DEPARTMENT OF NATURAL RESOURCES

Project Update on the Expansion and Enhancement of the Groundwater Monitoring Network for the 11-County Metropolitan Area

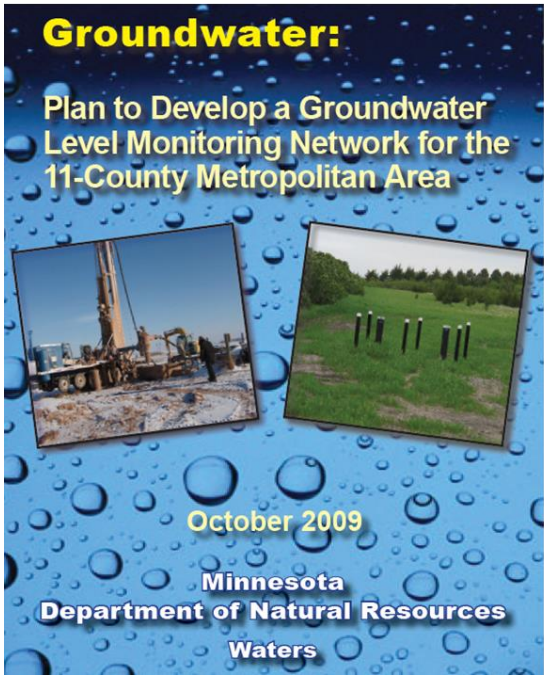
4/24/2018

Long-term plan objective

"The ultimate purpose of monitoring is to inform policy decisions and management actions. The backbone network can **provide information on trends, data for modeling, and assist in problem identification.**"—2009 DNR report "Plan to Develop a Groundwater Level Monitoring Network for the 11-county Metropolitan Area"

Background information

In 2009, the Legislature tasked DNR to develop plans to ensure the long-term protection of the State's surface water and groundwater resources (Figure 1). This document is a status update on the groundwater monitoring network expansion for the 11-County Twin Cities Metropolitan Area (TCMA). This project started in 2010 and this report outlines the progress that has been made to enhance the network and identifies plans and needed resources to continue the expansion of and to maintain the observation well network.



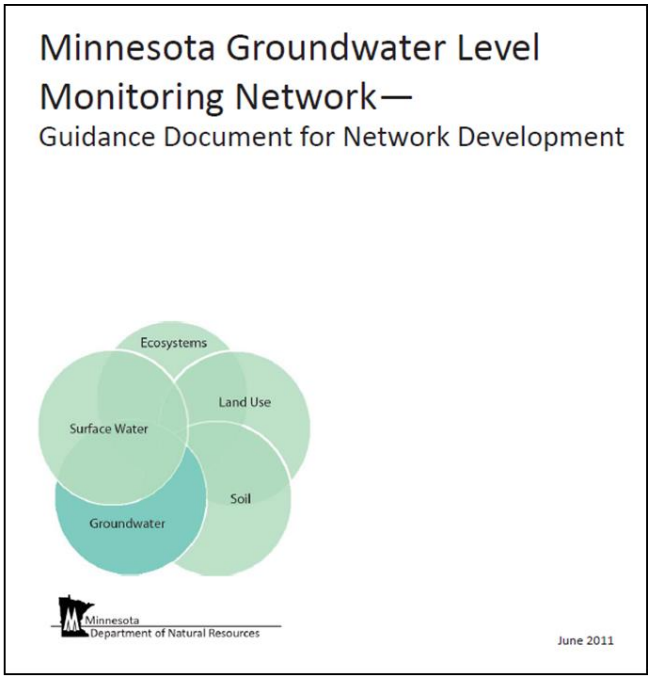


Figure 1. Two Minnesota DNR reports directing agency plans for groundwater monitoring.

Why is the network needed?

Groundwater is the primary resource for drinking water in the TCMA, accounting for 63% of use in the past ten years and increasing in volume on average by 3.3 billion gallons from the previous decade (Figure 2). In addition

to the DNR, numerous other agencies, scientists, and consultants use data from the observation well network to:

- assess impacts of cumulative use
- refine wellhead protection areas
- enhance the understanding of geologic and hydrogeologic characteristics
- calibrate and evaluate groundwater models
- assess resources for sustainable use and impacts from climate change

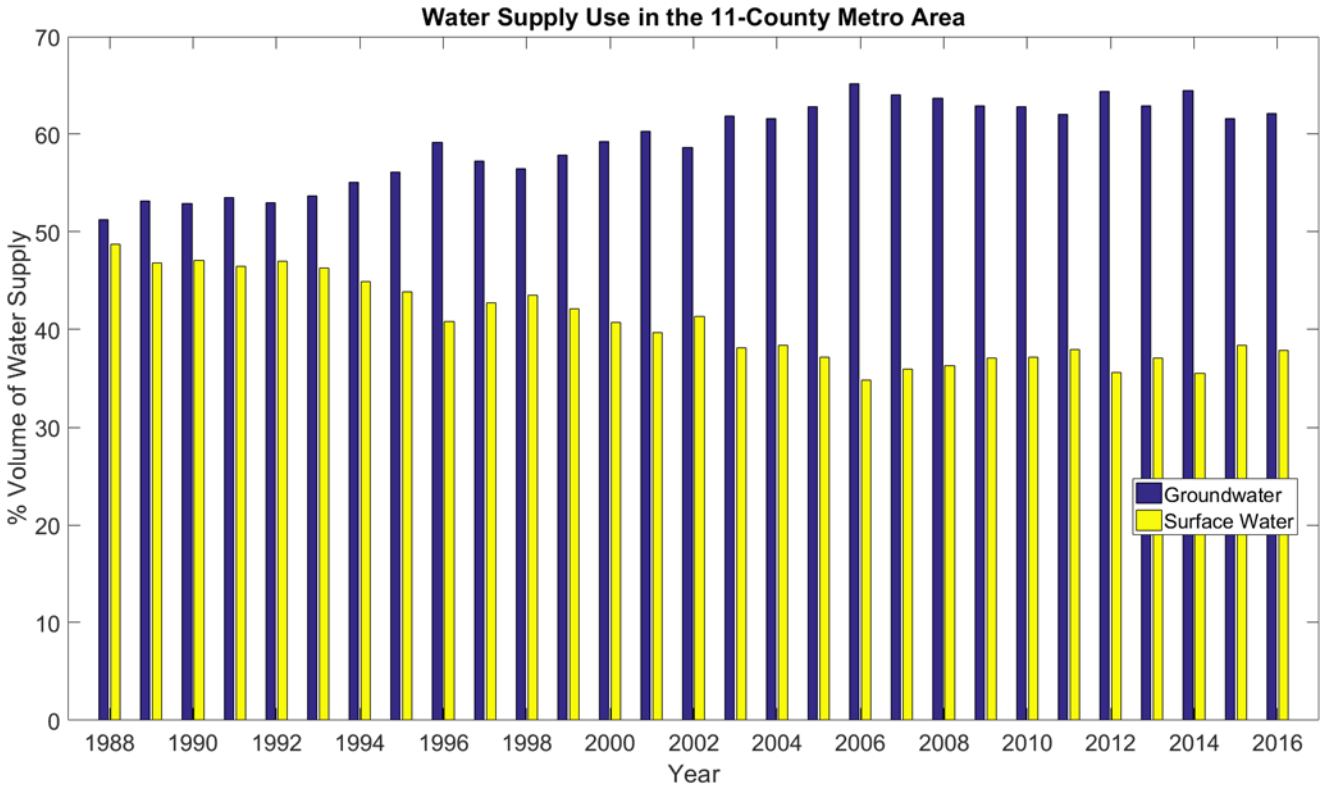


Figure 2. DNR reported water use for water supply in the 11-County Metropolitan over time by surface water and groundwater.

Summary of the existing network

Recent enhancements to the DNR groundwater monitoring network have concentrated on three major categories outlined in Table 1 of the 2009 report: Observation well network establishment, technical support/quality control/groundwater analysis, and data management and access through the web portal.

Network enhancements

Develop the DNR observation well network and initiate a targeted monitoring network

- The TCMA observation well network more than doubled since 2009—**113 wells in 2009, 148 added since** (Figure 3).
- As of January 2018, there are **261 observation wells at 167 sites, 58 of which are observation well nest sites where multiple wells monitor various aquifers and depths**.
- **212 out of 261 (81%) wells are instrumented with data loggers** that record hourly water levels.
- Work has **concentrated in parts of the TCMA with emergent resource concerns** (Dakota County and Northeast Metropolitan area.
- In addition to DNR observation wells, **data from 50 production wells in eight municipal well systems** are uploaded to DNR's database on a daily schedule.

Aquifer or stratigraphic interval monitored	Observation wells installed prior to October of 2009	Observation wells installed since October of 2009	Total observation wells as of January, 2018
Water Table	18	32	50
Quaternary Buried Aquifer	17	29	46
St. Peter Sandstone	4	1	5
Prairie du Chien Group	16	15	31
Jordan Sandstone	11	18	29
Prairie du Chien - Jordan	13	0	13
Tunnel City Group	5	8	13
Wonewoc Sandstone	4	9	13
Tunnel City – Wonewoc	5	6	11
Mt. Simon Sandstone	13	21	34
Other	7	9	16

Aquifer or stratigraphic interval monitored	Observation wells installed prior to October of 2009	Observation wells installed since October of 2009	Total observation wells as of January, 2018
Totals	**113**	**148**	**261**

Table 1. Count of observation wells by aquifer resource in 2009 and the number of additions since 2009.

Technical support/quality control/groundwater analysis

Technical support and quality control for data submittals are essential to maintaining the network expansion.

- **Established data exchange processes** whereby all cooperators provide standard data submissions to our database. Ten out of the eleven metropolitan counties have transitioned to "pilot" contracts, which cut monitoring costs in half and increase data quantity and quality by orders of magnitude.
- Established standard field and data management protocols to ensure comparability. As of January 2018, **196 out of 212 (92%) instrumented wells have been reviewed and archived by DNR staff** who implement these protocols.
- DNR observation well data are used state-wide for trend analyses, aquifer characterization, educational water level animation, and supply the USGS National Groundwater Monitoring Network with water level data.

Data management and access

There have been considerable enhancements to the observation well database, the website for data import, as well as the Cooperative Groundwater Monitoring website for external data access.

- Functionality in the website allows partners to submit a variety of data logger files to the database and website through a simple upload process.
- Pilot process was initiated to collect targeted monitoring data collected from permittees through MPARS.
- Data system upgrade for all of the water monitoring data that the DNR collects. The new database will add value to the hydrologic dataset collected by the DNR by incorporating several databases into one repository.

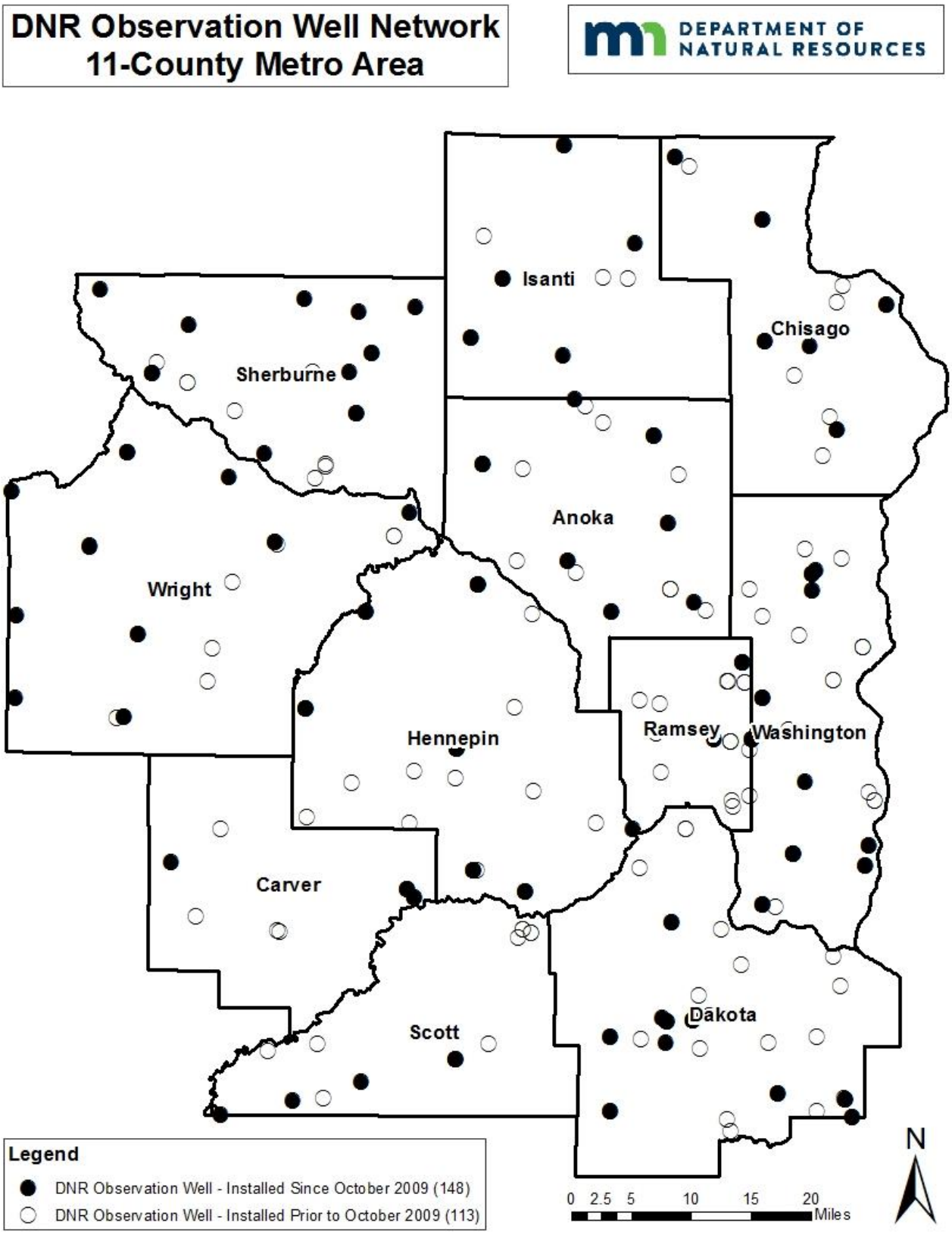


Figure 3. DNR observation well network locations from 2009 and 2018.

