Appendix M

Minnesota Land Use Maps

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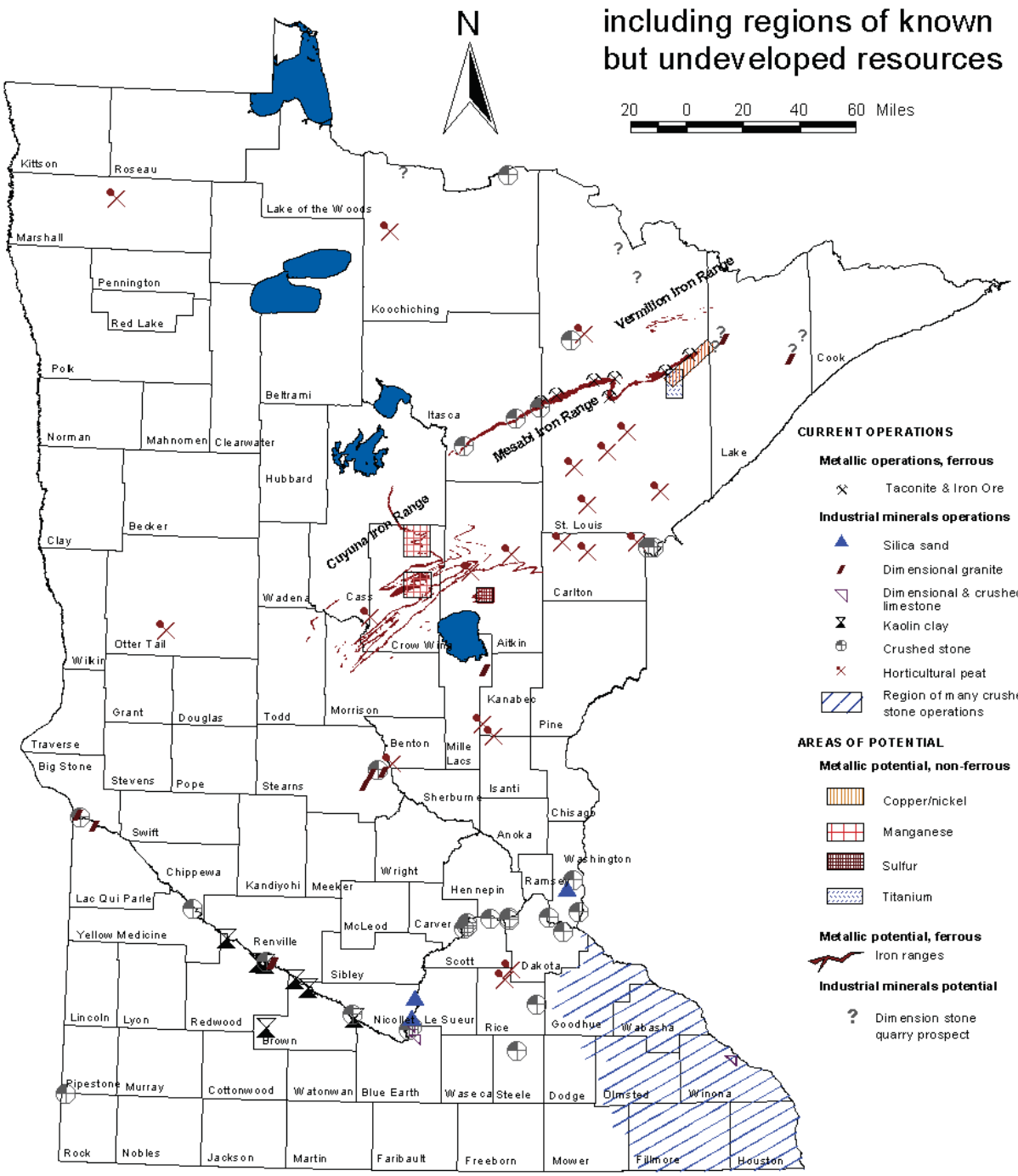
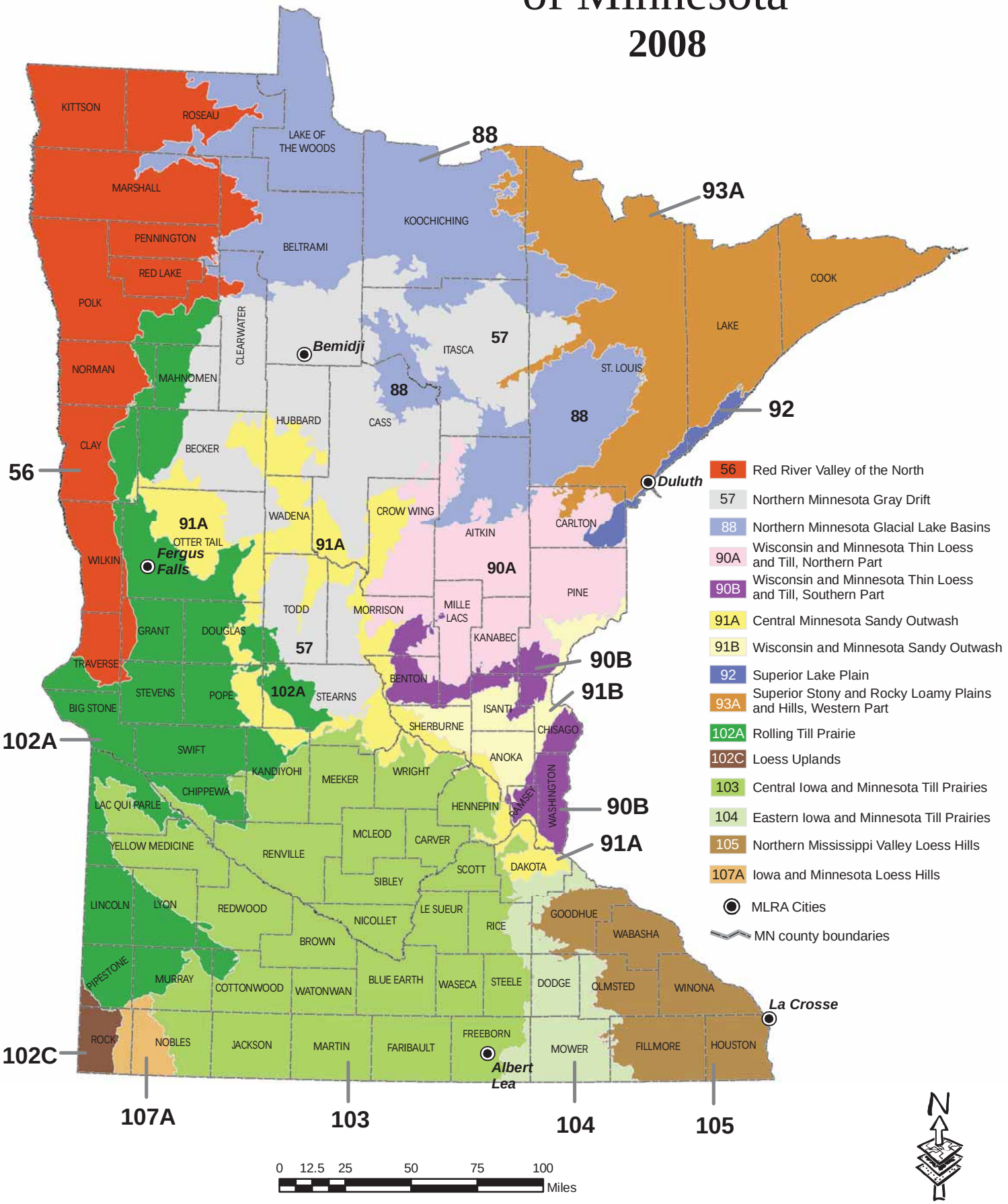
Mineral Industries of Minnesota

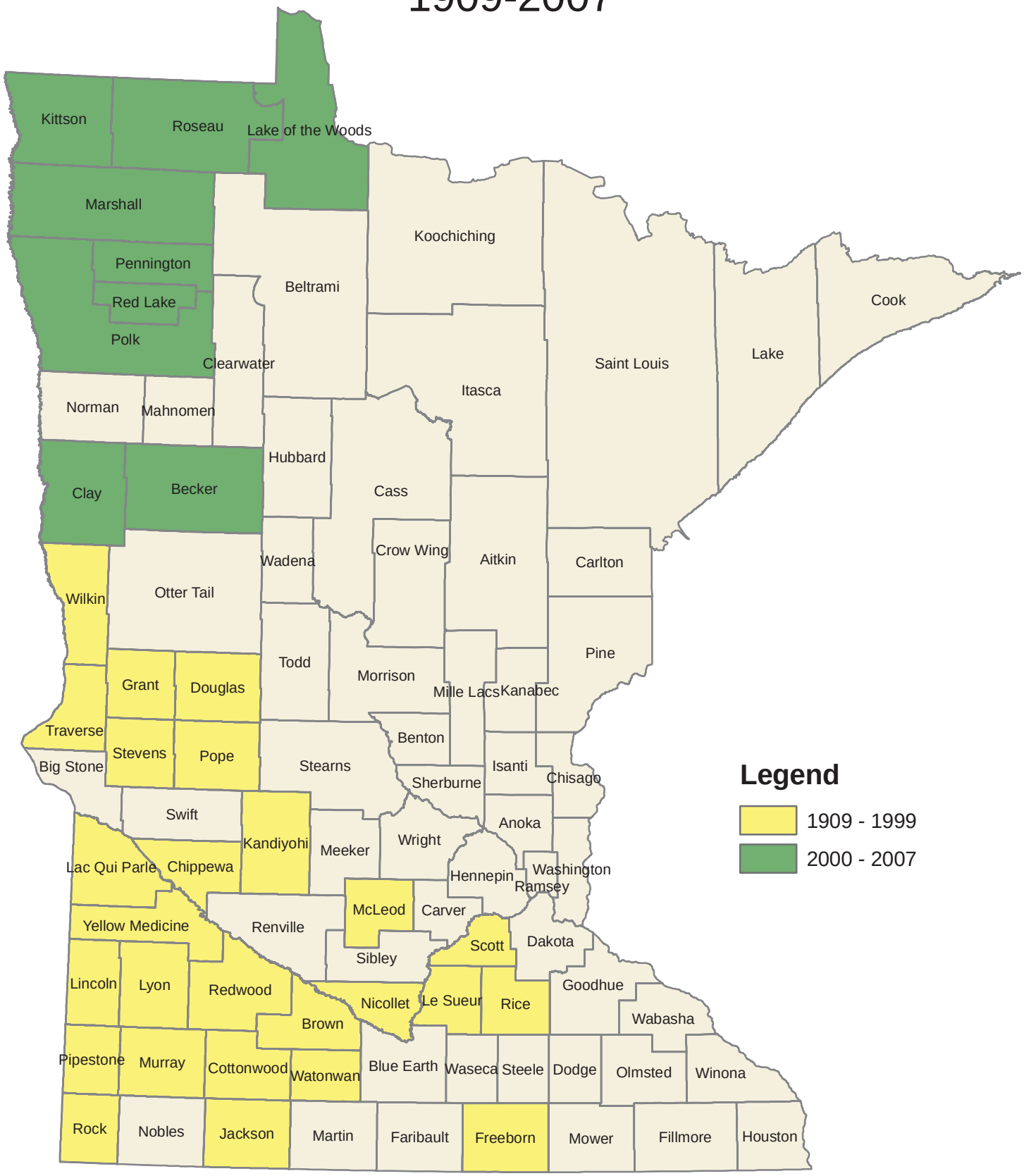


USDA NRCS
U.S. Department of Agriculture
Natural Resources Conservation Service

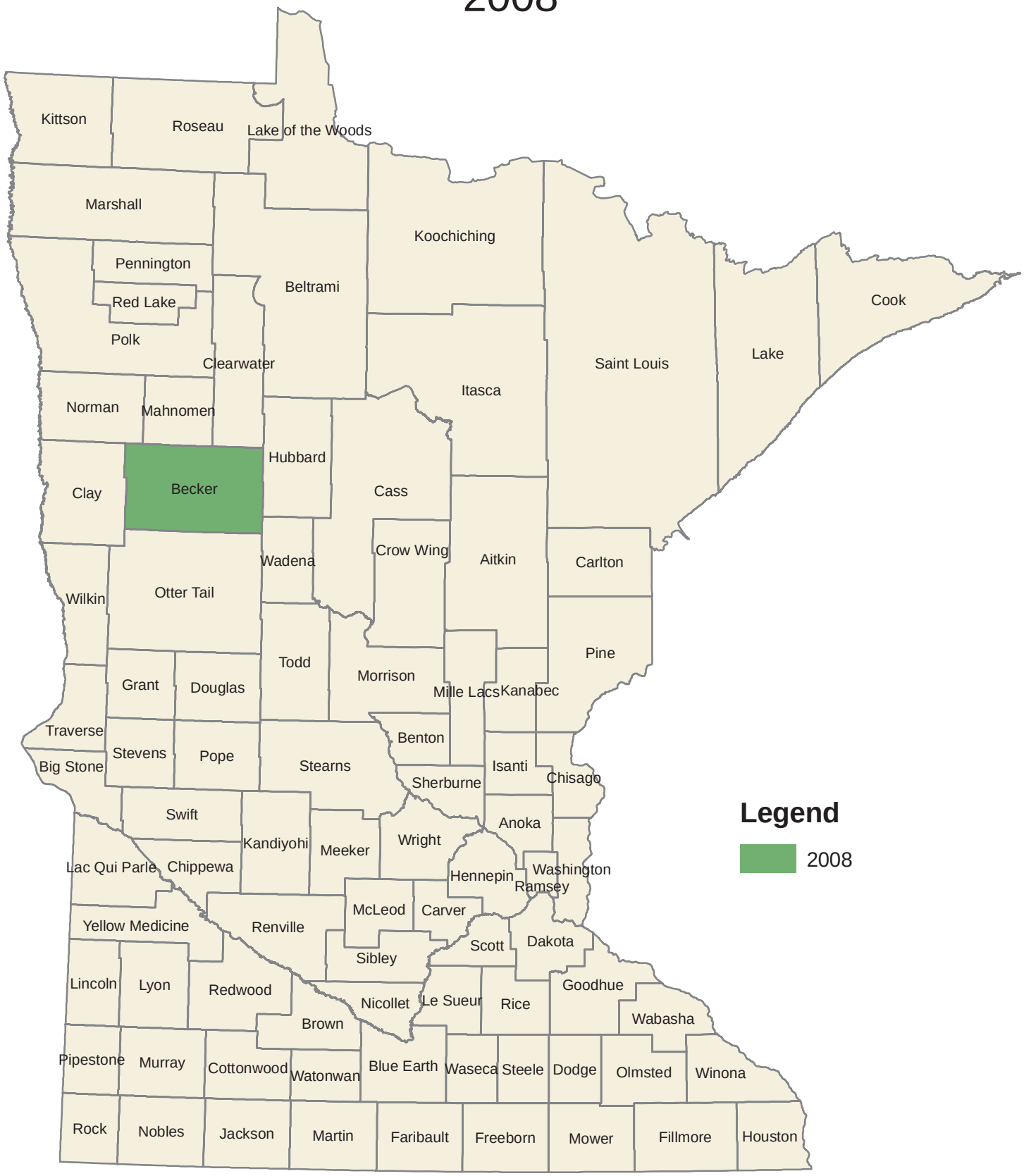
Major Land Resources Areas of Minnesota
2008



