	Inco Federal Preferential Rights

Data LevelLegend

11	Lloyd K. Johnson Federal Preferential Rights
13	American Shield State Lease, <5 years old
14	Exxon Corp. State Lease, <5 years old
17	Duval Federal Prospecting Permit
20	Phelps Dodge Federal Prospecting Permit
21	Heart Lake Association Federal Prospecting Permit Application
22	Lloyd K. Johnson Federal Prospecting Permit Application
23	Exxon Corp. Federal Prospecting Permit Application
25	Bear Creek Cu-Ni Holdings from Private Leasor
26	United States Steel Cu-Ni Holdings from Private Leasor
28	Erie State Lease, Iron Ore
29	Reserve State Lease, Iron Ore
30	Erie Iron Ore Holdings from Private Leasor
31	Reserve Iron Ore Holdings from Private Leasor



**DATA BIOGRAPHY**

SOURCE: U.S. Soil Conservation Service, General Soil Map of the Arrowhead Region.

INTERPRETATION: U.S. Soil Conservation Service

SOURCE DATE: General Soil Map of St. Louis County, parts 4 & 6 - April '74; General Soil Map of Lake County, parts 3 & 2 - March '74.

DESCRIPTION

Soil Associations are grouped and defined according to characteristic geographic patterns shown on aerial photographs. These associations are further defined through some field investigation and compilations from available detailed soils maps. Factors considered in defining soil series and associations are profile, color, structure, consistency, sequence of horizons, conditions of relief and drainage, and origin and mode of formation. The smallest mapping unit shown on the soil map is about 40 acres. See Appendix H

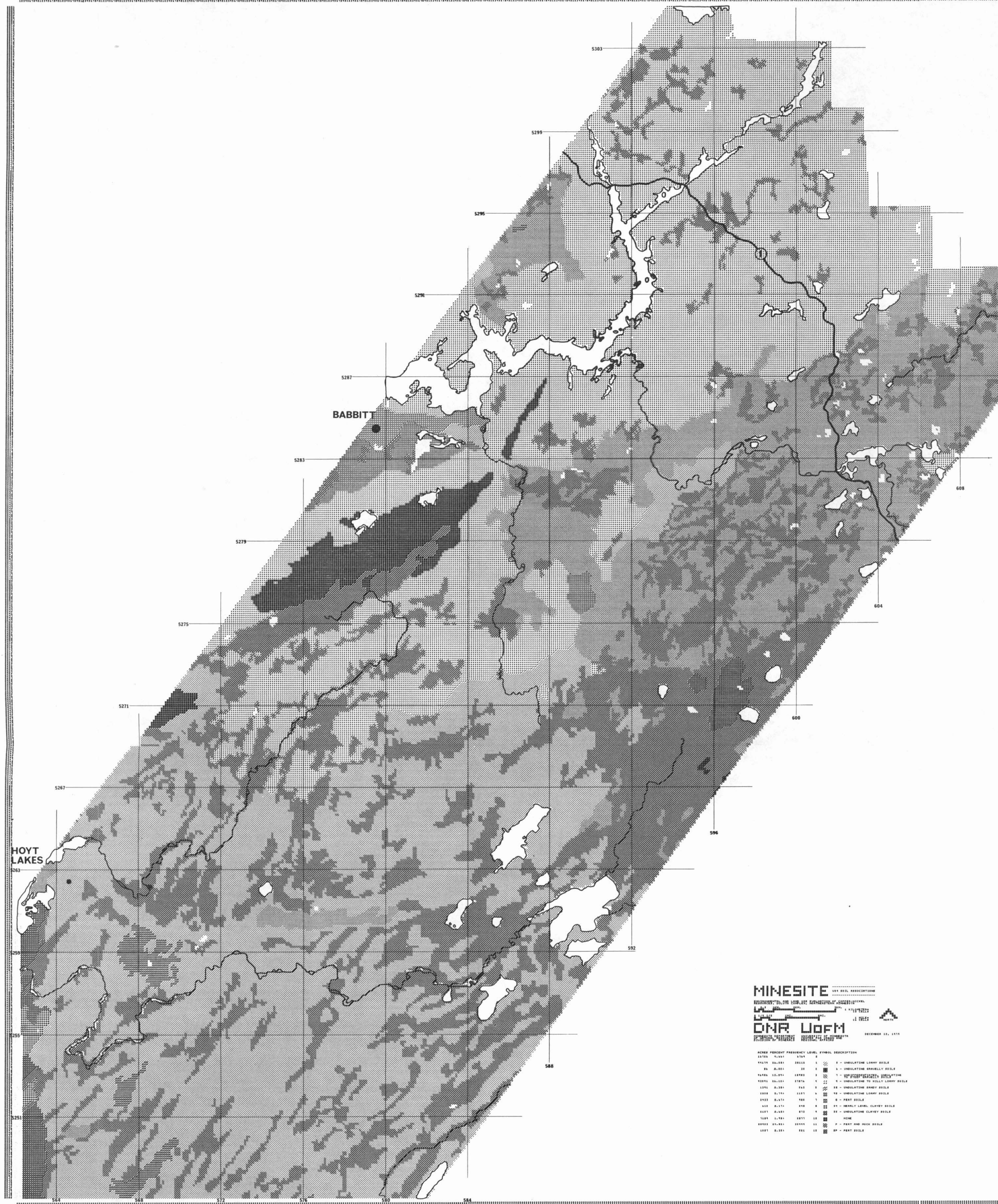
VERIFICATION for detailed information on soils series present in MINESITE area.

TECHNIQUE: Statistical Check - Appendix I

FINAL DATE VERIFIED: October 6, 1976

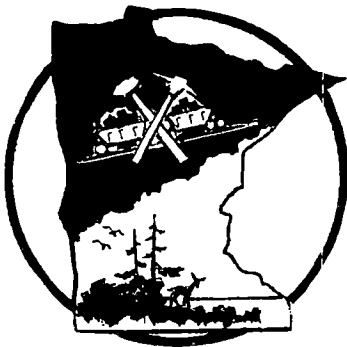
LEVELSData LevelLegend

1	5 - Undulating loamy soils
2	6 - Undulating gravelly soils
3	7 - Undifferentiated, undulating to steep gravelly soils
4	9 - Undulating to hilly loamy soils
5	28 - Undulating sandy soils
6	40 - Undulating loamy soils
7	G - Peat soils
8	54 - Nearly level clayey soils
9	55 - Undulating clayey soils
10	Mine
11	P - Peat and muck soils
12	SP - Peat soils



MINESITE USE SOIL ASSOCIATION
REPRESENTATION OF SOILS AND SUBSTRATA ASSOCIATIONS
 1:10,000
DNR UofM 1:10,000
DECEMBER 12, 1971

SOILS PRESENT	FREQUENCY	LEVEL	SUBSTRATA	SYMBOL	DESCRIPTION
1511	10.0%	1511	1	1	1 - UNULATING LOAMY SOIL
1512	10.0%	1512	2	2	2 - UNULATING SANDY SOIL
1513	10.0%	1513	3	3	3 - UNULATING SANDY SOIL
1514	10.0%	1514	4	4	4 - UNULATING SANDY SOIL
1515	10.0%	1515	5	5	5 - UNULATING SANDY SOIL
1516	10.0%	1516	6	6	6 - UNULATING SANDY SOIL
1517	10.0%	1517	7	7	7 - UNULATING SANDY SOIL
1518	10.0%	1518	8	8	8 - UNULATING SANDY SOIL
1519	10.0%	1519	9	9	9 - UNULATING SANDY SOIL
1520	10.0%	1520	10	10	10 - UNULATING SANDY SOIL
1521	10.0%	1521	11	11	11 - UNULATING SANDY SOIL
1522	10.0%	1522	12	12	12 - UNULATING SANDY SOIL
1523	10.0%	1523	13	13	13 - UNULATING SANDY SOIL
1524	10.0%	1524	14	14	14 - UNULATING SANDY SOIL
1525	10.0%	1525	15	15	15 - UNULATING SANDY SOIL
1526	10.0%	1526	16	16	16 - UNULATING SANDY SOIL
1527	10.0%	1527	17	17	17 - UNULATING SANDY SOIL
1528	10.0%	1528	18	18	18 - UNULATING SANDY SOIL
1529	10.0%	1529	19	19	19 - UNULATING SANDY SOIL
1530	10.0%	1530	20	20	20 - UNULATING SANDY SOIL
1531	10.0%	1531	21	21	21 - UNULATING SANDY SOIL
1532	10.0%	1532	22	22	22 - UNULATING SANDY SOIL
1533	10.0%	1533	23	23	23 - UNULATING SANDY SOIL
1534	10.0%	1534	24	24	24 - UNULATING SANDY SOIL
1535	10.0%	1535	25	25	25 - UNULATING SANDY SOIL
1536	10.0%	1536	26	26	26 - UNULATING SANDY SOIL
1537	10.0%	1537	27	27	27 - UNULATING SANDY SOIL
1538	10.0%	1538	28	28	28 - UNULATING SANDY SOIL
1539	10.0%	1539	29	29	29 - UNULATING SANDY SOIL
1540	10.0%	1540	30	30	30 - UNULATING SANDY SOIL
1541	10.0%	1541	31	31	31 - UNULATING SANDY SOIL
1542	10.0%	1542	32	32	32 - UNULATING SANDY SOIL
1543	10.0%	1543	33	33	33 - UNULATING SANDY SOIL
1544	10.0%	1544	34	34	34 - UNULATING SANDY SOIL
1545	10.0%	1545	35	35	35 - UNULATING SANDY SOIL
1546	10.0%	1546	36	36	36 - UNULATING SANDY SOIL
1547	10.0%	1547	37	37	37 - UNULATING SANDY SOIL
1548	10.0%	1548	38	38	38 - UNULATING SANDY SOIL
1549	10.0%	1549	39	39	39 - UNULATING SANDY SOIL
1550	10.0%	1550	40	40	40 - UNULATING SANDY SOIL
1551	10.0%	1551	41	41	41 - UNULATING SANDY SOIL
1552	10.0%	1552	42	42	42 - UNULATING SANDY SOIL
1553	10.0%	1553	43	43	43 - UNULATING SANDY SOIL
1554	10.0%	1554	44	44	44 - UNULATING SANDY SOIL
1555	10.0%	1555	45	45	45 - UNULATING SANDY SOIL
1556	10.0%	1556	46	46	46 - UNULATING SANDY SOIL
1557	10.0%	1557	47	47	47 - UNULATING SANDY SOIL
1558	10.0%	1558	48	48	48 - UNULATING SANDY SOIL
1559	10.0%	1559	49	49	49 - UNULATING SANDY SOIL
1560	10.0%	1560	50	50	50 - UNULATING SANDY SOIL
1561	10.0%	1561	51	51	51 - UNULATING SANDY SOIL
1562	10.0%	1562	52	52	52 - UNULATING SANDY SOIL
1563	10.0%	1563	53	53	53 - UNULATING SANDY SOIL
1564	10.0%	1564	54	54	54 - UNULATING SANDY SOIL
1565	10.0%	1565	55	55	55 - UNULATING SANDY SOIL
1566	10.0%	1566	56	56	56 - UNULATING SANDY SOIL
1567	10.0%	1567	57	57	57 - UNULATING SANDY SOIL
1568	10.0%	1568	58	58	58 - UNULATING SANDY SOIL
1569	10.0%	1569	59	59	59 - UNULATING SANDY SOIL
1570	10.0%	1570	60	60	60 - UNULATING SANDY SOIL
1571	10.0%	1571	61	61	61 - UNULATING SANDY SOIL
1572	10.0%	1572	62	62	62 - UNULATING SANDY SOIL
1573	10.0%	1573	63	63	63 - UNULATING SANDY SOIL
1574	10.0%	1574	64	64	64 - UNULATING SANDY SOIL
1575	10.0%	1575	65	65	65 - UNULATING SANDY SOIL
1576	10.0%	1576	66	66	66 - UNULATING SANDY SOIL
1577	10.0%	1577	67	67	67 - UNULATING SANDY SOIL
1578	10.0%	1578	68	68	68 - UNULATING SANDY SOIL
1579	10.0%	1579	69	69	69 - UNULATING SANDY SOIL
1580	10.0%	1580	70	70	70 - UNULATING SANDY SOIL
1581	10.0%	1581	71	71	71 - UNULATING SANDY SOIL
1582	10.0%	1582	72	72	72 - UNULATING SANDY SOIL
1583	10.0%	1583	73	73	73 - UNULATING SANDY SOIL
1584	10.0%	1584	74	74	74 - UNULATING SANDY SOIL
1585	10.0%	1585	75	75	75 - UNULATING SANDY SOIL
1586	10.0%	1586	76	76	76 - UNULATING SANDY SOIL
1587	10.0%	1587	77	77	77 - UNULATING SANDY SOIL
1588	10.0%	1588	78	78	78 - UNULATING SANDY SOIL
1589	10.0%	1589	79	79	79 - UNULATING SANDY SOIL
1590	10.0%	1590	80	80	80 - UNULATING SANDY SOIL
1591	10.0%	1591	81	81	81 - UNULATING SANDY SOIL
1592	10.0%	1592	82	82	82 - UNULATING SANDY SOIL
1593	10.0%	1593	83	83	83 - UNULATING SANDY SOIL
1594	10.0%	1594	84	84	84 - UNULATING SANDY SOIL
1595	10.0%	1595	85	85	85 - UNULATING SANDY SOIL
1596	10.0%	1596	86	86	86 - UNULATING SANDY SOIL
1597	10.0%	1597	87	87	87 - UNULATING SANDY SOIL
1598	10.0%	1598	88	88	88 - UNULATING SANDY SOIL
1599	10.0%	1599	89	89	89 - UNULATING SANDY SOIL
1600	10.0%	1600	90	90	90 - UNULATING SANDY SOIL
1601	10.0%	1601	91	91	91 - UNULATING SANDY SOIL
1602	10.0%	1602	92	92	92 - UNULATING SANDY SOIL
1603	10.0%	1603	93	93	93 - UNULATING SANDY SOIL
1604	10.0%	1604	94	94	94 - UNULATING SANDY SOIL
1605	10.0%	1605	95	95	95 - UNULATING SANDY SOIL
1606	10.0%	1606	96	96	96 - UNULATING SANDY SOIL
1607	10.0%	1607	97	97	97 - UNULATING SANDY SOIL
1608	10.0%	1608	98	98	98 - UNULATING SANDY SOIL
1609	10.0%	1609	99	99	99 - UNULATING SANDY SOIL
1610	10.0%	1610	100	100	100 - UNULATING SANDY SOIL



DATA BIOGRAPHY

SOURCE: Same as maps listed for V02, and Superior National Forest Map (1972).

INTERPRETATION: MINESITE Staff, DNR

SOURCE DATE: See map dates listed for V02

DESCRIPTION

Individual cells containing a transportation data level were coded according to the classification system used on USGS Quadrangle Maps.

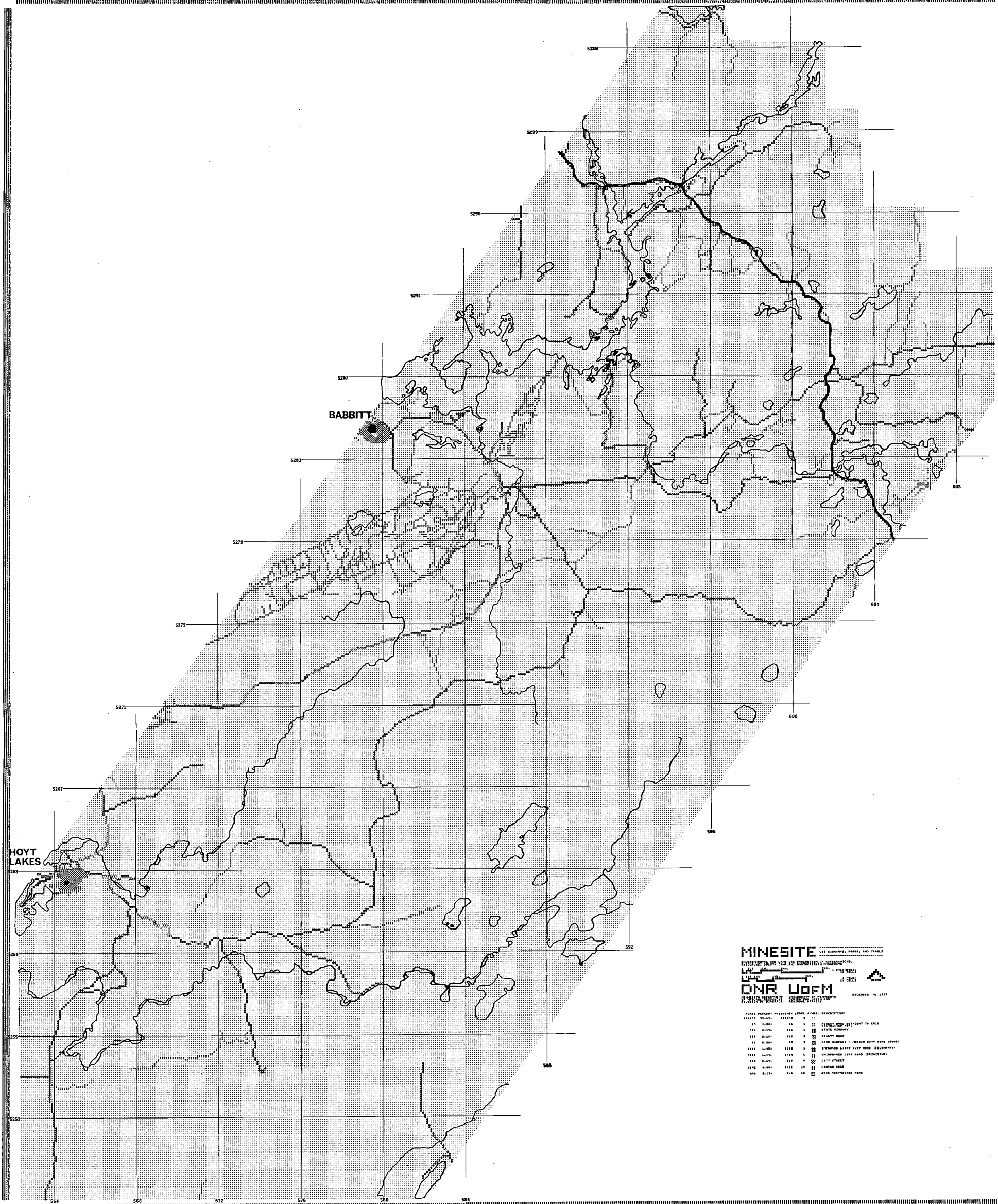
VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: September 27, 1976

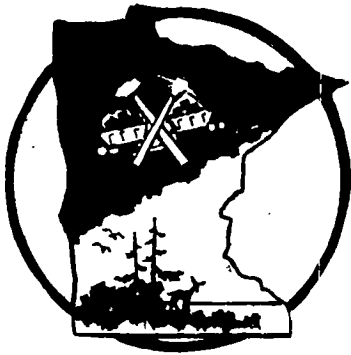
LEVELS

<u>Data Level</u>	<u>Legend</u>
1	Forest Road Adjacent to Erie Restricted Road
2	State Highway
3	County Road
4	Hard Surface - Medium Duty Road (Good)
5	Improved Light Duty Road (Secondary)
6	Unimproved Dirt Road (Primitive)
9	City Street
14	Mining Road
15	Erie Restricted Road



MINESITE
 MINNESOTA DEPARTMENT OF MINES AND GEOLOGY
 DIVISION OF MINES
CONR UOQM
 MINNESOTA DEPARTMENT OF MINES AND GEOLOGY
 DECEMBER 14, 1974

ACRES	PERCENT	PERMANENCY	LEVEL	SYMBOL	DESCRIPTION
101	0.184	100	1	1	CONR UOQM
101	0.184	100	1	1	STATE HIGHWAY
101	0.184	100	1	1	COUNTY ROAD
101	0.184	100	1	1	ROAD JUMP - HATCH DUTY ROAD (1000)
101	0.184	100	1	1	IMPAVED LIGHT DUTY ROAD (DECEMBER)
101	0.184	100	1	1	UNIMPAVED LIGHT DUTY ROAD (DECEMBER)
101	0.184	100	1	1	CITY STREET
101	0.184	100	1	1	PIPING ROAD
101	0.184	100	1	1	ROAD RESTRICTED ROAD

**DATA BIOGRAPHY**

USGS Topo Maps: Greenwood L. (1954); Gabbro L., Markham, SOURCE: Brimson (1957); Bear Island, Kangas Bay (1965); Babbitt (NW,NE,SW,SE), Allen, Isaac L., Aurora (1969PR*); Superior National Forest Map (1972).

INTERPRETATION:

MINESITE Staff, DNR

SOURCE DATE:

See map dates listed above

DESCRIPTION

Individual cells containing a railroad or utility are coded according to the classification system used on the USGS Quadrangle Maps. In cases where two data levels occur within a cell, a common level is assigned to that cell.

