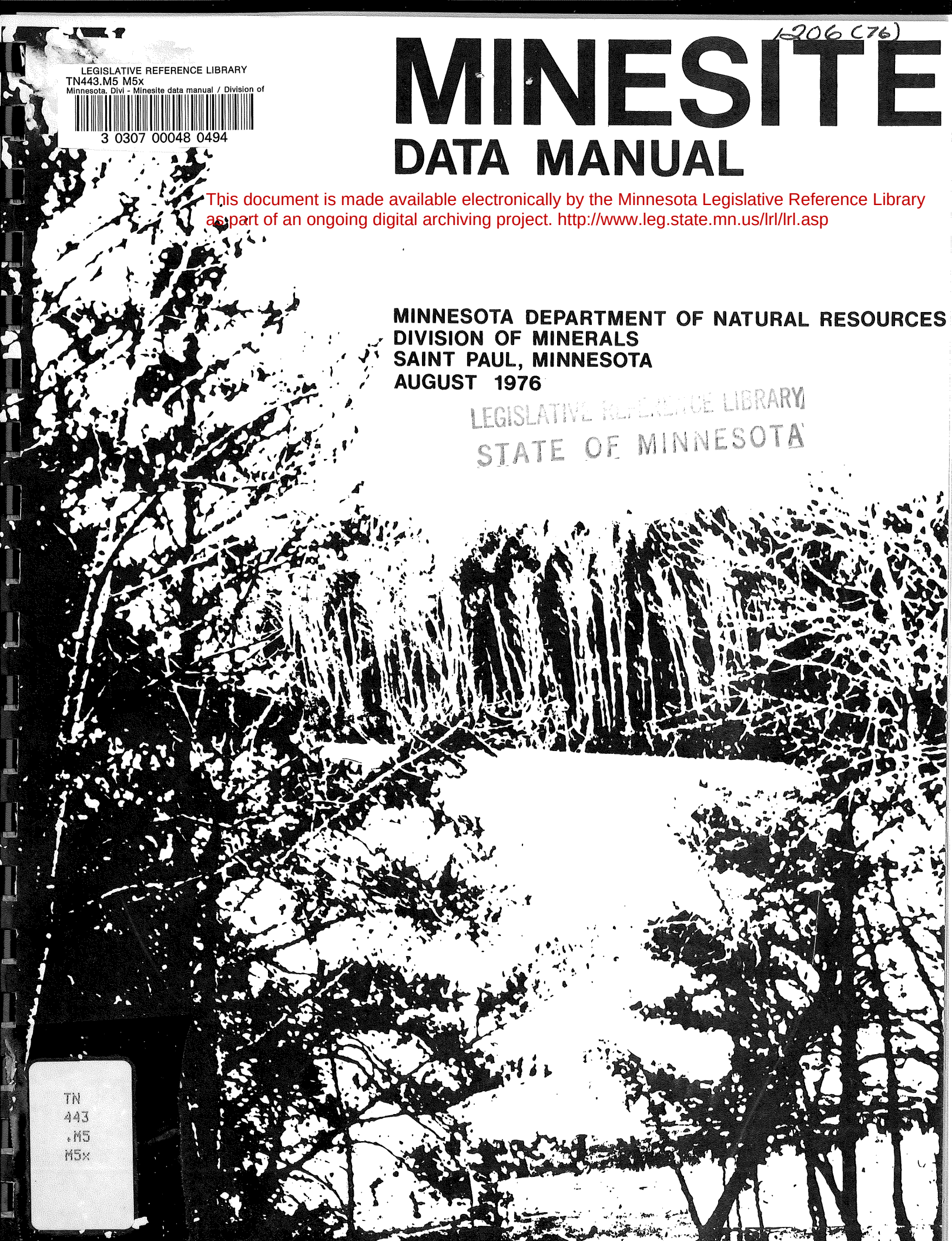
MINESITE
DATA MANUAL

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



MINESITE
Data Manual

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

TABLE OF CONTENTS

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 also provided significant input into the study.

Consultants

Bather, Ringrose, Wolsfeld, Inc.
Edina, Minnesota

Earth Systems 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

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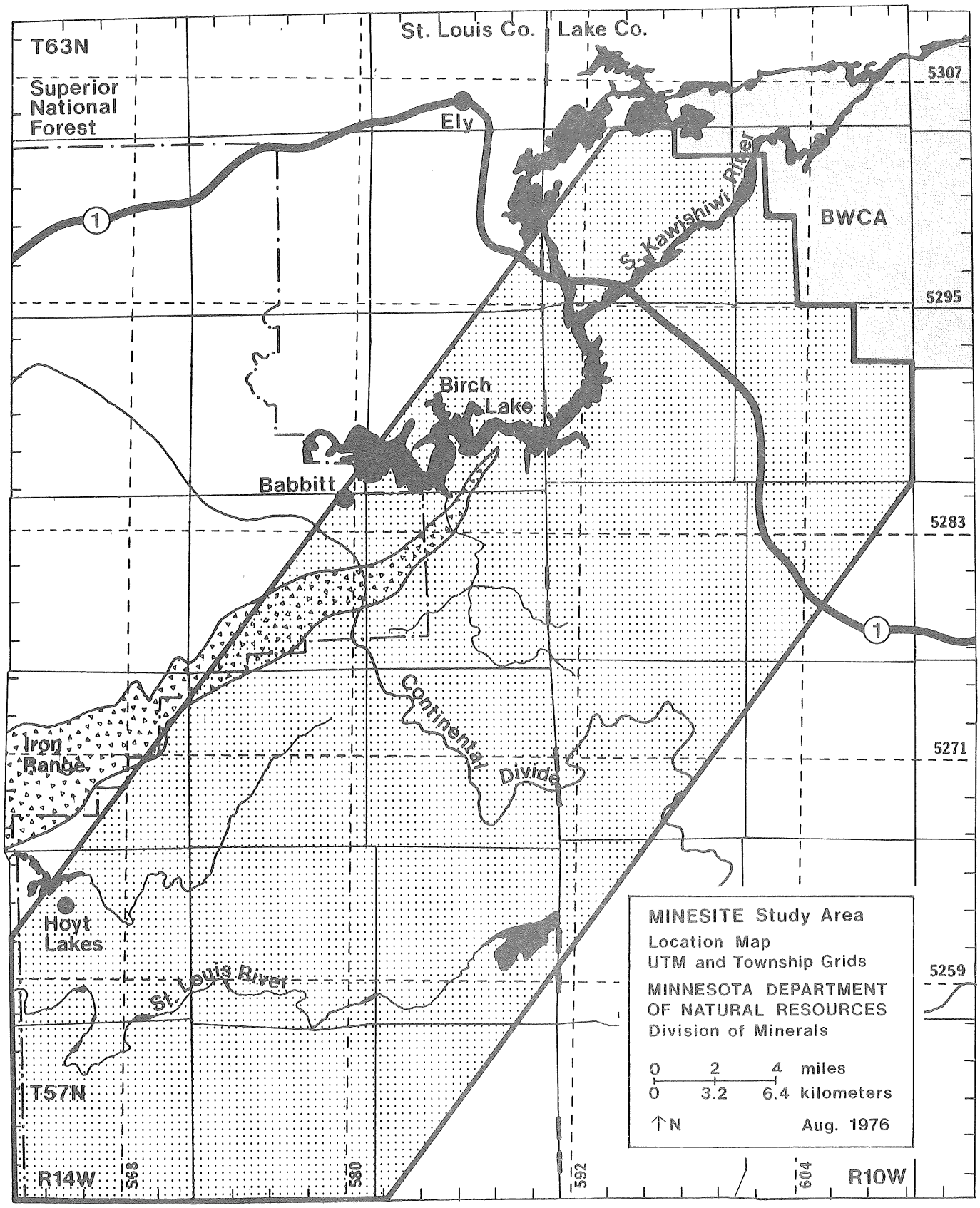
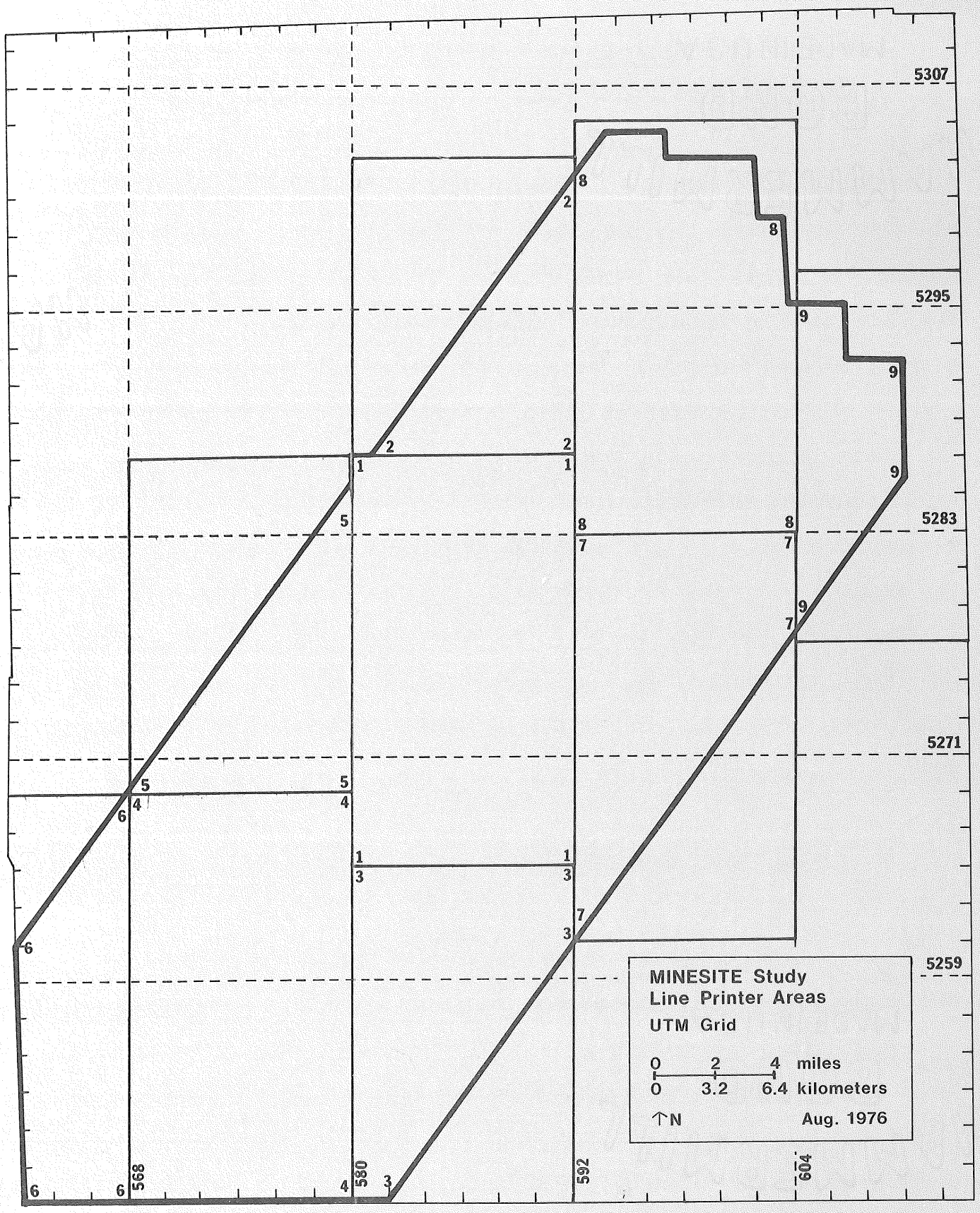

T63N
St. Louis Co.
Lake Co.
Superior National Forest
Ely
S. Kawishiwi River
BWCA
5307
5295
Birch Lake
Babbitt
5283
1
Continental Divide
Iron Range
5271
Hoyt Lakes
St. Louis River
5259
T57N
R14W
368
580
592
604
R10W
MINESITE Study Area
Location Map
UTM and Township Grids
MINNESOTA DEPARTMENT OF NATURAL RESOURCES
Division of Minerals
0 2 4 miles
0 3.2 6.4 kilometers
↑N
Aug. 1976


5307
5295
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MINESITE Study
Line Printer Areas
UTM Grid
0 2 4 miles
0 3.2 6.4 kilometers
↑N
Aug. 1976

Description of Variables

Based on the study area previously outlined, a total of twenty-eight separate compilations of data, or variables, have been computerized and mapped. These variables are listed in the table of contents. Twenty-five of the variables are resource inventories and the three remaining variables serve other purposes. V30 breaks the study area into watershed areas. V91 divides the area into 9 smaller study areas. V95 provides access and orientation to the Minnesota Land Management Information System (MLMIS) 40-acre data base.

Data is plotted using a cell system based on Universal Transverse Mercator (UTM) coordinates for all variables, except V08 Surface Ownership and V95 MINESITE Area. Variables 8 and 95 use the MLMIS standardized 40-acre grid based on Township-Range designations. The best possible fit for the 2 grids has been obtained.

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 1 hectare. This corresponds to an area in the English system of approximately $2\frac{1}{2}$ acres.

Two of the data variables, as mentioned previously, use a standardized Township-Range grid where data was originally plotted according to standardized square 40-acre cells. As a result of this standardization and the fact that the government surveyed townships are not composed of perfect square forties, the Township-Range grid cannot be perfectly superimposed over the UTM grid which is a uniform metric grid. This may have resulted in some internal distortion within V08 and V95, although the two grids have been fit

together as accurately as possible.

In the handbook, each data variable has an identification sheet followed by a photographed computer map. On the identification sheet, the data variable is listed, along with its identifying number, name, its source, group responsible for interpretation and date of the information source. This is followed by a brief description of the variable and, beginning at the bottom of the sheet, a listing of data levels that have been coded for each inventory.

The verification section of the sheet refers to the system used in error checking the transformation of data from a base map to a final computer map. It does not refer to the reliability of the original data source, only to the computerization process. Two verification techniques were used in computerizing data: an individual cell check and a statistical check. The method of statistical checking is outlined in Appendix I. This section also includes the final verification date or approval date for each data variable.

The data maps which follow the identification sheets are dot plots of the resource inventories in the computer files. In the title block on each map all of the data levels inventoried within the study area have been listed along with the symbol plotted on the map and the frequency of its occurrence. In most cases, the symbols used are tones which create the appearance of shading. If many levels occur on the map, the data levels are grouped and the shades follow a logical sequence. For example, on the percent slope variable the shades become more intense as the slope becomes steeper. An orientation overlay has been placed over each data map

before it was photographed and reduced.

In several instances, the variables required additional explanation beyond that provided on the identification sheets. These explanations are included in the appendices.

Site Map (V01)

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

LEVELS

Data Level	Legend
44	MINESITE
45	MINESITE

5303
5299
5295
5291
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5283
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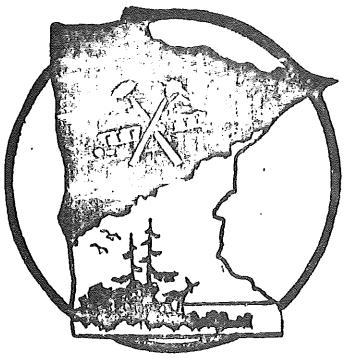
BABBITT
HOYT LAKES
1
MINESITE
DNR UOFM



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

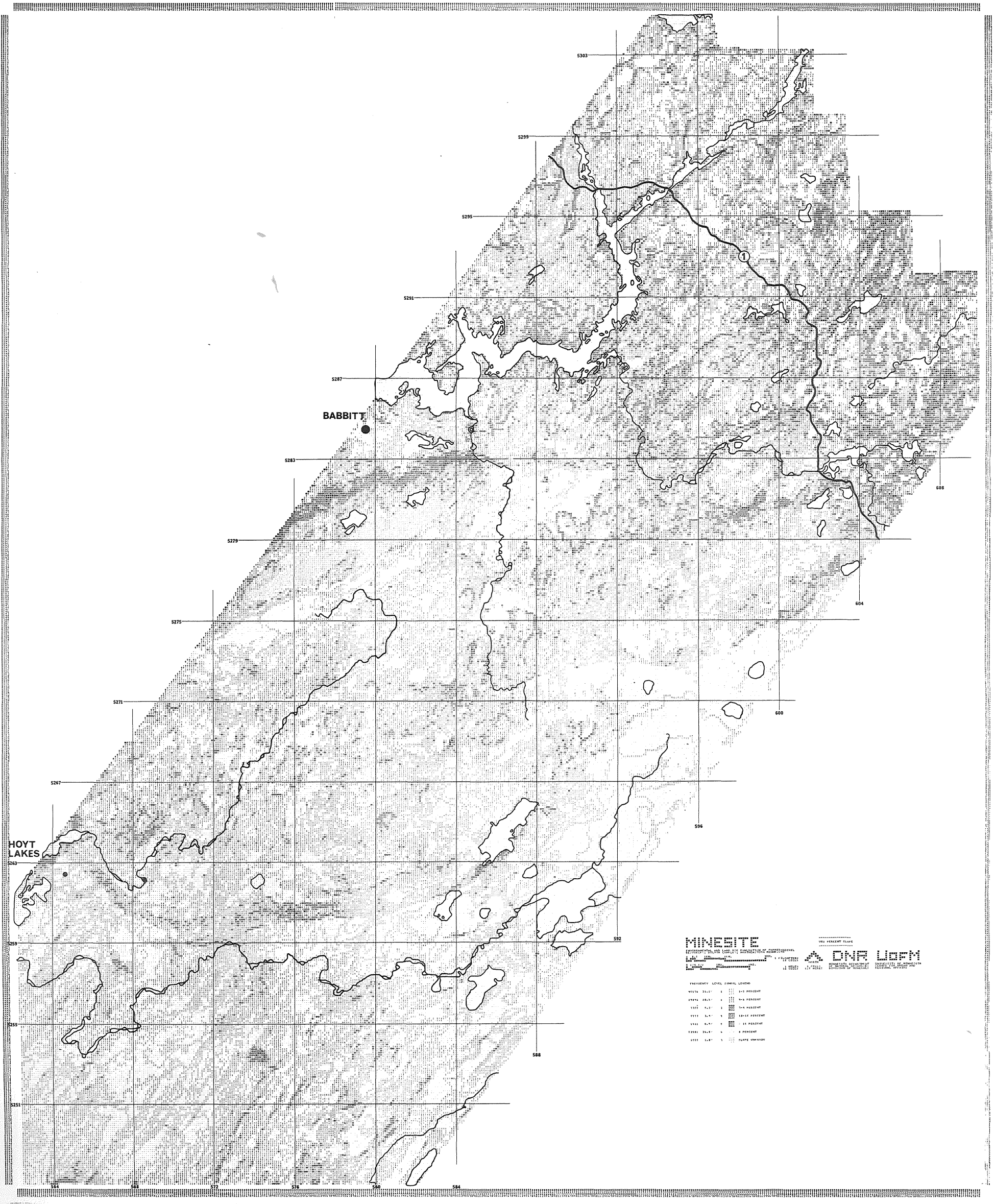
TECHNIQUE: Statistical Check - Appendix I

FINAL DATE VERIFIED: October 12, 1976
*photo revised

LEVELS

Data Level	Legend
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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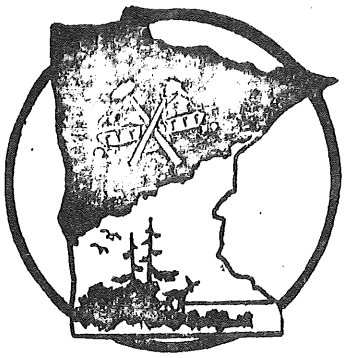
DNR UofM



Slope Orientation (V03)

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

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

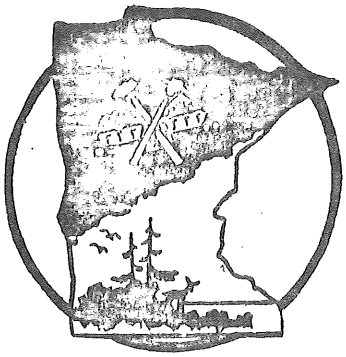
*areas recently disturbed, usually by mining activities

BABBITT

HOYT LAKES

MINESITE

DNR UofM



Bedrock Geology (V04)

DATA BIOGRAPHY

SOURCE: MGS Publications: Open file geologic maps Allen, Babbitt (NW, NE, SW, SE), Ely, Kangas Bay; SP-8; M-2; M-11; Hibbing Sheet. DNR Two Harbors Geologic Map.