Anthrax in Minnesota
1909-2007



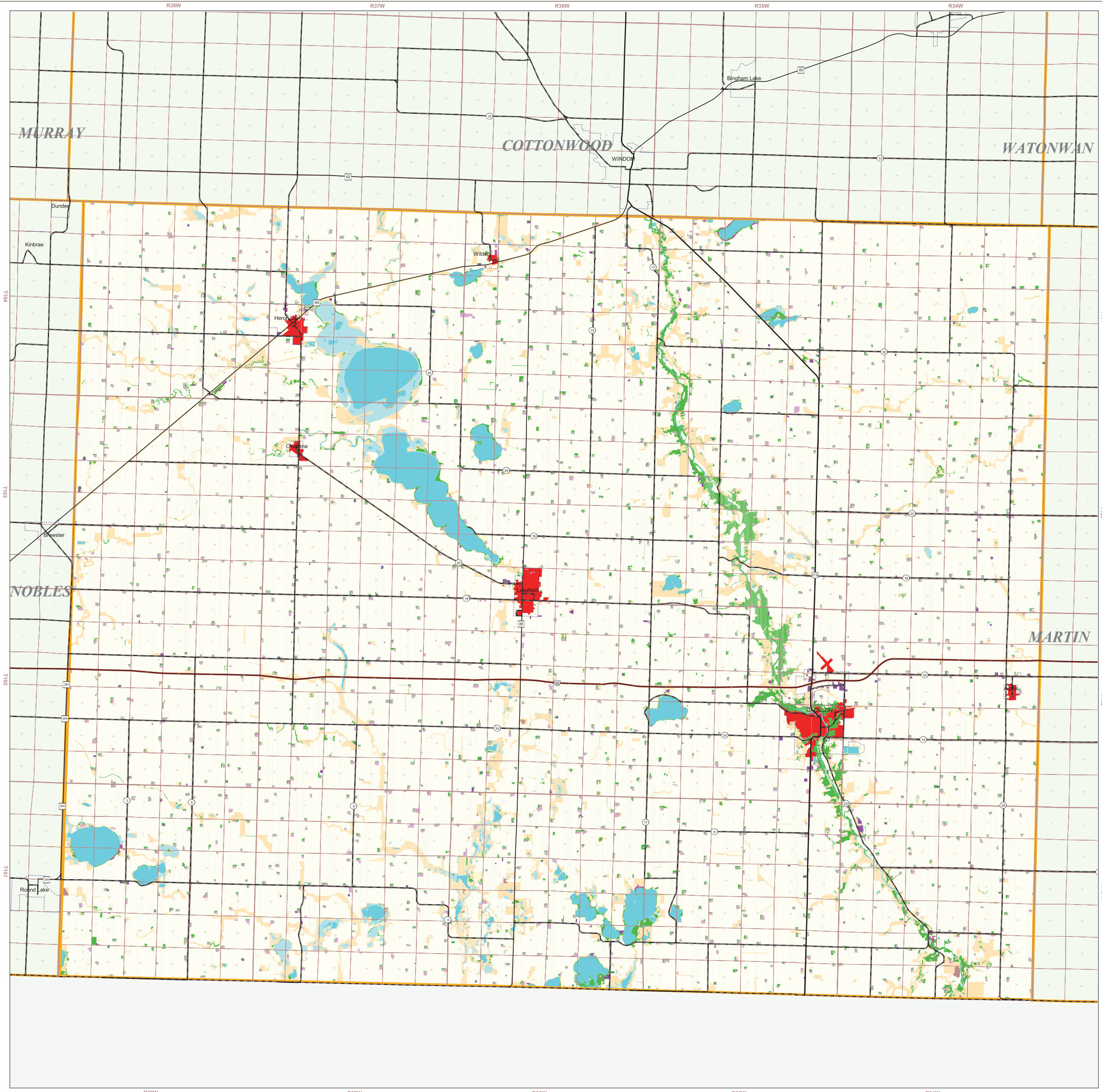
Anthrax in Minnesota 2008



Jackson County Land Use and Cover

State of Minnesota

1988 - 1990



MAP FEATURES

Land Use[1]

- Urban and Industrial
- Farmsteads and Rural Residences
- Rural Residential Development Complexes
- Other Rural Developments
- Cultivated Land
- Transitional Agricultural Land
- Grassland
- Grassland-Shrub-Tree Complex (Deciduous)
- Grassland-Shrub-Tree Complex (Coniferous)
- Deciduous Forest
- Coniferous Forest
- Water
- Wetlands
- Gravel Pits and Open Mines
- Bare Rock
- Exposed Soil, Sandbars, and Sand Dunes
- Unclassified/Unlabeled/Outside State or County

Cities[2]

COUNTY SEAT

Other Cities

Municipal Boundary

Highways[3]

- Interstate Highway
- U.S. Trunk Highway
- State Trunk Highway
- County State-Aid Highway (CSAH)

Public Land Survey[4]

- State Boundary
- County Boundary
- Township & Range
- Section

T34 Township

R25W Range & Direction

Data Sources

1 *The International Coalition Source Photography Dates: 1988-1990*

2 *TIGER/Line Census Files, U.S. Bureau of the Census, 1995.*

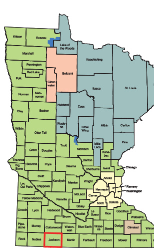
3 *Minnesota Department of Transportation, 1997-98.*

4 *Produced by the Minnesota Land Management Information Center from U.S. Geological Survey (USGS), 1:100,000 scale, 30'x60' quadrangle maps published between 1977 and 1986.*

Jackson County Land Use Statistics

Source: The Land Management Information Center (LMIC)

DESCRIPTION	ACRES	% ACRES
Urban and Industrial	2027.4	0.4
Farmsteads and Rural Residences	6163.6	1.3
Rural Residential Development Complexes	102	< 0.1
Other Rural Developments	765.3	0.2
Cultivated Land	397508.5	86.4
Transitional Agricultural Land	87.3	< 0.1
Grassland	27012.5	5.9
Grassland-Shrub-Tree Complex (Deciduous)	270.7	< 0.1
Grassland-Shrub-Tree Complex (Coniferous)	0	0
Deciduous Forest	10590.9	2.3
Coniferous Forest	2.5	< 0.1
Water	11369.1	2.5
Wetlands	4154.3	0.9
Gravel Pits and Open Mines	139.3	< 0.1
Bare Rock	0	0
Exposed Soil	21.4	< 0.1
Unlabeled/unclassified/Outside State or Outside County	42.6	< 0.1
TOTAL	**26,591**	**100%**

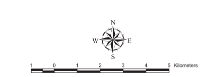


Mapped County Location

Land Use Data Sources*

- Bemidji State University - Department of Geography; Beltrami and Clearwater County Soil and Water Conservation Districts; Source Photography Date: 1986
- Manitoba Remote Sensing Centre; Source Imagery Dates: 1991-1996
- Rochester - Olmsted Planning Department; Source Photography Date: 1992
- The International Coalition; Source Photography Dates: 1988-1990
- Metropolitan Council; Source Photography Date: 1990
- Department of Natural Resources; Division of Forestry - Resource Assessment; Source Imagery Date: 1992, 1993 and 1996

** Land use classifications vary slightly between data sources.*



ABOUT THIS MAP

Data Sources: The land use / land cover categories displayed on this map were derived from sources that included the U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service's (ASCS) low altitude, section-centered, 35mm color aerial photography taken during 1988-1990 and U.S. Fish and Wildlife Service National Wetlands Inventory (NWI) 1:24,000-scale field maps. Landsat satellite images (date unrecorded) were used to verify the classifications.

Data Interpretation and Computerization: The project was coordinated by The International Coalition for Land and Water Stewardship in the Red River Basin. Land use / land cover interpretation was performed by DPA International. The smallest area interpreted was approximately 2.5 acres.

Land use / land cover information was transcribed on to stable-base mylars registered to U.S. Geological Survey 1:24,000-scale topographic maps and then digitized by DPA International or Alexandria Technical College staff. Minnesota Department of Natural Resources MIS Bureau staff then joined the digitized files together to create county coverages.

On-line documentation: http://lucy.lmic.state.mn.us/metadata/luse89.html

Credits and Acknowledgements

Data collection and interpretation supported by the Minnesota Future Resources Fund as recommended by the Legislative Commission on Minnesota Resources (LCMR).

The following groups also participated over an extended period:

Alexandria Technical College - GIS Program
DPA International
The International Coalition
Minnesota Board of Water and Soil Resources
Minnesota Department of Natural Resources
Minnesota Land Management Information Center
North Dakota State University - Agricultural Engineering Department
The Red River Management Board
University of Minnesota - Department of Forest Resources
University of North Dakota - Geography Department
Widseth, Smith and Nolting

Map Projection: UTM, Extended Zone 15
Datum: NAD83

Distribution information

This map was prepared in April, 1999. Both the map and the data used to create it are available from the Land Management Information Center at Minnesota Planning.

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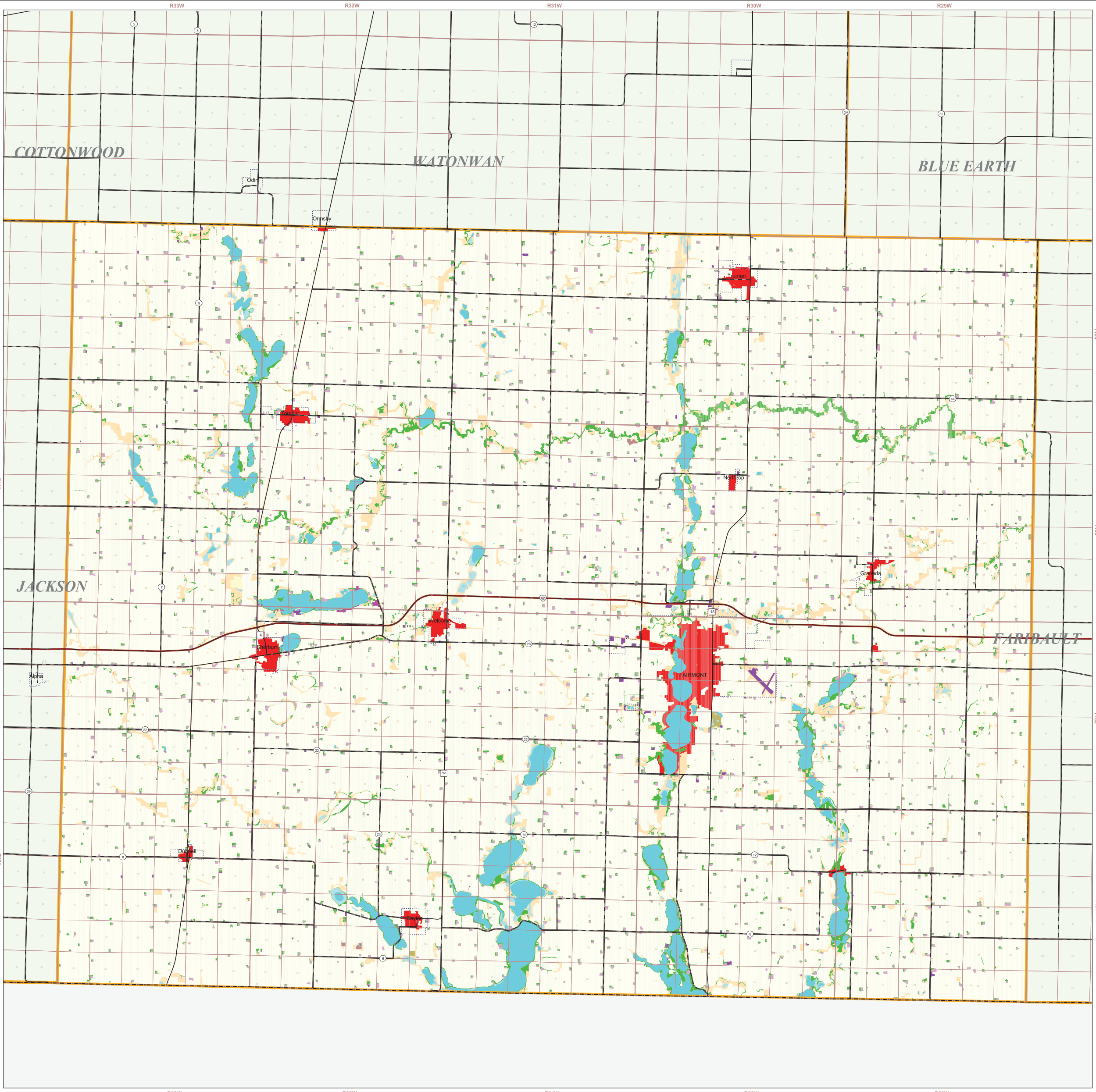
MN PLANNING