VERIFICATION

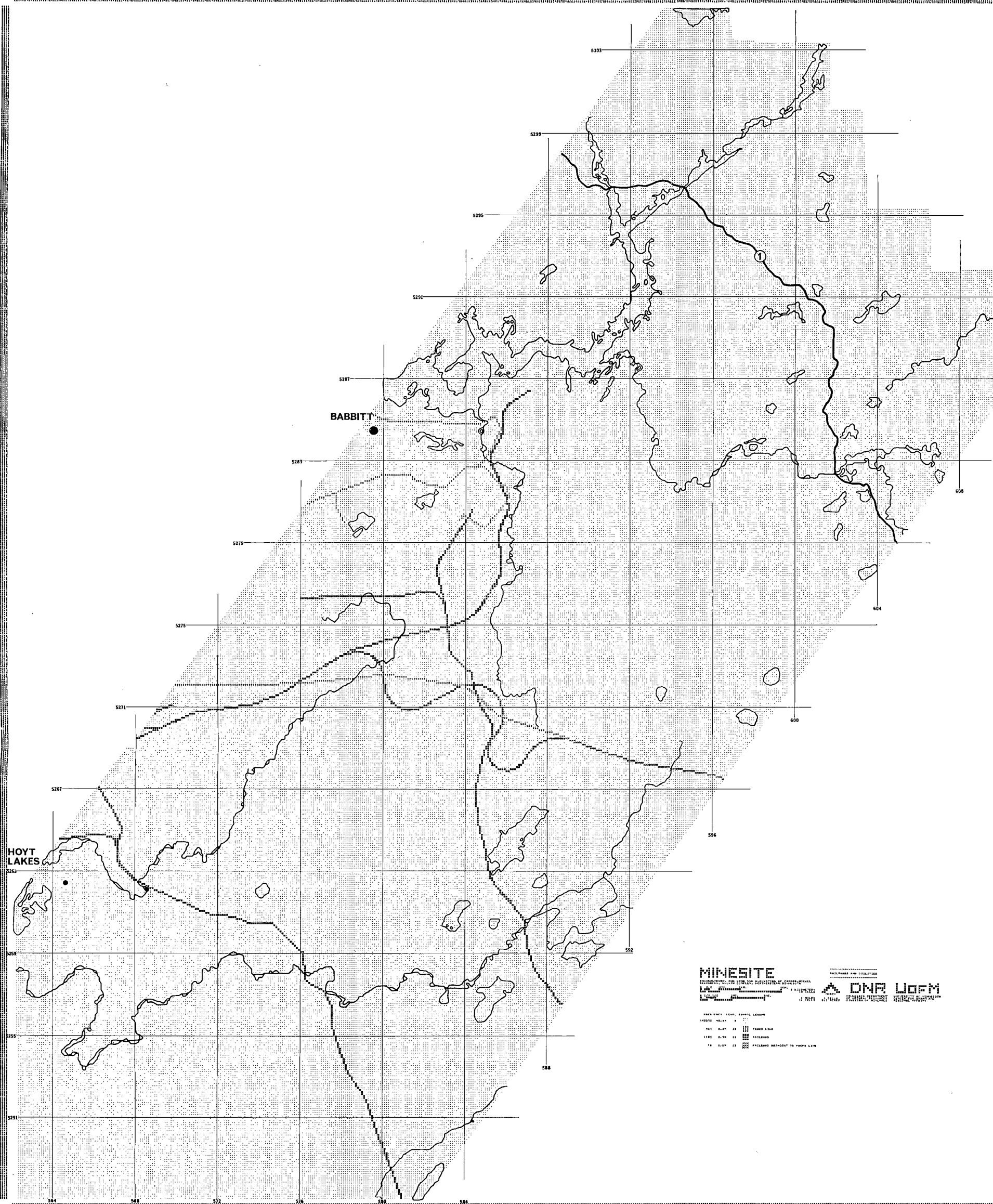
TECHNIQUE: All cells checked

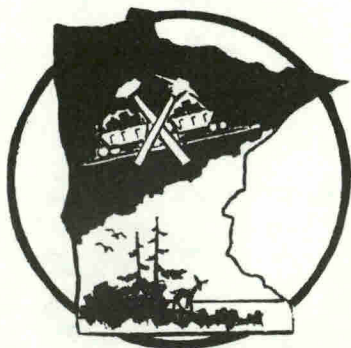
FINAL DATE VERIFIED: August 24, 1976

*photo revised

LEVELS

<u>Data Level</u>	<u>Legend</u>
0	
10	Power line
11	Railroad
13	Railroad adjacent to power line





DATA BIOGRAPHY

"Mineral Resources of a Portion of the Duluth Complex and Adjacent Rocks in St. Louis and Lake Counties, Northeastern Minnesota," Report 93, Division of Minerals, DNR, W.H. Listerud and D.G. Meineke, 1977.

INTERPRETATION: MINESITE Staff, DNR

SOURCE DATE: Listerud and Meineke 1977.

DESCRIPTION

The Mineral Resource Polygon Map shows the area of influence assigned to each of 324 drill holes used in the study "Mineral Resources of a Portion of the Duluth Complex and Adjacent Rocks in St. Louis and Lake Counties, Northeastern Minnesota," by W.H. Listerud and D.G. Meineke. For a description of how this information was incorporated for the MINESITE study, see Appendix I.

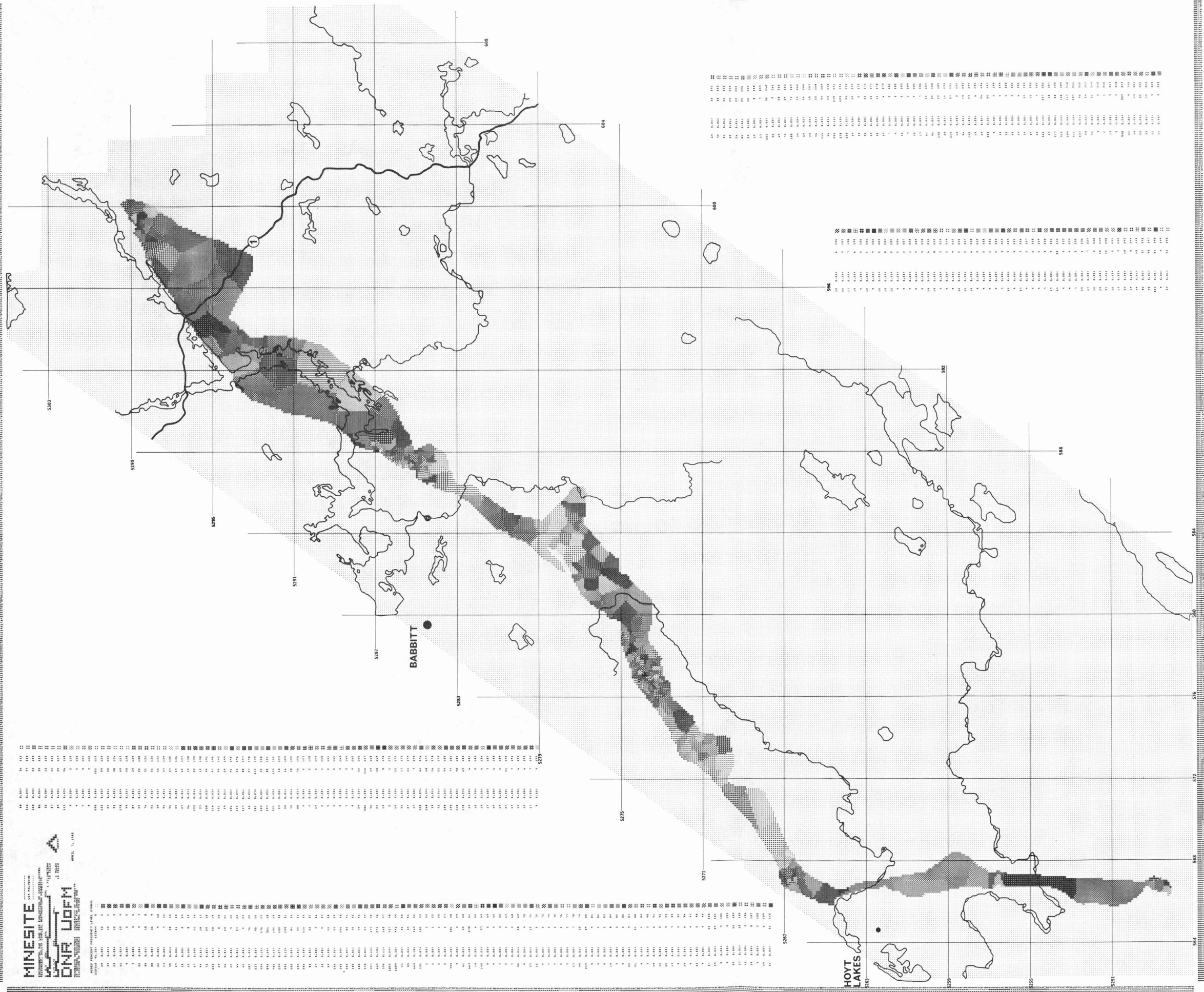
VERIFICATION

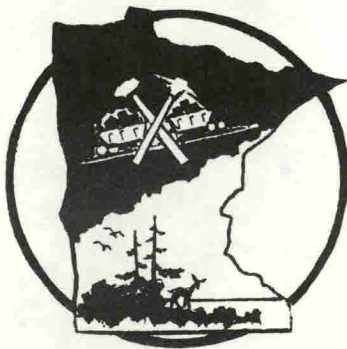
TECHNIQUE: All cells checked

FINAL DATE VERIFIED: September 2, 1977

LEVELS

Polygon Map data levels represent the area of influence assigned to each of 324 drill holes used in the Listerud and Meineke study referenced above.



**DATA BIOGRAPHY**

SOURCE: Derived from V06 Watersheds

INTERPRETATION: MINESITE Staff, DNR

SOURCE DATE: See map dates listed for V06 Watersheds

DESCRIPTION

All cells within a watershed boundary are assigned the appropriate data level. Watersheds are named according to the major river or stream in that watershed.

VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: September 2, 1976

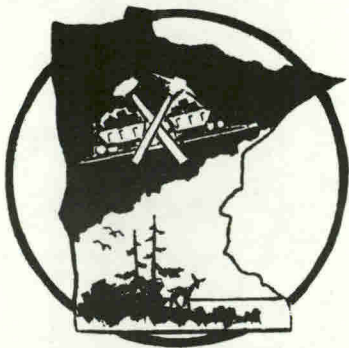
LEVELSData LevelLegend

9	South Kawishiwi
10	St. Louis
11	Isabella
12	Stony River
13	Partridge
14	Whiteface
16	Embarrass
17	Dunka River
18	North River
19	Colvin Creek
20	Argo Creek
21	Sand River

Data LevelLegend

22	Nip Creek
23	Denley Creek
25	Kawishiwi River
26	Bear Island River





Proposed Recreation Area
and Research Areas

(V31)

DATA BIOGRAPHY

SOURCE: Derived from V14 Recreational-Historical-Archeological Sites

INTERPRETATION: MINESITE Staff, DNR

SOURCE DATE: September 1976

DESCRIPTION

All cells within a recreation or research area boundary are assigned the appropriate data level.

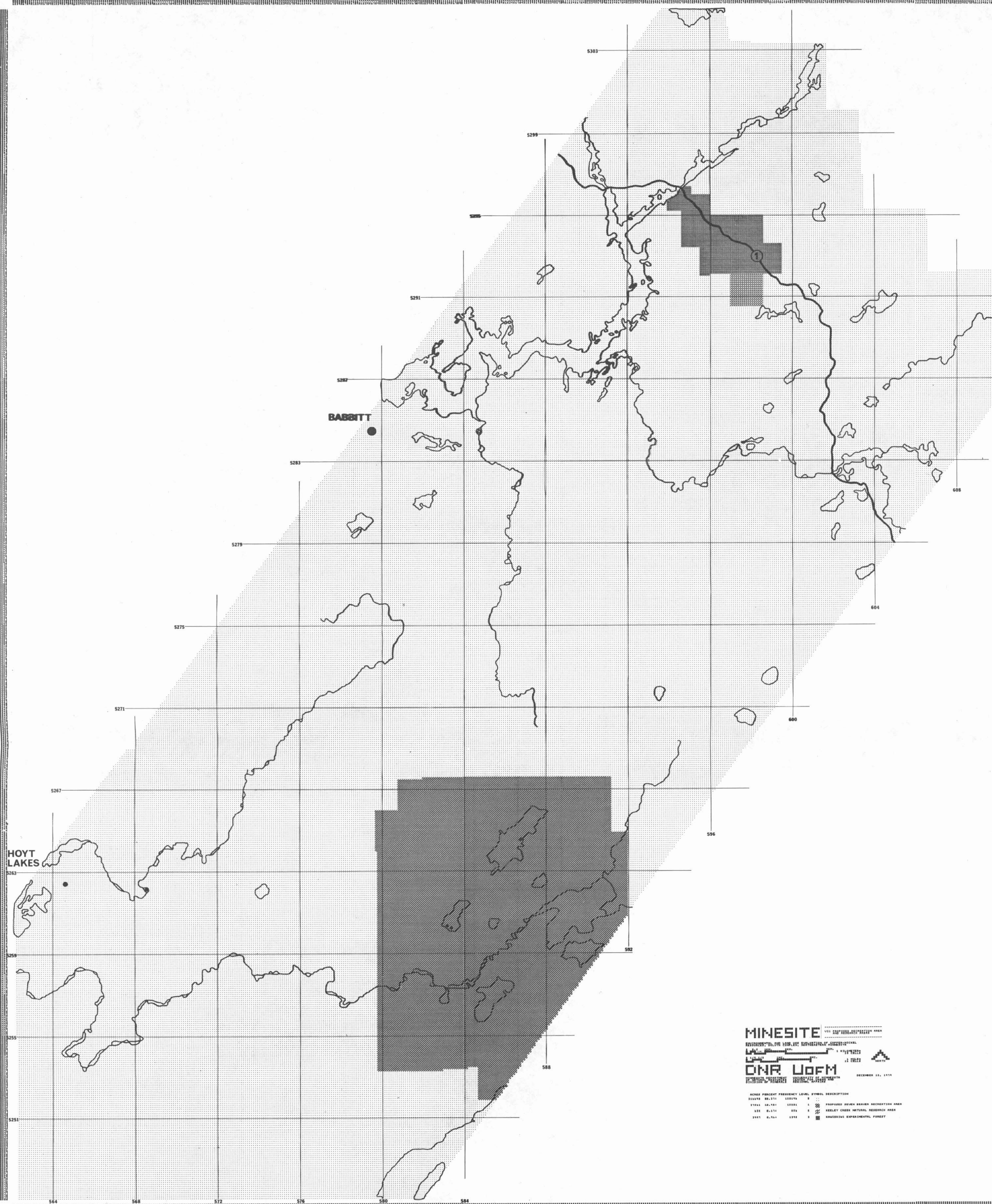
VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: January 31, 1977

LEVELS

<u>Data Level</u>	<u>Legend</u>
1	Proposed Seven Beaver Recreation Area
2	Keeley Creek Natural Research Area
3	Kawishiwi Experimental Forest



MINESITE U.S. GEOLOGICAL SURVEY

DNR UofM MINNESOTA DEPARTMENT OF NATURAL RESOURCES

DECEMBER 11, 1978

STATE	FEDERAL	LEVEL	SYMBOL	DESCRIPTION
STATE	FEDERAL	LEVEL	SYMBOL	PROPOSED DEER HAVEN RECREATION AREA
STATE	FEDERAL	LEVEL	SYMBOL	DEER HAVEN NATIONAL RECREATION AREA
STATE	FEDERAL	LEVEL	SYMBOL	MINNESOTA DEPARTMENT OF NATURAL RESOURCES



Wolf, Moose, Pine Marten Areas --
Potential Caribou Release Site

(V32)

DATA BIOGRAPHY

SOURCE: Derived from V21 Natural Resource Sites

INTERPRETATION: MINESITE Staff, DNR

SOURCE DATE: November 29, 1977

DESCRIPTION

All cells within a natural resource site boundary are assigned the appropriate data level.

VERIFICATION

TECHNIQUE: All cells checked

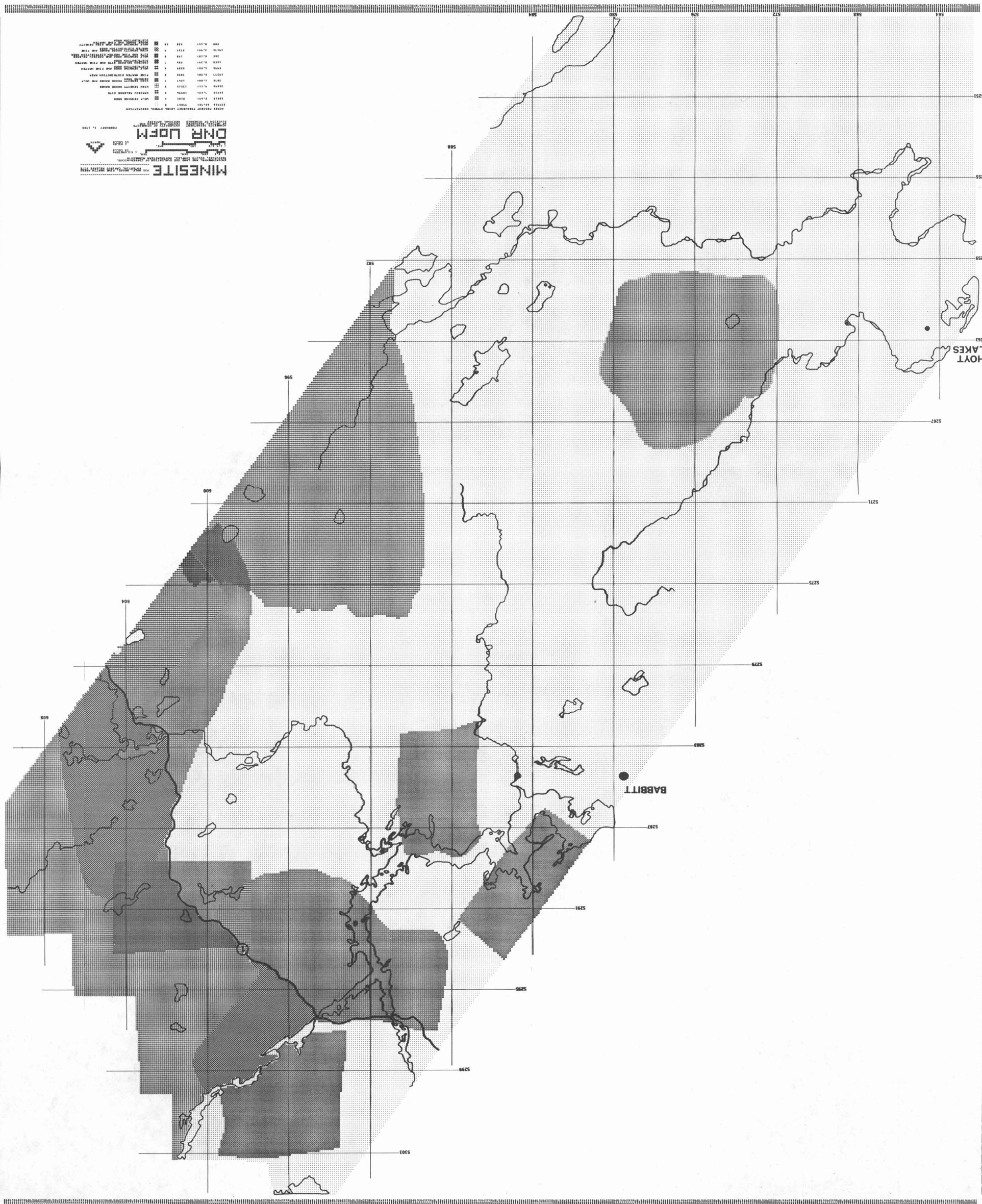
FINAL DATE VERIFIED: February 8, 1977

LEVELS

Data Level

Legend

1	Wolf Denning Area
2	Caribou Release Site
3	High Density Moose Range
4	High Density Moose Range and Wolf Denning Area
5	Pine Marten Distribution Area
6	Wolf Denning Area and Pine Marten Distribution Area
7	Caribou Release Site and Pine Marten Distribution Area
8	Wolf Denning Area and Caribou Release Site and Pine Marten Distribution Area
9	High Density Moose Range and Pine Marten Distribution Area
10	Wolf Denning Area and High Density Moose Range and Pine Marten Distribution Area



**DATA BIOGRAPHY**

SOURCE: Division of Minerals, DNR

INTERPRETATION: Division of Minerals, DNR

SOURCE DATE: June 1973

DESCRIPTION

This variable defines 9 sub-units for the MINESITE study area. Area 1 is the pilot study area.