INTERPRETATION:
MINESITE Staff

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

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. Continuity between map sheets is resolved by interpretation. The legend describes a map code followed by a descriptive title of the rock group.

VERIFICATION

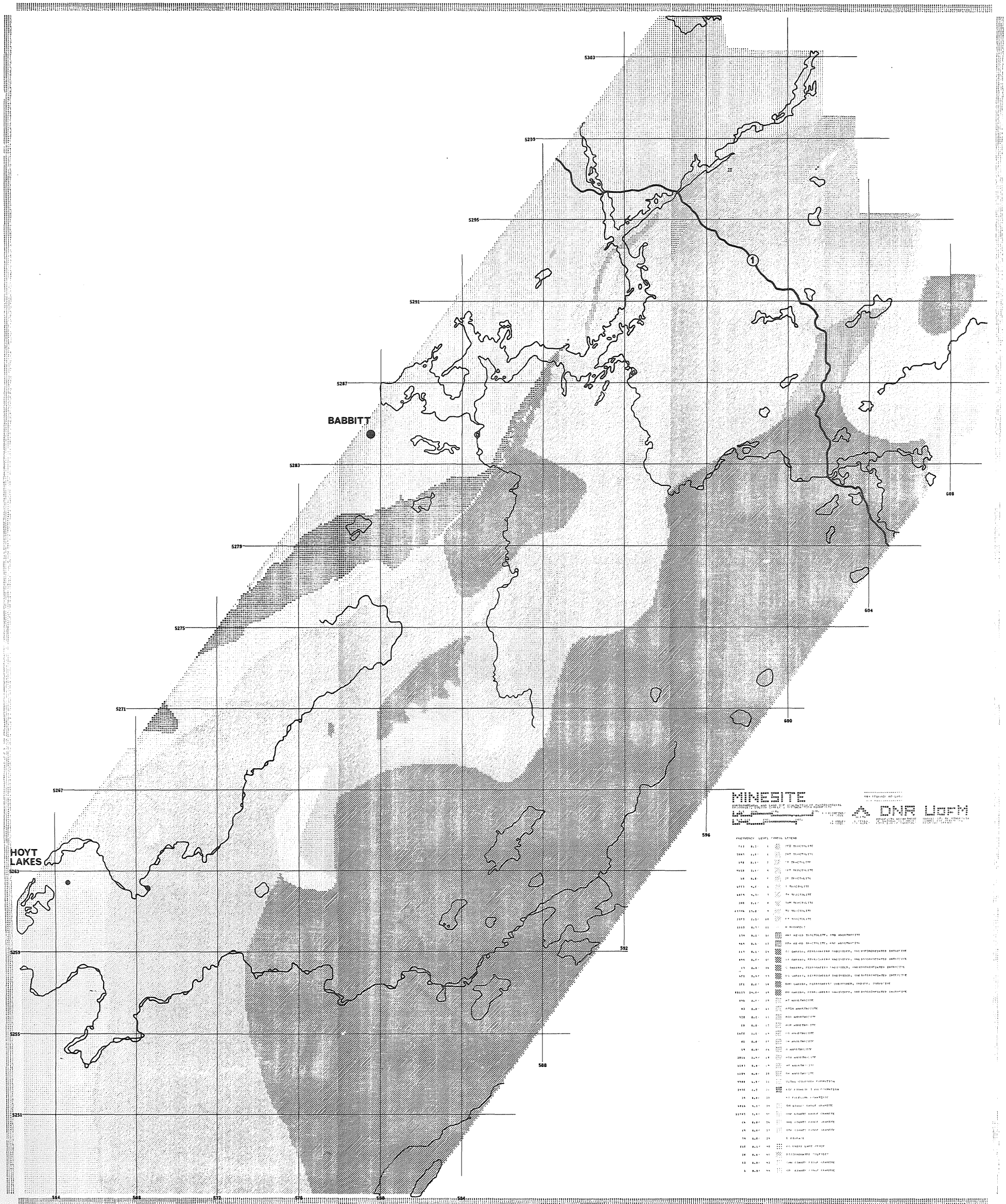
TECHNIQUE: All cells checked

FINAL DATE VERIFIED: August 18, 1976

LEVELS

Data Level	Legend
1	scz - Troctolite
2	sat - Troctolite
3	st - Troctolite
4	spt - Troctolite
5	sp - Troctolite
6	t - Troctolite
7	ta - Troctolite
8	tam - Troctolite
9	tu - Troctolite
10	bt - Troctolite
11	h - Hornfels
12	mas - Mixed Troctolite and Anorthosite

Data Level	Legend
13	mta - Mixéd Troctolite and Anorthosite
14	g_2 - Gabbro, Ferrogabbro Undivided Undifferentiated Intrusive
15	g_1 - Gabbro, Ferrogabbro Undivided Undifferentiated Intrusive
16	g - Gabbro, Ferrogabbro Undivided Undifferentiated Intrusive
17	bg - Gabbro, Ferrogabbro Undivided Undifferentiated Intrusive
18	dmu - Gabbro, Ferrogabbro Undivided Undifferentiated Intrusive
19	du - Gabbro, Ferrogabbro Undivided Undifferentiated Intrusive
20	at - Anorthosite
21	atgm- Anorthosite
22	ago - Anorthosite
23	agh - Anorthosite
24	ag - Anorthosite
25	sa - Anorthosite
26	a - Anorthosite
28	agu - Anorthosite
29	au - Anorthosite
30	da - Anorthosite
31	v,vag-Virginia Formation
32	bif - Biwabik Iron Formation
33	pq - Pokegama Quartzite
34	gm - Giants Range Granite
35	gap - Giants Range Granite
36	gae - Giants Range Granite
37	ggb - Giants Range Granite
39	d - Diabase
40	kg - Knife Lake Group
41	- Disseminated Sulfides
43	gmh - Giants Range Granite
44	gd - Giants Range Granite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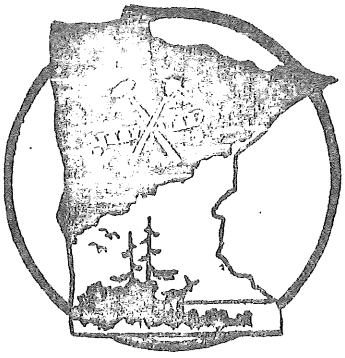
MINESITE
DNR UofM
FREQUENCY LEVEL SYMBOL LEGEND



Surface Hydrology (V05)

DATA BIOGRAPHY

SOURCE: USGS Topo Maps: Aurora, Embarrass, Isaac L., Allen (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 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 it covered more than half of a cell.

VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: September 2, 1976

LEVELS

Data Level	Legend
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

BABBITT

HOYT LAKES

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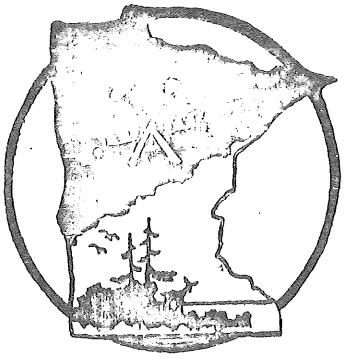
DNR UoFM



Watersheds (V06)

DATA BIOGRAPHY

SOURCE: USGS Topo Maps: Aurora, Embarrass, Isaac L., Allen (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

Data Level	Legend
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 Level	Legend
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

BABBITT

HOYT LAKES

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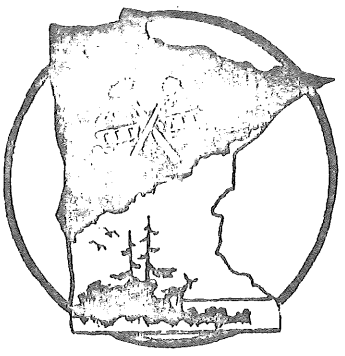
MINESITE

DNR UDFM



Surface Ownership (V08)

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 Resources, Land Classification Study.

INTERPRETATION:

MLMIS Staff

SOURCE DATE: State, BIA, and Forest Service - 1973. All other Federal ownership - 1969.

DESCRIPTION In V95, sixteen MINESITE cells were assigned to a single forty acre MLMIS cell based upon MLMIS Township and Range standard section line designations. Using these assignments, the MLMIS surface ownership data was superimposed on the MINESITE UTM grid. Due to the discrepancy in cell size and difficult nature of assigning cells to a standardized land survey grid, this variable is regional and should not be considered cell specific. It should be noted that the MLMIS files contain other ownership categories existing throughout the state which do not appear in this study area.

VERIFICATION

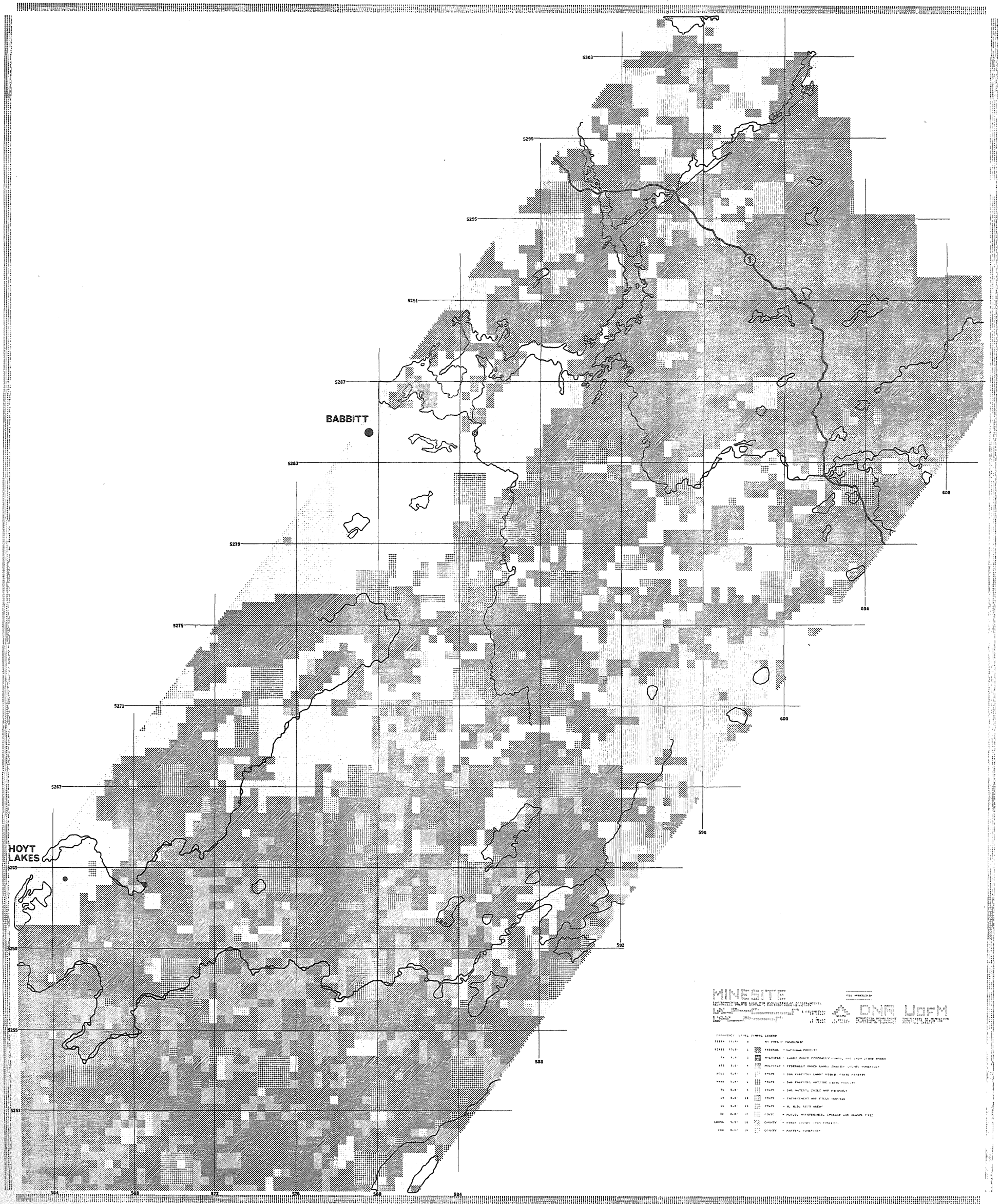
TECHNIQUE: Checked by MLMIS Staff

FINAL DATE VERIFIED: October 20, 1976

LEVELS

Data Level	Legend
0	No Public Ownership
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 Lands within State Forests
6	State - DNR Forestry outside State Forests
7	State - DNR Waters, Soils and Minerals
10	State - Enforcement and Field Service
14	State - Minnesota Highway Department Rest Areas

Data Level	Legend
15	State - Minnesota Highway Department Maintenance, Storage and Gravel Pits
18	County - Other County (Tax Forfeit)
19	County - Partial Ownership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HOYT LAKES
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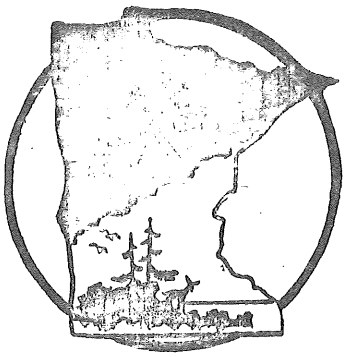
MINESITE
DNR Uorm
FREQUENCY LEVEL PARCEL LEGEND
NO PUBLIC OWNERSHIP
FEDERAL - NATIONAL FOREST
MULTIPLE - LANDS OVER FEDERALLY OWNED, BUT SNOW STATE OWNED
MULTIPLE - FEDERALLY OWNED LAND, SMALLER AMOUNT, OWNERSHIP
STATE - DNR FORESTRY LANDS WITHIN STATE FORESTS
STATE - DNR FORESTRY OUTSIDE STATE FOREST
STATE - DNR WATER, SOILS AND MINERALS
STATE - ENFORCEMENT AND FIELD SERVICE
STATE - M. N.D. ACTY MENT
STATE - M.N.D. MAINTENANCE, STORAGE AND GRAVEL PITS
COUNTY - OTHER COUNTY TAX FORFEIT
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

Data Level	Legend	Data Level	Legend
1	1340's and 1350's	12	1560's and 1570's
2	1360's and 1370's	13	1580's and 1590's
3	1380's and 1390's	14	1600's and 1610's
4	1400's and 1410's	15	1620's and 1630's
5	1420's and 1430's	16	1640's and 1650's
6	1440's and 1450's	17	1660's and 1670's
7	1460's and 1470's	18	1680's and 1690's
8	1480's and 1490's	19	1700's and 1710's
9	1500's and 1510's	20	1720's and 1730's
10	1520's and 1530's	21	1740's and 1750's
11	1540's and 1550's	22	1760's and 1770's

Data Level	Legend	Data Level	Legend
23	1780's and 1790's	30	1900's and 1910's
24	1800's and 1810's	31	1920's and 1930's
25	1820's and 1830's	32	1940's and 1950's
26	1840's and 1850's	33	1960's and 1970's
28	1860's and 1870's	34	1980's and 1990's
29	1880's and 1890's	35	Elevation Unknown*

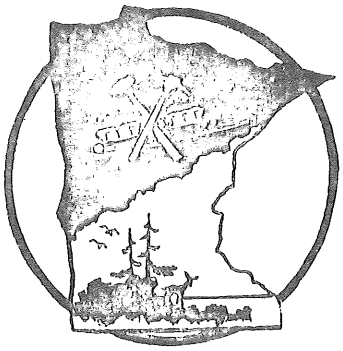
*areas recently disturbed, usually by mining activities

BABBITT

HOYT LAKES

MINESITE

DNR UGFM



Soil Landscape Units (V10)

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, and topographic patterns identified from aerial photography 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