LAND MANAGEMENT INFORMATION CENTER

Martin County Land Use and Cover

State of Minnesota

1988 - 1990



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Cities[2]

COUNTY SEAT

Other Cities

Municipal Boundary

Highways[3]

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Public Land Survey[4]

- State Boundary
- County Boundary
- Township & Range
- Section

T34 Township

R25W Range & Direction

Data Sources

1 *The International Coalition Source Photography Dates: 1988-1990*

2 *TIGER/Line Census Files, U.S. Bureau of the Census, 1995.*

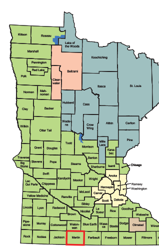
3 *Minnesota Department of Transportation, 1997-98.*

4 *Produced by the Minnesota Land Management Information Center from U.S. Geological Survey (USGS), 1:100,000 scale, 30'x60' quadrangle maps published between 1977 and 1986.*

Martin County Land Use Statistics

Source: The Land Management Information Center (LMIC)

DESCRIPTION	ACRES	% ACRES
Urban and Industrial	4448.6	1
Farmsteads and Rural Residences	6553.6	1.4
Rural Residential Development Complexes	74.7	< 0.1
Other Rural Developments	703.8	0.2
Cultivated Land	410992.1	88.1
Transitional Agricultural Land	112.1	< 0.1
Grassland	17229.6	3.7
Grassland-Shrub-Tree Complex (Deciduous)	403	< 0.1
Grassland-Shrub-Tree Complex (Coniferous)	0	0
Deciduous Forest	11431	2.4
Coniferous Forest	0	0
Water	12637.8	2.7
Wetlands	1774.5	0.4
Gravel Pits and Open Mines	115.3	< 0.1
Bare Rock	0	0
Exposed Soil	92	< 0.1
Unlabeled/unclassified/Outside State or Outside County	35.1	< 0.1
TOTAL	**26,489**	**100%**



Mapped County Location

Land Use Data Sources*

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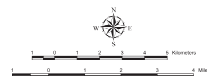

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Liability statement

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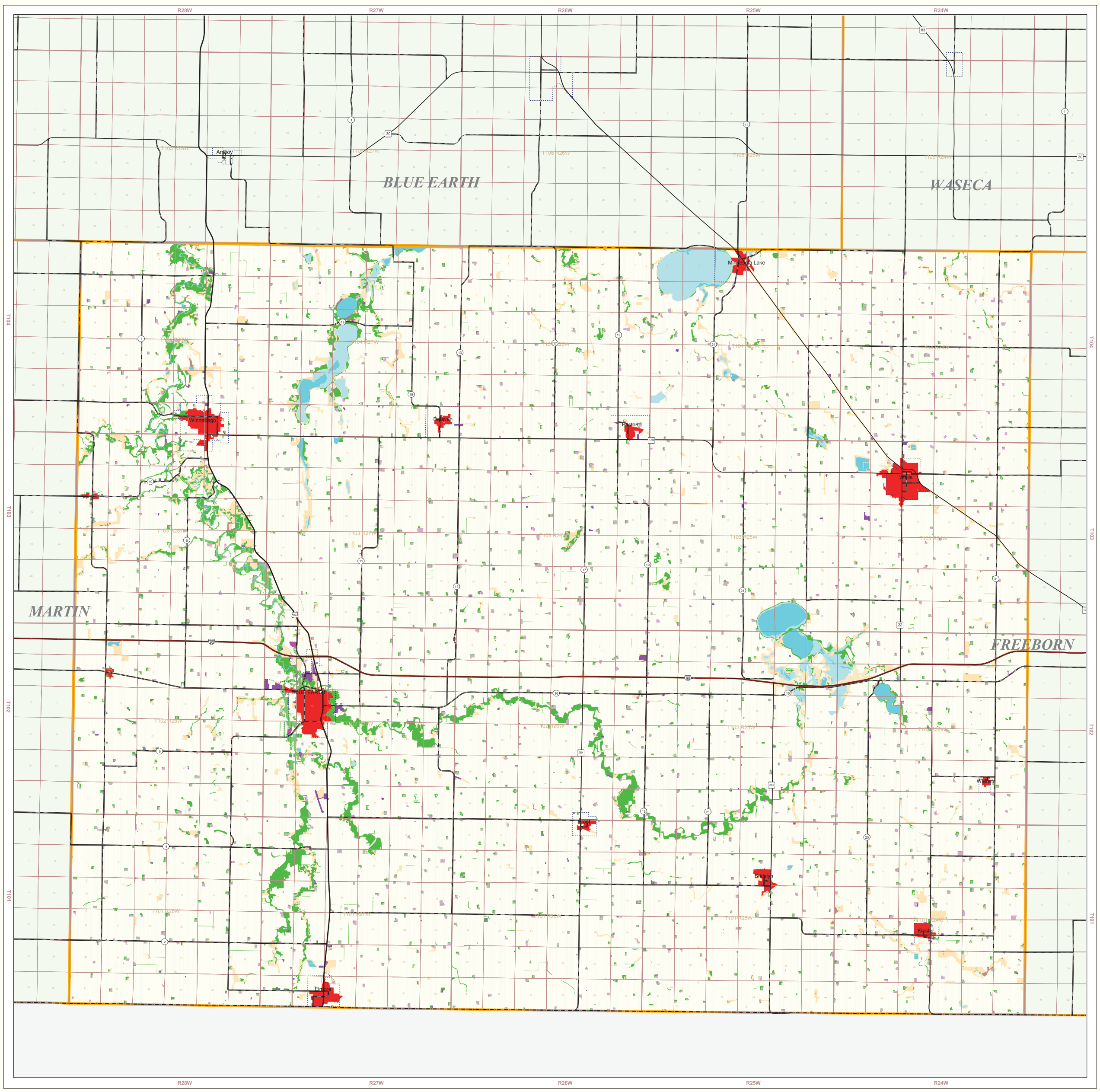
MN PLANNING

LAND MANAGEMENT INFORMATION CENTER

Faribault County Land Use and Cover

State of Minnesota

1988 - 1990



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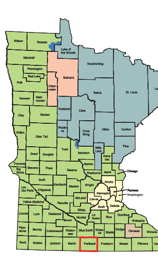
Faribault County Land Use Statistics

Source: The Land Management Information Center (LMIC)

DESCRIPTION	ACRES	% ACRES
Urban and Industrial	3495.3	0.8
Farmsteads and Rural Residences	5890.7	1.3
Rural Residential Development Complexes	57.7	< 0.1
Other Rural Developments	806.1	0.2
Cultivated Land	415031.9	89.9
Transitional Agricultural Land	0	0
Grassland	13044	2.8
Grassland-Shrub-Tree Complex (Deciduous)	625.2	0.1
Grassland-Shrub-Tree Complex (Coniferous)	0	0
Deciduous Forest	15377.3	3.3
Coniferous Forest	0	0
Water	2859.2	0.6
Wetlands	4184.5	0.9
Gravel Pits and Open Mines	88.1	< 0.1
Bare Rock	0	0
Exposed Soil	14.4	< 0.1
Unlabeled/unclassified/Outside State or Outside County	0	0
TOTAL	**23,149**	**100%**



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N W E S

1 0 1 2 3 4 5 Kilometers

1 0 1 2 3 4 Miles

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MN PLANNING
LAND MANAGEMENT INFORMATION CENTER

QUATERNARY GEOLOGY OF MINNESOTA

The Quaternary Period comprises the "Great Ice Age" or Pleistocene Epoch, which began about 2 million years ago and ended only about 10 thousand years ago. It also includes the Holocene or Recent Epoch, which spans the last 10 thousand years. By comparison with bedrock formations in Minnesota, which range from about 100 million to more than 3,500 million years in age, Quaternary formations represent only a very small part of the state's geologic history. However, glacial drift spread by Pleistocene ice sheets covers most of Minnesota and ranges to hundreds of feet in thickness, so that Quaternary geology is the major influence on topography, soils, water, and land uses–in short, the environment of Minnesota.

Quaternary geologic units are unconsolidated sedimentary materials deposited by water, wind and plant growth, and by glacial ice and meltwaters. This map portrays the distribution of Quaternary formations. Outcrops of bedrock, which are common only in the northeast and along larger river valleys in the south, are not shown on this map.

HOLOCENE DEPOSITS

PEAT—Accumulations of partially decayed vegetation, especially mosses, reeds and sedges, in wet, poorly-drained areas. Peat is valuable as an organic soil conditioner and chemical feedstock and as a potential energy resource. It is a very poor base for roads and other construction.

ALLUVIUM—Sand and gravel, locally interbedded with silt, clay and organic material, deposited on present floodplains. Sand and gravel deposits, copious shallow ground water and flat terrain make alluvial plains attractive for urban and industrial development, but they are flood-prone, and sensitive to pollution. They are valuable for agriculture and wildlife.

PLEISTOCENE DEPOSITS

There were four major ice advances in North America during the Pleistocene Epoch: the Nebraskan, Kansan, Illinoisan and Wisconsinan Glaciations. Each lasted tens of thousands of years and was followed by a warmer period when the ice melted. Each deposited sediments, called drift, over vast areas. Drift deposited during the last stage of the Wisconsinan Glaciation covers most of Minnesota and conceals evidence of older ice advances except in the southeast and southwest corners of the state.

Redistributed Drift

Some drift deposited by glaciers was quickly eroded, transported and redeposited by water and wind in lakes, on floodplains and on land beyond the margin of the ice.

GLACIAL LAKE DEPOSITS—Clay, silt and sand with local gravel bars and beaches deposited on the beds and margins of extensive lakes that existed when outlets for meltwater were blocked by ice or by glacial deposits which have now eroded away. Major glacial lakes were: Lake Agassiz in northwestern and north-central Minnesota, Lakes Upham and Aitkin northwest of Duluth, and Lake Minnesota south of Mankato. Due to the prevalence of fine silt and clay, glacial lake deposits present drainage and construction problems and tend to be poor groundwater sources. They form extensive areas of flat farmland, notably the Red River Valley.

TERRACE DEPOSITS—Stratified sand and gravel with some interbedded silt and clay occurring along stream valleys above the level of present floodplains. During glacial melting, stream flow was larger than at present, and floodplains were built up by glacial sediments. Recent streams have cut into older floodplains leaving remnants as terraces. Terrace tops are commonly flat and well drained. They are attractive for residential and industrial development, but they also contain valuable sand and gravel resources.

LOESS—Eolian silt and fine sand blown from unvegetated drift exposed along major glacial streams. Loess is shown on the map for areas where it is commonly more than 2 meters (6.5 feet) thick. Excellent agricultural soils are formed in loess.

OUTWASH—Sand, silt and gravel carried from glaciers by meltwater and spread over wide areas. The deposits are typically sorted into discontinuous and interfingering beds of silt, sand and gravel called stratified drift. Outwash plains have flat topography, sandy soils, and many gravel deposits. Shallow ground water is commonly abundant for irrigation.

Late Wisconsinan Drift Deposited Directly From Glaciers

The ice of each glaciation accumulated in northern Canada and moved southward in a complex series of tongue-like extrusions or lobes. Near the center of ice accumulation, the moving ice scoured the land surface down to hard bedrock and picked up a load of rock fragments and soil. Farther from the center the ice deposited this drift from its base. Areas of ice-scoured, exposed bedrock occur mainly in northeastern Minnesota; deposition predominated throughout the rest of the state. Drift deposited directly from ice is called till. In general, till is an unsorted mixture of all sizes of rock from boulders to clay and "rock flour." It tends to be stiff, stony and impervious. Till of different lobes differs in composition depending on the geology "upstream" along the path of the advancing ice.

Till deposited from the base of an ice lobe forms a smooth to undulating blanket called a ground moraine. Such till is stiff and compact; it yields little ground water.

Till deposited at ice margins or from stagnating masses of melting ice forms irregular pitted to hilly topography with many ponds and lakes. These landforms are called end moraines, recessional moraines and stagnation moraines. These deposits may contain pockets of sand, gravel and boulders with some local ground water.

DES MOINES LOBE TILL—Smooth to undulating moraine (pms) and pitted to hilly moraine (pmh). The Des Moines lobe is the most recent glacial lobe. It advanced through the Red River Valley into Iowa. Sublobes extended eastward into the St. Louis River basin and northeastward across Minneapolis and St. Paul, incorporating drift from earlier lobes. Des Moines lobe till is typically clay-rich. It is mainly composed of gray (olive-brown where oxidized) calcareous silt and clay, with lesser amounts of sand and gravel. Shale and limestone are diagnostic.