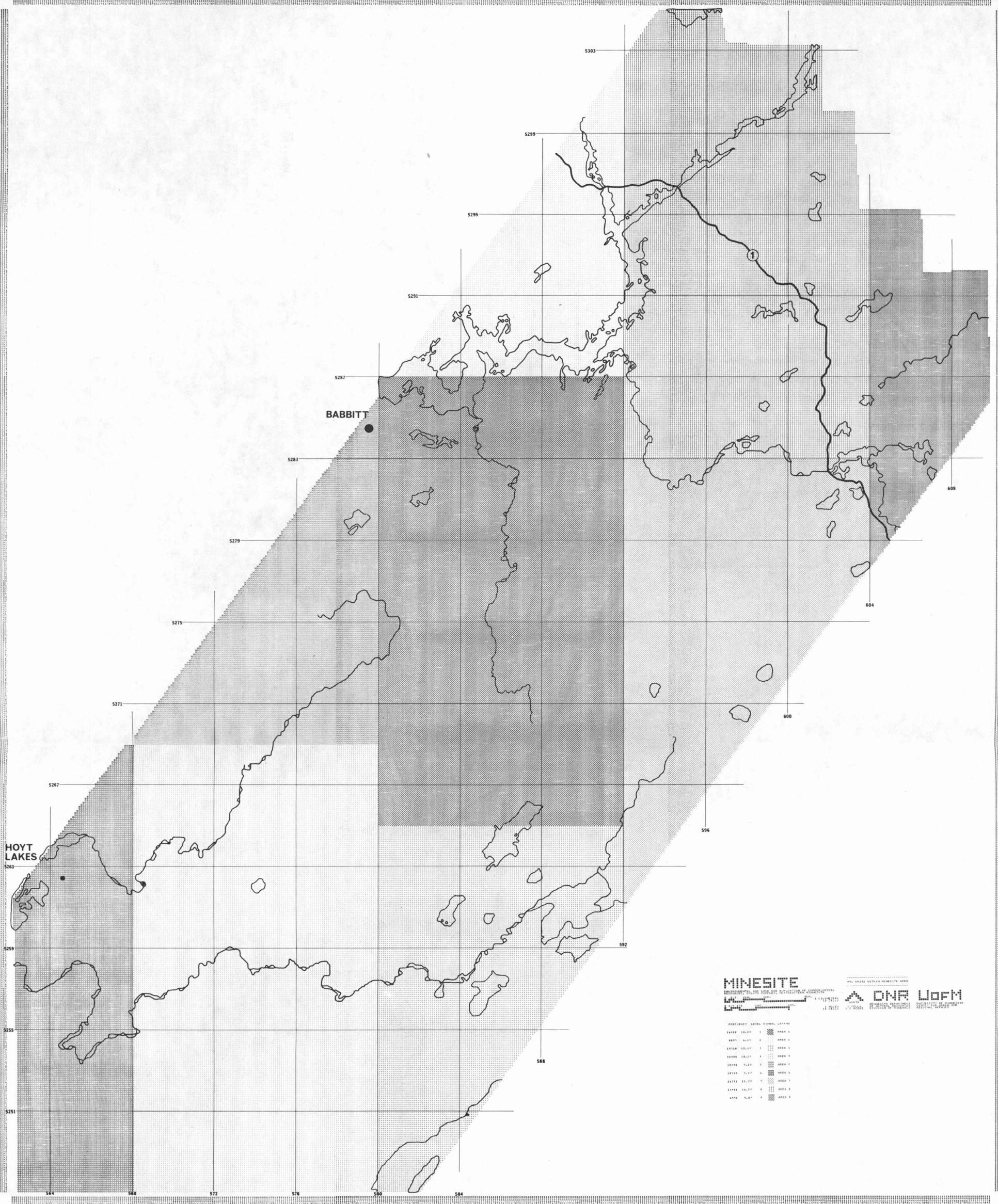
VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: September 2, 1976

LEVELS

<u>Data Level</u>	<u>Legend</u>
1	Area 1 - Pilot Area
2	Area 2
3	Area 3
4	Area 4
5	Area 5
6	Area 6
7	Area 7
8	Area 8
9	Area 9



MINESITE

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINES AND MINERAL INDUSTRIES

ONLY UNITS WITHIN MINNESOTA AREA

DNR **UDFM**

FREQUENCY LEVEL SYMBOL LOCATION			
EXTRA 10.0"	1	AREA 1	
EXTRA 10.0"	2	AREA 2	
EXTRA 10.0"	3	AREA 3	
EXTRA 10.0"	4	AREA 4	
EXTRA 10.0"	5	AREA 5	
EXTRA 10.0"	6	AREA 6	
EXTRA 10.0"	7	AREA 7	
EXTRA 10.0"	8	AREA 8	
EXTRA 10.0"	9	AREA 9	



DATA BIOGRAPHY

SOURCE: Division of Minerals, DNR

INTERPRETATION: MINESITE Staff, DNR and MLMIS

SOURCE DATE: August 1976

DESCRIPTION

The MINESITE area was superimposed upon the MLMIS regional 40-acre study area. This allows for cross referencing of the $2\frac{1}{2}$ acre MINESITE study cells and the 40-acre MLMIS regional study cells. However, this data should be carefully used because the MLMIS standardized township grid results in some $2\frac{1}{2}$ acre MINESITE cells not being completely correct as to location. Nevertheless, the best possible fit has been achieved and should be adequate for many uses.

VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: September 17, 1976

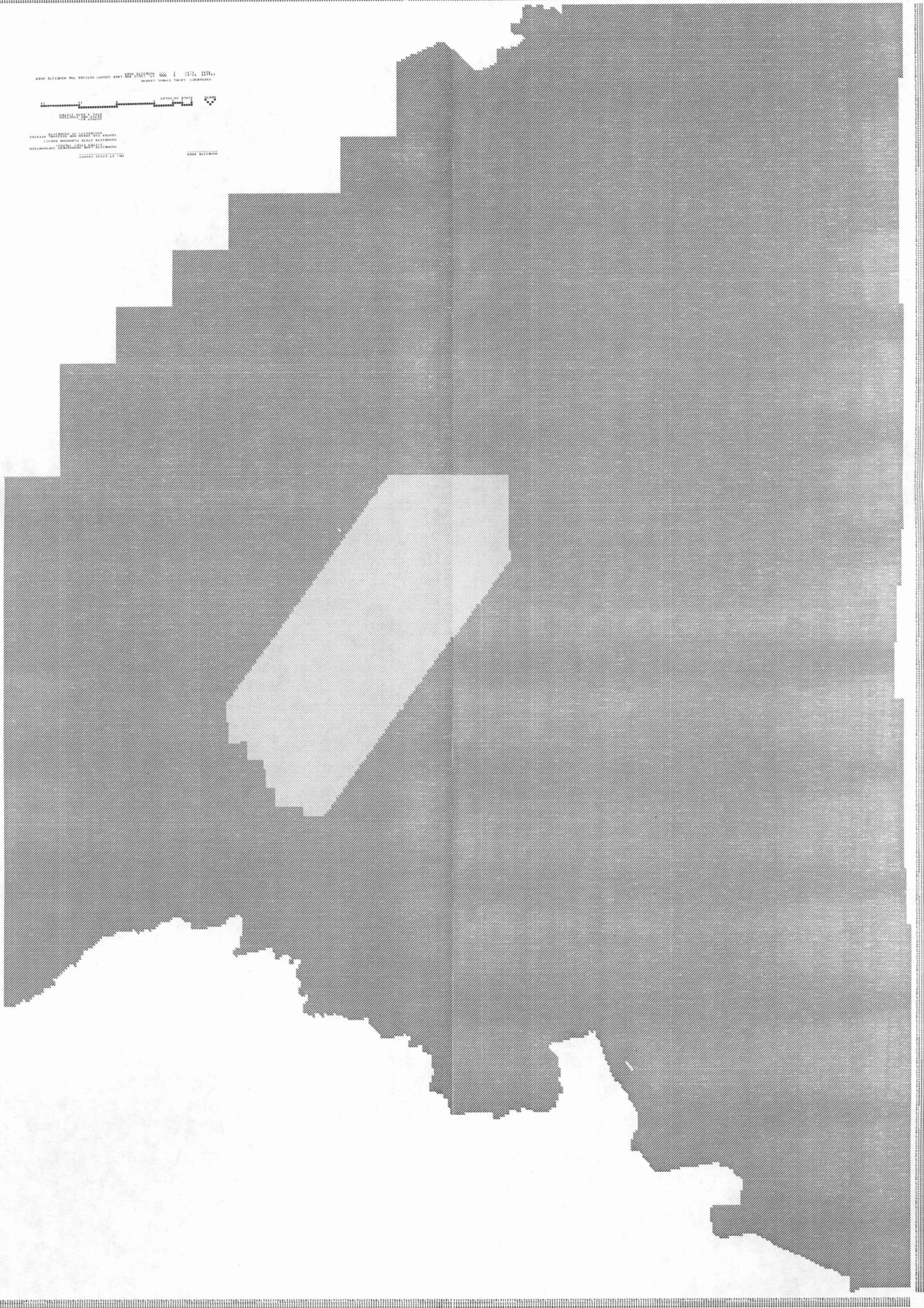
LEVELS

<u>Data Level</u>	<u>Legend</u>
0	St. Louis and Lake County outside the MINESITE area
1	MINESITE Area

WEEK ENDING 10/10/1966 10/10/1966 10/10/1966
WEEK ENDING 10/10/1966 10/10/1966 10/10/1966

10/10/1966 10/10/1966 10/10/1966
10/10/1966 10/10/1966 10/10/1966

10/10/1966 10/10/1966 10/10/1966
10/10/1966 10/10/1966 10/10/1966



**DATA BIOGRAPHY**

Lake and stream Surveys, Division of Fish and Wildlife, DNR; Lake
SOURCE: and Stream Survey Summary Sheets, MINESITE Staff, DNR; Jack Skrypek,
Gary Seisnop, Paul Dietrich, Division of Fish and Wildlife, DNR. MINESITE data
variables used: Lake and Stream Surveys (V22) and Watershed Areas (V30).

INTERPRETATION:

MINESITE Staff, DNR

SOURCE DATE: September, 1977

DESCRIPTION

Data levels described in V22 Lake and Stream Surveys are not detailed enough to take advantage of some of the information contained in DNR Fisheries surveys. To provide an expanded set of lake and stream data levels, V22 was subdivided according to watersheds in V30 Watershed Areas. By this process, data levels previously grouped in V22 became discrete data levels in V133. For example, the 12 soft-water walleye lakes represented by one data level in V22 became 10 discrete data levels in V133, with only two sets of two lakes remaining grouped. Interpretation of Fisheries survey information could then be done on a nearly individual basis according to the actual characteristics of one or perhaps two particular lakes or streams.

VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: December 1977

LEVELS

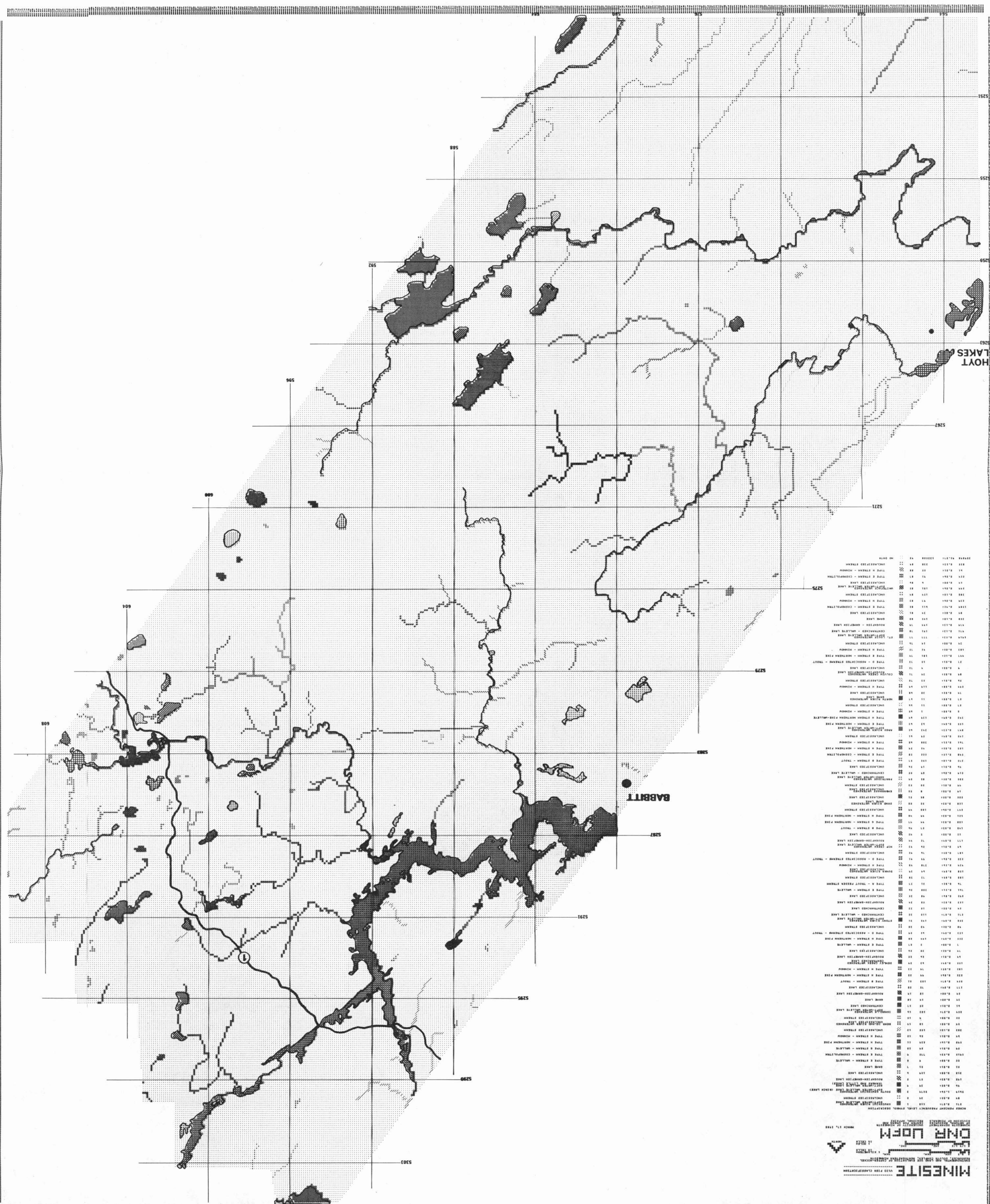
<u>Data Level</u>	<u>Legend</u>
1	Kawishiwi River Watershed: Soft-water Walleye Lake
2	" : Unclassified Stream
3	South Kawishiwi Watershed: Soft-water Walleye Lake (Birch Lake)
4	" : Soft-water Walleye Lake (Kangus and Little Lakes)
5	" : Roughfish - Gamefish
6	" : Unclassified Lake
7	" : Game Lake
8	" : Type E Stream - Walleye
9	" : Type E Stream - Cosmopolitan
10	" : Type G Stream - Walleye

<u>Data Level</u>	<u>Legend</u>	
11	South Kawishiwi Watershed:	Type H Stream - Northern Pike
12	"	: Type H Stream - Minnow
13	"	: Unclassified Stream
14	Bear Island River Watershed	: Unclassified Lake
15	"	: Unclassified Stream
16	Isabella Watershed	: Soft-water Walleye Lake
17	"	: Centrarchid Lake
18	"	: Game Lake
19	"	: Roughfish - Gamefish Lake
20	"	: Unclassified Lake
21	"	: Type B Stream - Trout
22	"	: Type H Stream - Northern Pike
23	"	: Type H Stream - Minnow
24	Denley Creek Watershed	: Centrarchid Lake
25	"	: Roughfish - Gamefish Lake
26	"	: Unclassified Lake
27	"	: Type E Stream - Walleye
28	"	: Type H Stream - Northern Pike
29	"	: Type D - Associated Streams - Trout
30	"	: Unclassified Stream
31	Stony River Watershed	: Soft-water Walleye Lake
32	"	: Centrarchid - Walleye Lake
33	"	: Centrarchid Lake
34	"	: Roughfish - Gamefish Lake
35	"	: Unclassified Lake
36	"	: Type E Stream - Walleye
37	"	: Type A - Trout Feeder Stream
38	"	: Unclassified Stream
39	Dunka River Watershed	: Unclassified Lake
40	"	: Type H Stream - Minnow
41	"	: Type D Associated Streams - Trout
42	"	: Unclassified Stream
43	Nip Creek Watershed	: Soft-water Walleye Lake
44	"	: Roughfish - Gamefish Lake

Fish Classification (V133), continued

<u>Data Level</u>	<u>Legend</u>	
45	Nip Creek Watershed	: Unclassified Lake
46	"	: Type B Stream - Trout
47	"	: Type G Stream - Northern Pike
48	"	: Type H Stream - Northern Pike
49	"	: Unclassified Stream
50	Sand River Watershed	: Game Lake
51	"	: Unclassified Lake
52	Embarrass Watershed	: Unclassified Lake
53	"	: Unclassified Stream
54	Partridge Watershed	: Soft-water Walleye Lake
55	"	: Centrarchid - Walleye Lake
56	"	: Unclassified Lake
57	"	: Type B Stream - Trout
58	"	: Type E Stream - Cosmopolitan
59	"	: Type H Stream - Northern Pike
60	"	: Type H Stream - Minnow
61	"	: Unclassified Stream
62	Argo River Watershed	: Soft-water Walleye Lake
63	"	: Type E Stream - Northern Pike
64	"	: Type H Stream - Northern Pike-Walleye
65	"	: Type H Stream - Minnow
66	"	: Unclassified Stream
67	North River Watershed	: Game Lake
68	"	: Unclassified Lake
69	"	: Type H Stream - Minnow
70	"	: Unclassified Stream
71	Colvin Creek Watershed	: Roughfish-Gamefish Lake
72	"	: Unclassified Lake
73	"	: Type D - Associated Streams - Trout
74	"	: Type E Stream - Northern Pike
75	"	: Type H Stream - Minnow
76	"	: Unclassified Stream
77	St. Louis Watershed	: Soft-water Walleye Lake
78	"	: Centrarchid - Wall-eye Lake

<u>Data Level</u>	<u>Legend</u>	
79	St. Louis Watershed	: Roughfish - Gamefish Lake
80	"	: Game Lake
81	"	: Unclassified Lake
82	"	: Type E Stream - Cosmopolitan
83	"	: Type H Stream - Minnow
84	"	: Unclassified Stream
85	Whiteface Watershed	: Soft-water Walleye Lake
86	"	: Unclassified Lake
87	"	: Type E Stream - Cosmopolitan
88	"	: Type H Stream - Minnow
89	"	: Unclassified Stream



Appendix A - Definition of Slope Categories (V02)

The percent slope variable, V02, is based on the number of topographic contour lines intersecting a geographic cell. The data was derived from USGS topographic maps. Contour intervals on these maps are 10 and 20-ft. intervals, for 7.5 and 15 minute quadrangles respectively.

To determine the percent slope in a given cell, the number of contour lines intersecting that cell are counted. Using conversion factors and the established data levels, each cell is assigned its proper percent slope. An example assignment, using a 10-ft. contour line, is as follows: one line crossing the cell horizontally or vertically is an approximate 3% slope. If the line crosses the cell diagonally, the slope is approximately 2.2%. Therefore, one line crossing a cell at any angle is automatically assigned data level 1 which represents a 1 to 3% slope. If one contour line crosses a single cell using a 20-ft. contour interval, it corresponds to two lines crossing a cell for a map using a 10-ft. contour. If the line crosses vertically or horizontally, it corresponds to a slope of approximately 6%, and if it crosses diagonally, it corresponds to a slope of approximately 4.5%. This cell is assigned data level 2, which represents a 4 to 6% slope.

When using this variable in later analysis models, care should be taken in grouping data because of the 10-ft. and 20-ft. elevation intervals from the original data. When appropriate, data levels 1 and 2 should be grouped together, and levels 3 and 4 should also be grouped together.

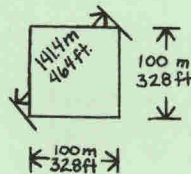
Data level 7 is defined as an area of unknown slope. These

areas are predominately mining areas where significant mining activity has occurred since the last time the topographic map for the specific areas was updated. The mining activity is usually either stockpiling or open pit mining.

The following calculations provide conversions for the V02 data level assignments.

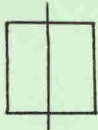
Definition of % Slope Categories (Topographic maps with a 10 foot elevation interval)

Cell Size

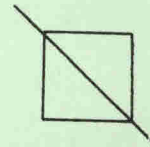


$$\begin{aligned} 100 \text{ m} \times \sqrt{2} &= 141.4 \text{ m} \\ 100 \text{ m} \times 3.28 \text{ ft/m} &= 328 \text{ ft.} \\ 141.4 \text{ m} \times 3.28 \text{ ft/m} &= 464 \text{ ft.} \end{aligned}$$

A 1-3% Slope (1 elevation contour line)

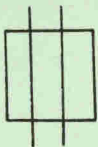


$$\frac{10}{328} \times 100 = 3.0\%$$

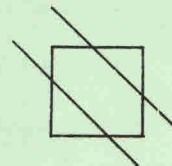


$$\frac{10}{464} \times 100 = 2.2\%$$

B 4-6% Slope (2 elevation contour lines)



$$\frac{20}{328} \times 100 = 6.1\%$$

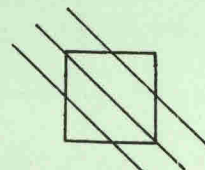


$$\frac{20}{464} \times 100 = 4.3\%$$

C 7-9% Slope (3 elevation contour lines)

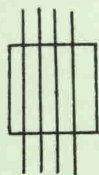


$$\frac{30}{328} \times 100 = 9.1\%$$

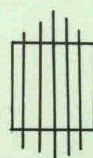


$$\frac{30}{464} \times 100 = 6.5\%$$

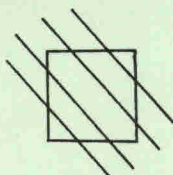
D 10-15% Slope (4-5 elevation contour lines)



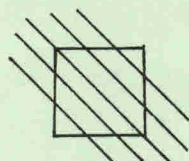
$$\frac{40}{328} \times 100 = 12.2\%$$



$$\frac{50}{328} \times 100 = 15.2\%$$

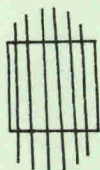


$$\frac{40}{464} \times 100 = 8.6\%$$

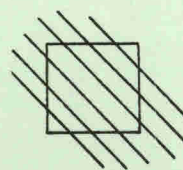


$$\frac{50}{464} \times 100 = 10.8\%$$

E >15% Slope (>5 elevation contour lines)



$$\frac{60}{328} \times 100 = 18.3\%$$



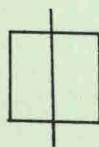
$$\frac{60}{464} \times 100 = 12.9\%$$

F 0% Slope (No elevation contour lines)

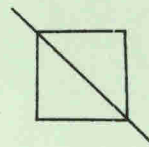
G Unknown slope orientation - areas recently disturbed, generally from mining activities, and as yet have not been updated on USGS quadrangle maps.

Definition of % Slope Categories (Topographic maps with a 20-foot elevation interval)

B 4-6% Slope (1 elevation contour line)

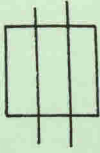


$$\frac{20}{328} \times 100 = 6.1\%$$

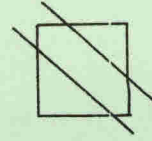


$$\frac{20}{464} \times 100 = 4.3\%$$

D 10-15% Slope (2 elevation contour lines)



$$\frac{40}{328} \times 100 = 12.2\%$$

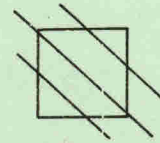


$$\frac{40}{464} \times 100 = 8.6\%$$

E >15% Slope (3 or more elevation contour lines)



$$\frac{60}{328} \times 100 = 18.3\%$$



$$\frac{60}{464} \times 100 = 12.9\%$$

Appendix B - Description of Soil Landscape Units (V10)

The Soil Landscape Units map was prepared for use in Superior National Forest planning. The information mapped is inadequate for site specific planning but can be helpful in locating areas that are generally well suited, poorly suited, or unsuited for specific uses.