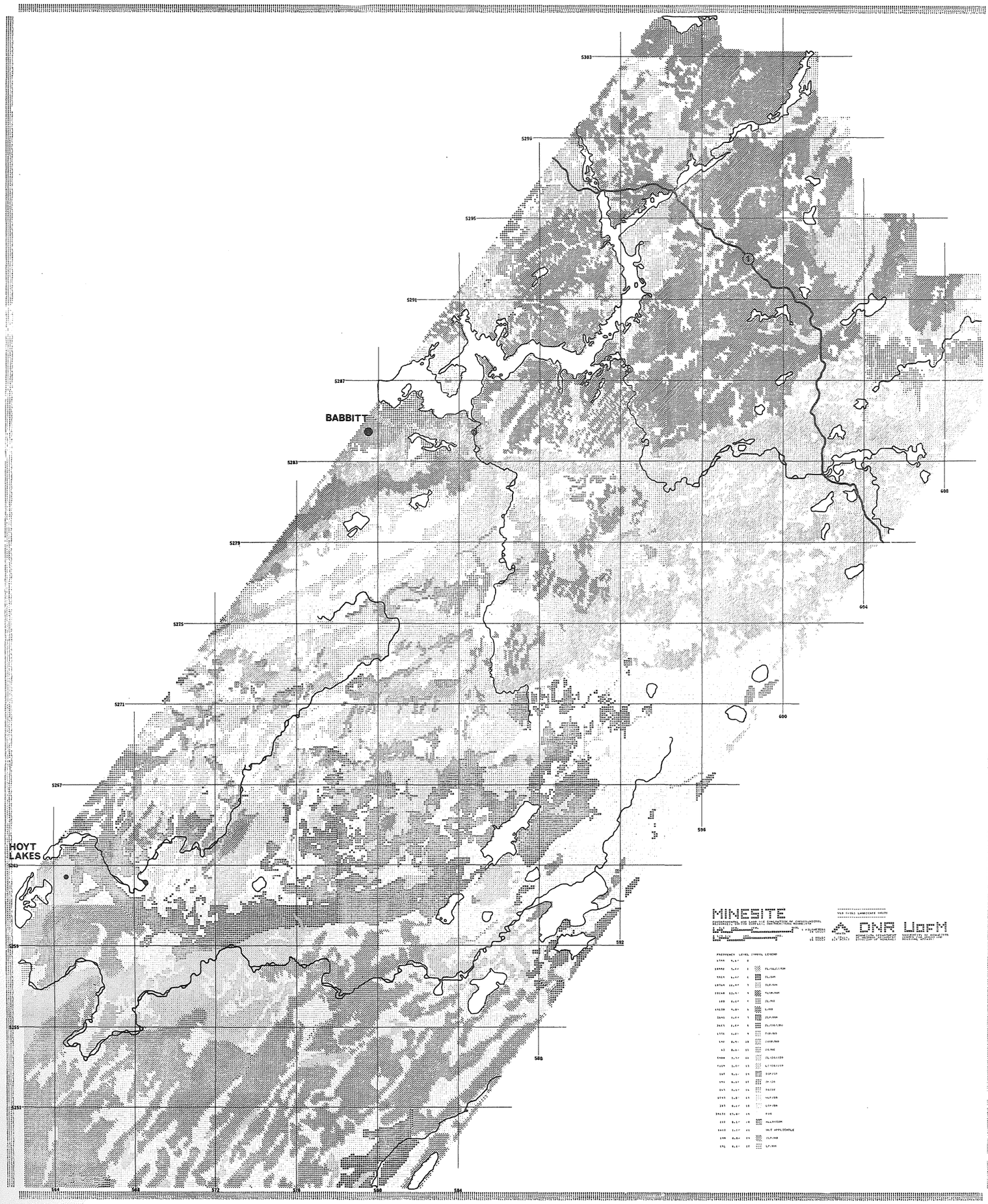
TECHNIQUE: Statistical Check - Appendix I

FINAL DATE VERIFIED: October 20, 1976

LEVELS

Data Level	Legend	Data Level	Legend
0			
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
17	OLP / DR
18	LOP / DR
19	Bog
20	Alluvium
21	Not applicable
24	SLP / RD
25	LP / RM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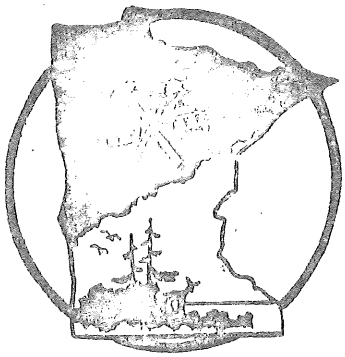
MINESITE
DNR UofM



Depth to Duluth Complex Contact (V11)

DATA BIOGRAPHY

SOURCE: Division of Minerals, DNR

INTERPRETATION: Division of Minerals, DNR

SOURCE DATE: December 1975

DESCRIPTION

The area within a few hundred feet of the basal contact of the Duluth Complex contains the majority of the 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. Using this data, the depth to this contact was projected and plotted.

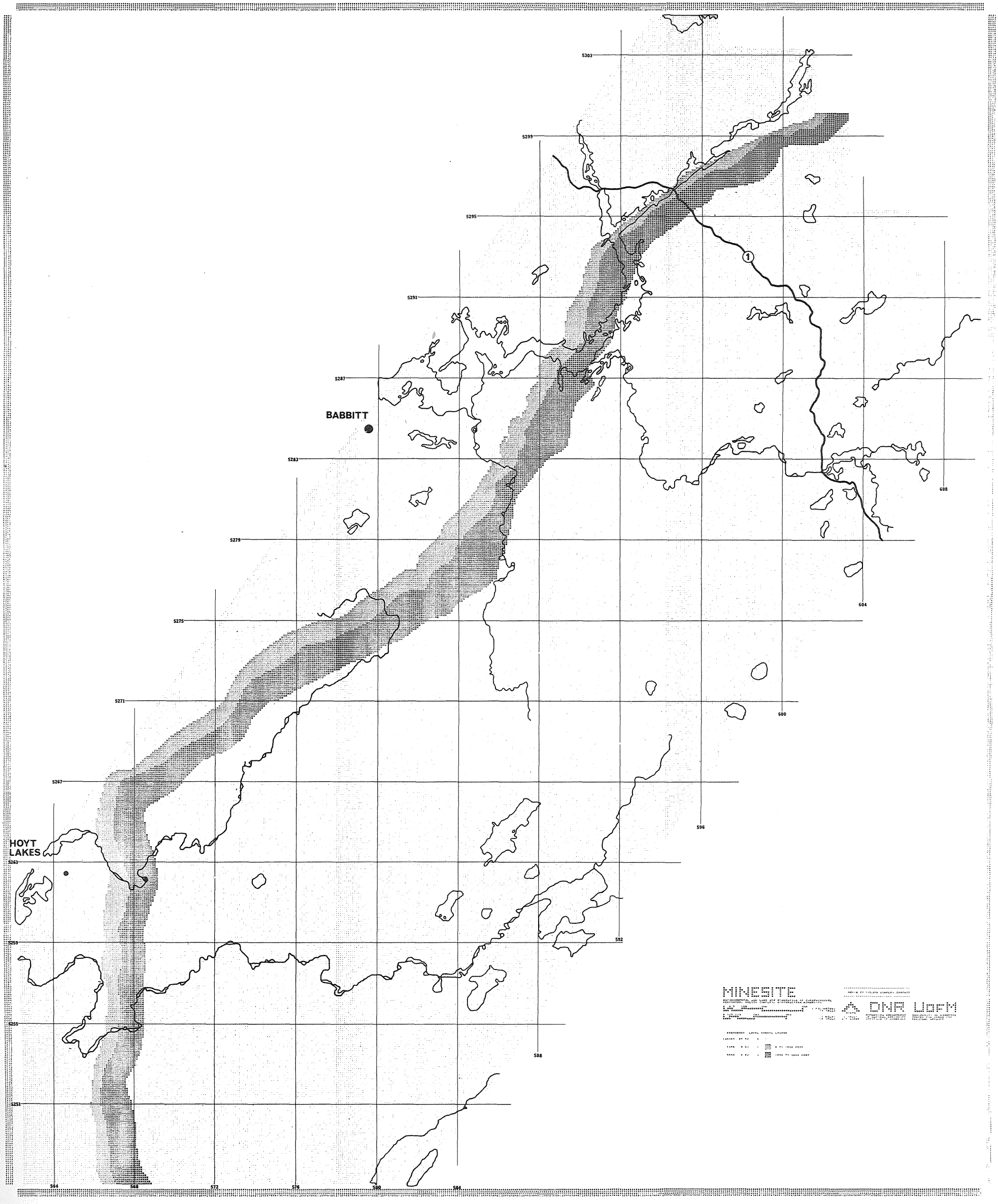
VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: August 18, 1976

LEVELS

Data Level	Legend
0	
1	0 to 1,000 feet
2	1,000 to 3,000 feet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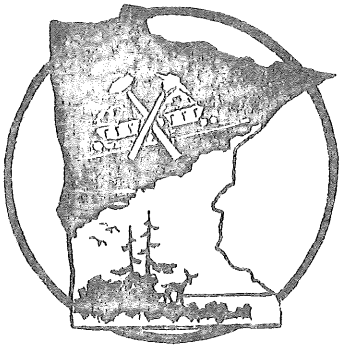


Land Use (V12)

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, US Forest Service Ownership Maps, Superior National Forest Map.

INTERPRETATION: MINESITE Staff, DNR

SOURCE DATE: See map dates listed above

DESCRIPTION

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

VERIFICATION

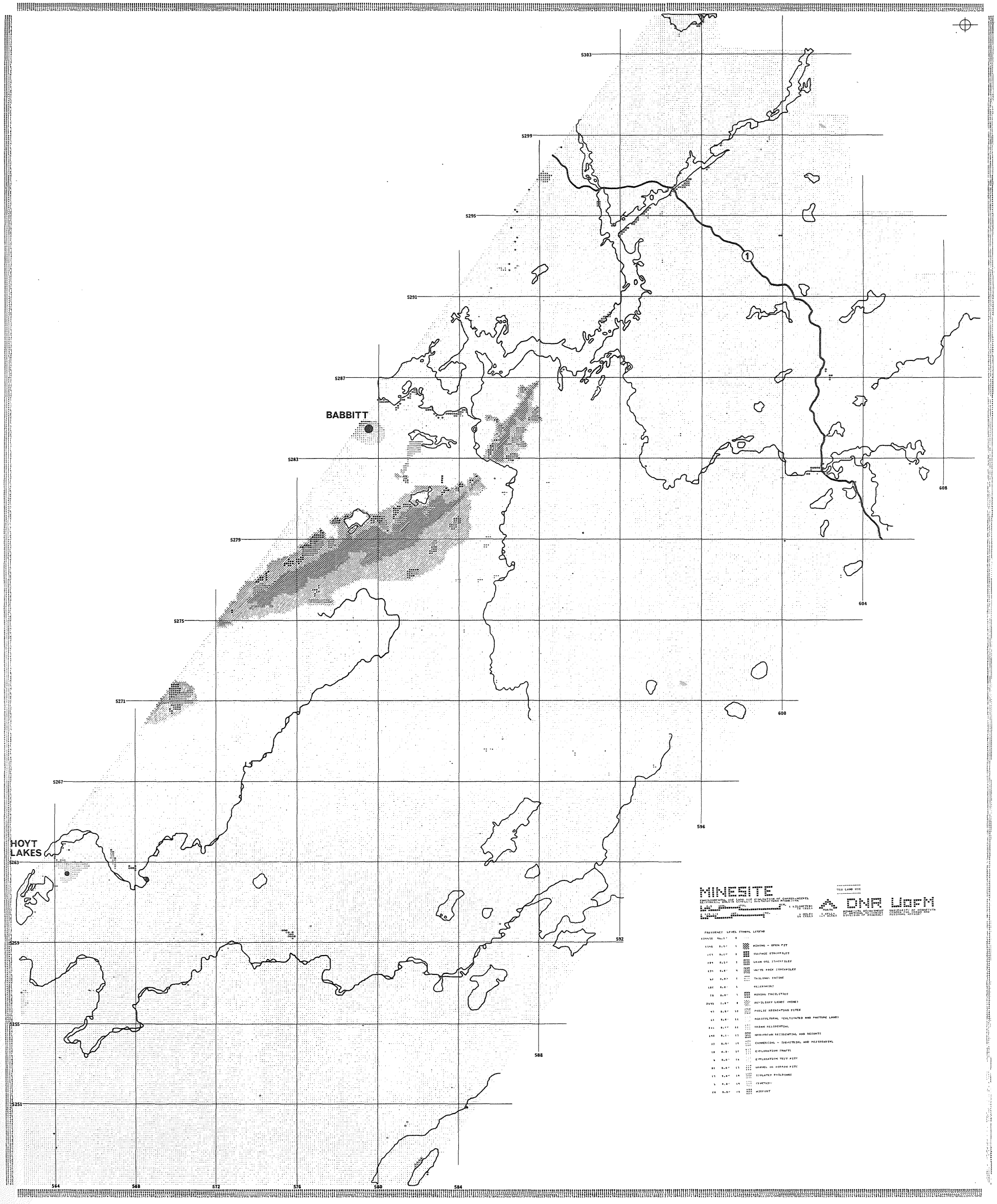
TECHNIQUE: All cells checked

FINAL DATE VERIFIED: October 19, 1976

LEVELS

Data Level	Legend
0	
1	Mining - Open Pit
2	Surface Stockpiles
3	Lean Ore Stockpiles
4	Waste Rock Stockpiles
5	Tailings Basins
6	Reservoirs
7	Mining Facilities
8	Auxiliary Lands (Mine)
10	Public Recreation Sites
11	Agriculture (Cultivated and pasture land)

Data Level	Legend
12	Urban Residential
13	Non-Urban Residential and Resorts (Some possibly abandoned)
14	Commercial-Industrial and Residential
15	Exploration Shafts
16	Exploration Test Pits
17	Gravel or Borrow Pits
18	Isolated Buildings (Some possibly abandoned)
19	Cemetery
20	Airport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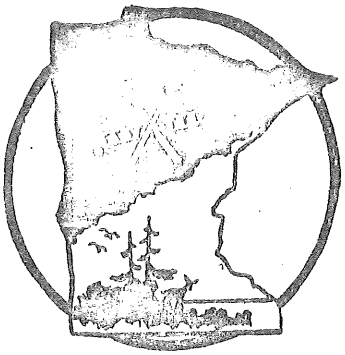
MINESITE
ENVIRONMENTAL AND LAND USE EVALUATION OF COPPER-NICKEL RESOURCES WITHIN NORTHEASTERN MINNESOTA
DNR LiEPN
MINING CITY: DEPARTMENT OF NATURAL RESOURCES DIVISION OF MINERALS
UNIVERSITY OF MINNESOTA DULUTH NATURAL RESOURCES RESEARCH INSTITUTE
LAND USE
FREQUENCY LEVEL SYMBOL LEGEND
MINING - OPEN PIT
SURFACE STOCKPILES
LEAN ORE STOCKPILES
WASTE ROCK STOCKPILES
TAILINGS BASINS
RESERVOIRS
MINING FACILITIES
NON-MINING RESIDENTIAL AND RESORTS
COMMERCIAL - INDUSTRIAL AND RESIDENTIAL
EXPLORATION SHAFTS
EXPLORATION TEST PITS
GRAVEL OR BORROW PITS
ISOLATED BUILDINGS
CEMETERY
AIRPORT



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

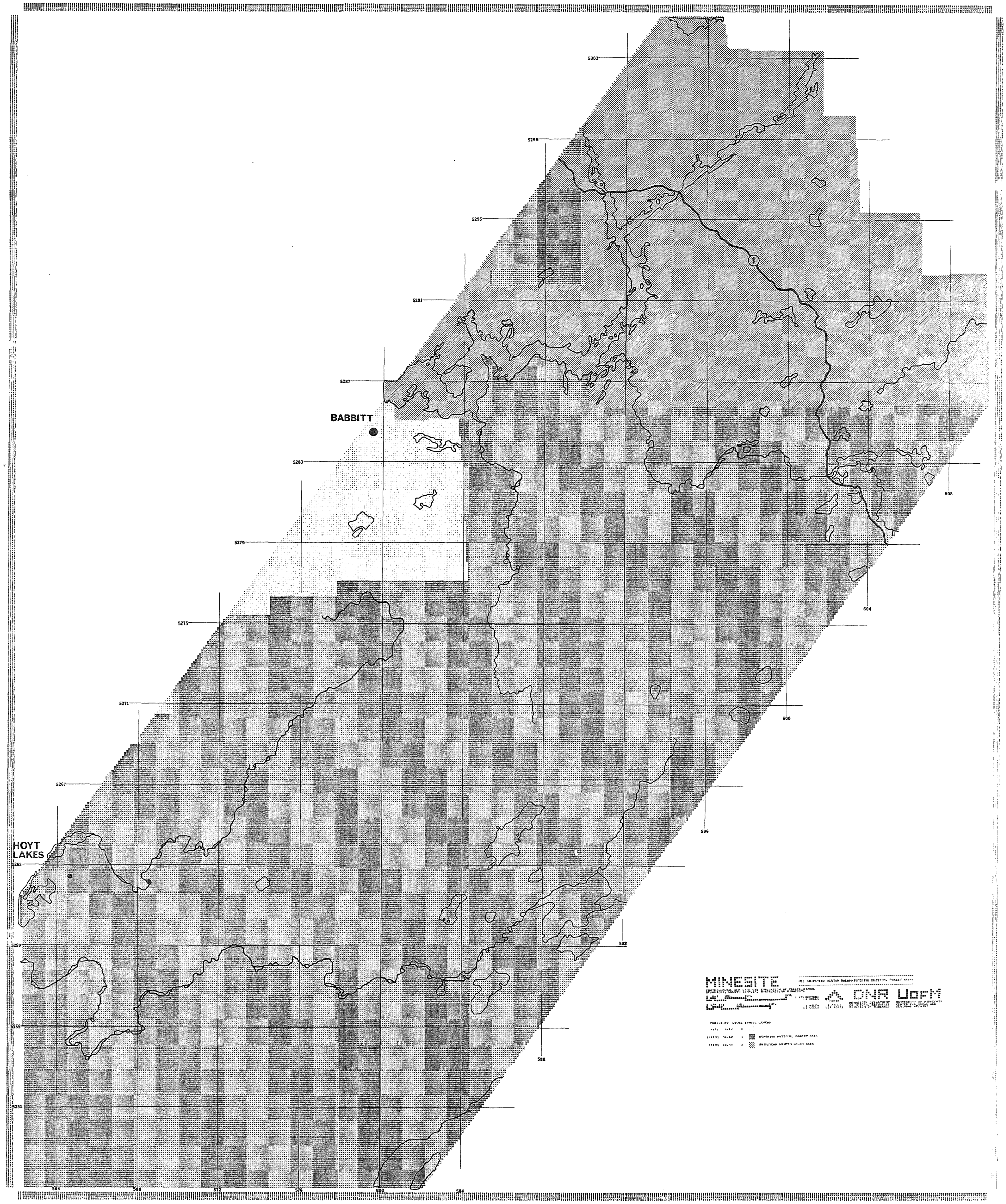
TECHNIQUE: All cells checked

FINAL DATE VERIFIED: September 24, 1976

LEVELS

Data Level	Legend
0	
1	Superior National Forest Area
2	Shipstead Newton Nolan Area*

*Also within the Superior National Forest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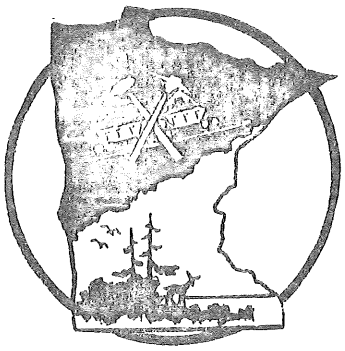


Recreation-Historical-
Archeological Sites (V14)

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 exact location of the sites is approximate, based upon the best available information.

VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: October 20, 1976

LEVELS

Data Level	Legend
0	
1	Lumbering Site
2	Approximate Mine Site Location
3	Keeley Creek Research Natural 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

Data Level	Legend
11	Lookout Tower
12	Snowmobile Trail
13	Scenic Wayside
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

BABBITT

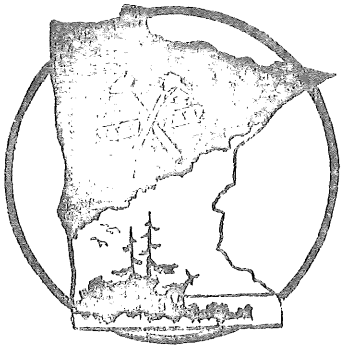
HOYT LAKES

MINESITE

DNR UofM

FREQUENCY LEVEL SYMBOL LEGEND

1	0.0%	1	LUMBERING SITE
3	0.0%	2	APPROXIMATE MINE SITE LOCATION
48	0.0%	3	STELEY CREEK RESEARCH NATURAL AREA BOUNDARY
1	0.0%	4	APPROXIMATE GHOST TOWN LOCATION
13	0.0%	5	INDIAN CULTURAL SITE
16	0.0%	6	BOAT LAUNCHING SITE - PUBLIC ACCESS
961	0.1%	7	PROPOSED SEVEN BEAVER RECREATION AREA BOUNDARY
1	0.0%	8	OUTWARD BOUND SCHOOL
169	0.1%	10	STACK LAKE PLANTATION
826	0.3%	11	SNOWMOBILE TRAIL
199	0.1%	12	KAWISHIWI EXPERIMENTAL FOREST BOUNDARY
12	0.0%	13	SNOWMOBILE TRAIL + PROPOSED SEVEN BEAVER RECREATION BOUNDARY
1	0.0%	14	LUMBERING SITE + PROPOSED SEVEN BEAVER RECREATION BOUNDARY
678	0.1%	15	EARLY ROAD
836	0.3%	16	INDIAN TRAIL
8	0.0%	17	INDIAN TRAIL AND BIRCH LAKE PLANTATION
8	0.0%	20	INDIAN TRAIL + PROPOSED SEVEN BEAVER RECREATION BOUNDARY
8	0.0%	21	INDIAN TRAIL AND SNOWMOBILE TRAIL
1	0.0%	22	INDIAN TRAIL + SNOWMOBILE TRAIL + SEVEN BEAVER BOUNDARY



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

Data Level	Legend
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

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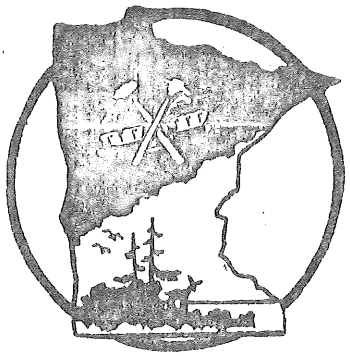
BABBITT
HOYT LAKES
MINESITE
DNR UofM



Vegetation (V16)

DATA BIOGRAPHY

SOURCE: See reference for Appendix D - Vegetation Inventory

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

SOURCE DATE: February 1975

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 which could be assigned marketing and pricing factors and could be distinguished on black and white infrared aerial photographs (Appendix D - Vegetation Survey).

VERIFICATION

TECHNIQUE: Statistical check - Appendix I

FINAL DATE VERIFIED: September 16, 1976

LEVELS

Data Level	Legend
0	
1	Aspen and paper birch
2	Spruce-fir
3	White cedar
4	Lowland shrubs
5	Ash, elm, soft maple, etc.
6	Farm
7	Open areas of grass
8	Hazel, pin cherry, etc.
9	Industrial and residential
10	Jack pine

Data Level	Legend
11	Non-productive swamp
12	Open water (lakes, ponds, etc.)
13	Northern hardwoods
14	Mixed aspen, birch, fir, pine, etc.
15	Marsh
16	Planted species - species cannot be identified on aerial photos
17	Mixed spruce, balsam, cedar, etc.
18	Red pine
19	Black spruce
20	Tamarack
23	White pine
24	Harvested
26	Quarry or gravel pit

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HOYT LAKES

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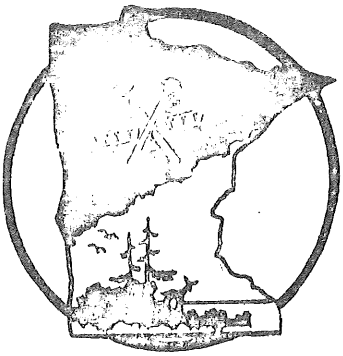
MINESITE

VEGETATION

DNR UofM

FREQUENCY LEVEL TYMCEL LEGEND

811	0.1%	0		
19348	10.1%	1		ASPEN AND PAPER BIRCH
11378	6.1%	2		JACK PINE
372	0.2%	3		WHITE CEDAR
1233	0.6%	4		LOWLAND CONIFER
199	0.1%	5		ALDER, SOFT MAPLE, ETC.
186	0.0%	6		FARM
311	0.2%	7		OPEN WATER OF GRAVEL
471	0.2%	8		HAZELL, PIN CHERRY, ETC.
4284	2.2%	9		INDUSTRIAL AND RESIDENTIAL
9873	5.1%	10		JACK PINE
1949	0.8%	11		NON-PRODUCTIVE SWAMP
6313	3.3%	12		OPEN WATER (LAKES, PONDS, ETC.)
4671	2.4%	13		MIXED ASPEN, LIRCH, FIR, PINE, ETC.
476	0.2%	14		MARSH
9686	5.0%	15		PLANTED SPECIES CANNOT BE IDENTIFIED ON AERIAL PHOTOS
17879	11.1	16		MIXED SPRUCE, TAMARACK, CEDAR, ETC.
1252	0.6	17		RED PINE
12778	6.6%	18		BLACK SPRUCE
194	0.1%	19		TAMARACK
1	0.0	20		WHITE PINE
193	0.1%	21		HARVESTED
45	0.0%	24		QUARRY OR GRAVEL PIT



Timber Cutting History (V17)

DATA BIOGRAPHY

SOURCE: Limnological Research Center, University of Minnesota

INTERPRETATION: Limnological Research Center

SOURCE DATE: July 1975

DESCRIPTION

Using aerial photography 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.

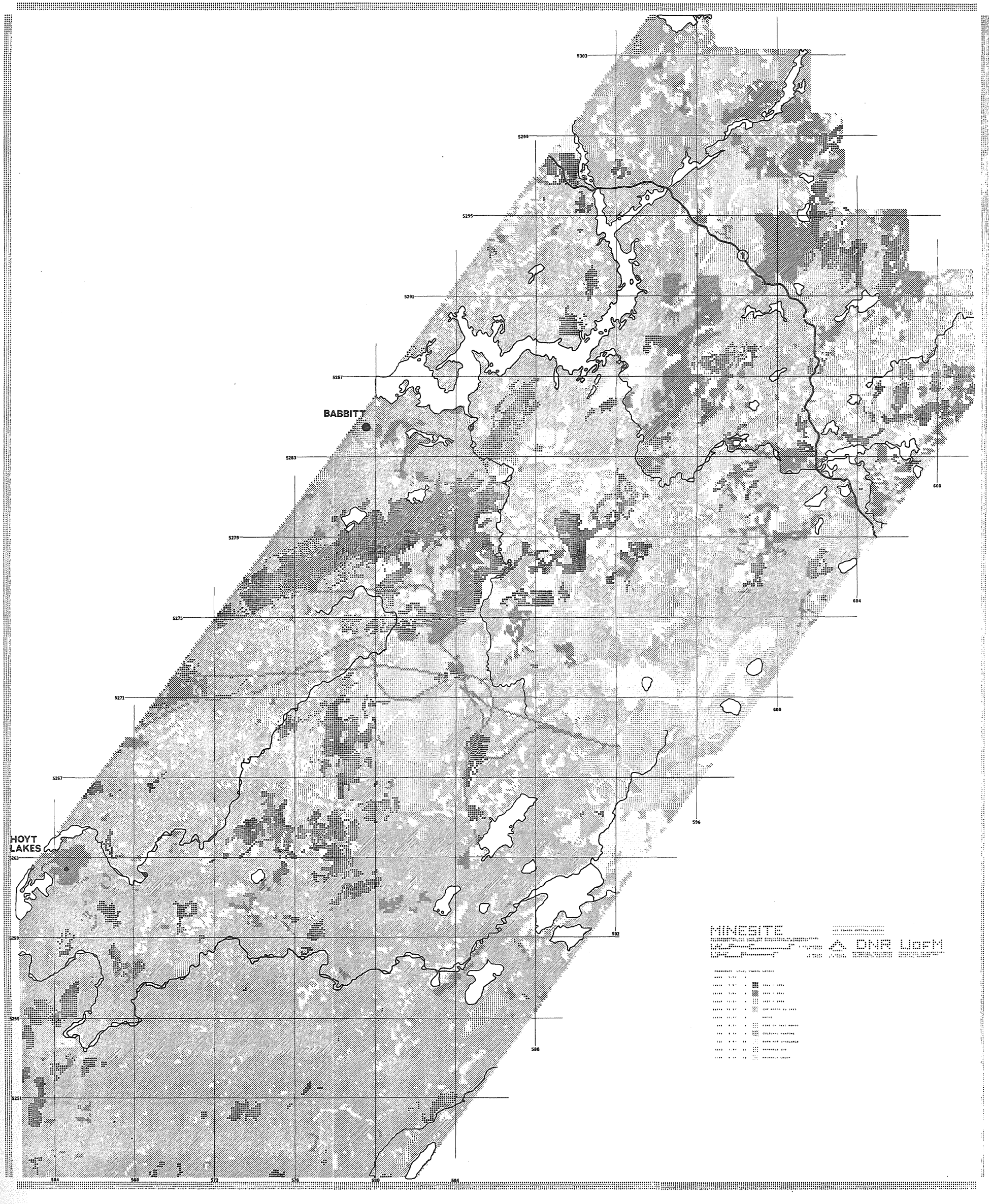
VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: September 16, 1976

LEVELS

Data Level	Legend
0	
2	1962-1970
3	1949-1961
4	1937-1948
5	Cut prior to 1937
7	Uncut
8	Fire area on 1961 photos
9	Cultural features
10	Data not available
11	Probably cut
12	Probably uncut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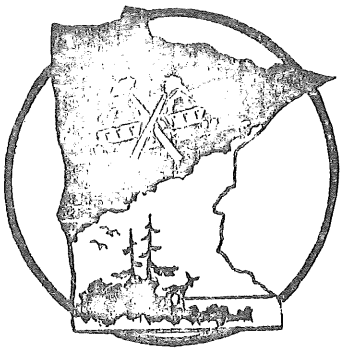


Crown Density (V18)

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; seedlings and saplings are based upon number of trees per acre (Appendix F - Vegetation Size and Density Classes (V18 and V19)).

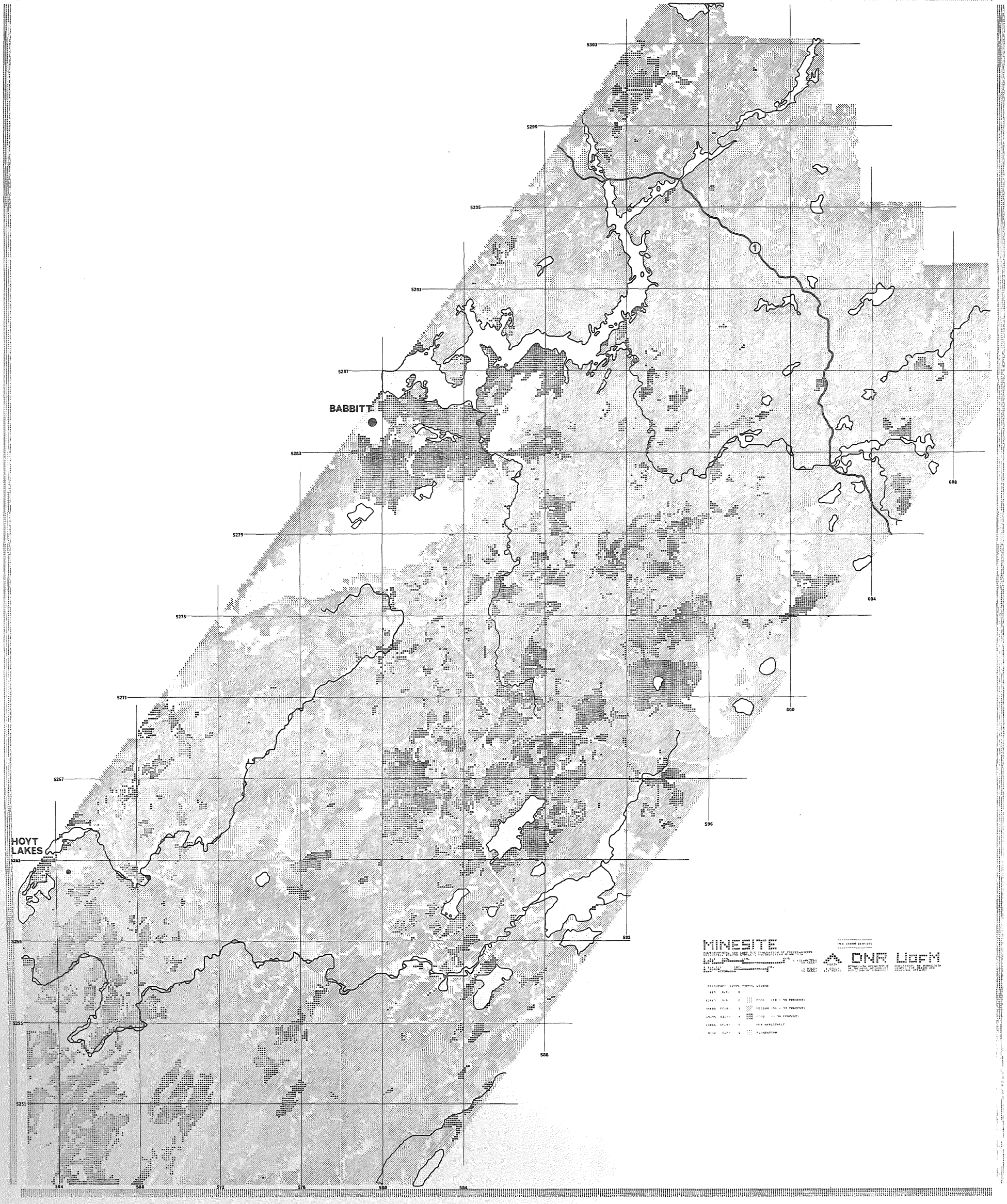
VERIFICATION

TECHNIQUE: Statistical check - Appendix I

FINAL DATE VERIFIED: September 12, 1976

LEVELS

Data Level	Legend
0	
2	Poor (10-40%)
3	Medium (41-70%)
4	Good (>70%)
5	Not applicable
6	Plantation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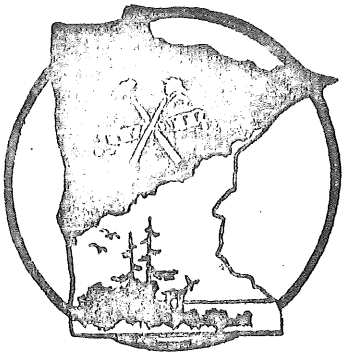
DNR
UofM



Forest Size Classes (V19)

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 $4\frac{1}{2}$ feet above ground (Appendix F).

VERIFICATION

TECHNIQUE: Statistical check-Appendix I

FINAL DATE VERIFIED: September 15, 1976

LEVELS

Data Level	Legend
0	
1	Seedlings (0-1 in. dbh)
2	Saplings (1-5 in. dbh)
3	Pole Timber (5-9 in. dbh)
4	Small Saw Timber (9-15 in. dbh)
5	Large Saw Timber (15 in. dbh)
6	Not applicable
7	Plantation

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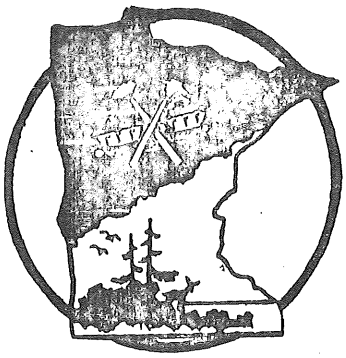
MINESITE

DNR UofM



Forest Height Classes (V20)

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.

