DEPARTMENT OF NATURAL RESOURCES

Cold Spring Groundwater Study

Existing Data Summary Report
06/30/2017

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Executive Summary

The Minnesota Department of Natural Resources (DNR) was directed by the Minnesota State Legislature (Minnesota State Legislature, 2016) to "*conduct necessary monitoring of stream flow and water levels and develop a groundwater model to determine the amount of water that can be sustainably pumped in the area of Cold Spring Creek for area businesses, agriculture, and city needs*." The first two steps in creating a working model are compiling a data summary and creating a representation of the groundwater flow system. These steps allow us to identify major data gaps for the creation of a numerical model. An interim numerical model will be created to help guide field collection and provide information to stakeholders. After three years of data collection, a refined numerical model will be created. That model will be used to inform the understanding of the connection between Cold Spring Creek and nearby pumping.

Data Summary

The Cold Spring Creek area (Figure 1) has been studied since 1980; see Appendix A for a full study area timeline. This long history provides data from multiple sources to help support the creation of a numerical model. Existing data on the hydrogeology and hydraulic properties of the groundwater system were compiled from a variety of sources including but not limited to the following:

- Minnesota Department of Health (MDH) Minnesota Well Index (MWI)
- DNR observation wells
- DNR lake level data
- DNR Fisheries discharge data
- Minnesota Pollution Control Agency (MPCA) stream monitoring data
- United States Geological Survey (USGS) monitoring wells
- USGS data from previous studies including groundwater and surface water data (Lindgren, 2001)
- Minnesota Department of Transportation (MDOT) boring logs
- DNR/MDH aquifer test database (currently in progress)
- Correspondence with staff from MDH/DNR/USGS
- Midwestern Regional Climate Center (MRCC) climate data
- Multi-Resolution Land Characteristics Consortium (MRLC) land cover dataset
- Natural Resources Conservation Service (NRCS) soil maps and characteristics

A full description of the existing data within the Cold Spring area can be found in Appendix B. Identified data gaps for the construction of a refined numerical model include the following:

- Cold Spring Creek streambed conductance
- Spring locations
- Potentiometric surface at study area scale
- Vertical hydraulic conductivity of till

- Daily pumping information from City and Cold Spring Brewing Company (CSBC) wells

Additional data gaps will be identified through sensitivity and/or data-worth analysis and will be completed on the interim numerical model.

The interim numerical model is being built on an expedited timeline, therefore it will only approximate the effects on stream baseflow of pumping from CSBC and City wells. However, the results will be sufficient to provide CSBC and the City with an approximation of how much water may be pumped at existing wells near the stream, as well as existing and potential future wells farther from the stream. The refined groundwater model will be designed to calculate the effect on stream baseflow more precisely for CSBC, City wells, and other groundwater appropriators.

Representation of the Groundwater Flow System

First, a study area is determined, usually a rectangular shape with boundaries on groundwater divides. The previously developed USGS had water entering from the northern boundary that contributed to the City, CSBC, and Gold 'N Plump wells. The study area was increased proportionally for this project to ensure that water contributing to these wells originates from within the study area.

A representation of the groundwater system is developed from the compiled data. This representation is used as the basis for the development of a numerical flow model (Figure 24).

Water falls on the landscape as rain or snow and either runs across the landscape as run-off or enters the aquifer system as *recharge*. Groundwater moves through the aquifer and can be removed actively by discharge from pumping or naturally at low points in the landscape such as streams, lakes, and wetlands. When a well is pumped, it lowers the water table in the surrounding area, creating a *cone of depression*. This can capture and remove water that would normally flow to the natural discharge point.

Groundwater near the land surface can be removed from the aquifer system through plant uptake for growth, *evaporation* or *transpiration* (evaporation of water from plant leaves).

Groundwater moves through the leaky till to the sand and gravel lenses within the till. It can then either be removed by pumping, evaporation, transpiration, or continue to flow slowly through the till until it reaches a discharge point or a deeper aquifer.

1.0 Introduction

Groundwater use in and around Cold Spring, Minnesota impacts Cold Spring Creek, as shown through multiple field investigations and models: Minnesota Department of Natural Resources (DNR), Minnesota Department of Health (MDH) and United States Geological Survey (USGS). The glacial aquifer system, which is strongly connected to Cold Spring Creek, supplies the City of Cold Spring (the City), Cold Spring Brewing Company (CSBC), and numerous private and irrigation wells. Cold Spring Creek is a designated trout stream protected by Minnesota Statute 103G.285. The *Report to the Minnesota State Legislature: definitions and thresholds for negative impacts to surface waters* (DNR, 2016) defines negative impacts to surface waters, including trout streams.

The DNR was directed by the Minnesota State Legislature (Minnesota State Legislature, 2016) to "*conduct necessary monitoring of stream flow and water levels and develop a groundwater model to determine the amount of water that can be sustainably pumped in the area of Cold Spring Creek for area businesses, agriculture, and city needs*."

The first two steps in creating a numerical model are compiling a data summary and creating a representation of groundwater flow. These help identify major data gaps for the creation of the ultimate goal, the refined *numerical model,* which will quantify the total impact to Cold Spring Creek from all groundwater pumping within the numerical model's extent. The refined numerical model will be finalized after three years of monitoring and analysis to fill the data gaps.

1.1 Background

There are many competing water needs in and around Cold Spring Creek including, but not limited to the following:

- Municipal Supply
- Commercial
- Industrial
- Agricultural
- Ecological

An interim numerical model is under development to help quantify these competing needs and determine the interaction between wells in the area and Cold Spring Creek. The first steps to creating a numerical model are to evaluate existing data, determine existing data gaps, and develop a representation of the groundwater flow system.

Because the interim groundwater model is being built on an expedited timeline, the interim model will only be intended to approximate the effects of pumping on stream baseflow from CSBC and City wells. The interim numerical model will be run in steady-state (rather than transient) and will be used to guide field-data collection in order to reduce uncertainty in the refined numerical model. We expect the results of the interim numerical model to be slightly different from and less precise than the refined model. However, the results of will be sufficient to provide CSBC and the City with an approximation of how much water may be pumped at existing wells near the stream, as well as existing and future wells farther from the stream. The refined model will be designed to calculate the effect on stream baseflow more precisely for CSBC and City wells as well as other groundwater appropriators.

1.1.1 Site Description

The study area covers about 47 square miles (mi^2) in southeastern Stearns County in central Minnesota (Figure 1). The city of Cold Spring is located near the study area. The topography is rolling in the upland area, steep around streams, and generally flat along the Sauk River valley. Steep bluffs dip down to the Sauk River valley about one mile northeast of the downtown area of Cold Spring and along the southeast side of the Sauk River.

The study area is drained by the Sauk and the South Fork of the Watab rivers. The Sauk River, which drains most of the study area, flows generally east northeast through the study area to the confluence with the Mississippi River about eight miles northeast. The Watab River drains a small portion of the northern part of the study area to its confluence with the Mississippi River about twelve miles northeast.

The average precipitation in the study area is approximately 27.7 inches (Sauk River Watershed District, 2014). Of that, an average of 4.4 to 9.0 inches recharges the surficial aquifers (Smith, 2015) and 4.5 inches leaves the basin as runoff (Donald G. Baker E. L., 1978). In addition, 15 to 20 percent of irrigated water returns to the surficial aquifer as recharge. The rest leaves the basin as evapotranspiration (Lindholm, 1980)

1.1.2 Site History

Cold Spring Creek is listed as a trout stream that runs through the city of Cold Spring adjacent to municipal and brewery supply wells. During the summer of 1980, Cold Spring Creek dried up during routine construction dewatering by the City. The DNR recommended monitoring to help identify the groundwater/creek interaction. In 2001 the USGS created a groundwater model primarily to determine the contribution area to high capacity wells in the area and to understand the interaction between the Sauk River valley aquifer, the Sauk River, and Cold Spring Creek. Starting around 2006, City and CSBC needs increased. Temporary appropriations have been granted through the end of 2017 for CSBC and through the end of 2021 for the City due to legislative action while the DNR builds a groundwater model to evaluate different options. A full timeline of the study area history relevant to water appropriation can be found in Appendix A.

2.0 Sources of Information

Existing data on the hydrogeology and hydraulic properties of the groundwater system were compiled from a variety of sources including but not limited to the following:

- MDH Minnesota Well Index (MWI)
- DNR observation wells
- DNR Lake level data
- DNR Fisheries discharge data

- Minnesota Pollution Control Agency (MPCA) Stream Monitoring
- USGS monitoring wells
- USGS data from previous studies including groundwater and surface water data (Lindgren, 2001)
- Minnesota Department of Transportation (MDOT) boring logs
- DNR/MDH aquifer test database
- Correspondence with staff from MDH/DNR/USGS
- Midwestern Regional Climate Center (MRCC) Climate data
- Multi-Resolution Land Characteristics Consortium (MRLC) land cover dataset
- Natural Resources Conservation Service (NRCS) soil maps and characteristics

A discussion of selected data can be found in sections 2.1 through 2.4 below. A full discussion of the existing data which informed the conceptual model can be found in Appendix B. Additional data will be gathered in support of the refined numerical model; that data collection work plan will be described in a separate report.

2.1 Groundwater

There are 10 existing DNR observation wells within the study area (Figure 2), all within the Quaternary aquifer system. Monitoring for these wells start between 1976 and 2016. Some wells have more than 40 years of data, while others have a few months of data. The wells are not generally closely spaced within the study area, and the confidence in the water level data is high.

MWI contains well logs and water levels for most of the identified wells within the study area (Figure 3). However, well logs can vary greatly based on the individual who logs the well and how soon the water levels were measured after drilling. Water levels taken shortly after drilling may not have equalized to the surrounding conditions. The wells are not closely spaced throughout the study area, and the data confidence is low.

Through the development of the previous groundwater model (Lindgren, 2001) the USGS constructed 28 observation wells within the study area (Figure 4) and took water level measurements at 31 domestic wells. The wells are closely spaced in the central part of the study area and the confidence in the data is high.

A total of 18 aquifer tests have been conducted in and around the study area. A total of 7 aquifer tests are shown on Figure 5; these pump tests have at least a 24-hour pumping period. A selection of aquifer tests and computed values can be found in Table 1 below. Information on additional aquifer tests can be found in Appendix B.

The USGS, in cooperation with the MPCA, estimated potential recharge for the state of Minnesota using a one-kilometer grid (Westenbroek, 2015). The potential recharge analysis used the Soil-Water-Balance (SWB) code (S.M. Westenbroek, 2010) to calculate potential recharge. The data is well spread out throughout the study area, but the grid is coarse (Figure 6) and grid cells with many lakes and wetlands have an assumed value of zero for potential recharge.

Table 1: Aquifer Test Values

Aquifer Test	Unique Well Number	Aquifer	Number of Observation Wells	Pumping Test Length (hrs)	Transmissivity (ft^2/day)	Thickness (ft)	Hydraulic Conductivity (ft/day)	Storativity (unitless)
Gold 'N Plump	456037	Surficial Sand	1	24	11,000	40	275	0.28
City of Cold Spring Well #2	241387	Surficial Sand	2	24	22,650	40	567	0.1
City of Cold Spring Well #6	686699	Surficial Sand	2	24	33,700 76,400	101	330 756	-
City of St Joseph	737006	Surficial Sand	3	24	92,000	75	1,228	0.00123
USGS 1978	123015	Drift	4	24	43,994	68	649	0.16
USGS 1977	124212	Drift	5	6	15,998	25.4	630	0.14
City of Chisago Well #5	160147	Drift	1	3	2,764	160	17.28	0.0029

2.2 Surface Water

The DNR Division of Fish and Wildlife collected stage data on Cold Spring Creek from 2002 through 2011, and developed a rating curve to calculate flow. This data can be used to determine baseflow data for the creek. The DNR and MPCA have identified 16 stream monitoring locations within the study area, located on Cold Spring Creek, Kinzer Creek, unnamed tributaries to the Sauk River, and Sauk River (Figure 7).

Streamflow data collected during the creation of the previous USGS model (Figure 8) are used in baseflow calculations; however, the minimal period of record (one year) causes the baseflow calculations to be biased by the weather during the period of record.

The DNR monitors 10 lake levels within the study area (Figure 9). The length of monitoring varies per lake with some having been monitored for 30 to 80 years.

2.3 Other Data

There are two DNR and one Midwestern Regional Climate Center (MRCC) climate stations within the study area (Figure 10). These three stations have a limited period of record of climate data. However, the Collegeville St. John station located less than four miles north of the study area boundary has over 100 years (1892-2017) of daily data (MRCC, 2017).

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) provides high quality soil maps (Figure 11) and soil property data (NRCS, 2017) throughout the study area.

The MRLC provides a National Land Cover Dataset (NLCD) across the United States from 2001, 2006, and 2011 (Figures 12 through 15) (C.G. Homer, 2015) (Fry, 2011) (Homer, 2007). This can show the changes in land use from 2001 through 2011. MRLC provides a NLCD for 1992 (Vogelmann, 2001) and includes a note that the 1992 NLCD is not recommended for direct comparisons with any subsequent NLCD data products.

2.4 Identified Data Gaps

Identified data gaps for the construction of a refined numerical model include the following:

- Cold Spring Creek streambed conductance
- Spring locations
- Potentiometric surface at the study area scale
- Vertical hydraulic conductivity of till
- Daily flow rates from City and CSBC wells

Additional data gaps will be identified through sensitivity and data-worth analysis to be completed on the interim Cold Spring groundwater model.

3.0 Hydrogeologic Setting

3.1 Geologic Deposits

The geology in the study area is largely glacial till and outwash overlying bedrock. Surficial deposits (Figure 16) consist mostly of glacial till and outwash sands and gravels deposited by the Des Moines and Superior lobes (Meyer, 1995). The Sauk River and other hydrologic processes eroded the glacial sediment the Sauk River bedrock valley. This causes a thinning of the glacial sediment within the Sauk River bedrock valley. Highly permeable sand and gravel were deposited over the thin layer of glacial sediment and the sand and gravel and glacial sediment are highly hydraulically connected (Gold N Plump, 1995).

3.1.1 Quaternary

The upland glacial deposits (Figure 17) are mainly till, containing buried outwash. The locations of the buried outwash lenses are complex and not well understood. It is commonly the main source of water where surficial outwash is absent. Outwash sands and gravels from the Des Moines lobe (New Ulm Formation) fill most of the Sauk River valley. The glacial deposits within the valley have been eroded by the Sauk River and alluvium has been deposited (Lindgren, 2001).

3.1.2 Bedrock

Quaternary deposits are underlain by Cretaceous and Precambrian bedrock (Figure 18) throughout the study area. The Precambrian bedrock exists in both weathered and unweathered states, potentially making the unweathered bedrock surface topographically irregular. Precambrian igneous and metamorphic rocks directly underlie the glacial sediment in portions of the study area. These dense rocks generally have low porosity and permeability but low yields can be obtained from discontinuous fractures (Lindholm, 1980). Discontinuous Cretaceous shale deposits separate glacial sediment from the underlying igneous and metamorphic rocks in portions of the study area.

3.2 Hydrogeologic Units

There are five main aquifer units in the study area (Figure 19):

- Surficial sand aquifer (which includes the New Ulm Formation Sand, where present),
- Cromwell Formation sand aquifer
- Hewitt Formation sand aquifer
- Sauk Centre sand aquifer and
- Fractured bedrock aquifer.

This discussion focuses on the dominant water bearing formations: the Surficial Sand aquifer and the Hewitt Formation sand aquifer. The northeastern part of the study area includes areas of the Hewitt Formation sand aquifer. The aquifer thickness ranges from 5 to 69 feet. Underlying the Hewitt Formation till deposits is a thin sand lens (Sauk Centre sand aquifer, typically about 10 feet thick), which is likely connected to the overlying Hewitt Formation sand aquifer through the thin (less than 5 feet thick in some locations) layers of leaky till. Moving to the south toward the Sauk River valley, the surficial sands of the Sauk River valley aquifer become more aerially widespread.

The Sauk River valley aquifer consists of river deposited sand and gravel units and highly hydraulically connected portions of the New Ulm sand aquifer. Some of the units are buried under till, and other units consist of surficial sand deposits. Maximum saturated thickness of the Sauk River valley aquifer is about 50 feet. Well yields are greater than 1,000 gallons per minute where sufficient saturated thickness is penetrated (Lindgren, 2001).

A fractured bedrock aquifer underlies most of the study area, although, this aquifer is not very productive or often used because of its depth and the existence of overlying sand and gravel aquifers.

3.3 Hydraulic Properties

Hydraulic properties of glacially-deposited aquifer systems are highly variable. The glacial deposit units can act as either aquifers or aquitards. Movement of water through the glacial deposits is intergranular. Table 2 below has some common hydraulic conductivities of the materials in the study area.

Table 2. Hydraulic conductivities of selected materials in the study area

Material	Hydraulic Conductivity (ft/day)	Source
Confined glacial sand and gravel aquifer	10 to 750	(Delin, 1988)
Gravel	700	(Lindholm, 1980)
Clay	10	(Lindholm, 1980)
Till	1.4×10^{-1}	(Delin, 1988)
Till	10^{-6} to 1	(Cherry, 1979)
Till	8.6×10^{-6} to 1.8	(Delin, 1988)
Till	1.8×10^{-2}*	(Delin, 1988)
Weathered bedrock	9.35^{-1} to 14.7	(Health, 1983)

*Vertical hydraulic conductivity

3.4 Groundwater Flow, Sources, and Discharge

Regional groundwater flow is toward the Sauk and Mississippi rivers, and locally the groundwater is discharged to smaller streams and lakes. Within the study area, groundwater flow is to the Sauk River valley from the upland formations. The Sauk River valley is composed of outwash deposits of sand, gravelly sand, and gravel interbedded with till and clay. The Sauk River valley generally narrows as it moves west to east through the study area. In general the depth to groundwater increases with increasing distance from the Sauk River.

Sources of water into the study area include the following:

- Recharge from precipitation
- Groundwater flow through study area boundaries
- Leakage through till and clays layers to buried aquifer units

There appears to be a groundwater divide north of the Study Area boundary (the topographic high north of Big Fish Lake). The western boundary is part of the Sauk River valley, and groundwater likely flows west to east over the western boundary through the valley.

Groundwater is discharged from the aquifer through the following processes:

- Withdrawals from wells
- Groundwater evapotranspiration
- Discharges to springs, streams, and lakes

3.4.1 Groundwater Withdrawals

Groundwater provides the main source of drinking water for residents within the study area. Most of the public water supply wells are located in the Sauk Valley aquifer (Figure 20). Total pumping within the study area from 2007 to 2016 can be found in Table 3 and Figure 21.

Table 3. Pumping in study area by use 2007 through 2016

Use	Number of Wells[1]	Average Water Use[2] (MGY)	Percent of Water Use in Study Area
Industrial Processing	12	303.6	26.5
Domestic	736	80.6[3]	7.0
Irrigation	47	401.5	35.1
Public Water Supply	17	316.9	27.7
Water Supply/Industrial Processing	5	41.1	3.6
Other	194	1.12	0.1

[1]Number of wells as described in MWI with use taken from the Minnesota DNR Permitting and Reporting System (MPARS). Where no permit could be found domestic use was assumed.

[2]As reported to the DNR through the MPARS

[3]Assume 300 gallons per day per family of four (Penn State College of Agricultural Sciences, 2017)

3.4.2 Stream-Aquifer Seepage

Stream-aquifer seepage describes the movement of water between the stream and the underlying aquifer system. Seepage may occur from the aquifer to the stream (gaining stream/reach), resulting in increased flows and cooler summer water temperatures. Seepage may also occur from the stream to the aquifer (losing stream/reach), resulting in decreased or potentially disappearing flows. Streams may switch from gaining to losing depending on the location and the water-table aquifer elevation. The rate of stream seepage depends on the following:

1. Type and thickness of streambed material
2. Vertical hydraulic conductivity of streambed material
3. Hydraulic conductivity of aquifer near stream
4. The difference in head between the stream and the aquifer

During low-flow periods groundwater represents most of the flow in Cold Spring Creek. It is generally referred to as a gaining stream for reaches four through seven (Figure 22). Reach 3 and Tributary Wetland are wetland areas and not to be considered significantly gaining or losing. Reach 2 is a channelized stream with low flow and is unlikely to be significantly gaining or losing. Reach 1 is a wetland ditched for drainage with low flow and unlikely to be significantly gaining or losing.

Evaluating stream-aquifer seepage on the Sauk River can be problematic because the baseflow range tends to be within measurement error. The USGS monitored flow on the Sauk River in preparation for the 2001 USGS report and determined that shortly downstream of the City the Sauk River is a gaining river, near the Gold ‘n Plump poultry processing plant the Sauk River is a losing river, switching back to a gaining river as it moves east (Figure 23).