About 22 percent of the MINESITE area has a detailed soil resource inventory developed from field observation. Based upon these observations a soil landscape model was developed to project classifications to those areas not inventoried. These models are based upon geology, drainage patterns, local relief, slope, vegetation, and topographic patterns identified from aerial photography and topographic maps. Quality control checks of the areas projected were made through selected ground traverses.

<u>SL/GLS</u> RM	Rainy moraine, sandy loam over gravelly loamy sand, well drained, >4' to bedrock.
<u>SL</u> RM	Rainy moraine, sandy loam, well drained, >4' to bedrock
<u>SLB</u> RM	Rainy moraine, bedrock controlled, sandy loam, well drained, some <4', mostly <u>></u> 4' to bedrock.
<u>SLVB</u> RM	Rainy moraine, bedrock controlled, sandy loam, well drained, <40" to bedrock.
<u>SL</u> RD	Rainy drumlin, sandy loam, well drained, >4' to bedrock.
<u>L</u> RD	Rainy drumlin, loam, well drained, >4' to bedrock.
<u>SLP</u> RM	Rainy moraine, sandy loam, poorly to somewhat poorly drained, >4' to bedrock.
<u>SL/SG</u> RO	Rainy outwash plain, sandy loam over sand and gravel, well drained, >4' to bedrock.

<u>SGB</u> <u>RO</u>	Rainy outwash plain, bedrock controlled, sand and gravel, well drained, >4' to bedrock.
<u>SGVB</u> <u>RO</u>	Rainy outwash plain, bedrock controlled, sand and gravel, well drained, <40" to bedrock.
<u>SG</u> <u>RE</u>	Rainy esker, sand and gravel, well drained, >4' to bedrock.
<u>SL/SG</u> <u>SO</u>	Superior outwash plain, sandy loam over sand and gravel, well drained, >4' to bedrock.
<u>LS/SG</u> <u>SO</u>	Superior outwash plain, loamy sand over sand and gravel, well drained, >4' to bedrock.
<u>SGP</u> <u>SO</u>	Superior outwash plain, sand and gravel, poorly drained, >4' to bedrock.
<u>SP</u> <u>SO</u>	Superior outwash plain, medium and fine sand, poorly drained, >4' to bedrock.
<u>SG</u> <u>SE</u>	Superior esker, sand and gravel, well drained, >4' to bedrock.
<u>OLP</u> <u>DR</u>	Drainway, peat with inclusions of loam, poorly drained, >4' to bedrock.
<u>LOP</u> <u>DR</u>	Drainway, loam with inclusions of peat, poorly drained, >4' to bedrock.
Bg	Bog, peat, poorly drained, >4' to bedrock.
Al	Alluvial, soils varied, well to poorly drained, >4' to bedrock.
<u>L-CL</u> <u>DM</u>	Des Moines Moraine, loam to clay loam, well drained, >4' to bedrock.
<u>SLP</u> <u>RD</u>	Rainy drumlin, sandy loam, poorly to somewhat poorly drained, >4' to bedrock.
<u>LP</u> <u>RM</u>	Rainy moraine, loam, poorly drained, >4' to bedrock.

Appendix C - Taconite Reserves and Potential Resources (V15)

The purpose of this variable is to delineate possible open pit and underground taconite resources beyond existing mining company plans. This is important for determining long-term taconite resource priorities. Data used in the evaluation is primarily public information previously published or on open file at the Minnesota Geological Survey or the Division of Minerals, Department of Natural Resources, Hibbing Office. A reference list is included at the back of this Appendix.

The analysis contains several data limitations, particularly on the down dip extension of the Biwabik Iron Formation. These limitations include minimal data on the thickness of the iron formation layers, the dip as the formation approaches the Duluth Gabbro Contact and the southerly extent of the iron formation. Consequently, lines separating resource categories are approximate and are designed to provide regional indications of iron formation characteristics. No attempt was made to calculate quantities of taconite available in a category. However, rough calculations could be completed if an average thickness was assumed.

The established resource categories provide no indication of the timing of mining within any specific category. This is due to the problems of projecting resource demands, economics, technology, and individual mining company resources and requirements. However, between categories, an indication of probable sequence and timing can be made based on current trends. The open pit limits represent a period greater than 40 years into the future and probably represent a range of 80 to 100 years. For an indi-

vidual company, an important factor is mineral and surface ownership control. A specific company may approach the open pit limits sooner depending on its resource requirements and its control of adequate ore supplies either by ownership or lease.

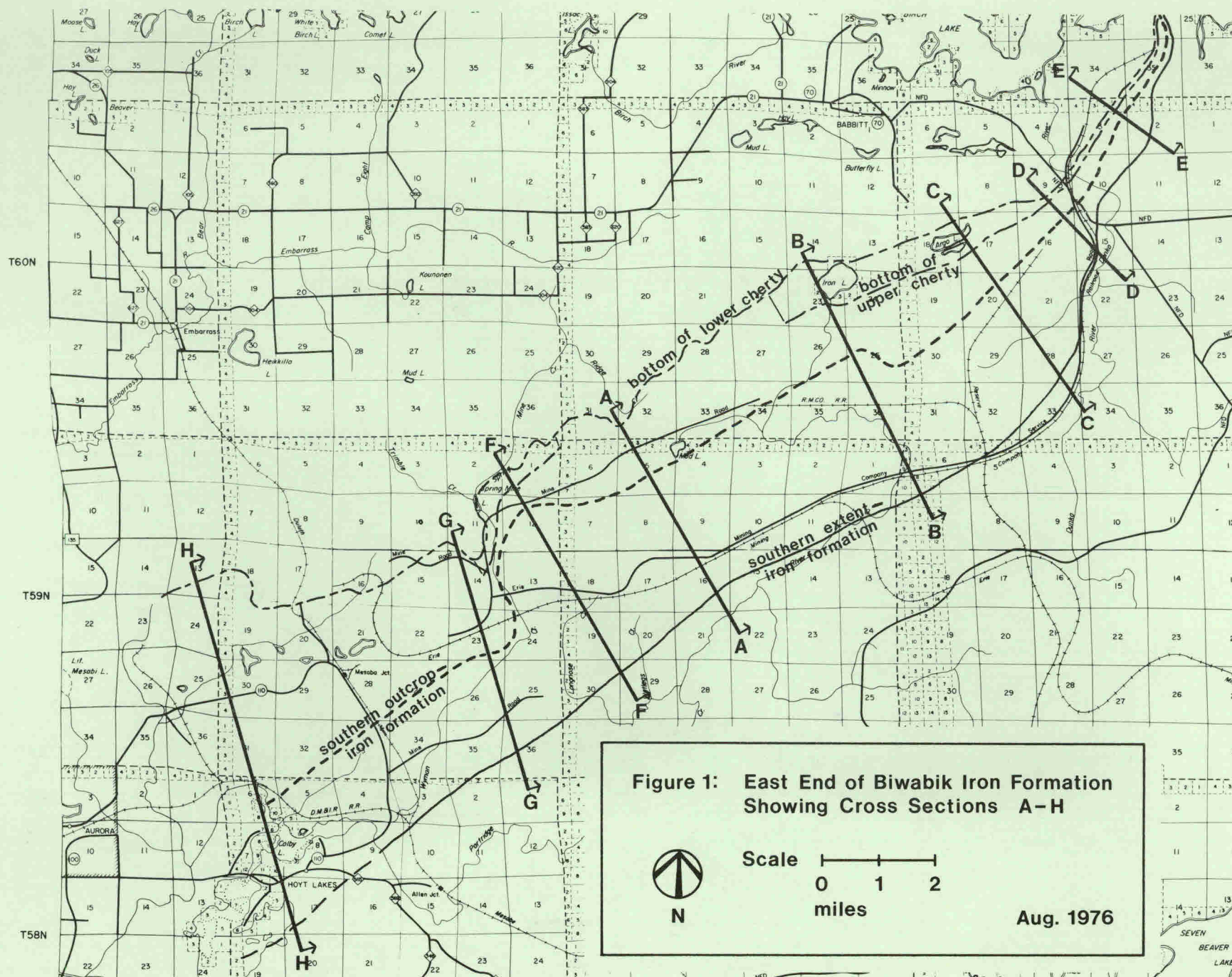
The progression from open pit to underground taconite mining could be 60 or more years into the future. The most probable reasons for progression from open pit to underground would be if an operator was unable to maintain production due to limited open pit operating space, to improve ore quality, to extend the mine life, or a combination of these.

The initial stage of the study was to plot the following available data.

1. Surface outcrop of the Biwabik Iron Formation.
2. Surface outcrop contact of the base of the upper cherty layer (6).
3. Strike and dip of surface outcrops and dips from published cross sections and drill core (2, 3, 5, 6, 9, 14, 15, 16).
4. Southern extent of the Biwabik Iron Formation (4).
5. Depth to the top of the Biwabik Iron Formation from available open file and confidential copper-nickel drilling.
6. Thickness of the iron formation layers (1, 2, 5, 8, 15, 16).

This data was then interpreted using several cross sections labeled A-H. Figure 1 shows a plan map of section locations and Figure 2 illustrates a typical cross section. The data interpretation was completed using the following assumptions.

1. The average depth of surface overburden is 20 ft. (13).
2. One foot of rock stripping can be removed at a cost similar to 2 feet of unconsolidated overburden (17).



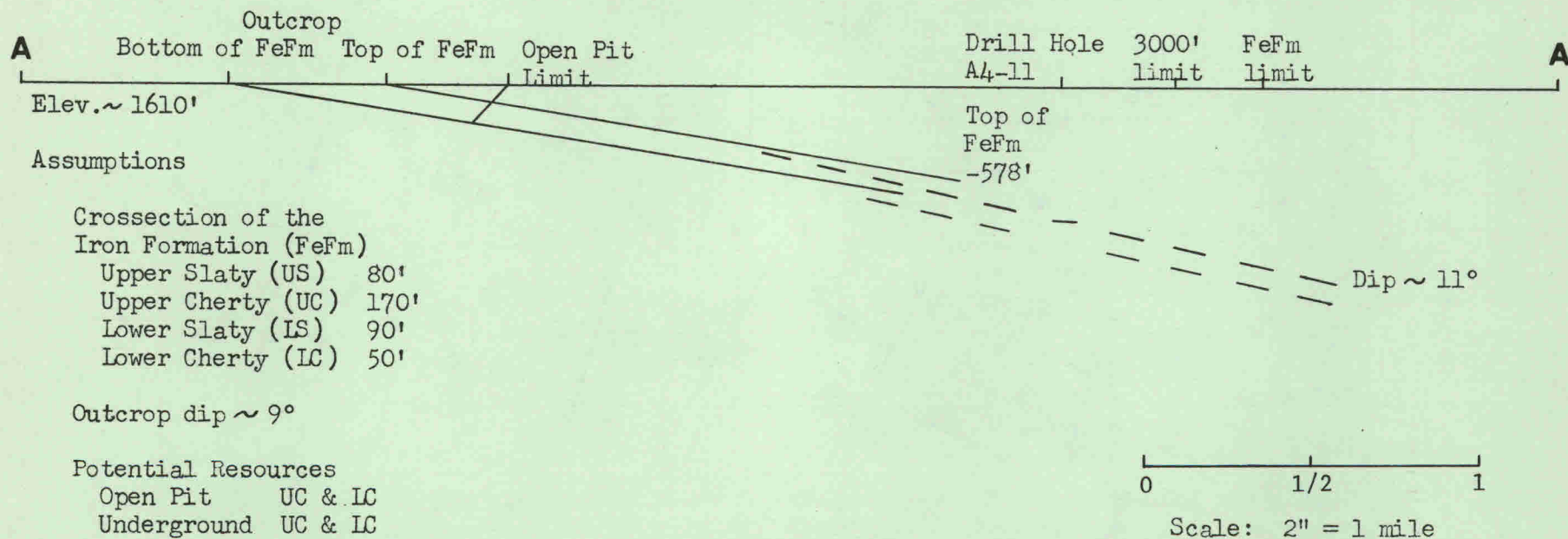


Figure 2 Cross-section A-A Biwabik Iron Formation

3. The open pit stripping limit is 2:1 on a ton for ton basis. This corresponds to an approximate $2\frac{1}{2}$:1 ultimate stripping limit on a yard for yard basis. Waste rock density is assumed at 12-14 cubic feet/ton and taconite ore at 10-12 cubic feet/ton (16, 17).
4. The ultimate stripping limit can be approximated by a ratio of the thickness of waste rock to the ore layer thickness plus $\frac{1}{2}$ the overburden depth measured vertically.
5. The hanging wall open pit limit has a pit slope ratio of 1:1 (17).
6. The minimum ore layer thickness for open pit mining would be approximately 30-40 feet (16, 17).
7. The upper cherty and lower cherty layers are the mineable ore layers within the Biwabik Iron Formation. The total ore layer thickness was utilized in the stripping ratio calculation. It was assumed that lean ore within the ore horizon would be stockpiled and processed near the end of an operation or that lean ore remaining in the ground would be mined during later stages of the operation as it became economical (17).
8. The minimum ore layer thickness for underground mining would be approximately 20 feet (17).
9. A maximum underground mining depth of 5,000 feet is assumed and two depth categories are delineated (17).
10. Underground mining of taconite ore with a dip greater than 10° would require a new or modified large scale mining technique (17).
11. Typical iron formation thicknesses and dips are assumed for each cross section.

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16. Yardley, D.H., "In Pit Disposal of Tailings", Appendix C, Draft Environmental Impact Statement Technical Appendix, Reserve Mining Company's Proposed On Land Tailings Disposal Plan, October 1975.
17. Yardley, D.H., Personal Communication, 3/18/76.

Appendix D - Vegetation Inventory (V16)

Four vegetation variables were mapped for the MINESITE project under a contract with the Remote Sensing Laboratory, College of Forestry, University of Minnesota. These variables include: (1) vegetation cover types, (2) density class, (3) size class, and (4) height class.

Standard methods of aerial photo interpretation and vegetation type classification are used to map the cover types. A classification scheme was developed which met the following criteria:

1. The types are ones commonly used by forest managers.
2. Types could be assigned marketing and pricing factors singly or aggregately.
3. Types could be distinguished on the available black and white infrared aerial photos.
4. The scheme is related to the ecosystem classification which has been previously developed by the Limnological Research Center, University of Minnesota.

Interpreters used both the cover type classification scheme detailed in V16 as well as the key below to delineate boundaries and symbolize the cover types on matte acetate photo overlays.

This key is used only as an aid in identification of cover types in conjunction with other characteristics.

Key to Photo Appearance of Tree Species (Cover Type)

<u>Tone</u>	<u>Cover Type</u>	<u>Texture</u>	<u>Remarks</u>
Very dark gray	J	Velvety	Hazy, smooth
	S	Hard	Carpet-like

to	Q	Hard	
	B	Hard	
Dark gray	T	Hard	
	C	Hard	

	R	Soft	Circular outline
Medium	W	Soft	Star shaped
gray	G	Smooth	
	H	Carpet-like	
Light gray	A	Fluffy	
to very	E	Soft	
light gray	D	Carpet-like	
	O	Smooth	

A classification scheme was also described by the Limnological Research Center, University of Minnesota, which grouped species into ecosystems. Groupings include upland, transitional, and bog ecosystems. A tabulation of the descriptions of the two classifications is given in the order they appear in the data levels for V16.

CLASSIFICATION SCHEME

COVER TYPE¹:

<u>Species</u>	<u>Cover Type Description</u>
Aspen and paper birch*	More than 50% trembling aspen, large tooth aspen, Balm of Gilead and paper birch.
Jack pine*	More than 50% pine with jack pine outweighing white and red pine.
Red pine*	More than 50% pine with red pine outweighing white and jack pine.
White pine*	More than 50% pine with white pine outweighing red pine and jack pine.
Northern hardwoods*	More than 50% northern hardwood species (maple, yellow birch, basswood, elm).
Mixed conifer and deciduous*	Natural or logged upland areas containing a mix of aspen, birch, pines and spruce. May also contain red maple and balsam fir.
Upland shrubs	Upland shrubs (hazel, pin cherry, etc.) with less than 10% stocked commercial tree species.
Grassland	All upland open areas of grass with less than 10% stocked commercial tree species. Include administrative areas.

Plantation	Areas that have been planted but species cannot be identified on the aerial photographs.
Spruce-fir*	A mixed hardwood-coniferous type composed of more than 50% white spruce and balsam fir.
Lowland shrubs	Lowland shrubs (alder, etc.) with less than 10% stocked commercial tree species.
Marsh	Marsh (grass, sedges, and some lowland brush), bog or open muskeg.
Water	Lakes, ponds, flowage, streams.
Non-productive swamp	Spruce, tamarack or cedar bog which will not produce trees of pulpwood size in 100 years.
White cedar*	More than 50% swamp conifers with white cedar outweighing other species.
Black spruce*	More than 50% swamp conifers with black spruce outweighing other species.
Mixed conifer swamp*	Spruce, cedar, balsam, and tamarack comprising more than 50% of the stand.
Tamarack*	More than 50% swamp conifers with tamarack outweighing other species.
Swamp or bottomland hardwoods*	More than 50% composed of bottomland hardwoods (ash, elm, Balm of Gilead, soft maple).
Cutover	Only one growing season elapsed since area harvested.
Farm	Crop, orchard, or pasture, but not farm woodland.
Industrial and residential	Platted areas used for industry or residence.
Quarry or gravel pit	

*All asterisked cover types must be further described with a size class, a 20' height class and a density class (V18, V19, V20). All other types are considered non-forested or plantations.

ECOSYSTEM²:

Species

Ecosystem

Aspen and paper birch

U1 - Aspen and birch comprising about 90% of the canopy. This unit occurs mainly on uplands either as young stands following logging or as very old stands with a fir understory that is not apparent on photos.

Jack pine

U2 - Natural pure pine stands, mixed red and jack pine or pure jack pine. They occur mainly on outwash plains, and to date they are about 60 years old, rimmed with natural U3 where there are topographic breaks. They were probably just young enough to escape cutting until now. Even-aged stands suggest they are of fire origin. The forest floor is often dry, with interrupted herb layer and only a scattered shrub layer. Wherever possible such stands are aged by boring the trees and counting the rings.

Red pine

White pine

Northern hardwoods

U3 - Mixed conifers and deciduous elements. These stands come in several varieties.

1. Natural stands of mixed aspen, birch, pines, and some spruce on topographic breaks.

Mixed conifer and deciduous

2. After logging with no apparent planting. These stands appear to date from the late 1940's. Many large birch and aspen trees were left standing, creating a savanna-like appearance. Some old pines were often left as well. There is regeneration of scattered conifers, young aspen, and often red maple and cherry. Shrub layer varies with dryness of soil and often is thick.

Upland shrubs

U4 - Upland shrubs (hazel, pin cherry, etc.) and grass with less than 10% stocked commercial tree species.

Grassland

Plantation

U6 - Plantation*. Wherever possible these stands have been aged and so far fall into two main age classes: 5-7

years and 18-23 years. The latter may give the appearance of the second category of U3 above. Most recently cut areas that show as clearcuts on photos have been replanted, some with fire after cutting and some without. Evidence of such fire is noted when known. In one case the fire escaped, leaving an adjoining area with natural pine regeneration that should probably be categorized as U2.

*Older plantation stands have been grouped in U2 or U3 above.

Spruce-fir

T1 - Mixed spruce, pine, and fir. Often occurs on topographic breaks and intergrades into both U3 (with addition of deciduous elements) and B2 below. When former logging left scattered coniferous remnants, a savanna-like version of T1 occurs, characterized by widely spaced broad-branching jack pines. When the structure of the forest is unusual, as in this case, it is noted on the map.

Lowland shrubs

Marsh

Water

Non-productive swamp

B1 - Wetlands giving an even grey appearance on photos, comprised of five different types:

1. Carex (sedge) fens, open grassy wetlands with much standing water.
2. Carex and shrub fens. The shrubs are usually alder and dogwood.
3. Cutover wetlands that have become drier since cutting but still contain wetland elements.
4. Ericaceous bogs (heather family) without spruce.
5. Ericaceous bogs with Larix (tamarack).

White cedar

Black spruce

Mixed conifer swamp

Tamarack

B2 - Conifer wetlands.

1. With spruce.
 2. With cedar, only separable when they occur in large pure stands.
-

Swamp or bottomland
hardwoods

B3 - Ash wetlands. Occur where there is a good supply of nutrients from neighboring uplands, usually along rivers or in draws. May have a cedar understory. The herb component of these communities is unique and has affinities with the flora of southern Minnesota.

Harvested

D1 - Cutover with only one growing season elapsed.

Farm
Industrial and residential
Quarry or gravel pit

D2 - Under permanent unnatural use.

REFERENCES

1. "Vegetation Mapping, Inventory and Analysis for MINESITE Project", Remote Sensing Laboratory, College of Forestry, University of Minnesota, February 1975.
2. Wright, H.E., "Vegetation Mapping in the Copper-Nickel Mining Area", Report to All-University Council on Environmental Quality, August 1973.

Appendix E - Timber Cutting History (V17)

Timber cutting history was determined by aerial photo interpretation followed by some field checking. Stereoscopic air photo coverage of most of the area was available in four series, spaced roughly 11 years apart. Photos were not strictly comparable because of inherent differences between them which created some problems in interpretation. Attempts were made to resolve these problems during interpretation.

Laboratory procedure was carried out as follows. Acetate was layed over alternate photos in the 1937 and 1970 series with logged areas then encircled in colored pencil. Cut areas from intervening years were visually transferred onto the 1970 acetates. Map units were then transferred from acetates to U.S. Geological Survey topographic maps using a reflecting projector. Where recent logging overlaps older logging, the area was then shaded the color of the most recent.

The following criteria were used to identify logged areas on the air photos:

1. Presence of parallel cut lines in the forest.
2. Presence of networks of roads and trails in the vicinity of forests that show openings in the canopy.
3. Presence of extensive young forests dotted with taller conifers, aspen, and birch.
4. Areas with no trees at all or with a homogeneous soft grey tone. (This tone on uplands denotes very young plantations, but in wetlands it denotes either meadow or carr).
5. Presence of linear patterns resulting from regular thinning or other treatments.
6. Disappearance of individual trees or clumps of trees that were visible on earlier photos.