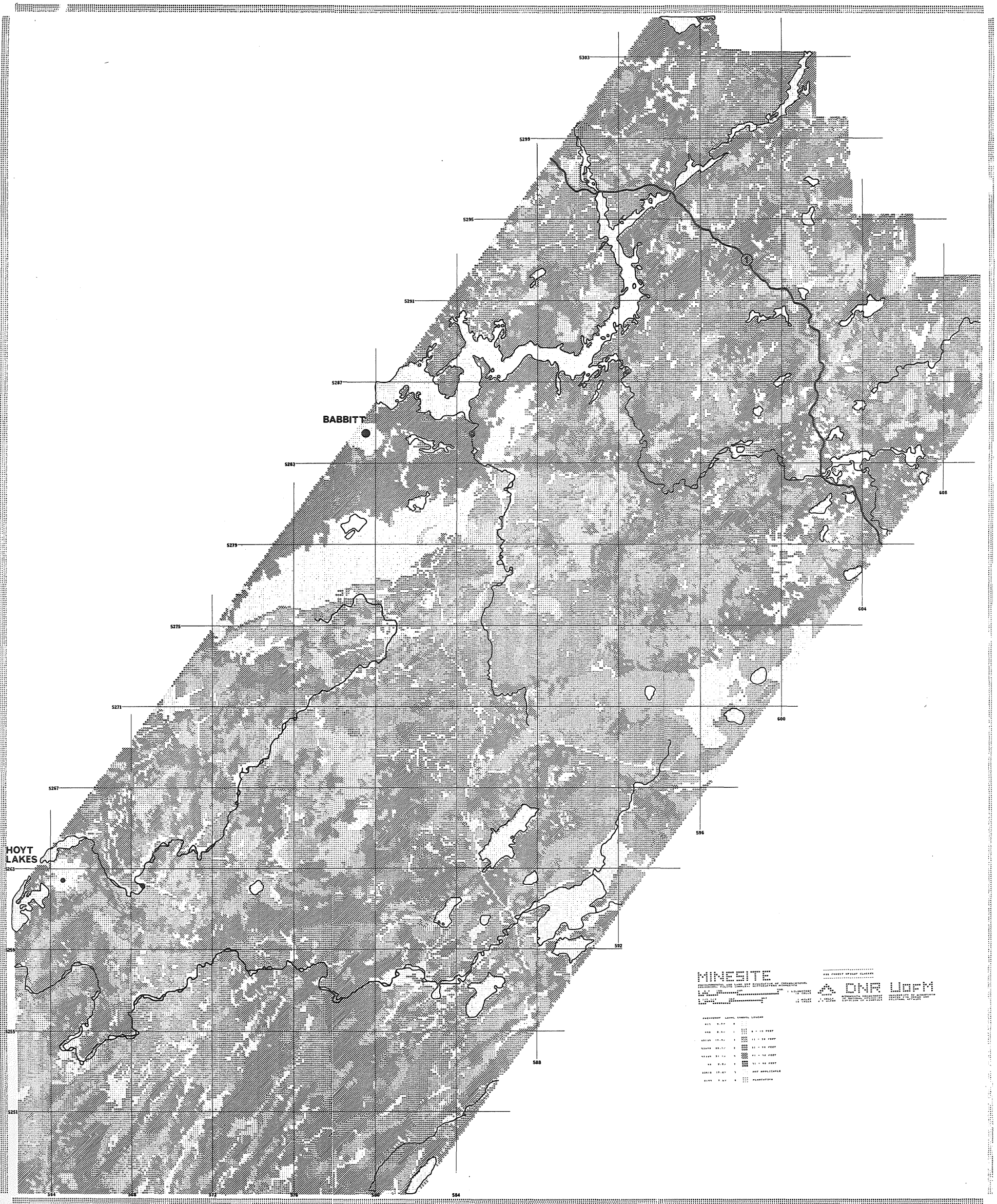
VERIFICATION

TECHNIQUE: Statistical check-Appendix I

FINAL DATE VERIFIED: September 15, 1976

LEVELS

Data Level	Legend
0	
1	0-10 ft.
2	11-30 ft.
3	31-50 ft.
4	51-70 ft.
5	71-90 ft.
6	91-110 ft.
7	Not applicable
8	Plantation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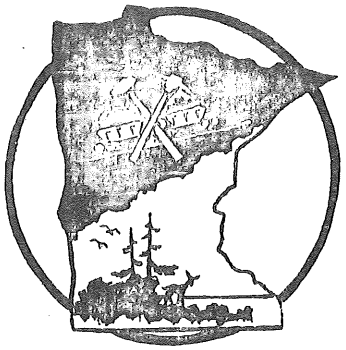


Natural Resource Sites (V21)

DATA BIOGRAPHY

SOURCE: 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

This inventory contains identified natural resource sites. Since the area has not been uniformly surveyed, additional sites undoubtedly exist in the area which will require map updating when located. The Caribou Release Site should be considered as a habitat area potentially suitable for reintroduction of caribou. Data levels are plotted as either areas or boundaries. Several mapped data levels show approximate boundaries based on the best information available. In some cases unique wildlife species areas have been expanded when mapped so that specific sites are not readily locatable.

VERIFICATION

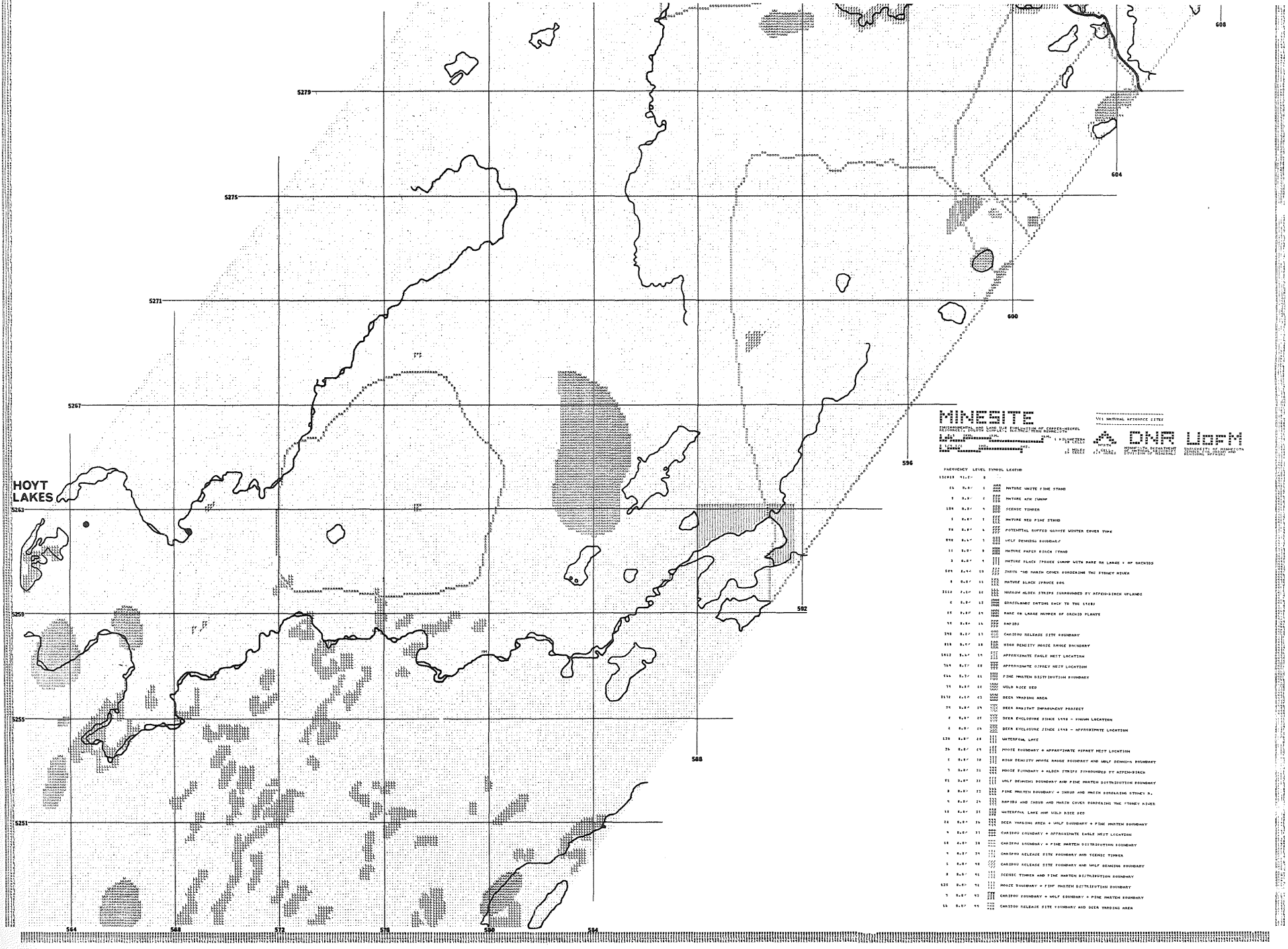
TECHNIQUE: All cells checked

FINAL DATE VERIFIED: October 19, 1976

LEVELS

Data Level	Legend
0	
1	Mature White Pine Stand
2	Mature Ash Swamp
3	Exceptional Wildlife and Fish Habitat
4	Scenic Timber
5	Mature Red Pine Stand
6	Potential Ruffed Grouse Winter Cover Type
7	Wolf Denning Boundary
8	Mature Paper Birch Stand
9	Mature Black Spruce Swamp with rare or large numbers of orchids

Data Level	Legend
10	Shrub and marsh cover bordering the Stoney River
11	Mature Black Spruce Bog
12	Narrow Alder strips surrounded by Aspen-Birch Uplands
13	Grassland dating back to 1920s
14	Rare or large number of orchid plants
15	Water Falls
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	Wild Rice Bed
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 Shrub and marsh cover bordering the Stoney River
34	Rapids and Shrub and marsh cover bordering the Stoney River
35	Waterfowl Lake and Wild Rice Bed
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
40	Caribou Release Site Boundary and Wolf Denning Boundary
41	Scenic Timber 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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MINESITE

ENVIRONMENTAL AND LAND USE EVALUATION OF COPPER-NICKEL
MINERAL LEASING CONSIDERATIONS, SOUTHEAST ST. LOUIS COUNTY, NORTHEASTERN MINNESOTA

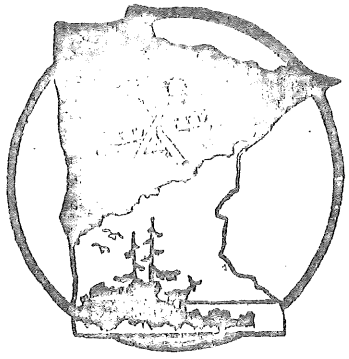
VCL NATURAL RESOURCE SITES

DNR UofM

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINERALS

UNIVERSITY OF MINNESOTA
DULUTH, MINNESOTA
NATURAL RESOURCES RESEARCH INSTITUTE

FREQUENCY	LEVEL	SYMBOL	LEGEND
1.1%	0.0/	1	MATURE WHITE PINE STAND
1	0.0/	C	MATURE ASH SWAMP
1.8%	0.0/	9	SCENIC TIMBER
1	0.0/	7	MATURE RED PINE STAND
7.5	0.0/	6	POTENTIAL RUFFED GROUSE WINTER COVER TYPE
9.9%	0.0/	5	WOLF DENNING BOUNDARY
11	0.0/	8	MATURE PAPER BIRCH STAND
3	0.0/	A	MATURE BLACK SPRUCE SWAMP WITH RARE OR LARGE # OF ORCHIDS
3.4%	0.0/	10	SNOW-TAM MARSH COVER BORDERING THE STONEY RIVER
8	0.0/	11	MATURE BLACK SPRUCE BOG
2112	0.1/	12	NARROW ALDER STRIPS SURROUNDED BY ASPEN-BIRCH UPLANDS
C	0.0/	13	GRASSLANDS DATING BACK TO THE 1580
1F	0.0/	1A	RARE OR LARGE NUMBER OF ORCHID PLANTS
99	0.0/	1B	RAPIDS
3%	0.0/	17	CARIBOU RELEASE SITE BOUNDARY
81%	0.0/	18	HIGH DENSITY MOOSE RANGE BOUNDARY
1912	0.0/	19	APPROXIMATE EAGLE NEST LOCATION
749	0.0/	2B	APPROXIMATE OSPREY NEST LOCATION
5%	0.0/	1C	FINE MARTEN DISTRIBUTION BOUNDARY
99	0.0/	1E	WILD RICE BED
1172	0.1/	2D	DEER YARDING AREA
79	0.0/	2F	DEER HABITAT IMPROVEMENT PROJECT
F	0.0/	2F	DEER ENCLOSURE SINCE 1998 - KNOWN LOCATION
E	0.0/	2E	DEER ENCLOSURE SINCE 1998 - APPROXIMATE LOCATION
128	0.0/	28	WATERFOWL LAKE
3%	0.0/	29	MOOSE BOUNDARY + APPROXIMATE OSPREY NEST LOCATION
C	0.0/	30	HIGH DENSITY MOOSE RANGE BOUNDARY AND WOLF DENNING BOUNDARY
7	0.0/	31	MOOSE B'UNDARY + ALDER STRIPS SURROUNDED BY ASPEN-BIRCH
F1	0.0/	32	WOLF DENNING BOUNDARY AND FINE MARTEN DISTRIBUTION BOUNDARY
8	0.0/	33	FINE MARTEN BOUNDARY + SWAMP AND MARSH BORDERING STONEY R.
9	0.0/	34	RAPIDS AND SWAMP AND MARSH COVER BORDERING THE STONEY RIVER
12	0.0/	35	WATERFOWL LAKE AND WILD RICE BED
23	0.0/	36	DEER YARDING AREA + WOLF BOUNDARY + FINE MARTEN BOUNDARY
9	0.0/	37	CARIBOU BOUNDARY + APPROXIMATE EAGLE NEST LOCATION
18	0.0/	38	CARIBOU BOUNDARY + FINE MARTEN DISTRIBUTION BOUNDARY
9	0.0/	39	CARIBOU RELEASE SITE BOUNDARY AND SCENIC TIMBER
1	0.0/	3A	CARIBOU RELEASE SITE BOUNDARY AND WOLF DENNING BOUNDARY
8	0.0/	4C	SCENIC TIMBER AND FINE MARTEN DISTRIBUTION BOUNDARY
63%	0.0/	4D	MOOSE BOUNDARY + FINE MARTEN DISTRIBUTION BOUNDARY
3	0.0/	42	CARIBOU BOUNDARY + WOLF BOUNDARY + FINE MARTEN BOUNDARY
14	0.0/	44	CARIBOU RELEASE SITE BOUNDARY AND DEER YARDING AREA



Lake and Stream Surveys
(Fish Habitat) (V22)

DATA BIOGRAPHY

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

INTERPRETATION: Division of Fisheries, DNR

SOURCE DATE: April 23, 1976

DESCRIPTION

Streams and lakes are classified based on 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 that are 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, however, it is representative of the system expected to be adopted (Appendix G - Lake and Stream Surveys).

VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: September 7, 1976

LEVELS

Data Level	Legend
0	
	Type A - Trout streams with enough natural reproduction to sustain a fishery.
1	1. Main
2	2. Feeder
3	Type B - Trout streams with lack of natural reproduction or overabundant competing species.
4	Type C - Steelhead streams.
5	Type D - Associated streams - trout (put and take stocking necessary).

Data Level	Legend
	Type E - Warmwater gamefish streams
6	1. Walleye
7	2. Northern pike
8	3. Catfish-smallmouth bass
9	4. Cosmopolitan
10	5. Muskellunge
11	Type F - Warmwater streams dominated by carp.
	Type H - Warmwater feeder streams
12	1. Northern pike (spawning)
13	2. Walleye (spawning)
14	3. Minnow
15	Unclassified stream
16	Trout lake
17	Soft-water walleye lake
18	Hard-water walleye lake
19	Centrarchid-walleye lake
20	Centrarchid lake
21	Roughfish-gamefish lake
22	Bullhead lake
23	Unclassified lake
	Type G - Warmwater connector streams
24	1. Walleye
25	2. Northern pike
26	Game Lake

BABBITT

HOYT LAKES

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MINESITE

1981 LAKE AND STREAM SURVEY (FISH HABITAT)

ENVIRONMENTAL AND LAND USE EVALUATION OF COPPER-NICKEL
DEVELOPMENT WITH SPECIAL REFERENCE TO WATER QUALITY MANAGEMENT

0 1 2 3 4 5 MILES
0 1 2 3 4 5 6 7 8 KILOMETERS

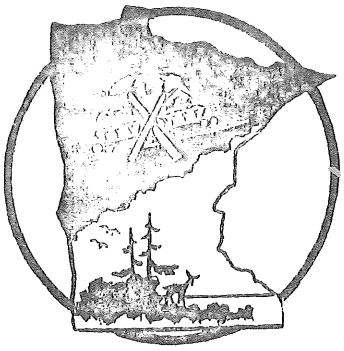
DNR UofM

MINNESOTA DEPARTMENT OF NATURAL RESOURCES — DIVISION OF MINERALS

UNIVERSITY OF MINNESOTA — DULUTH CAMPUS — GEOLOGICAL SURVEY

FREQUENCY LEVEL SYMBOL LEGEND

571621	92.1%	0	
198	0.1%	1	TYPE A STREAM - TROUT STREAM
54	0.0%	2	TYPE D STREAM - ASSOCIATED STREAMS - TROUT
381	0.1%	4	TYPE E STREAM - WALLEYE
199	0.0%	5	TYPE E STREAM - NORTHERN PIKE
1781	1.0%	6	TYPE E STREAM - COMPOSITE/FWN
99	0.0	14	TYPE N STREAM - NORTHERN PIKE (SPAWNING)
1852	1.0%	15	TYPE N STREAM - MIXED
197	0.0%	16	UNCLASSIFIED STREAM
881	0.1%	17	LAKE - SOFT-WATER WALLEYE
82	0.0%	18	LAKE - HARD-WATER WALLEYE
397	0.1%	19	LAKE - CENTRARCHID - WALLEYE
188	0.0%	20	LAKE - CENTRARCHID
91	0.1%	21	LAKE - ROUGHFISH - GAMEFISH
183	0.0%	23	UNCLASSIFIED LAKE
38	0.0%	24	TYPE A STREAM - WALLEYE
99	0.0%	25	TYPE A STREAM - NORTHERN PIKE
178	0.0%	26	NAME LAKE



Mineral Leasing (V23)