4.0 Representation of the Groundwater Flow System

The system representation is based on geologic and hydrogeologic data currently available within the study area. This representation is used as the basis for the development of a numerical flow model. A depiction of the representation can be found on Figure 24. A representation of groundwater pumping near a stream can be found on Figure 25.

The study area was determined as a rectangular shape with boundaries on groundwater divides where possible. The previously developed USGS had water entering from the northern boundary that contributed to the City, CSBC, and Gold ‘N Plump wells. This area was increased proportionally for this project to ensure that water contributing to these wells originates from within the study area.

Water falls on the landscape as precipitation and either runs across the landscape as overland flow or enters the aquifer system as recharge. Groundwater moves through the aquifer and naturally discharges at low points in the landscape such as streams and wetlands. Groundwater is removed from the aquifer system through pumping. When a well is pumped a cone of depression is created where the water table is lowered in an area surrounding the well. This can affect the rate of discharge to the natural discharge points. When the groundwater surface is near the land surface, groundwater can be removed from the system through vegetation uptake for growth, evaporation, or transpiration. Groundwater moves through the leaky till to the sand and gravel lenses within the till where it can either be removed by pumping or continue to flow slowly through the till.

North of the study area is a presumed groundwater divide, as shown in the Stearns County Atlas Part B. The location of the groundwater divide may be affected by pumping. There is some through flow from some areas across the northern boundary into the study area. The western boundary of the study area is largely defined by the Sauk River valley aquifer system including the following: Kolling Creek, Sauk River, and the Sauk River chain of lakes. In general, the southern and eastern boundaries of the study area are defined by a combination of groundwater divides and surface subwatershed boundaries. There is some through flow from some area across the southern and eastern boundary into the study area.

5.0 List of Abbreviations and Glossary

aquifer	An underground layer of water-bearing permeable rock or unconsolidated materials (sand and gravel) from which groundwater can be extracted using a water well.
baseflow	The sustained flow (amount of water) in a stream that comes from groundwater discharge or seepage. Groundwater flows underground until and if the water table intersects the land surface where the flowing water then becomes surface water in the form of springs, streams/rivers, lakes and wetlands. Baseflow is the continual contribution of groundwater to rivers and is an important source of flow between rainstorms.
bedrock	The consolidated rock underlying unconsolidated surface materials such as soil or glacial sediment.
cone of depression	Where the water table is lowered surrounding a well due to pumping.
DNR	Minnesota Department of Natural Resources.
evaporation	The process by which water or other liquids change from liquids to a gas vapor; evaporation can return infiltrated water to the atmosphere from upper soil layers before it reaches groundwater or surface water, and occur from leaf surfaces (interception), water bodies (lakes, streams, wetlands, oceans), or small puddled depressions in the landscape.
evapotranspiration	Loss of water to the atmosphere from a land area by transpiration by plants (water that is released from plants during photosynthesis) and evaporation from the soil and open bodies of water. Essentially the combination of evaporation and transpiration.
gaining stream	A stream reach that receives a measureable percentage of its flow from groundwater.
glacial	Relating to or derived from a glacier.
groundwater	Water that collects or flows beneath the earth surface, filling the porous spaces below the water table in soil, sediment, and rocks.
hydraulic	Relating to water movement.
hydraulic conductivity	The rate at which groundwater flows through a unit cross-section of an aquifer.
hydraulic head (head)	The energy that causes groundwater to flow; the sum of the elevation head and the pressure head.
infiltration	The movement of water from the land surface into the subsurface under unsaturated conditions.

potential recharge	The movement of water through soil below the root zone, but not necessarily to the groundwater system.
losing stream	A stream that loses a measureable percentage of its flow to groundwater.
MRLC	Multi-Resolution Land Characteristics Consortium.
MDH	Minnesota Department of Health.
MDOT	Minnesota Department of Transportation.
MPCA	Minnesota Pollution Control Agency.
MRCC	Midwest Regional Climate Center.
MWI	Minnesota Well Index: a database developed and maintained by the Minnesota Department of Health and Minnesota Geological Survey containing basic information for wells drilled in Minnesota such as location, depth, and static water level. The database contains construction and geological information from the well record (well log) for many wells. It is available online through the Minnesota Well Index mapping application (http://www.health.state.mn.us/divs/eh/cwi/index.html).
NLCD	National Land Cover Dataset.
NRCS	Natural Resources Conservation Service.
numerical model	A computer model that uses MODFLOW or other source code to simplify real-world systems and use differential equations to calculate groundwater flow.
overland flow	The result of precipitation that does not infiltrate into the ground; often referred to as run-off.
potentiometric surface	A surface representing the total head of groundwater in an aquifer and defined by the levels to which water will rise in tightly case wells.
quaternary	Geologic time period that began 2.588 million years ago and continues to today. The Quaternary Period comprises the Pleistocene and Holocene epochs.
recharge	The process through which water enters the groundwater system.
SWB	Soil-Water Balance.
till	Unsorted glacial sediment deposited directly by ice. It is derived from the erosion and entrainment of rock and sediment over which the glacier has passed.
transmissivity	An aquifer's capacity to transmit water, determined by multiplying the hydraulic conductivity of the aquifer material by the thickness of the aquifer.

transpiration	The process by which plants take up water through their roots and then give off water vapor through their leaves (open stomata).
USDA	United States Department of Agriculture.
USGS	United States Geological Survey.

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Figures

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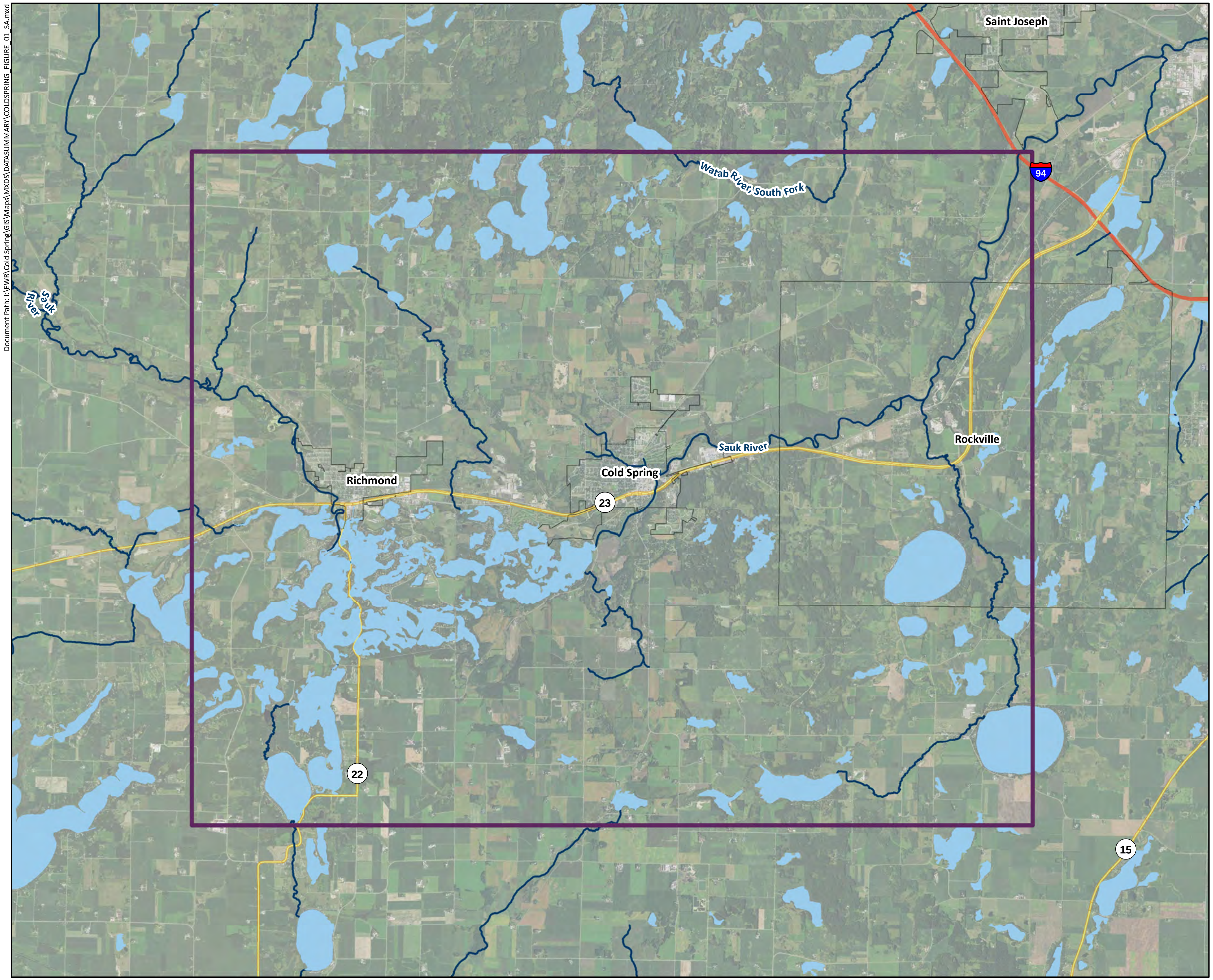


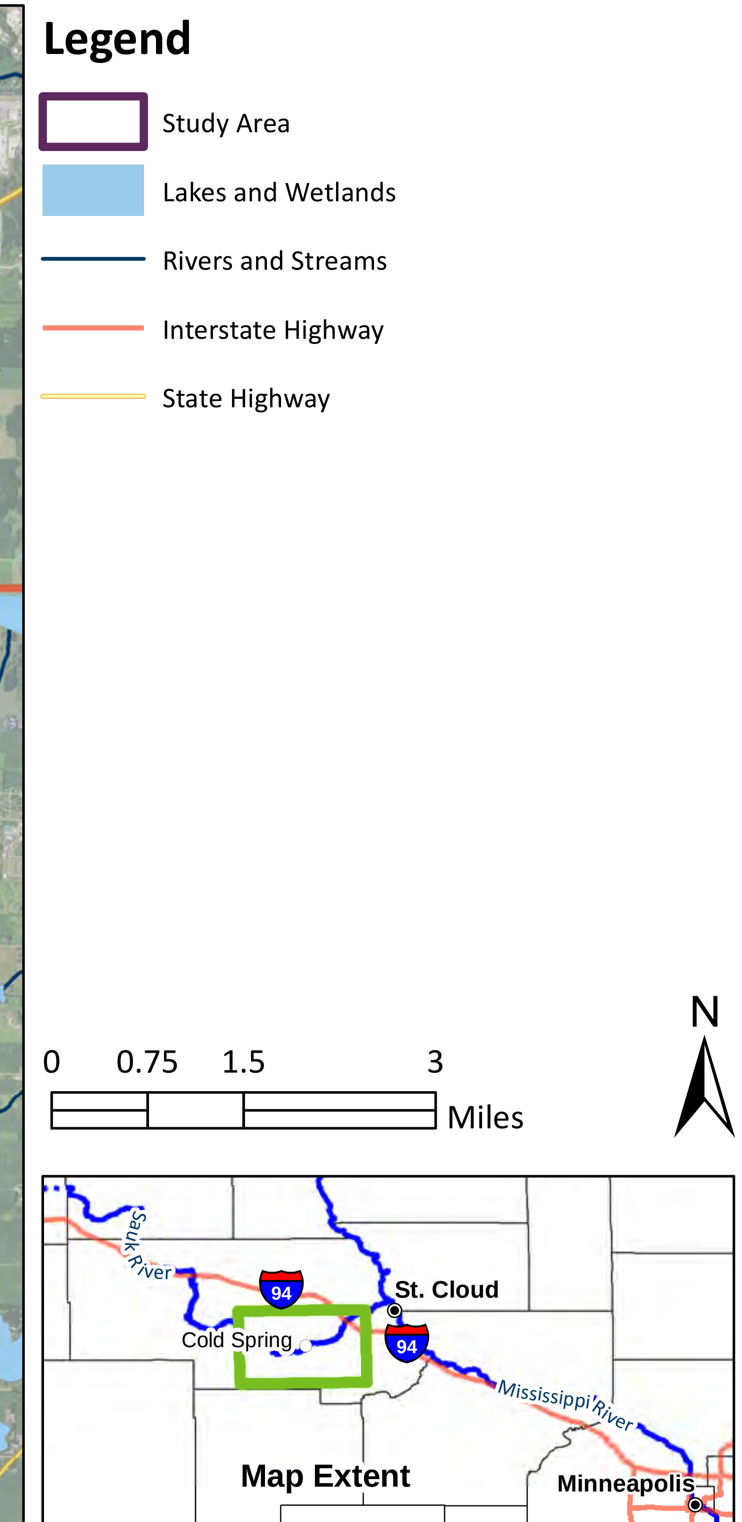


Figure 1. Study Area

Cold Spring Groundwater Study
Existing Data Summary Report

DEPARTMENT OF NATURAL RESOURCES

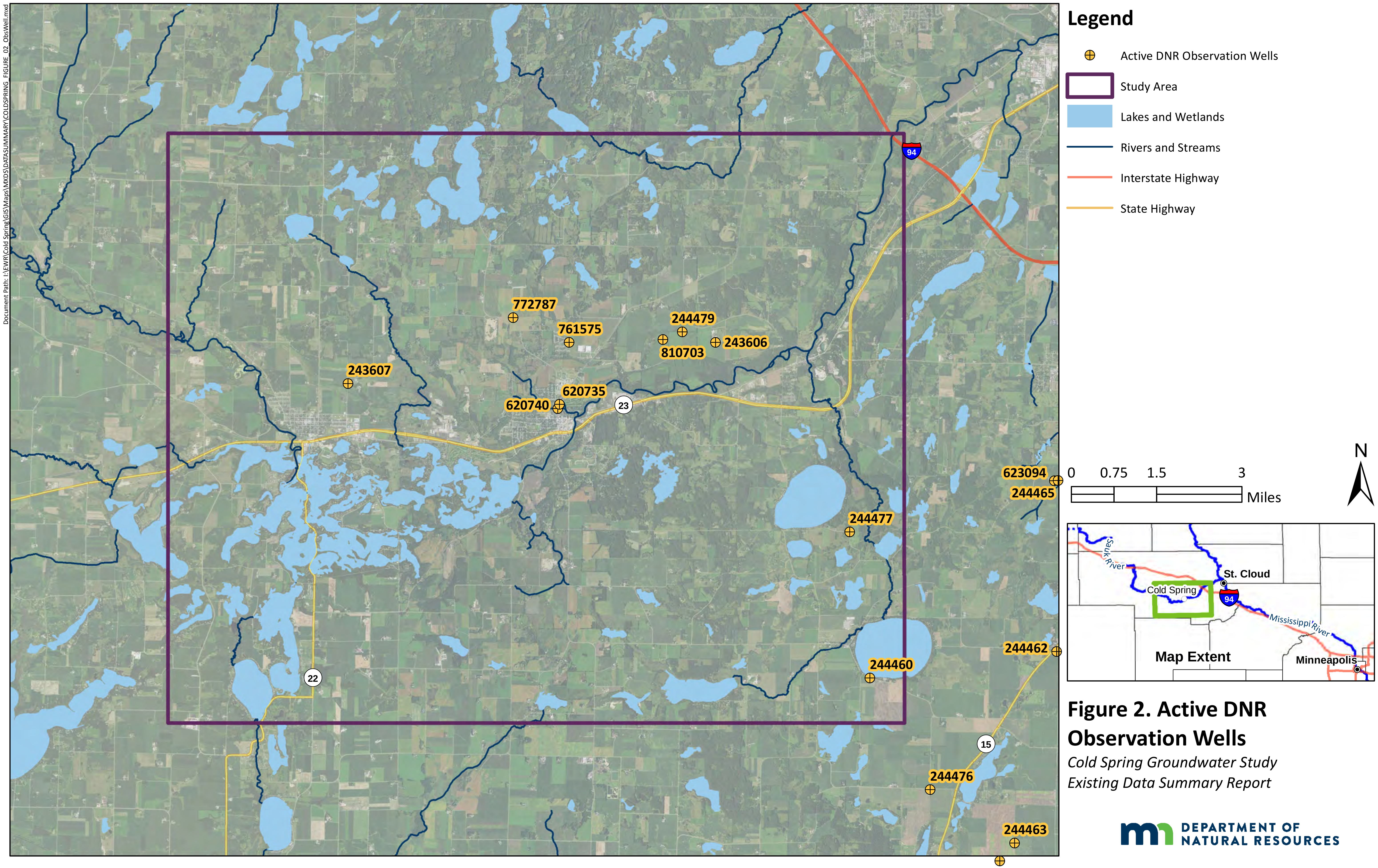
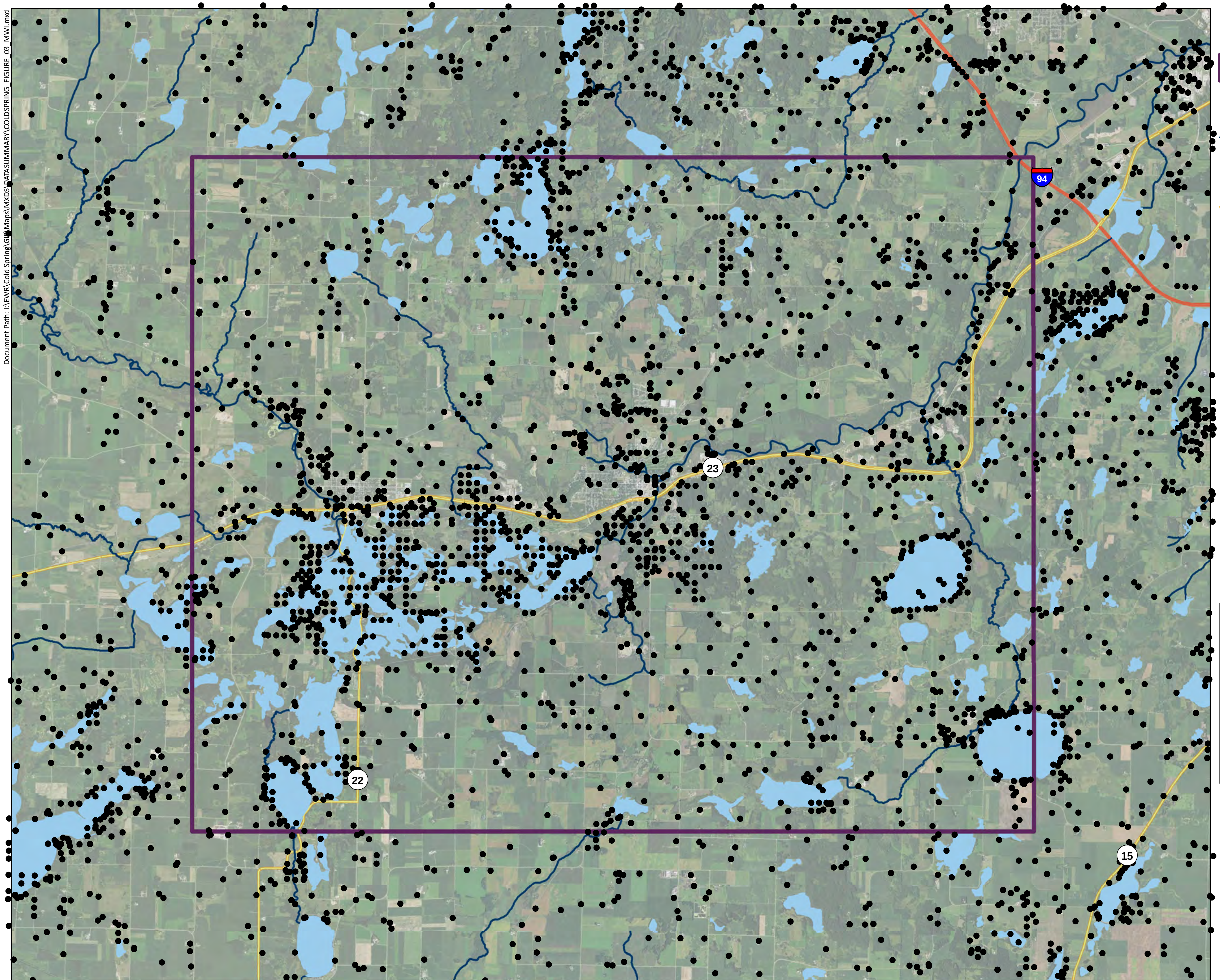