7. Landings and piles of logs.
8. Open landscape with high windrows (rock raking).
9. Presence of roads and trails in inaccessible areas, across swamps, or ending blindly in the vicinity of the forest with unusually open canopies.

Areas mapped as "uncut" are those in which it is most certain that cutting has never taken place. Upland uncut areas are probably either conifer stands that must have been too young for logging in an earlier era, or mixed stands dominated by decadent aspen and birch with an understory of fir. Most uncut areas are in wetlands, but wetlands are the least reliable to map because early logging of black spruce in wetlands preceded logging of upland jack pine. A conservative guideline for understanding a wetland is not to consider it uncut unless it consists of lowland shrubs, marsh, or sedge meadows with very few trees.

Two additional map units were needed to explain other possibilities within the wetlands. Areas coded "probably uncut" are raised bogs and closed spruce stands with roads close to them but no apparent cutting visible within them. Areas coded "probably cut" include:

1. Spruce bogs with fairly open canopies and a reticulate appearance on the photos but no visible slash lines.
2. Raised bogs that appear to have a cut pattern superimposed on the natural pattern.
3. Areas coded as nonproductive swamp on the vegetation map.
4. Areas that have obviously been cut but the date is uncertain.

Appendix F - Vegetation Size and Density Classes (V18, V19)

Crown Density Classes (V18)

1. Seedlings, Saplings

Density Class

Description (trees/acre)

Seedlings

Saplings

Poor

200-750

175-350

Medium

800-1350

400-700

Good

1400+

750+

2. Poles, Saw timber

Density Class

Description

Poor

10 to 40% crown closure

Medium

41 to 70% crown closure

Good

71% crown closure and over

3.

Not applicable
Plantation

Description

Non-forested vegetation types in V16.
Areas that have been planted but species
cannot be identified on the aerial photo.

Size Classes (V19)

Size Class

Description

Seedlings (0-1")

Young stands of commercial tree species
from 1" high to 0.9" dbh.

Saplings (1-5")

Stands of trees ranging between 1.0"
dbh and the minimum pole timber size.

Poles (5-9")

Stands in which most of the merchant-
able volume is in trees between 5.0"
dbh and the minimum sawtimber size.
Not less than 10% stocking.

Small sawtimber (9-14") Most of the bf volume in trees less
than 15.0" dbh.

LAKES: Ecological Classification for Fisheries Management

The Ecological Classification of lakes denotes the basic lake type. This classification is described in terms of the natural and characteristic fish populations which are best adapted to the physical, chemical, and biological characteristics of a lake and which the lake could be expected to support if it were left alone with no special management applied to it. The arrangement in each system is in order of progression from the oligotrophic to the eutrophic.

The northern pike, as a species, has been omitted from the name designations because it is generally found in nearly all types of lakes, with the exception, perhaps, of trout lakes.

A brief description of the characteristics for each type of lake is given below as a guide in classification. The principal ecological types and their descriptions are as follows:

Trout	Deep, rocky, infertile lakes with oxygen throughout. Tullibee and suckers are other principal components of the population. Typical lakes: Mountain, Clearwater--Cook County.
Soft-water walleye	Infertile, medium to large size lakes in northeastern Minnesota with natural walleye populations. Typical lakes: Pike--Cook County, Vermilion--St. Louis County.
Hard-water walleye	Moderately fertile, medium to large size lakes in which walleyes are well established naturally. Typical lakes: Mille Lacs, Winnibigoshish, Leech.
Centrarchid--walleye	Medium to large sized, usually lakes consisting of many ecologically different bays or sections some being natural walleye habitat, others more suitable for panfish species. May also have substantial bullhead and/or carp and/or buffalo

populations. Typical lakes: Minnetonka, Sally, Minnewaska.

Centrarchid

Medium and small sized, weedy, fertile, hardwater lakes. Usually no large open areas. May also contain moderate to substantial populations of carp, and/or buffalo and/or bullheads. Typical lakes: Gladstone--Crow Wing County, Maple--Douglas County.

Roughfish--gamefish

Fertile hardwater lakes in southern and central Minnesota characterized by relatively large rough-fish (carp, buffalo, sheepshead, bullhead) populations. Many may occasionally winterkill. Typical lakes: Tetonka--Le Sueur County, Long--Ramsey County, and Washington--Blue Earth County.

Bullhead

Shallow lakes, in which frequent winter-kills promote the dominance of bullheads. Typical lakes: Christina, Star, Bear.

Unclassified

These are often small lakes whose native fish populations do not fit any of the above categories. Lakes reclaimed for stream trout stocking may fall in this category. Use this classification with caution; it is not intended as a catchall or a substitute for careful analysis.

STREAMS: Classification for Fisheries Management

TYPE A.

Trout Streams

Defined as streams capable of supporting an acceptable sport fishery through natural reproduction. Streams in this group will be managed by protection of the stream from physical abuse of the habitat, by development of the stream for public fishing areas through acquisition of stream frontage and improvement of habitat, and by regulation to promote the optimum sustained recreational use. As a general procedure trout populations in these streams will not be maintained at artificial levels by maintenance or put-and-take stocking.

Due to the fact that streams in this category will range from small brushy feeder streams characterized by cold water and small trout to the large produc-

tive main channel areas, streams in this type should be divided into two sub-categories:

A-1 Main channel streams

Streams large enough to support a significant fishery with all types of common gear--bait, spin-cast, and fly fishing.

A-2 Feeder streams

Defined as too small or brushy to provide more than a limited trout fishery.

NOTE: It is probable that Type A2 (Feeder streams) will comprise a significant mileage of the total Minnesota trout streams. It is important both for inventory and management purposes to differentiate these small streams from the more fishable downstream areas. First, it would be unwise to confuse these small streams with our top-notch large fishable trout streams on a quantitative basis; secondly, the feeder streams are unique in some aspects. In some cases these small streams may be directly tributary to non-trout water but still may afford a bona fide trout fishery in their own right. In many cases the greatest value of these small streams is found in their contribution of cold water and recruitment of small trout to the larger downstream areas. In any case, streams that have more than one type should be divided into sectors and each classified individually.

TYPE B.
Trout Streams

Defined as streams capable of supporting a trout population of dominant interest to the sport fishery except for the lack of natural reproduction or over-abundant competing species. Streams in this group will be managed similarly to Type A streams except that efforts may be called for to maintain trout populations at artificially high levels. Population manipulation practices for this purpose may include artificial spawning areas, maintenance stocking of fish, and population control with fish toxicants.

TYPE C.
Steelhead Streams

Defined as streams providing a principal sport fishery for anadromous trout or salmon species. These are waters where the migration of anadromous fish provide a significant fall and spring sport fishery. Management will principally lie in public access along stream banks, maintaining ingress and egress from the lake and regulations permitting the taking of fish during the migration periods. Maintenance stocking of trout may be a beneficial management practice in some instances.

NOTE: Streams in this category may actually be all, or in part, Type A, B, or D trout streams, but should be designated in this group if an existing anadromous population warrants the extended trout season.

TYPE D.
Associated streams--
Trout

Defined as streams not capable of supporting trout populations over extended periods of time, or streams which may contain limited populations of trout, but which have a greater interest or value to the sport fishery in supporting other species of fish. Streams in this group will not be regulated as designated trout waters. If managed for trout fishing, it should be on a put-and-take basis utilizing catchable sized rainbow trout.

TYPE E.
Warmwater gamefish
streams

Defined as streams capable of supporting an acceptable resident sport fishery through natural reproduction. Such stream classification will be subdivided according to the principal species sought although other game and coarse fish species may be present. Streams in this group will be managed by preservation and development of the habitat and natural spawning sites by development of the stream for public fishing areas through acquisition of stream frontage, maintenance of minimum water flows where regulated by upstream reservoirs, and by regulations to promote the optimum sustained recreational use. Generally gamefish populations in these streams will not be maintained at artificial levels by maintenance or put-and-take stocking except that trophy fish species such as muskellunge may be stocked in certain streams managed for

this species.

The subdivisions of warmwater gamefish stream classification are as follows:

E-1 Walleye

E-2 Northern pike

E-3 Catfish--smallmouth bass

E-4 Cosmopolitan (large river)

E-5 Muskellunge

TYPE F.
Warmwater carp
streams

Defined as streams dominated by carp to the extent that management for gamefish species is not feasible because of the cost of carp control. Management of these streams will be restricted to adoption of regulations for optimum sustained harvest of bait species. When practical methods for carp control are found such streams may be re-classified.

TYPE G.
Warmwater connector
streams

Defined as streams having a sport fishery owing its existence to fish populations in adjacent lakes or larger tributaries. In general such streams may vary from mouths of large tributaries to streams conducting the flow from lake to lake. Streams in this group will be managed by protection of the stream habitat including their free-flowing condition and minimum flows and by development of the stream for public fishing areas through acquisition of stream frontage.

These streams will be of two types.

G-1 Warmwater connector streams -
walleye

G-2 Warmwater connector streams -
northern pike

TYPE H.
Warmwater feeder
streams

Defined as streams not capable of providing any significant sport fishery because of small size, shallow character or intermittant nature. Streams of this group will only be managed if utilized in migration of spawning gamefish species.

In such a case acquisition of the stream through easement or purchase will protect it from channelization or barriers.

The subdivisions of warmwater feeder stream classification are as follows:

H-1 Northern pike (spawning)

H-2 Walleye (spawning)

H-3 Minnow

REFERENCES

1. Kuehn, J.H., "Classification of Minnesota Streams for Fisheries Management Purposes (Tentative 1966)", Minnesota Stream Survey Instructions, p. 40-44, Division of Game and Fish, Minnesota Department of Natural Resources.
2. Scidmore, W.J., Manual of Instructions For Lake Surveys, Special Publication No. 1, Minnesota Department of Conservation, Division of Game and Fish, Revised 1970.

Appendix H - Soil Association Survey Sheets (V24)

On the following pages Soil Survey Interpretations are listed for the soil classifications which occur within the MINESITE area. These interpretations were developed by soil scientists of the Soil Conservation Service, Forest Service and the Agricultural Experiment Station, University of Minnesota.

The information contained within the Soil Survey Interpretation sheets, along with V24 Soil Associations, will be useful tools for general or preliminary planning. The interpretative data will be used to group the soil classifications into specific data levels reflecting the desired properties or selected uses needed for an analysis step.

Soil Assn. Number	Major Soil Interpretations	Interpretative Sheet Numbers	Proportion of Major Soils (%)
5	5A	5A	65
	5B	5B; 51B	15
	Minor Soils		20
6	6A	6A; 7B	75
	6B	6B; 7A	15
	Minor Soils		20
7	7A	6B; 7A	60
	7B	6A; 7B	15
	7C	7C; 43A; 44A; 46A; 47A	15
	Minor Soils		10
9	9A	9A; 40A	45
	9B	9B; 40B	40
	9C	9C; 10C; 11A; 40C	5
	Minor Soils		10

Soil Assn. Number	Major Soil Interpretations	Interpretative Sheet Numbers	Proportion of Major Soils (%)
28	28A	28A; 29A	60
	28B	28B; 29B	30
	Minor Soils		10
40	40A	9A; 40A	45
	40B	9B; 40B	40
	40C	9C; 10C	5
	Minor Soils	11A; 40C	10
54	54A	54A; 55B	60
	54B	54B; 55A	30
	Minor Soils		10
55	55A	54B; 55A	60
	55B	54A; 55B	30
	Minor Soils		10
G	GA	GA	65
	Minor Soils		35
P	PA	19B; PA	65
	Minor Soils		35
SP	SPA	SPA	50
	SPB	SPB	35
	Minor Soils		15

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS ^{1/}

SERIES 5A
STATE Minnesota
MLRA 89, 90
Rev. DHP-ELP 11/71

This series consists of gently sloping to steep well drained soils formed in more than 40 inches of brownish, medium and strongly acid gravelly sandy loam over bedrock. At depths of 14 to 28 inches there occurs a well developed fragipan ranging in thickness from 10 to 35 inches or more. Percent of coarse fragment typically is 25 to 35 percent. The fragipan restricts root penetration. The terrain is sloping to hilly and is located in the Laurentian Shield country of northeastern Minnesota.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHO		4	10	40	200						
0 to 16	Gravelly sandy loam	SM	A-2		50-75	40-65	30-55	20-35	10-20	0-4	2.0-6.3	0.10-0.14	4.5 - 6.0	Low
16 to 50 (fragipan)	Gravelly sandy loam	SM	A-2		50-75	40-65	30-55	20-35	10-20	0-4	0.06-0.2	.05-.09	5.1 - 6.0	Low
Flooding None Depth to water table: Below 5 feet Corrosivity - uncoated steel: Low														
Hydrologic group: C Depth to bedrock: Below 5 feet Corrosivity - concrete: Moderate														

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Good to fair: slopes to 25%; difficult to dig if dry
Sand	Poor
Gravel	Poor
Topsoil	Poor: high coarse fragment content

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe: slow permeability, shallow to fragipan
Sewage Lagoons	Severe: most slopes over 6 percent
Shallow Excavations	Moderate to severe: high coarse fragment content, difficult to dig when dry, slopes to 25%
Dwellings:	
With Basements	Slight to severe: features favorable except for slope which ranges from 2 to 25 percent
Without Basements	
Sanitary Landfill	Moderate: high content of coarse fragments; difficult to dig when dry, slopes to 25 percent
Local Roads and Streets	Slight to severe: features favorable except for slope
Potential Frost Action	Low

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	High coarse fragment content, slope to 25 percent
Embankments, Dikes, and Levees	Stable fill, moderately pervious, high coarse fragment content.
Drainage of Cropland and Pasture	
Irrigation	
Terraces and Diversions	
Grassed Waterways	

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Moderate to severe: slow permeability, sloping to hilly terrain
Picnic Areas	Moderate to severe: sloping to hilly terrain
Playgrounds	Severe: most slopes over 6 percent
Paths and Trails	Slight to moderate sloping to hilly terrain

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss					
		K	T				
2 to 18 percent slopes	Vie	.37	3,2				
18 to 25 percent slopes	Vie						

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for--							Potential for--		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
	Poor	Fair	Fair	Fair	Fair	V. Poor	V. Poor	Poor	Fair	Very poor

WOODLAND SUITABILITY

Phases of Series	Ordi-nation	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
All		White birch Trembling aspen White pine Red pine White spruce	- - - - .	Slight to severe on steeper slopes	Slight to moderate	Slight	Moderate		Red pine Jack pine White spruce	

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

OTHER

Low potential productivity. Moderate to low natural fertility; no native plants suitable for grazing. Watershed - Deep to bedrock; morhumus; permeability 0.06-0.2"/hr.; moderate runoff; well drained.

MN-SOILS-3
11-71
(File Code SOILS-12)

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SOIL SURVEY INTERPRETATIONS ^{1/}

SERIES 5B; 51B
STATE Minnesota
MLRA 89,90

This series consists of slightly concave and nearly level, somewhat poorly and poorly drained soils formed in sandy loam glacial till under a mixed deciduous-coniferous forest. Typically they have black loam surface horizons; mottled dark brown and brown loam subsurface horizons; mottled dark brown sandy loam subsoil horizons and dark brown sandy loam underlying material. A fragipan typically begins at 18 inches. Slopes are less than 2 percent. Most areas are forested.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHTO		4	10	40	200						
0-11	GR-L	ML-CL	A-4	0-5	90-100	70-80	60-75	55-65	15-30	0-10	0.6-2.0	.16-.18	5.1-5.5	Low
11-45	GR-SL	SM	A-2	0-5	85-95	70-80	55-65	20-30	10-20	0-4	0.2-0.6	.08-.13	5.1-6.0	V.Low
45-60	GR-SL	SM	A-2	0-5	85-95	70-80	55-65	20-30	10-20	0-4	0.2-0.6	<u>2/</u>	5.1-6.0	V.Low
Flooding <u>None</u>										Hydrologic group: <u>C</u>				
Depth to water table: Normally perched at depths of 2 ft. or less except for parts of July-September.										Depth to bedrock: Greater than five feet.				
Corrosivity - uncoated steel: <u>Low</u>										Corrosivity - concrete: Moderate				

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Fair to Poor - high water table
Sand	Poor
Gravel	Poor
Topsoil	Fair to Poor - small stones, high water table

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe - percolates slowly, wet
Sewage Lagoons	Severe - wet
Shallow Excavations	Severe - wet
Dwellings:	
With Basements	Severe - wet
Without Basements	Moderate to severe - wet
Sanitary Landfill	
Area:	Severe - wet
Trench:	Severe - wet
Local Roads and Streets	Severe - wet, frost action
Potential Frost Action	High

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Moderately slow permeability; somewhat poorly and poorly drained.
Embankments, Dikes, and Levees	Medium shear strength, medium to high susceptibility to piping
Drainage of Cropland and Pasture	Moderately slow permeability
Irrigation	Somewhat poorly and poorly drained; moderately slow permeability
Terraces and Diversions	Generally not needed
Grassed Waterways	Generally not needed

MN-SOILS-3
11-71
(File Code SOILS-12)

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Moderate to severe - wet
Picnic Areas	Moderate to severe - wet
Playgrounds	Moderate to severe - wet
Paths and Trails	Moderate to severe - wet

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss					
		K	T				
All	IIIw						

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for--							Potential for--		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
All	Poor	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
All	2w	Aspen E. Wh. Pine N. Red Oak Red Pine		Slight	Moderate	Slight	Moderate to Severe	White Pine Aspen White Spruce	White Spruce Red Pine	

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

OTHER

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MN-SOILS-3

(File Code SOILS-12)

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS

MLRA

STATE Minnesota

SERIES 6A: 7B

This series consists of deep excessively drained soils formed in loamy material over stratified sand and gravel under deciduous and coniferous forest on plane and convex slopes of outwash plains, eskers, and kames. Typically, they have black, sandy loam surface layers 1 inch thick; dark grayish brown, sandy loam suburface layers 2 inches thick; dark reddish brown and reddish brown, sandy loam subsoil 12 inches thick; and yellowish brown, gravelly very coarse sand underlying material. Slopes range from 1 to 60 percent. Most areas are forested.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	USDA Texture	Classification	Coarse Fract. > 3 in. %	Percentage less than 3 inches	Passing Sieve No. 4	Passing Sieve No. 10	Passing Sieve No. 40	Passing Sieve No. 200	LL	PI	Permeability in./hr.	Available Water Capacity in./in.	Soil Reaction pH	Shrink-Swell Potential
0-15	SL	SM	A-4	0-5	90-100	80-95	55-75	35-50	--	NP	0.6-2.0	.18-.24	4.5-6.5	Low
15-60	GR-COS	GM, GP, SP	A-1	0-10	40-85	35-75	10-45	0-5	--	NP	> 20	.02-.04	4.5-6.5	V. Low
Floodings: None														
Depth to water table: greater than five feet														
Depth to bedrock: 40-120 inches														
Corrosivity - uncoated steel: Low														
Corrosivity - concrete: Moderate														

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Good
Sand	Good
Gravel	Good
Topsoil	Poor: thin layer, small stones

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	0-8%: slight 8-15%: moderate-slope 15%: severe-slope
Sewage Lagoons	Severe: seepage
Shallow Excavations	0-15%: moderate-small stones; 15%: severe-slope
Dwellings:	
With Basements	0-8%: slight; 8-15%: moderate-slope; 15%: severe-slope
Without Basements	
Sanitary Landfill	(Trench and Area) Severe: seepage
Local Roads and Streets	0-8%: slight; 8-15%: moderate-slope; 15%: severe-slope
Potential Frost Action	Low

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Seepage
Embankments, Dikes, and Levees	Seepage
Drainage of Cropland and Pasture	Not needed
Irrigation	Slope, seepage
Terraces and Diversions	Slope, too sandy
Grassed Waterways	Slope, roughness
Excavated Ponds Aquifer Recharge	Deep to water

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	0-8%: slight; 8-15%: moderate-slope; 15+%: severe-slope
Picnic Areas	0-8%: slight; 8-15%: moderate-slope; 15+%: severe-slope
Playgrounds	0-2%: slight; 2-6%: moderate-slope; 6+%: severe-slope.
Paths and Trails	0-15%: slight; 15-25%: moderate-slope; 25+%: severe-slope

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss					
		K	T				
0-2%	3S						
2-6%	3E						
6-12%	4E						
12-18%	6E						
18-35%	7E						

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for--							Potential for--		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
0-12%	Fair	Good	Good	Fair	Fair	V.Poor	V.Poor	Good	Good	V.Poor
12-35%	Poor	Poor	Good	Fair	Fair	V.Poor	V.Poor	Fair	Fair	V.Poor

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
0-12%	3S	Red Pine E.Wh.Pine Jack Pine	55 55 60	Slight	Slight	Moderate	Slight		Red Pine Wh.Spruce	
12-35%	4S	Wh.Spruce Red Pine E.Wh.Pine Jack Pine	60 55 55 60	Moderate	Moderate	Severe	Slight		Red Pine Jack Pine	

RANGE

Phases of Series	Range Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor
0-12%	Northern White-Cedar, Red Pine, Russian-Olive, White Spruce, Jack Pine, Siberian Crabapple, Eastern Red Cedar, Hackberry, Silver Buffalobery, Siberian Peashrub, Bur Oak, Tatarian Honeysuckle	11,20,15 18,20,12 15,18,12 10,18,10	

OTHER

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FOR INTERIM USE

Subject to change on completion of coordination between MLRA'S

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SOIL SURVEY INTERPRETATIONS ^{1/}

