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RE: Data Catalog for Bureau of Land Management Environmental Impact Statement

1 Introduction

This report catalogs the baseline data that TMM has collected, is currently collecting, and plans on collecting in the future. This data catalog should be used to provide line of sight on the format and breadth of project data and baseline information that will be delivered in support of the anticipated federal Environmental Impact Statement (EIS).

This report discusses TMM's Environmental Data Management System (EDMS), QA / QC protocols, and then reviews the baseline data collection by sorting into three time periods as follows: data previously collected, scheduled for collection in 2020, and identified as future data collection efforts. Figures are included where possible to help define the geographic extent of the data collection.

TMM plans to supply the data outlined in this data catalog as part of future data packages which will be provided during the EIS process. These data packages will include the full complement of data used to characterize the baseline conditions and any data used to support the impact assessments. Additionally, these documents will contain detailed information on the data collection methods, results, and interpretations. The data packages will also describe the impact assessment models, which were selected and why, how they were used, and where applicable how they are related.

2 Environmental Data Management System

TMM's data is hosted in an EDMS which provides TMM a single repository of spatial and tabular data and relates those data to documents located in TMM's document management system. The EDMS brings together information supporting the environmental review and project development in a readily accessible format, providing a platform to create agency reports to support the BLM's EIS efforts. The EDMS is hosted on a cloud server, built on state-of-the-art industry leading platforms. Spatial mapping and locational data are maintained through ArcGIS Online developed by ESRI, while tabular environmental field and laboratory analytical data are maintained through EQuIS Online developed by EarthSoft. These platforms are flexible and allow for data to be exported in a number of ways to support the needs of the end user. Additionally, TMM uses desktop ArcGIS software, specifically ArcMap 10.x and can provide spatial files as feature files or as geodatabases.

3 Data QA / QC

Several consulting firms have been engaged by TMM to collect various types of baseline data, with each firm being responsible for developing and implementing their own QA / QC procedures. The QA / QC procedures are documented as part of the Quality Assurance Project Plan (QAPP) and each firm is tasked to review field methodology, laboratory processes, and analytical results. In addition to the QA / QC procedures implemented as part of the individual scopes and baseline collection tasks - all data inputted into the EDMS are subject to a data validation process. This process includes:

- verifying that the dataset has been submitted in the expected format;
- conducting a completeness review against a sample plan or Chain of Custody;
- completing a quality check against historical or expected variation; and
- verifying reference values.

This additional data validation verifies the data's:

- Authenticity: data can be proven to be what it purports to be.
- Reliability: data can be trusted as full and accurate representation.
- Integrity: data is complete and unaltered.
- Usability: data can be located, retrieved, preserved, and interpreted easily.

4 Data Already Collected

The objective of the baseline data collection effort is to obtain data that accurately reflects environmental conditions to adequately characterize the baseline conditions and support impact analysis for the proposed Project. As such, the baseline data collection has evolved with the Project to reflect Project changes and the evolution of the understanding of the environment surrounding the site. The baseline data includes both TMM collected Project-specific data and public data from state and federal agencies. Project-specific baseline data collection has been ongoing since 2007 and TMM has an extensive catalog of baseline data for a number of resources discussed in detail below.

4.1 Surface Water

Surface water data includes: water quality, continuous stream gage, monthly stage monitoring, stream flow measurements, stream morphology, and lake stage. Surface water data comprises both Project-specific data collected by TMM and public data collected by the Minnesota Department of Natural Resources (MDNR), U.S. Geological Survey (USGS), and U.S. Forest Service (USFS). Public and project-specific surface water hydrology and water quality monitoring locations are shown on Figure 1.

Public Surface Water Data

USGS stream flow data are available for several gauging stations in the vicinity of the Project area. The period of record ranges from 1951 to the present; however, none of the gauging station records cover the full period. Additionally, lake stage data have been recorded daily at Birch Lake and White Iron Lake. Tables 1 and 2 show summaries of the flow and lake stage data.

A long water quality record exists for the USGS station at the South Kawishiwi River, which was sampled monthly from 1966 to 1970 and quarterly until 1995. The baseline data also contains MDNR water chemistry data, MDNR watershed monitoring and assessment data, and USGS water chemistry, bedrock, soil, and streambed sediment data.

Project-Specific Surface Water Data

Surface water baseline hydrology and water quality in the vicinity of the Project area has been characterized through targeted investigations since 2007. The Project surface water monitoring network includes stage, stream flow, and water quality monitoring sites. The number of monitoring sites and frequency of monitoring has been refined as the Project has evolved. Stream flow monitoring has been conducted in:

- Filson Creek;
- North Nokomis Creek;
- Stony River;
- Denley Creek; and
- Unnamed Creek.

Table 3 shows a summary of the surface water quality data collected.

Parameters monitored as part of the Project surface water quality program have varied by monitoring location and monitoring events. In general, monitored parameters have included field measured parameters such as pH and temperature; general parameters such as alkalinity, chloride, and sulfate; nutrients such as nitrogen and phosphorus; and metals such as aluminum, copper, and mercury. A listing of all parameters collected during the surface water quality program are listed in Table 4.

TMM has also conducted stream morphology surveys. Stream morphology assessments were completed at seven reaches on six watercourses in 2008. In 2019, a stream morphology assessment was completed on Keeley Creek at three reaches.

TMM has conducted baseline wild rice monitoring that has included vegetative surveys, macrophyte collection, and water quality monitoring. Wild rice sampling and processing was done as part of 2018 wild rice survey along with identifying other aquatic macrophytes growing in or near wild rice stands. The purpose of these observations and the sampling was to provide an overview of dominant macrophyte species in the water bodies. Table 5 shows a summary of the wild rice data collected and Figure 2 shows areas surveyed in the vicinity of the Project area during 2018.

4.2 Groundwater

Groundwater data includes groundwater levels, groundwater sampling, downhole geophysical data, and hydraulic conductivity data. While some public hydrogeologic data is available, most of the hydrogeologic data about the Project area has been obtained by TMM through targeted, site-specific investigations since 2008.

Public Groundwater Data

Three public reports have been conducted that inform the baseline hydrogeology and groundwater quality conditions within the Project area. These include:

- Siegel, D. and Ericson D., 1980. Hydrology and Water Quality of the Copper-Nickel Study Region, Northeastern Minnesota. U.S. Geological Survey Water-Resources Investigations Open-File Report 80-739.
- Ground Water Monitoring and Assessment Program (GWMAP), 1999. Baseline Water Quality of Minnesota's Principal Aquifers – Region 1, Northeastern Minnesota. St. Paul, Minnesota. January 1999.
- Rye, Marty, 2020. Results of Water Quality Sampling of Existing Drinking Water Wells Near the South Kawishiwi River. U.S. Forest Service Report. March 25, 2020.

Project-Specific Groundwater Data

TMM has installed a monitor well network in the Project area and conducted field investigations including various downhole geophysical testing of open exploration boreholes, hydraulic conductivity testing, groundwater level readings from the monitor well / piezometer network, and groundwater quality sampling.

Monitor Well Network

Monitor wells and piezometers to facilitate testing, sample acquisition, and water level measurements have been installed in the Project area since 2014. The monitoring points were installed as "nested sites" with several wells installed at pre-determined discrete intervals at each drill pad to target the various hydrogeologic units (HGU). Table 6 shows a summary of the monitor well network and Figure 3 shows the location of the monitor well network. The wells target the HGUs of interest and are designed as follow:

- QUM HGU – Q1 piezometers and Q2 monitor wells.
    - Q1 Wells – Hand augered piezometers installed in wetland settings located as close to a well pad site as possible. These wells are intended to provide wetland water level data and are typically shallow (3 to 7 feet [ft] [0.9 to 2.1 meters [m]) 2 inch steel installations; and
    - Q2 Wells – Sonic drilled monitor wells installed at the nested pad and screened in the QUM above the bedrock to intersect the water table. Q2 wells are constructed with 2-inch polyvinyl chloride (PVC) and terminate at the bedrock surface.

- Shallow Bedrock HGU – B1 and B2 monitor wells.
    - B1 Wells – isolate the top zone of 30 to 50 ft (9.14 to 15.2 m) into the competent shallow bedrock HGU. Two-inch PVC wells installed by setting a cemented surface casing into the bedrock and then coring into the bedrock to approximately 40 to 50 ft (12.2 to 15.2 m) and isolating the well in competent bedrock (screened in the bottom approximately 20 ft [6.1 m] of bedrock); and
    - B2 Wells – isolate the zone of 100 to 150 ft (30.5 to 45.7 m) into the shallow bedrock HGU. Two-inch PVC wells installed by setting a cemented surface casing into the bedrock and then coring into the bedrock to approximately 150 ft (45.7 m) and isolating the well in bedrock (screened in the bottom approximately 20 to 30 ft [6.1 to 9.1 m] of bedrock).
- Deep Bedrock HGU – B4 monitor wells.
    - B4 Wells – 2-inch or 5-inchstainless steel wells installed by setting a cemented surface casing into the bedrock and then coring into the bedrock to the approximate bottom of the BMZ (approximately 300 ft to 2,200 ft [91.4 m to 670.6 m] depending on location) and isolating the well in the BMZ (approximately 200 ft [61 m] of screen).
- Vibrating Wire Piezometers – Installed by setting a cemented surface casing into the bedrock and then coring into the bedrock to selected intervals and setting pressure transducers at three discrete intervals.

Geophysical Testing

Geophysical testing has been conducted at selected existing exploration boreholes including: acoustic televiewer photography of fractures in the borehole wall, downhole hydrogeophysical logging, and discrete-interval inflatable packer testing. The goal of the geophysical testing has been to characterize the spatial and depth distribution of hydraulic conductivity within the bedrock. TMM has conducted borehole hydrogeophysical testing at over 400 intervals in 74 boreholes located in the underground mine area. Figure 4 shows the hydrogeophysical testing corehole locations.

Hydraulic Conductivity Testing in Monitor Wells

To define the hydraulic characteristics, monitor wells have been used for aquifer testing. Aquifer testing was implemented in two steps:

1. Slug Testing – volume displacement within each well was implemented and the resulting water level response was recorded; and
2. Wells that exhibited the capability to produce enough groundwater based on drilling observations and slug test results were then pump tested. After a constant pumping rate was identified, each tested well was allowed to recover and then the constant rate was applied while measuring pumping rate and water levels over time. At the

end of the test the pumping was terminated and the corresponding recovery was recorded.

Monitor well hydraulic conductivity testing included 132 tests. Table 7 shows a summary of the monitor well hydraulic conductivity testing. Figure 5 shows an example hydrophysical log from the hydraulic conductivity testing.

Groundwater Level Measurements

Each groundwater monitoring point has been surveyed to determine an elevation reference point. Monthly water level measurements are obtained by measuring the depth to groundwater from the surveyed measuring point. The water elevation data is used to determine groundwater flow direction, seasonal variation, response to precipitation trends, model calibration, and further inform the hydrogeologic model / HGU differentiation. Monthly water level data acquisition is anticipated to continue through the permitting process. Table 8 shows a summary of the groundwater levels collected.

Groundwater Quality Sampling

Groundwater sampling commenced in the second quarter of 2018 and has been conducted on a quarterly basis at all available wells once they are constructed and adequately developed. Sample protocol included initial water level measurements, a pre-determined well purging methodology, field parameter data acquisition via an instrumented flow through cell, sample preservation for laboratory analysis, and documentation. Table 9 shows a summary of the groundwater quality data. Parameters measured for the groundwater quality program are listed in Table 4.

4.3 Terrestrial and Aquatic Resources

Terrestrial and aquatic resource data includes land cover, habitat – both terrestrial and aquatic, vegetation, sensitive species and general wildlife surveys, and non-native invasive plant surveys. Terrestrial and aquatic resource data includes both Project specific data has been collected by TMM and public data which has been collected by the MDNR, Minnesota Pollution Control Agency (MPCA), USGS, U.S. Fish & Wildlife Service (USFWS), and USFS.

Public Terrestrial and Aquatic Resources Data

Public data have been extensively used to help characterize the baseline conditions for terrestrial and aquatic resources. These data have been used for desktop analysis to assist in field surveys and project-specific data collection. These data include (figures are included where available to show data collected for the Project area):

- Land Cover and Habitat
    - USGS Gap Analysis Program (GAP) / LANDFIRE – Figures 6 and 7
    - USGS National Land Cover Database – Figures 8 and 9
    - MDNR / USFS Ecological Classification System – searched for Project area

  - MDNR Minnesota Biological Survey – Figures 10 and 11
- Vegetative, Terrestrial Wildlife, and Sensitive Species Baseline
  - MDNR Rare Species Guide – searched for Project area
  - Minnesota Natural Heritage Information System Database – Figure 12
  - USFS Regional Forester Sensitive Species – searched for Project area
  - USFWS Midwest Region Endangered Species – searched for Project area
  - USFWS Information for Planning and Consultation – searched for Project area
- Aquatic Species Baseline
  - MPCA Environmental Data Access – Figure 13
  - MPCA Rainy River-Headwaters Monitoring and Assessment Report MDNR Fishes of Minnesota Mapper – searched for Project area
  - USFS Current Invasive Plants – searched for Project area

Project-Specific Terrestrial and Aquatic Resources Data

Project-specific field surveys were conducted during the summer of 2019 to characterize the site conditions for terrestrial and aquatic resources. The 2,434.8 acres were surveyed to document the occurrence of:

- native plant communities (NPC);
- sensitive vegetation; and
- wildlife both common and sensitive species

These initial surveys covered the potential ground disturbance area of the transmission corridor (75 ft either side of centerline), plant site, water intake corridor, access road, and underground mine area.

4.4 Wetland Resources

Wetlands data includes wetland acres, wetland types, hydrology, and vegetation. Wetlands data includes both Project-specific data collected by TMM and public data which has been compiled by the MDNR.