Figure 2. Active DNR Observation Wells

Cold Spring Groundwater Study
Existing Data Summary Report

DEPARTMENT OF NATURAL RESOURCES



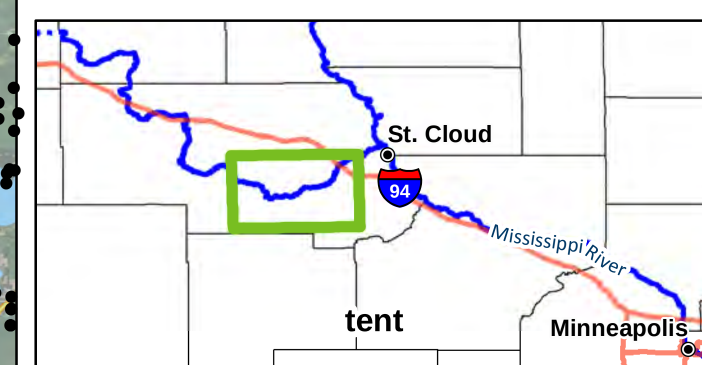


Figure 3. Minnesota Well Index

Cold Spring Groundwater Study
Existing Data Summary Report

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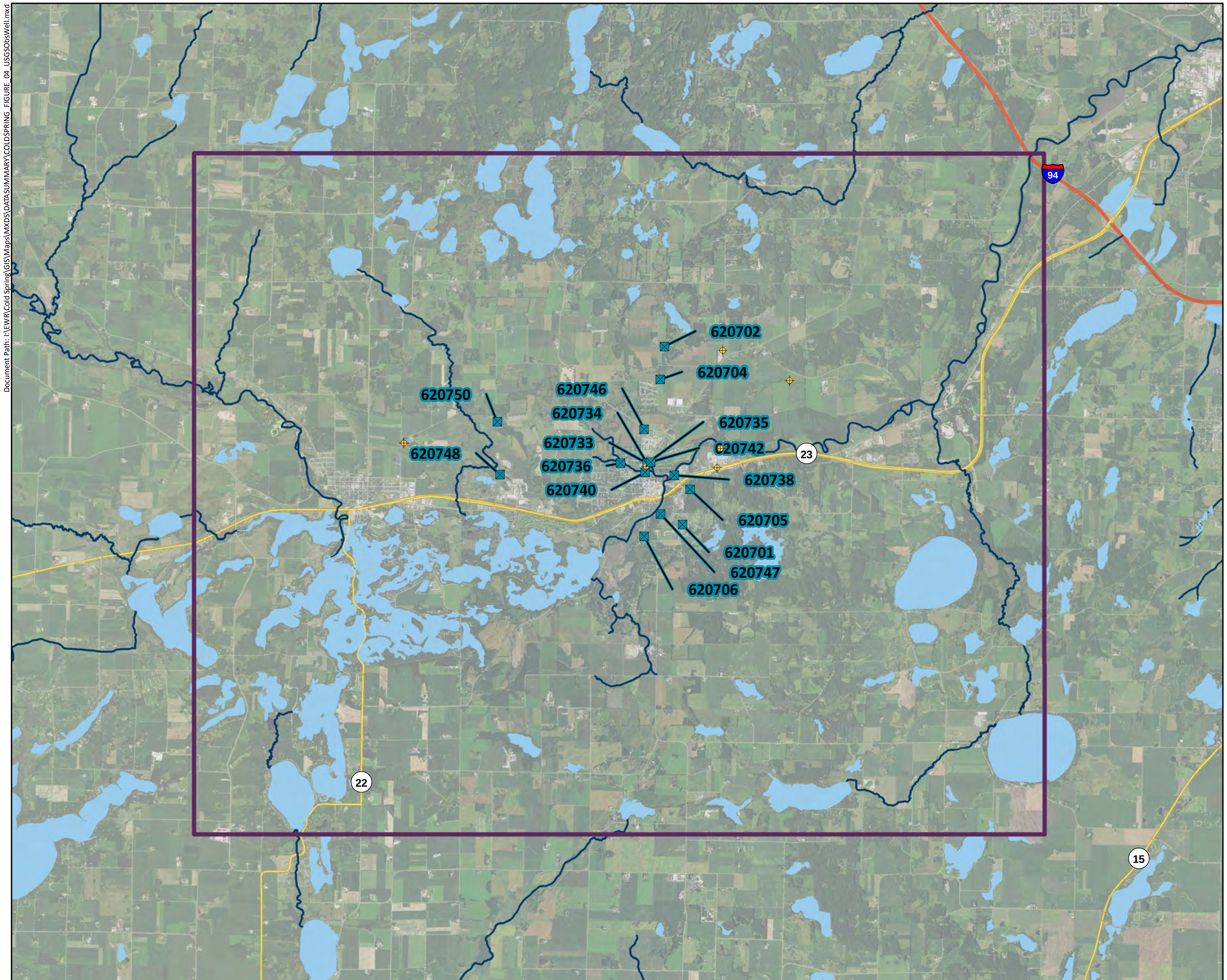

Legend

USGS Observation Wells

- Sealed
- Active
- Study Area
- Lakes and Wetlands
- Rivers and Streams
- Interstate Highway
- State Highway

0 0.75 1.5 3 Miles

N

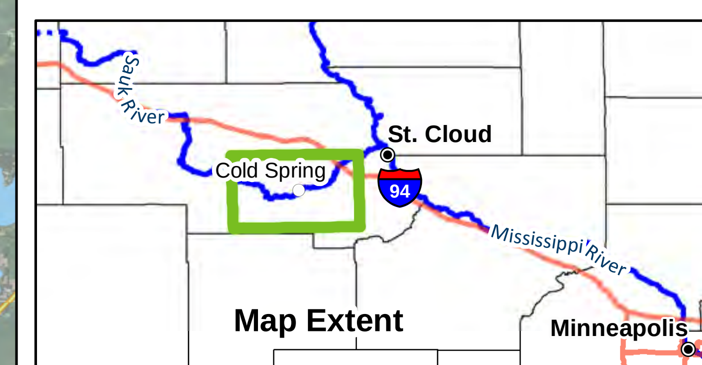

Figure 4. USGS Observation Wells

Cold Spring Groundwater Study
Existing Data Summary Report

DEPARTMENT OF NATURAL RESOURCES

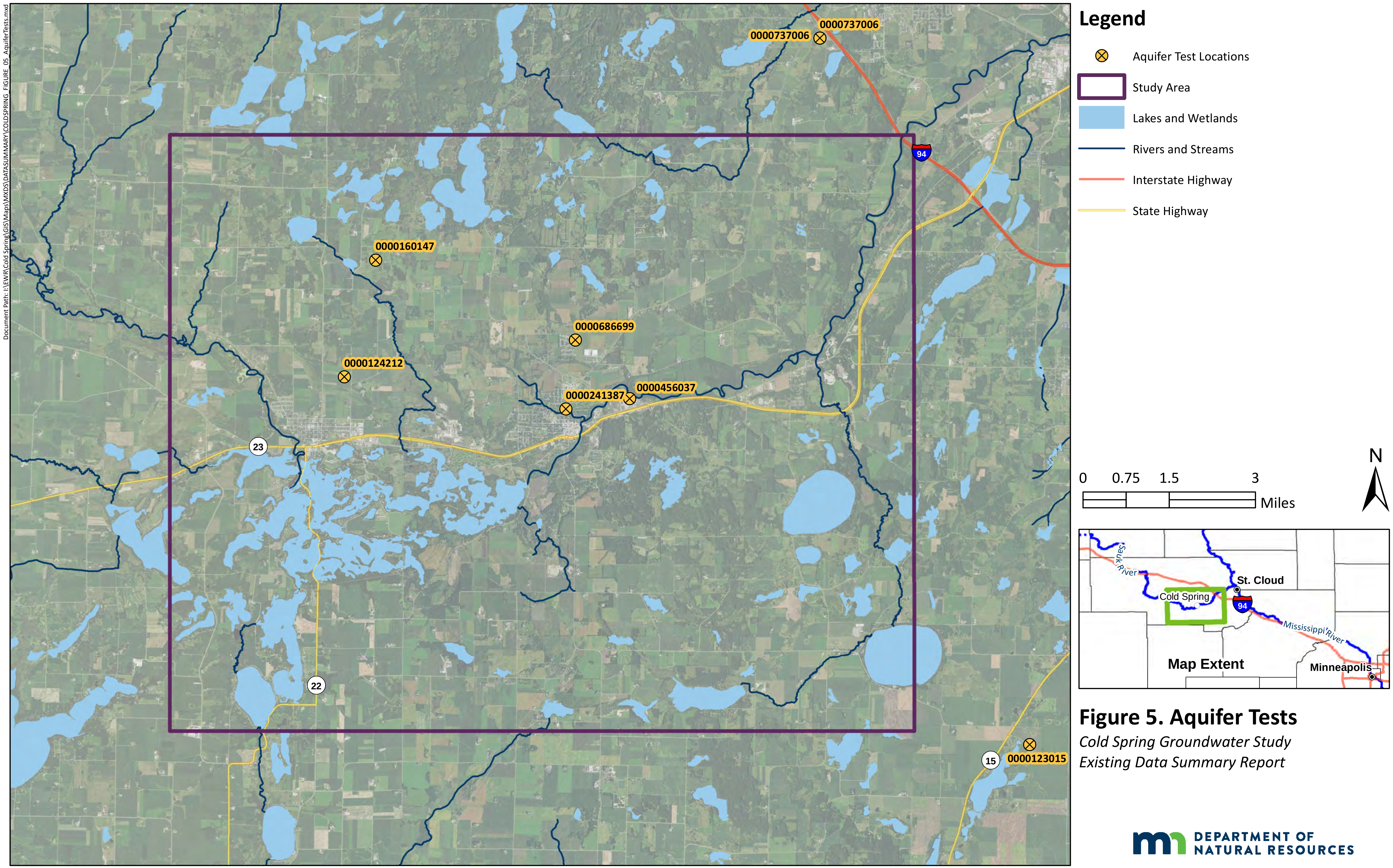

Figure 5. Aquifer Tests

Cold Spring Groundwater Study

Existing Data Summary Report

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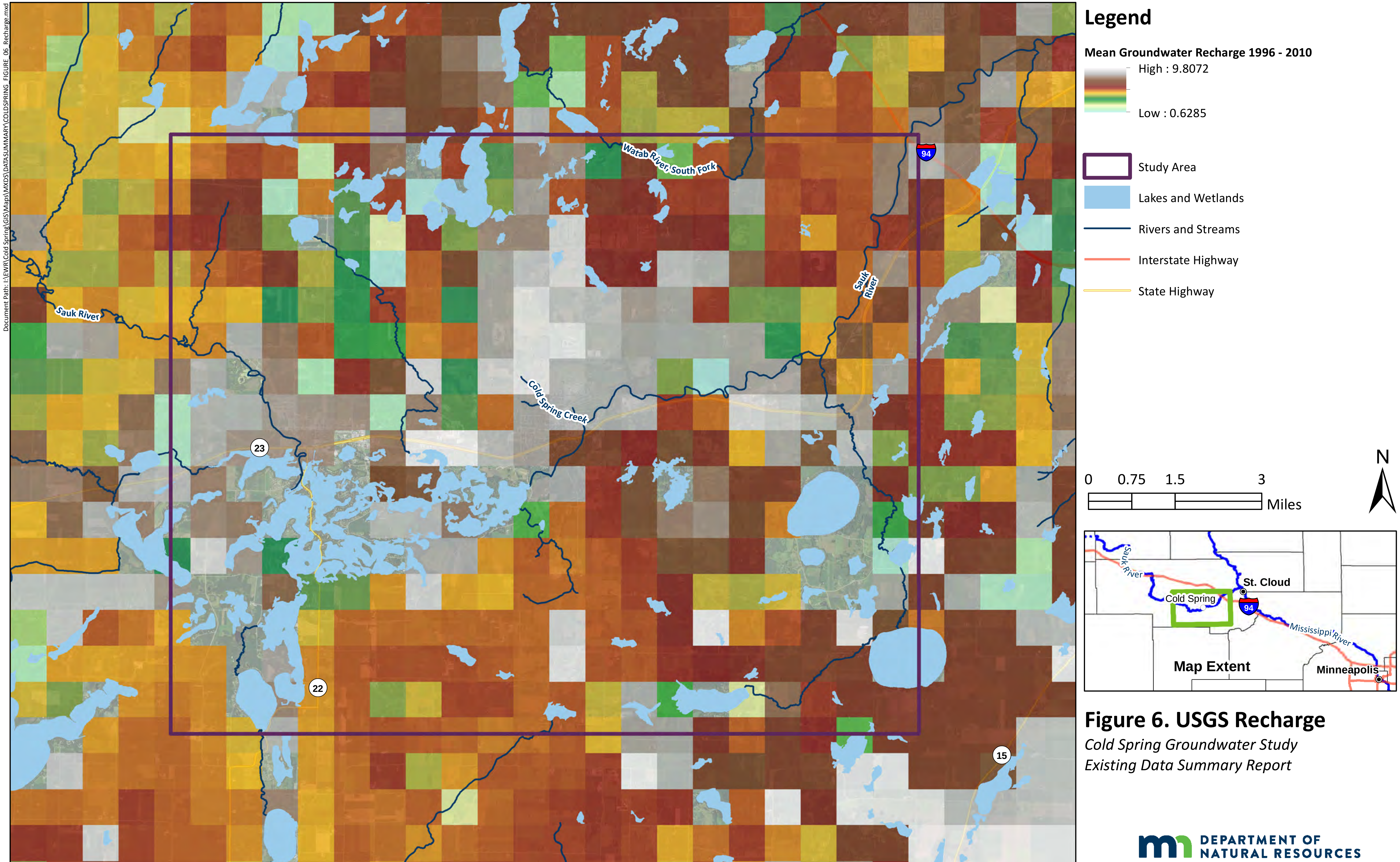

Figure 6. USGS Recharge

Cold Spring Groundwater Study
Existing Data Summary Report

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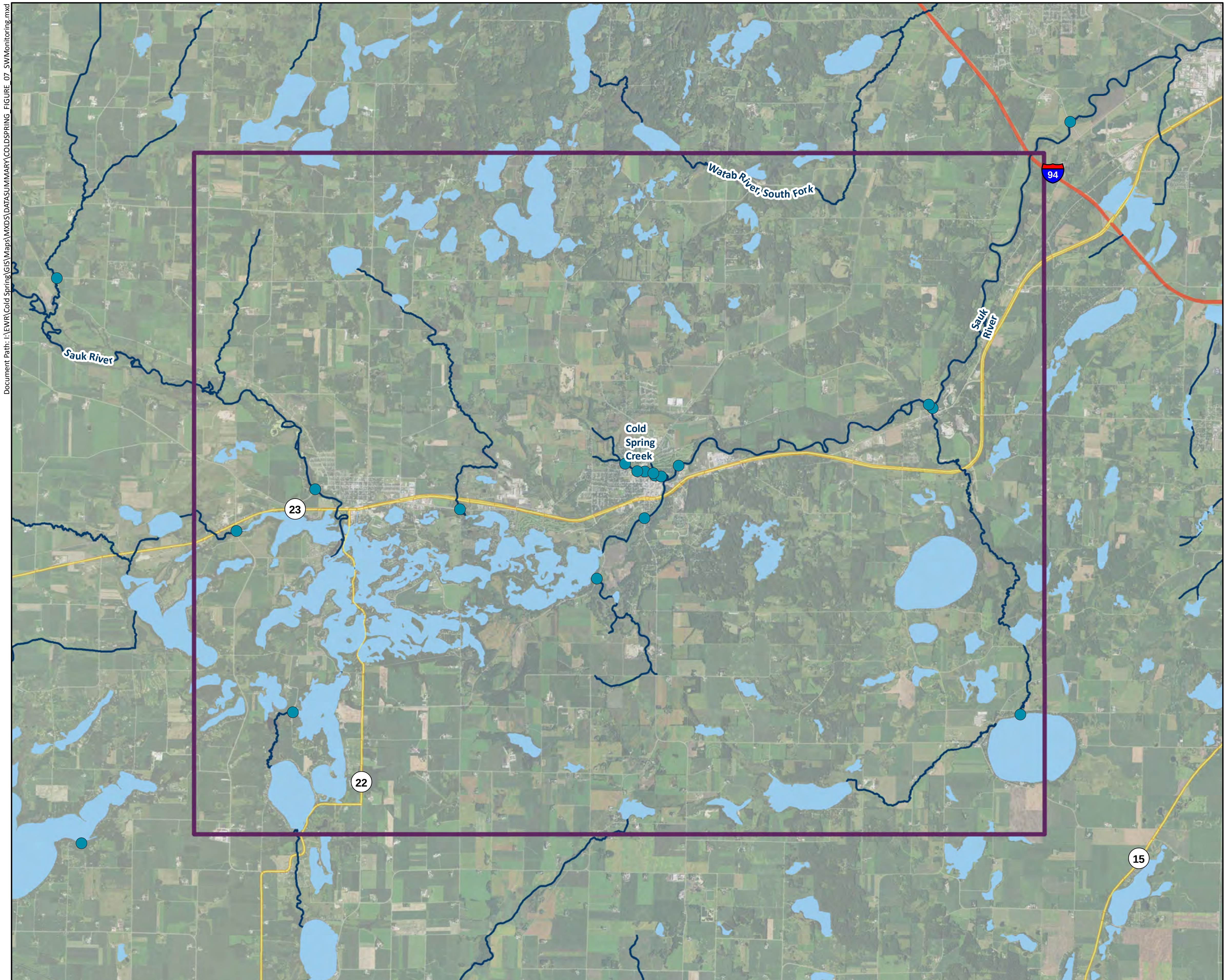