SERIES 6B, 7A
STATE Minnesota
MLRA 89 & 90-2
D.P. RL 2-72

This series consists of nearly level to very steep, excessively drained soils formed in outwash material. These soils are on outwash eskers and ice-contact glacial deposits. Native vegetation was forest. The surface layer is dark reddish brown decomposed plant remains about 2 inches thick. The subsurface layer is gray very gravelly coarse sandy loam about 5 inches thick. The subsoil is strong brown, gravelly loamy sand about 10 inches thick. The underlying material is brown very gravelly coarse sand. Permeability is very rapid. The available water capacity is very low and organic matter content is low. These soils contain many cobbles and boulders.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHO		4	10	40	200						
0-15	Very Gravelly loamy sand	GW, GP cr SP	A-1	0-10	20-60	10-50	4-30	0-5	NP	NP	Greater than 20.	0.03-0.05	5.1-6.5	Low
15-60	Very Gravelly loam sand	GW, GP or SP	A-1	5-20	20-60	10-50	4-30	0-5	NP	NP	Greater than 20.	0.02-0.04	5.1-6.5	Low
Flooding None										Hydrologic group: A				
Depth to water table: Greater than 5 feet										Depth to bedrock: Normally greater than 6 feet				
Corrosivity - uncoated steel: Low										Corrosivity - concrete: Low				

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Good: high shear strength; low compressibility
Sand	Poor: quantity of sand is low
Gravel	Good: stones and boulders
Topsoil	Poor: coarse textured; stones and boulders

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Slight: very rapid permeability; moderate on 6 to 12 percent slopes; severe on slopes over 12 percent; hazard of polluting underground water
Sewage Lagoons	Severe: very rapid permeability; coarse textured
Shallow Excavations	Severe: stones and boulders; very gravelly
Dwellings: With Basements	Slight: on 0 to 6 percent slopes; moderate on 6 to 12 percent slopes; severe on more than 12 percent slopes
Sanitary Landfill (trench type)	Severe: very rapid permeability; coarse textured
Local Roads and Streets	Slight: on 0 to 6 percent slopes; moderate on 6 to 12 percent slopes; severe on more than 12 percent slopes.
Potential Frost Action	

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	High compacted permeability
Embankments, Dikes, and Levees	High compacted permeability; low compressibility; high shear strength
Drainage of Cropland and Pasture	Not needed; excessively drained
Irrigation	Very low available water capacity
Terraces and Diversions	Coarse textured; stones and boulders
Grassed Waterways	Coarse textured; stones and boulders

MN-SOILS-3
11-71
(File Code SOILS-12)

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Moderate; many coarse fragments at the surface; 0 to 12 percent slopes; severe on more than 12 percent slopes
Picnic Areas	Moderate; many coarse fragments at the surface; 0 to 12 percent slopes; severe on more than 12 percent slopes
Playgrounds	Severe; many coarse fragments at the surface
Paths and Trails	Moderate; many coarse fragments at the surface; 0 to 25 percent slopes; severe more than 25 percent slopes

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss					
		K	T				
0 to 12% slopes	VIIs	.20	3	-	-	-	
12-18% slopes	VIIs			No information at this time			
18-35% slopes	VIIIs						

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for--							Potential for--		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
All	very poor	poor	poor	very poor	very poor	very poor	very poor	poor	very poor	very poor

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
All	4s	Jack Pine Trembling Aspen	40 or less 50 or less	Slight increases with steep slopes	Moderate 0-12% slopes increases with steep slopes	Moderate to severe	Low	Jack Pine	Jack Pine	

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

OTHER

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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS ^{1/}

SERIES 7C;43A; 44A; 46A; 47A

STATE Minnesota

MLRA 90

Revised Draft DP-RRL 12-72

This series consists of nearly level to steep, excessively drained soils formed in 1 to 2 feet of loamy material over stratified sand and gravel. These soils are on plane and convex slopes of outwash plains, eskers and kames. Native vegetation was forest. In a representative profile the surface layer is black sandy loam about 1 inch thick. The subsoil is dark brown, very friable, sandy loam about 13 inches thick. The underlying material is reddish brown gravelly coarse sand. Permeability is moderate in the upper part of the profile and very rapid in the lower part of the profile. The available water capacity is low and organic matter content is low. The availability of phosphorus is low, and of potassium is low.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHO		4	10	40	200						
0-8	sandy loam	SM	A-4	0-1	90-100	80-95	55-75	35-50	NP	NP	0.6-2.0	0.22-0.24	4.5-6.0	low
8-14	sandy loam	SM	A-4	0-1	90-100	80-95	55-75	35-50	NP	NP	0.6-2.0	0.18-0.21	4.5-6.0	low
14-60	gravelly coarse sand,	GW, GP or SP	A-1	0-10	40-85	35-75	10-45	0-5	NP	NP	Greater than 20	0.02-0.04	5.6-6.5	low
Flooding None										Hydrologic group: B				
Depth to water table: More than 6 feet										Depth to bedrock: More than 6 feet				
Corrosivity - uncoated steel: Very low										Corrosivity - concrete: Moderate				

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Good: high shear strength; low compressibility; low shrink-swell
Sand	Fair: mixed with gravel; needs screening; deposits are generally thick.
Gravel	Good: stratified sand and gravel; some stones and boulders; water table is deep
Topsoil	Fair: upper 1 to 2 feet is sandy loam material; may have some coarse fragments.

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Slight: very rapid permeability ^{2/} Severe: on more than 12 percent slopes ^{2/}	Moderate: 6-12 percent slopes ^{2/}
Sewage Lagoons	Severe: very rapid permeability; coarse textured material	
Shallow Excavations	Severe: many coarse fragments	
Dwellings: With Basements	Slight: high shear strength; low shrink-swell; low compressibility; excessively drained Moderate: 6-12 percent slopes	Severe: greater than 12 percent slopes
Sanitary Landfill (Trench type)	Severe: very rapid permeability ^{2/}	
Local Roads and Streets	Slight: 0-6 percent slopes Severe: on more than 12 percent; good natural drainage; low susceptibility to frost	Moderate: 6-12 percent slopes
Potential Frost Action	Low	heaving

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	very rapid permeability
Embankments, Dikes, and Levees	High shear strength; good compaction characteristics; high compacted permeability low compressibility; good resistance to piping
Drainage of Cropland and Pasture	generally not needed, excessively drained
Irrigation	Low available water holding capacity
Terraces and Diversions	Coarse textured material below depths of 1 to 2 feet; low available water holding capacity
Grassed Waterways	Coarse Textured material below depths of 1 to 2 feet; low available water holding capacity.

^{1/} Use in conjunction with Guide to Soil Survey Interpretation Sheets.

^{2/} Pollution is hazard to water supplies.

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Slight: 0-6 percent slopes Moderate: over 6 percent slopes
Picnic Areas	Slight: 0-12 percent slopes Moderate: over 12 percent slopes
Playgrounds	Slight: 0-2 percent slopes Moderate: 2-6 percent slopes Severe: over 6 percent slopes
Paths and Trails	Slight: 0-6 percent slopes Moderate: slopes over 6 percent

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss		Oats Bu./Ac.	Corn Silage Ton./Ac.	Bluegrass Pasture AUM	Legume-Grass	
		K	T				Ton./Ac.	AUM
0-2% slopes	IIIc	.24	2.2	70	8	4.0	3.5	5.0
2-6% slopes	IIIe			70	8	4.0	3.5	5.0
6-12% slopes	IVe			60	7	4.0	3.5	5.0
2-12% slopes	IVe			60-70	7-8	4.0	3.5	5.0
12-18% slopes	VIe			—	—	4.0	—	—
18-25% slopes	VIIe			—	—	4.0	—	—
12-25% slopes	VIIe			—	—	4.0	—	—
25-35% slopes	VIIIe			—	—	—	—	—

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for --							Potential for --		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
0-12%	Fair	Good	Good	Fair	Fair	Very Poor	Very poor	Good	Good	Very poor
12-35%	Poor	Poor	Good	Fair	Fair	Very poor	Very poor	Fair	Good	Very poor

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
0-12%	3s	Red Pine	55	Slight: 0	Slight	Moderate	Slight to Moderate	Red Pine	Red Pine	
		White Pine	55	-12%				Jack Pine	Jack Pine	
		Jack Pine	60		Moderate to Severe	Moderate		White Pine		
		White Spruce	50	Moderate to Severe						
12-35%										

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

OTHER

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FOR INTERIM USE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS ^{1/}

SERIES 9A; 40A
STATE Minnesota 9/71
MLRA 99, 00
Rev. DHP 11/71

This series consists of gently sloping to steep well drained soils formed in 20 to 40 inches of dark brown, medium acid, gravelly sandy loam glacial till that is underlain by bedrock. The dominated bedrock is gabbro and granite. Surface stones typically occupy less than 5 percent of surface and varies locally to 30 percent. Subsurface coarse fragment content typically is 25 percent. These soils occur on sloping to hilly terrain in the Laurentian Shield country of northeastern Minnesota.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHO		4	10	40	200						
0 to 28	Gravelly sandy loam	SM	A-2		50-85	40-75	30-55	25-35	10-20	0-4	2.0 to 6.3	0.10 to 0.14	5.1 to 6.0	Low
Flooding None Depth to water table: 20 to 40 inches Corrosivity - uncoated steel: Low														
Hydrologic group: C Depth to bedrock: 20 to 40 inches Corrosivity - concrete: moderate to high														

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Fair: limited volume of material, poor on slopes over 18 percent
Sand	Poor
Gravel	Poor
Topsoil	Poor: low natural fertility; 25% coarse fragments

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe: bedrock at 20 to 40 inches, sloping to hilly terrain
Sewage Lagoons	Severe: bedrock at 20 to 40 inches, sloping to hilly terrain
Shallow Excavations	Severe: bedrock at 20 to 40 inches
Dwellings: With Basements Without Basements	Severe: bedrock at 20 to 40 inches; sloping to hilly terrain
Sanitary Landfill	Severe: bedrock at 20 to 40 inches; sloping to hilly terrain
Local Roads and Streets	Severe: bedrock at 20 to 40 inches, sloping to hilly terrain
Potential Frost Action	Low

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Bedrock at 20 to 40 inches, no or very few available sites
Embankments, Dikes, and Levees	Bedrock at 20 to 40 inches, high content of coarse fragments
Drainage of Cropland and Pasture	
Irrigation	
Terraces and Diversions	
Grassed Waterways	

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Moderate to sloping to hilly terrain
Picnic Areas	Moderate to severe; sloping to hilly terrain
Playgrounds	Severe: sloping to hilly terrain
Paths and Trails	Slight to moderate; sloping to hilly terrain

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss					
		K	T				
2 to 18 percent slopes	VIe	.37	2,2				
18 to 35 percent slopes	VIIe						

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for --							Potential for --		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
All	V. Poor	Fair	Fair	Fair	Fair	V. Poor	V. Poor	Poor	Fair	Very poor

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
All		Jack pine	50-60	Slight	Slight to	Slight	Moderate		Jack pine	
		Trembling aspen	-	to	severe on				Red pine	
		White pine	-	severe	steeper				White spruce	
		White spruce	-	on	slopes					
		Red pine	-	steeper slopes						

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

OTHER

Potential productivity is low. Moderate to low natural fertility; no native plants suitable for grazing. Watershed - Shallow to bedrock; erodibility class III; mor humus; *infiltration 0.15-0.3"/hr. permeability 2-6.3"/hr; moderate runoff; well drained. * Infiltration rates need further consideration.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS ^{1/}

SERIES 9B; 40B
STATE Minnesota
MLRA 89,90
Rev. DHP-ELB 11/71

This series consists of gently sloping to steep well drained soils formed in 8 to 20 inches of brownish and reddish gravelly coarse sandy loam, glacial till underlain by bedrock. Coarse fragment content typically is about 20 percent. Soils are subject to seasonal drouthiness. These soils occur on sloping to hilly terrain in the Laurentian Shield country of northeastern Minnesota.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHO		4	10	40	200						
0-15	Gravelly coarse sandy loam	SM	A-2		50-85	40-75	30-44	25-35	10-20	0-4	2.0 to 6.3	0.10 to 0.14	5.1 to 6.0	Low
15+	Bedrock													
Flooding None										Hydrologic group: B				
Depth to water table: 5 feet										Depth to bedrock: 8 to 20 inches				
Corrosivity - uncoated steel: Low										Corrosivity - concrete: Moderate to high				

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Fair; limited volume of material; poor on slopes over 18 percent
Sand	Unsuited
Gravel	Unsuited
Topsoil	Poor; low natural fertility; shallow to bedrock

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe: shallow to bedrock
Sewage Lagoons	Severe: shallow to bedrock; moderately rapid permeability; sloping to hilly terrain
Shallow Excavations	Severe: shallow to bedrock, sloping to hilly terrain
Dwellings: With Basements Without Basements	Severe: shallow to bedrock, sloping to hilly terrain
Sanitary Landfill	Severe: shallow to bedrock, sloping to hilly terrain
Local Roads and Streets	Severe: shallow to bedrock, sloping to hilly terrain
Potential Frost Action	Low

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Shallow to bedrock, no or very few suitable sites
Embankments, Dikes, and Levees	Moderately rapid permeability, shallow to bedrock
Drainage of Cropland and Pasture	
Irrigation	
Terraces and Diversions	
Grassed Waterways	

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Moderate or severe on slopes over 18%; shallow to bedrock; low natural fertility; subject to compaction; low natural carrying capacity for intensive use
Picnic Areas	Moderate, severe on slopes over 18 percent, shallow to bedrock; sloping to hilly terrain; low natural fertility
Playgrounds	Severe; sloping to hilly terrain; subject to compaction; low natural carrying capacity for intensive use
Paths and Trails	Slight, moderate on slopes over 18 percent: sloping to hilly terrain

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss					
		K	T				
2 to 18% slope	VIe	.37	2,2				
18-35% slope	VIIe						

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for--							Potential for--		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
All	V. Poor	Fair	Fair	Fair	Fair	V. Poor	V. Poor	Poor	Fair	Very poor

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
All		Jack pine Trembling aspen White spruce	50 50 45	Moderate to severe on steeper slopes	Slight to severe on steeper slopes	Slight	Slight		Jack pine Red pine	

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

OTHER

Potential productivity is low. Low natural fertility. No native plants suitable for grazing. Watershed - shallow to bedrock; erodibility class III; morhumus; *infiltration 0.15 to 0.3"/hr.; permeability 2 to 6.3"/hr.; moderate runoff; well drained. *Infiltration rate needs further consideration.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS ^{1/}

SERIES 9C; 10C; 11A; 40C
Minnesota
STATE
89 00
MLRA
Rev. DHP-ELB 11/71

This series consists of somewhat excessively drained soils formed in 4 to 8 inches of dark brown and strong brown, strongly and very strongly acid loam over bedrock. Bedrock outcroppings are common. The terrain is broken, irregular and sloping to hilly. These soils occur within the Laurentian Shield country of northeastern Minnesota.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHTO		4	10	40	200						
0 to 8	Loam	ML-CL	A-4		75-95	70-90	60-80	55-70	10-30	5-10	0.63 to 2.0	0.15 to 0.20	4.5 to 5.5	Low
8+	Bedrock													
Flooding None										Hydrologic group: D				
Depth to water table: Over 5 feet										Depth to bedrock: 8 inches or less				
Corrosivity - uncoated steel: Low										Corrosivity - concrete: Moderate to high				

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Poor: shallow soil, outcrops of bedrock are common
Sand	Unsuited
Gravel	Unsuited
Topsoil	Poor: extremely shallow to bedrock

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe: extremely shallow to bedrock; sloping to hilly terrain
Sewage Lagoons	Severe: extremely shallow to bedrock; sloping to hilly terrain
Shallow Excavations	Severe: extremely shallow to bedrock; sloping to hilly terrain
Dwellings: With Basements Without Basements	Severe: extremely shallow to bedrock; sloping to hilly terrain; low clay content; well drained
Sanitary Landfill	Severe: extremely shallow to bedrock; sloping to hilly terrain
Local Roads and Streets	Severe: extremely shallow to bedrock; sloping to hilly terrain
Potential Frost Action	Low

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Shallow to bedrock, no suitable sites
Embankments, Dikes, and Levees	Shallow to bedrock, limited volume of material
Drainage of Cropland and Pasture	
Irrigation	
Terraces and Diversions	
Grassed Waterways	

^{1/} Use in conjunction with Guide to Soil Survey Interpretation Sheets.

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Severe: irregular, broken sloping to hilly terrain; extremely shallow soils; soils subject to compaction; low natural fertility
Picnic Areas	Severe: irregular, broken, sloping to hilly terrain
Playgrounds	Severe: irregular, broken, sloping to hilly terrain; extremely shallow soils
Paths and Trails	Moderate on 5 to 18 percent slopes and severe on slopes over 18 percent; irregular broken, sloping to hilly terrain

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss					
		K	T				
5 to 18 percent slopes	VIIIs	-	-				
18 to 35 percent slopes	VIIIs						

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for--							Potential for--		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
	V. Poor	Poor	Poor	Poor	Poor	V. Poor	V. Poor	Poor	Poor	Very poor

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
All		Jack pine	<40	Moderate to severe	Moderate to severe	Slight	Slight		Jack pine	

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

OTHER

Watershed - Extremely shallow to bedrock; morhumus; permeability 0.63-2.0"/hr.; rapid runoff; low storage; somewhat excessively drained.

SOIL SURVEY INTERPRETATIONS ^{1/}

This series consists of deep excessively drained soils formed in glacial outwash under coniferous forest on outwash plains and valley trains. Typically they have black and very dark grayish brown loamy coarse sand 4 inches thick; dark brown, dark yellowish brown and brown coarse sand subsoils 20 inches thick; and pale brown coarse sand underlying material. Slopes range from 0 to 12 percent. Most areas are forested, a few cropped or pastured.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHO		4	10	40	200						
0-4	LCOS	SM	A-2	-	95-100	85-100	60-80	10-30	-	-	6.0-20	0.10-0.12	4.5-6.0	Low
4-60	COS, S	SP	A-3	-	95-100	85-100	50-75	0-10	-	-	6.0-20	0.05-0.07	4.5-6.0	Low
Flooding None Hydrologic group: A Depth to water table: greater than 6 feet Depth to bedrock: greater than 60 inches Corrosivity - uncoated steel: Low Corrosivity - concrete: Moderate														

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Good
Sand	Good
Gravel	Unsuited
Topsoil	Poor - too sandy

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Hazard of pollution	
0-8%: slight	8+%: moderate - slope	
Sewage Lagoons	Hazard of pollution	
Severe - seepage		
Shallow Excavations	Severe - cutbanks cave	
Dwellings:		
With Basements	0-8%: slight	8+%: moderate - slope
Without Basements		
Sanitary Landfill	Hazard of pollution	
Severe - seepage		
Local Roads and Streets	0-8%: slight 8+%: moderate - slope	
Potential Frost Action	Low	

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Seepage
Embankments, Dikes, and Levees	Seepage
Drainage of Cropland and Pasture	Not needed
Irrigation	Droughty, seepage
Terraces and Diversions	Erodes easily, too sandy
Grassed Waterways	Droughty

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Moderate - too sandy
Picnic Areas	Moderate - too sandy
Playgrounds	0-6%: moderate - too sandy 6+%: severe - slope
Paths and Trails	Moderate - too sandy

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss		Corn Silage (tons)	Oats (Bu)	Grass-Legume Hay (tons)	Kentucky Bluegrass (AUM)
		K	T				
0-12%	4s	.20	5	8	40	2.5	1.2

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for--							Potential for--		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
All	Poor	Poor	Fair	Poor	Poor	V. Poor	V. Poor	Poor	Poor	V. Poor

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
All	3s	Red Pine White Pine Jack Pine White Spruce	56 54 60 59						Red Pine White Spruce	

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor
Group 6	Eastern Red Cedar Red Pine Jack Pine Ponderosa Pine	15 20 21 20	

OTHER

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MN-SOILS-3
11-71
(File Code SOILS-12)

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SOIL SURVEY INTERPRETATIONS 1/

SERIES 28B; 29B
STATE Minnesota
MLRA 88
PRCN, RHH

This series consists of deep excessively drained soils formed in sandy outwash under coniferous and deciduous forest on smooth and pitted plains. Typically they have organic layers 2 inches thick; very dark gray and dark grayish brown loamy sand surface layers 2 to 4 inches thick; dark brown loamy sand subsurface layers 10 inches thick; layered brown and yellowish brown coarse sand and dark brown loamy coarse sand subsoil 27 inches thick; and pale brown or brown sand or coarse sand underlying material. Slopes are 0 to 35 percent. The main use is for forestry.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHTO		4	10	40	200						
0-13	LS	SM	A-1,A-2	0-2	95-100	90-100	50-75	15-30		NP	6.0-20	.10-.12	5.1-6.0	V. Low
13-40	COS	SP,SM	A-1	0-5	80-100	75-100	40-70	0-10	--	NP	>20	.03-.05	5.1-6.0	V. Low
28-30	COS	SM,SP	A-1	0-5	80-100	75-100	40-70	10-20		NP	6.0-20	.05-.07	5.6-6.5	V. Low
40-60	S	SP,SM	A-1	0-5	80-100	75-100	40-70	0-10	--	NP	>20	.02-.04	5.6-7.8	V. Low
Flooding None										Hydrologic group: A				
Depth to water table: > 6 feet										Depth to bedrock: > 60 inches				
Corrosivity - uncoated steel: Low										Corrosivity - concrete: Med., Med., low, low				

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Good-area reclaim
Sand	Good
Gravel	Poor-excessive fines
Topsoil	Poor-too sandy

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Potential hazard of pollution to water supplies, all slope phases. 0-8%: slight; 8-15%: moderate-slope; 15+%: severe-slope.
Sewage Lagoons	All: severe-seepage. Potential hazard of pollution to water supplies, all slope phases.
Shallow Excavations	All: severe-cutbanks cave
Dwellings:	
With Basements	0-8%: slight; 8-15%: moderate-slope; 15+%: severe-slope.
Without Basements	0-8%: slight; 8-15%: moderate-slope; 15+%: severe-slope
Sanitary Landfill	Potential hazard of pollution to water supplies, all slope phases. (Area) All: severe-seepage (Trench) All: severe-too sandy, seepage
Local Roads and Streets	0-8%: slight; 8-15%: moderate-slope; 15+%: severe-slope
Potential Frost Action	Low

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Seepage
Embankments, Dikes, and Levees	Seepage, piping, erodes easily
Drainage of Cropland and Pasture	Not needed
Irrigation	Drouthy, fast intake
Terraces and Diversions	Too sandy, erodes easily, piping
Grassed Waterways	Drouthy, erodes easily, slope
Excavated Ponds	Aquifer Fed: no water

MN-SOILS-3
11-71
(File Code SOILS-12)

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	0-15%: moderate-too sandy; 15%: severe-slope.
Picnic Areas	0-15%: moderate-too sandy; 15%: severe-slope.
Playgrounds	0-6%: moderate--too sandy. 6%: severe-slope.
Paths and Trails	0-25%: moderate-too sandy; 25%: severe-slope.