SUPERIOR LOBE TILL—Smooth to undulating moraine (pss) and pitted to hilly moraine (psh). Ice of the Superior lobe moved out of the Lake Superior basin in several pulses, spreading westward across the Mille Lacs area and southward across the Minneapolis-St. Paul area. It interacted with the partly contemporaneous Rainy lobe along the Laurentian Divide. Superior lobe till is generally reddish-brown, sandy to stony, and non-calcareous; it contains abundant fragments of volcanic, granitic, gabbroic and metamorphic rocks, red sandstone and conglomerate. Where it incorporates earlier lake deposits, it is locally silty or clayey.

RAINY LOBE TILL—Smooth to undulating moraine (prs) and pitted to hilly moraine (prh). The Rainy lobe moved southward into Minnesota along a broad front from Lake of the Woods almost to Lake Superior, where it met ice from the Lake Superior basin along the Laurentian divide and moved southwestward. It advanced to the vicinity of Little Falls overriding drift and perhaps encountering ice remaining from the earlier Wadena lobe. Part of the Rainy lobe drift area was later overridden by the St. Louis sublobe of the Des Moines lobe. Rainy lobe till is grayish brown (moderate brown where oxidized), non-calcareous and generally sandy with abundant fragments of granitic, metamorphic and greenstone volcanic rocks.

WADENA LOBE TILL—Smooth to undulating moraine (pws) and pitted to hilly moraine (pwh). The Wadena lobe was the earliest of the Late Wisconsinan glacial lobes. A large remnant of its till and outwash survives in northwest-central Minnesota in an area that was not overridden by any of the three later lobes. A large drumlin field indicates movement of ice from the north or a little east of north. Wadena lobe till is gray (yellowish brown where oxidized) and calcareous with fragments of igneous and metamorphic rocks, some limestone and little or no shale.

Pre-Late Wisconsinan Materials

At one time or another, prior to the Late Wisconsinan, all of Minnesota must have been covered by glaciers. Evidence is concealed beneath Late Wisconsinan drift except in the southwestern and southeastern corners of the state where there are deposits of weathered and stream-dissected drift that are older than Late Wisconsinan and could be Illinoisan or Kansan in age.

OLD RED DRIFT—Moderate to dusky-brown till and outwash found mainly in Dakota and southern Washington Counties. Fragments of gabbro, felsite and red sandstone are notable. Some exposures show a distinct weathered profile overlain by younger drift.

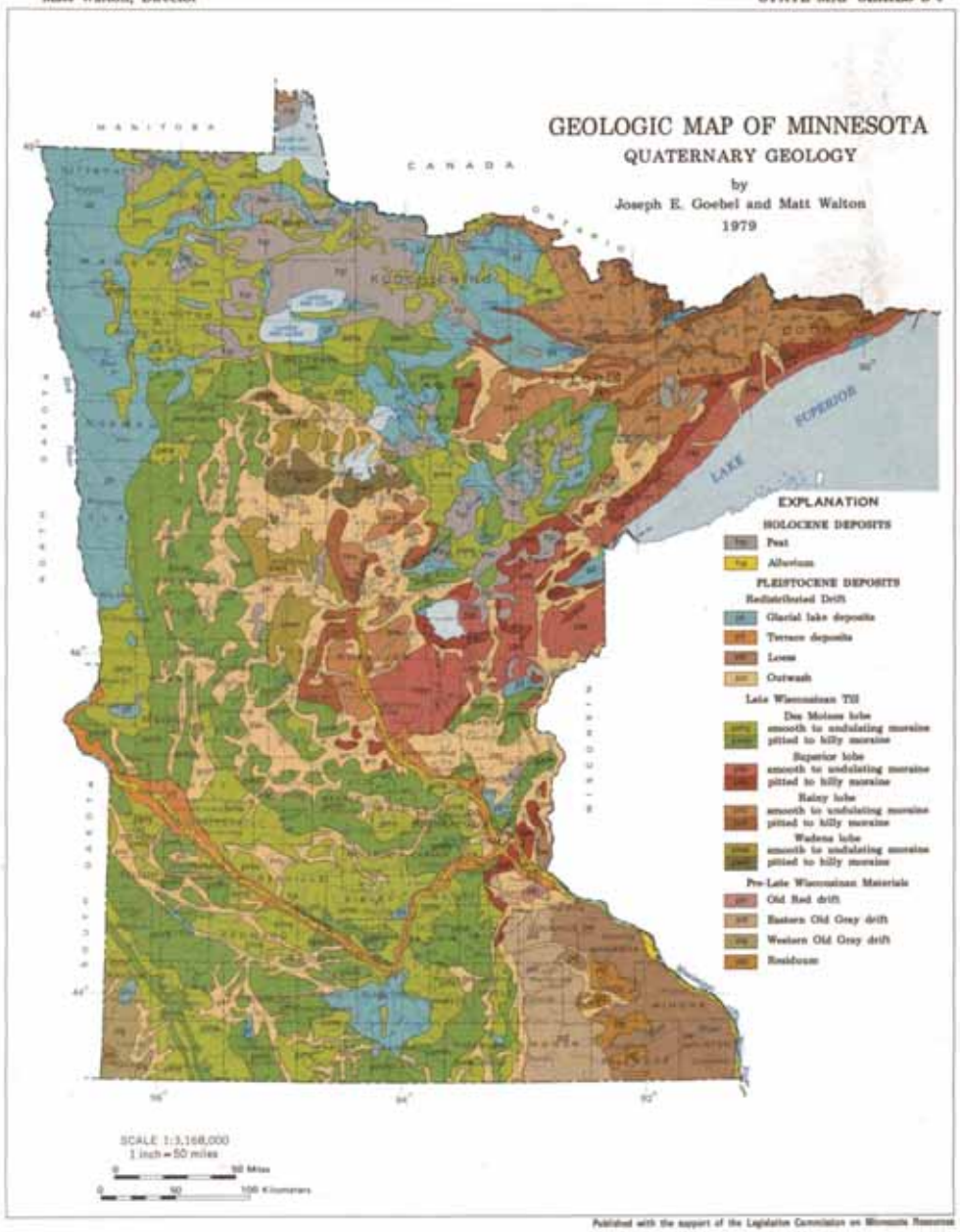
EASTERN OLD GRAY DRIFT—Moderate yellowish-brown weathered silty till and outwash. It contains fragments of igneous and metamorphic rocks, limestone and sandstone, but lacks shale. It appears to underlie Old Red Drift in southern Dakota County.

WESTERN OLD GRAY DRIFT—Dark-gray, strongly weathered, clayey, stream-dissected till and outwash with fragments of quartzite, granite and limestone.

RESIDUUM—Soils of uncertain age and origin, including some old weathered drift and loess, on weathered pre-Quaternary rocks.

Minnesota Geological Survey
University of Minnesota
Matt Walton, Director

STATE MAP SERIES S-4



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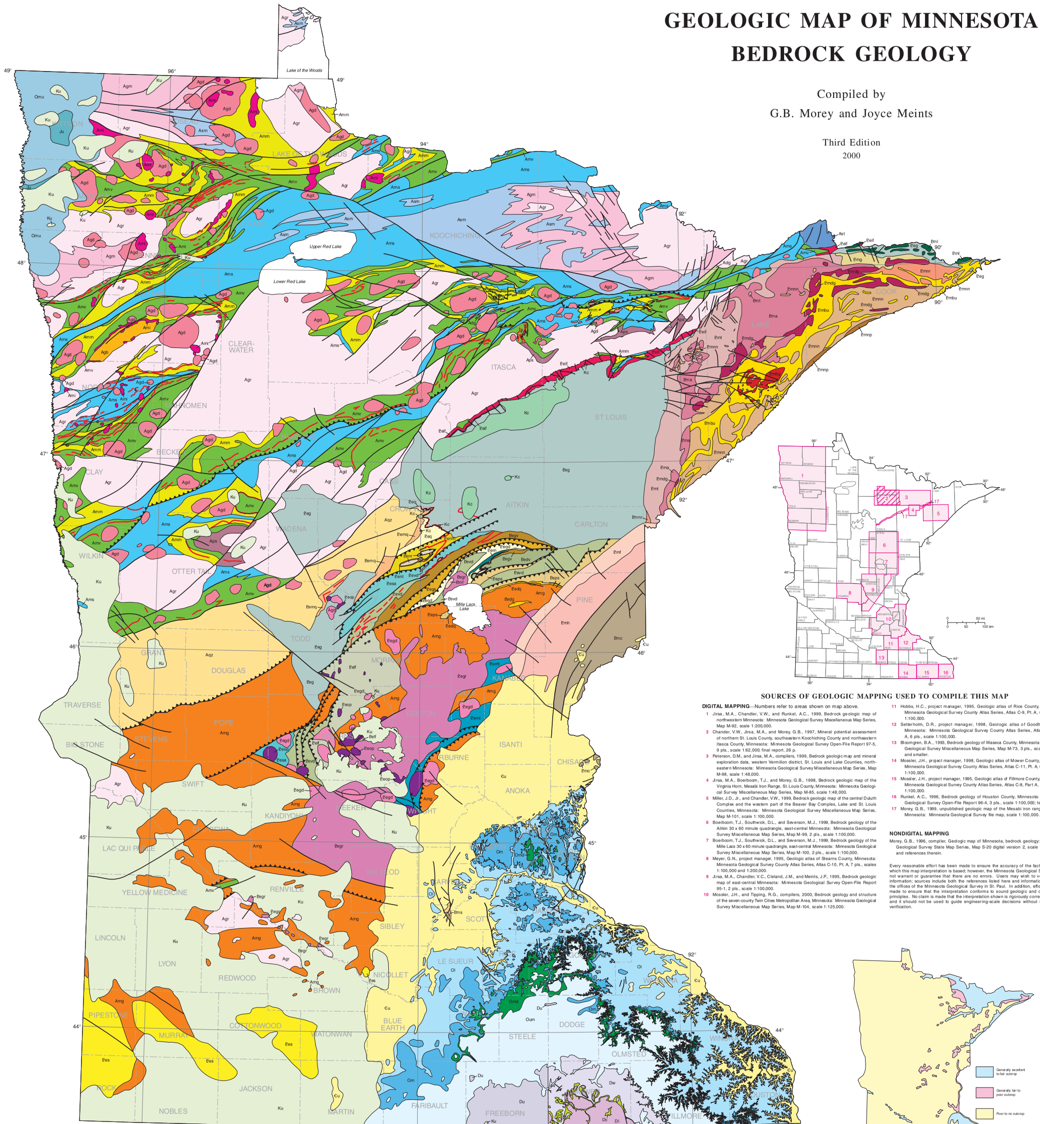
UNIVERSITY OF MINNESOTA
MINNESOTA GEOLOGICAL SURVEY
D.L. Southwick, Director

STATE MAP SERIES
S-20, 3rd Edition
Minnesota Bedrock Geology

GEOLOGIC MAP OF MINNESOTA
BEDROCK GEOLOGY

Compiled by
G.B. Morey and Joyce Meints

Third Edition
2000



Base modified from 1990 CENSUS TIGER/Line Files of U.S. Bureau of Census (source scale 1:100,000) and Digital Chart of the World (ESRI version).
Lambert Conformal Conic Projection
Standard parallels 33° N and 45° N.

SCALE 1:1,000,000
25 0 25 50 MILES
25 0 25 50 75 KILOMETERS

Geology compiled 2000
GIS compilation and cartography by Joyce Meints;
digital cartography by Philip Heywood

SOURCES OF GEOLOGIC MAPPING USED TO COMPILE THIS MAP

DIGITAL MAPPING—Numbers refer to areas shown on map above.

1 Jirsa, M.A., Chandler, V.W., and Runkel, A.C., 1999, Bedrock geologic map of northwestern Minnesota: Minnesota Geological Survey Miscellaneous Map Series, Map M-92, scale 1:200,000.
2 Chander, V.W., Jirsa, M.A., and Morey, G.B., 1997, Mineral potential assessment of northern St. Louis County, southeastern Koochiching County and northeastern Itasca County, Minnesota: Minnesota Geological Survey Open-File Report 97-5, 9 pls., scale 1:62,000; final report, 26 p.
3 Peterson, D.M., and Jirsa, M.A., compilers, 1999, Bedrock geologic map and mineral exploration data, western Vermilion district, St. Louis and Lake Counties, northeastern Minnesota: Minnesota Geological Survey Miscellaneous Map Series, Map M-98, scale 1:48,000.
4 Jirsa, M.A., Boerboom, T.J., and Morey, G.B., 1998, Bedrock geologic map of the Virginia Horn, Mesabi Iron Range, St. Louis County, Minnesota: Minnesota Geological Survey Miscellaneous Map Series, Map M-85, scale 1:48,000.
5 Miller, J.D., Jr., and Chandler, V.W., 1999, Bedrock geologic map of the central Duluth Complex and the western part of the Beaver Bay Complex, Lake and St. Louis Counties, Minnesota: Minnesota Geological Survey Miscellaneous Map Series, Map M-101, scale 1:100,000.
6 Boerboom, T.J., Southwick, D.L., and Severson, M.J., 1999, Bedrock geology of the Aitkin 30 x 60 minute quadrangle, east-central Minnesota: Minnesota Geological Survey Miscellaneous Map Series, Map M-99, 2 pls., scale 1:100,000.
7 Boerboom, T.J., Southwick, D.L., and Severson, M.J., 1999, Bedrock geology of the Mille Lacs 30 x 60 minute quadrangle, east-central Minnesota: Minnesota Geological Survey Miscellaneous Map Series, Map M-100, 2 pls., scale 1:100,000.
8 Meyer, G.N., project manager, 1995, Geologic atlas of Stearns County, Minnesota: Minnesota Geological Survey County Atlas Series, Atlas C-10, Pt. A, 7 pls., scales 1:100,000 and 1:200,000.
9 Jirsa, M.A., Chandler, V.C., Cleland, J.M., and Meints, J.P., 1995, Bedrock geologic map of east-central Minnesota: Minnesota Geological Survey Open-File Report 95-1, 2 pls., scale 1:100,000.
10 Mossler, J.H., and Tipping, R.G., compilers, 2000, Bedrock geology and structure of the seven-county Twin Cities Metropolitan Area, Minnesota: Minnesota Geological Survey Miscellaneous Map Series, Map M-104, scale 1:125,000.
11 Hobbs, H.C., project manager, 1995, Geologic atlas of Rice County, Minnesota: Minnesota Geological Survey County Atlas Series, Atlas C-9, Pt. A, 6 pls., scale 1:100,000.
12 Setterholm, D.R., project manager, 1998, Geologic atlas of Goodhue County, Minnesota: Minnesota Geological Survey County Atlas Series, Atlas C-12, Pt. A, 6 pls., scale 1:100,000.
13 Bloomgren, B.A., 1993, Bedrock geology of Waseca County, Minnesota: Minnesota Geological Survey Miscellaneous Map Series, Map M-73, 3 pls., scale 1:62,500 and smaller.
14 Mossler, J.H., project manager, 1998, Geologic atlas of Mower County, Minnesota: Minnesota Geological Survey County Atlas Series, Atlas C-11, Pt. A, 6 pls., scale 1:100,000.
15 Mossler, J.H., project manager, 1995, Geologic atlas of Fillmore County, Minnesota: Minnesota Geological Survey County Atlas Series, Atlas C-8, Part A, 5 pls., scale 1:100,000.
16 Runkel, A.C., 1996, Bedrock geology of Houston County, Minnesota: Minnesota Geological Survey Open-File Report 96-4, 3 pls., scale 1:100,000; text, 13 p.
17 Morey, G.B., 1999, unpublished geologic map of the Mesabi iron range, northern Minnesota: Minnesota Geological Survey file map, scale 1:100,000.