Network needs

Develop the network with new wells and supplement with permit monitoring

The next needed phase in developing the TCMA observation well network is **to continue expanding the network through drilling and cooperation with local partners, to initiate the collection of targeted monitoring from data gathered by water appropriation permitees, to collect chemistry samples from all active observation wells, and to initiate a regular, well-defined maintenance schedule**. Regional bedrock aquifers have been incorporated in recent well installations, but there are still gaps present in bedrock aquifers including: the Wonewoc Sandstone, Tunnel City Group, Jordan Sandstone, Prairie du Chien Group, St. Peter Sandstone aquifers (Table 2). The Prairie du Chien and Jordan aquifers are the main bedrock aquifers used for supply in the TCMA. The Tunnel City and Wonewoc aquifers are the next major aquifers beneath the Prairie du Chien and Jordan aquifers that are currently used in a limited capacity, but have potential for increased demands. Baseline water chemistry in DNR observation wells will provide additional information on pollution sensitivity, recharge characteristics, and residence times. Finally, a recurring 10-year maintenance schedule to DNR observation wells will prolong the investment and effectively identify issues for repair or replacement.

- **Drill 50-80 more wells in 10-15 more well nests**. The 2009 report suggests having a network of 380 wells in 60 nests. This proposed phase of network enhancements would expand the network to 310-340 wells at 68-73 well nests.
- **Twenty-one new wells to monitor and characterize the Tunnel City-Wonewoc** aquifer at a regional scale. Collecting baseline data from the Tunnel City-Wonewoc aquifers provide important information for a deep resource that potentially has limited recharge rates and could experience increased demand in the future.
- **Sixteen new wells to fill gaps in the Prairie du Chien and Jordan aquifers**. These locations are in areas of intense appropriation.
- **Expand the shallow monitoring network** in a greater density than the deep bedrock aquifers. Shallow sand and gravel wells (i.e., Quaternary wells) will be installed at all new well nest locations that are suitable, but additional monitoring is needed between bedrock nests. Shallow well installations can be performed by the DNR drill rig at low costs and should be in places where surface water impacts from groundwater appropriation are a local concern.
- Supplement background monitoring with targeting monitoring provided by appropriators in the area

***Cost estimate for proposed network expansion: Approx. $2,415,000**

Aquifer	Proposed number of wells to install to complete 11 county metro network	Estimated cost of installing proposed wells
Quaternary (shallow) aquifers	15-40	$75,000

Aquifer	Proposed number of wells to install to complete 11 county metro network	Estimated cost of installing proposed wells
St. Peter Sandstone	2	$70,000
Prairie du Chien Group	9	$375,000
Jordan Sandstone	7	$410,000
Tunnel City Group	9	$595,000
Wonewoc Sandstone	12	$755,000
Mt. Simon	2	$135,000
Totals	**41**	**$2,415,000**

Table 2. Proposed new wells needed for the TCMA network with aquifers and estimated costs.

Maintenance needs

- Maintenance for water level transducers- All instrumented wells within the TCMA are visited at least once a year for transducer maintenance (Table 3)
- Well Maintenance- Every 10 years- pump each well to maintain connection with the aquifer, slug test wells to help quantify the connection to the aquifer, and perform other site maintenance as needed (straightening or replacing protection posts, replacing broken locking caps/locks/identification tags, and trimming back vegetation/brush/trees around the well)
- Well Sealing and retirement- As Needed--Very few observation wells will need to be sealed in the coming years

*Cost estimate for a 1-year transducer maintenance (projected with 3% increases per year): ~$80-90/well or **$17,600/year for the current network** and **~$26,000/year for the proposed network.**

*Cost estimate for a 10-year well maintenance visit: ~$450-510/well **or $11,745/year for the current network** and **$17,700/year for the proposed network**.

*The cost to collect water samples per well assumes that staff visit the well for 10-year maintenance and is an additional $960-1,080/well or **$349,000 for the 350 well network**.

Maintenance type	Cost per well	Cost per year for current network (261 wells)	Cost per year for proposed network (350 wells with increased costs)
1-year transducer	$80-90	$17,600	$26,300
10 - year well maintenance	$450-510	$11,745 (26 wells/year)	$17,700 (35 wells/year)
Chemistry water samples	$960-1,080	$96,000 (100 wells/year)	$37,800 (35 wells/year)
Total estimates		**$125,345**	**$81,800**

Table 3. Summary of anticipated maintenance costs for the TCMA network under current size and under projected size at build-out. Costs are also assumed to increase 3% annually.

Technical support/quality control/groundwater analysis

Various agencies, industries, and citizens have applied analysis of water level data from the DNR observation well network. It is assumed that as the data records grow and additional wells are installed, there will be a **continued need for technical support**. Additionally, as water level records become long enough to document significant trends, **standard analytical tools and products will need to be developed**. **$35,000/year**

Data management and access through the website

The new database will add value to the hydrologic dataset collected by the DNR by incorporating several databases into one repository. After the transfer to this database is complete, an integrated website will be built that gives public access to the all hydrologic and climate data. **$50,000/year**

Current Challenges

The 11-county observation well network has expanded considerably since the 2009 report that outlined the needs and benefits of such a project. As outlined in this report, there is still work needed to reach some of the goals listed. Questions that still need to be answered are:

- How does this aquifer system work and how might we use the network to test conceptual models of the hydrogeologic setting?
    - What is the relationship between climate, groundwater storage, groundwater appropriations, and groundwater contributions to critical ecosystems on the surface? We understand much more about parts of the system than we did 10 years ago, but specific questions about connections between surface water and the Prairie du Chien-Jordan aquifer still exists.
    - We are still uncertain about the connections and recharge characteristics of the Tunnel City Wonewoc aquifer, beneath the Prairie du Chien-Jordan aquifer.
    - What are the long-term and seasonal changes in groundwater storage due to effects of climate and of withdrawals? In an area so heavily pumped, we struggle to locate natural conditions of the Prairie du Chien and Jordan aquifers where major pumping does not affect water levels. This

background or baseline condition is essential in evaluating impacts from use as it provides a reference for comparison for climate signal and natural fluctuations.

- What are the natural chemical characteristics of the aquifers within the observation well network?
    - Do areas with concentrated recharge practice appropriate land use that encourages clean recharge to these aquifers? What is the estimated amount of bedrock aquifer recharge and where is it concentrated?
    - How is groundwater chemistry changing over time? What is the minimum groundwater sampling frequency needed to identify changes? Are there currently signs of contamination from the surface in any areas within the network?
- How can we improve data management and web access to data from DNR hydrologic datasets as well as hydrologic data from local monitoring partners and other state agencies?
    - How can we ensure that monitoring locations meet the goals of multiple network partners?
    - How are data most commonly used and what formats are most useful to our common user?

Appendix A

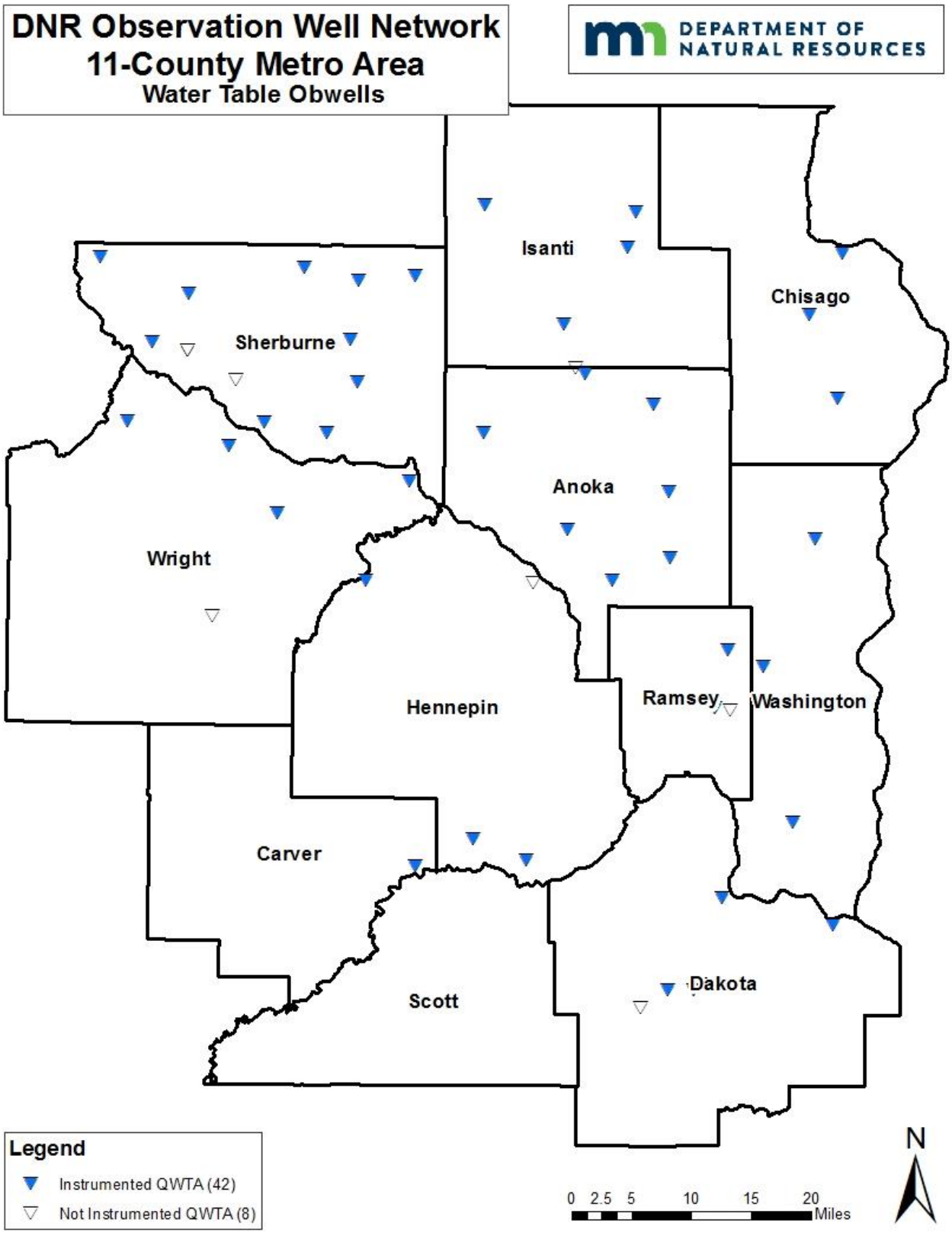


Figure A1: DNR 11-county metro observation well network water table (QWTA) observation well locations

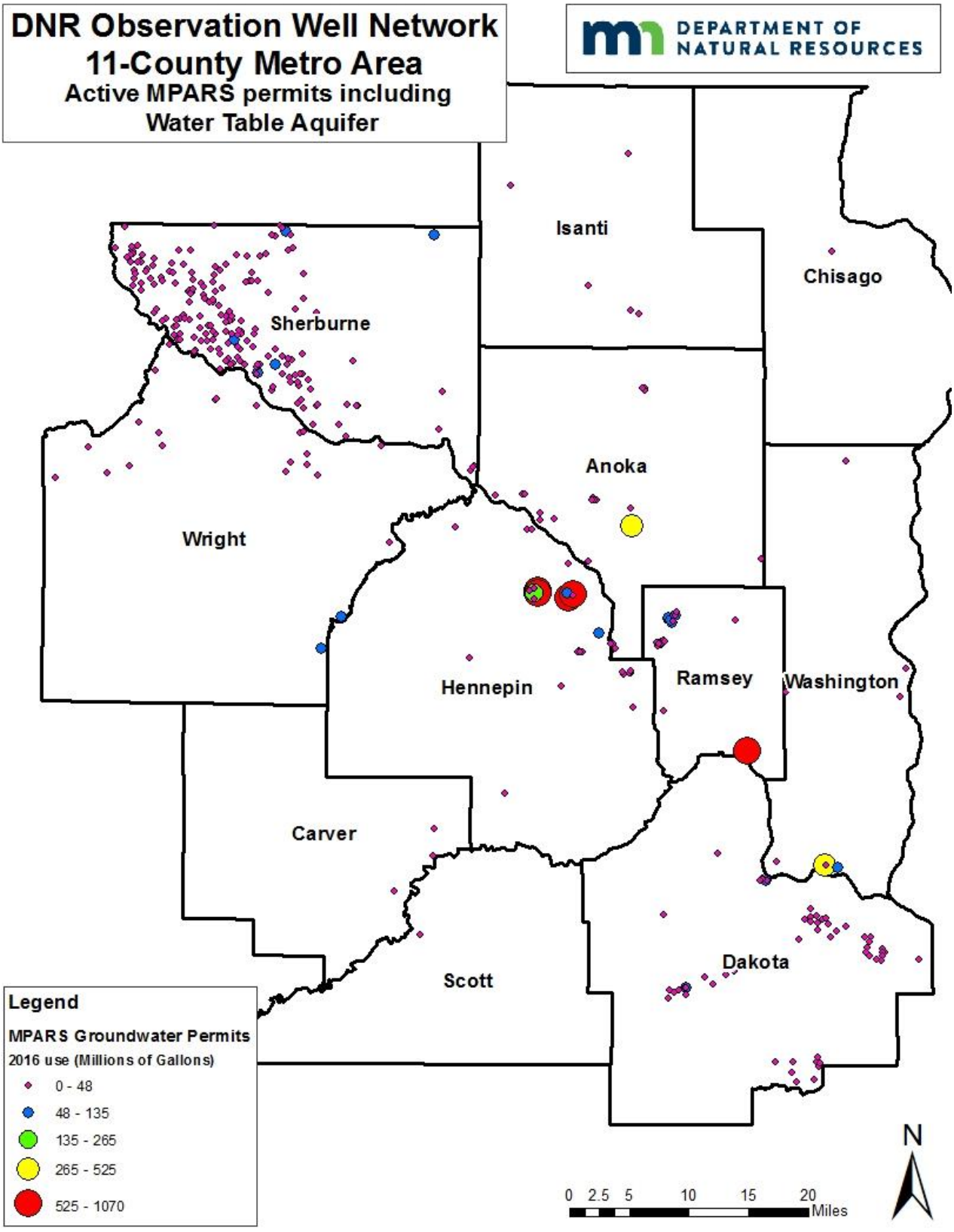


Figure A2: Active MPARS permits in the 11-county metro with wells intersecting the water table aquifer (QWTA).