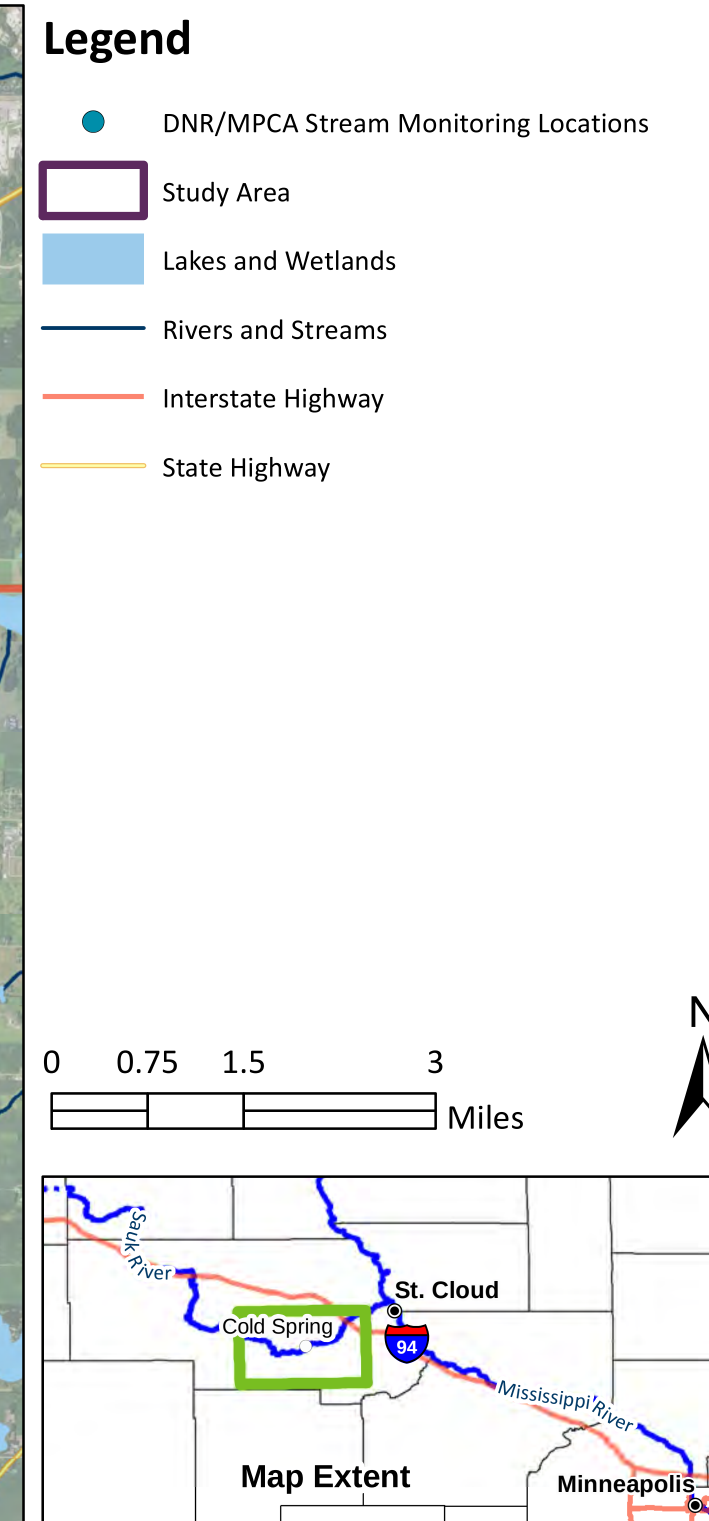

Figure 7. Surface Water Monitoring Locations

Cold Spring Groundwater Study
Existing Data Summary Report

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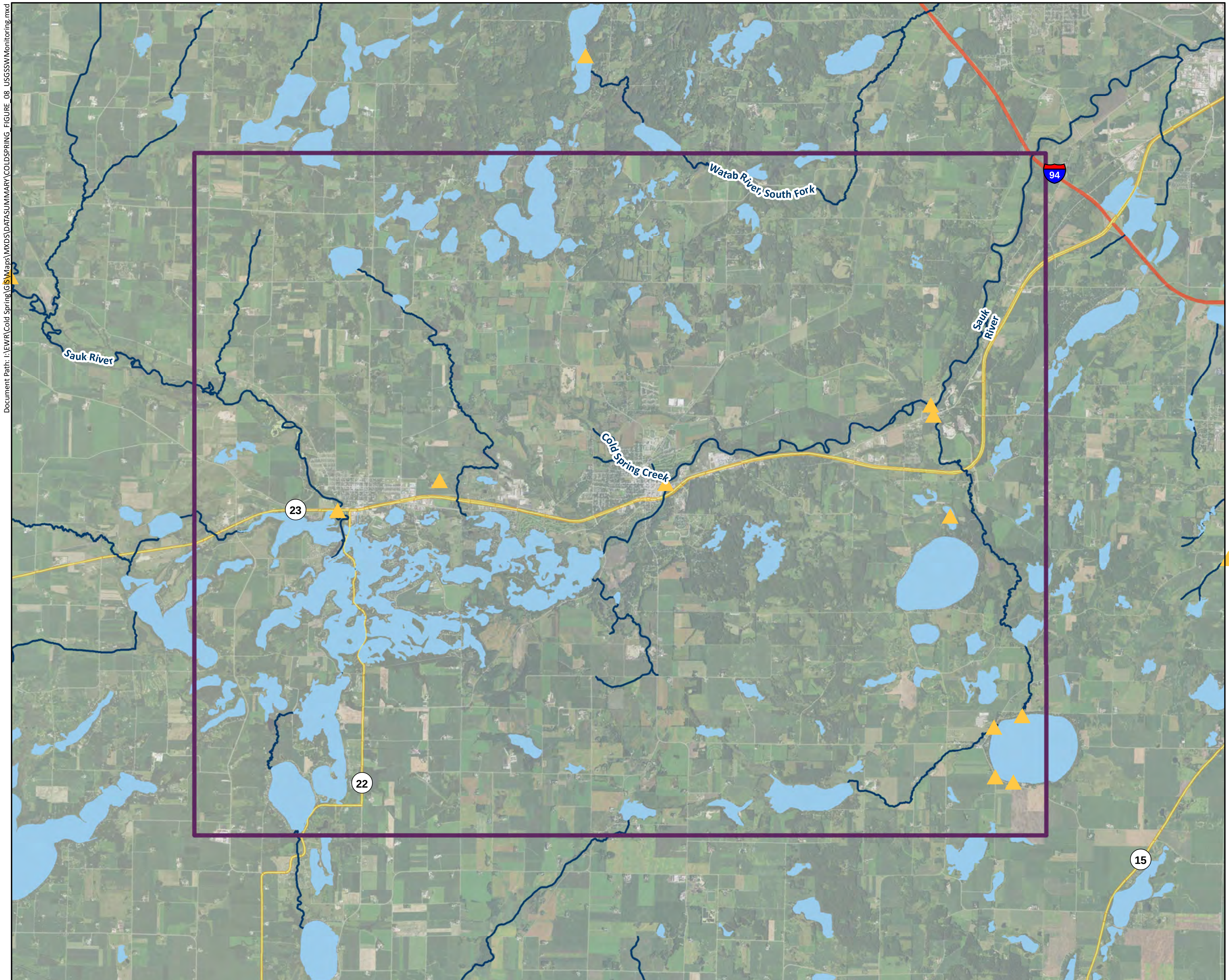

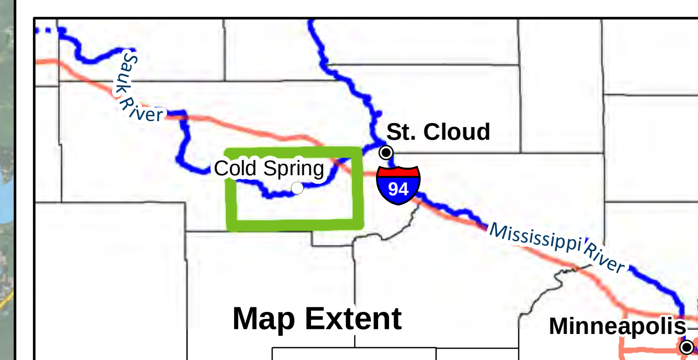

Figure 8. USGS Surface Water Monitoring Locations

Cold Spring Groundwater Study
Existing Data Summary Report

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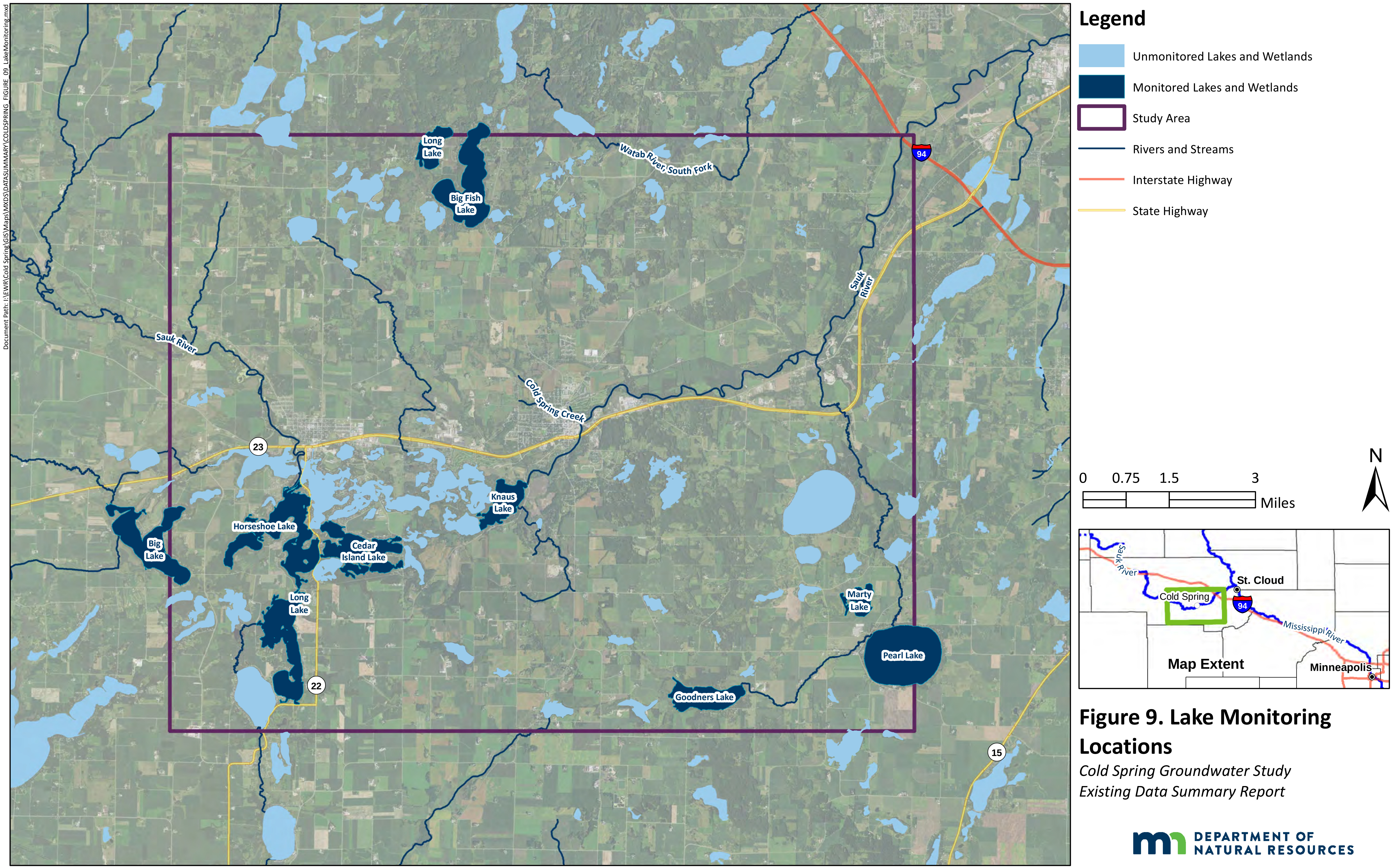

Figure 9. Lake Monitoring Locations

Cold Spring Groundwater Study
Existing Data Summary Report

DEPARTMENT OF NATURAL RESOURCES

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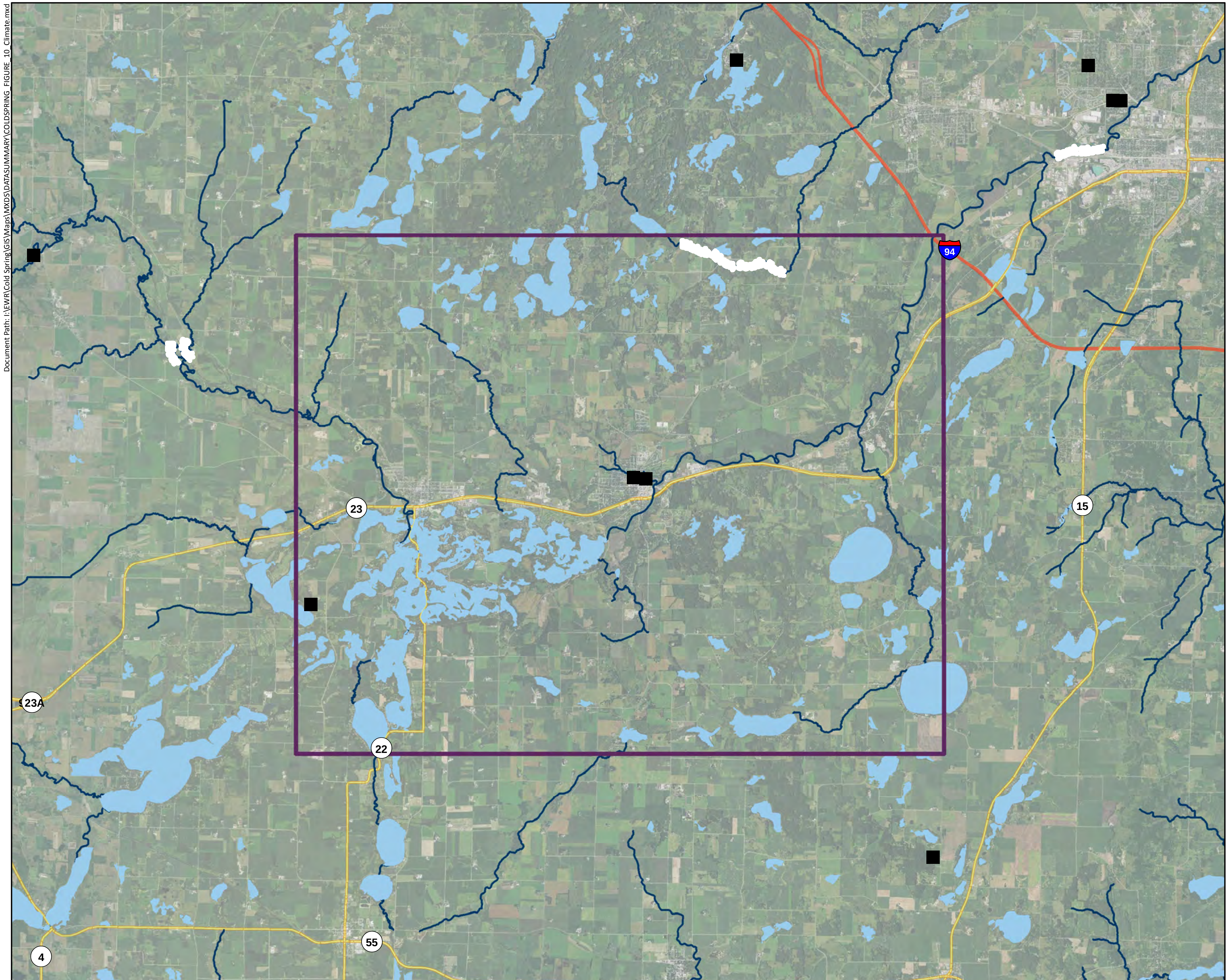


Legend

- Climate Monitoring Stations
- Study Area
- Lakes and Wetlands
- Rivers and Streams
- Interstate Highway
- State Highway

0 1 2 4 Miles

N

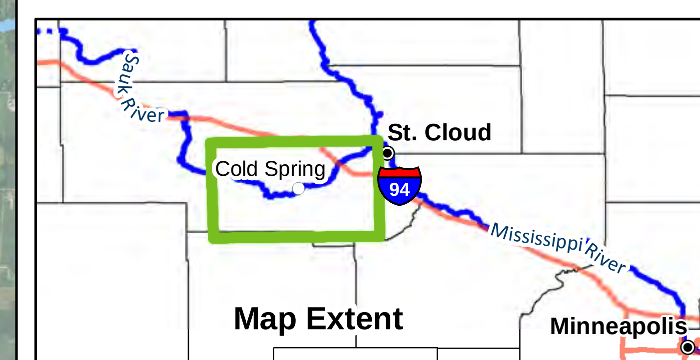
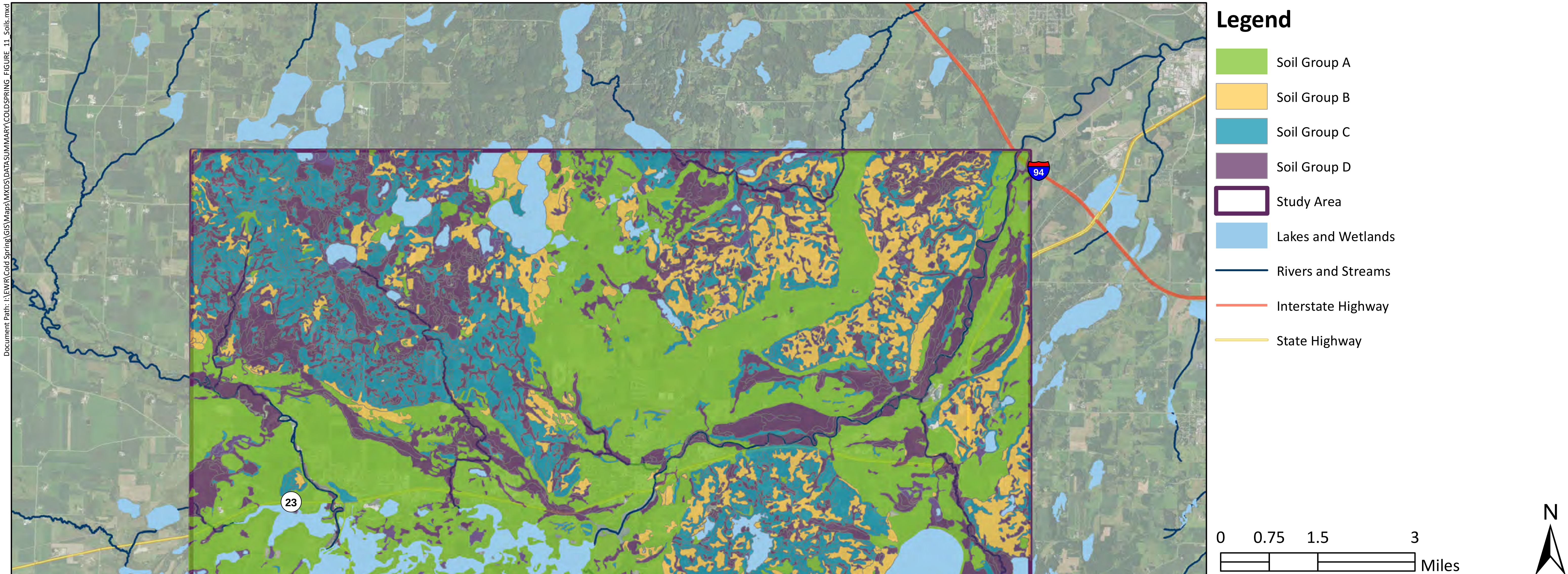


Figure 10. Climate Monitoring

Cold Spring Groundwater Study
Existing Data Summary Report

DEPARTMENT OF NATURAL RESOURCES



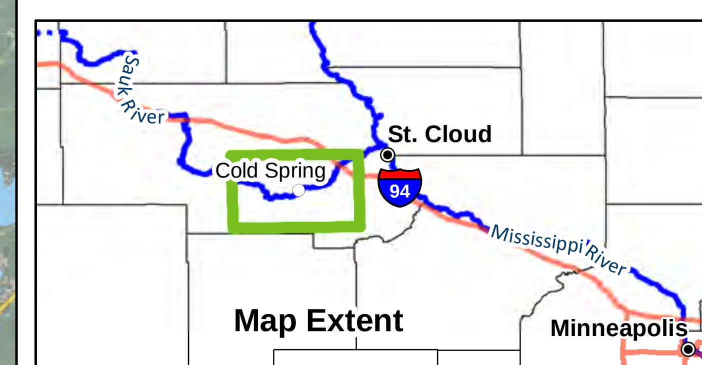


Figure 11. Soils

Cold Spring Groundwater Study
Existing Data Summary Report

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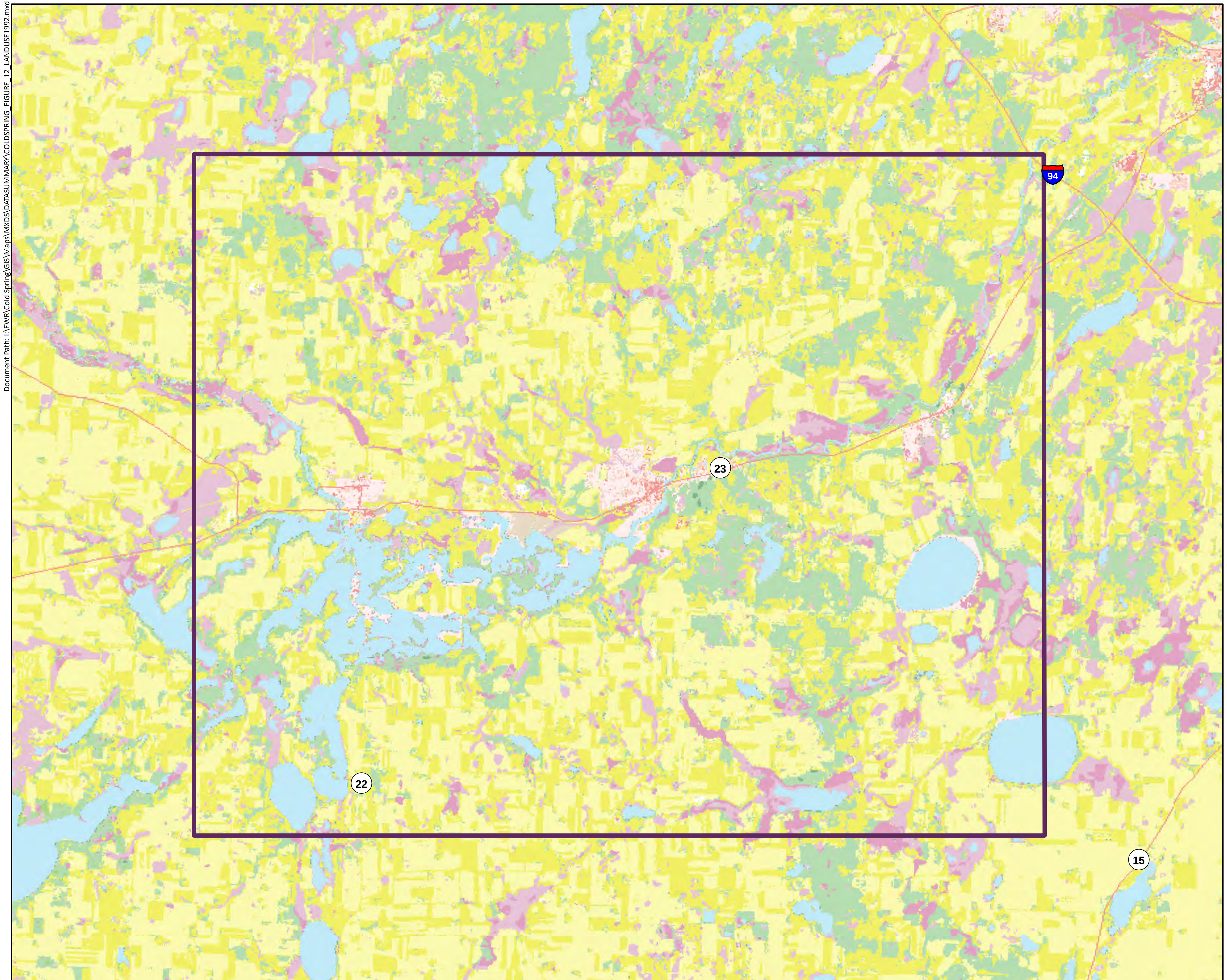