NONDIGITAL MAPPING

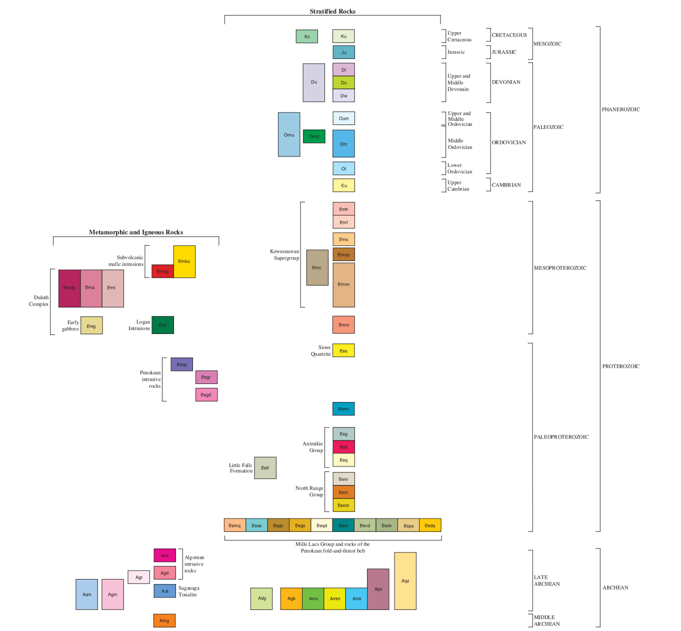
Morey, G.B., 1996, compiler, Geologic map of Minnesota, bedrock geology: Minnesota Geological Survey State Map Series, Map S-20 digital version 2, scale 1:1,000,000 and references therein.

Every reasonable effort has been made to ensure the accuracy of the factual data on which this map interpretation is based; however, the Minnesota Geological Survey does not warrant or guarantee that there are no errors. Users may wish to verify critical information; sources include both the references listed here and information on file at the offices of the Minnesota Geological Survey in St. Paul. In addition, effort has been made to ensure that the interpretation conforms to sound geologic and cartographic principles. No claim is made that the interpretation shown is rigorously correct, however, and it should not be used to guide engineering-scale decisions without site-specific verification.

Generally excellent to fair outcrop
Generally fair to poor outcrop
Poor to no outcrop

DIAGRAM SHOWING GEOLOGIC RELIABILITY BASED ON DENSITY OF BEDROCK OUTCROP

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

MESOZOIC ROCKS

Ku Cretaceous rocks, undivided—Dakota, Graneros, Greenhorn, Carlile, Niobrara, and Pierre formations and their nonmarine equivalents in northwestern, southwestern, and southeastern Minnesota.

Kc Coleraine Formation—Jasper-pebble conglomerate, sandstone, and shale of diverse origin on the Mesabi range of northern Minnesota, and unnamed sandstone and shale of nonmarine to marine origin in east-central Minnesota.

Ju Jurassic rocks, undivided—Unnamed units of green, gray, brown, and red shale, white to tan micritic limestone and dolostone, and white, fine- to coarse-grained sandstone and siltstone; unit contains nodules of chert and gypsum.

PALEOZOIC ROCKS

Du Devonian rocks, undivided—Limestone, dolomitic limestone, and dolostone of the Cedar Valley and Wapsipinicon Groups.

Dl Lithograph City Formation, Coralville Formation and Hinckle and Eagle City Members of the Little Cedar Formation (Cedar Valley Group), undivided—Limestone, dolostone, and lesser amounts of shale.

Dc Chickasaw Member of the Little Cedar Formation (Cedar Valley Group)—Light-gray to medium-gray shale and silty shale.

Dw Bassett Member of the Little Cedar Formation (Cedar Valley Group) and Pinicon Ridge and Spillville Formations (Wapsipinicon Group)—Dolostone and shaly dolostone.

Oum Upper and Middle Ordovician rocks, undivided—Limestone and shaly limestone of the Maquoketa and Dubuque Formations, and limestone and dolostone of the Galena Group in the Hollandale embayment of southeastern Minnesota.

Omu Middle and Upper Ordovician rocks, undivided—Sandstone and shaly sandstone of the Winnipeg Formation and limestone and dolomitic limestone of the Red River Formation along the east edge of the Williston Basin in northwestern Minnesota.

Om Middle Ordovician rocks, undivided—Decorah Shale; limestone of the Platteville Formation; shaly rocks of the Glenwood Formation; and St. Peter Sandstone in the Hollandale embayment of southeastern Minnesota.

Omd Decorah Shale (Middle Ordovician)—Light-greenish-gray shale and lesser amounts of coquinoid limestone, especially in the upper half of the formation. Mapped as a separate unit where possible.

Ol Lower Ordovician rocks, undivided—Shakopee and Oneota Formations of the Prairie du Chien Group in the Hollandale embayment of southeastern Minnesota. Unit consists dominantly of dolostone and dolomitic limestone. The Shakopee also contains intervals of quartz arenite, including a pronounced basal unit named the New Richmond Member.

€u Upper Cambrian rocks, undivided—Jordan Sandstone; dolomitic, glauconitic, and silty glauconitic rocks of the St. Lawrence and Franconia Formations; Ironton and Galesville Sandstones; sandy and shaly rocks of the Eau Claire Formation; and the Mt. Simon Sandstone.

MESOPROTEROZOIC ROCKS

Ᵽmh Hinckley Sandstone—Buff to tan quartz arenite of lacustrine and eolian origin.

Ᵽmf Fond du Lac Formation—Red to dark-brown shale, feldspathic sandstone, and arkose of fluvial origin. Includes the Oldenberg Point Member, a pronounced basal unit of quartz-pebble conglomerate in the Duluth area.

Ᵽms Solor Church Formation—Dark-red to dark-brown shale, siltstone, and lithic sandstone of fluvial origin in Scott and Carver Counties; metamorphosed to zeolite facies.

Ᵽmc Chengwatana Volcanic Group—Basalt and related volcanogenic and interflow sedimentary rocks in east-central Minnesota.

North Shore Volcanic Group.

Ᵽmnp *Schroeder-Lutsen basalts*—Predominantly ophitic olivine tholeiitic basalt unconformably over older, normally polarized volcanic rocks. Based on its stratigraphic position and geochemical affinities, the unit may be correlative with the Lake Shore traps of northern Michigan .

Ᵽmnn *Normally polarized volcanic rocks, undivided*—Basalt, andesitic basalt, rhyolite, and related volcanogenic interflow sedimentary rocks along and inland from the North Shore of Lake Superior.

Ᵽmnr *Reversely polarized volcanic rocks, undivided*—Mixed tholeiitic diabasic and porphyritic basalt, trachybasalt, and rhyolite in far northeastern Minnesota and porphyritic and diabasic basalt near Duluth. Includes units of a basal quartz arenite, Puckwunge Sandstone and Nopeming Formation, in northeastern Minnesota and near Duluth, respectively.

Subvolcanic mafic rocks, undivided.

Ᵽmbu *Beaver Bay Complex and other named and unnamed gabbroic-troctolitic intrusions*—Includes a number of other intrusions in a variety of dikes and sills such as the Endion sill and the Pigeon River Intrusions.

Ᵽmbg *Selected granophyric and leuco-granitic phases of troctolitic-gabbroic intrusions in the Beaver Bay Complex.*

Duluth Complex.

Ᵽmdg *Felsic series*—Granophyric granite and related felsic rocks.

Ᵽmt *Troctolitic and gabbroic cumulate rocks*—Constitute at least nine named and several unnamed intrusions.

Ᵽma *Anorthositic series*—Plagioclase-rich gabbroic cumulates and related rocks.

Ᵽmg *Early gabbros*—Gabbro and related rocks in northeastern Minnesota that have petrologic affinities to the Logan Intrusions.

Ᵽml Logan Intrusions—Diabase, porphyritic diabase, gabbro, and related felsic sills and dikes.

PALEOPROTEROZOIC ROCKS

Ᵽes Sioux Quartzite—Red quartzite of fluvial to possibly marginally marine origin. Includes quartz-pebble conglomerate, claystone (catlinite, also called pipestone), a basal (rhyolite) pebble conglomerate in Pipestone County, and a basal (granite, quartz, chert, iron-formation) conglomerate in Nicollet County on the Minnesota River.

Ᵽeop Post-tectonic intrusions of the Penokean orogen—Small stocks of olivine pyroxenite in Morrison County; small plutons of hornblende-rich diorite and gabbro that contain layers and lenses of nelsonite, pyroxenite, and anorthosite in Todd County.

Ᵽegr Late-tectonic intrusions of the Penokean orogen—Includes the St. Cloud and Rockville Granites and Reformatory granodiorite of east-central Minnesota, the Section 28 granite, the Cedar Mountain Complex, and other unnamed intrusions exposed along the Minnesota River Valley in southwestern Minnesota.

Ᵽegd Syntectonic intrusions of the Penokean orogen—Includes the Pierz Granite, the Freedhem and Bradbury Creek Granodiorites, and several unnamed intrusions of granite, granodiorite, tonalite, and gabbro in east-central Minnesota.

Ᵽemt Unnamed schistose, volcanic, and hypabyssal rocks of mafic composition and volcanic, volcaniclastic, and intrusive rocks of felsic composition—May be correlative with rocks of the Wisconsin magmatic terranes.

Animikie Group.

Ᵽeg *Shale, siltstone, feldspathic graywacke, and associated volcaniclastic rocks*—Includes the Rove Formation in Cook County, the Virginia Formation in St. Louis, Itasca, and Lake Counties, and the Thomson Formation in Carlton County.

Ᵽeif *Iron-formation*—Includes the Gunflint Iron Formation in Cook County and the Biwabik Iron Formation and subjacent units of arenite and conglomerate assigned to the Pokegama Quartzite in Itasca, St. Louis, and Lake Counties. Also includes thin lenses of iron-formation (Remer Member) in the Virginia Formation in Itasca County.

Ᵽeq *Pokegama Quartzite*—Quartz arenite, siltstone, and shale. Shown only in Crow Wing County.

Little Falls Formation.

Ᵽelf Quartz-rich slate, argillite, and schist in the northwestward extent of the unit and coarse-grained megacrystic garnet-staurolite-schist in the southeastward extent—Unit has an uncertain stratigraphic position relative to other Paleoproterozoic stratified units but is apparently younger than the Mille Lacs and North Range Groups.

North Range Group.

Ᵽenr *Rabbit Lake Formation*—Mudstone, graywacke, iron-rich strata, and associated mafic metavolcanic rocks metamorphosed to the greenschist facies. Includes thin beds of carbonate-silicate iron-formation.

Ᵽent *Trommald Formation*—Carbonate-silicate iron-formation overlain by hematite iron-formation and associated manganese oxide deposits. Also contains substantial quantities of volcanic and hypabyssal rocks of generally mafic composition. Metamorphosed to the greenschist facies.

Ᵽenm *Mahnomen Formation*—Claystone, shale, siltstone, and graywacke metamorphosed to the greenschist facies.

Mille Lacs Group and related rocks of the Penokean fold-and-thrust belt.

Ᵽemq *Quartz arenite, siltstone, and chert-rich dolostone of the Trout Lake Formation in Crow Wing County.*

Ᵽesa *Slate, argillite, and metasiltstone metamorphosed to the lower greenschist facies*—Includes lesser amounts of mafic hypabyssal intrusions, and fragmental mafic volcanic rocks.

Ᵽegv *Graphitic schist, slate, and silicate iron-formation metamorphosed to the lower greenschist facies and related conditions*—Includes substantial quantities of mafic to intermediate igneous rocks.