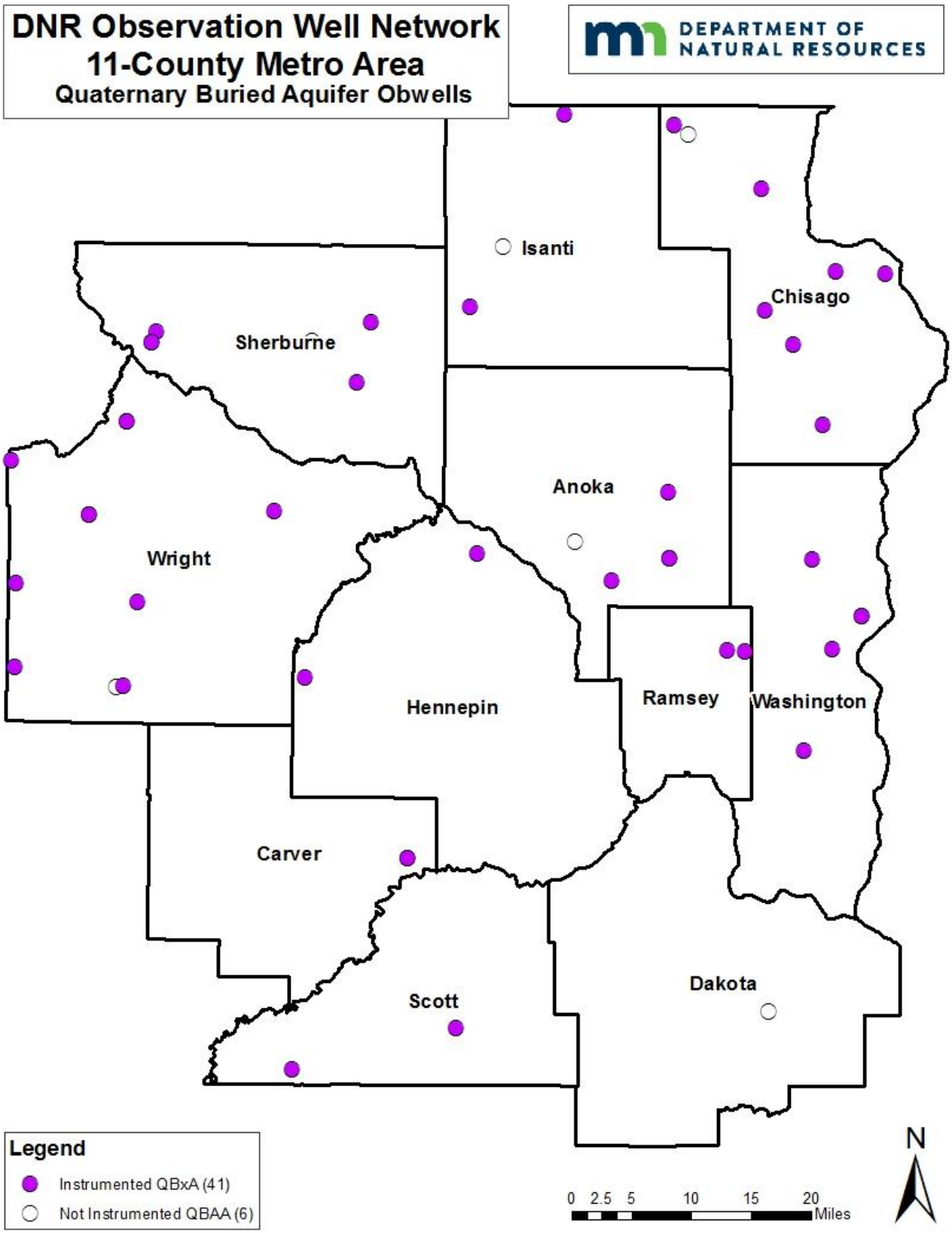


Figure A3: DNR 11-county metro observation well network Quaternary buried aquifer (QBAA) observation well locations.

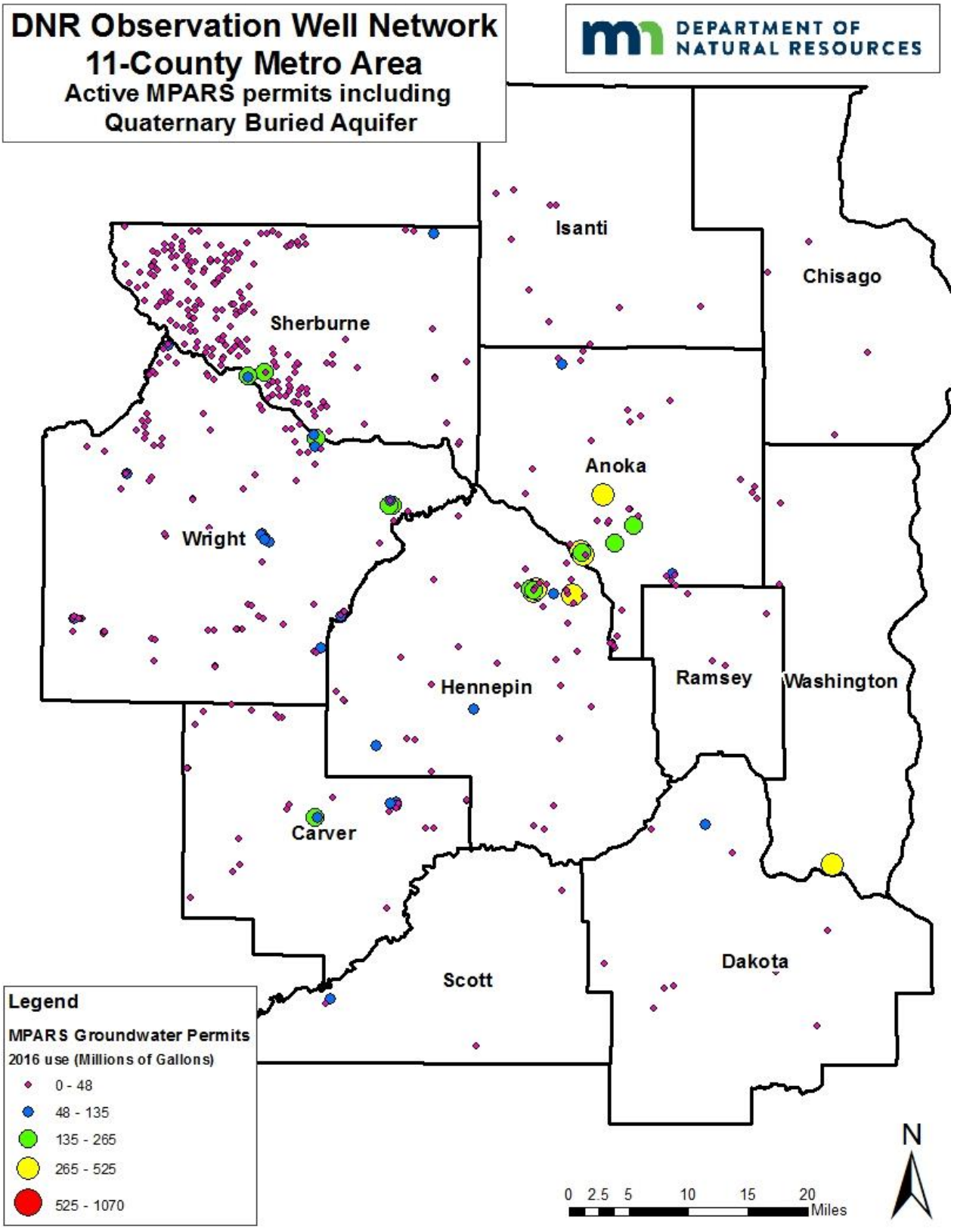


Figure A4: Active MPARS permits in the 11-county metro with wells intersecting a Quaternary buried aquifer (QBAA).

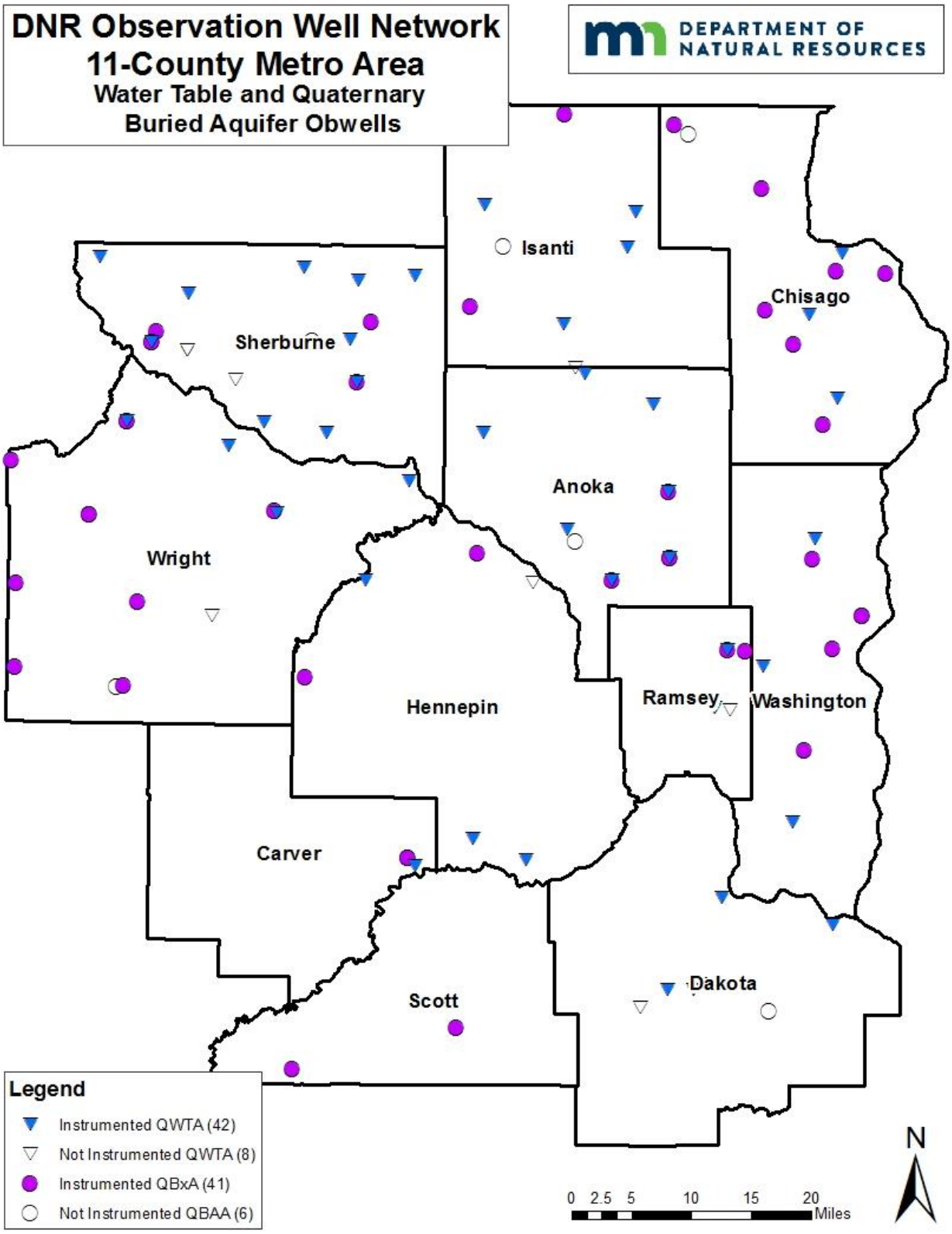


Figure A5: DNR 11-county metro observation well network water table and quaternary buried aquifer observation well locations (QWTA and QBAA).

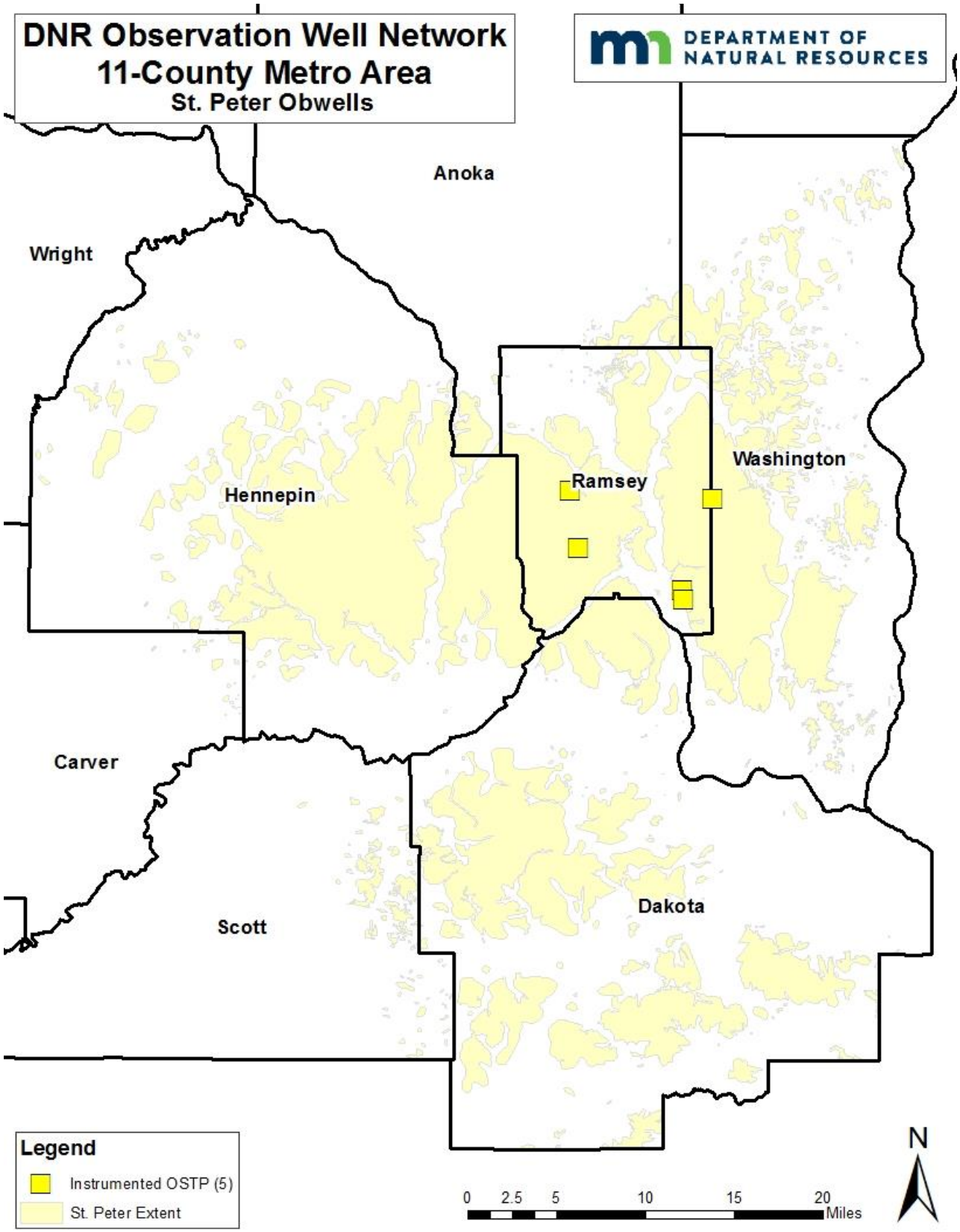


Figure A6: DNR 11-county metro observation well network St. Peter sandstone (OSTP) observation well locations