Public Wetlands Data

Initial data collection for wetland resources baseline conditions used publically available data for desktop analysis. Specifically, the Minnesota update of the National Wetland Inventory (NWI) was used to establish a baseline of wetlands in the Project area. This is a public geographic information system database maintained by the MDNR based on the framework of

the NWI and was created for use for wetland regulation and management, land use and conservation planning, environmental impact assessment, and natural resource inventories. Figures 14 and 15 show the NWI data collected for the Project area.

Project-Specific Wetlands Data

Project-specific field surveys and delineations were conducted during the summer of 2019 to characterize the site conditions for wetland resources. The 2,434.8 acres within the Project area were surveyed at a wetland delineation level. This delineation level effort included data on hydrology, vegetation, soil, dominant species, NPCs, disturbances, biodiversity, etc.

4.5 Archaeological Sites, Historic Properties and Cultural Resources

Project-specific archaeological surveys to assess baseline historic, archaeological, and cultural resources, have been conducted since 2011. These Project-specific surveys were informed by background research from Minnesota State Historic Preservation Office, Minnesota Office of the State Archaeologist, and USFS files. The background research collected information on archaeological sites within one mile of the Project area, as well as on intensive archaeological surveys previously conducted within the Project area. At the end of summer 2019, 570.8 acres within the Project area had been surveyed. These surveys include Phase I, Phase IA, Phase IB Shovel Testing and more intensive surveys where necessary. The surveys are focused specifically on areas of potential ground disturbances. The construction limits of the ventilation raise site and access road, water intake corridor, plant site, access road, have complete survey coverage.

4.6 Noise

Ambient noise levels were measured by USFS staff in the Project area between 2014 and 2016. This data was acquired from the USFS in September 2017 and includes a total of 11 measurement sites, with five of those sites specific to TMM. Data were collected during winter months only (January – March), when manmade noise producing activity, such as boating, was generally at a minimum, leaves were off the trees thus wind noise is less, and other natural sources of sound were also at a minimum. Ambient noise measurement locations are shown on Figure 16.

4.7 Air Quality

Air quality baseline relies on public data to assess the ambient conditions in the vicinity of the Project. The baseline data specifically use data from MPCA monitoring stations. The MPCA has ambient monitoring data available for monitoring stations throughout the state and provides air modeling design values for projects in these locations. The design values include different size fractions of particulate matter (PM), specifically $PM_{2.5}$ and PM_{10}. The 24-hour $PM_{2.5}$ and annual $PM_{2.5}$ ambient background concentrations were acquired from the Ely, Minnesota (Station No. 0005) location, which is relatively close to the Project area. The 24-hour PM_{10} concentrations were obtained from Silver Bay (Station No. 7640-1), near the North Shore process plant site. While this site is located along Lake Superior, this is the closest site that has ambient background concentrations processed for PM10.

The ambient background levels for 1 hour and annual nitrogen dioxide (NO_2); 24-hour, 3 hour, 1-hour, and annual sulfur dioxide (SO_2); and 1-hour carbon monoxide (CO), and 8-hour CO were determined using data from Rosemount (Station No. 0423) near Minneapolis as the most representative location. This site was used because there are no recent design values available for these gaseous pollutants in northern Minnesota.

4.8 Meteorology

Project-specific meteorological data has been recorded on site hourly since June 8, 2018 and has 268,522 climate measurements including wind speed, wind direction, temperature, radiation flux, relative humidity, barometric pressure.

4.9 Mine Material Characterization Program

This Project-specific program's goal is to analyze mined material and provide an evaluation of Project environmental geochemistry through both static (short-term) and kinetic (long-term) testing. To date, baseline data has been focused on static testing. The 269 samples of waste rock and ore have been included in the static testing program as well as a bulk tailings sample and an engineered tailings backfill sample both generated from pilot plant testing.

Static testing is conducted to describe bulk chemical characteristics of a material. As it relates to the Project, the purpose of static testing is to identify the potential of particular rock types to leach metals or generate acid. Static testing results may initially indicate a potential for acid rock drainage (ARD) and / or metal leaching (ML) but kinetic testing is required to verify if the potential would be realized. The static testing program is comprised of the following tests:

Acid-Base Accounting (ABA)

ABA is conducted to predict the acid generation characteristics of a material and is based on the relative difference between the material's net acid generation potential and net acid neutralization potential. The acid generation potential of a sample is estimated based on its total sulfur or sulfide sulfur content. Neutralization potential is determined by titration or calculated based on carbon or total inorganic carbon content.

Chemical Analysis (Elemental and Whole Rock Analysis)

Characterization of a material's chemical composition is fundamental to understanding its environmental behavior. The results from solid-phase chemical analysis can be used to infer which elements are of potential environmental concern, although a high concentration of a particular element does not necessarily imply that this element would indeed be mobilized in concentrations that may lead to environmental impacts. Two methods would be used to determine chemical composition:

- Elemental Analysis: Elemental composition would be determined using an acid digestion to release elements into the solution phase followed by analysis of the elements in the resulting digestion.
- Whole Rock Analysis: Whole rock analysis is performed by x-ray fluorescence (XRF), an analytical method used for chemical characterization of major elements in materials

through the use of x-ray excitation and measurement of secondary fluorescence radiation from energy or wavelength-dispersed spectrum.

Net Acid Generation Testing (NAG test)

The NAG test determines the ARD potential of a sample. The NAG test procedure uses a strong oxidant (hydrogen peroxide) to rapidly oxidize sulfide minerals in a crushed rock sample. The neutralization potential can then be directly challenged by the acidity generated by rapidly oxidizing sulfides. If the sample has sufficient available NP, the alkalinity of the whole rock would not be entirely depleted, and the system is expected to have the capacity to remain circum-neutral. If there is inadequate available NP, then the pH of the test solution would fall below 4.5 and there would be net acidity rather than net alkalinity. In this case, a sample shows potential for acid generation.

This test may also be used to evaluate metal leaching through analysis of the NAG test leachate.

Mineralogical and Petrological Analysis

Mineralogical Analysis: Mineralogical analysis is conducted to identify and quantify both the crystalline and amorphous phases present in rock samples. In combination with the bulk chemical characteristics, the mineralogical information can be used to explain and predict the ARD / ML potential of the materials tested. Mineralogical findings, specifically the absence or presence of sulfide and carbonate mineral phases, are considered in the interpretation of ABA results.

Petrological Analysis: Petrology is the study of the composition, origin, structure, and formation of rocks. Petrography, a branch of petrology, focuses on the description and classification of rocks through the use of microscopic examination. The objective of petrological analysis by microscopic examination is to characterize mineral modal abundance, mineral grain size, mineral texture, and mineral alteration. Petrological analysis would focus on sulfide and neutralization (i.e., carbonates and silicates) characterization.

4.10 Soils

Public Soils Data

Public data was used to assess the soil conditions within the Project area. The Natural Resources Conservation Service (NRCS) maintains a public inventory of soil survey data for Minnesota. This inventory contains a variety of information on soil map unit distribution, physical and chemical characteristics, and information on soil usability for purposes such as structural foundations, septic fields, and other uses. The inventory also contains information on sensitive soils, which in the Project area include both hydric soils (which are susceptible to rutting in non-frozen conditions) and thin soils over shallow bedrock (which are susceptible to erosion when disturbed). The baseline NRCS data collected for the Project area is shown on Figures 17 and 18.

In addition to the NRCS data, the USFS maintains a public inventory of Ecological Land Types (ELT), which includes natural community information on geologic landforms, soils, and

associated botanical assemblages within the SNF. These data are part of a hierarchy of landscape information that is intended to guide decision-making, inform environmental analyses, and direct the management and monitoring of natural resources on public lands. The baseline ELT data collected for the Project area is shown on Figures 19 and 20.

Project-Specific Soils Data

Additionally, the thickness of unconsolidated sediments was recorded during the installation of monitor wells in and around the underground mine area.

5 Current Data Collection

TMM continues data collection in 2020 to establish coverage necessary to characterize the baseline conditions in the Project area and support future impact analysis.

5.1 Surface Water

In addition to the field efforts completed to date, ongoing sampling, monitoring, and testing activities to occur during 2020 to supplement surface water baseline data include:

- Quarterly water quality sampling (Q2 - Q4);
- Updated public data logger data (MDNR / USGS sites);
- Updated water level and discharge data; and
- Instrumented gaging stations will be installed in Keeley Creek.

5.2 Groundwater

In addition to the field efforts completed to date, ongoing sampling, monitoring, and testing activities to occur during 2020 to supplement groundwater baseline data include:

- Slug and pump testing of monitor wells installed at the Plant Area in 2019;
- Monthly water level data acquisition;
- Quarterly water quality sampling;
- Pilot-scale wetland hydrology investigation;
- Installation of additional groundwater wells pending approval of a submitted Plan of Operations; and
- Wetland infiltration testing.

Additional work also includes tailings management site hydrogeology investigation (monitor well and corehole installation, vibrating-wire piezometer installation, corehole packer testing, slug and pumping tests in monitor wells).

5.3 Terrestrial and Aquatic Resources

Continued field surveys building off of the work done during 2019 will be conducted during 2020. The 2020 survey will focus on finalizing the initial surveys from 2019 and collecting baseline data in the tailings management site. The field surveys are planned for approximately 1,254.7 additional acres and similar to the existing field surveys will focus on:

- Determining the occurrence of NPC class;
- Documenting critical habitat for state and federal threatened or endangered species;
- Wildlife surveys; and
- Conducting an inventory of the sensitive wildlife and general wildlife species.

5.4 Wetland Resources

Continued field surveys building off of the work done during 2019 will be conducted during 2020. The 2020 survey will focus on finalizing the initial surveys from 2019 and collecting baseline data in the tailings management site. The field surveys are planned for approximately 1,254.7 additional acres. The surveys will be performed at a wetland delineation level, including data on hydrology, vegetation, soil, dominant species, NPCs, disturbances, biodiversity, etc.

5.5 Archaeological Sites, Historic Properties and Cultural Resources

Continued field surveys building off of the work done during 2019 will be conducted during 2020. The 2020 survey will focus on collecting baseline data in the tailings management site and are planned for approximately 1,268.6 additional acres.

5.6 Noise

No data collection has been proposed for noise in 2020.

5.7 Air Quality

No data collection has been proposed for air quality in 2020.

5.8 Meteorology

Meteorological data will continue to be recorded on site in 2020 with the addition of a pan evaporation station installed in June.

5.9 Mine Material Characterization Program

Kinetic testing of 5 ore and 29 waste rock samples started in June and December 2019, respectively and continues in 2020. The kinetic testing evaluates the weathering behavior of mine materials under defined conditions. For samples that do show reactivity, kinetic testing

indicates field-scale leaching over time. The kinetic testing program is comprised of the following tests:

Humidity Cell Testing (HCT)

HCT testing is conducted to evaluate the weathering behavior of a sample over time under exposed conditions. This test involves weekly flushing of a 1-kilogram sample with deionized water. Leachates are filtered and analyzed for dissolved analytes to determine soluble minerals in the weathered samples and to estimate lag times to acid generation. Testing is typically conducted for a minimum 20-week period, but testing may need to be extended for "uncertain" or slow-reacting materials. Early flush results can indicate the presence of acid salts. Later results are indicative of long-term conditions and are used to estimate release rates of sulfates and metals.

Diffusion Testing

Diffusion testing is conducted to evaluate the weathering behavior of a sample over time under submerged conditions. The potential for constituent leaching from a sample by diffusive processes is evaluated by submerging the sample in a container of deionized water for variable periods of time (i.e., hours) and analyzing the resultant leachate for dissolved analytes.

5.10 Soils

No data collection has been proposed for soils in 2020.

6 Future Data Collection

Future data collection is designed to supplement the existing data and to ensure adequate data is available for baseline characterization and impact analysis. TMM anticipates the baseline data collection necessary to inform the EIS will be substantially complete for the proposed Project by the end of 2021. Additionally, future data collection may also include any alternatives to the proposed Project that are identified and included in the EIS.

Future data collection would also include compiling additional complete records of public data currently being collected, as well as incorporating additional public datasets related to the various resources which may include:

- National Oceanic and Atmospheric Administration local and regional climate databases
- National Weather Service and Midwest Climate Center data
- USGS Precipitation and Recharge data
- MDNR LiDAR elevation data
- USGS and MDNR Stream and River Gaging Stations Data

- USGS National Water Information Data

6.1 Surface Water

Planned ongoing sampling, monitoring, and testing activities to supplement surface water baseline data include:

- Water quality sampling;
- Gaging station on Keeley Creek; and
- Additional water level and discharge data.

6.2 Groundwater

Planned ongoing sampling, monitoring, and testing activities to supplement groundwater baseline data include:

- Water level data acquisition; and
- Water quality sampling. This sampling will include sampling of any new wells approved by the USFS and the BLM.

6.3 Terrestrial and Aquatic Resources

Based on the results from the 2019-2020 field work, additional baseline data collection may be planned. This work may include specific terrestrial and aquatic species surveys as determined by habitat investigations.

6.4 Wetland Resources

Additional wetland data collection to support indirect wetland analysis may be planned beyond 2020. This baseline data collection may include:

- Installing nested piezometers;
- Collecting and measuring undisturbed peat thicknesses and subsurface structure;
- Characterizing wetland water quality; and
- Characterizing wetland seasonal water level variability.

6.5 Archaeological Sites, Historic Properties and Cultural Resources

No ongoing baseline collection work is planned beyond 2020.

6.6 Noise

No ongoing baseline collection work is planned beyond 2020.

6.7 Air Quality

No ongoing baseline collection work is planned beyond 2020.

6.8 Meteorology

Meteorological and pan evaporation data will continue to be recorded on site.

6.9 Mine Material Characterization Program

Results from current kinetic testing and coordination with the MDNR will identify any ongoing or future baseline collection necessary.

6.10 Soils

No ongoing baseline collection work is planned beyond 2020.