Ᵽegs *Graphitic schist, phyllite and slate interbedded on a fine scale.*

Ᵽeqd *Quartzite at Dam Lake*—Quartz arenite and sericitic quartz schist; includes a substantial component of mafic volcanic rock fragments.

Ᵽem *Metadiabase, undivided.*

Ᵽevd *Metabasalt, metadiabase, and metasedimentary rocks metamorphosed to lower amphibolite facies*—Includes fragmental volcanic rocks, mafic hypabyssal intrusions, graphitic argillite, and oxide iron-formation.

Ᵽedv *Metabasalt, metadiabase, and metasedimentary rocks metamorphosed to lower greenschist facies*—Includes fragmental volcanic rocks, mafic hypabyssal intrusions, graywacke, graphitic argillite and oxide iron formation.

Ᵽeps *Metagraywacke, metasiltstone and a variety of schistose rocks metamorphosed to the amphibolite facies.*

Ᵽedq *Denham Formation*—Quartz arenite and siltstone, oxide iron-formation, marble, mafic hypabyssal intrusions and fragmental volcanic rocks metamorphosed to the staurolite grade of the amphibolite facies.

LATE ARCHEAN ROCKS

Ami Post-tectonic mafic intrusions—Gabbro, peridotite, pyroxenite, and their metamorphic equivalents. Unit also includes small intrusive complexes of anorthosite, gabbroic anorthosite, and anorthositic gabbro. Generally characterized by pronounced magnetic signatures.

Agd Multiphase intrusions of hornblende-pyroxene-bearing and biotite-bearing monzonite, monzodiorite, diorite, syenite, and granodiorite—Typically postdates regional metamorphism and deformation associated with the Algoman orogen.

Agr Syntectonic to pretectonic granitoid rocks—Granite and granodiorite of the Vermilion Granitic Complex, the Giants Range and Bemidji batholiths, as well as smaller intrusions of tonalite and monzonite of the Algoman orogen in northern Minnesota. Also includes the Odessa, Sacred Heart, and Fort Ridgely Granites exposed along the Minnesota River Valley in southwestern Minnesota.

Agm Granite-rich migmatite—Granitic gneiss, paragneiss, schist, and migmatite in the Vermilion Granitic Complex and other parts of extreme northern Minnesota. Grades into granitoid rocks.

Ast Saganaga Tonalite of northeastern Minnesota—Emplaced more-or-less contemporaneously with deposition of metasedimentary and metavolcanic rocks.

Asm Paragneiss and schist-rich migmatite—Grades into undivided metasedimentary rocks (unit Ams).

Ams Metasedimentary rocks, undivided—Graywacke, slate, local units of conglomerate, arenite, graphitic slate, fine-grained felsic volcanogenic, and volcaniclastic rocks, lean oxide iron-formation (shown in red) and its metamorphic equivalents. Includes the Knife Lake Group and the Lake Vermilion Formation in northeastern Minnesota.

Amm Mixed metavolcanic rocks—Mafic to felsic volcanic sequences that have variable amounts of felsic volcanogenic and volcaniclastic rocks and lean iron-formation. Includes parts of the Ely Greenstone and the Soudan Iron Formation (shown in red) in northeastern Minnesota.

Amv Mafic metavolcanic rocks—Dominantly basalt that contains thin sedimentary units, including iron-formation (shown in red). Includes parts of the Ely Greenstone and the Newton Lake Formation in northeastern Minnesota. Also includes metabasalt exposed in the Minnesota River Valley.

Agb Anorthosite, gabbroic anorthosite, and anorthositic gabbro of the Mentor mafic intrusive complex in Polk County.

Adg Gabbro, diorite, peridotite, and associated komatiitic flows of the Deer Lake sequence in Itasca County and the upper part of the Newton Lake Formation in Lake and St. Louis Counties.

Aps Paragneiss, schist, and amphibolite—Amphibolite-facies equivalent of units Amv and Ams; locally includes abundant intrusions of unit Agr.

Aqz Felsic to intermediate volcanic and volcaniclastic rocks, mica schist, phyllite, and granitoid rocks—Variably and cataclastically deformed. Unit forms aeromagnetic "quiet zone" and probably contains some rocks of Paleoproterozoic age.

MIDDLE ARCHEAN AND OLDER ROCKS

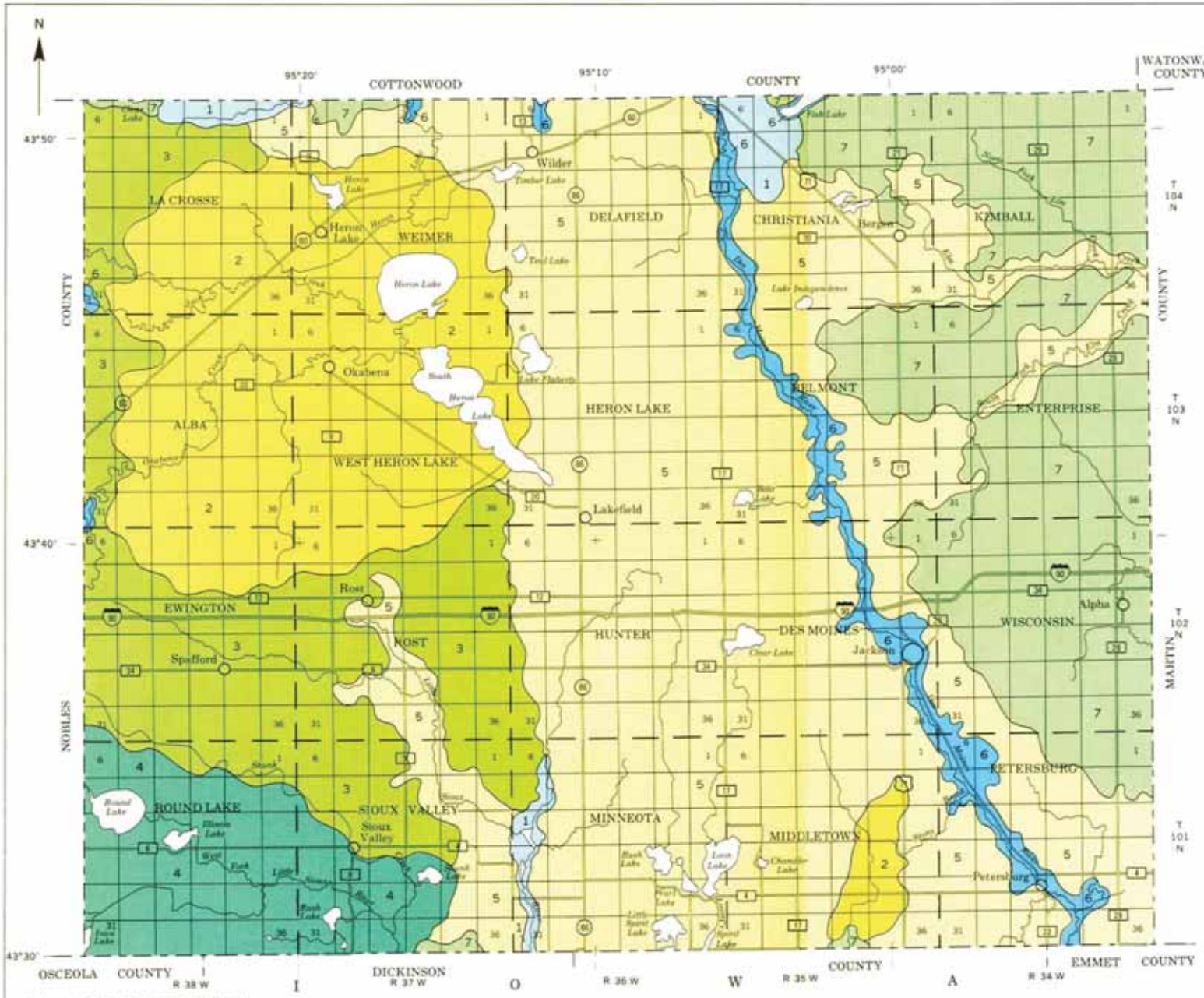
Amg Migmatitic gneiss, amphibolite, and granite—Montevideo and Morton Gneisses (3,600–3,000 m.y.) in the Minnesota River Valley, southwestern Minnesota; McGrath Gneiss (2,750 m.y.) east of Mille Lacs Lake; components of Hillman Migmatite southwest of Mille Lacs Lake; and Sartell Gneiss in Stearns County. Inferred to include various younger rocks, including granitoid intrusions in the Hillman Migmatite and pillowed basalt in poorly exposed areas of southwestern Minnesota.

Geologic contact—Located principally by inference or by airborne magnetic surveys except in the very few places where the contact is exposed.

Inferred trace of a steeply dipping fault.

Inferred trace of a thrust fault or structural discontinuity that is interpreted to have involved thrust displacement—Teeth are on the upper plate.

Iron-formation.



LEGEND*

1 — ESTHERVILLE-DICKMAN association: Nearly level to rolling, somewhat excessively drained and well drained, loamy soils that formed in glacial outwash on uplands

2 — LURA-COLLINWOOD association: Nearly level, very poorly drained, poorly drained, and moderately well drained, clayey soils that formed in lacustrine material on uplands

3 — COLLINWOOD-WALDORF-CLARION association: Nearly level and gently sloping, moderately well drained, poorly drained, and well drained, clayey and loamy soils that formed in lacustrine material and glacial till on uplands

4 — CLARION-LURA-COLLINWOOD association: Nearly level to hilly, well drained, very poorly drained, poorly drained, and moderately well drained, loamy and clayey soils that formed in glacial till and lacustrine material on uplands

5 — CLARION-DELFT association: Nearly level to hilly, well drained and poorly drained, loamy soils that formed in glacial till on uplands

6 — COLAND-TERRIL-SWANLAKE association: Nearly level to very steep, poorly drained, moderately well drained, and well drained, loamy soils that formed in alluvium, colluvium, and glacial till on bottom land and uplands

7 — CANISTEO-GLENCOE-NICOLLET association: Nearly level, poorly drained, very poorly drained, and moderately well drained, loamy soils that formed in glacial till and loamy sediments on uplands

*The texture terms in the descriptive headings refer to the surface layer of the major soils in each association.

COMPILED 1986

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MINNESOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