Legend

Land Cover Class

- Open Water
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Barren Land
- Decidious Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands
- Study Area

0 0.75 1.5 3 Miles

N

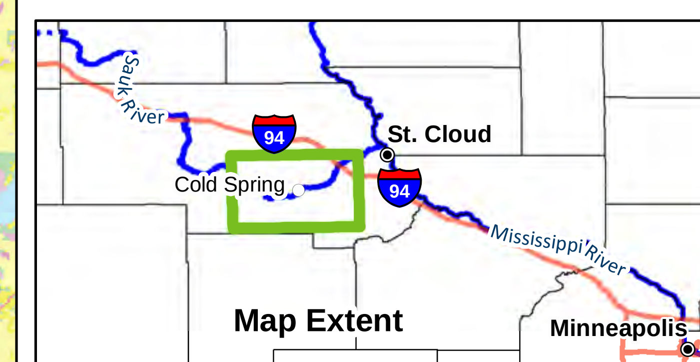

Figure 12. Land Cover 1992

Cold Spring Groundwater Study
Existing Data Summary Report

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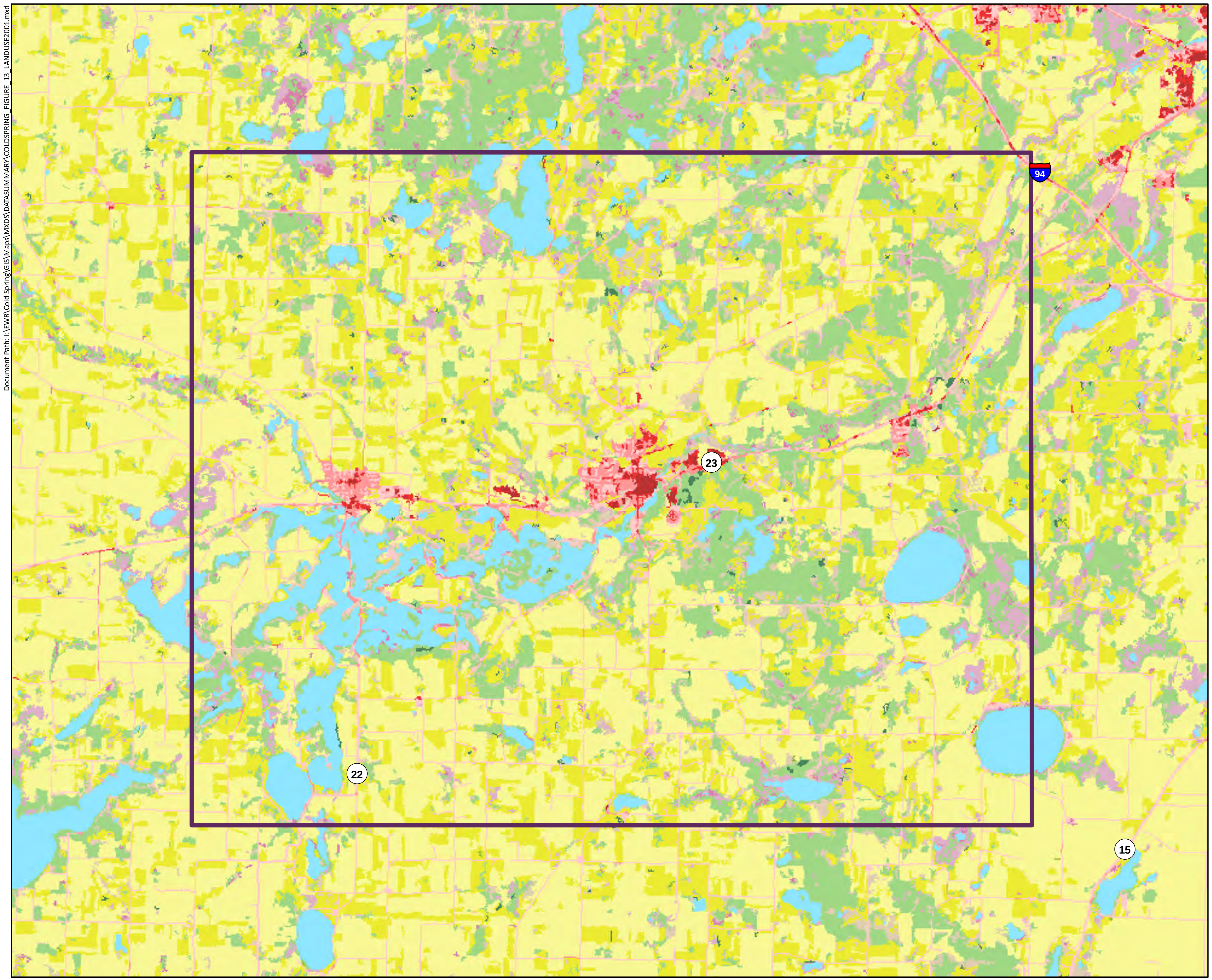

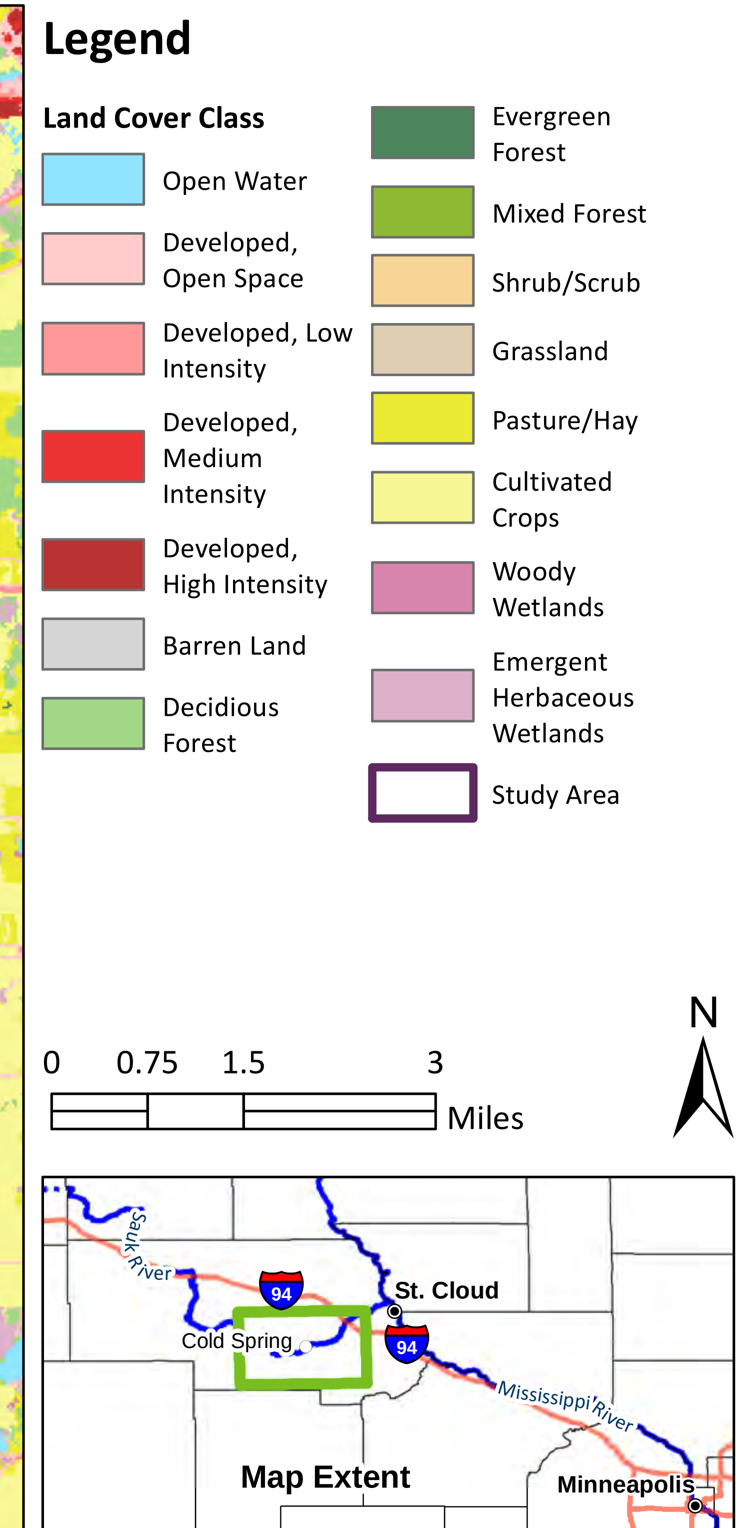

Figure 13. Land Cover 2001

Cold Spring Groundwater Study
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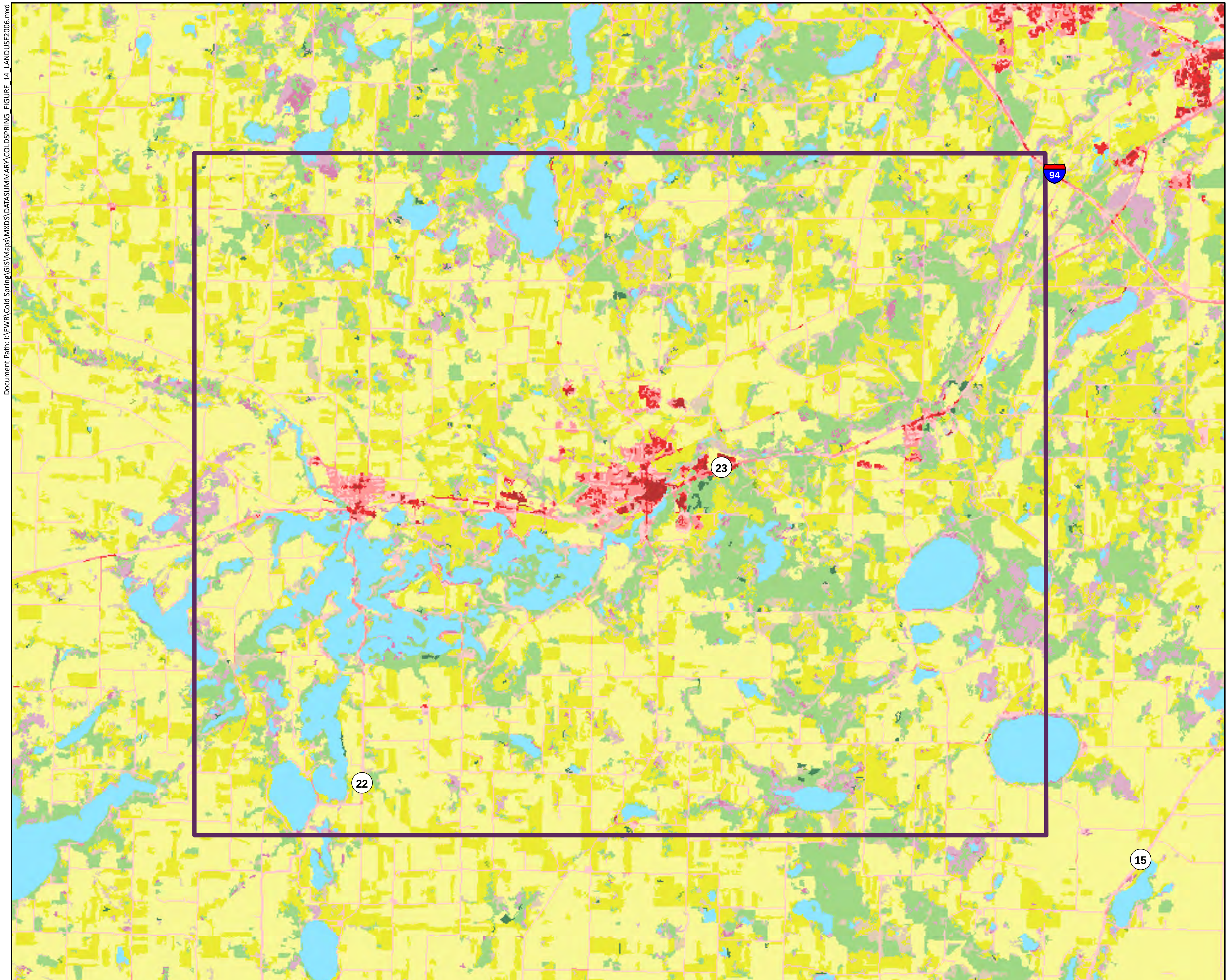

Legend

Land Cover Class

- Open Water
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Barren Land
- Decidious Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands
- Study Area

0 0.75 1.5 3 Miles

N

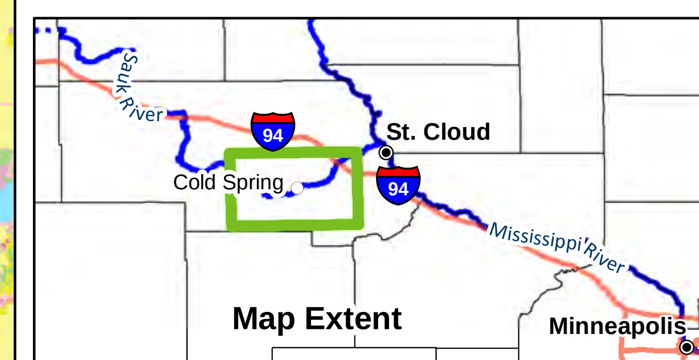

Figure 14. Land Cover 2006

Cold Spring Groundwater Study
Existing Data Summary Report

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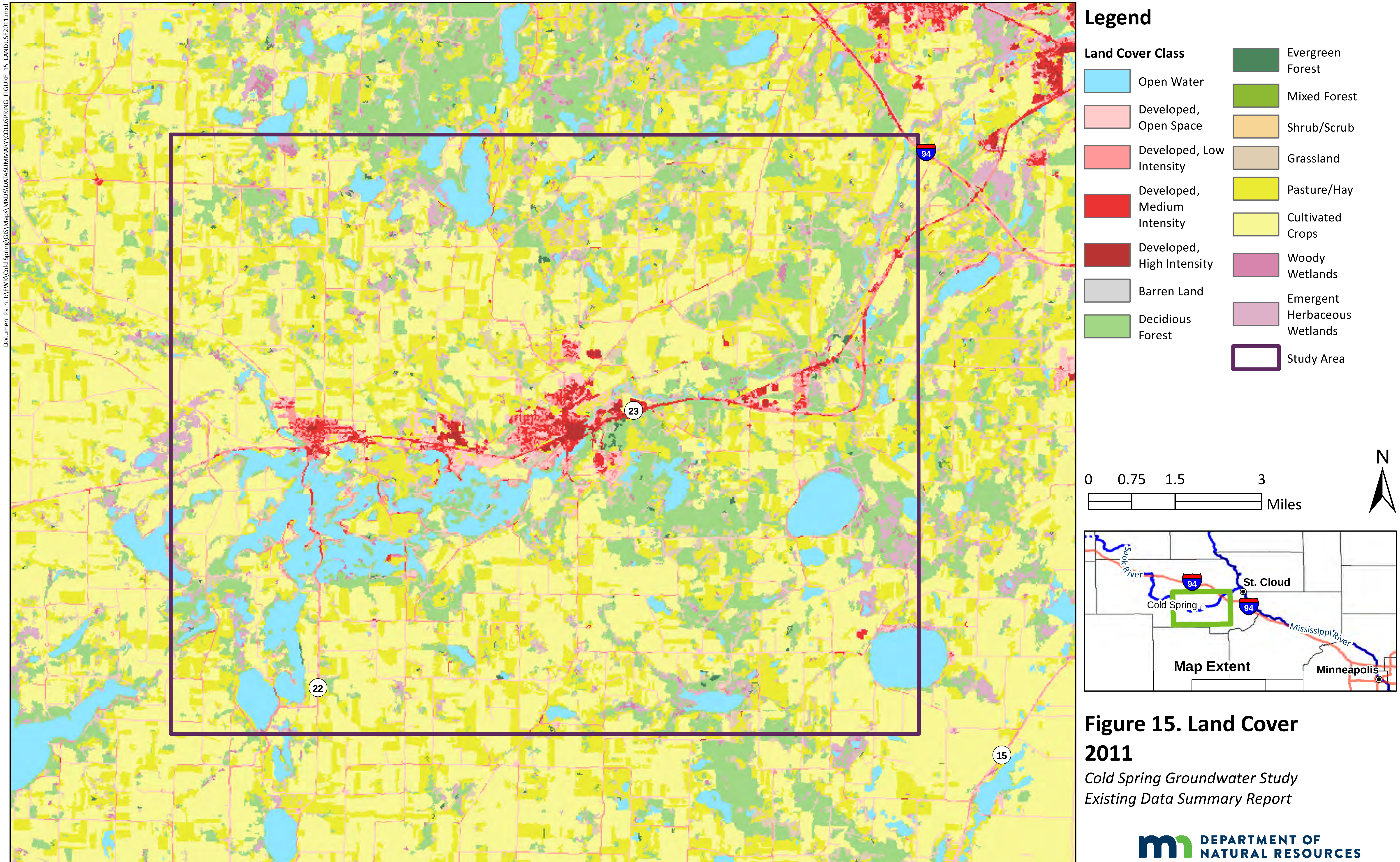

Figure 15. Land Cover 2011

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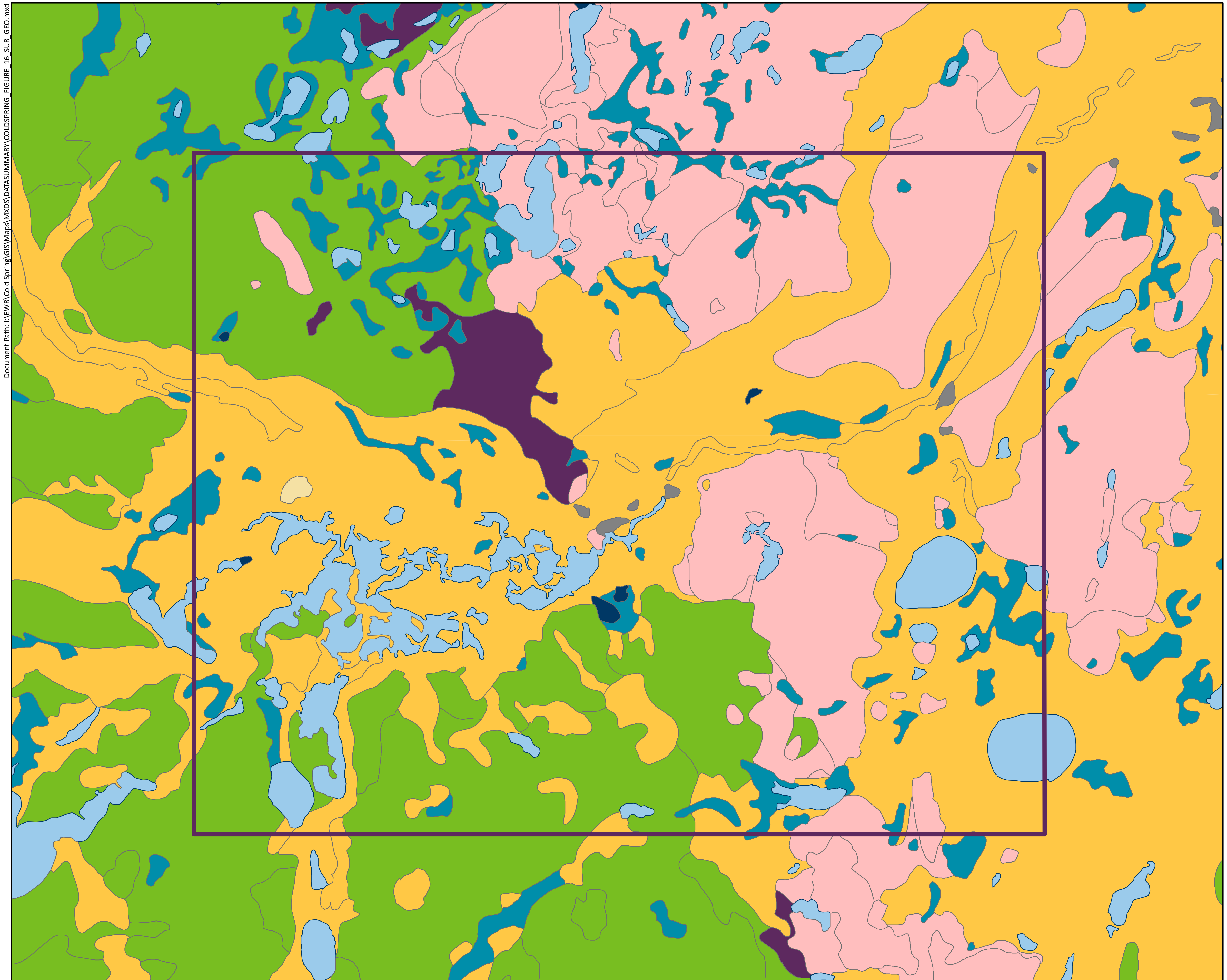