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss		CORN SILAGE	OATS	GRASS- LEGUME HAY	BROMEGRASS ALFALFA	GRASS- CLOVER	KENTUCKY BLUEGRASS
		K	T	(Tons)	(Bu)	(Tons)	(AUM)	(AUM)	(AUM)
0-3%	4S			8	45	2.2	4.0	3.1	2.0
3-12%	4S			7.5	40	2.0	4.0	3.1	2.0
12-35%	7S			--	--	--	3.0	2.0	1.5

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for--							Potential for--		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
0-15%	Poor	Poor	Fair	Poor	Poor	V.Poor	V.Poor	Poor	Poor	V.Poor
15-35%	V.Poor	V.Poor	Fair	Poor	Poor	V.Poor	V.Poor	Poor	Poor	V.Poor

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
0-12%	3S	Red Pine E. Wh. Pine Jack Pine	56 54 60	Slight	Slight	Severe	Slight		Red Pine Wh. Spruce Jack Pine	
12-35%	4S	Wh. Spruce Red Pine E. Wh. Pine Jack Pine	59 52 50 57	Moderate	Moderate	Severe	Slight		Red Pine Jack Pine	
		Wh. Spruce	54							

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor
0-12%	E.Red Cedar, N. Wh. Cedar, Wh. Spruce, Red Pine, E. Wh. Pine, Russian-Olive, Siberian Crabapple, Tatarian Honeysuckle, Siberian Pea Shrub	15, 11, 18, 20, 20, 15, 12, 10, 10	
12-35% North facing	E.Red Cedar, Wh. Spruce, Red Pine, Siberian Pea Shrub	18, 22, 25, 12	
12-35% South facing	E.Red Cedar, Wh. Spruce, Red Pine, Siberian Pea Shrub	12, 0, 15, 10	

OTHER

B 0 to 12 percent slopes: windbreak suitability group 6. 12 to 35 percent slopes: windbreak suitability group 7.

SOIL SURVEY INTERPRETATIONS ^{1/}

This series consists of deep, somewhat poorly and poorly drained soils formed in reddish brown clayey glacial till under a deciduous and coniferous forest on nearly level till plains and good moraine. Typically they have grayish brown, loam surface layers 9 inches thick; reddish brown clay subsoil layers 25 inches thick; reddish brown silty clay underlying material. Slopes range from 0 to 2 percent.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. > 3 in. %	Percentage less than 3 inches				LL	PI	Permeability In./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential	
	USDA Texture	Unified	AASHTO		Passing Sieve No. --										
0-9	Loam	ML ML-CL	A-4	0	95-100	90-100	80-85	65-90	15-25	0-4	0.6-2.0	.20-.22	4.5-6.0	Low	
9-36	Clay	CL MH-CH	A-7	0	95-100	90-100	80-85	65-90	40-60	20-35	.06-0.2	.10-.14	5.1-8.1	Mod.	
36-60	Silty Clay	CL MH-CH	A-7	0	95-100	90-100	80-85	65-90	40-60	20-35	.06-0.2	.09-.15	7.4-8.1	Mod.	
Flooding Occasional - brief															Hydrologic group: C
Depth to water table: 1 to 3 feet, perched, Oct.-June															Depth to bedrock: Greater than five feet.
Corrosivity - uncoated steel: Moderate															Corrosivity - concrete: Moderate

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Fair: frost action, shrink-swell
Sand	Unsuitable
Gravel	Unsuitable
Topsoil	Fair: thin layer

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe: percolates slowly
Sewage Lagoons	Slight: percolates slowly
Shallow Excavations	Severe: floods, too clayey, wet
Dwellings:	
With Basements	Severe: wet
Sanitary Landfill	(Trench) Severe: wet, too clayey, percolates slowly, floods.
Local Roads and Streets	Severe: floods, wet
Potential Frost Action	Moderate

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Favorable
Embankments, Dikes, and Levees	Favorable
Drainage of Cropland and Pasture	Fair: slowly, wet
Irrigation	Not
Terraces and Diversions	Not needed
Grassed Waterways	Not, percolates slowly

MN-SOILS 3
11-71
(File title SOILS-12)

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Severe: percs slowly, wet
Picnic Areas	Severe: wet
Playgrounds	Severe: wet, floods
Paths and Trails	Moderate: floods, wet

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss K T		Oats (SU)	Corn Silage/Pasture	Bluegrass (AUM)	Legume-Grass Hay (T/A)	Pasture (AUM)
All	IIIw			80	14	5.0	4.5	6.5

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for--							Potential for--		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
All	Poor	Fair	Good	Fair	Good	Good	Good	Fair	Good	Good

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
All	2w	Red Pine E. Wh. Pine Wh. Spruce Northern Hardwoods	60 60 60 60-70	Slight	Moderate	Moderate	Moderate to Severe	Wh. Spruce E. Wh. Pine Northern Hardwoods	Wh. Spruce Northern Hardwoods	

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

OTHER

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FOR INTERIM USE

Subject to change on completion of coordination between MLRA'S

H-24

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SOIL SURVEY INTERPRETATIONS ^{1/}

SERIES 54B; 55A
STATE Minnesota
MLRA 90

Rev. GDN, RRL 2-72

This series consists of nearly level to hilly, well and moderately well drained soils formed in reddish brown clayey material. These soils are on moraines and lake plains. Native vegetation is forest. The surface layer is dark gray loam about 2 inches thick. The subsurface layer is grayish brown loam about 6 inches thick. The subsoil is reddish brown clay about 26 inches thick. The underlying material is reddish brown clay. Permeability is slow. The available water capacity is moderate and organic matter content is low. The availability of phosphorous is low, and of potassium is low.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHTO		4	10	40	200						
0-8	Loam	ML ML-CL	A-4	0	95-100	90-100	80-85	65-90	15-25	0-4	0.6-2.0	.20-.22	4.5-6.0	Low
8-34	Clay	CL or MH-CH	A-7	0	95-100	90-100	80-95	65-90	40-60	20-35	0.06-0.2	0.1-0.14	5.1-8.4	Moderate
34-60	Clay	CL or MH-CH	A-7	0	95-100	90-100	80-95	65-90	40-60	20-35	0.06-0.2	0.1-0.14	7.4-8.4	Moderate
Flooding None										Hydrologic group: C				
Depth to water table: Greater than 5 feet										Depth to bedrock: Greater than 10 feet				
Corrosivity - uncoated steel: Moderate										Corrosivity - concrete: Moderate				

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Fair: low to medium shear strength; medium compressibility; fair to good workability
Sand	Not suitable
Gravel	Not suitable
Topsoil	Fair: moderately thick loamy material; low organic matter content

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe: slow permeability
Sewage Lagoons	Slight: slow permeability; moderate: on slopes 2-6 percent; severe: on slopes over 6%
Shallow Excavations	Moderate: clayey material; severe: over 12 percent slopes
Dwellings: With Basements	Moderate: moderate shrink-swell; severe: over 12 percent slopes
Sanitary Landfill (Trench type)	Severe: poor workability
Local Roads and Streets	Severe: moderate to high susceptibility to frost action
Potential Frost Action	Moderate to high

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Slow permeability
Embankments, Dikes, and Levees	Medium to low shear strength; medium compressibility
Drainage of Cropland and Pasture	Generally not needed
Irrigation	Moderate available water capacity; slow permeability
Terraces and Diversions	Clayey material; slow permeability; poor workability
Grassed Waterways	Clayey material; slow permeability

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Moderate: slow permeability; Severe: on slopes over 12 percent
Picnic Areas	Slight: on nearly level slopes; Moderate: on slopes 6-12 percent; Severe: on slopes 12 percent
Playgrounds	Moderate: slow permeability; Severe: on slopes over 6 percent
Paths and Trails	Slight: 0-12 percent slopes; Moderate: on slopes 12-25 percent slopes; Severe: over 25 percent slopes

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss		Oats	Corn Silage	Bluegrass Pasture	Legume-Grass	
		K	T				T	AUM
0-2% slopes	IIC	.43	3.2	80 Bu.	14	5.0	4.5	6.5
2-6% slopes	IIE			80	14	5.0	4.5	6.5
6-12% slopes	IIIE			70	10	5.0	4.5	6.5
2-11% slopes	IIIE			70-80	10-14	5.0	4.5	6.5
12-25% slopes	VIe			-	-	4.0	-	-

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for --							Potential for --		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
0-12%	Good	Good	Good	Good	Good	Poor	Very Poor	Good	Good	Very Poor
12-25%	Poor	Fair	Good	Good	Good	Very poor	Very poor	Fair	Good	Very poor

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
0-12%	2c	Aspen	70	Slight	Slight	Slight	Moderate to Slight	Red Pine	Red Pine	
		Red Pine	60					Basswood	Black Spruce	
		White Pine	50					Red Oak	White Spruce	
		Jack Pine	60	Moderate	Moderate	Slight	Moderate to Severe	White Pine	Basswood	
12-25%		Northern Hardwoods	60					White Spruce	Red Oak	

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

OTHER

--

SOIL SURVEY INTERPRETATIONS ^{1/}

Series - CA

STATE Minnesota

MLRA 88-90

Revised Draft GDN, RRL 2-72

These are extremely to very strongly acid deep organic soils. They consist of moderately decomposed dark brown or dark reddish brown herbaceous material throughout most of the layers from 12 to 51 inches. Normally these soils occupy bogs ranging from 10 to more than 600 acres in size. Black spruce along with a few tamarack are the major trees growing on these soils. The permeability is moderate to moderately rapid. The available water capacity is very high.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHO		4	10	40	200						
0-20	Peat (fibric)	PT	A-8	0	Not suitable for engineering sieve analysis				--	--	6-20+	0.58-0.70	3.5-4.5	High
20-70	Peat (hemic)	PT	A-8	0					--	--	0.6-6.0	0.48-0.58	4.0-5.0	High
Flooding None										Hydrologic group: D				
Depth to water table: Near surface during most of growing season										Depth to bedrock: Greater than 5 feet				
Corrosivity - uncoated steel: High										Corrosivity - concrete: High				

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Poor: organic soils; low bearing capacity
Sand	Not suitable
Gravel	Not suitable
Topsoil	Poor when used alone. Fair to good when mixed mineral soils; needs lime

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe: high water table; very poorly drained
Sewage Lagoons	Severe: high water table; more than 30 percent organic matter
Shallow Excavations	Severe: high water table; poor side slope stability
Dwellings: With Basements	Severe: very poorly drained; high water table
Sanitary Landfill (trench type)	Severe: very poorly drained; high water table
Local Roads and Streets	Severe: high water table; high susceptibility to frost action; high shrink-swell potential more than 30 percent organic matter
Potential Frost Action	High

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	High water table
Embankments, Dikes, and Levees	High water table; low compacted loaded permeability; poor stability more than 30 percent organic matter
Drainage of Cropland and Pasture	High water table; subsidence is common after drainage
Irrigation	High water table; very poorly drained
Terraces and Diversions	Not applicable; nearly level
Grassed Waterways	Not applicable; nearly level

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Severe: high water table; poor trafficability
Picnic Areas	Severe: high water table; poor trafficability
Playgrounds	Severe: high water table; poor trafficability
Paths and Trails	Severe: high water table; poor trafficability

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss		Oats	Corn Silage		Legume - Grass		Bluegrass Pasture
		K	T				Hay	Pasture	
All	IVW	--	--	B/A 60	T/A 12		T/A 4.5	AUM 6.7	AUM 5.3

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for --							Potential for --		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
530S	Very Poor	Very Poor	Poor	Very Poor	Poor	Poor	Good	Very Poor	Very Poor	Fair
530	Very Poor	Poor	Poor	Poor	Poor	Good	Good	Very Poor	Very Poor	Good

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
All	5w	Black Spruce Tamarack	15-40	Slight	Severe	Severe	Severe	Black Spruce Tamarack	Black Spruce Tamarack	

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

CROPLAND OTHER

Potential yields are moderate for the commonly cultivated crops. The choice of crops is limited by climate, low fertility, and a high water table. Crops that can withstand light frost and have a short growing season are best suited. These include carrots, cabbage, cauliflower, celery, potatoes, cultured sod, radishes, onions and the like. Wind erosion and fire are special hazards.

FOR INTERIM USE

Subject to change on completion of coordination between MLRA's

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS ^{1/}

SERIES 19B; PA

STATE Minnesota

MLRA 89-90

Revised Draft GDN-RRL 1-73

These are medium to slightly acid deep very poorly drained organic soils. They consist of moderately decomposed dark reddish brown woody materials throughout most of the layers from 12 to 51 inches. Normally these soils occupy bogs ranging from 10 to more than 600 acres in size. White cedar, tamarack, black spruce and in places black ash are the major trees growing on these soils. Some areas are nearly treeless and have chiefly lowland brush. These soils have a high inherent fertility.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHO		4	10	40	200						
0-60	Mucky Peat (hemic)	PT	A-B	0	Not suitable for engineering sieve analysis				—	—	10-20	.48-.58	5.1-6.5	High ^{2/}

Flooding None

Hydrologic group: D

Depth to water table: Near surface during most of growing season

Depth to bedrock: Greater than 5 feet

Corrosivity - uncoated steel: High

Corrosivity - concrete: Moderate

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Poor: organic soils; low bearing capacity; high water table
Sand	Not suitable
Gravel	Not suitable
Topsoil	Poor when used alone. Fair to good when mixed with mineral soil; high water table.

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe: high water table; very poorly drained
Sewage Lagoons	Severe: high water table; more than 30 percent organic matter.
Shallow Excavations	Severe: high water table; very poorly drained; low resistance to sloughing
Dwellings; With Basements	Severe: high water table; very poorly drained
Sanitary Landfill (Trench type)	Severe: very poorly drained; high water table
Local Roads and Streets	Severe: high water table; high susceptibility to frost action; high shrink-swell potential more than 30 percent organic matter
Potential Frost Action	High

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	High water table
Embankments, Dikes, and Levees	High water table; low shear strength
Drainage of Cropland and Pasture	High water table; very poorly drained; organic soil;
Irrigation	High water table; very poorly drained
Terraces and Diversions	Not applicable; nearly level bog
Grassed Waterways	Not applicable; nearly level bog

^{1/} Use in conjunction with Guide to Soil Survey Interpretation Sheets.

^{2/} Shrinkage is very high, but the pressure exerted upon swelling is rather low.

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Severe: high water table; poor trafficability
Picnic Areas	Severe: high water table; poor trafficability
Playgrounds	Severe: high water table; poor trafficability
Paths and Trails	Severe: high water table; poor trafficability

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss		Bu. Oats	Tons-Corn Silage	AUM Pasture	Tons Legume-grass	AUM
		K	T					
All	IVW	—	—	60	12	Bluegrass 5.0	4.5	6.5

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for--							Potential for--		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
All	Very Poor	Poor	Good	Fair	Fair	Good	Good	Poor	Poor	Good

WOODLAND SUITABILITY

Phases of Series	Ordi-nation	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
All	5w	Black Spruce Tamarack White Cedar	30-40	Slight	Severe	Severe	Severe	Black Spruce Tamarack White Cedar	Black Spruce Tamarack White Cedar	

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

CROPLAND

Potential yields are moderate for the commonly cultivated crops. The choice of crops is limited by climate, and a high water table. Crops that can withstand light frost and have a short growing season are best suited. These include carrots, cabbage, cauliflower, celery, potatoes, cultured sod, radishes, onions and the like. Soil blowing and fire are special hazards.

FOR INTERIM USE

US7A-361 LINCOLN, NEBR. 1973

Subject to change on completion of coordination between MLRA'S

SOIL SURVEY INTERPRETATIONS ^{1/}

SERIES SPA
STATE MINNESOTA
MLRA 88, 89
REV. RRL 8-18-71

These soils are extremely acid, deep organic soils. They consist of slightly decomposed, reddish brown sphagnum fibers throughout most of the upper 5 feet. Normally they occupy areas within large bogs that have slightly convex surfaces. Mapped areas are usually circular or oblong and range from about 100 to more than 600 acres in size. Black spruce along with a few tamarack are the major trees growing on these soils.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential															
	USDA Texture	Unified	AASHO		4	10	40	200																					
0-60"	Fibric	Pt	-		Not suitable for engineering -- sieve analysis					--	12-20	0.55-0.65	3.5-4.5	High															
Flooding None															Hydrologic group: D														
Depth to water table: 0 to 2 feet.															Depth to bedrock: 5 to many feet.														
Corrosivity - uncoated steel: Very high.															Corrosivity - concrete: High														

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Poor; organic soils; very low bearing capacity.
Sand	Not suitable.
Gravel	Not suitable.
Topsoil	Poor when used alone. Fair to good when mixed with mineral soil; needs lime. High water table.

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe: High water table, organic material.
Sewage Lagoons	Severe: High water table; more than 30% organic matter.
Shallow Excavations	Severe: High water table, organic material.
Dwellings: With Basements Without Basements	Severe: High water table; low shear strength; high shrink-swell potential high compressibility; very low bearing values.
Sanitary Landfill	Severe: High water table; poor trafficability.
Local Roads and Streets	Severe: High water table; high susceptibility to frost action; high shrink-swell potential; more than 30% organic matter.
Potential Frost Action	High

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Organic soil, high water table.
Embankments, Dikes, and Levees	High water table; poor stability; more than 30% organic matter.
Drainage of Cropland and Pasture	Water table at the surface or within 1-2 feet during the growing season; usually drained by open ditches.
Irrigation	
Terraces and Diversions	
Grassed Waterways	

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Severe: High water table; poor trafficability.
Picnic Areas	Severe: High water table; poor trafficability.
Playgrounds	Severe: High water table; poor trafficability.
Paths and Trails	Severe: High water table; poor trafficability.

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss					
		K	T				
0 to 2% slope	VIIw	-	-				

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for--							Potential for--		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
All	Very Poor	Very Poor	Very Poor	Very Poor	Very Poor	Good	Good	Very Poor	Very Poor	Fair

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
All	5w	Black spruce	20-30	Slight	Severe	Severe	Severe		Black Spruce	

RANGE

Phases of Series	Range Site Name	Climate Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

OTHER

Potential yields are poor for the commonly cultivated crops. The choice of crops is limited by climate, low fertility, and a high water table. Crops that can withstand light frost and have a short growing season are best suited. These include carrots, cabbage, cauliflower, celery, potatoes, cultured sod, radishes, onions and the like. These peats are well suited for commercial peat harvesting.

FOR INTERIM USE

Subject to change on completion of coordination between MLRA'S

Page 2 of 2

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SOIL SURVEY INTERPRETATIONS ^{1/}

SERIES SPB
STATE MINNESOTA
MLRA 88, 89, 90
REV. 10-71

These are extremely acid, deep organic soils. They consist of slightly decomposed reddish brown sphagnum material throughout the upper three to four feet. Below this is moderately decomposed, dark reddish brown herbaceous material. These soils occur in relatively narrow bands around the outer edge of large raised bogs, and in circular or oblong areas in small bogs.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHO		4	10	40	200						
0-38	Fibric	Pt	-		Not suitable for engineering - sieve analysis				-	-	6-20	0.55-0.65	3.4-4.5	High
38-60	Hemic	Pt	-						--	-	2.0-6.3	0.45-0.55	4.0-4.5	High
Flooding None Hydrologic group: D Depth to water table: 0 to 2 feet. Depth to bedrock: 5 to many feet. Corrosivity - uncoated steel: Very high. Corrosivity - concrete: High														

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Poor: Organic soils; very low bearing capacity.
Sand	Not suitable.
Gravel	Not suitable.
Topsoil	Poor when used alone. Fair to good when mixed with mineral soil; needs lime. High water table.

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe: Highwater table; organic material.
Sewage Lagoons	Severe. High water table; more than 30% organic matter.
Shallow Excavations	Severe: High water table, organic material.
Dwellings:	Severe: High water table; low shear strength; high shrink-swell potential; high compressibility; very low bearing values.
With Basements	
Without Basements	
Sanitary Landfill	Severe: High water table; poor trafficability.
Local Roads and Streets	Severe: High water table; high susceptibility to frost action; high shrink-swell potential; more than 30% organic matter.
Potential Frost Action	High

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Organic soil, high water table.
Embankments, Dikes, and Levees	High water table; poor stability; organic material.
Drainage of Cropland and Pasture	Water table at the surface or within 1-2 feet during the growing season; usually drained by open ditches.
Irrigation	
Terraces and Diversions	
Grassed Waterways	

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Severe: High water table; poor trafficability.
Picnic Areas	Severe: High water table; poor trafficability.
Playgrounds	Severe: High water table; poor trafficability.
Paths and Trails	Severe: High water table; poor trafficability.

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss					
		K	T				
0 to 2% slopes VIIw		-	-	--	--	--	--

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for --							Potential for --		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
All	Very poor	Very poor	Very poor	Very poor	Very poor	Good	Good	Very poor	Very poor	Fair

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
All	5W	Black Spruce	20-40	Slight	Severe	Severe	Severe		Black Spruce	

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

OTHER

Potential yields are poor for the commonly cultivated crops. The choice of crops is limited by climate, low fertility, and a high water table. Crops that can withstand light frost and have a short growing are best suited. These include carrots, cabbage, cauliflower, cranberries, celery, potatoes, cultured sod, radishes, onions and the like.