Attachments

Table 1 Public Data Loggers

	Discharge Measurements	Logger Locations	Time Frame
USGS / MDNR Surface Water Data Loggers	280,753	18	1942-1964; 1974-1985; 2003-current
MDNR Loggers	107,518	4	2018

Notes:
Combination of daily and hourly measurements.15-minute Stage Measurements + 31,105 15-minute precipitation measurements.
MDNR = Minnesota Department of Natural Resources; USGS = United States Geological Survey

Table 2 Public Water Levels

	Total Daily Flow Measurements	Daily Level Measurements
Lake Elevation Data	7,269	14,538

Notes:
Daily Values since 2000.

Table 3 Water Quality Data

	Samples	Sampling Locations	Sampling Events	Sampling Parameters	Time Frame of Sampling	QC Samples
Project-specific Surface Water Quality	126,580	62	45	72	2007 - current	16,115 (EB, FB, FD, TB)
Public Water Quality	8163	27	13	60	1976-1977, 2012, 2014-2018	90 (FD)
Public Bedrock / Soil / Sediment Data	6,345	81	6	48	2013 - 2015	325 (FD)

Notes:
EB = Equipment Blank ;FB = Field Blank; FD = Field Duplicate; MB = Method Blank; TB = Trip Blank

Table 4 Surface Water / Groundwater Parameters Measured

	Surface Water Sampling	Groundwater Sampling
Total Parameters	70	55
Parameters	Alkalinity, Total as CaCO3; Alkalinity,Bicarbonate (CaCO3); Aluminum; Antimony; Arsenic; Bacteria, E. coli; Barium; Beryllium; Biochemical Oxygen Demand (5-day); Boron; Cadmium; Calcium; Carbon, dissolved organic; Carbon, total organic; Chemical Oxygen Demand; Chloride; Chlorophyll a, not pheophytin-adjusted; Chlorophyll a, pheophytin-adjusted; Chromium; Cobalt; Color; Copper; Cyanide; Dissolved oxygen; Fibers, total ambiguous; Fibers, total amphibole; Fibers, total chrysotile; Fibers, total non-amphibole, non-chrysotile; Fluoride; Hardness, as CaCO3; Ice depth; Iron; Lead; Lithium; Magnesium; Manganese; Mercury; Methyl mercury; Molybdenum; Nickel; Nitrogen, ammonia, as N; Nitrogen, NO3 + NO2; Nitrogen, total kjeldahl (TKN); Nitrogen, total organic, as N; Oil and Grease; Palladium; pH; Phosphorus as P; Platinum; Potassium; Redox (oxidation potential); Salinity; Secchi disc; Selenium; Silver; Sodium; Solids, total dissolved; Solids, total suspended; Specific Conductance; Strontium; Sulfate, as SO4; Sulfide, as S^{2-}; Temperature; Thallium; Tin; Titanium; Total fibers; Turbidity; Vanadium; Zinc	Alkalinity, Total as CaCO3; Alkalinity, Bicarbonate (CaCO3); Alkalinity,Carbonate (CaCO3); Aluminum; Antimony; Arsenic; Barium; Beryllium; Boron; Bromide; Cadmium; Calcium; Carbon, dissolved organic; Chloride; Chromium; Cobalt; Copper; Dissolved oxygen; Fluoride; Hardness, as CaCO3; Iron; Iron, Ferrous; Lead; Lithium; Magnesium; Manganese; Mercury; Methane; Molybdenum; Nickel; Nitrogen, ammonia, as N; Nitrogen, NO3 + NO2; Orthophosphate, as P; Palladium; pH; Phosphorus, as P; Platinum; Potassium; Redox Potential; Selenium; Silicon, as Si; Silver; Sodium; Solids, total dissolved; Solids, total suspended; Specific Conductance; Strontium; Sulfate, as SO4; Sulfide, as S^{2-}; Temperature; Thallium; Titanium; Turbidity; Uranium-238; Zinc

Table 5 Wild Rice Data

	Samples	Sampling Locations	Sampling Events	Sampling Parameters
Project-specific Wild Rice	1,346	353	11	7

Notes:
FD = Field Duplicate
MB = Method Blank

Table 6 Summary of Monitor Wells and Piezometers

Year	Q1 Piezometer	Q2 Monitor Wells	B1 Monitor Wells	B2 Monitor Wells	B4 Monitor Wells	Vibrating Wire Piezometer	TOTAL
2014	18	3	0	0	0	0	21
2015	0	0	0	0	0	2	2
2016	3	0	2	2	0	0	7
2017	0	0	2	2	0	0	4
2018	0	4	7	7	4	0	22
2019	9	7	10	10	2	0	38
TOTAL	30	14	21	21	6	2	94

Table 7 Summary of Monitor Well Hydraulic Conductivity Testing

Year	Monitor Wells Slug Tested	Monitor Wells Pump Tested	TOTAL
2017	7	1	8
2018	21	19	40
2019	42	42	84
TOTAL	70	62	132

Table 8 Groundwater Water Level Data

	Water Level Elevations	Sampling Locations
Project-specific Water Level	5,890	115
Project-specific Wetland Water Level	1,176	

Table 9 Groundwater Water Quality Data

	Samples	Sampling Locations	Sampling Events	Sampling Parameters	Time Frame of Sampling	QC Samples
Project-specific Groundwater Quality	22,170	66	8	55	2018Q2 - current	2036 QC samples (EB, FBLL, FD, TB)
Public Water Quality	216	12	1	18	2012	

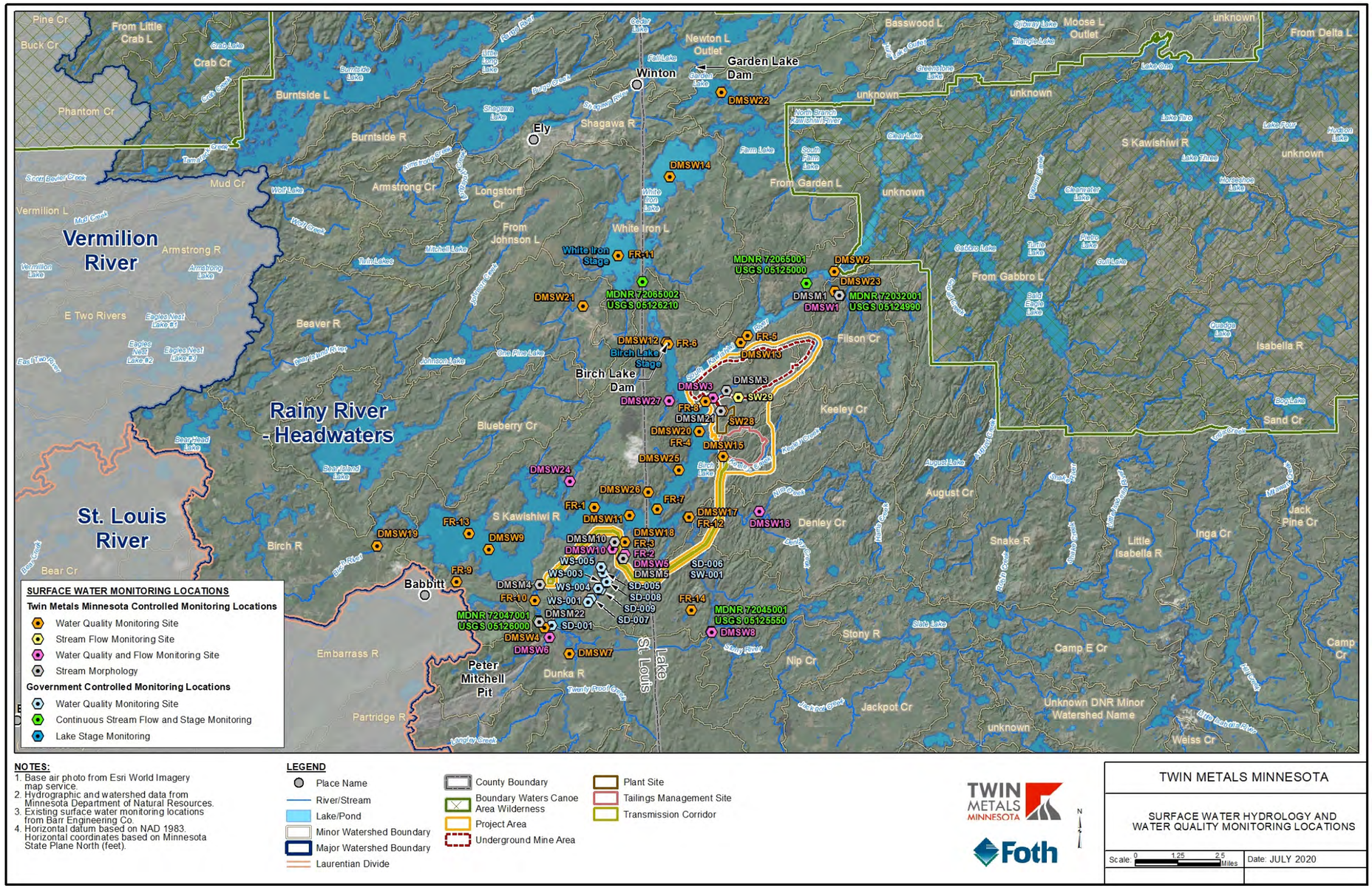
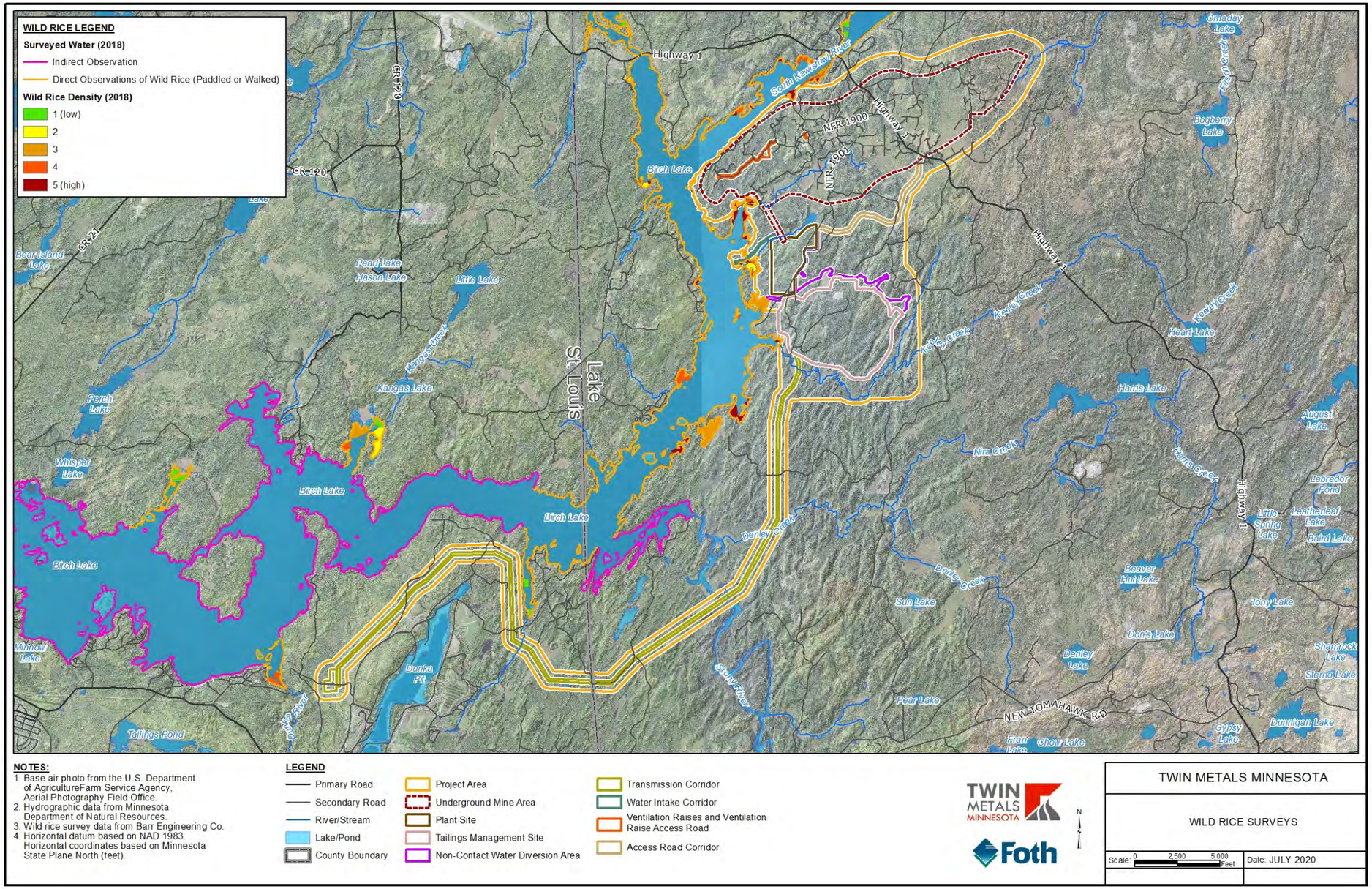


Fig 1 Surface Water Hydrology and Water Quality Monitoring Locations



NOTES:
1. Base air photo from the U.S. Department of AgricultureFarm Service Agency, Aerial Photography Field Office.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Wild rice survey data from Barr Engineering Co.
4. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