Legend

Surficial Geology

DESCRIPTION

- Precambrian
- Sand and Gravel
- Des Moines Till
- Des Moines till/Superior cmplx
- Superior Till
- Marl
- Peat
- Winnipeg Till
- Water
- Study Area

0 0.75 1.5 3 Miles

N

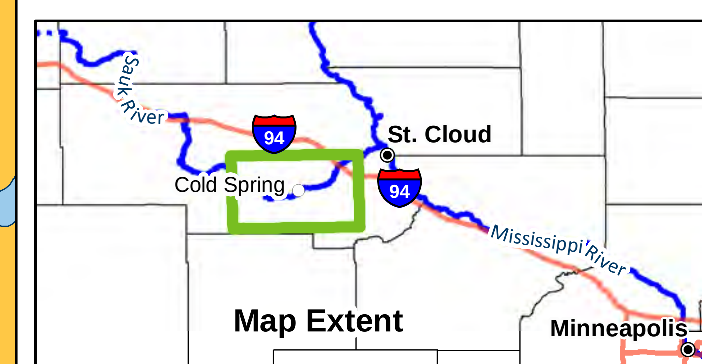

Figure 16. Surficial Geology

Cold Spring Groundwater Study
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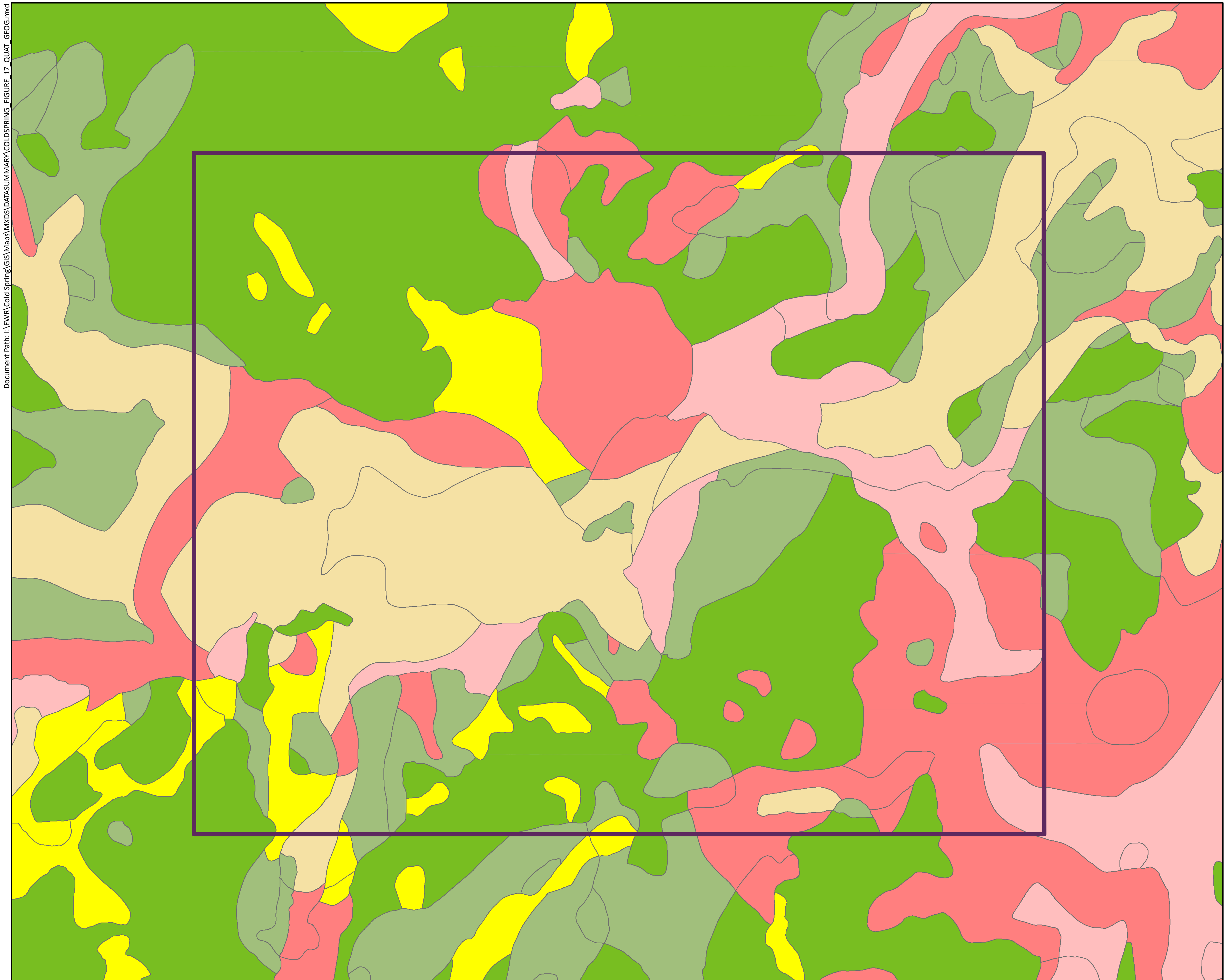

Legend

Quaternary Deposits

- Clayey to sandy till with thick sand layers
- Clayey to sandy till with thin sand layers
- Till, sand and gravel
- Sand and Gravel outwash
- > 50 feet of sand to gravel over till
- < 50 feet of sand to gravel over till
- Study Area

N

0 0.75 1.5 3 Miles

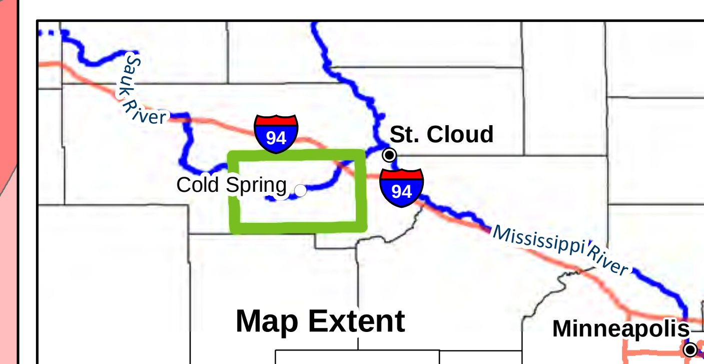

Figure 17. Quaternerary Geology

Cold Spring Groundwater Study
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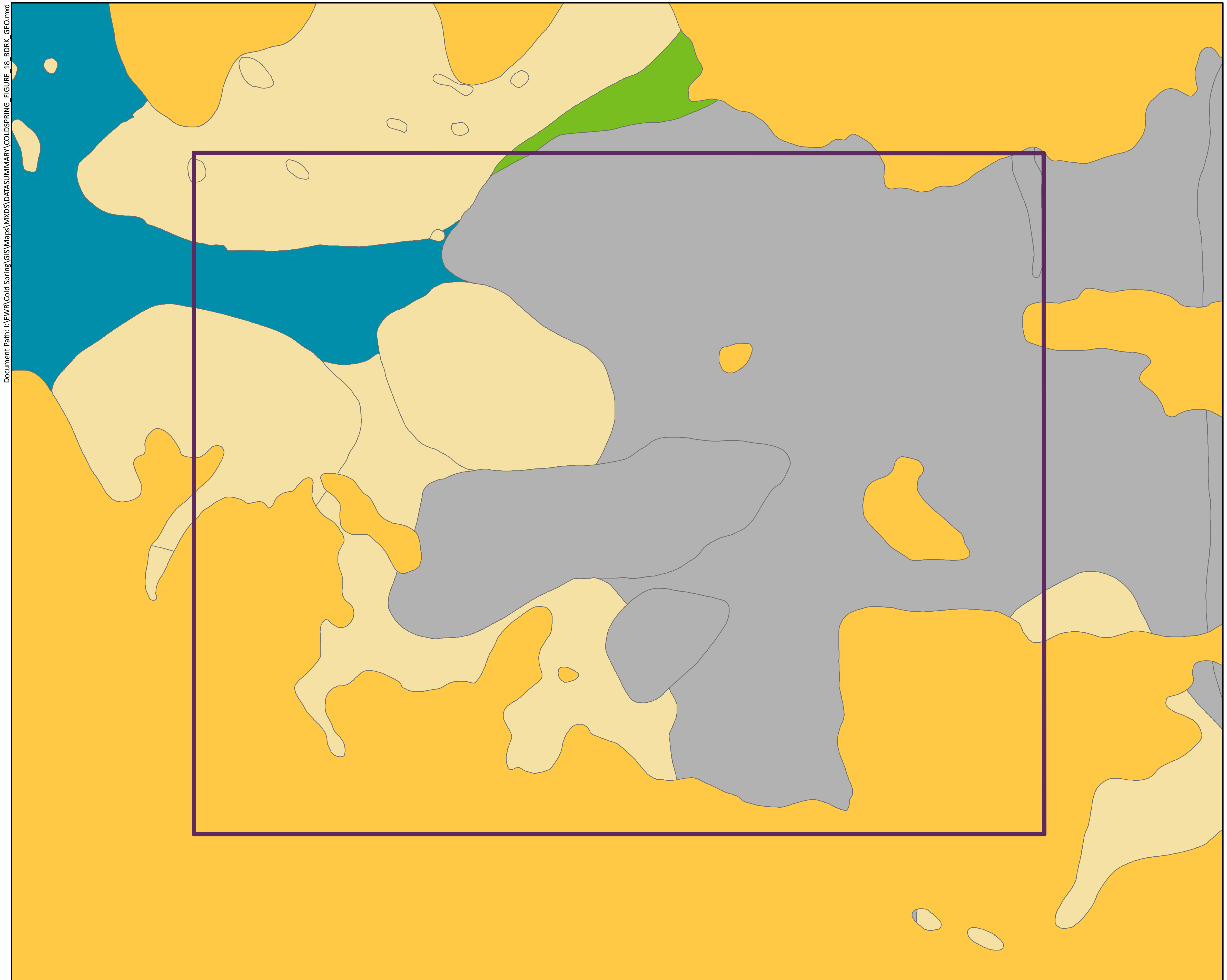

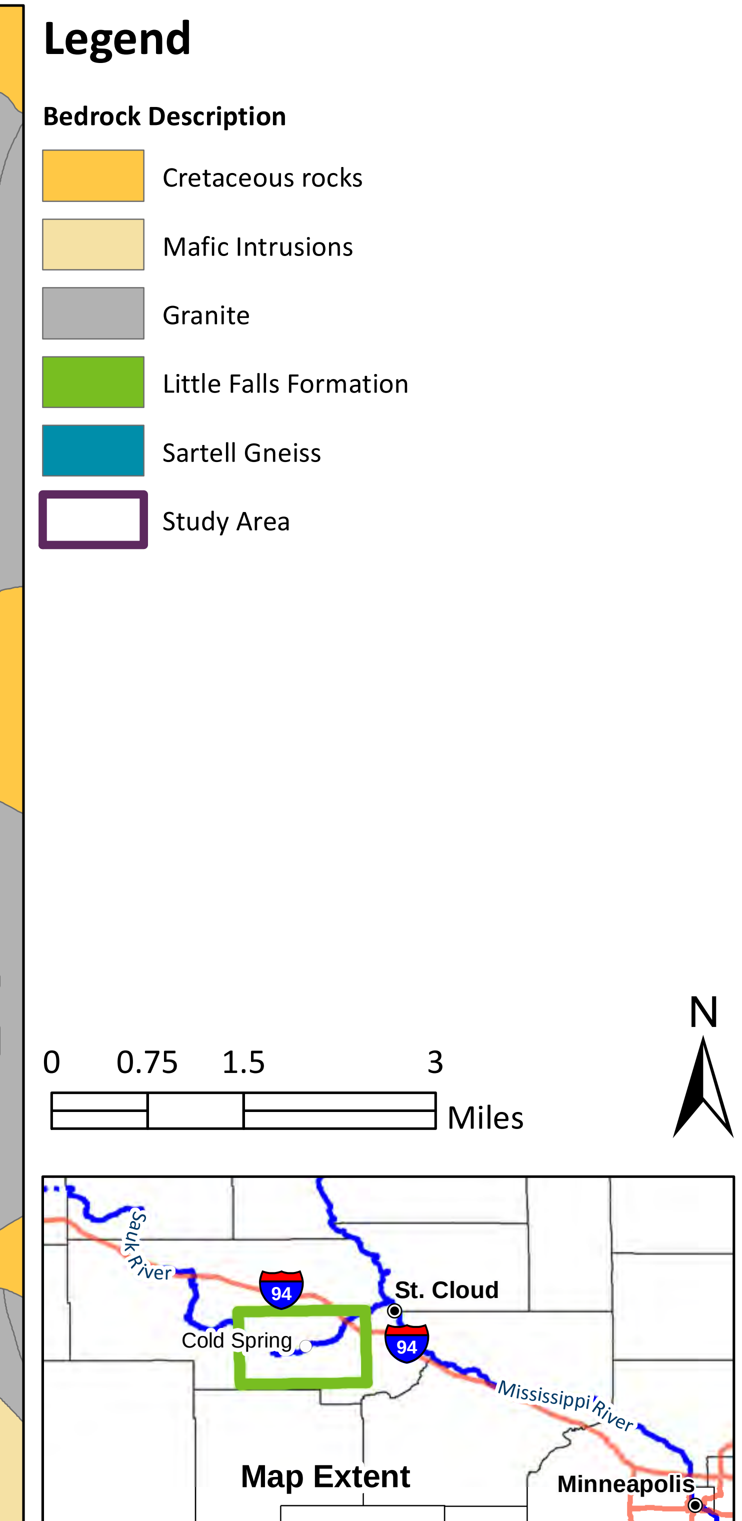

Figure 18. Bedrock Geology

Cold Spring Groundwater Study

Existing Data Summary Report

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Figure 19. Stratigraphic Column

Cold Spring Groundwater Study
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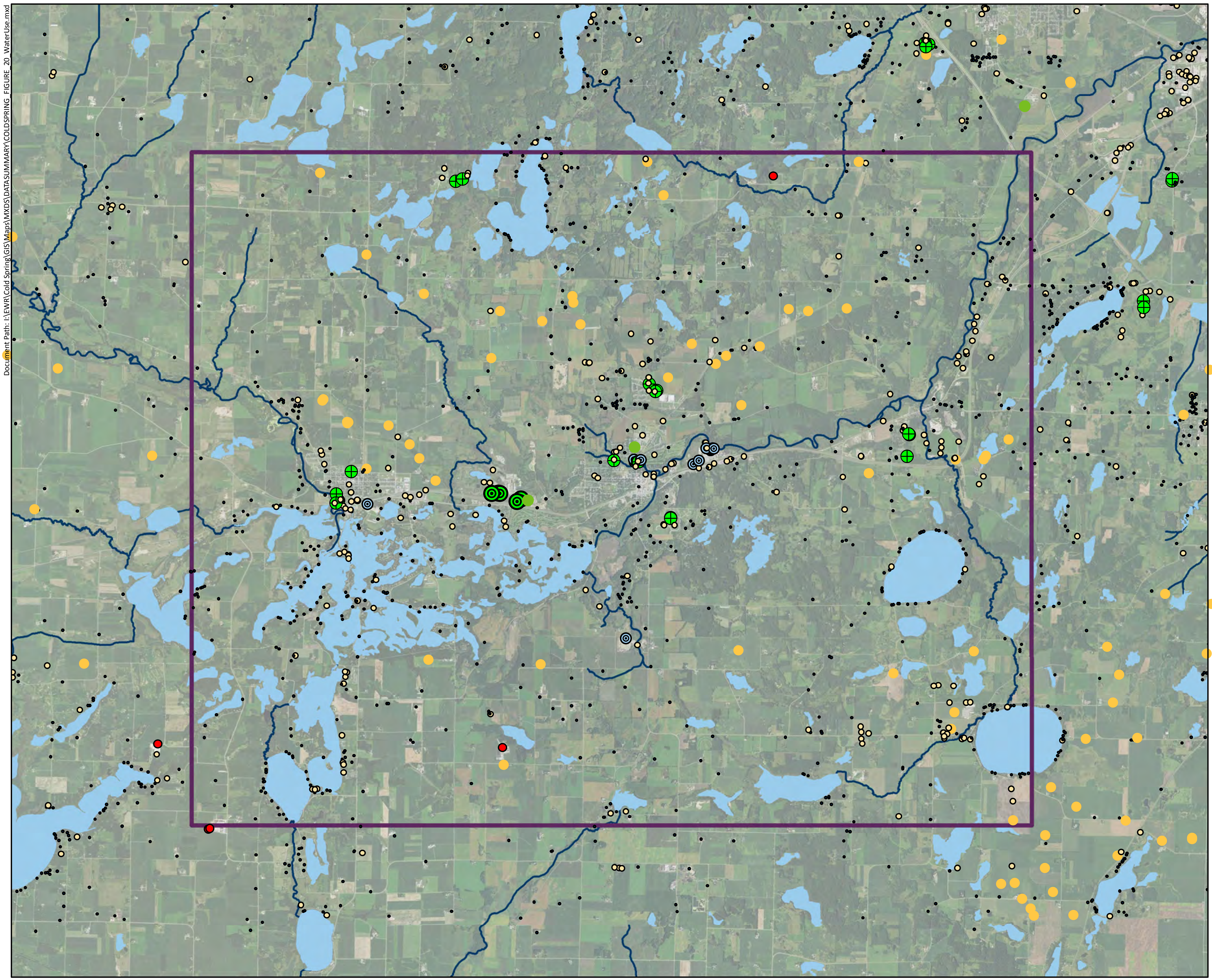