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

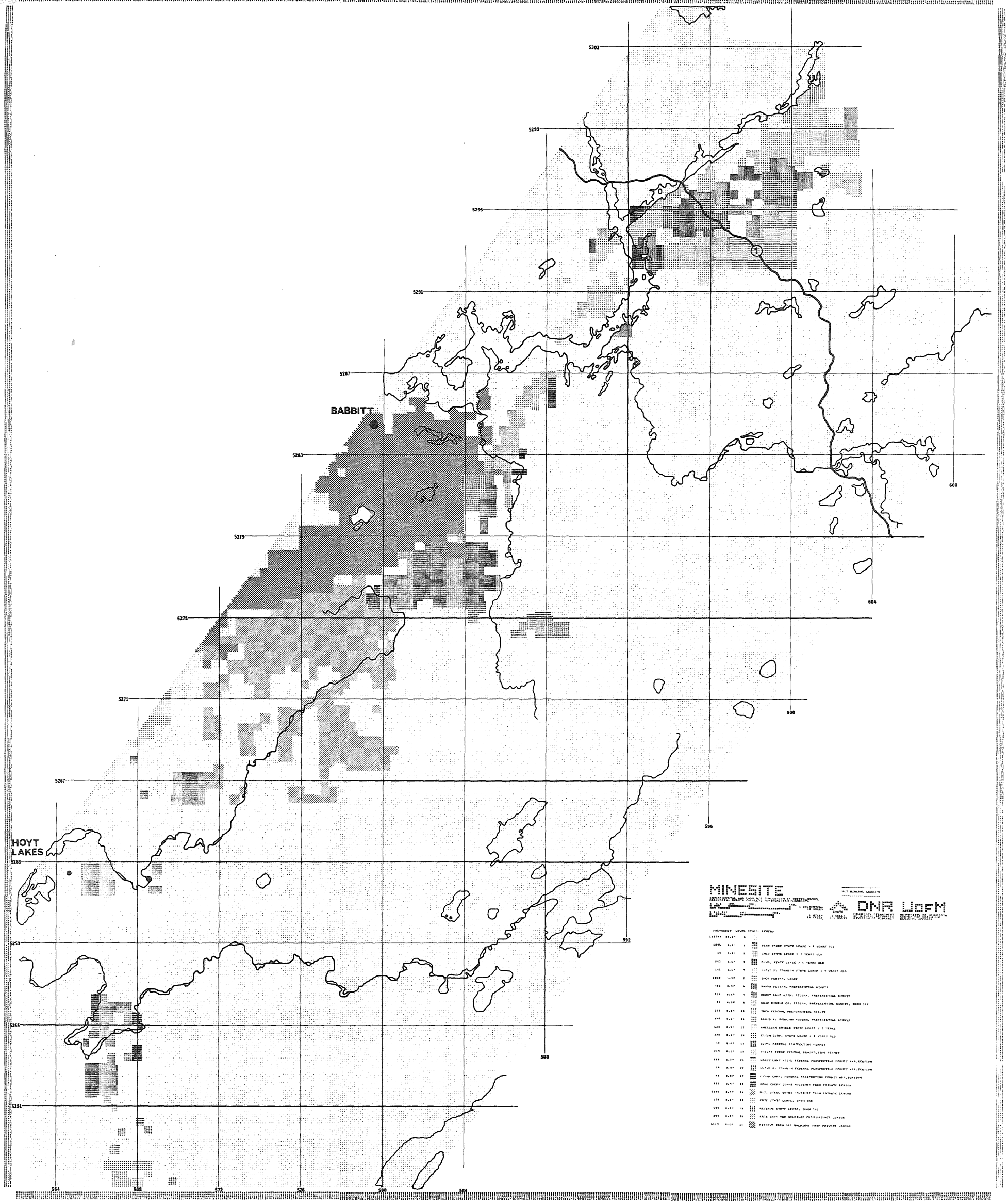
TECHNIQUE: All cells checked

FINAL DATE VERIFIED: September 27, 1976

LEVELS

Data Level	Legend
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 Level	Legend
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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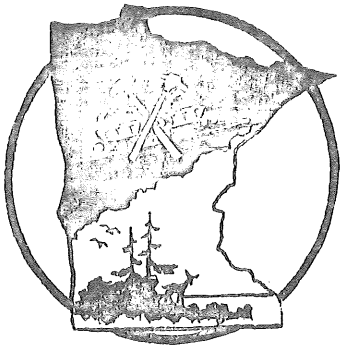

Soil Associations (V24)

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 for detailed information on soils series present in MINESITE area.

VERIFICATION

TECHNIQUE: Statistical Check - Appendix I

FINAL DATE VERIFIED: October 6, 1976

LEVELS

Data Level	Legend
0	
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

Data Level	Legend
13	Mine
16	P - Peat and muck soils
19	SP - Peat soils

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MINESITE

SOIL ASSOCIATIONS

ENVIRONMENTAL AND LAND USE EVALUATION OF COPPER-NICKEL DEVELOPMENT, SOUTH SUPERIOR, NORTHEASTERN MINNESOTA

1 KILOMETER
10 MILES
1 INCH
1.2 MILES

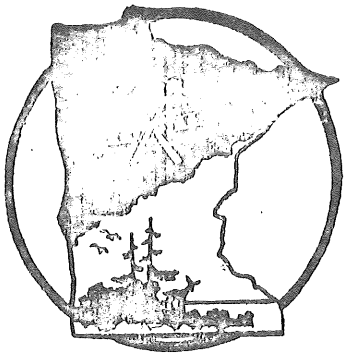
DNR UofM

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINERALS

UNIVERSITY OF MINNESOTA
REGIONAL GEOLOGY AND GEOPHYSICAL MAPPING

FREQUENCY LEVEL SYMBOL LEGEND

4749	4.1%	2			
19111	16.4%	3		C	UNDULATING LOAMY SOILS
35	0.0%	4		G	UNDULATING GRAVELLY SOILS
15983	13.8%	5		U	UNDIFFERENTIATED UNDULATING TO STEEP GRAVELLY SOILS
27876	24.1%	6		K	UNDULATING TO HILLY LOAMY SOILS
193	0.2%	7		KS	UNDULATING SANDY SOILS
1117	0.7%	8		KG	UNDULATING LOAMY SOILS
987	0.8%	9		O	PEAT SOILS
298	0.1%	10		FC	NEARLY LEVEL CLAYEY SOILS
972	0.8%	11		CC	UNDULATING CLAYEY SOILS
1877	1.5%	12		MINE	
25999	22.4%	15		P	PEAT AND MUCK SOILS
421	0.3%	19		SP	PEAT SOILS



Highways, Roads, and Trails (V25)

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 24, 1976

LEVELS

Data Level	Legend
0	
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 Streets
14	Mining Roads
15	Erie Restricted Road
16	Federal Highway

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MINESITE

ENVIRONMENTAL AND LAND USE EVALUATION OF COPPER-NICKEL RESOURCES, DULUTH COMPLEX, NORTHEASTERN MINNESOTA

1 MILE
1 KILOMETER
1 INCH = 2 MILES
1 INCH = 3.2 KILOMETERS

USE HIGHWAYS, ROADS AND TRAILS

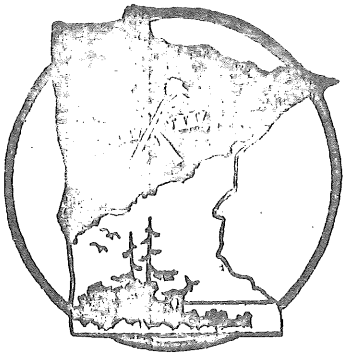
DNR UofM

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINERALS

UNIVERSITY OF MINNESOTA DULUTH
REGIONAL AFFAIRS

FREQUENCY LEVEL SYMBOL LEGEND

138478	95.6%	0	
11	0.0%	1	FOREST ROAD ADJACENT TO ERIE RESTRICTED ROAD
884	0.1%	2	STATE HIGHWAY
886	0.1%	3	COUNTY ROAD
33	0.0%	4	HARD SURFACE - MEDIUM DUTY ROAD (GOOD)
2168	1.5%	5	IMPROVED LIGHT DUTY ROAD (SECONDARY)
1787	1.2%	6	UNIMPROVED DIRT ROAD (PRIMITIVE)
813	0.6%	7	CITY STREETS
1422	0.9%	19	MINING ROADS
648	0.4%	18	ERIE RESTRICTED ROAD



Railroads and Utilities (V26)

DATA BIOGRAPHY

SOURCE: USGS Topo Maps: Greenwood L. (1954); Gabbro L., Markham, 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.

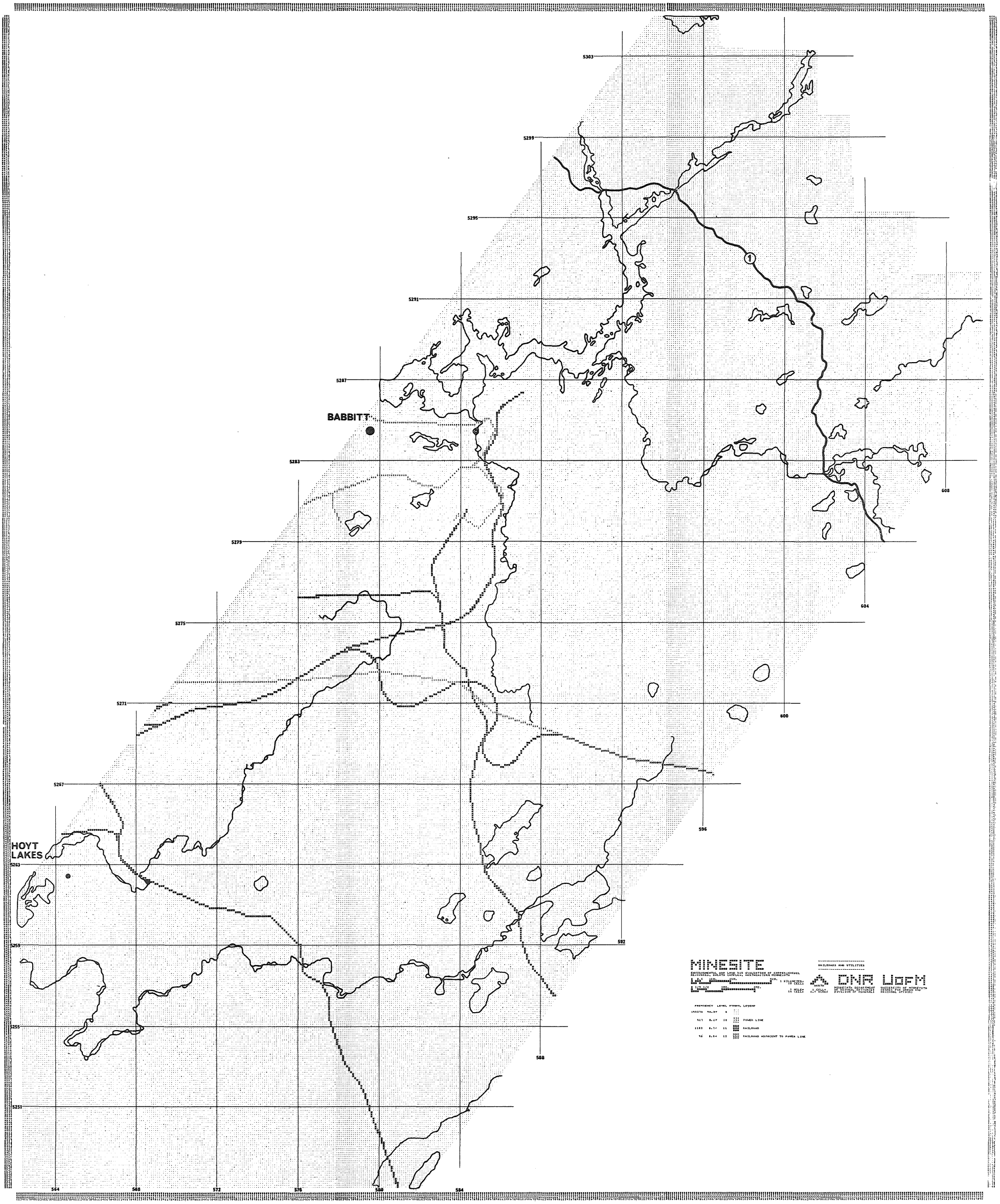
VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: August 24, 1976
*photo revised

LEVELS

Data Level	Legend
0	
10	Power line
11	Railroad
13	Railroad adjacent to power line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RAILROAD AND UTILITIES
DNR UofM
FREQUENCY LEVEL SYMBOL LEGEND
POWER LINE
RAILROAD
RAILROAD ADJACENT TO POWER LINE

Watershed Areas (V30)

DATA BIOGRAPHY

SOURCE: Derived from V06 Watersheds

INTERPRETATION: MINESITE Staff, DNR

SOURCE DATE:

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: May 18, 1976

LEVELS

Data Level	Legend	Data Level	Legend
9	South Kawishiwi	22	Nip Creek
10	St. Louis	23	Denley Creek
11	Isabella	25	Kawishiwi River
12	Stony River	26	Bear Island River
13	Partridge		
14	Whiteface		
16	Embarrass		
17	Dunka River		
18	North River		
19	Colvin Creek		
20	Argo Creek		
21	Sand River		

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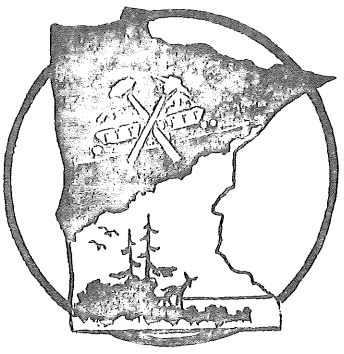


Units Within the MINESITE Area (V91)

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.

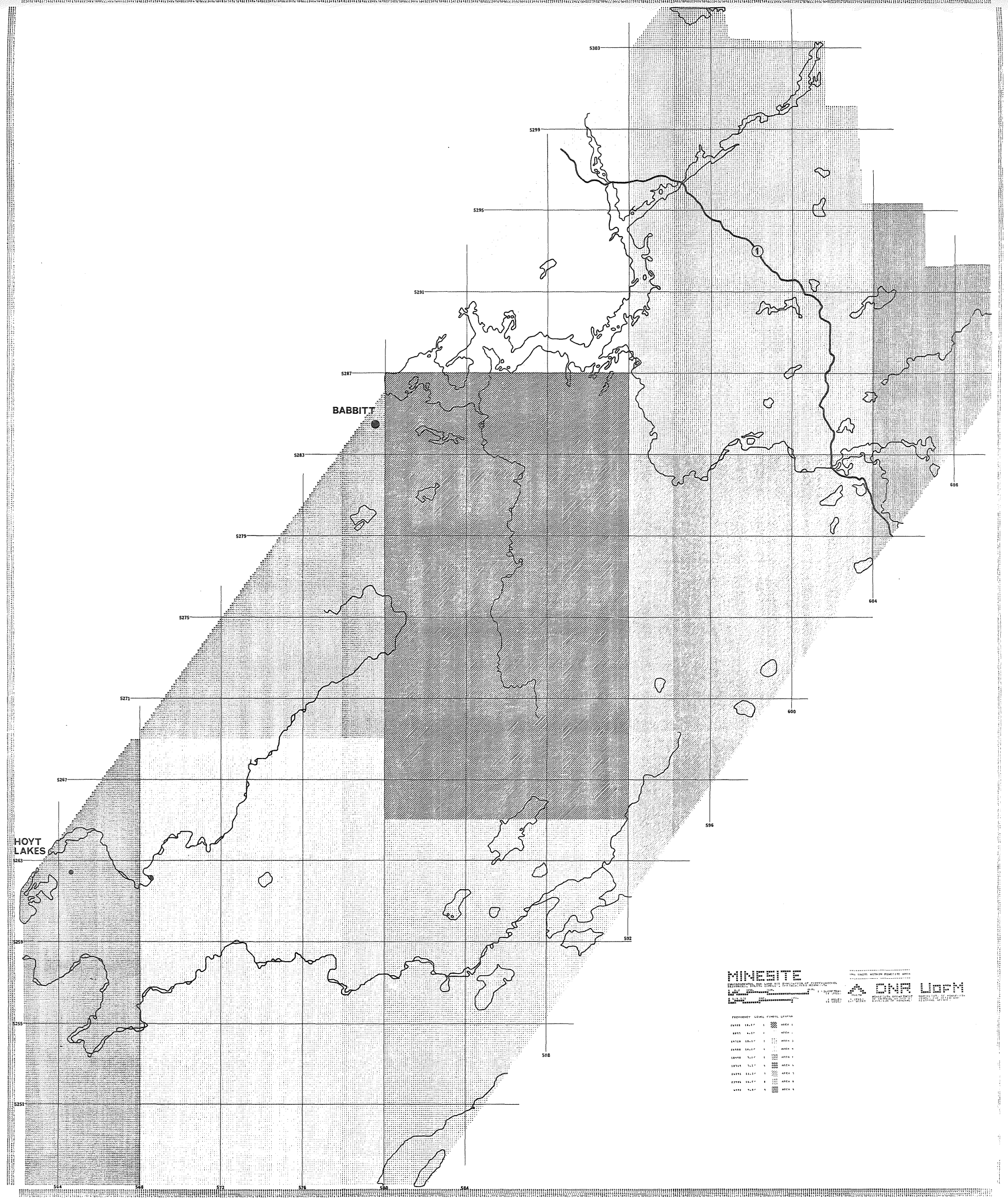
VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: September 2, 1976

LEVELS

Data Level	Legend
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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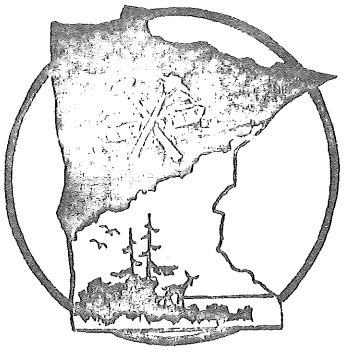


MINESITE Area (V95)

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.