TWIN METALS MINNESOTA

WILD RICE SURVEYS

Scale: 0 2,500 5,000 Feet

Date: JULY 2020

Fig 2 Wild Rice Surveys

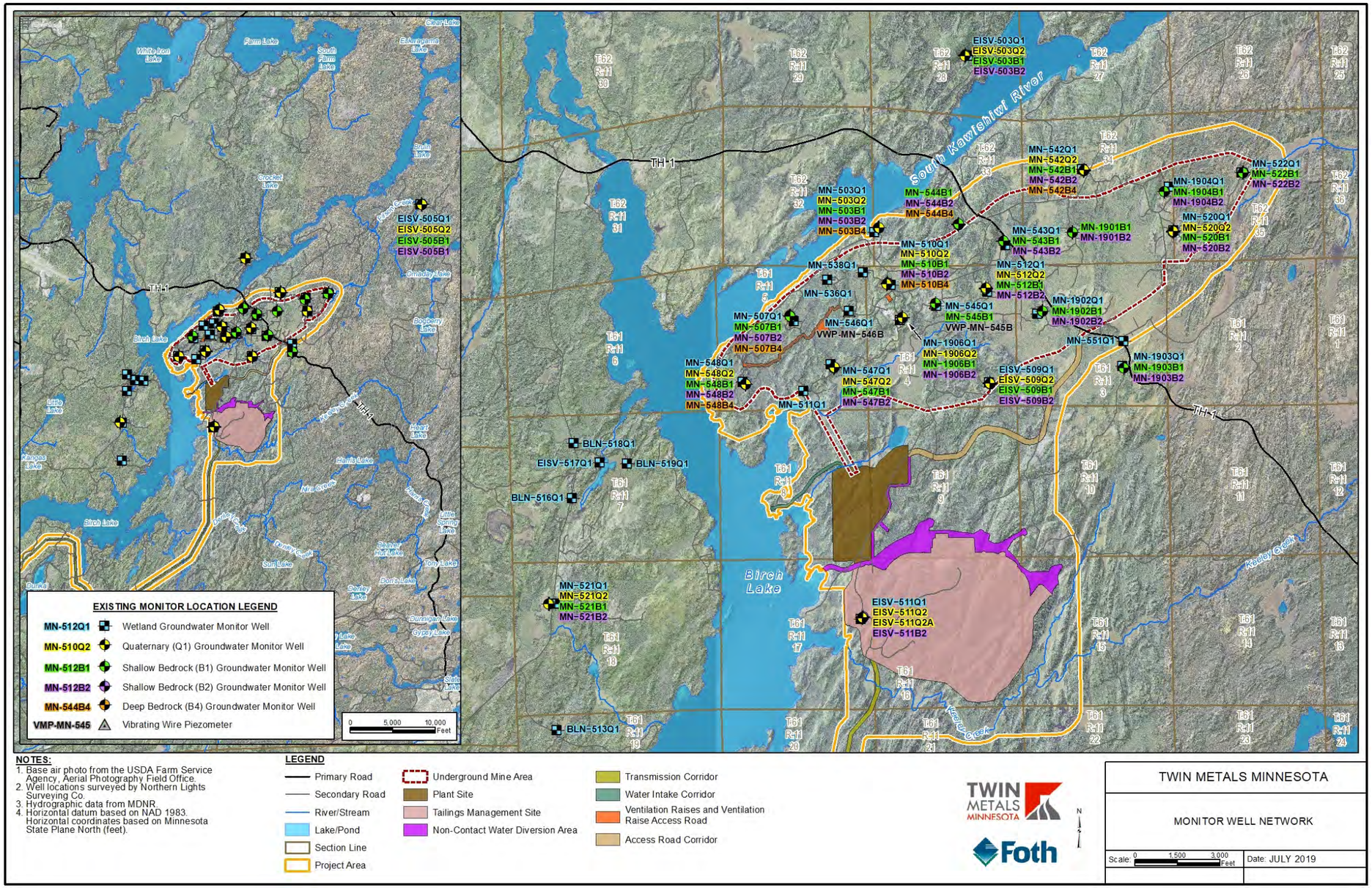


Fig 3 Monitor Well Network

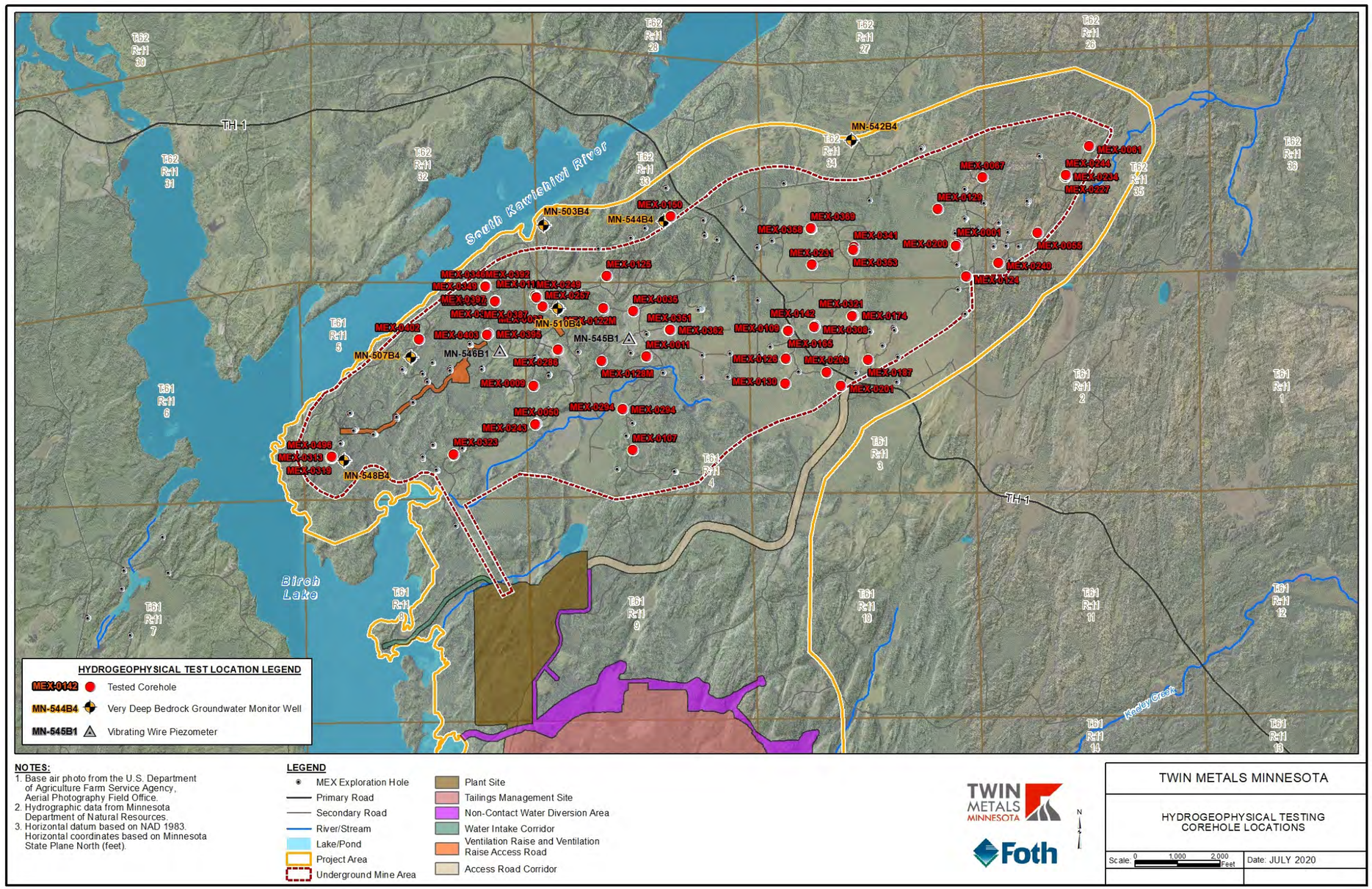


Fig 4 Hydrogeophysical Testing Corehole Locations

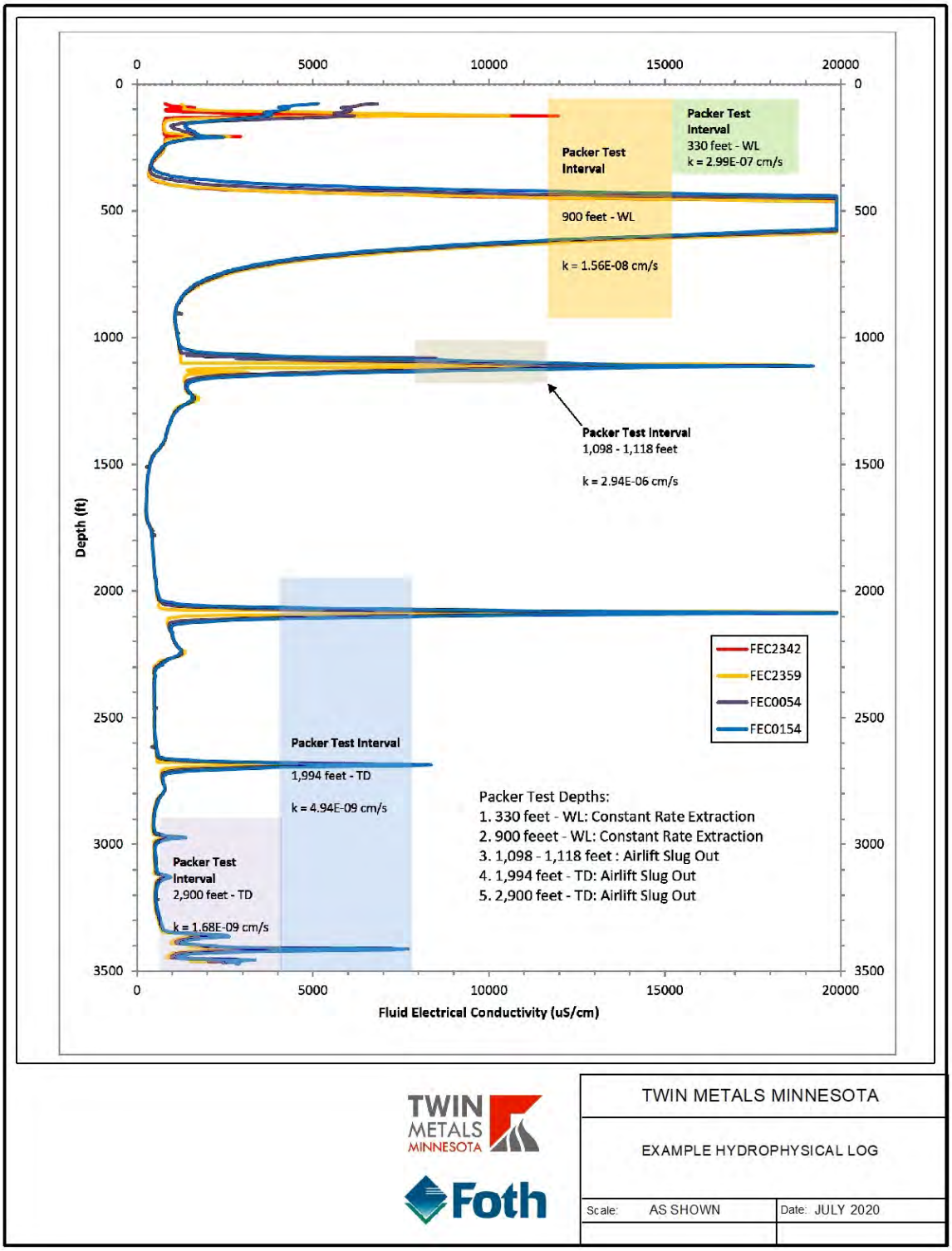


Fig 5 Example Hydrophysical Log

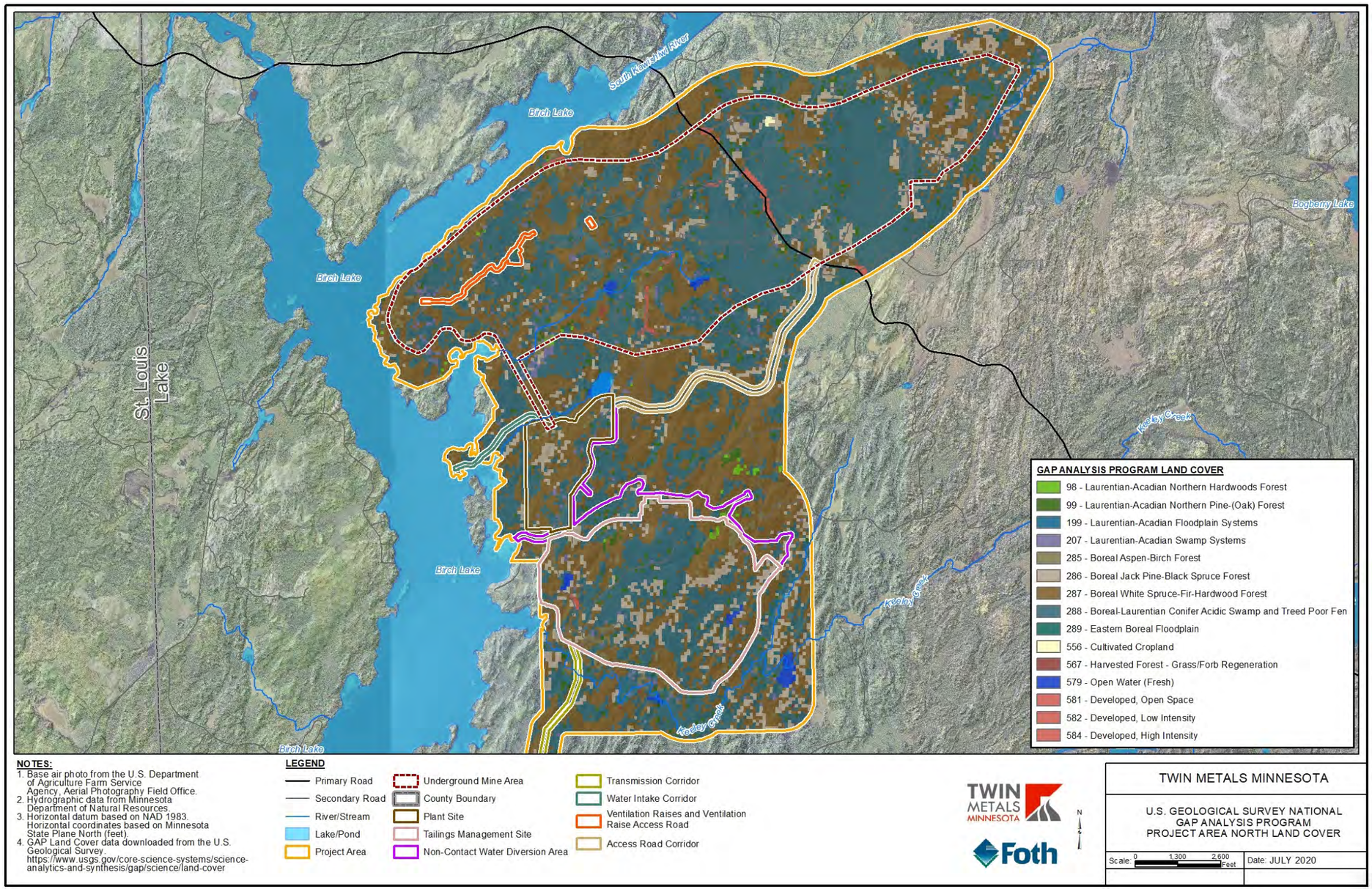


Fig 6 U.S. Geological Survey National Gap Analysis Program Project Area North Land Cover