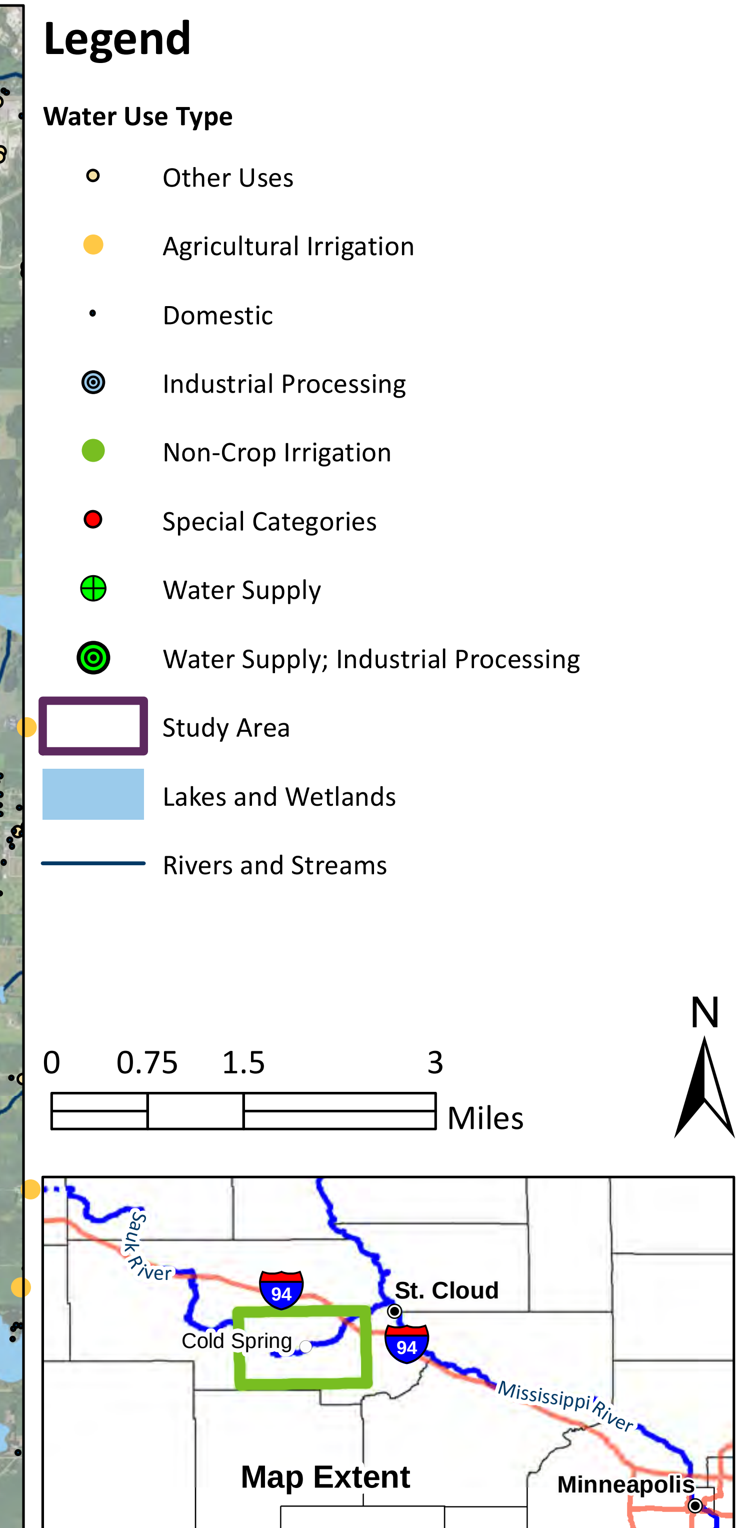

Figure 20. Water Use

Cold Spring Groundwater Study
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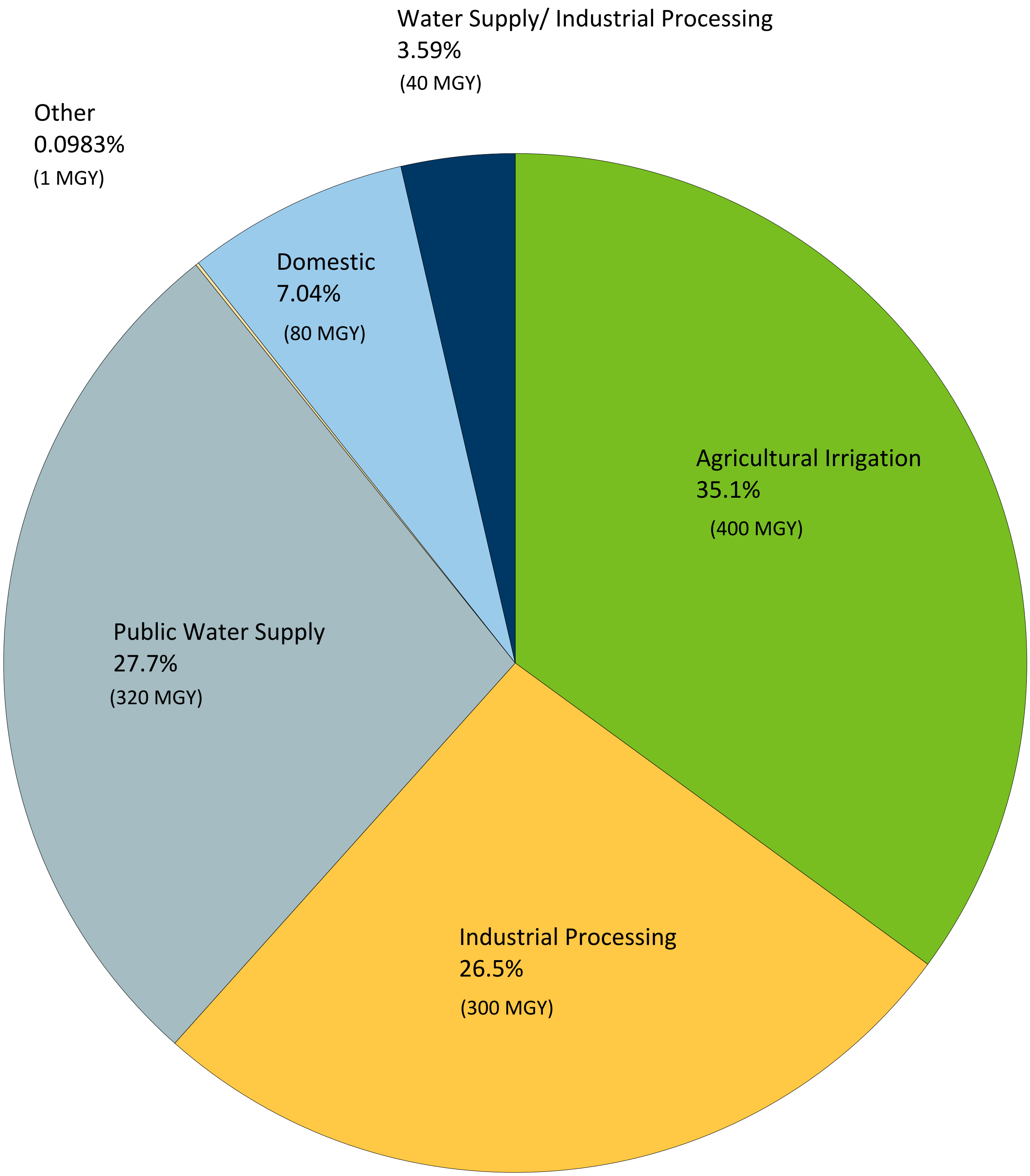

Figure 21. Water Use

Cold Spring Groundwater Study
Existing Data Summary Report

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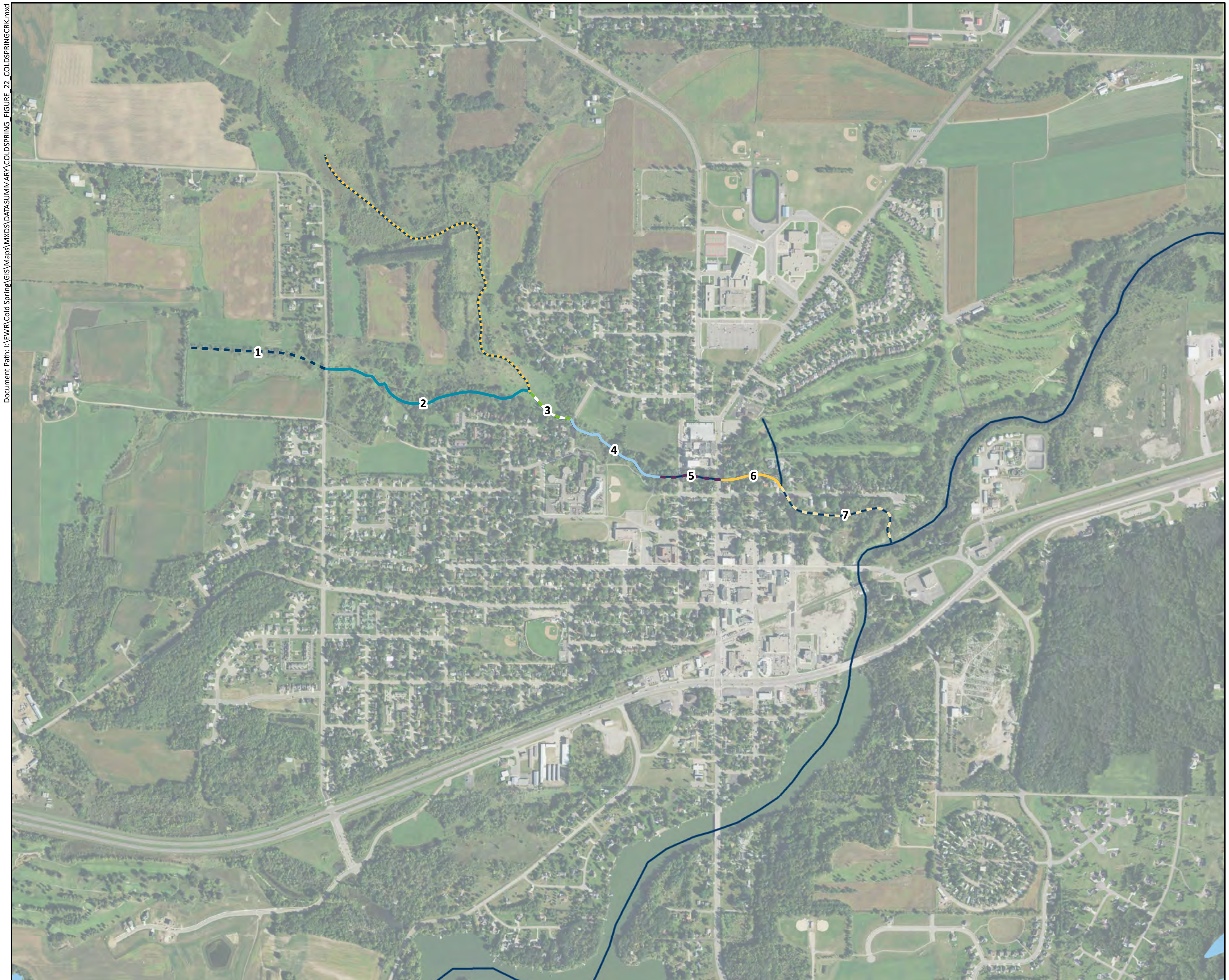

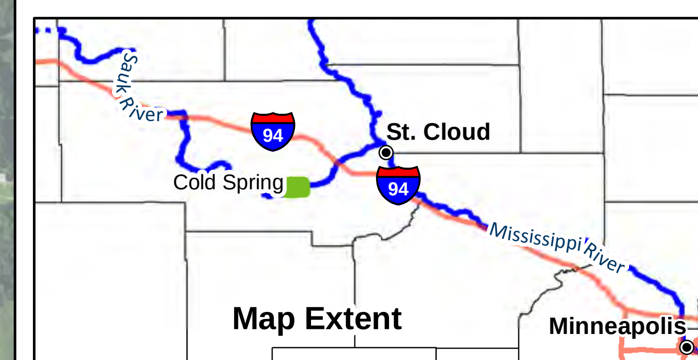

Figure 22. Cold Spring Creek

Cold Spring Groundwater Study
Existing Data Summary Report

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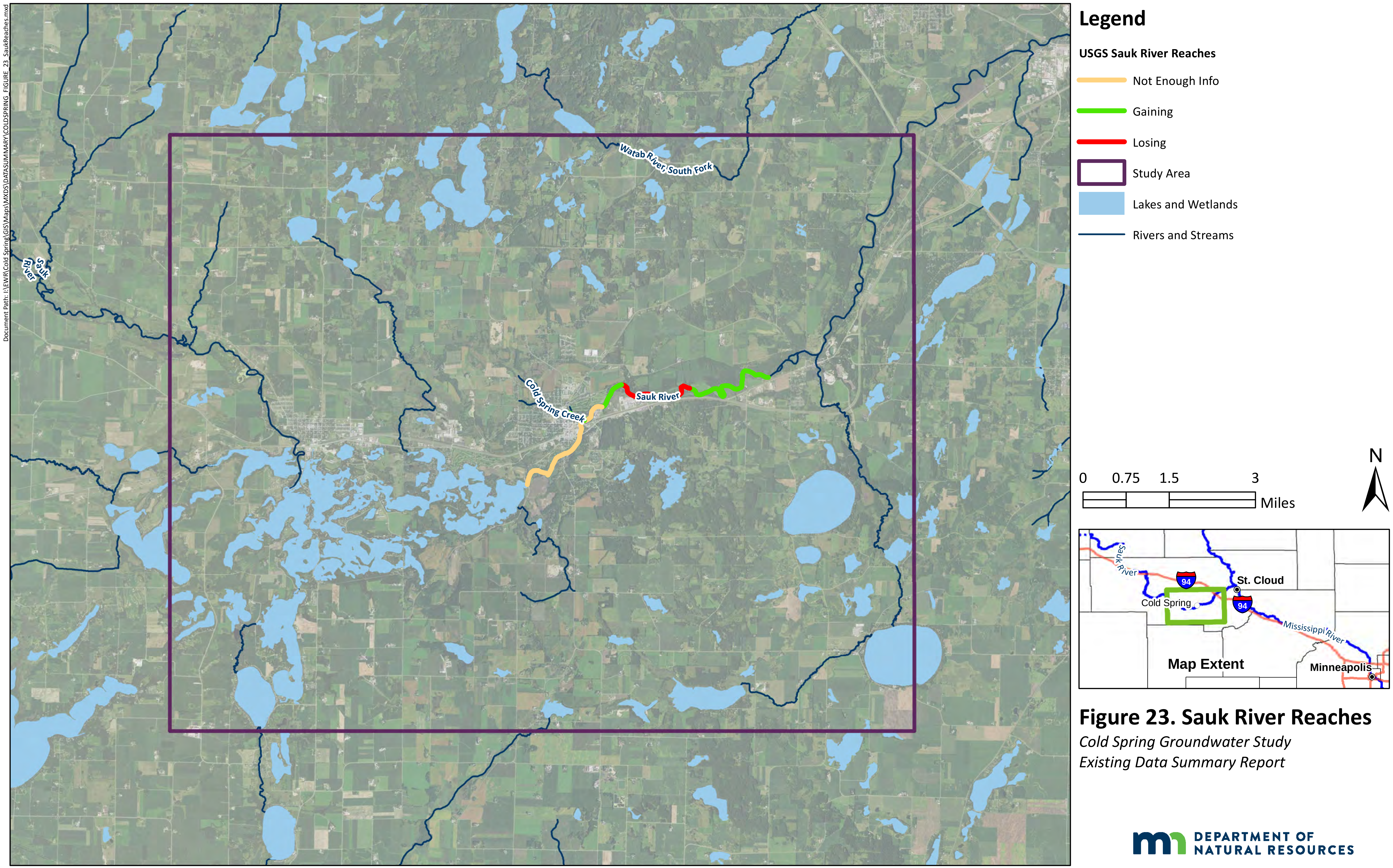

Figure 23. Sauk River Reaches

Cold Spring Groundwater Study
Existing Data Summary Report

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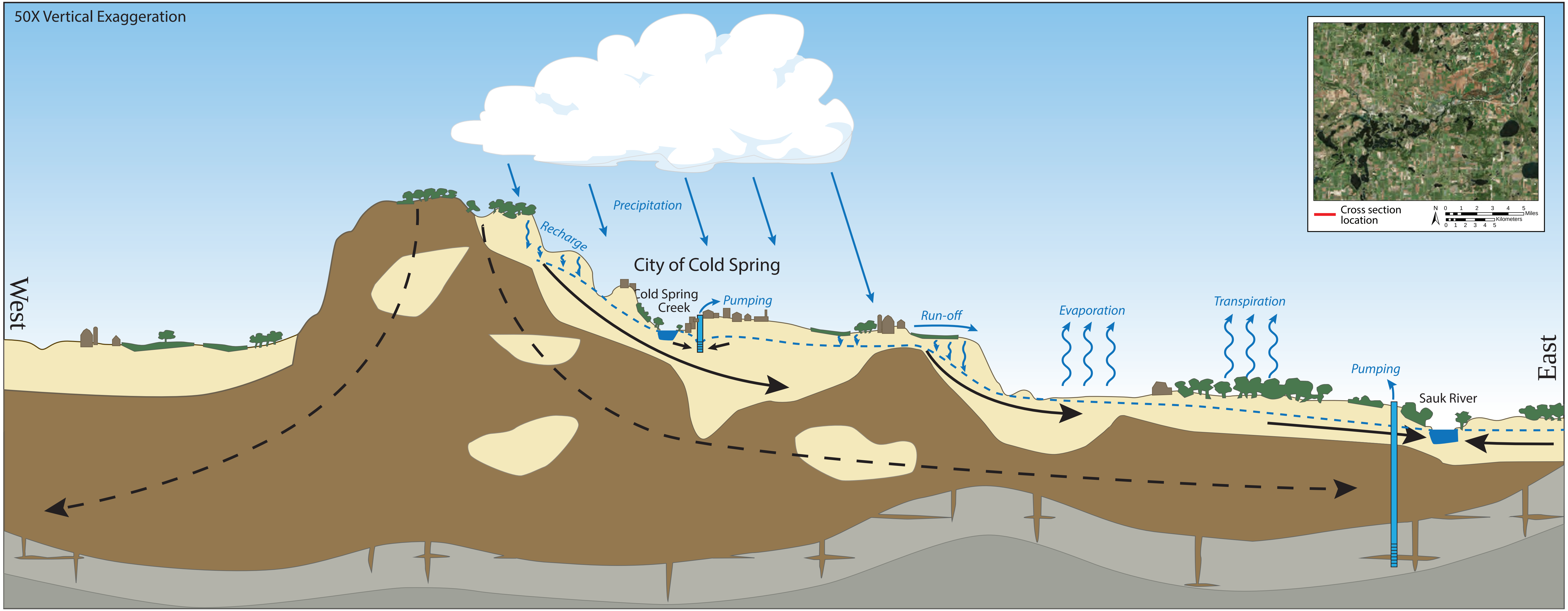

Assumed groundwater flow direction

Groundwater flow direction

Water table

Sand

Till

Fractured bedrock

Bedrock

Figure 24. System Representation

Cold Spring Groundwater Study
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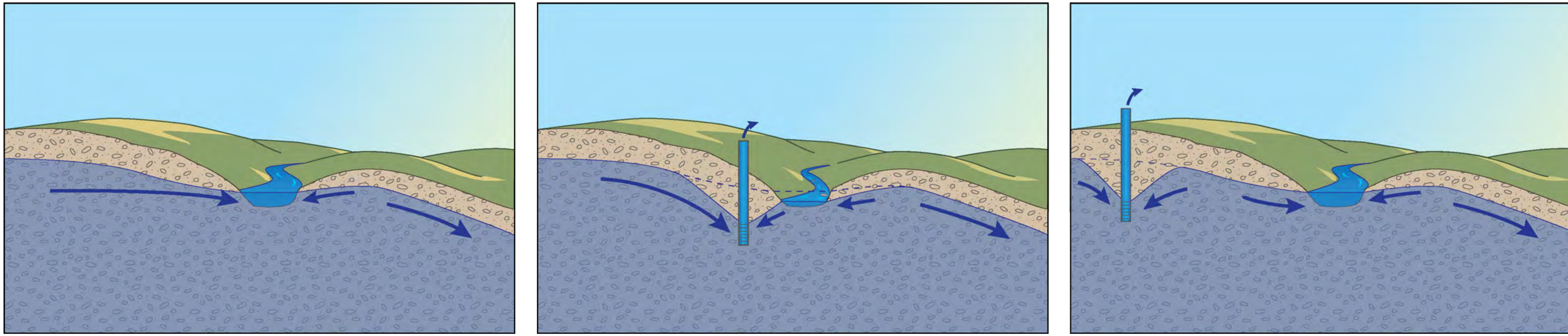
Natural State

Pumping Near to Stream

Pumping Far From Stream



In a natural state water flows to natural discharge points such as a stream or low points in the landscape.

When pumping takes place a cone of depression is formed. This is where the water table is below the natural water level. When this cone of depression is near a groundwater connected surface water body, water can be diverted from the surface water body.

When pumping takes place a cone of depression is formed. This is where the water table is below the natural water level. The further away the well is from a surface water body the less likely the cone of depression will remove water from the surface water body.