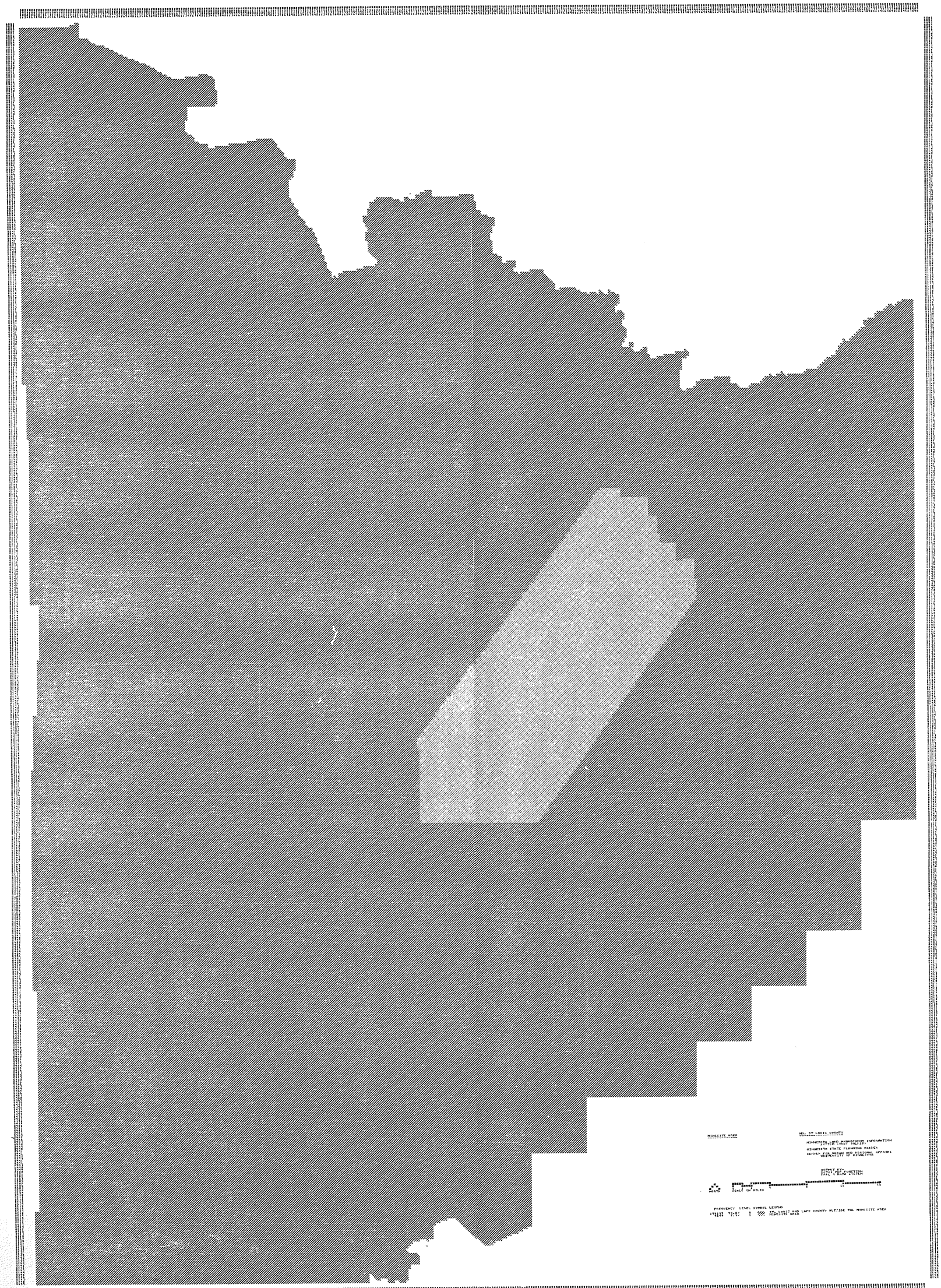
VERIFICATION

TECHNIQUE: All cells checked

FINAL DATE VERIFIED: September 17, 1976

LEVELS

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


MINNESOTA LAND MANAGEMENT INFORMATION SYSTEM
MINNESOTA STATE PLANNING AGENCY
CENTER FOR URBAN AND REGIONAL AFFAIRS
UNIVERSITY OF MINNESOTA
SURVEY OF
PUBLIC LAND SYSTEM
NORTH
SCALE IN MILES
FREQUENCY LEVEL SYMBOL LEGEND
MINESITE AREA
MU. ST LOUIS COUNTY
ST. LOUIS AND LAKE COUNTY OUTSIDE THE MINESITE AREA

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.

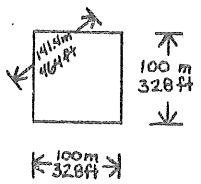
Data level 7 is defined as an area of unknown slope. These

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.

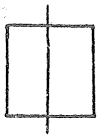
Definition of % Slope Categories (Topographic maps with a 10 foot elevation interval)

Cell Size

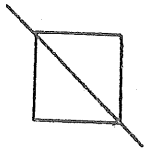


100 m x $\sqrt{2}$ = 141.4m
100 m x 3.28ft/m = 328 ft.
141.4 m x 3.28ft/m = 464 ft.

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

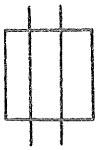


$\frac{10}{328}$ x 100 = 3.0%

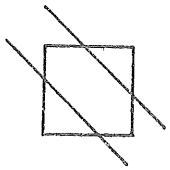


$\frac{10}{464}$ x 100 = 2.2%

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



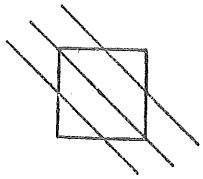
$\frac{20}{328}$ x 100 = 6.1%



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

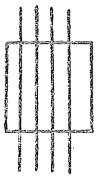
C 7-9% Slope (3 elevation contour lines)

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



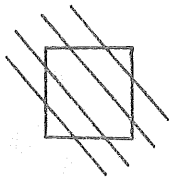
$\frac{30}{464}$ x 100 = 6.5%

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

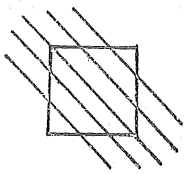


$\frac{40}{328}$ x 100 = 12.2%

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

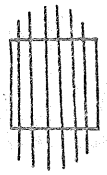


$\frac{40}{464}$ x 100 = 8.6%

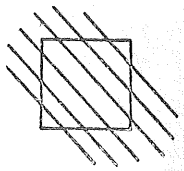


$\frac{50}{464}$ x 100 = 10.8%

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



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



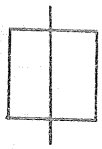
$\frac{60}{464}$ x 100 = 12.9%

F 0% Slope (No elevation contour lines)

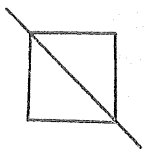
G Unknown slope orientation - areas recently disturbed, generally from mining activities, and as yet have not been updated on USGS quadrangle maps.

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

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



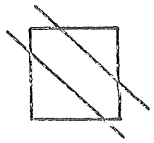
$\frac{20}{328}$ x 100 = 6.1%



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

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

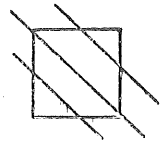
$\frac{40}{328} \times 100 = 12.2\%$



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

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.

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

SGB / RO	Rainy outwash plain, bedrock controlled, sand and gravel, well drained, ≥4' to bedrock.
SGVB / RO	Rainy outwash plain, bedrock controlled, sand and gravel, well drained, <40" to bedrock.
SG / RE	Rainy esker, sand and gravel, well drained, >4' to bedrock.
SL/SG / SO	Superior outwash plain, sandy loam over sand and gravel, well drained, >4' to bedrock.
LS/SG / SO	Superior outwash plain, loamy sand over sand and gravel, well drained, >4' to bedrock.
SGP / SO	Superior outwash plain, sand and gravel, poorly drained, >4' to bedrock.
SP / SO	Superior outwash plain, medium and fine sand, poorly drained, >4' to bedrock.
SG / SE	Superior esker, sand and gravel, well drained, >4' to bedrock.
OLP / DR	Drainway, peat with inclusions of loam, poorly drained, >4' to bedrock.
LOP / DR	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.
SLP / RD	Rainy drumlin, sandy loam, poorly to somewhat poorly drained, >4' to bedrock.
LP / RM	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).

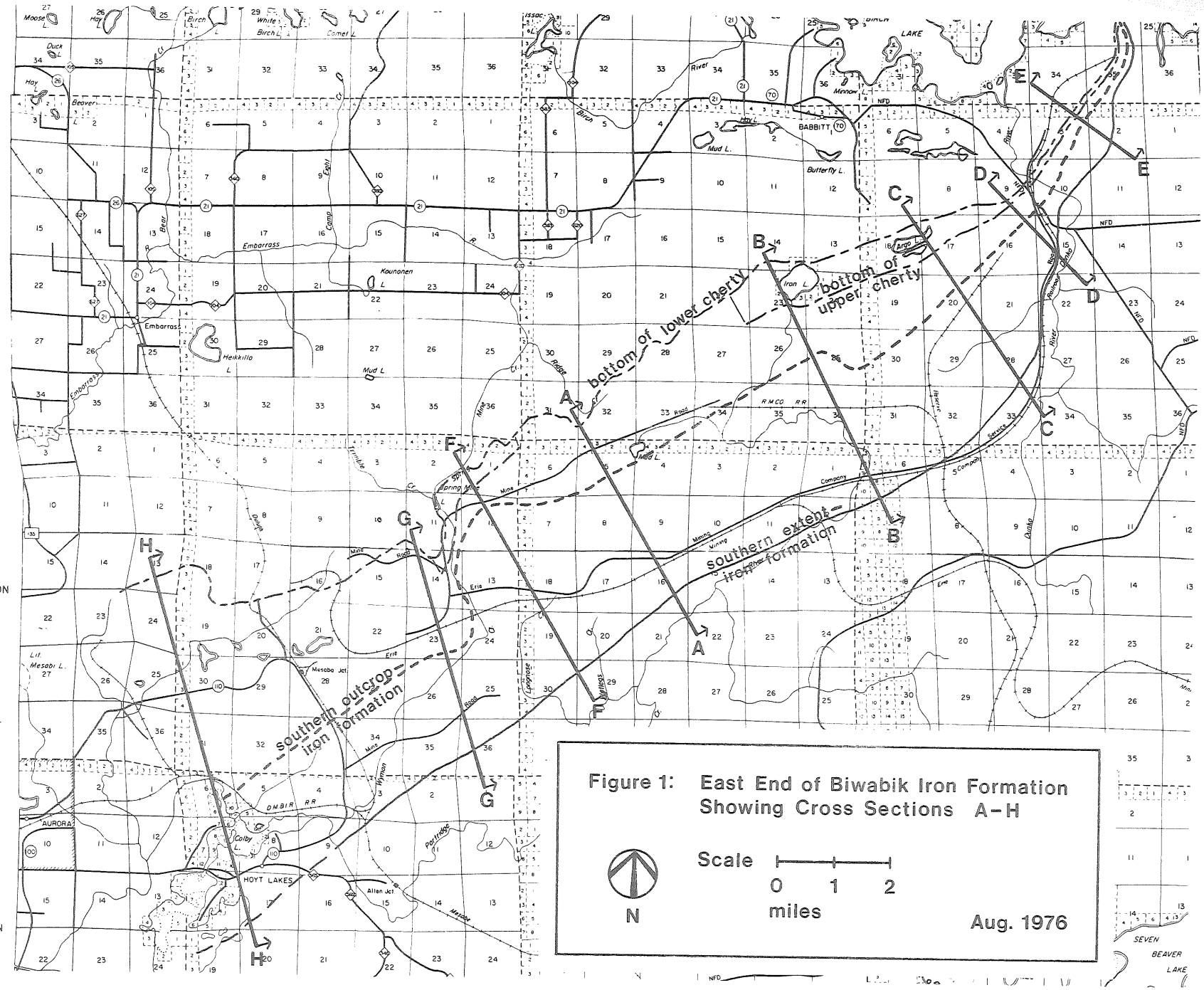


Figure 1: East End of Biwabik Iron Formation Showing Cross Sections A–H

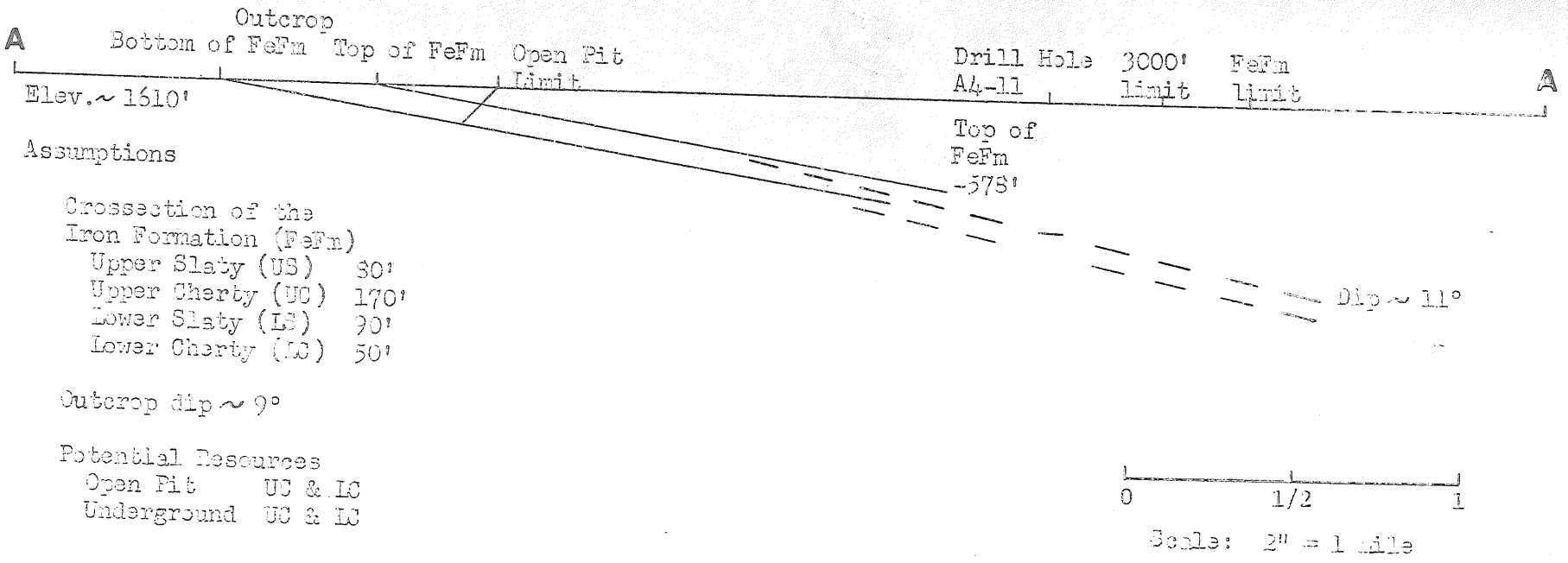


Figure 2 Crossection A-A Biwabik Iron Formation

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^{o} would require a new or modified large scale mining technique (17).

11. Typical iron formation thicknesses and dips are assumed for each cross section.

REFERENCES

1. Bonnichsen, B., "General Geology and Petrology of the Metamorphosed Biwabik Iron Formation, Dunka River Area, Minnesota", Ph.D. Thesis, University of Minnesota, June 1968.

2. Bonnichsen, B., "Geology of the Metamorphosed Biwabik Iron Formation, Dunka River Area, Minnesota", 29th Annual Mining Symposium, University of Minnesota, January 1968.

3. Bonnichsen, B., "Metamorphism of the Biwabik Iron Formation, Dunka River Area, Minnesota", Technical Sessions Abstracts, 14th Annual Institute on Lake Superior Geology, Wisconsin State University, May 1968.

4. "Extent of Biwabik Formation as indicated by drilling", Open File Map, Minnesota Department of Natural Resources, Division of Minerals, 12/18/75.

5. Griffin, W.L. & G.B. Morey, "The Geology of the Isaac Lake Quadrangle, St. Louis County, Minnesota", Minnesota Geological Survey SP-8, University of Minnesota 1969.

6. Grout, F.F. & T.M. Broderick, "The Magnetite Deposits of the Eastern Mesabi Range, Minnesota", Minnesota Geological Survey, Bulletin No. 17, 1919.

7. Gruner, Ph.D., J.W., "The Mineralogy and Geology of the Taconites and Iron Ores of the Mesabi Range, Minnesota", Minnesota Geological Survey, University of Minnesota, 1946.

8. Gunderson, J.N. & G.M. Schwartz, "Geology of Metamorphosed Biwabik Iron Formation, Mesabi District, Minnesota", Minnesota Geological Survey Bulletin 43, University of Minnesota, 1962.

9. Pfleider, E.P., G.B. Morey & R.L. Bleifuss, "Mesabi Deep Drilling Project Progress Report No. 1", 29th Annual Mining Symposium, University of Minnesota, January 1968.

10. Pfleider, E.P. & J. Scofield, " A Preliminary Economic Analysis of the Underground Mining of Minnesota Taconite", 28th Annual Mining Symposium, University of Minnesota, January 1967.

11. Pfleider, E.P. & D.H. Yardley, "Underground Mining of Minnesota Taconite--A Future Probability", 24th Annual Mining Symposium, University of Minnesota, January 1963.

12. Pfleider, E.P. & D.H. Yardley, "Underground Mining of Minnesota Taconite", Transaction Society of Mining Engineers AIME, September 1963.

13. Stark, James, "Drift Thickness Map, Hoyt Lakes - Kawishiwi Area, St. Louis and Lake Counties, Minnesota", Minnesota Geological Survey and Department of Natural Resources, 1974.

14. Thomte, W.L., "Mining Methods at Erie Mining Company", 24th Annual Mining Symposium, University of Minnesota, January 1963.

15. White, D.A., "The Stratigraphy and Structure of the Mesabi Range, Minnesota", Minnesota Geological Survey Bulletin 38, University of Minnesota, 1954.

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)

Tone	Cover Type	Texture	Remarks
Very dark gray	J	Velvety	Hazy, smooth
	S	Hard	Carpet-like
to	Q	Hard	
	B	Hard	
Dark gray	T	Hard	
	C	Hard	

Medium gray	R	Soft	Circular outline
	W	Soft	Star shaped
	G	Smooth	
Light gray to very light gray	H	Carpet-like	
	A	Fluffy	
	E	Soft	
	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 TYPE[1]:

Species	Cover Type Description
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.

ECOSYSTEM[2]:

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 Red pine White 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.
Northern hardwoods Mixed conifer and deciduous	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. 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 Grassland	U4 - Upland shrubs (hazel, pin cherry, etc.) and grass with less than 10% stocked commercial tree species.
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 homogenous 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.

	Description
Not applicable	Non-forested vegetation types in V16.
Plantation	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 merchantable 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.