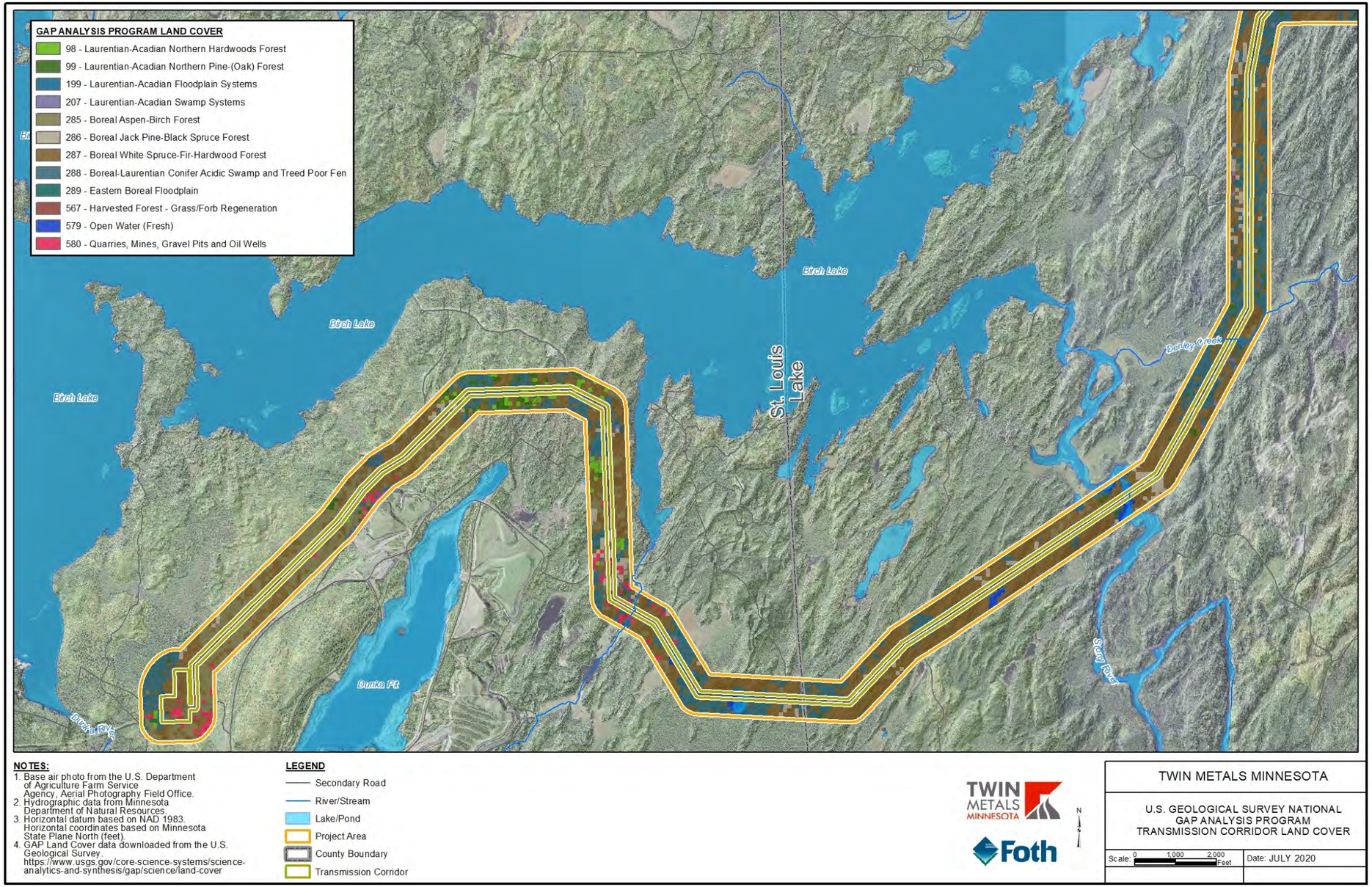


Fig 7 U.S. Geological Survey National Gap Analysis Program Transmission Corridor Land Cover

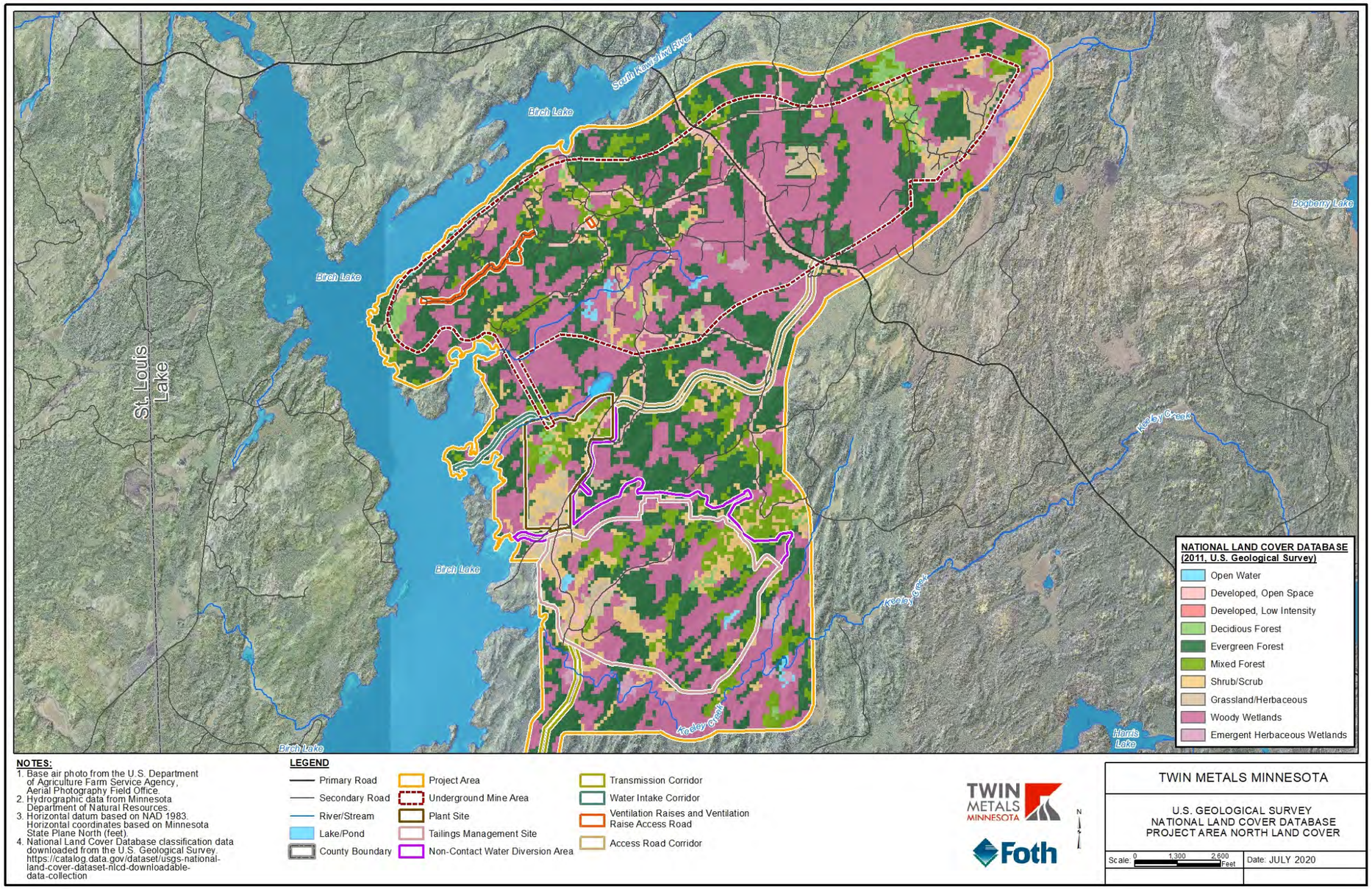


Fig 8 U.S. Geological Survey National Land Cover Database Project Area North Land Cover

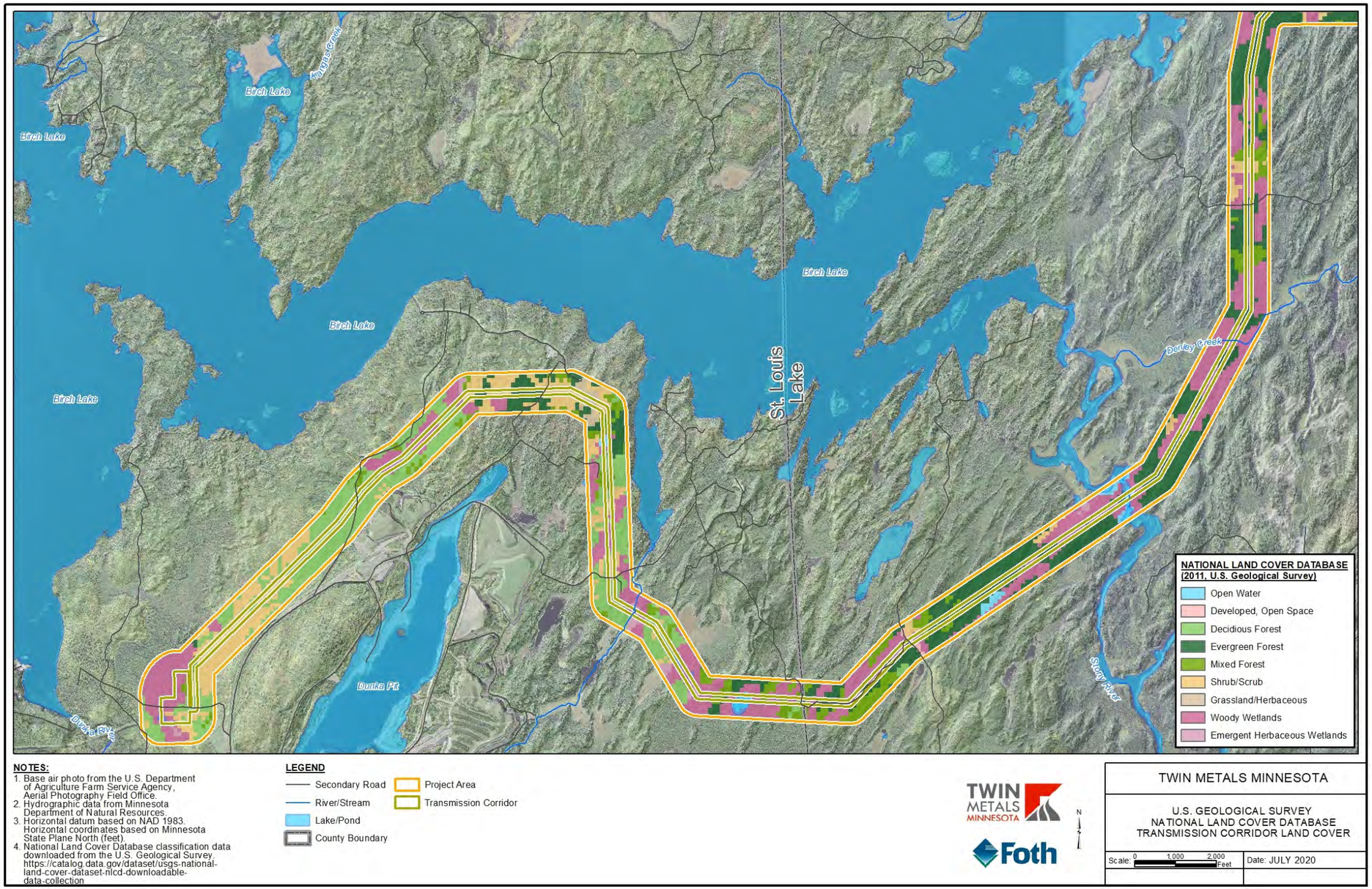


Fig 9 U.S. Geological Survey National Land Cover Database Transmission Corridor Land Cover