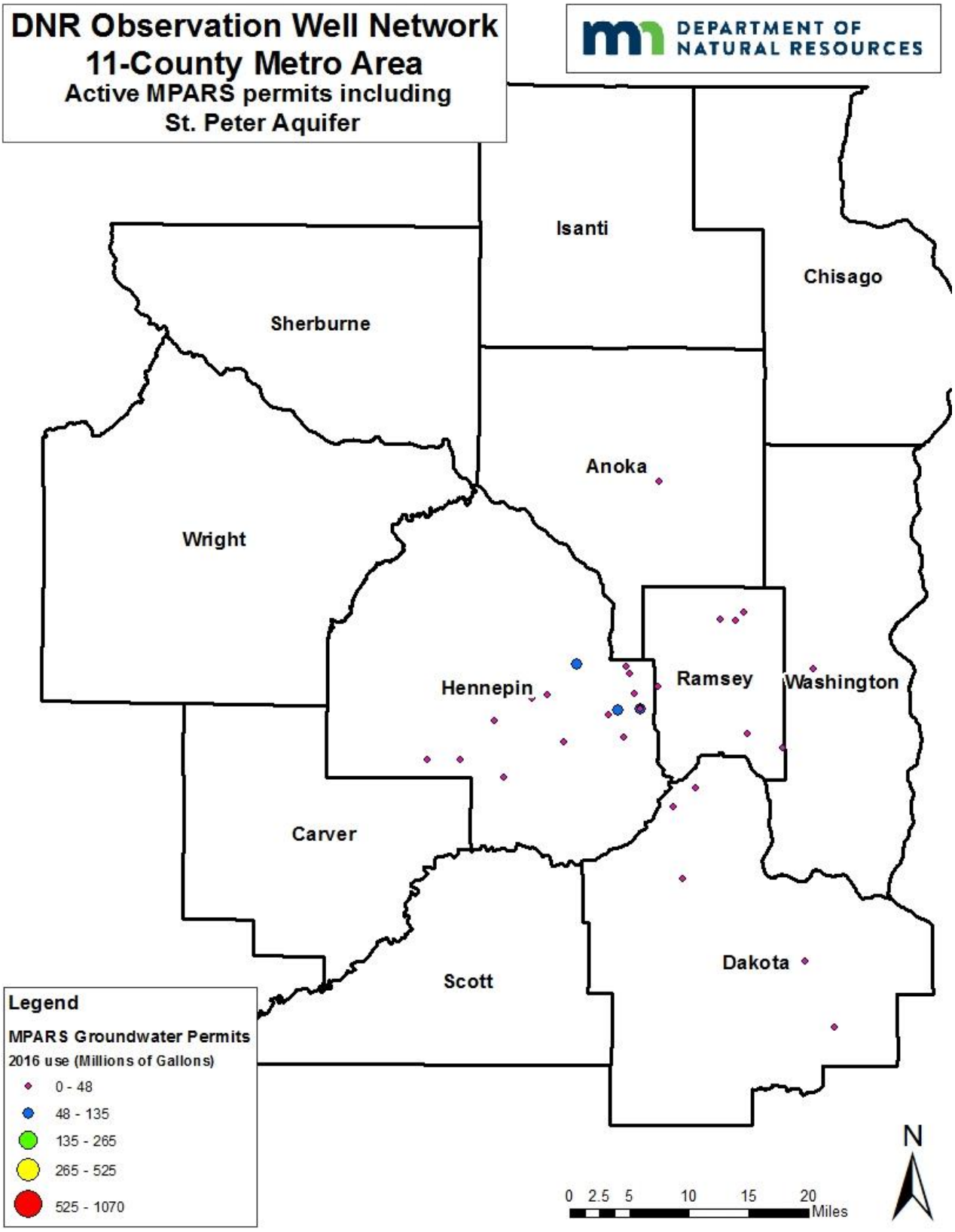


Figure A7: Active MPARS permits in the 11-county metro with wells intersecting the St. Peter sandstone aquifer (OSTP).

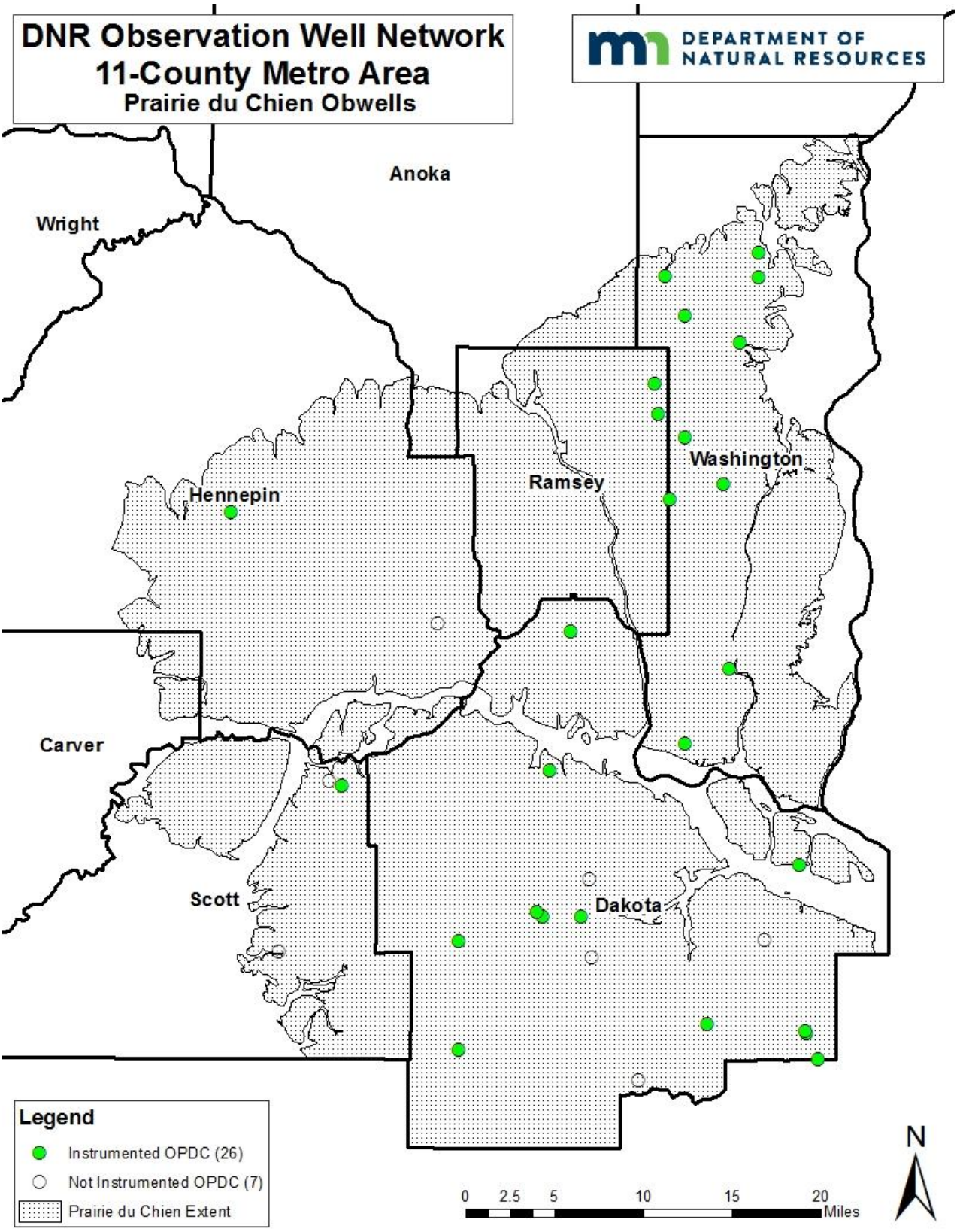


Figure A8: DNR 11-county metro observation well network Prairie du Chien group (OPDC) observation well locations.

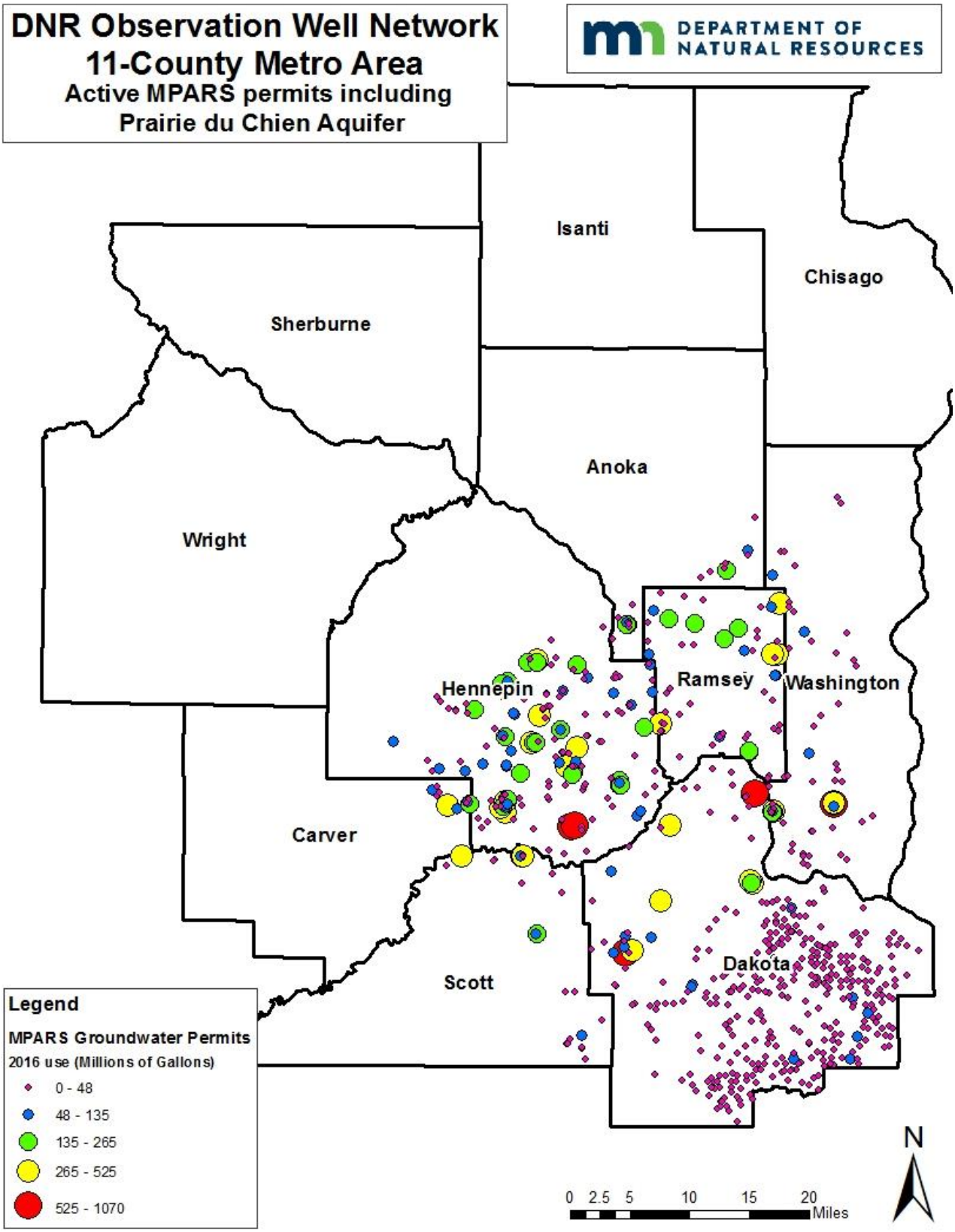


Figure A9: Active MPARS permits in the 11-county metro with wells intersecting the Prairie du Chien group (OPDC) aquifer.