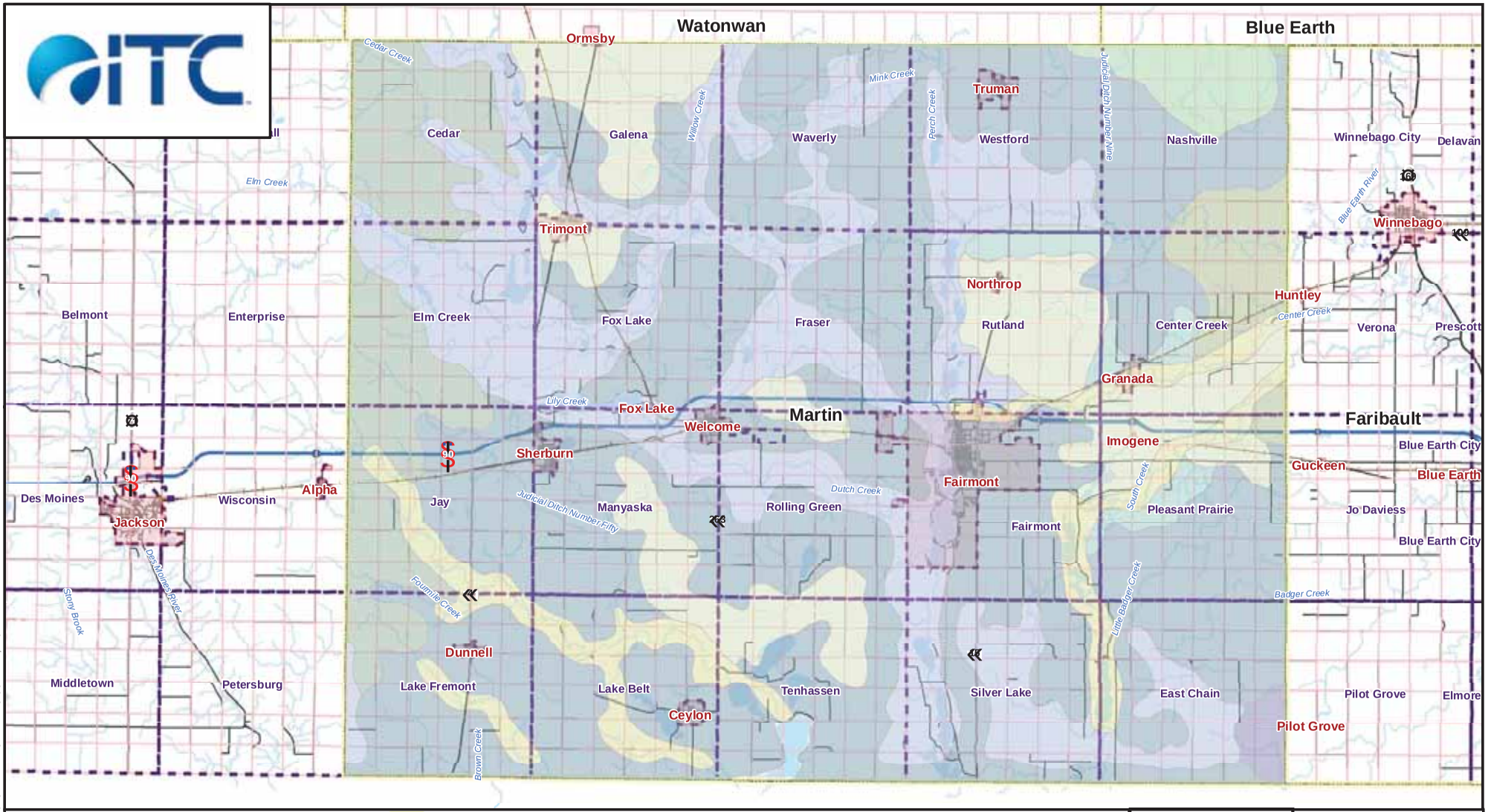
JACKSON COUNTY, MINNESOTA

Scale 1:190,080

1 0 1 2 3 Miles

1 0 2 4 Km

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



Appendix M
ITC Midwest
Minnesota-Iowa
345 kV Transmission Project

Martin County Soils

Issued: 3/14/2013

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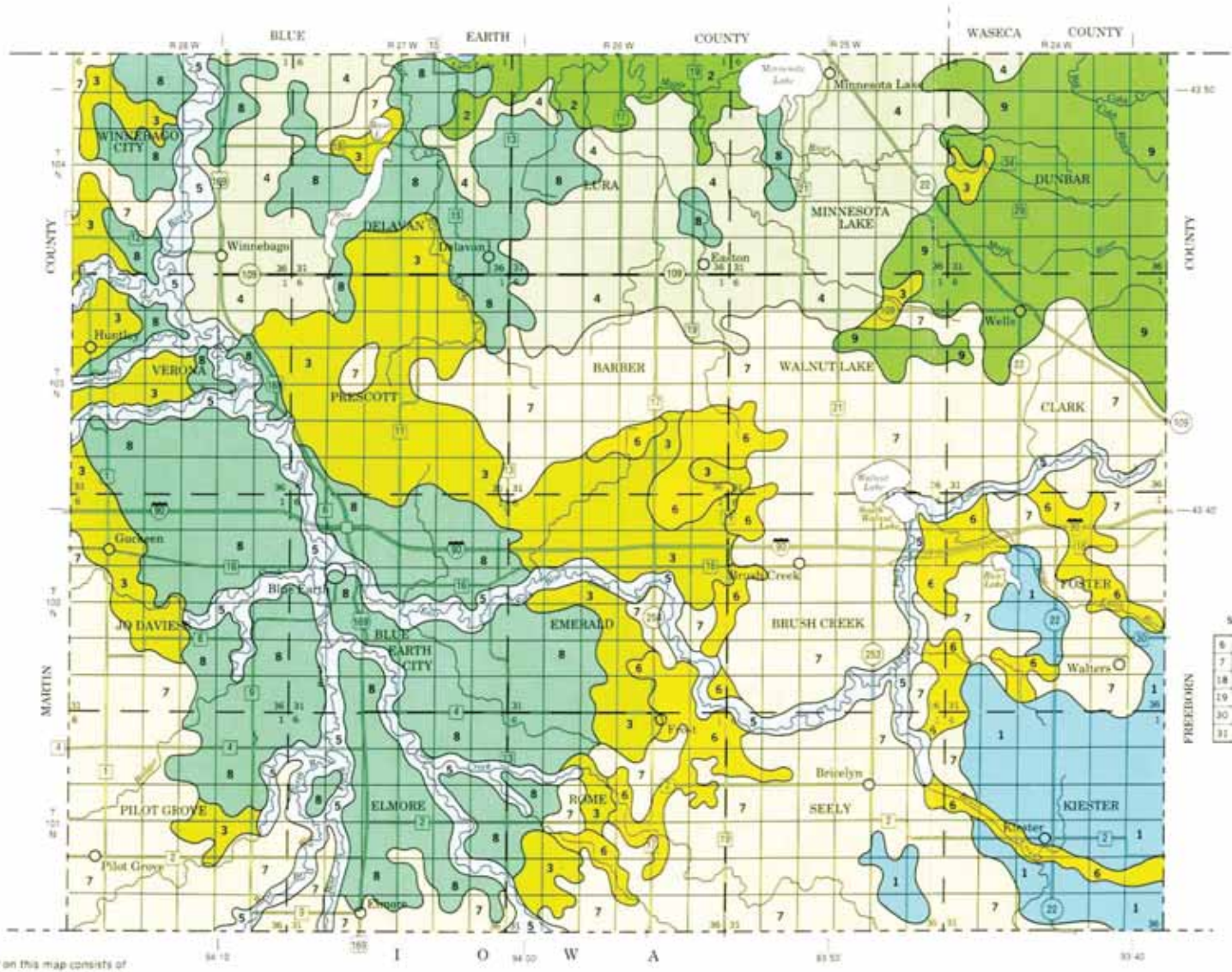

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

SOIL LEGEND

1. Clarion-Delft-Storden association
2. Beauford-Guckeen association
3. Spicer-Truman-Kingston association
4. Marna-Guckeen- association
5. Coland-Clarion association
6. Fieldon-Canisteo-Dickinson association
7. Canisteo-Clarion-Webster association
8. Waldorf-Collinwood association
9. Webster-Nicollet-Canisteo association

"The units in this legend are described in the text under the heading "General Soil Map Units."

Compiled 1989

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MINNESOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

FARIBAULT COUNTY, MINNESOTA

Scale 1:190,080

Appendix N

Map of Airports, Private Air Strips, Heliports, and Navigational Aids

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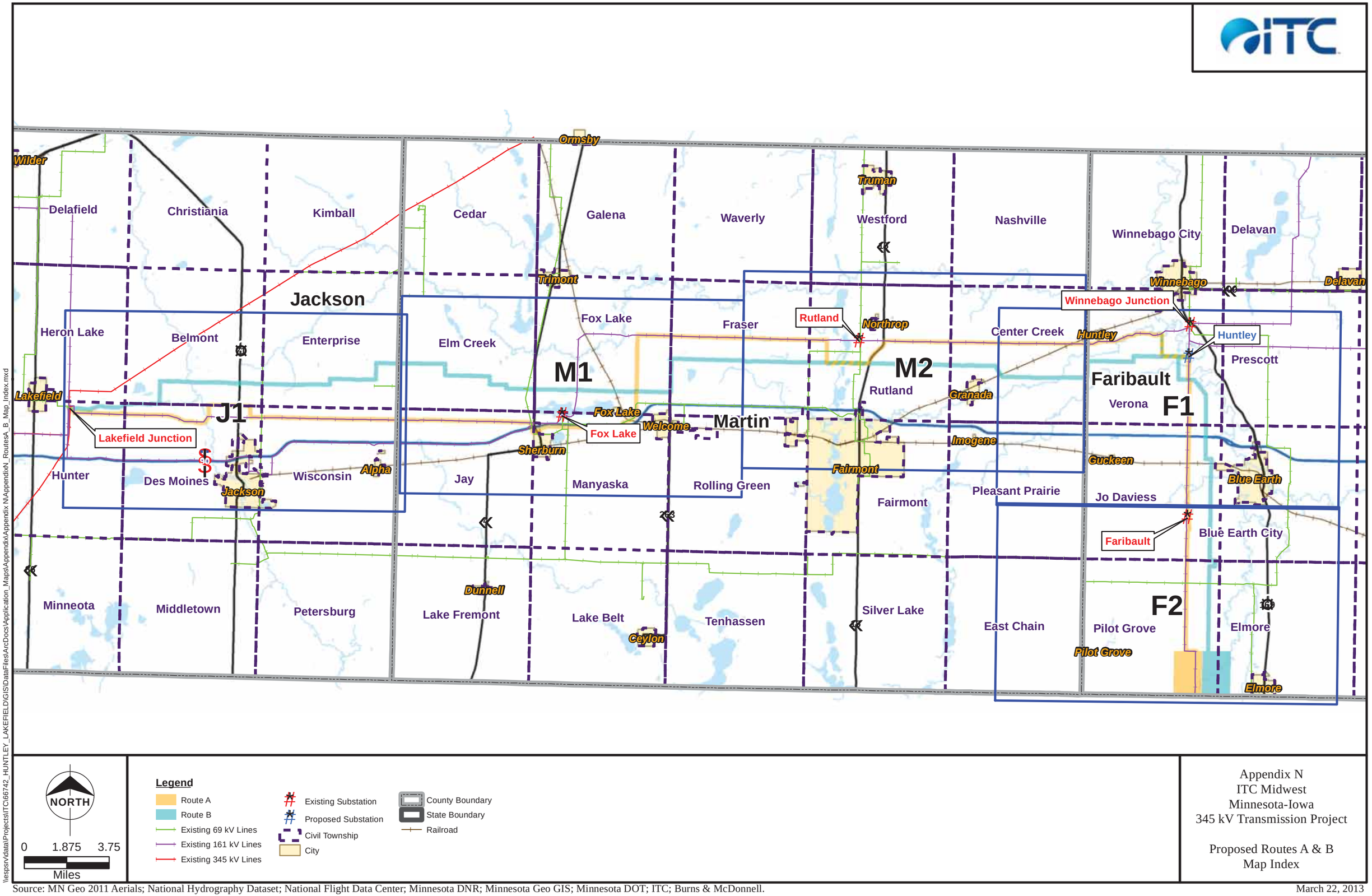

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NORTH

0 1.875 3.75

Miles

Legend

- Route A
- Route B
- Existing 69 kV Lines
- Existing 161 kV Lines
- Existing 345 kV Lines
- Existing Substation
- Proposed Substation
- Civil Township
- City
- County Boundary
- State Boundary
- Railroad

Appendix N
ITC Midwest
Minnesota-Iowa
345 kV Transmission Project

Proposed Routes A & B
Map Index

Source: MN Geo 2011 Aerials; National Hydrography Dataset; National Flight Data Center; Minnesota DNR; Minnesota Geo GIS; Minnesota DOT; ITC; Burns & McDonnell.

March 22, 2013

Kilen Woods State Park

Belmont
T103N R35W

Heron Lake
T103N R36W

Boot Lake

Bootleg Lake WMA

Toe WMA

Boot Lake WPA

Jackson

71

Arzt WMA

Enterprise
T103N R34W

Hunter
T102N R36W

Des Moines
T102N R35W

Wisconsin
T102N R34W

JACKSON MUNICIPAL AIRPORT

90

Clear Lake

JACKSON MEDICAL CENTER HELIPORT

Alpha

Jackson

Dead Horse WMA

NORTH

5,000 2,500 0

Feet

- Existing Substation Area
- Proposed Substation/Expansion
- Route A
- Route B
- Connector Segment
- Existing 69 kV Lines
- Existing 161 kV Lines
- Existing 345 kV Lines
- Railroad
- Existing Pipeline
- NHD Stream/River
- Civil Township
- Township Sections
- City
- County Boundary
- Local Park/Public Land
- WPA
- State Park or WMA
- Private Landing Strip
- Navigational Aids
- Airport
- Heliport

Locator Map

Jackson Co.

J1

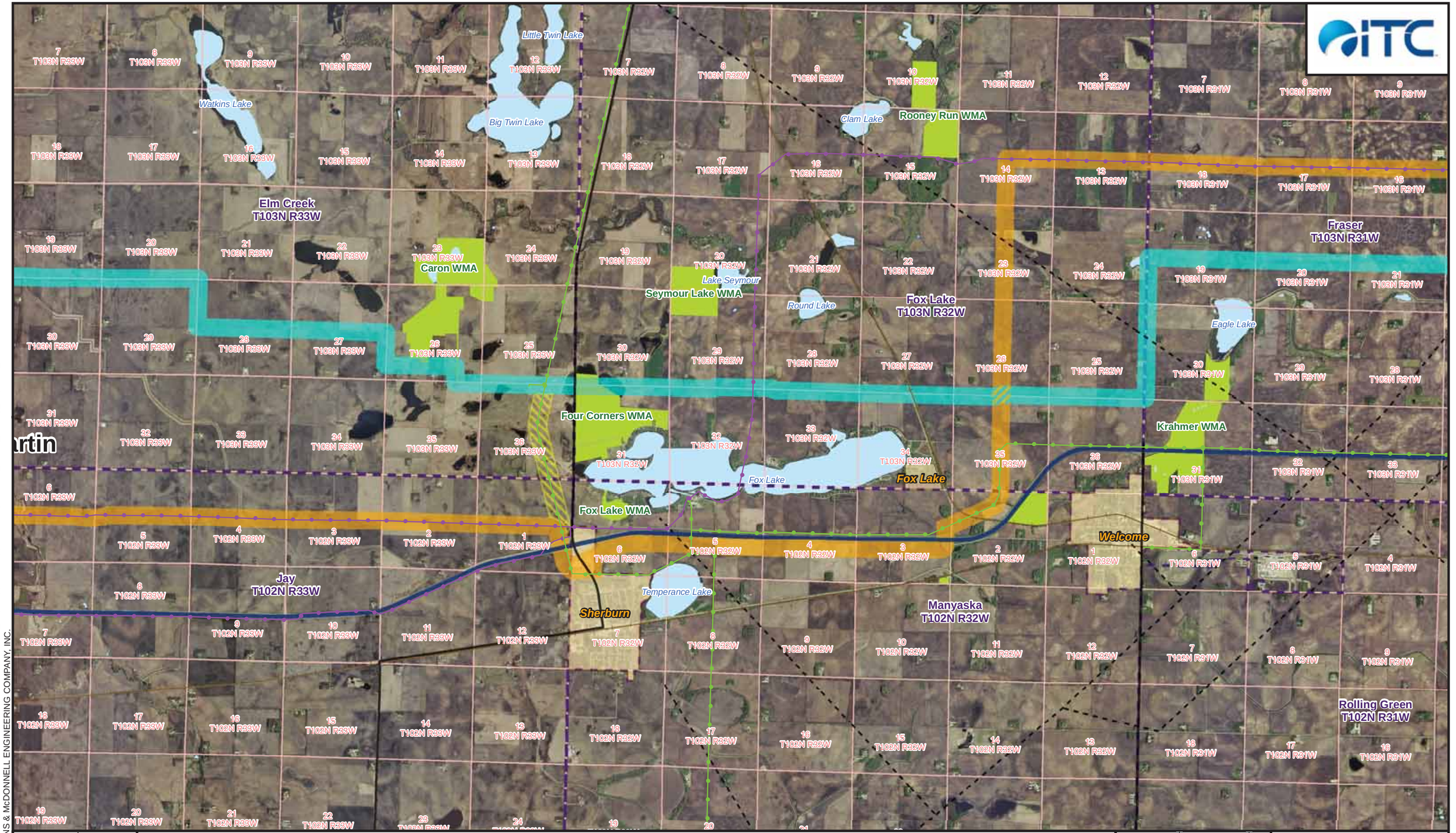
Appendix N
ITC Midwest
Minnesota-Iowa
345 kV Transmission Project

Jackson County - Air Navigation
Sheet 1 of 1

Source: MN Geo 2011 Aerials; National Hydrography Dataset; Minnesota DNR; Minnesota Geo GIS; Minnesota DOT; ITC; Burns & McDonnell.