Figure 25. Pumping System

Appendix A

Table 1: Study area groundwater appropriation timeline

Date	Activity
1952	First groundwater appropriation in Cold Spring Area
May 1964	Cold Spring Brewery application for work in beds of public waters 1964-0492
May 1966	City of Cold Spring files statement on appropriation of water 1966-6428 Groundwater: One 12-inch well 65 feet deep 350 gpm Surface Water: 2 pumps 2400 gpm
Dec 1975	City of Cold Spring applied for appropriation permit (1976-3179) Rate: 1160 gpm Appropriation: 138 mgy
Jun 1977	Permits issued after June 3, 1977, to appropriate water from streams designated trout streams by the commissioner's orders under section 97C.005 must be limited to temporary appropriations.
Summer 1980	Two dewatering projects to install sewer lines. First resulted in creek drying up between Fifth and Eighth Aves. Second did not dry up stream.
Aug 1980	City of Cold Spring installs culvert to direct stormwater into creek
Sep 1980	DNR Report on Cold Spring Brewery Creek notes the concern of groundwater/stream interactions. Recommends increased monitoring, aquifer tests, and cooperative pumping schedule
Feb 1984	Cold Spring Brewery application for well (1984-3211; 24 mgy) for beer processing and cooling
Mar 1988	Cold Spring Brewery application for well (1988-3220; 24 mgy)
1990	Minnesota Legislature adopted Minn Stat 103G.285(2012) which provides in pertinent part that appropriation “permits issued after June 3, 1977, to appropriate water from streams designated trout streams…must be limited to temporary appropriations” This provision required DNR to give heightened protection to trout streams in evaluating surface water appropriations.
Aug 1990	River Oaks Country Club application for permit (22 mgy)
Aug 1994	ISD 750 Irrigation permit 8.7 mgy
Jun 1995	City initiates Wellhead Protection Planning
Jul 1995	Gold N Plump releases its Groundwater Resources Evaluation –Wellhead Protection Area Delineation Report which used MODFLOW to determine impacts from their well use to the City of Cold Springs Wellhead protection area.
1996	City Well 1 (241386) exceeds Nitrate HCML level of 10 parts per million
Aug 1997	Permit 1976-3179 is amended to increase appropriation from 138 MGY tp 148 MGY at a rate of 1055 gpm.
Jan 1998	MPCA issued NPDES permit for once through noncontact cooling water and reverse osmosis reject water for a max of 62,000 gpd (max 44,000 gpd) with 1/3 of discharge being reject reverse osmosis water and 2/3 being non-contact cooling water. Expiration date 12/31/2002
Nov 1998	City well 4 constructed
Feb 1999	Request to transfer of permits 1984-3211 and 1988-3220 to Gluek Brewing Company. Permit transferred under the name REFLO Inc June 24,1999
Nov 1999	City well 5 constructed

Table 1: Study area groundwater appropriation timeline

Date	Activity
Unknown	Cold Spring Brewery applied for an amendment to add well #718237 and to increase authorization from 24 mgy to 80 mgy and to increase pumping rate from 100 to 500 gpm combined (100 gpm for 253011 and 400 gpm from well 718237)
Apr 2000	Permit 1976-3179 is amended to add wells 4 and 5. Volume stays the same (148 MGY) but max rate changes to 2315 gpm.
2001	USGS Groundwater investigation and model
Dec 2002	City Well 6 constructed
Sep 2003	Permit 1976-3179 is amended to increase appropriation from 148 MGY to 210 MGY. Rate remains 2315 gpm. 6/21/2004 Permit 1976-3179 is amended to increase appropriations from 210 MGY to 250 MGY. Rate increases to 3115 gpm. Well 6 is added.
2005	Gluek Brewing and Reflo requested to amend permit 1984-3211 to increase its appropriation to 60 mgy. Well 253011 was shifted to a standby well and #718237 became the primary source of appropriation. The DNR authorized the appropriation.
2006	The City of Cold Spring leased City Well 1 to Gluek Brewing Co which is located 435 feet from Cold Spring Creek.
2006	Reflo Inc for Gluek Brewing Co reported it had extracted 65.5 mgy in 2005 (5.5 million over it's authorized volume) and asked for an amendment to increase the volume to 80 mgy from well 718237
2006	Fish Kill on Cold Spring Creek (unknown cause)
Mar 2006	DNR approved amendment of permit 1984-3211 to authorize 80 mgy at a pumping rate of 500 gpm and permit 88-3220 to authorize 20 mgy at a pumping rate of 120 gpm
Dec 2006	Gluek Brewing Company may be expanding and City may allow use of old well by brewery. DNR advises additional testing to make sure there is no impact on the trout stream as a result of using this well.
2009	Fish Kill on Cold Spring Creek due to fire hydrant flush with chlorinated water
Apr 2009	Request by Cold Spring Brewery to amend Permit 1984-3211 to include well #241386 at 350 gpm and increase appropriation to 145 mgy. For the four previous years, they leased this well from the city and pumped volumes of of 39.8, 132.8, 114.3, and 132.8 million gallons
Jun 2009	DNR reviews stream information and determines that baseflow is reduced by pumping
Aug 2009	DNR tells Brewery they need to install loggers in observation wells 620734 and 620740 before the DNR can evaluate the amendment
9/17 - 10/8/2009	Data loggers deployed at 620734 & 620740
Dec 2009	DNR reviews monitoring results and determines that the drawdown from pumping reaches the trout stream

Table 1: Study area groundwater appropriation timeline

Date	Activity
Jun 2010	MN Statute 103G.287 Subdivision 2 added which acknowledges relationship of groundwater to surface water resources and makes appropriations that will have a negative effect upon surface water resources subject to 103G.285 (limited to temporary impacts).
Feb 2012	Permit is amended for 2 years to enable monitoring of impacts on the trout stream.
Mar 2012	Fisheries released a Stream Survey Report on Cold Spring Creek alternatively known as Brewery Creek. A stage logger was used to estimate discharge between 2002 and 2011 but was removed upon landowner's request.
Jan 2013	DNR sends letter to Cold Spring Brewery Company stating the permit volume will not be reduced to 80 mgy from 145 mgy immediately because they have demonstrated progress towards finding a new water source
Mar 2013	DNR received letter from City of Cold Spring asking for a 10 month extension on the Cold Spring Brewery permit (expiring 12/31/2014 instead of 2/28/2014) because the Brewery asked the City to provide them with the water and the City could not find a location to build a new well field. They needed time to do so.
Apr 2013	DNR responds to request for 10 month extension explaining MN Rules 6115.0750, subpart 2 prevents the extension of the permit. "..*a temporary permit is a one-time, limited life, not more than 12 months, nonrecurring appropriation of waters of the state. Requested time extensions shall be permitted but in no case shall the total length of time the permit remains in force exceed two years*."
Jun 2013	On June 18, 2013, Cold Spring Brewing submitted a written request to the DNR to extend Limited Permit 1984-3211 by 10 months to December 31, 2014. The letter requesting the extension was accompanied with numerous documents evidencing the Cold Spring Brewing's attempts to locate a new well field that would not adversely impact Cold Spring Creek or the City of Cold Spring's water supplies and which was not adversely impacted by nitrate concentrations.
Jul 2013	Minn. Stat. § 103G.285, subd. 1 (2012), authorizes the commissioner or his delegate to waive a limitation or requirement in subd. 5 for "just cause." The DNR approved the requested extension of Limited Permit 1984-3211 for "just cause". DNR sends letter to Cold Spring Brewing extending their permit 1984-3211 to December 31, 2014 with the following requirements: that new wells cannot impact Cold Spring Creek. They must provide DNR with the required info to evaluate new wells, they must find ways to reduce pumping in existing wells that impact the Creek, and permit 1984-3211 will be terminated after Dec 31, 2014.
Aug 2013	Cold Spring Brewing responded to letter saying they did not agree with terminating the permit after December 31, 2014. They wanted to go back to the original authorized volume of 24 mgy. One reason given was that they would need an additional 18.8 mgy from the city because they would have to RO treat the water first.

Table 1: Study area groundwater appropriation timeline

Date	Activity
Aug 2013	Cold Spring Brewery sent letter to DNR with a check for $500 stating they wanted to hold a hearing to contest the termination of their permits if the DNR pursued that line of action.
Oct 2013	Cold Spring Brewery applied for a construction dewatering permit for 30 manifolded wells near the stream to use between 11/11/13 and 11/22/13 for a total of 6 mgy at a rate of 300 gpm. Water to be discharged into the stream.
October 2014 - March 2015	DNR collected GW level data in wells 620740 and 620735 and correlated it to stream monitoring data at stations H16011007 and H16011008. Cold Spring Brewery shuts down over the holiday. A drop in Creek water level was seen when pumping resumed. The fourth condition was later changed to the submission of monthly updates on the progress made to complete a new water supply system prior to December 31, 2014
Jul 2014	The DNR analyzed available data to determine if groundwater appropriations have a negative impact. It was concluded that all permitted pumping in the area combines to reduce flow by as much as 1 cfs (approximately one-third of what would otherwise be the creek's flow).
Nov 2014	The city of Cold Spring and Cold Spring Brewing Company submitted a progress plan and requested an extension to Limited Permit 1984-3211 for three years to December 31, 2017
Dec 2014	Findings of fact for permit 1984-3211 is completed concerning a request by Cold Spring Brewing Company to extend the limited permit to December 31, 2017 while it works with the city to develop a new well field.
Jul 2016	The DNR was directed by the Legislature to "conduct necessary monitoring of stream flow and water levels and develop a groundwater model to determine the amount of water that can be sustainably pumped in the area of Cold Spring Creek for area businesses, agriculture, and city needs". Additionally, the DNR was directed (by Legislature) to increase the authorized volume for the City of Cold Spring by 100 million gallons for a 10 million gallon reduction in pumping from wells near Cold Spring Creek.
Aug 2016	Cold Spring Brewing and City of Cold Spring agree to reductions of 3MG on permit 1976-3179, 3MG on permit 1984-3211 and 4MG on 1988-3211 to meet the 10MG reduction requirement for 100 MG increase in authorized volume for City of Cold Spring for five years.
Dec 2016	The City of Cold Spring's permit 1976-3179 was amended to pump up to 347 mgy, an increase of 100 mgy per legislative decree (less 3 MG as agreed upon with Cold Spring Brewing. The authorized volume will return to 250 mgy after 12/31/2021 unless other arrangements are approved. Cold Spring Brewing permits were also amended to reduce authorized volumes.

Appendix B

Category	Name	Description	Source	Changes/Updates	Quality of Data (Poor/fair/Good/Excellent)	Quality of Spatial Data (Poor/fair/Good/Excellent)	GIS File Available
Wells							
	Coldspring Brewery pumping schedule	The general schedule of the times and rates that the Cold Spring Brewery pumps their wells	DNR/ColdSprings Brewery/ City of Cold Springs.	None	Poor	Poor	No
	Water Levels from the Department of Agriculture	Annual water levels from the Department of Agriculture from 2000 to 2014	DNR staff folder/Department of Ag	None	NA	NA	
	Nested wellls	Inactive nested USGS wells within the model boundary	USGS NWIS	This list was manually compiled using the NWIS mapper web site. Sites with multiple wells shown in the Mapper tool within the model boundary were manually entered into an Excel database. V-lookup was used in Excel to fill in the table using a complete table of inactive sites downloaded from the USGS NWIS Mapper website.	Fair	Good	Yes
	DNR Appropriation Permits	A list of all appropriation permits within the model boundary, their water use type, resource, Well ID,and well depth.	DNR	None	Good	Good	Yes
	Terminated DNR Appropriation Permits	Terminated DNR water appropriation permits within the model boundary	DNR	None	Good	NA	No
	Significant Permit Changes	A list of significant changes with appropriation permits within the model boundary such as suspending appropriations due to low flows.	DNR	None	Poor	Poor	No
	MNDOT well borings	GIS layer showing locations and general information about MNDOT well borings within the model boundary including hyperlinks to the boring records.	MNDOT	None	Good	Good	Yes
	CWI wells within model Boundary	CWI well information extracted from the CWI database and the GIS CWI Layer	CWI	None	Fair	Excellent	Yes
	MNDOT Gint files	MNDOT excel files exported from Gint with all of the soil boring information.	MNDOT	None	Good	Good	Yes
	DNR Observation Wells	Water Levels in DNR observations wells 243606, 243607, 244477, 244479, 277950, 620735, 620740, 761575, 772787, and 810703	DNR	None	Good	Good	Yes
	Domestic well information	Domestic well information gathered with permit applications.	MPARS permit files	None	Poor	Poor	No

Category	Name	Description	Source	Changes/Updates	Quality of Data (Poor/fair/Good/Excellent)	Quality of Spatial Data (Poor/fair/Good/Excellent)	GIS File Available
Wells							
	Surveyed Wells	A list of 22 wells that the DNR surveyed the ground and measuring point elevations within the model boundary. City wells 4, 5, and 6 are included on this list.	DNR groundwater technical unit	None	good	fair	No
	Domestic water levels from USGS	Water levels in 31 domestic wells from the winter of 1998 that the USGS used for their groundwater model in Stearns County.	USGS	None	Good	Good	Yes
	Water levels in observations wells from USGS	Water levels in 28 observation wells from December 1998 that the USGS measured and used in their Stearns County groundwater model.	USGS	None	Good	Good	Yes
	Wells located within USGS groundwater model boundary	A list of all wells within the USGS groundwater model for Stearns County with their static water level data	USGS	None	Fair	Good	No
	Water Appropriation wells used in USGS groundwater model.	Water Appropriation Data used in USGS Model (1988-1998)	USGS	None	Fair	Fair	No
	USGS Groundwater Model files	Scanned documents from the USGS files for their model including geology maps, cross sections, and wells used in their model.	USGS	None	Fair	Fair	No
	Appropriation permits with monitoring requirements	Permits within the model boundary with water level monitoring requirements	DNR	None	Poor	Poor	No
	Reported water use not in MPARS database	Known Reported water use from permits before 1986	DNR	None	Good	Poor	No
	DNR Cold Spring Piezometer	Logger data from a piezometer placed in Cold Spring Creek near the brewery December 2016 - January 2017	DNR	None	Good	Poor	No
	USGS NWIS wells	A list of wells within the model boundary with water level data exported from the NWIS Mapper website.	USGS	None	Fair	Excellent	Yes
	Water Levels for permit 2009-0573	Water levels in wells 270374 and 770859 for 2010 associated with monitoring requirements on permit 209-0573	DNR	None	Good	Poor	

Category	Name	Description	Source	Changes/Updates	Quality of Data (Poor/fair/Good/Excellent)	Quality of Spatial Data (Poor/fair/Good/Excellent)	GIS File Available
Wells							
	Water levels in wells 620704, 628958, and 628959 between 2000 and 2017	Water levels in nested wells near the City of Cold Spring	MNDA	None	Good	Poor	No
	CWI wells with static water levels	A GIS shapefile and table with all of the CWI wells within the model boundary with static water level information.	CWI	An Access database was used to query all CWI with static water levels within Stearns county. These were imported and clipped to the model boundary in GIS.	Fair	Excellent	Yes
Hydrogeology							
	Potential Recharge	USGS Calculated Potential Recharge	USGS	None	Excellent	Excellent	Yes
Surface Water							
	Lake water levels	Water level data for the following lakes; Big Fish(1966-2016), Big(1949 -2016) , Cedar Island(1967-1999), Gooders(1967-2005), Grand (1937 -2016) , Horseshoe(1979 - 2006) , Knaus(1967,1983 - 2016), long (2000-2016), Long73-139 (2000-2016), Marty(1984-1986), North Browns(1967,1981-2016), Pearl (1946, 1981-2016)	DNR	None	Good	Good	Yes
	List of all Lakes within Model Boundary	Public water basins within model boundary	DNR	None	Good	Good	Yes
	Loctions of DNR and MPCA stream monitoring locations	GIS file showing locations of DNR and MPCA monitoring locations within the model boundary	Minnesota Geospatial Commons/ MPCA Environmental Data Access	None	Good	Good	Yes
	Locations of temporary USGS gaging stations	Locations of USGS gaging stations used to collect discharge data for building the groundwater model in Stearns County	USGS	None	Good	Fair	Yes
	Stream Gage data used in USGS Groundwater Model	A list of the stream gage stations, their locations, and the discharge measurements taken in October 1998 and August 1999 by the USGS to use in their Groundwater Model.	USGS	None	Good	Good	Yes

Category	Name	Description	Source	Changes/Updates	Quality of Data (Poor/fair/Good/Excellent)	Quality of Spatial Data (Poor/fair/Good/ Excellent)	GIS File Available
Surface Water							
	Inactive USGS stream gage sites within model boundary	Discharge measurements from active and inactive stream gages within or in close proximity to the model boundary. Dates of measurements range from 1946-2017.	USGS NWIS	Data from wells 5272000 ,5272600 ,5273498 ,5273510 ,5270304, did not export directly fromt eh NWIS website so data for these were copy and pasted to the end of the table that was directly downloaded from the NWIS website. Coordinates for the wells were in a separate table so Vlookup was used in Excel to match the wells with the correct coordinates.	Good	Good	No
	Logger Data of Coldspring and Kinzer Creek discharge from DNR fisheries	Stage logger data from Coldspring Creek from 2002-2011 and Kinzer Creek Discharge measurements from 2004-2010 collected by DNR fisheries.	DNR Fisheries	None	Fair	Fair	No
	Cold Spring Creek Discharge Measurements	Discharge measurements from DNR gaging stations along Cold Spring Creek.	DNR Monitoring	None	Fair	Fair	No
	Wells with incorrect locations	Wells incorrectly located in MPARS and or MWI	DNR	None	Good	Poor	No
	DNR Stream gaging sites	Locations of DNR stream gages in Stearns County	DNR	None	Good	Good	Yes
Climate							
	Precipitation Data in Stearns County	All Precipitation data available in Stearns County from the DNR climatology group.	DNR Climatology	None	Good	Fair	No
	Precipitation Data from Albany 4.0 N Station	Daily precipitation data from 12/20/2009 to 1/6/2017 at the Albany 4.0 N Station	CliMATE	None	Fair	Poor	No
	Precipitation data from Albany Radio KASM Station	Daily precipitation data from 12/1/1975 to 12/31/1975 at the Albany Radio KASM Station. The station is no longer active.	CliMATE	None	Poor	Poor	No
	Precipitation data from CollegeVille Station	Daily precipitation data from 1/12/1892 to 1/5/2017 at theCollege Ville Station.	CliMATE	None	Excellent	Poor	No
	Precipitation data from Kimball 3N Station	Daily precipitation data from 2/25/2003 to 1/5/2017 at the Kimball 3N Station.	CliMATE	None	Good	Poor	No
	Precipitation stations in Stearns County	A list of 18 precipitation stations in Stearns County, their beginning and end dates of records avaialable, and their coordinates.	CliMATE	Manually entered some of this data fromt eh website into the table	Good	Good	Yes

Category	Name	Description	Source	Changes/Updates	Quality of Data (Poor/fair/Good/Excellent)	Quality of Spatial Data (Poor/fair/Good/Excellent)	GIS File Available
Climate							
	DNR Precipitation Stations in Stearns County	A list of precipitation stations within Stearns County that the DNR collects data for. (H16011007, H16011008, H16002001, H16051001, H17008003 , H18071001, and H18071002).	Erynn Jenzen from DNR	None	Fair	Fair	Yes
	Climate trends for Region 5; Temperature, precipitation, Palmer Drought	NOAA's climate trend data for region 5	NOAA	None	Good	Good	No
Model Information							
	SWB Manual	Manual for using the SWB model to calculate recharge	SWB website	None	NA	NA	No
	Modflow Manuals	Manuals for all Modflow packages, solvers, and processes	USGS	None	NA	NA	No
	Cold Spring Wellhead Protection Plan	Plan to protect groundwater around the City of Cold Spring analysis includes a model	MDH	None	Good	Poor	Yes
Geology							
	DNR Groundwater Atlas Cross Sections	Geological Cross Sections completed by the DNR Groundwater Atlas Group when Stearns County was completed in the 1990s	DNR Atlas Group	Clipped cross sections to model boundary	Good	Good	Yes
Other							
	Landcover 1992	National Land Cover Data Set - 1992	Multi-Resolution Land Characteristics Consortium (MRLC)	None	Poor	Excellent	Yes
	Landcover 2001	National Land Cover Data Set - 2001	Multi-Resolution Land Characteristics Consortium (MRLC)	None	Excellent	Excellent	Yes
	Landcover 2006	National Land Cover Data Set - 2006	Multi-Resolution Land Characteristics Consortium (MRLC)	None	Excellent	Excellent	Yes
	Landcover 2011	National Land Cover Data Set - 2011	Multi-Resolution Land Characteristics Consortium (MRLC)	None	Excellent	Excellent	Yes
	MPCA contaminated site (MPCA What's in my neighborhood)	Four known remediation sites within the model boundary that have or had groundwater contamination.	MPCA	None	Fair	Poor	No
	MDA What's in my neighborhood	Locations of remediation sites one within study area with prior groundwater contamination	MDA	None	Fair	Poor	No

Category	Name	Description	Source	Changes/Updates	Quality of Data (Poor/fair/Good/Excellent)	Quality of Spatial Data (Poor/fair/Good/Excellent)	GIS File Available
Other							
	United States Department of Agriculture (USDA) CropScape and Cropland Data Layer 2008-2016	Crop type layers	USDA	None	Excellent	Excellent	Yes
Aquifer Tests							
	Gold'N Plump #456037	Aquifer test completed for Gold N' Plump facility November 1993 from well 456037	MDH	None	Fair	Good	No
	Gold'N Plump Unknown Well	Aquifer test completed March 10, 1980	Traut	None	Poor	Poor	No
	Specific Capacity Test #241386		MDH	None	Poor	Poor	No
	City of Cold Spring #241387	Aquifer test completed 11/1/1997 from well 241387	MDH	None	Good	Good	No
	City of Cold Spring #614989	Aquifer test completed August 1998 from well 614989	MDH	None	Fair	Good	No
	City of Cold Spring #686699	Aquifer test completed February 2003 from well 686699	MDH	None	Good	Good	No
	City of Cold Spring 632093 and 614989			None	Fair	Fair	No
	Pump Test #792112	7.75 hour pump test completed on well 792122 on October 17, 2012		None	Poor	Poor	No
	Pump Test #277966	5 hour pump test completed on well 277966	DNR	None	Poor	Poor	No
	Aquifer Test #160147	Aquifer test completed 2/9/2000 from well 160147	DNR	None	Fair	Fair	No
	Aquifer Test #124212	Aquifer test tompleted sometime between 1969-1971 from well 124212	Report: Ground-Water Appraisal of Sand Plains in Benton, Sherburne, Stearn, and Wright Counties, Central MN, pg 21	None	Fair	Fair	No
	Aquifer Test #737006 and 737007	Aquifer test tompleted 2/5/2006 from wells 737006 and 737007	DNR	None	Fair	Fair	No
	Aquifer Test #737008	Aquifer test completed 2/8/2016 from well 737008		None	Fair	Fair	No
	Pump Test #770859	4 hour pump test completed 4/30/2009 on well 770859	DNR	None	Fair	Fair	No

Category	Name	Description	Source	Changes/Updates	Quality of Data (Poor/fair/Good/Excellent)	Quality of Spatial Data (Poor/fair/Good/Excellent)	GIS File Available
GIS							
	DNR Groundwater Atlas shapefiles	Shapefiles used by the DNR to make the Stearns County Groundwater Atlas	DNR	Assigned a coordinate system using the define tool in GIS. The readme text file associated with the shapefiles stated what coordinate system the shapefiles were in.	Excellent	Good	Yes
	MNDOT well borings	Locations of MNDOT well borings in the model boundary	MNDOT	None	Good	Fair	Yes