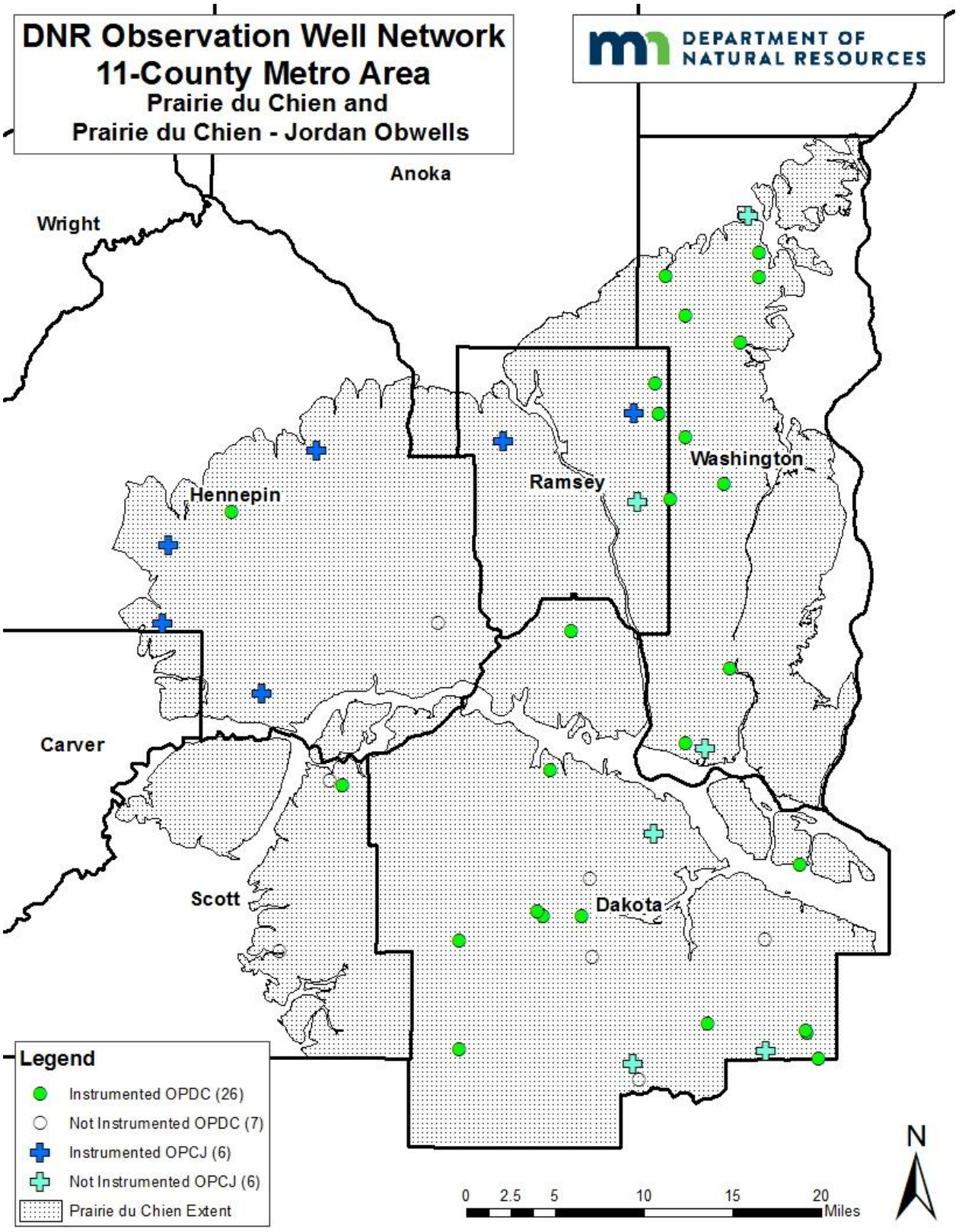


Figure A10: DNR 11-county metro observation well network Prairie du Chien (OPDC) and Prairie du Chien - Jordan (OPCJ) observation well locations.

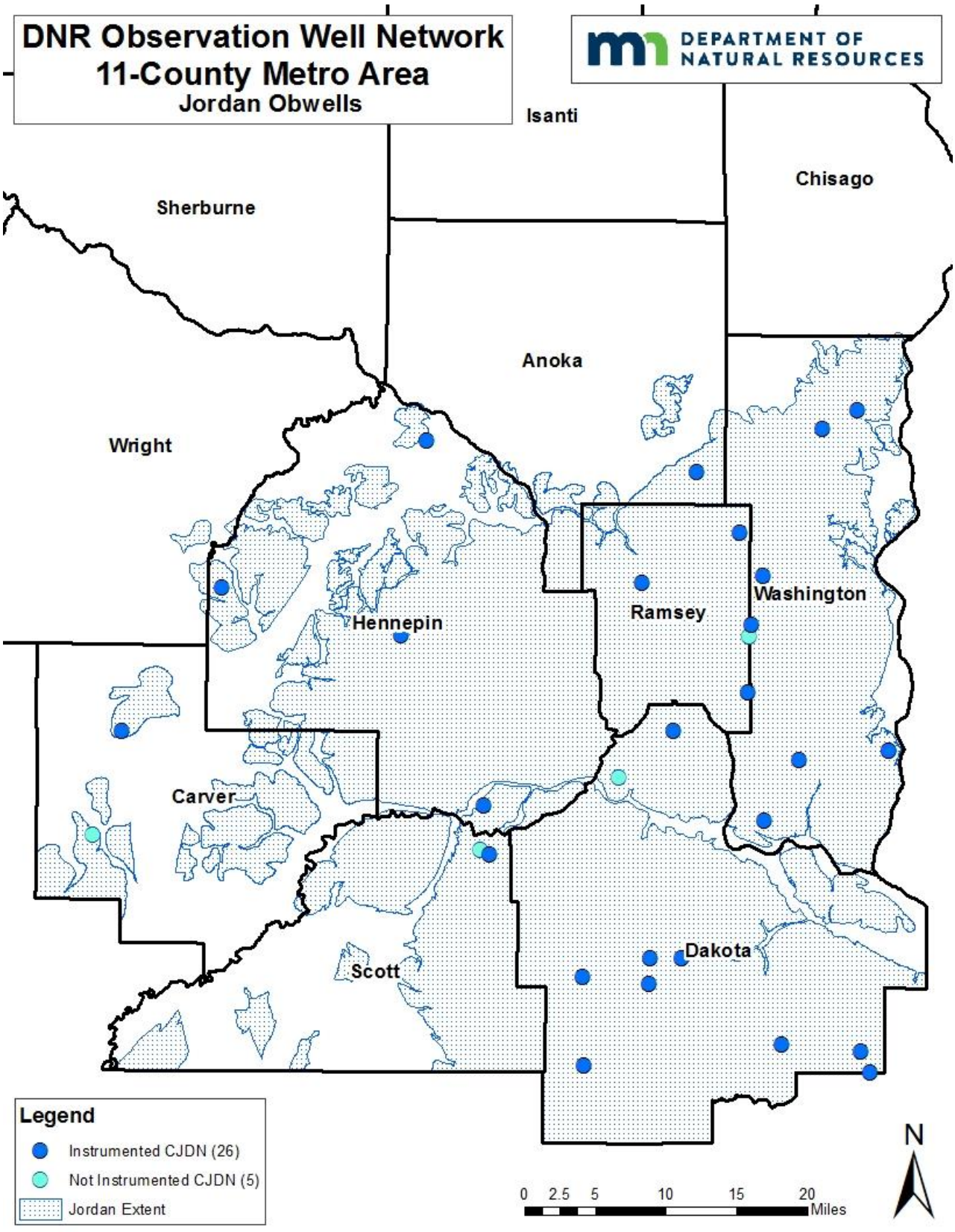


Figure A11: DNR 11-county metro observation well network Jordan sandstone (CJDN) observation well locations.

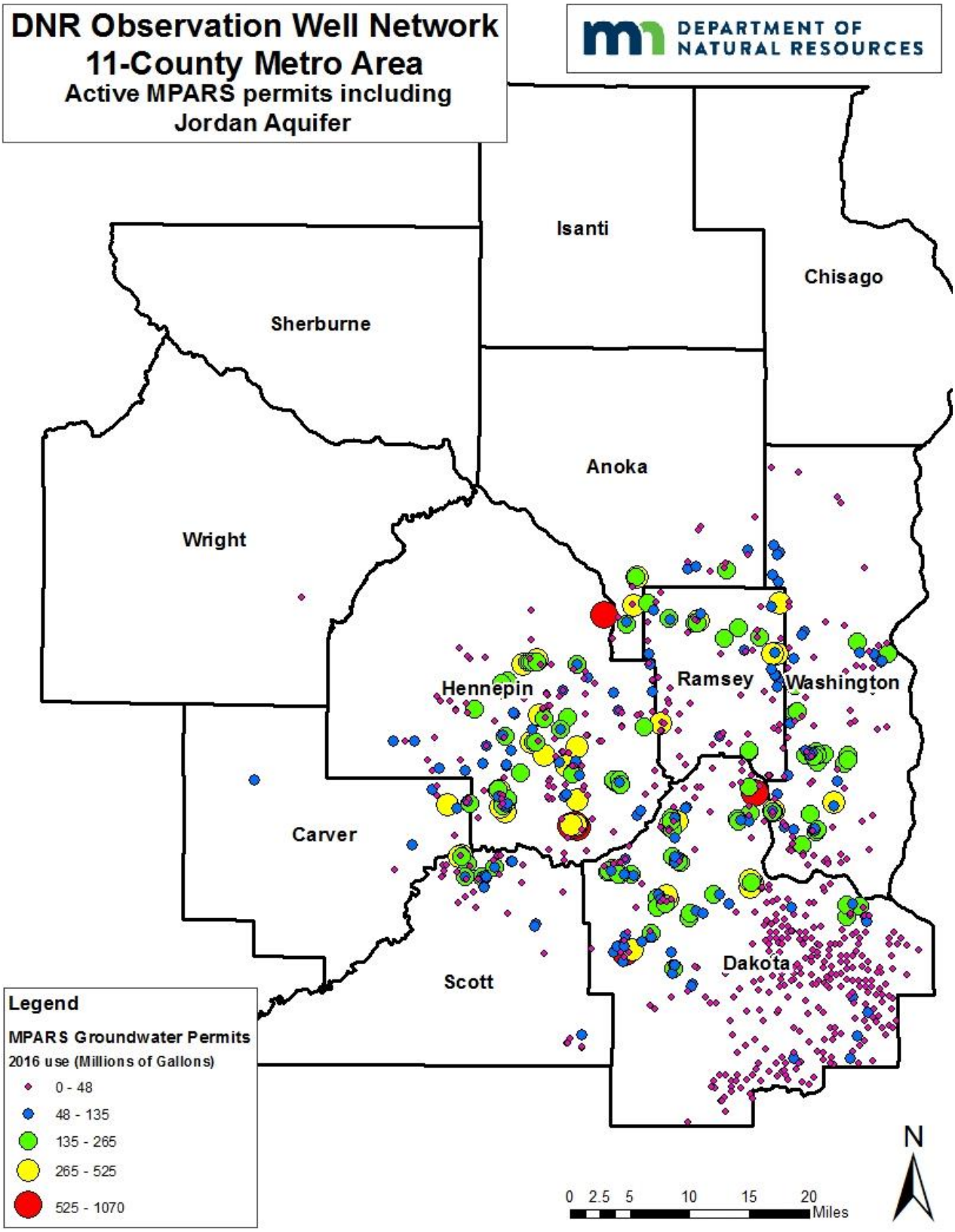


Figure A12: Active MPARS permits in the 11-county metro with wells intersecting the Jordan aquifer (CJDN).

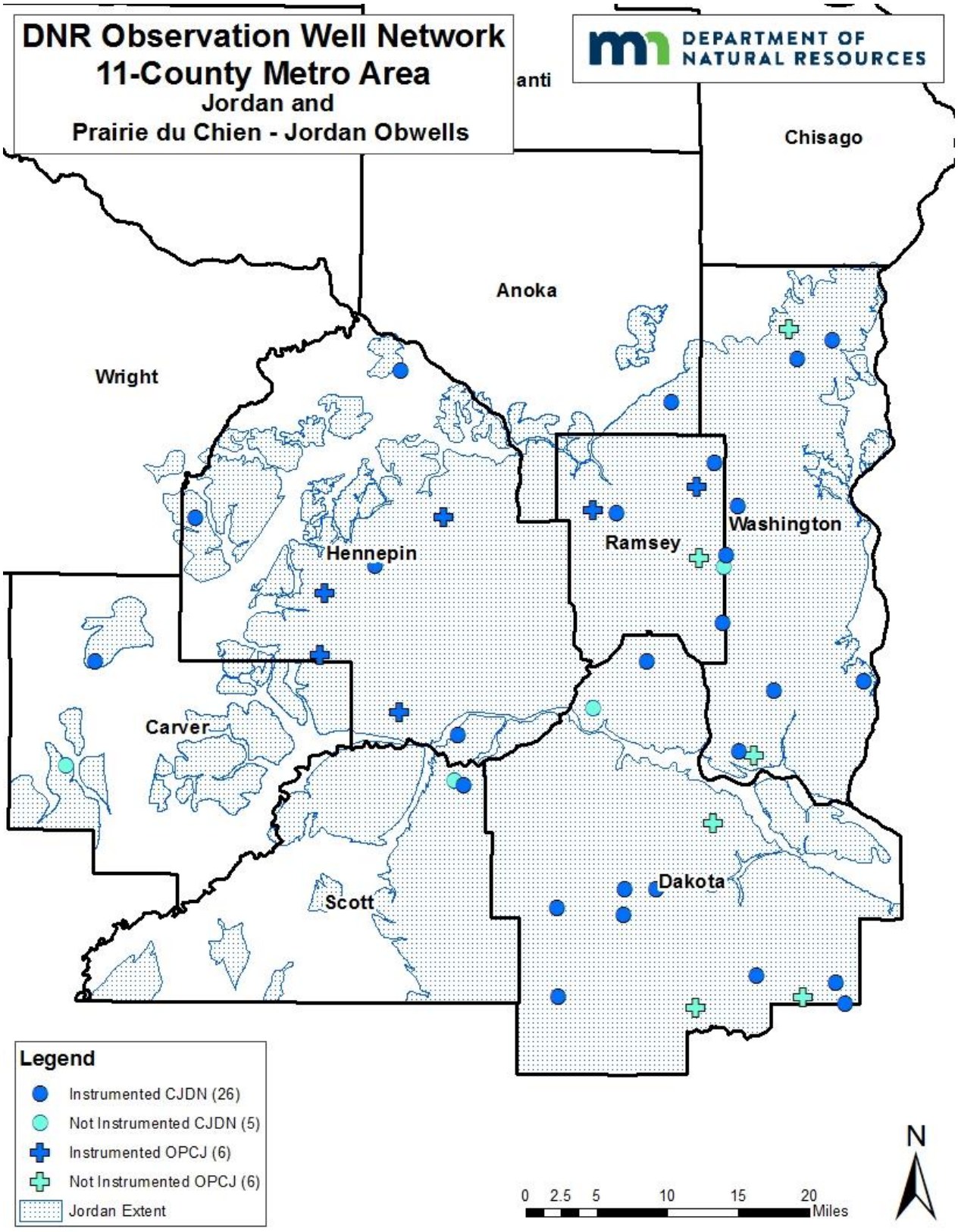


Figure A13: DNR 11-county metro observation well network Jordan and Prairie du Chien – Jordan (OPCJ) observation well locations.