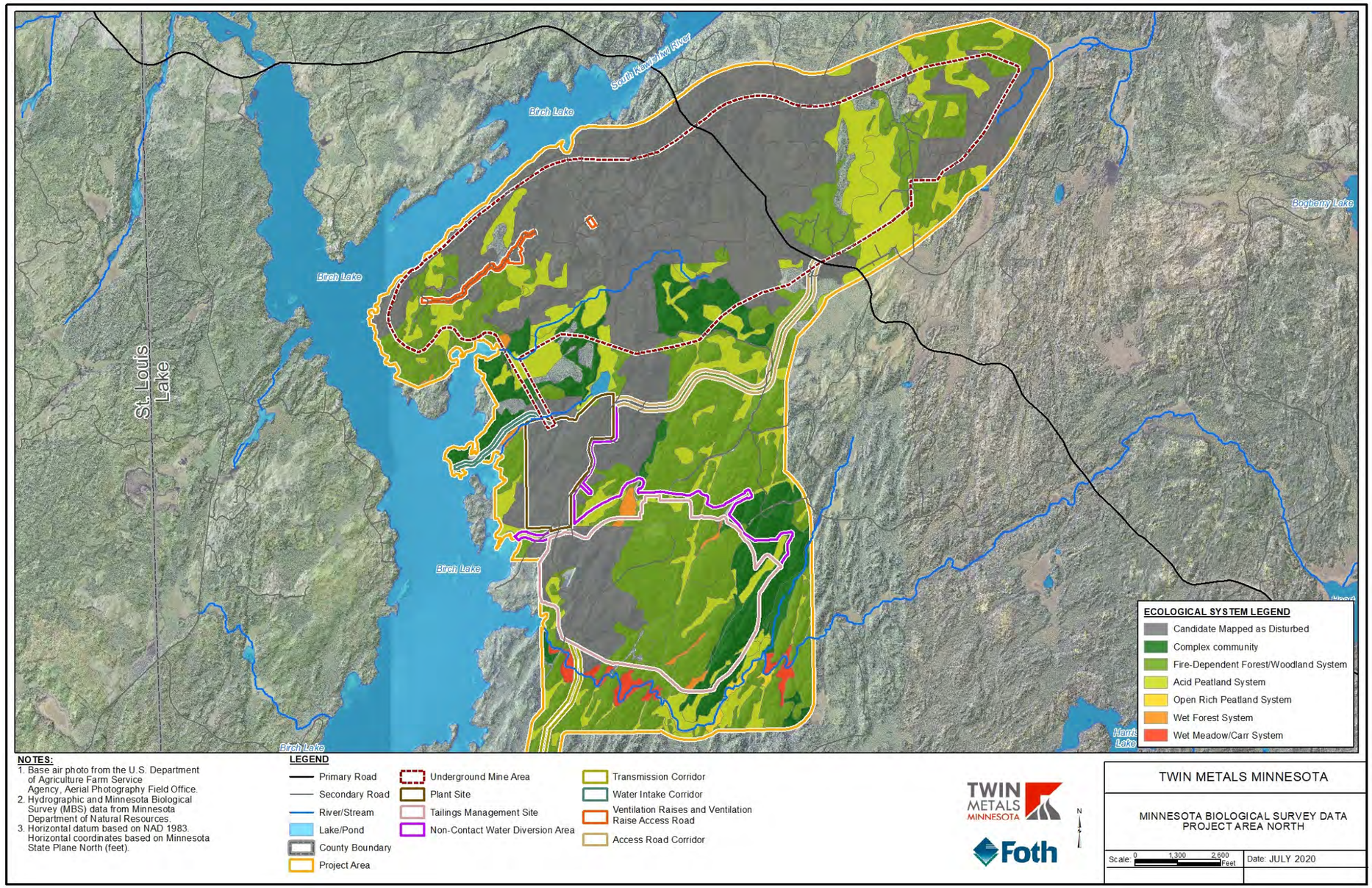


Fig 10 Minnesota Biological Survey Data Project Area North

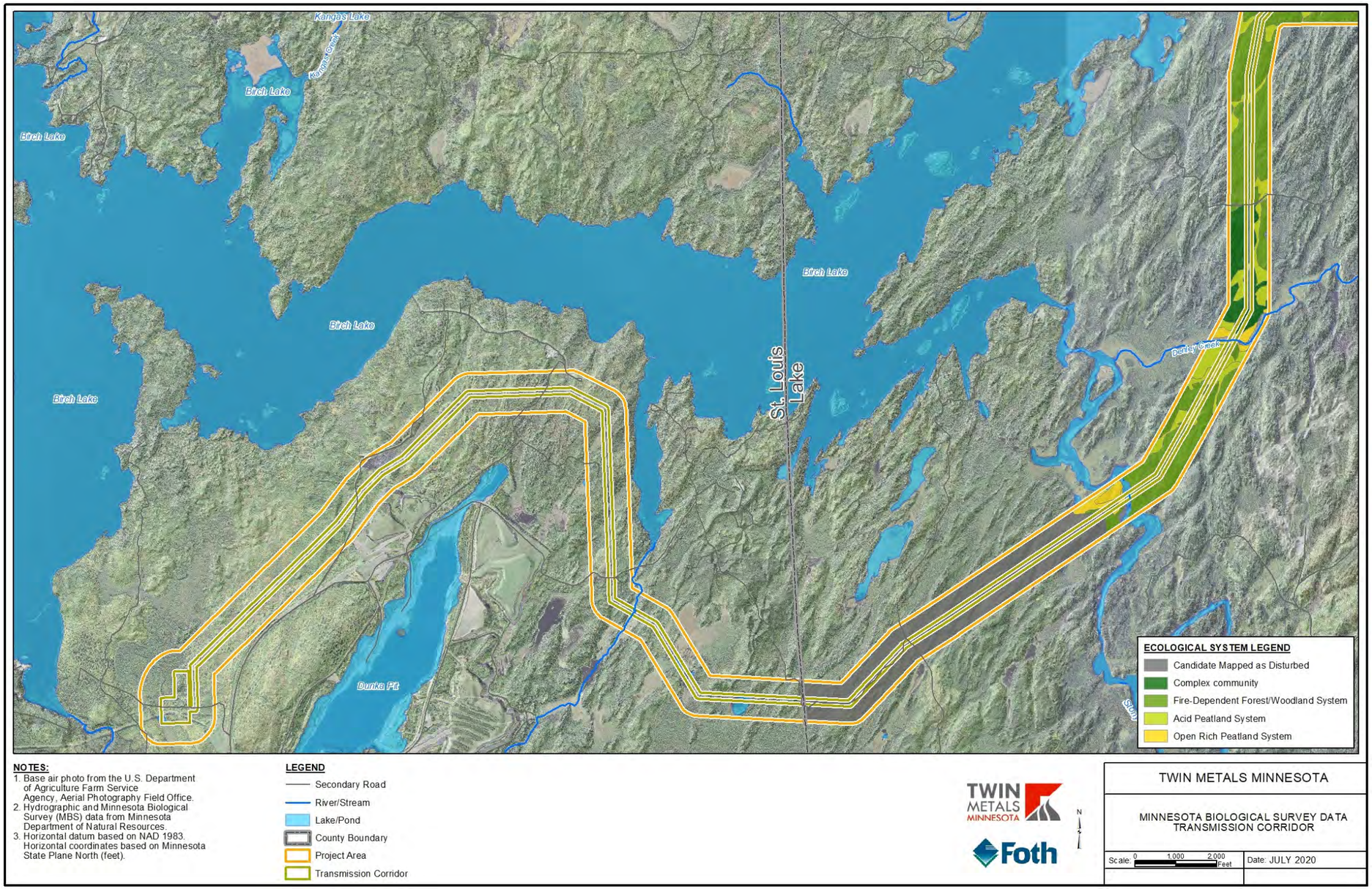


Fig 11 Minnesota Biological Survey Data Transmission Corridor

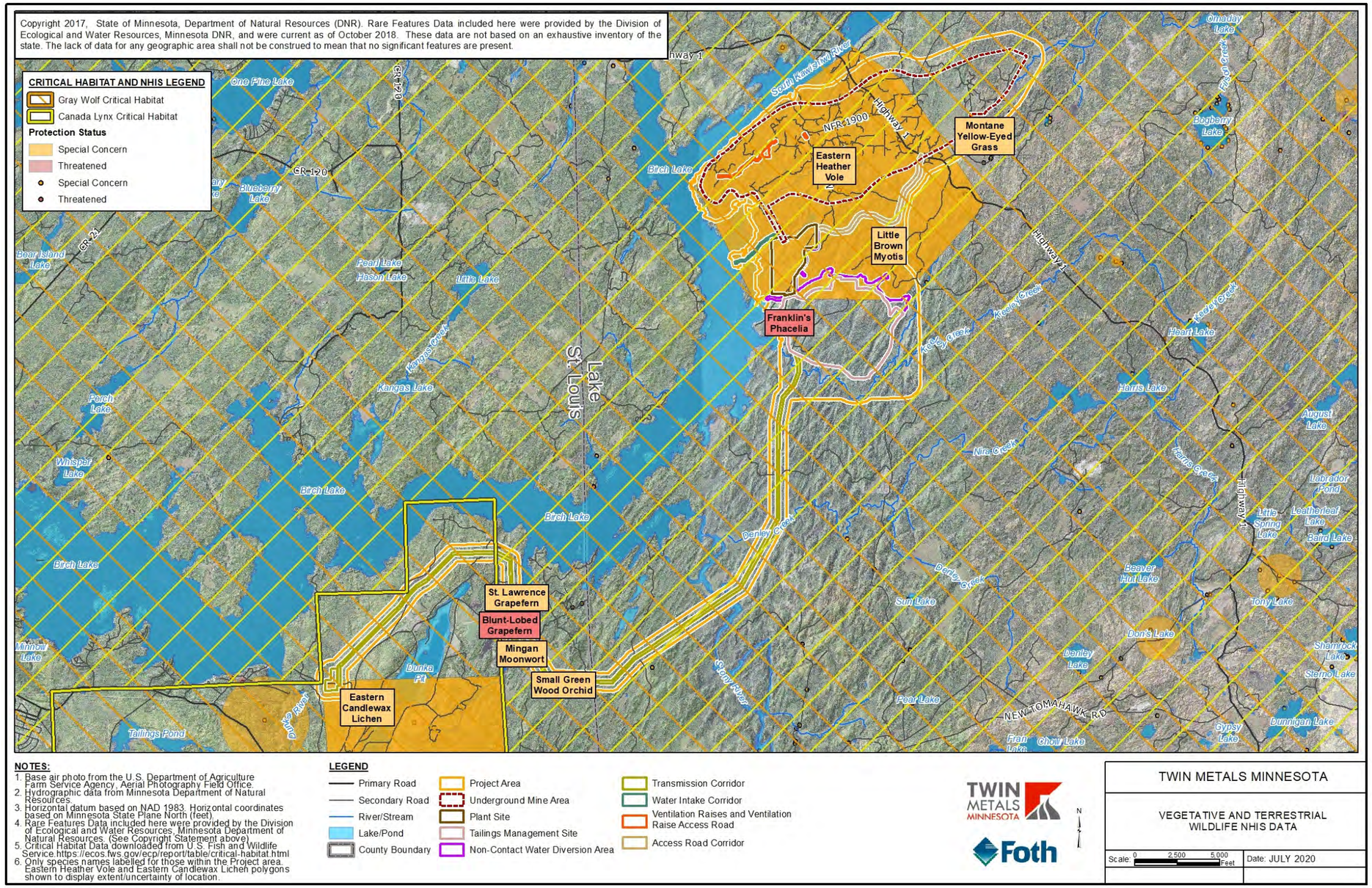


Fig 12 Vegetative and Terrestrial Wildlife NHIS Data

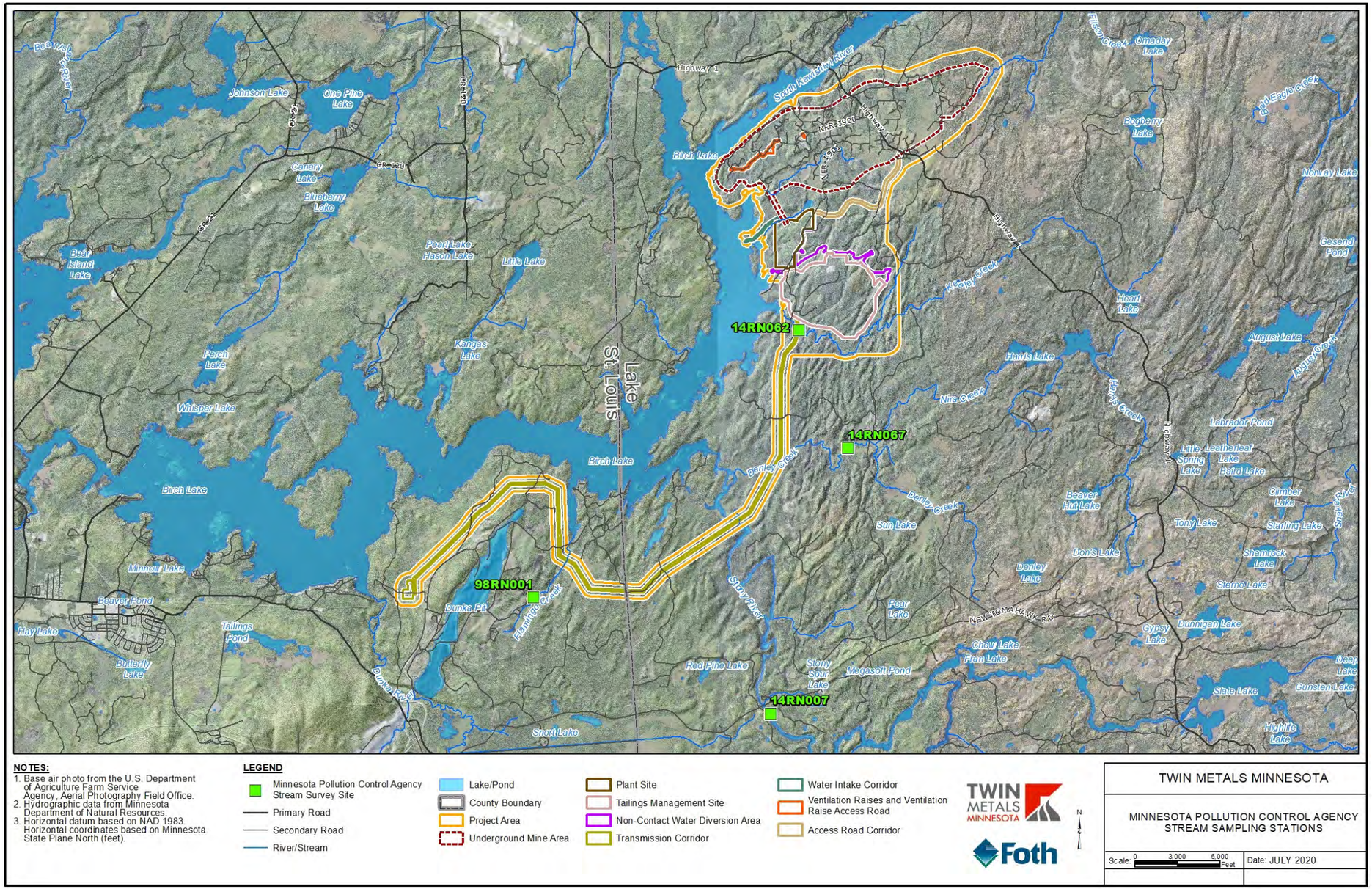