Issued: 3/22/2013

Path: R:\ITC\66742_HUNTLEY_LAKEFIELD\GIS\DataFiles\ArcDocs\Application_Maps\AppendixN_Jackson_County_Mapbook_3192013.mxd ebrenna 3/22/2013



NORTH

5,000 2,500 0

Feet

- Route A
- Route B
- Connector Segment
- Existing 69 kV Lines
- Existing 161 kV Lines
- Existing 345 kV Lines
- Railroad
- Existing Pipeline
- NHD Stream/River
- Civil Township
- Township Sections
- City
- County Boundary
- Local Park/Public Land
- WPA
- State Park or WMA
- Navigational Aid
- Private Landing Strip
- Airport
- Heliport

Locator Map

Appendix N
ITC Midwest
Minnesota-Iowa
345 kV Transmission Project

Martin County - Air Navigation
Sheet 1 of 2

Source: MN Geo 2011 Aerials; National Hydrography Dataset; Minnesota DNR; Minnesota Geo GIS; Minnesota DOT; ITC; Burns & McDonnell.

Issued: 3/22/2013

Martin Lake
High Lake
Lake Charlotte
Kiester Lake
Canright Lake
Buffalo Lake
George Lake
Budd Lake
Lake Imogene
Northrop
Granada
Fairmont
Imogene
FAIRMONT MUNICIPAL AIRPORT

Fraser
T103N R31W

Center Creek
T103N R29W

Rutland
T103N R30W

Rolling Green
T102N R31W

Fairmont
T102N R30W

Pleasant Prairie
T102N R29W

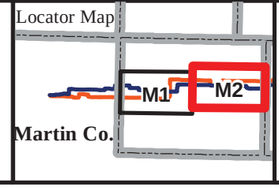
NORTH

5,000 2,500 0

Feet

- Route A
- Route B
- Connector Segment
- Existing 69 kV Lines
- Existing 161 kV Lines
- Existing 345 kV Lines
- Railroad
- Existing Pipeline
- NHD Stream/River
- Civil Township
- Township Sections
- City
- County Boundary
- Local Park/Public Land
- WPA
- State Park or WMA
- Navigational Aid
- Private Landing Strip
- Airport
- Heliport

Locator Map

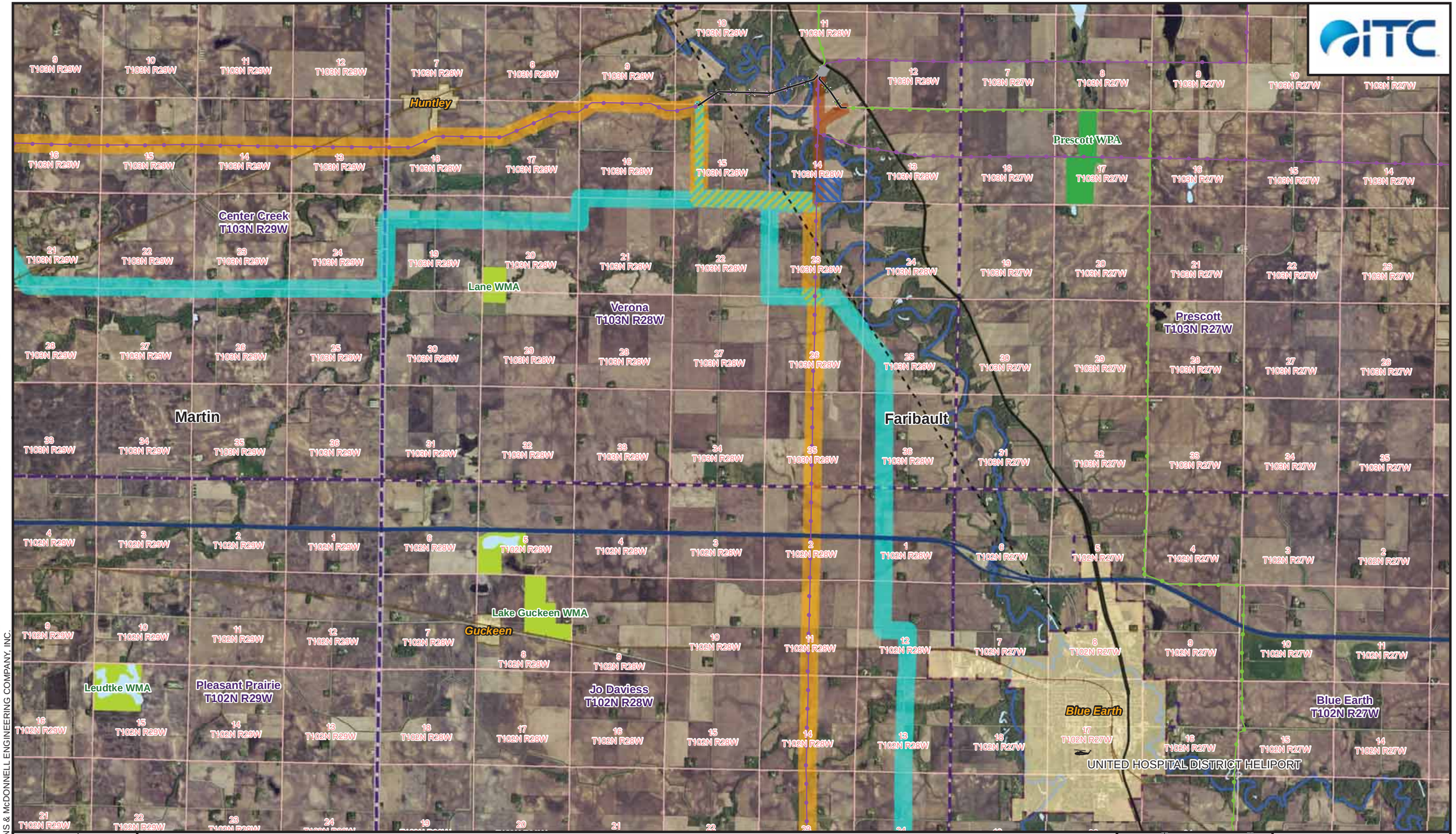


Appendix N
ITC Midwest
Minnesota-Iowa
345 kV Transmission Project

Martin County - Air Navigation
Sheet 2 of 2

Issued: 3/22/2013

Source: MN Geo 2011 Aerials; National Hydrography Dataset; Minnesota DNR; Minnesota Geo GIS; Minnesota DOT; ITC; Burns & McDonnell.

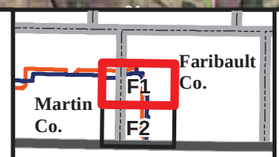


NORTH

5,000 2,500 0

Feet

- Huntley Substation
- Winnebago Substation- to be Removed
- Associated Facilities
- Route A
- Route B
- Connector Segment
- Existing 69 kV Lines
- Existing 161 kV Lines
- Existing 345 kV Lines
- Line to be Removed
- Railroad
- Existing Pipeline
- NHD Stream/River
- Civil Township
- MN Township Sections
- IA Township Sections
- City
- County Boundary
- State Boundary
- Local Park/Public Land
- WPA
- State Park or WMA
- Navigational Aid
- Private Landing Strip
- Airport
- Heliport



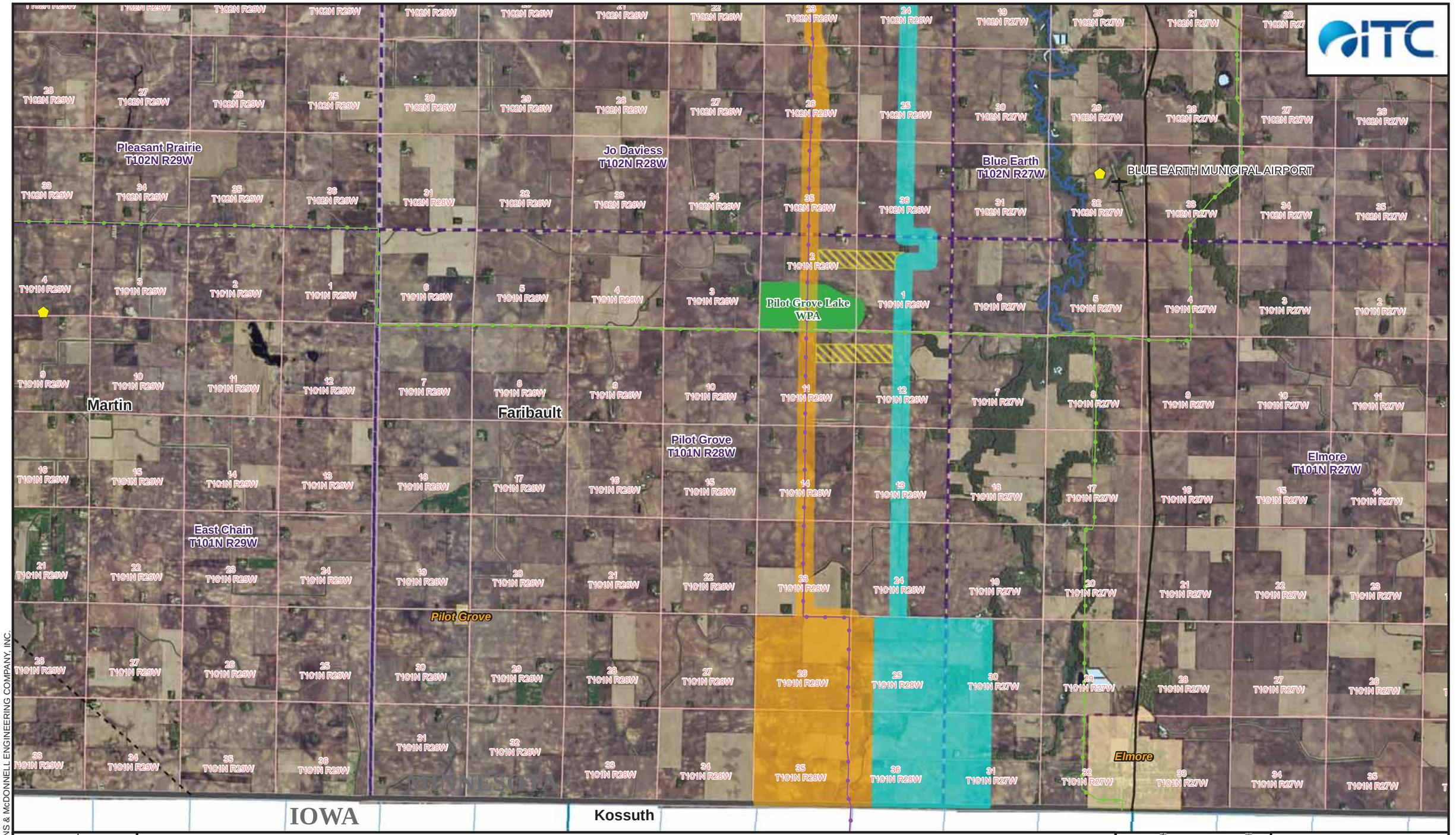
Locator Map

Appendix N
ITC Midwest
Minnesota-Iowa
345 kV Transmission Project

Faribault County - Air Navigation
Sheet 1 of 2

Issued: 3/22/2013

Source: MN Geo 2011 Aerial; National Hydrography Dataset; Minnesota DNR; Iowa DNR; Minnesota Geo GIS; Minnesota DOT; ITC; Burns & McDonnell.



NORTH

5,000 2,500 0

Feet

- Huntley Substation
- Winnebago Substation- to be Removed
- Associated Facilities
- Route A
- Route B
- Connector Segment
- Existing 69 kV Lines
- Existing 161 kV Lines
- Existing 345 kV Lines
- Line to be Removed
- Railroad
- Existing Pipeline
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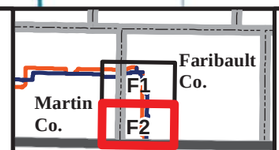
- MN Township Sections
- IA Township Sections
- City
- County Boundary
- State Boundary
- Local Park/Public Land
- WPA
- State Park or WMA
- Navigational Aid
- Private Landing Strip
- Airport
- Heliport



Locator Map

Appendix N
ITC Midwest
Minnesota-Iowa
345 kV Transmission Project

Faribault County - Air Navigation
Sheet 2 of 2

Source: MN Geo 2011 Aerial; National Hydrography Dataset; Minnesota DNR; Iowa DNR; Minnesota Geo GIS; Minnesota DOT; ITC; Burns & McDonnell.

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