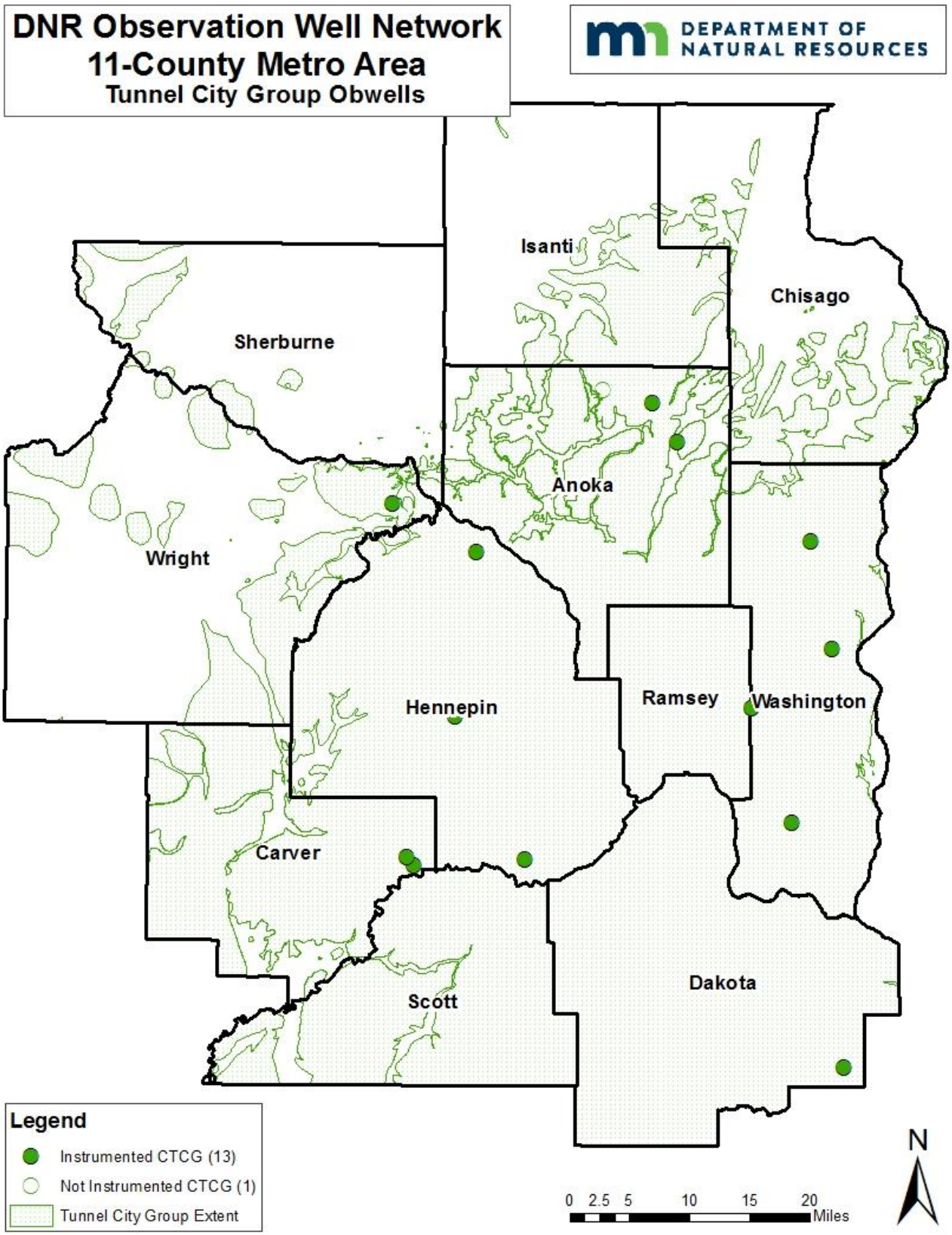


Figure A14: DNR 11-county metro observation well network Tunnel City group (CTCG) observation well locations.

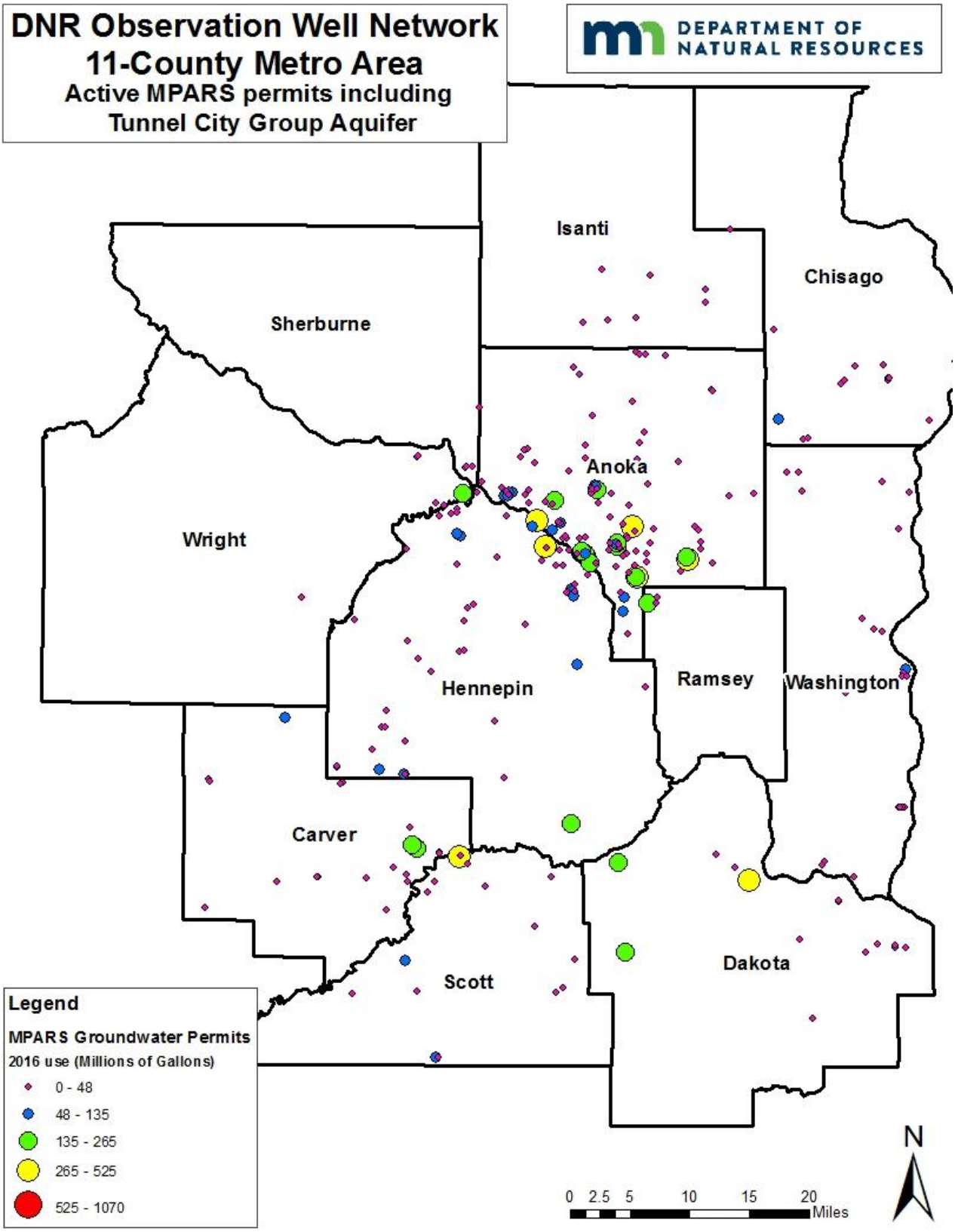


Figure A15: Active MPARS permits in the 11-county metro with wells intersecting the Tunnel City group aquifer (CTCG).

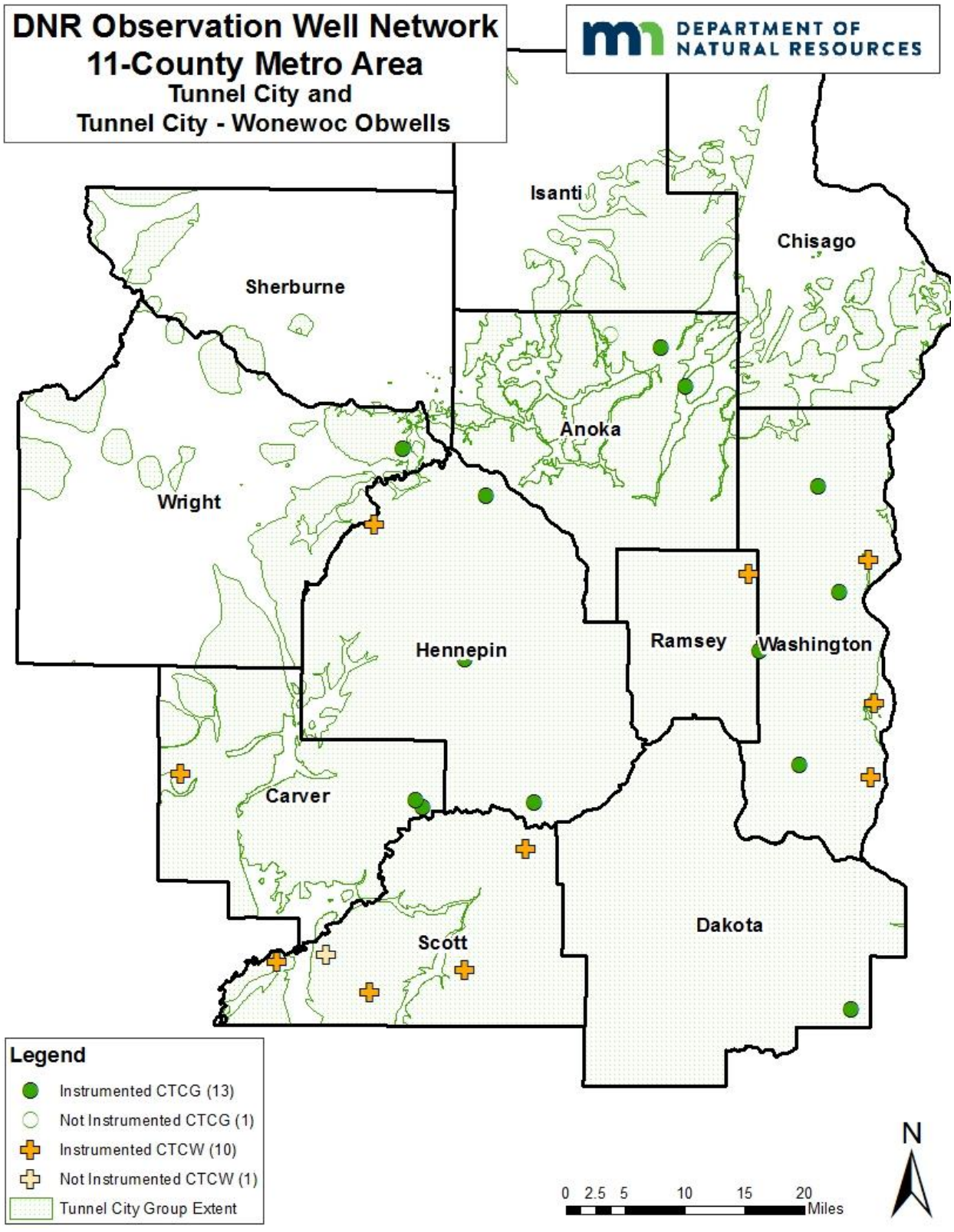


Figure A16: DNR 11-county metro observation well network Tunnel City (CTCG) and Tunnel City - Wonewoc (CTCW) observation well locations.