Fig 13 Minnesota Pollution Control Agency Stream Sampling Stations

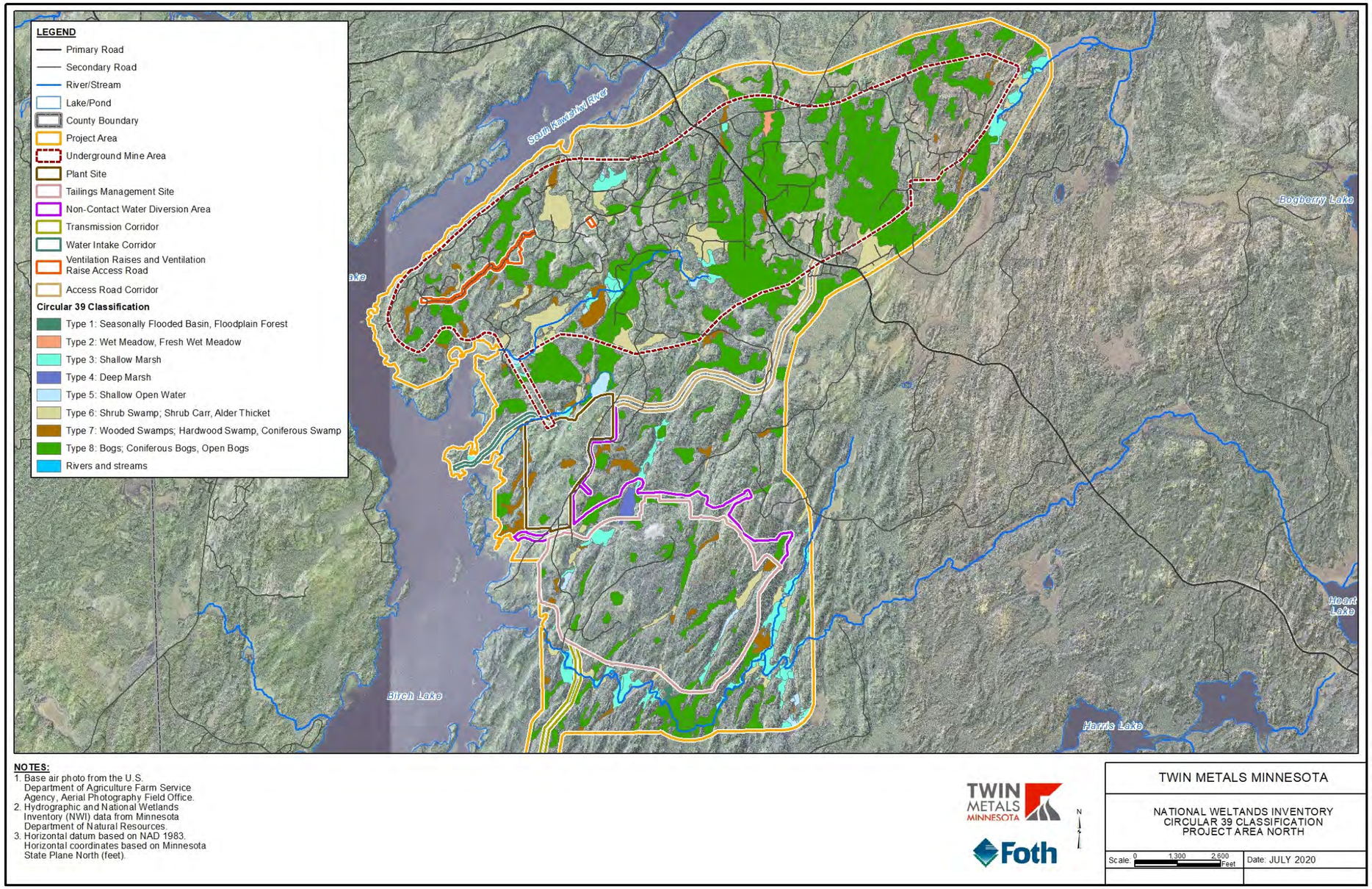


Fig 14 National Wetlands Inventory Circular 39 Classification Project Area North

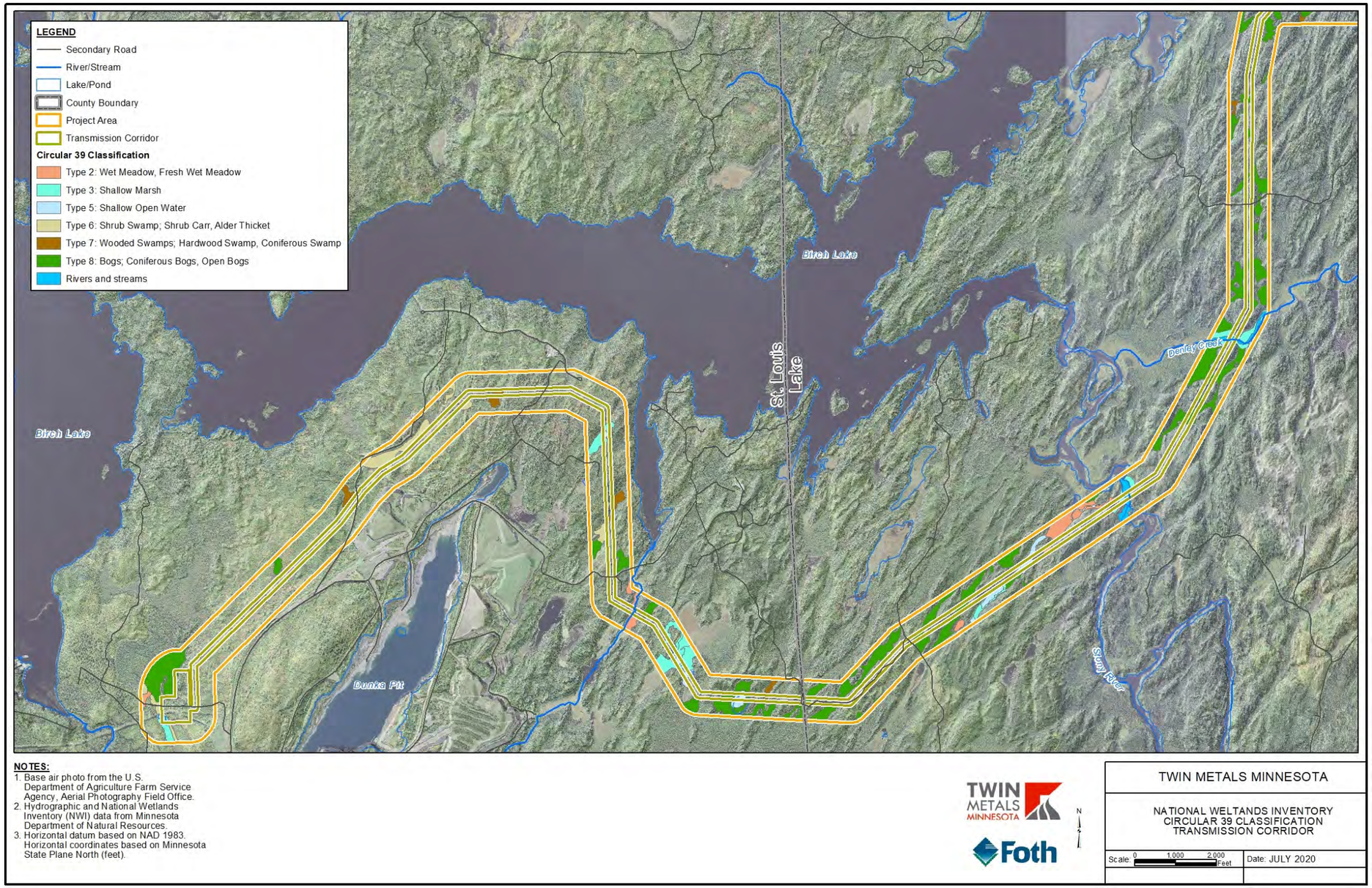


Fig 15 National Wetlands Inventory Circular 39 Classification Transmission Corridor