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

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 winterkills 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 such streams as 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; 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 11A; 40C	5
	Minor Soils		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-FLP 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
Hydrologic group: C
Depth to water table: Below 5 feet
Depth to bedrock: Below 5 feet
Corrosivity - uncoated steel: Low
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 Without Basements	Slight to severe: features favorable except for slope which ranges from 2 to 25 percen
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	

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

USDA-SCS-LINCOLN, NEBR. 1972

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	Soil Loss 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	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		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 porductivity. Moderate to low natural feritility; no native plants suitable for grazing. Watershed - Deep to bedrock; morhumus; permeability 0.06-0.2"/hr.; moderate runoff; well drained.

MLRA's

FOR INTERIM USE- Subject to change on completion of coordination between

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

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS 1/

SERIES Sn: Clb
STATE Minnesota
MLRA 82,90

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	AASHO		4	10	40	200						
0-11	GR-L	ML-CL	A-4	0-5	90-100	70-80	60-75	55-65	25-30	8-10	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	18-20	2-4	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	18-20	0-4	0.2-0.6	2/	5.1-6.0	V.Low

Flooding None
Hydrologic group: C
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: Low
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 - perco 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

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

2/ Because of high bulk density that restricts root penetration, only the upper 2 ft. of these horizons supplies moisture to plants.

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	Soil Loss 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

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

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS 1/

SERIES 6A ; 7B
STATE Minnesota
MLRA

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, caskers, and kames. Typically, they have black, sandy loam surface layers 1 inch thick; dark grayish brown, sandy loam subsurface 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)	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	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	GW, GP, SP	A-1	0-10	40-85	35-75	10-45	0-5	--	NP	> 20	.02-.04	4.5-6.5	V.Low

Flooding None
Hydrologic group: B
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 Without Basements	0-8%: slight; 8-15%: moderate-slope; 15+%: severe-slope
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, droughty
Excavated Ponds Aquifer Fed: Deep to water	

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

USDA-SCS-LINCOLN, NEBR. 1971

6A ; 7B

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

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%	Northern White-Cedar, Red Pine, Russian-Olive, White Spruce, Jack Pine, Siberian Crabapple, Eastern Red Cedar, Hackberry, Silver Buffaloberry Siberian Peashrub, Bur Oak, Tatarian Honeysuckle	11,20,15 18,20,12 15,18,12 10,18,10	

OTHER

FOR INTERIM USE
Subject to change on completion of coordination between MLRA'S

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

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 or 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

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

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	Soil Loss T				
0 to 12% slopes	VIs	.20	3	-	-	-	
12-18% slopes	VIs			No information at this time			
18-35% slopes	VIIs						

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	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

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/] Moderate: 6-12 percent slopes [2/] Severe: on more than 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	Severe: on more than 12 percent; good natural drainage; low susceptibility to frost heaving Slight: 0-6 percent slopes Moderate: 6-12 percent slopes
Potential Frost Action	Low

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 availabel 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 K	Soil Loss T	Oats	Corn Silage	Bluegrass Pasture	Legume-Grass	
				Bu/Ac.	Ton/Ac	AUM	Ton/Ac.	AUM
0-2% slopes	IIIs	.24	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	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
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 White Pine Jack Pine White Spruce	55 55 60 50	Slight:0-12%	Slight	Moderate	Slight to Moderate	Red Pine Jack Pine White Pine	Red Pine Jack Pine	
12-35 %				Moderate to Severe	Moderate to Severe	Moderate				

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

FOR INTERIM USE
Subject to change on completion of coordination between MLRA'S

USDA-SCS-LINCOLN, NEBR. 1973

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS 1/

SERIES 9A; 40A
STATE Minnesota 9/71
MLRA 90, 99
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		60-85	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
Hydrologic group: C
Depth to water table: 20 to 40 inches
Depth to bedrock: 20 to 40 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	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	

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

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	Soil Loss 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 Trembling aspen White pine White spruce Red pine	50-60 - - - -	Slight to severe on steeper slopes	Slight to severe on steeper slopes	Slight	Moderate		Jack pine 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

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 22; 408
STATE Minnesota
MLRA 89.00
Rev. DHP-FLB 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	

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

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	Soil Loss T				
2 to 18% slope 18-35% slope	VIe VIIe	.37	2,2				

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	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
STATE Minnesota
MLRA 99 99
Rev. DBP-FLB 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 Frags. >3 In. %	Percentage less than 3 inches Passing Sieve Size				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 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	Soil Loss T				
5 to 18 percent slopes	VIIs	-	-				
18 to 35 percent slopes	VIIs						

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.

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

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS 1/

SERIES 28A; 29A
STATE Minnesota
MLRA 88, 90

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 Without Basements	0-8%: slight 8+%: moderate - slope
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

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

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

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 K	Soil Loss T	Corn Silage (tons)	Oats (Bu)	Grass-Legume Hay (tons)	Kentucky Bluegrass (AUM)
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-- Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Potential for-- 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: Important Trees	Site Index	Woodland Management Hazards: Erosion Hazard	Equipment Limitations	Seedling Mortality	Plant Competition	Suitable Species: To Favor	To Plant	Other
All	3s	Red Pine	56						Red Pine	
		White Pine	54						White Spruce	
		Jack Pine	60							
		White Spruce	59							

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	15	
	Red Pine	20	
	Jack Pine	23	
	Ponderosa Pine	20	

OTHER

FOR INTERIM USE
Subject to change on completion of coordination between MLRA'S

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 69
PRCN, MMH

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	AASHO		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: Mod., Mod., low, low

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

Roadfill	Good-area reclaim
Sand	Good
Gravel	Poor-excisive 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
(Area) All: Potential hazrd of pollution to water supplies, all slope phases. 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

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

USDA-SCS-LINCOLN, NEBR. 1971

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 K	Soil Loss T	CORN SILAGE (Tons)	OATS (Bu)	GRASS-LEGUME HAY (Tons)	PROMEGRASS ALFALFA (AUM)	GRASS-CLOVER (AUM)	KENTUCKY BLUEGRASS (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-- Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Potential for-- 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: Important Trees	Site Index	Woodland Management Hazards: Erosion Hazard	Equipment Limitations	Seedling Mortality	Plant Competition	Suitable Species: To Favor	To Plant	Other
0-12%	3S	RedPine	56	Slight	Slight	Severe	Slight		Red Pine	
		E.Wh.Pine	54						Wh.Spruce	
		Jack Pine	60						Jack Pine	
		Wh.Spruce	59							
12-35%	4S	Red Pine	52	Moderate	Moderate	Severe	Slight		Red Pine	
		E.Wh.Pine	50						Jack Pine	
		Jack Pine	57							
		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.RedCedar,N.Wh.Cedar,Wh.Spruce,RedPine,E.Wh.Pine,	15,11,18,20,20,	
	Russian-Olive,SiberianCrabapple,TatarianHoneysuckle,	15,12,10,	
	Siberian Pea Shrub	10	
12-35% North facing	E.RedCedar,Wh.Spruce,RedPine,Siberian Pea Shrub	18,22,25,12	
12-35% South facing	E.RedCedar,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.

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

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS 1/

SERIES 544, 598
STATE Minnesota
MLRA

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.

Major Soil Horizons (Inches)	Classification			Coarse Frag.	Percentage passing sieve No.				LL	PI	Permeability In./Hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink-Swell Potential
	USDA Texture	Unified	AASHO	%	10	40	200							
0-9	Loam	ML, CL-ML, SM-SC	A-4	0	[illegible]	[illegible]	[illegible]		15-25	0-4	0.6-2.0	.20-.22	4.5-6.0	Low
9-36	Clay	CL MH-CH	A-7	0	[illegible]	[illegible]	80-95	60-90	40-60	20-35	.06-0.2	.10-.14	5.1-8.4	Mod.
36-60	Silty Clay	CL MH-CH	A-7	0	[illegible]	[illegible]	80-95	60-90	40-60	20-35	.06-0.2	.09-.15	7.4-8.4	Mod.

Flooding: Occasional - brief
Hydrologic group: C
Depth to water table: 1 to 3 feet perched, Oct.-[illegible]
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	Unsuited
Gravel	Unsuited
Topsoil	Fair: thin layer

[illegible] AND FEATURES AFFECTING USES

Septic Tank Filter Fields
Severe: perks slowly

Sewage Lagoons
Slight: perks slowly

Shallow Excavations
Severe: floods, too clayey, wet

Dwellings:
With Basements
Without Basements Severe: wet

Sanitary Landfill
(Trench) Severe: wet, too clayey, perks slowly, [illegible]

Local Roads and Streets
Severe: floods, wet

Potential Frost Action
Moderate

MAJOR [illegible] FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas
Favorable

Embankments, Dikes, and Levees
Favorable

Drainage of Cropland and Pasture
Perks slowly, wet

Irrigation
Wet

Terraces and Diversions
Not needed

Grassed Waterways
Wet, perks slowly

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

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

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Severe: perco 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	Soil Loss T	Oats (BU)	Corn Silage T/A	Bluegrass Pasture (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: Important Trees	Potential Productivity: Site Index	Woodland Management Hazards: Erosion Hazard	Woodland Management Hazards: Equipment Limitations	Woodland Management Hazards: Seedling Mortality	Woodland Management Hazards: Plant Competition	Suitable Species: To Favor	Suitable Species: To Plant	Other
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

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

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SERIES 54B; 55A
STATE Minnesota
MLRA 99
Rev. GDM, RPL 2-72

SOIL SURVEY INTERPRETATIONS 1/

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	AASHO		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

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

54B; 55A

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
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 K	Soil Loss T	Oats	Corn Silage	Bluegrass Pasture	Legume-Grass	
				Bu.		AUM	T	AUM
0-2% slopes	IIc	.43	3.2	80	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-- Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Potential for-- 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: Important Trees	Potential Productivity: Site Index	Woodland Management Hazards: Erosion Hazard	Woodland Management Hazards: Equipment Limitations	Woodland Management Hazards: Seedling Mortality	Woodland Management Hazards: Plant Competition	Suitable Species: To Favor	Suitable Species: To Plant	Other
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	White Pine	Basswood	
12-25%		Northern Hardwoods	60	Moderate		Slight	Severe	White Spruce	Red Oak Aspen	

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

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

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS 1/

Series - GA
STATE Minnesota
MLRA 88-90
Revised Draft GDN, PRL 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

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

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

Greenwood

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	Soil Loss T	Oats	Corn Silage		Legume - Grass Hay	Legume - Grass Pasture	Bluegrass Pasture
				B/A	T/A		T/A	AUM	AUM
All	IVW	--	--	60	12		4.5	6.7	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: Important Trees	Potential Productivity: Site Index	Woodland Management Hazards: Erosion Hazard	Woodland Management Hazards: Equipment Limitations	Woodland Management Hazards: Seeding Mortality	Woodland Management Hazards: Plant Competition	Suitable Species: To Favor	Suitable Species: To Plant	Other
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

SERIES 19B; PA
STATE Minnesota
MLRA 89-90

SOIL SURVEY INTERPRETATIONS 1/

Revised Draft GDN-BRL 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 seive 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 K	Soil Loss T	Bu. Oats	Tons-Corn Silage	AUM Pasture	Tons Legume-grass	AUM
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	Ordination	Potential Productivity: Important Trees	Potential Productivity: Site Index	Woodland Management Hazards: Erosion Hazard	Woodland Management Hazards: Equipment Limitations	Woodland Management Hazards: Seedling Mortality	Woodland Management Hazards: Plant Competition	Suitable Species: To Favor	Suitable Species: To Plant	Other
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.

USDA-SCS-LINCOLN, NEBR. 1973

FOR INTERIM USE
Subject to change on completion of coordination between MLRA'S

MRTSC Trial Form
File Code Soils-12
Rev. 9-10-71

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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	

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

USDA-SCS-LINCOLN, NEBR. 1971

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	Soil Loss 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	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 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

MRTSC Trial Form
File Code Soils-12
Rev. 9-10-71

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: 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; 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	

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

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	Soil Loss 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	Seedling 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

Appendix I - 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.

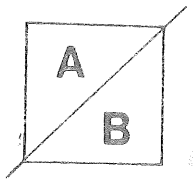
3. Transfer errors occur when the data symbols placed on coding forms are transferred incorrectly to the keypunch form from which computer input cards are keypunched. The keypunch form was designed so that the "shorthand coding" system could be used. This coding system reduces the number of cards required 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.

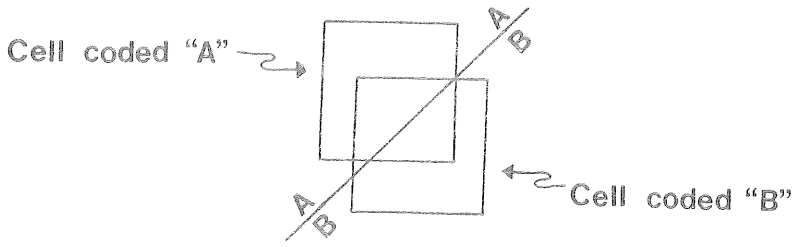
FIGURE 1



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 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

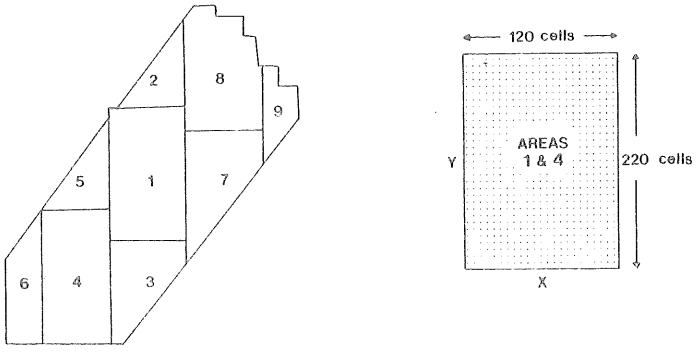
of 200 cells, 7.5%, or 15 wrong cells would represent $L_2(\pi)$. Again, simply stated, this means that the chances are 90% that the true percent of wrong cells among the total of all cells will fall within the range of 0 - 10%.

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.

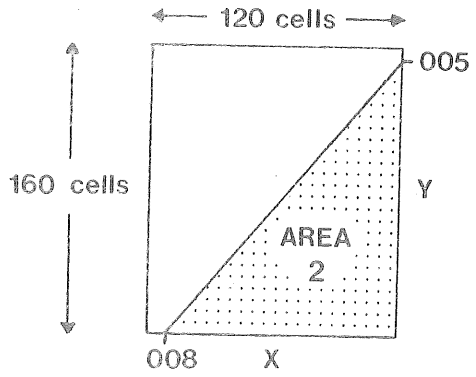
Here the 200 valid numbers for columns can be chosen first, followed by the 200 numbers for rows, because all cells printed on the map are "on-site". Each cell is then located and circled on the line printer data map. In a case where there is a repetition of selected cells, additional coordinate numbers 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 areas forms a diagonal across the map, rather than a rectangle, as shown in Figure 4.

FIGURE 4



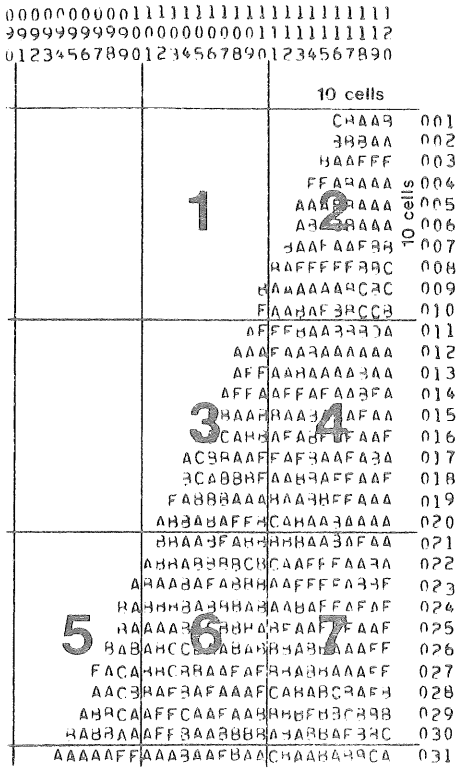
Notice that the first column containing a cell is 008, the first row is 005, and that greater than half the map is void of cells. Selection of cells falling within this void would add to the waste in choosing random numbers for coordinates of cells to be included in the sample. It is at this point that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

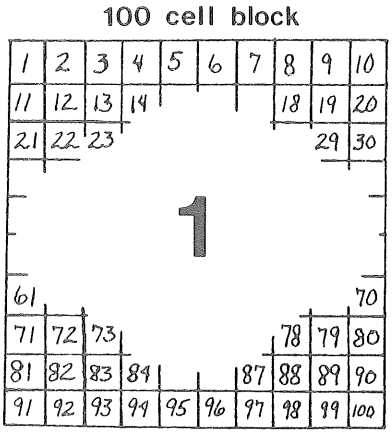
A basic requirement in random sampling is to insure that each potential sampling unit in a population has an equal chance of being in the sample. An illustration of how this requirement could be violated can be given using Area 2 as an example. The wrong way to proceed here would be to first select a 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 in enclosed. Figure 5 shows a portion of a map as an example of these blocks and how they are numbered.

FIGURE 5





As an illustration, suppose the area is divided into 85 blocks, each containing 100 cells. Three-digit random numbers are then selected for numbers in the range 1 - 85 to identify a block. These random numbers are paired with 3-digit random numbers from the 1 - 100 range which identify individual cells within the 100-cell blocks. This is repeated until a 200-cell sample is compiled. Pairs falling outside of the area are rejected during the selection process so some numbers are still wasted, although not nearly as many as would be under the procedure described earlier. The same conversion scheme adopted in (A) above is applied in selecting useable numbers.

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

for instance totals 35 or 105, ther 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.

Variable	Level Chosen	Level Acceptable (above & below)
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 / 5.9	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.

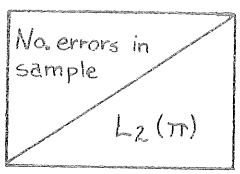
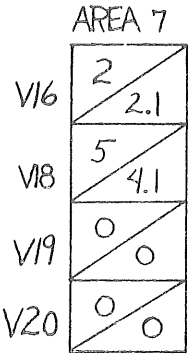


TABLE 2 CONT'D

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



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.