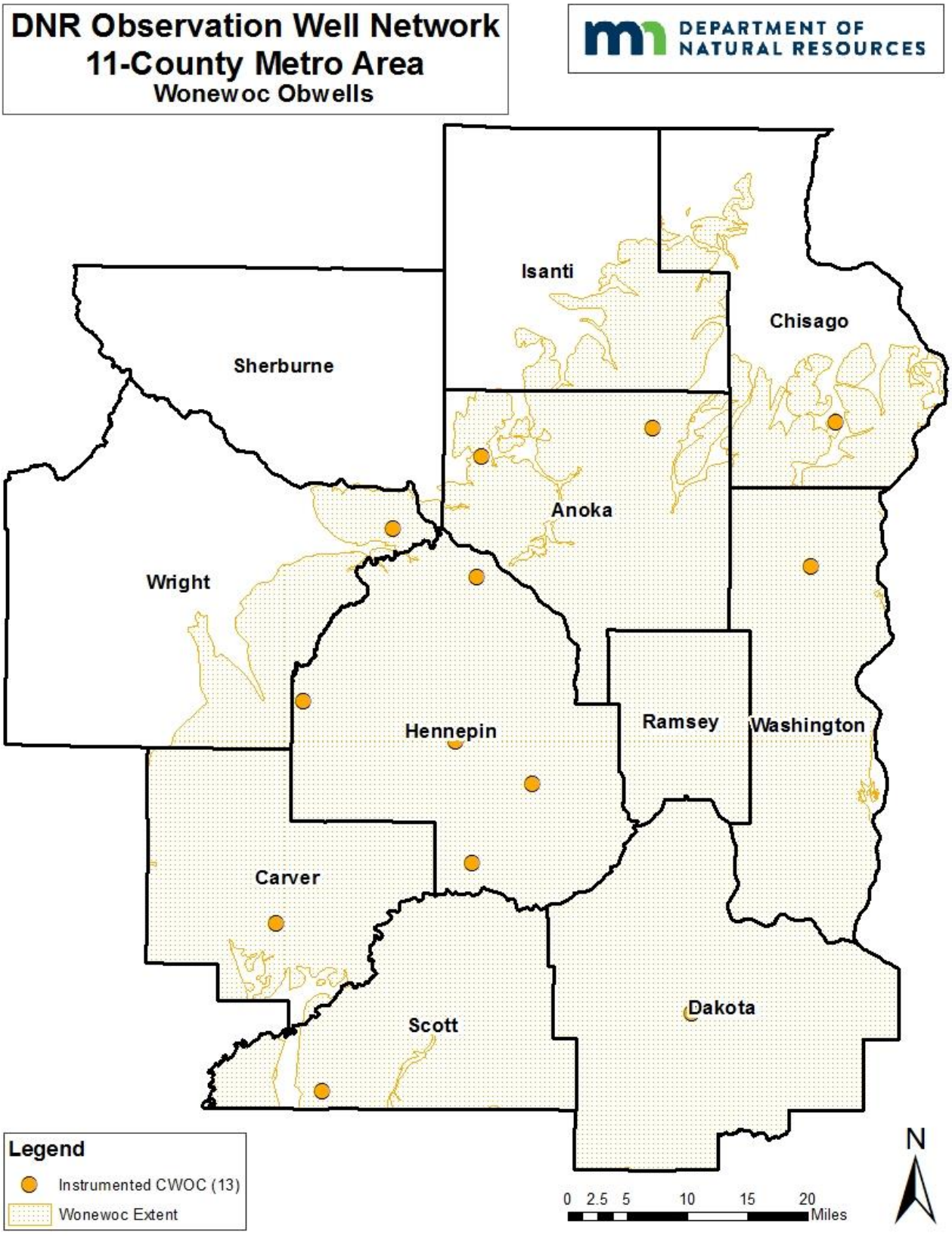


Figure A17: DNR 11-county metro observation well network Wonewoc sandstone (CWOC) observation well locations.

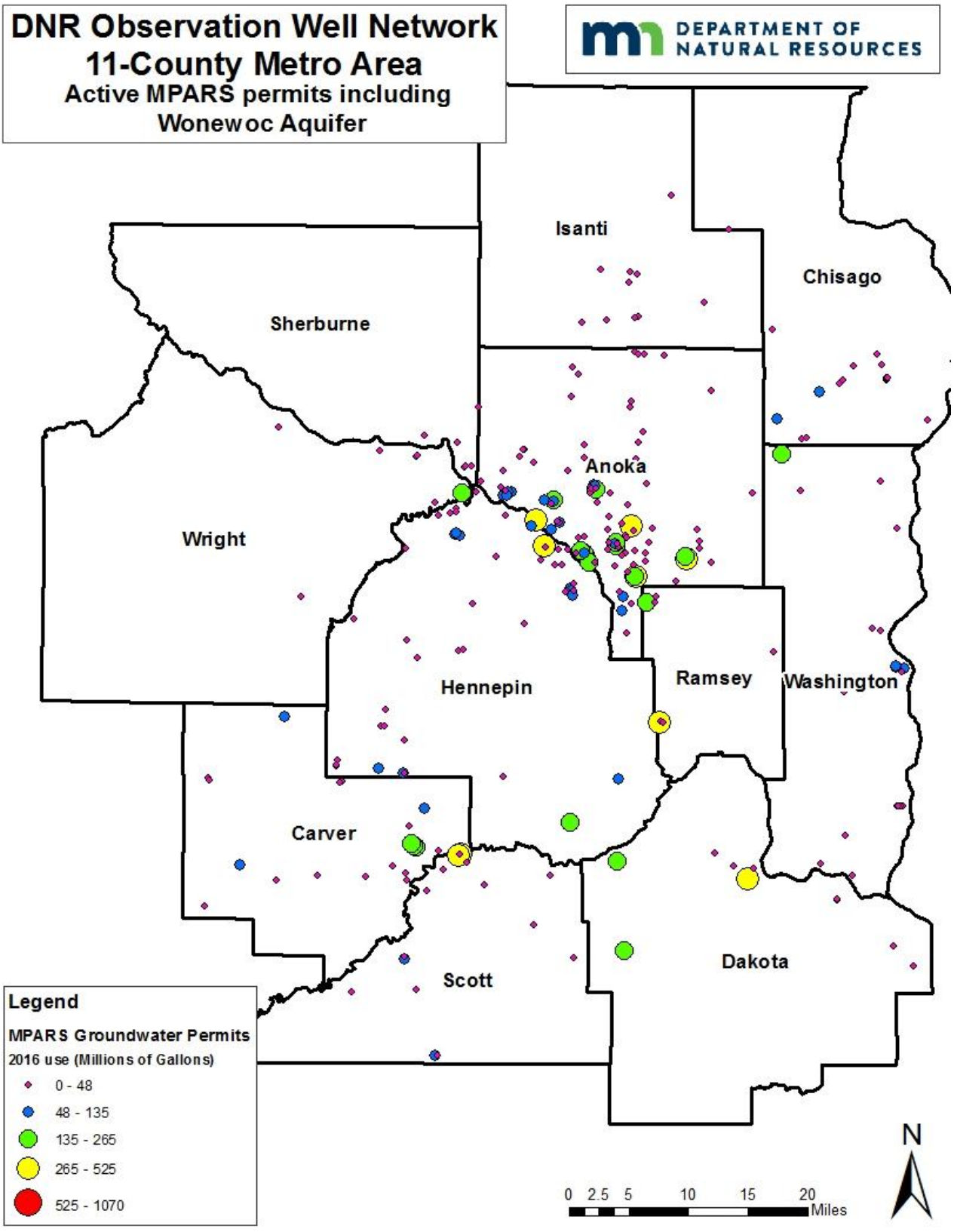
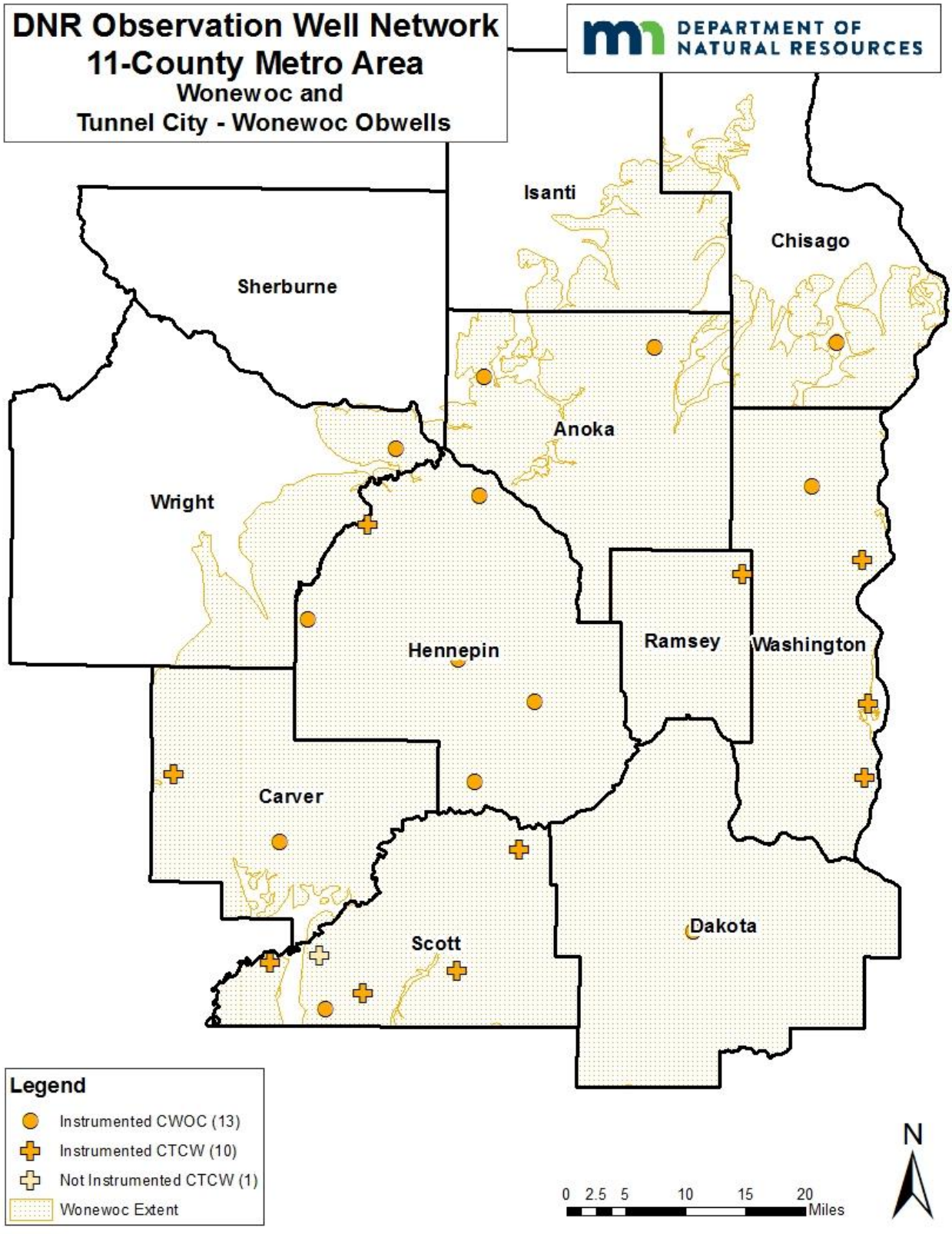
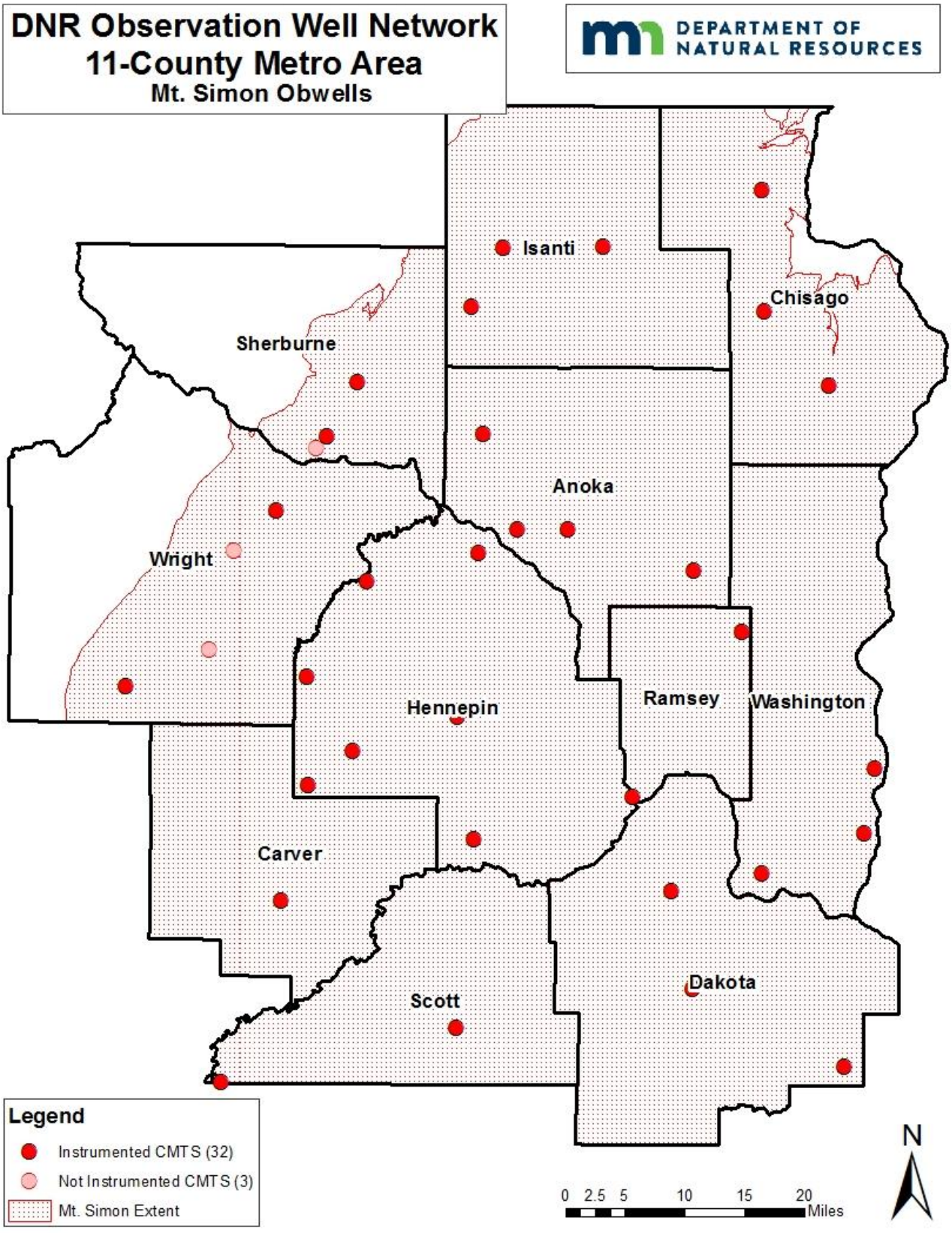


Figure A18: Active MPARS permits in the 11-county metro with wells intersecting the Wonewoc sandstone aquifer (CWOC).



Appendix A19: DNR 11-county metro observation well network Wonewoc (CWOC) and Tunnel City – Wonewoc (CTCW) observation well locations.



Appendix A20: DNR 11-county metro observation well network Mt. Simon sandstone (CMTS) observation well locations.