FOR INTERIM USE

Subject to change on completion of coordination between MLRA'S

Page 2 of 2

APPENDIX I - Mineral Resource Polygons (V29)

The Mineral Resource Polygon Map shows the area of influence assigned to each of 324 drill holes used in the study "Mineral Resources of a Portion of the Duluth Complex and Adjacent Rocks in St. Louis and Lake Counties, Northeastern Minnesota," by W.H. Listerud and D.G. Meineke. In order to qualify for use in the study, a drill hole had to contain mineralization meeting certain specifications, consisting of the following types:

- a. Type 1 is a minimum vertical thickness of 50 feet of $\geq .5\%$ copper.
- b. Type 2 is a minimum vertical thickness of 100 feet of $\geq .25\%$ copper in the top 100 feet of the core or core less than 100 feet in length if the base was reached by drilling less than 100 feet and the core was mineralized throughout.
- c. Type 3 is a minimum vertical thickness of 50 feet of $\geq 10\%$ TiO_2 .

Holes that did not indicate any of these types of mineralization qualified for use if they were drilled all the way to the footwall. The standard perpendicular bisector method of polygon construction was used to construct polygons in the Listerud and Meineke study and is described therein. The polygon map developed in that study was used as a base map for coding polygon data in the MINESITE Study. Coding followed the 50% rule; that is, if 50% or more of a cell contained data from a given polygon, it was assigned to that polygon. After all data had been coded and entered into the computer system, a computerized MINESITE polygon map was produced. Area comparisons of the planimetered Listerud and Meineke polygons

and the MINESITE polygons did not coincide exactly in all cases. In those cases where there was area discrepancy, MINESITE polygons were adjusted to reflect the actual percentage comparison of size between the planimetered polygons described in the Listerud and Meineke report.

The resource estimate was then obtained by multiplying the area of each polygon (number of cells x 107584 ft²) by the vertical thickness of its mineralized zones and dividing by the tonnage factor of 11 ft³/ton.

The information contained in the Polygon Map served as a data base in the creation of Interpretive Sheets and maps which included:

- a. Resource estimate of .25 - <.5% Copper.
- b. Resource estimate of \geq .5% Copper.
- c. Resource estimate of \geq 10% TiO₂.
- d. Resource estimate of \geq .5% Copper (or equivalent). Mineralization base above 500 ft.
- e. Resource estimate of \geq .5% Copper (or equivalent). Mineralization base between 500 and 1000 ft.
- f. Resource estimate of \geq .5% Copper (or equivalent). Mineralization base below 1000 ft.
- g. Resource estimate of \geq .5% Copper (or equivalent). Mineralization above 1000 ft.
- h. Resource estimate of \geq .5% Copper (or equivalent). Mineralization base between 1000-2000 ft.
- i. Resource estimate of \geq .5% Copper (or equivalent). Mineralization base between 2000-3000 ft.
- j. Resource estimate of \geq .5% Copper (or equivalent). Mineralization base below 3000 ft.
- k. Depth to thickness ratio.
- l. Summary of Copper-Nickel Resources

Appendix J - Statistical Check

Introduction

The MINESITE study is dependent on a data inventory representing various parameters (variables) which can be displayed in map form. Transforming data from base maps into computer-generated map representations of these base maps is the principal task to be completed before analysis stages can begin. There is a chance for the introduction of error throughout this transformation process. These errors would eventually show up on the final computer maps. A statistical sampling procedure was established to estimate this error on maps having the most complex distribution of data levels. Data base maps for the variables are assumed correct; hence, the statistical check is an estimate of error introduced somewhere between the time data was taken from the base maps and the time this data appeared on a final computer map.

Background

Variables included in the study differ drastically in nature. For some variables, each of the 145,000 cells in the study area must be represented by a symbol, an example being the elevation variable (V09). In others, only a fraction of the total cells have a symbol, an example being the transportation variable (V25).

On a map such as V25, it is quite simple to check the accuracy of the computer map by comparing it with base maps, either USGS topographic maps, Superior National Forest maps, or others which

might show additional transportation systems. Obvious errors, such as a gap in a string of cells representing a continuous road, are easy to detect.

In cases where the majority of the study area is coded and mapped, finding errors by such direct comparison methods usually would be difficult and time consuming. Exceptions, however, include variables such as bedrock geology (V04) that contain large blocks of fairly uniform data computer-coded with the same symbol. A cell-by-cell check of such variables is often reasonable despite the large number of cells involved, primarily because it involves linear boundary checks such as those used with the transportation variable.

However, most variables covering a large proportion of the study area, such as the elevation variable (V09), have symbols that, in part, seem to be arranged in a random manner, here due to the changes in elevation between cells. To error check each cell on such maps would require that each cell be reinterpreted, consuming probably as much time as did the original coding. It was for this type of variable that statistical sampling procedures were designed, to replace the cell-by-cell verification used on the other maps.

Types of Error

Several types of error can be introduced during various stages of the transformation process and are discussed below.

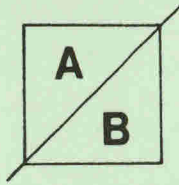
1. Misinterpretation error originates when the coder simply does not understand correctly the information represented within a cell on the original data map and codes the wrong data level.
2. Misplacement error originates when (a) the coding grid is mistakenly placed in the wrong position on the base

map during coding, or (b) in filling out the coding form, the symbol from the data map is not placed in the corresponding cell on the form, or (c) grid lines are drawn on the base maps in the wrong position.

3. Transfer errors occur when the data symbols placed on coding forms are transferred incorrectly to the keypunch form from which computer input cards are keypunched. The keypunch form was designed so that the "shorthand coding" system could be used. This coding system reduces the number of cards required to be keypunched and the number of entries made on each card. The format of this keypunch form and the procedure in which it is filled out are somewhat involved, making this step of the procedure particularly susceptible to error. Some gross transfer errors are easily recognized on the computer maps, but others can go unnoticed. Since the keypunched cards are a direct link to the computer map, an error made on a card appears as an error on the map.
4. Errors made in keypunching computer cards are another explanation for incorrect symbols showing up on a computer map. This could occur when transfer forms are punched, or when cards are corrected to change data on data maps.
5. Another type of error can be introduced when correcting either line printer or dot plot data maps. When errors are found on a map and a new computer card is punched to show correct data, the cell or cells corrected sometimes do not show up changed on the updated maps. This could be due to an error of omitting an entry on a card, or to the wrong cell being changed. If the wrong cells are changed on a line printer map, it is often impossible to find the location of those cells because previous cards are disposed of when new ones are keypunched. When changes are made on a dot plot map but do not show up on an updated map, the card deck can be checked to explain why.

Not to be confused with errors are the contradictions in data level selection that can arise when personal judgment is called upon to make decisions. These may show up when a coder, in selecting a symbol for a particular cell, may be uncertain of his choice or may not have a clear choice. As a hypothetical example, when a coder placed the coding grid over the base map, the following cell configuration resulted.

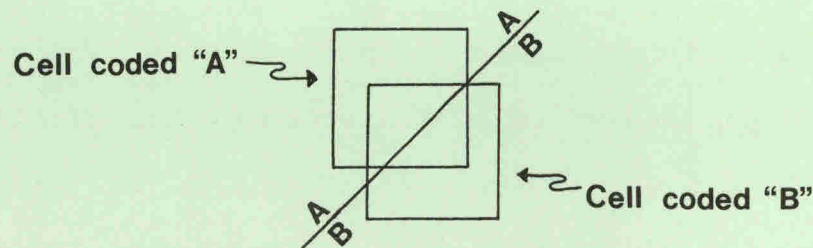
FIGURE 1



The letters in the diagram represent different data levels, each occupying what appears to be about half of the cell. In this case the coder must decide which letter to use. Either letter (A or B) would be equally correct, and a person checking the coding at a later date may choose the alternate and equally correct letter. Both choices would be correct.

Similar contradictions may also be caused by a poorly fitting grid overlay, the alignment of which is, again, based upon an individual's judgment. The following example shows how grid alignment could result in different symbols being chosen by coders. If a coder were not to apply a consistent rule in aligning a grid, it is conceivable that the same coder, checking the coding of the same cell at a later time, could make an alternate choice.

FIGURE 2



Statistical Check

1. Theory

The statistical check is initiated by taking a random sample of the "population" (total cells on a map). Once the percent of wrong cells in this sample is determined, the percent of wrong cells in the "population" can be estimated with a specified degree of certainty. The statistical method used is the method of "confidence limits".

The check begins with the random selection of 200 cells, the calculated minimum number required for an "upper one-sided confidence limit" of 90%. This means that the chances are 90% that the "true percentage" of wrong cells in the population will fall within a range from zero to a calculated upper limit. This range is known as a "confidence range". The percentage of wrong cells in the sample is used to determine the upper limit of the "confidence range", calculated here on the basis of a sample size of 200. Table 1 shows this relationship.

TABLE 1

P	$L_2(\pi)$
1%	2.1%
2%	3.4%
3%	4.8%
4%	5.9%
5%	7.1%
6%	8.3%
7%	9.4%
8%	10.6%

P = percent of wrong cells among a random sample of 200 cells.
 π = the true percentage of wrong cells among all the cells.
 $L_2(\pi)$ = the upper one-sided 90% confidence limit for π .

For example, a sample of 200 cells is taken and six wrong cells

are discovered. This results in:

$$P = \frac{6}{200} \times 100\% = 3\%$$

Looking at Table 1 for $P = 3\%$, we find that the upper one-sided 90% confidence limit $L_2(\pi)$ is 4.8%. What this means, simply, is that the chances are 90% that π (the true percent of wrong cells among all the cells) will fall within the range 0 - 4.8%. Another way this might be stated is that the chances are 10% that π will be greater than 4.8%.

There is nothing unique about the selection of a confidence coefficient of 90%. Any other value could have been chosen, but a change in the confidence limit $L_2(\pi)$ and the sample size would result. A reduction of the risk of not finding the true percent within a given range would increase the upper confidence limit, thereby increasing the range in which π might be found. As a hypothetical example, assume a 95% confidence coefficient is adopted in the example above; then the value of $L_2(\pi)$ for $P = 3\%$ will increase from the 4.8% to a higher value of, say, 6%. At the same time a sample size of about 400 would be required. The 90% was suggested because it seemed to be a satisfactory trade-off between the length of the confidence range and the risk that the true percentage of wrong cells would fall outside of the confidence range 0 - $L_2(\pi)$, and because it kept the random sample size at a reasonable number of 200, rather than 400, or greater.

For the MINESITE study, a confidence limit of 10% was deemed suitable. Referring to Table 1, a value of P for $L_2(\pi) = 10\%$ is interpolated to equal 7.5%. This means that, among a sample

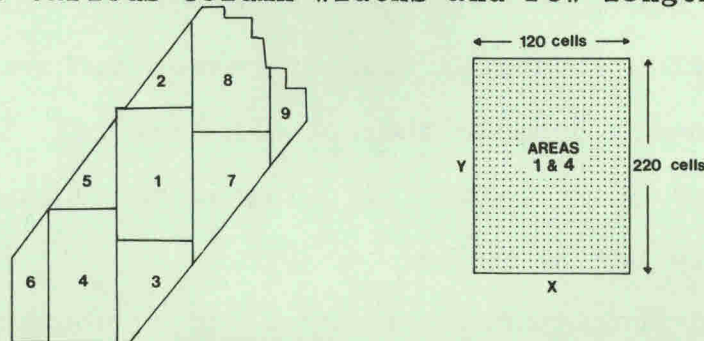
of 200 cells, 7.5%, or 15 wrong cells would represent $L_2(\pi)$. Again, simply stated, this means that the chances are 90% that the true percent of wrong cells among the total of all cells will fall within the range of 0 - 10%.

2. Random Sample Selection

Two methods were applied for selecting a random sample of 200 cells from line printer maps of the nine MINESITE areas. One method was used for areas 1 and 4 and the other for the remaining seven areas.

Areas 1 and 4 are unlike the others in that they are rectangular in shape, both having cells arranged 120 columns wide and 220 rows long. The other seven areas have various geometric shapes, hence various column widths and row lengths (Figure 3).

FIGURE 3



A. Sampling for Areas 1 and 4

For areas 1 and 4, the procedure for selecting the sample was to select x (column) and y (row) cell coordinates using a 3-digit random number table, which gives numbers in the range 000 - 999.

Since we would be interested only in numbers 001 - 120 for columns, all other numbers chosen greater than 120 would become wasted, for instance the numbers 313, 678, 505, 825, 450, and 918.

To reduce this waste, the following scheme was adopted:

- When the first digit is ODD, turn it into a ONE.
- When the first digit is EVEN, turn it into a ZERO.

Using this scheme, the above numbers are changed as shown below, and then serve to identify columns.

313	becomes	113
678	"	078
505	"	105
825	"	025
450	"	050
918	"	118

Unfortunately, some 3-digit numbers in addition to 121 - 199, will still be useless.

340	becomes	140
570	"	170
935	"	135
787	"	187

A similar scheme was devised to select the rows among the numbers 001 - 220, converting larger random numbers to numbers within this range. Suppose the numbers 375, 443, 518, 680, 755, and 812 are chosen, the following scheme shows how they are converted to useful numbers:

- When a number starts with 3, 4, or 5 subtract 300.
- When a number starts with 6, 7, or 8 subtract 600.

Any number starting with a 9 becomes useless, as well as the following sets:

221-300, 521-600, and 821-899.

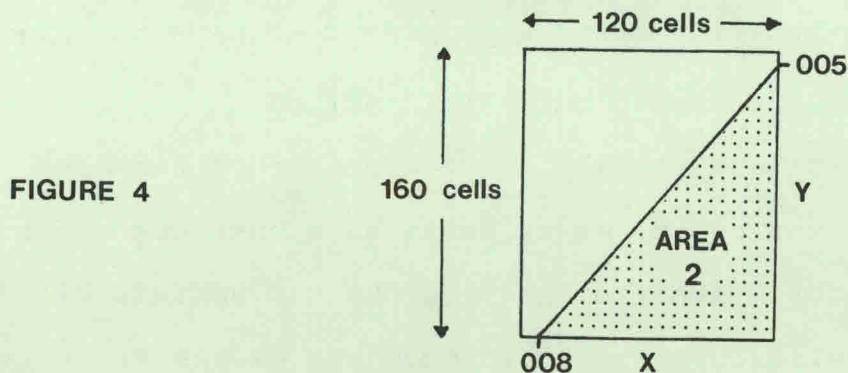
Because of wasted numbers, in order to obtain the 200-cell sample, useful numbers representing columns (x) and rows (y) are chosen from among an average of 340 numbers when selecting columns and from among more than 275 numbers when selecting rows.

Here the 200 valid numbers for columns can be chosen first, followed by the 200 numbers for rows, because all cells printed on the map are "on-site". Each cell is then located and circled on the line printer data map. In a case where there is a repetition of selected cells, additional coordinate numbers are chosen so that the sample represents 200 individual cells.

B. Sampling for Areas 2, 3, and 5 - 9.

These areas each have a unique shape and contain a different number of cells as shown earlier in Figure 3. These facts, for the most part, prohibit the efficient use of the cell selection procedure described above.

As an example, the line printer map for Area 2 is the same 120 columns wide but only 160 rows long. In addition, the border of the cells within this area forms a diagonal across the map, rather than a rectangle, as shown in Figure 4.



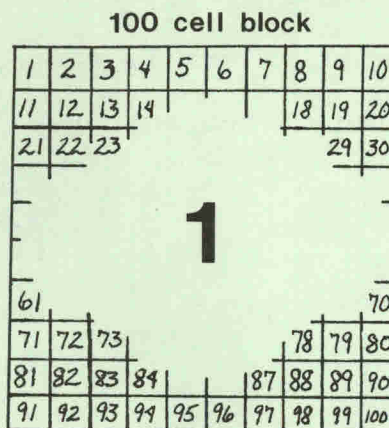
Notice that the first column containing a cell is 008, the first row is 005, and that greater than half the map is void of cells. Selection of cells falling within this void would add to the waste in choosing random numbers for coordinates of cells to be included in the sample. It is at this point that a caution must be given to avoid improper sampling techniques.

A basic requirement in random sampling is to insure that each potential sampling unit in a population has an equal chance of being in the sample. An illustration of how this requirement could be violated can be given using Area 2 as an example. The wrong way to proceed here would be to first select a column in the range 008 - 120 and then look for a new random number in the range 005 - 160 until a row is found that gives an on-site cell. Though it would decrease the number of wasted numbers, such a procedure would not provide an equal chance to all cells in the population for inclusion in the sample.

The proper procedure might be to select pairs of random numbers until the required 200 are found, rejecting pairs that fall outside the area. This would be almost the same method used for Areas 1 and 4. This is a rather inefficient procedure for Area 2 since so many numbers are wasted, but for areas where much of the map is on-site (such as Area 8), it would be most efficient to select the sample using this method.

A more efficient and equally correct procedure has been devised for Area 2 and other areas containing numerous off-site cells. This procedure involves dividing the map up into blocks of 100 cells, 10 cells on each side. Complete blocks are drawn even if only one cell is enclosed. Figure 5 shows a portion of a map as an example of these blocks and how they are numbered.

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It would be advantageous if the number of blocks were to number 100, or at least near but lower than 100, to minimize the waste of 3-digit random numbers. If the number of blocks,

for instance totals 35 or 105, then there may be no advantage in using this method. Perhaps then it would be just as easy to use the selection method used for Areas 1 and 4 described earlier.

The 100-cell block is handy because there is no waste of 3-digit numbers if the first digit is converted to zero. Conversion of numbers over 100 is as follows:

112	becomes	012
374	"	074
654	"	054
000	"	100
900	"	100

3. Use of Sample

When the 200-cell sample is chosen for a particular variable, each sample cell is compared with the corresponding cell on the original data base map from which the computer mapping originated. The percent of error in the sample is calculated and the map is accepted if the error does not exceed 7.5% of the sample (15 cells wrong in 200), as explained above. If the sample error exceeds 7.5%, the sample is rejected. This requires that every cell on the computer map be checked against corresponding cells on the base maps, and those found to be in error corrected. Erroneous cells on accepted maps must also be corrected. If a sampler notices errors not included in the 200-cell sample, these must also be corrected but they do not count toward the percent error in the random sample. Because of these corrections, the map may be somewhat more accurate than the % infers if they occur in multi-cell arrangements, rather than in individual, ran-

domly distributed cells.

When comparing the computer map against the data map, some leeway is given for several variables when a cell seems to be in error. The cell may not really be in error at all but, rather, a checker may not agree with the original coder as the result of a judgment decision, as described earlier. A one data level difference (above or below) is allowed for V02 - Percent Slope (levels 1-6), V03 - Slope Orientation (levels 1-9), and V09 - Elevation (levels 1-34) in cases where there is no clear choice of data level. An example on each variable is given.

<u>Variable</u>	<u>Level Chosen</u>	<u>Level Acceptable (above & below)</u>
V02	2 (4-6%)	1 (1-3%) or 3 (7-9%)
V03	3 (East)	2 (NE) or 4 (SE)
V09	10 (1520's & 30's)	9 (1500's & 10's) or 11 (1540's & 50's)

These variances are not counted as errors in this case, and the cells remain as originally coded.

Once the 200-cell sample is chosen for the first computer map in each of the nine areas, other variables can be tested using those same cells if the variables have no dependence between one another. Areas 1 and 4 are identical in shape, the other seven are not, so there are initially eight different 200-cell samples used. For example, the data levels coded for V02 - Percent Slope taken from a USGS topographic base map have no direct connection with the data coded for V09 - Elevation, other than that the same base map is used for both. In contrast, the data for the vegetation variables V16, V18, V19, and V20 were interpreted as a group on base maps and then later separated into four variables during coding. Therefore, there is an interde-

pendence between them requiring that a different 200-cell sample be chosen for each. If any one of these four variables were to fail the check, then all cells on all these maps would require comparison with the base maps.

Results of Statistical Check

The chart below lists the mapped variables that were statistically checked along with 1) the number of errors found and 2) the confidence limit corresponding to the percentage of sample error.

TABLE 2

	AREA								
	1	2	3	4	5	6	7	8	9
V02 % Slope	2 2.1	12 8.3	0 0	11 7.7	8 5.9	11 7.7	5 4.1	8 5.9	13 8.9
V03 Slope Orientation	15 10	11 7.7	23 *	19 9.4	22 *	7 5.4	3 2.8	4 3.4	13 8.9
V09 Elevation	1 1	0 0	0 0	0 0	0 0	0 0	0 0	0 0	3 2.8
V10 Soil Landscape Units	2 2.1	3 2.8	4 3.4	4 3.4	6 4.8	4 3.4	1 1	18 *	1 1
V16 Vegetation	1 1	1 1	2 2.1	3 2.8	6 4.8	2 2.1	+	0 0	14 9.4
V18 Crown Density	1 1	6 4.8	0 0	1 1	0 0	3 2.8	+	3 2.8	15 10
V19 Size Class	0 0	1 1	2 2.1	2 2.1	1 1	0 0	+	0 0	13 8.9
V20 Height Class	0 0	4 3.4	1 1	2 2.1	1 1	5 4.1	16 +	1 1	10 7.1
V24 Soil Associations	2 2.1	1 1	3 2.8	2 2.1	3 2.8	5 4.1	2 2.1	1 1	1 1

*Upper one-sided 90% confidence limit of 10% exceeded; all cells subsequently error checked.

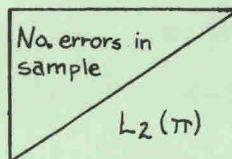


TABLE 2 CONT'D

+V20 Area 7 rejected; V16, V18, V19
and V20 recoded and rechecked with
the following results:

	AREA 7
V16	2 2.1
V18	5 4.1
V19	0 0
V20	0 0

Variable 03 - Slope Orientation for Areas 3 and 5, and
V10 - Soil Landscape Units for Area 8 failed by exceeding the
15 errors allowed in the sample, so each cell had to be checked
and corrected when necessary.

Variable 16, V18, V19, and V20 for Area 7 were rejected
based upon the failure of V20 because of the interdependent nature
of these variables. It was then discovered that UTM grid lines
were misaligned when originally coded. These variables were
recoded and were again statistically checked, with all passing,
as shown at the bottom of Table 2.

REFERENCES

1. Written and verbal communication with Leonard Wroblewski, Research Analyst, Environment Section, Division of Fish and Wildlife, March 1975 to present.
2. Guttman and Wilks, Introductory Engineering Statistics, John Wiley & Sons, 1965, 340 pp.