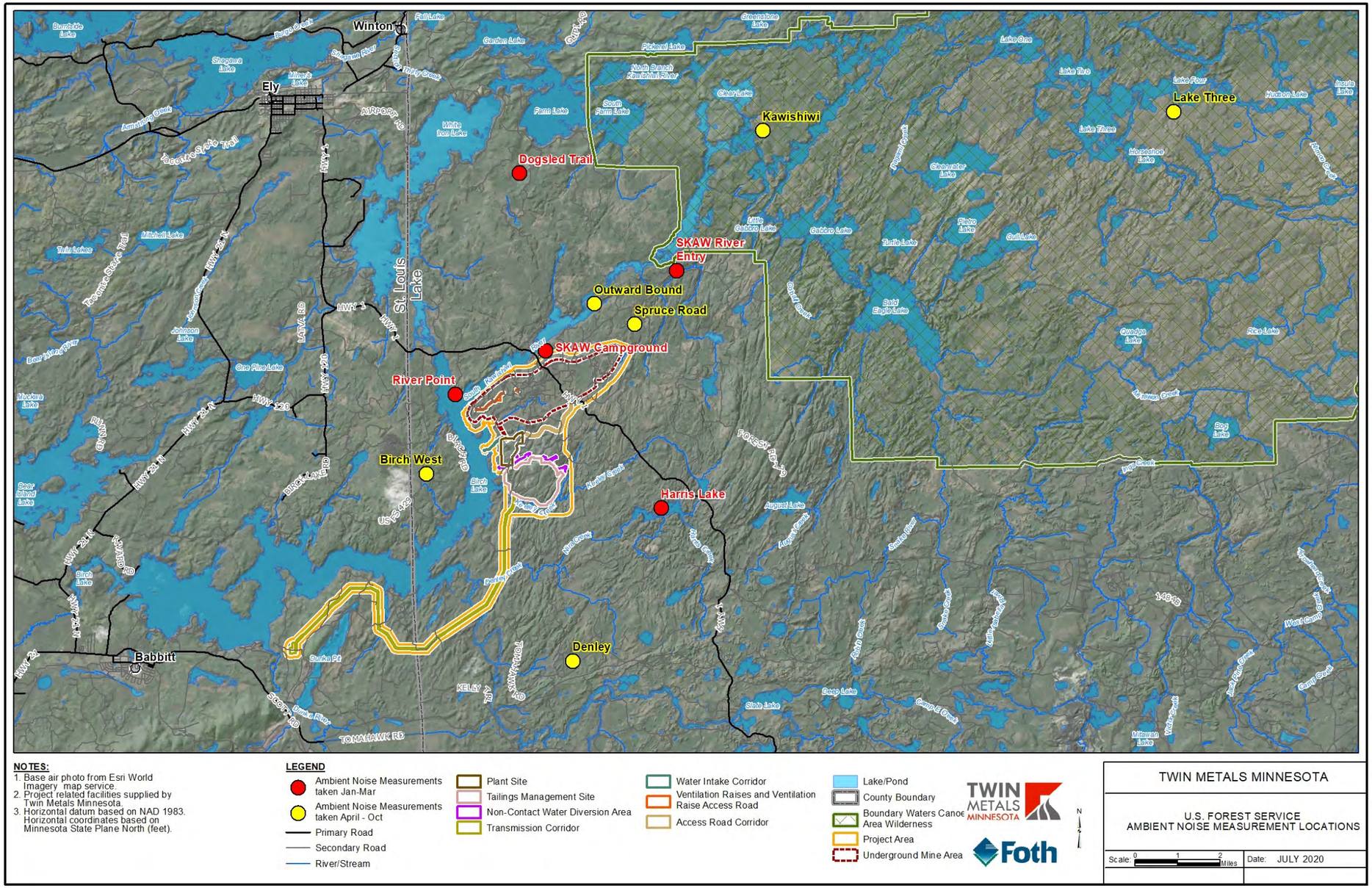


Fig 16 U.S. Forest Service Ambient Noise Measurement Locations

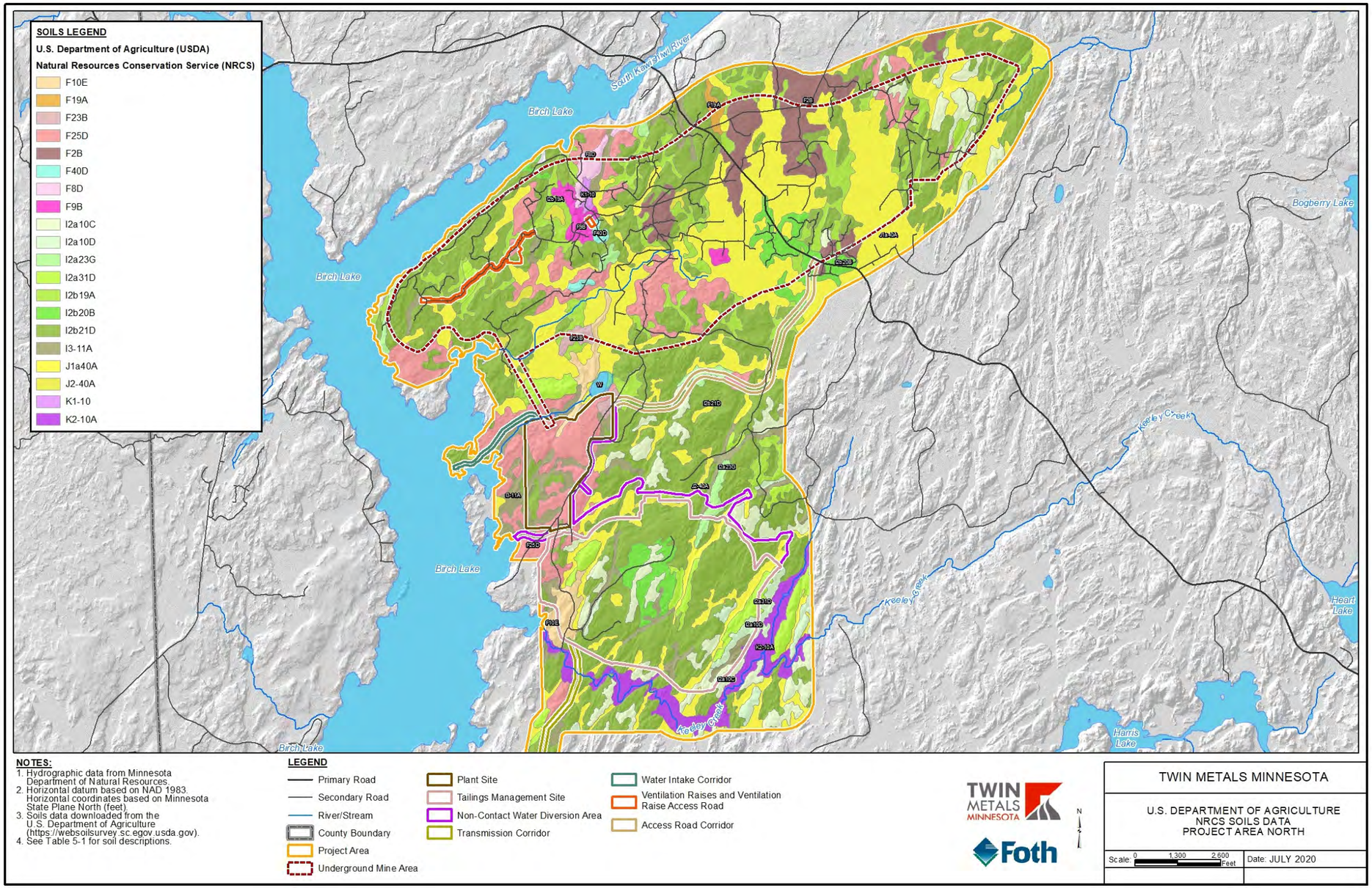


Fig 17 U.S. Department of Agriculture NRCS Soil Data Project Area North

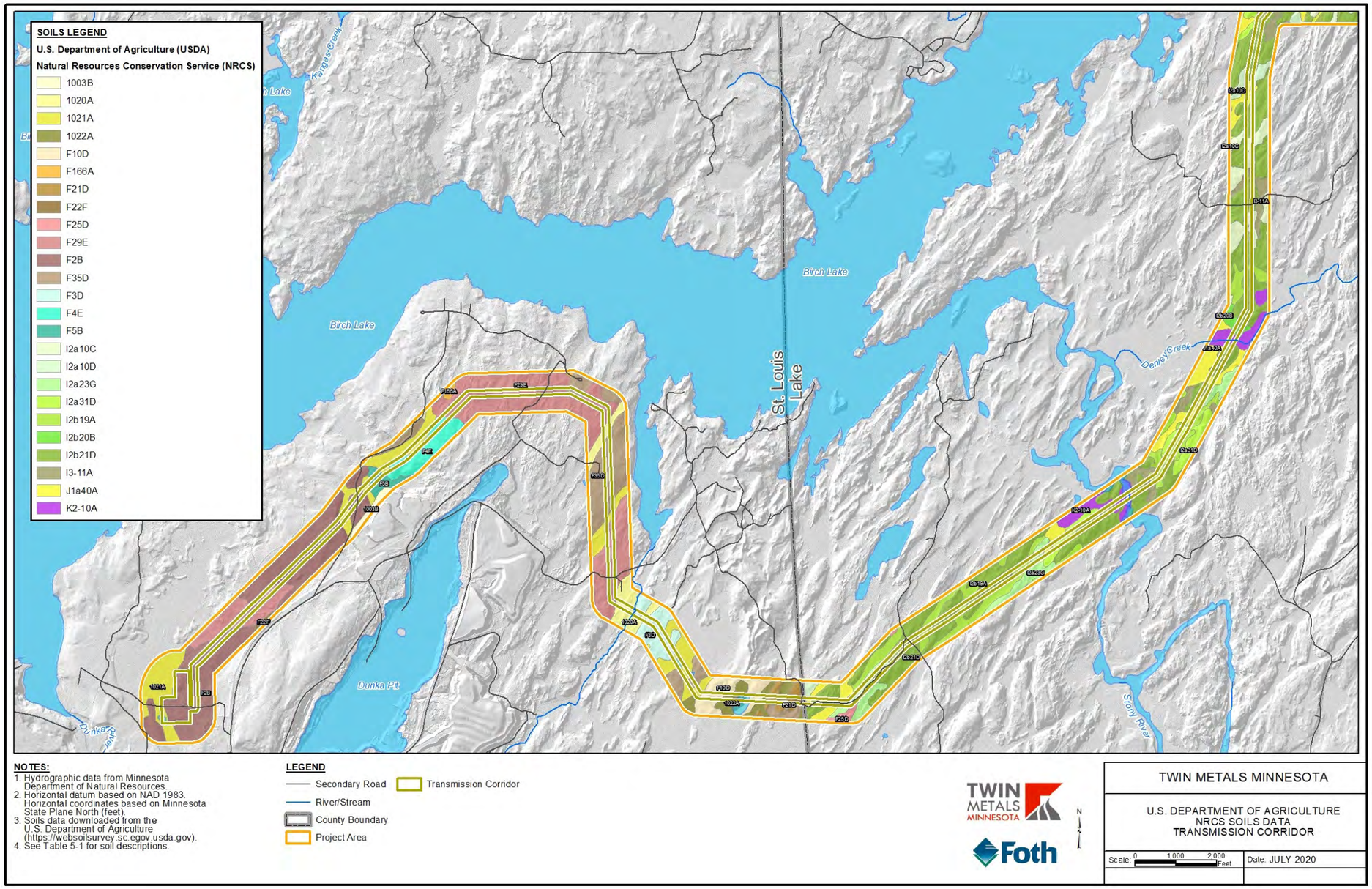


Fig 18 U.S. Department of Agriculture NRCS Soils Data Transmission Corridor

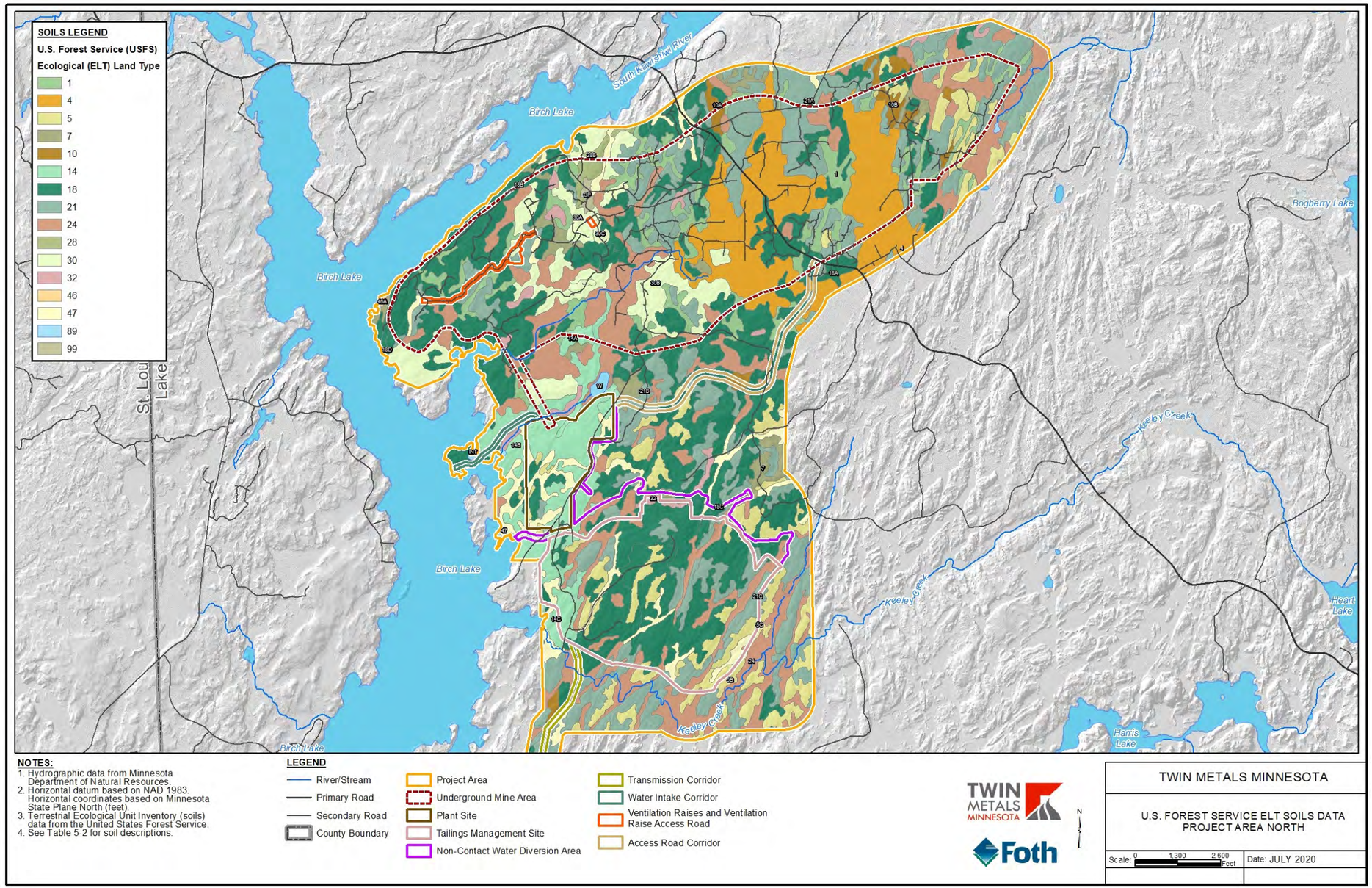


Fig 19 U.S. Forest Service ELT Soils Data Project Area North

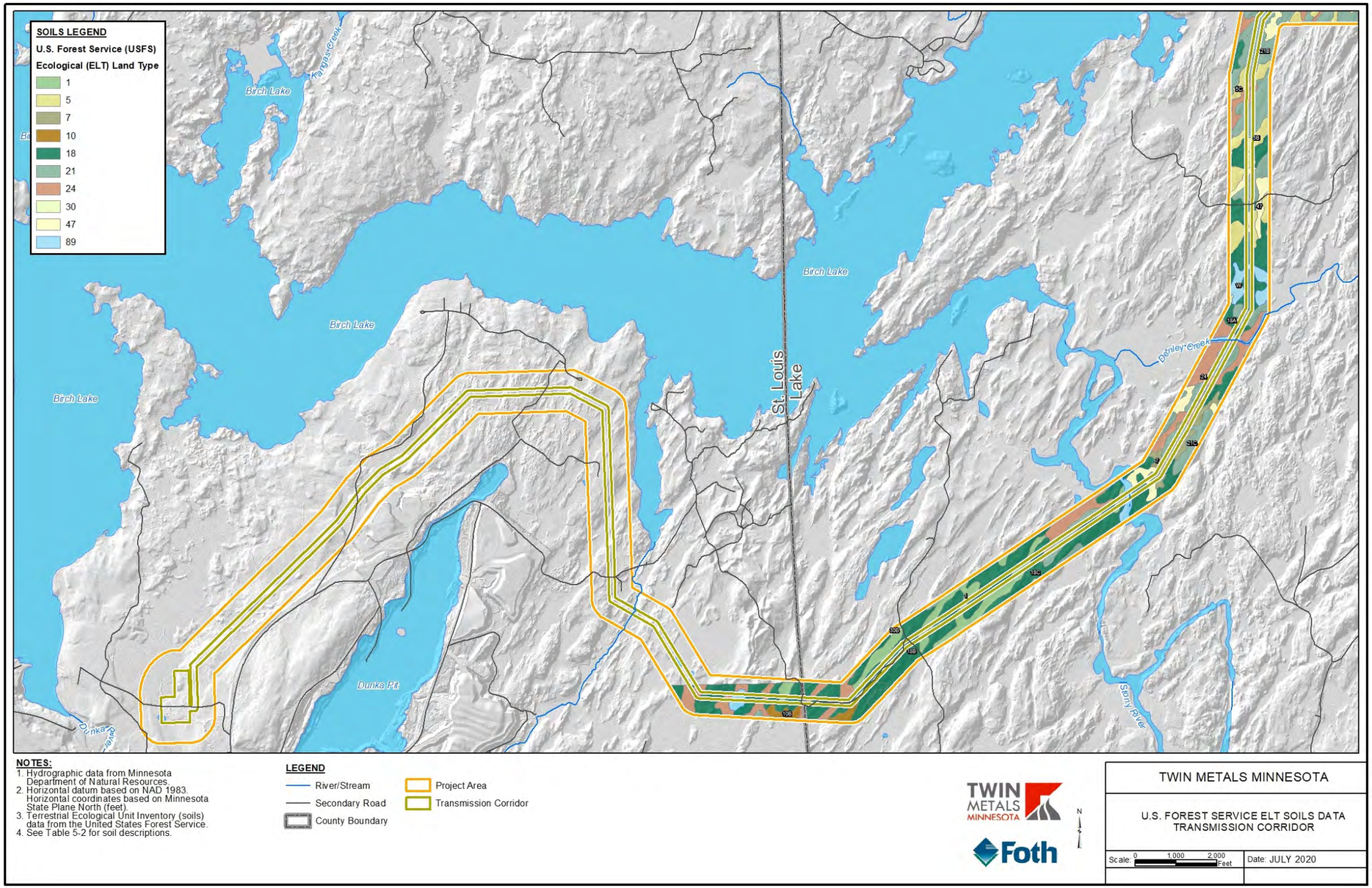


Fig 20 U.S. Forest Service ELT Soils Data Transmission Corridor