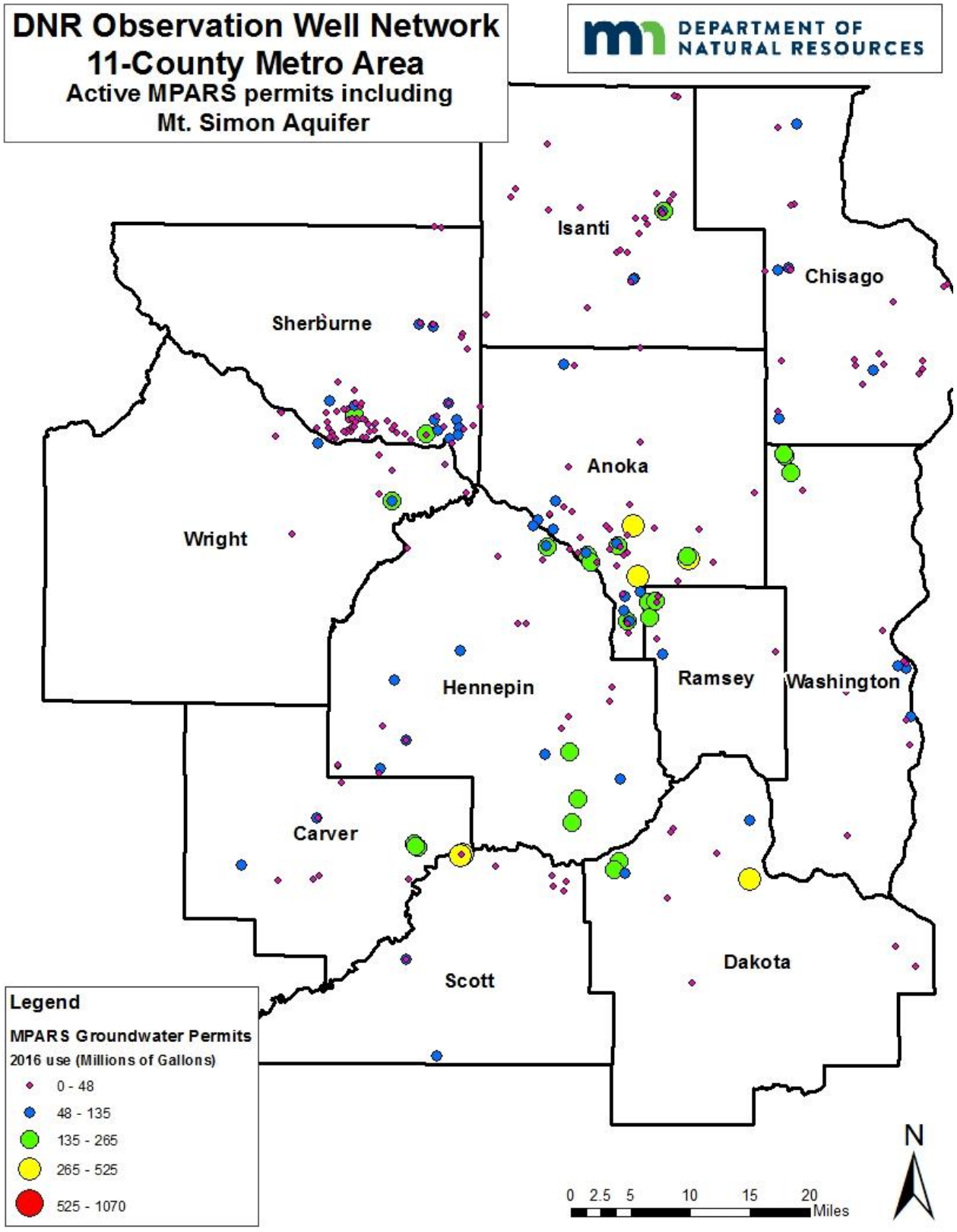


Figure A21: Active MPARS permits in the 11-county metro with wells intersecting the Mt. Simon aquifer (CMTS).

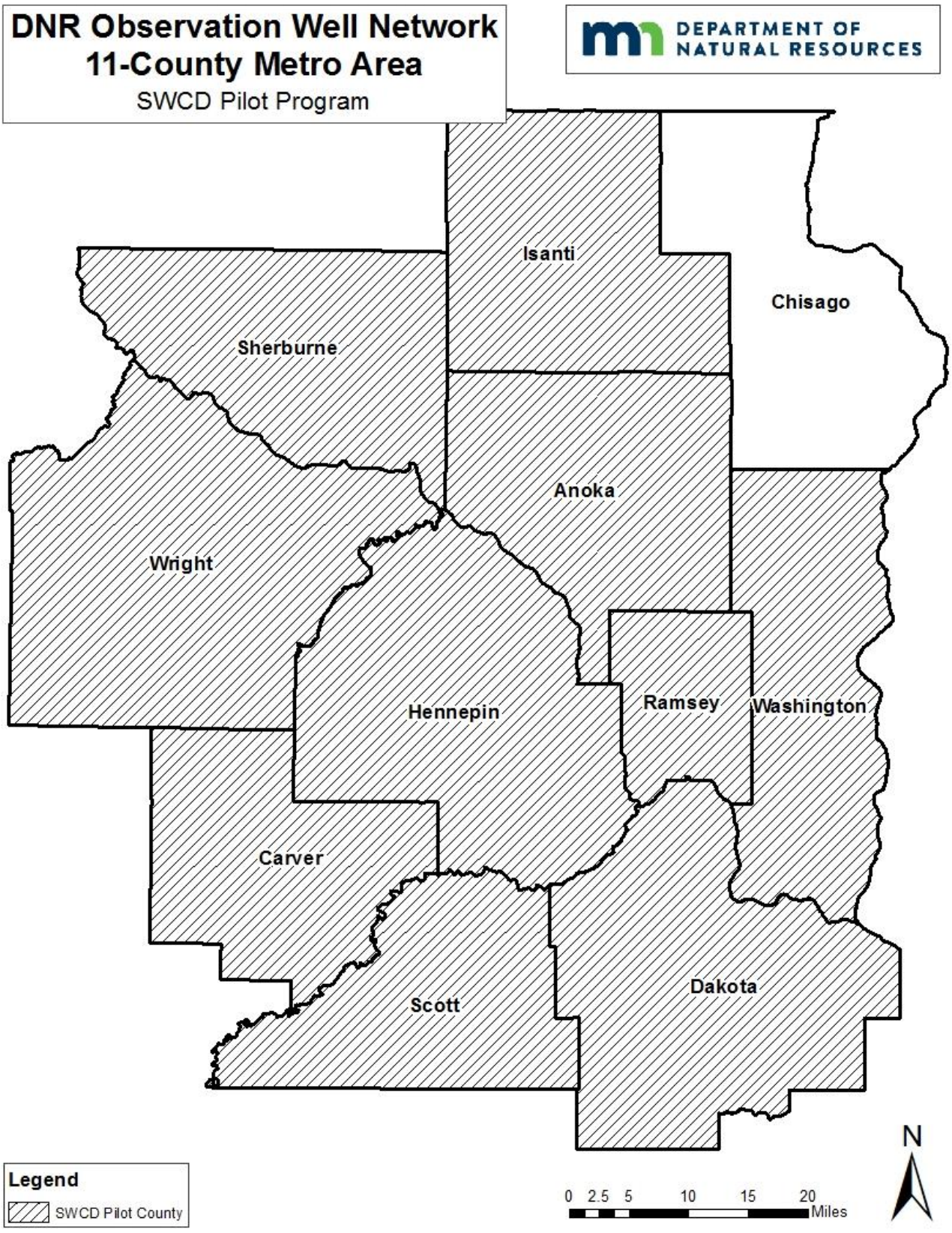


Figure A22: Counties in the 11-county metro area participating in the SWCD pilot program

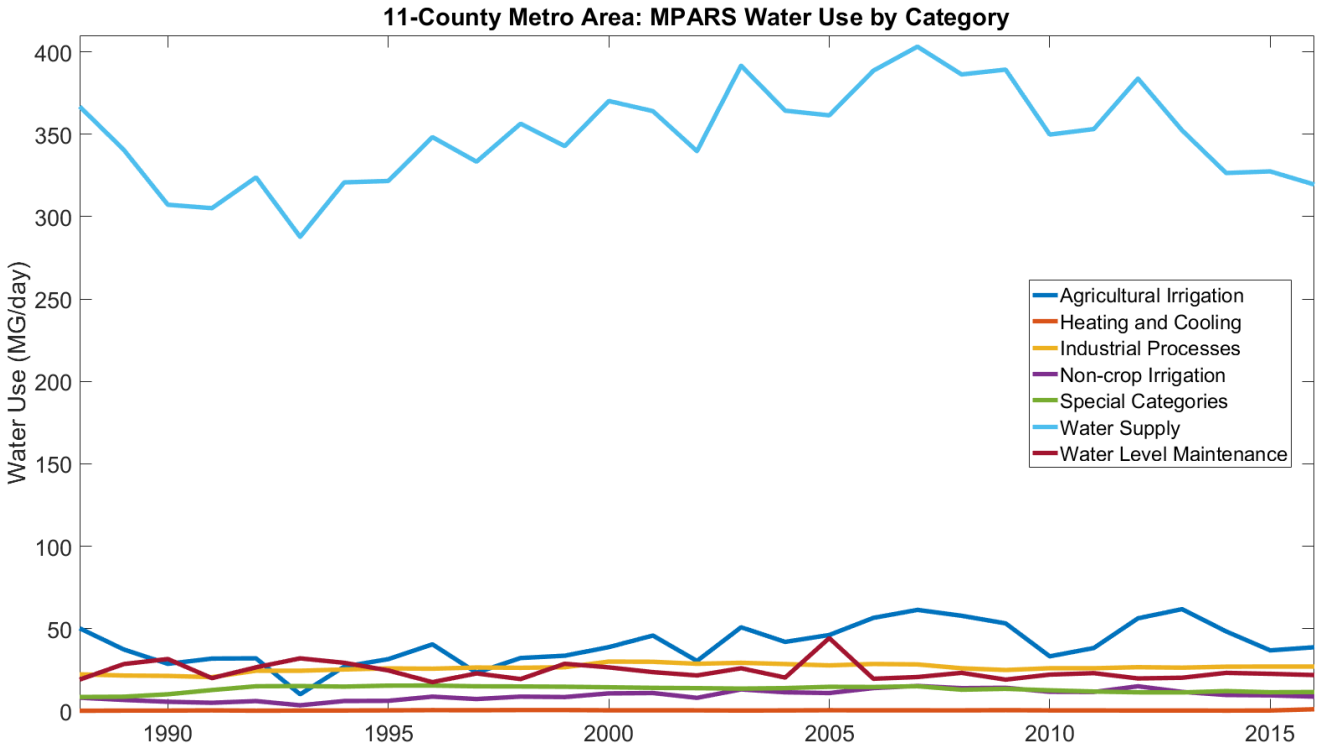
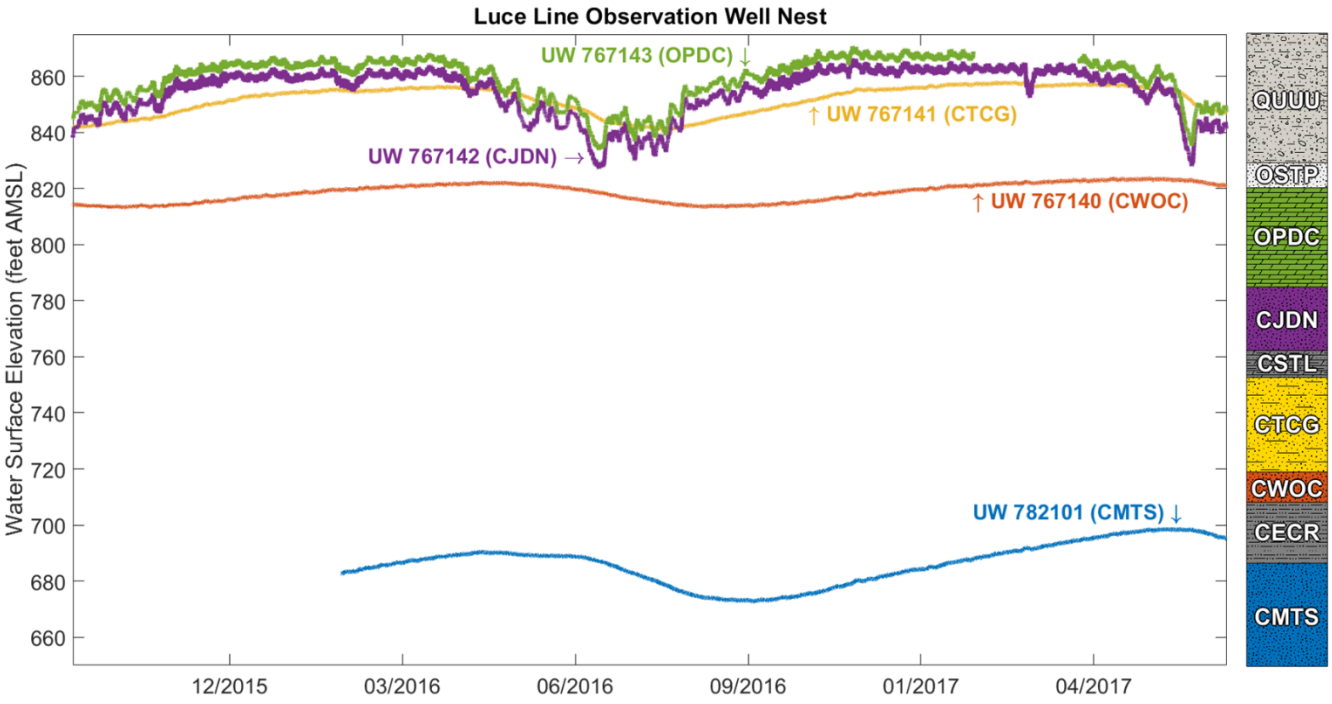


Figure A23: MPARS water use by category in the 11-county metro area



QUUU – Undifferentiated Quaternary Sediment
OSTP – St. Peter Sandstone Aquifer
OPDC – Prairie du Chien Group Aquifer
CJDN – Jordan Sandstone Aquifer
CSTL – St. Lawrence Formation
CTCG – Tunnel City Group Aquifer
CWOC – Wonewoc Sandstone Aquifer
CECR – Eau Claire Formation
CMTS – Mt. Simon Sandstone Aquifer

Figure A24: Hydrograph and generalized stratigraphic column for the Luce Line trail observation well nest in Plymouth. Stratigraphic column shows position and relative thickness of hydrostratigraphic units present, stratigraphic elevations do not correspond to the water surface elevations portrayed on the hydrograph axis.

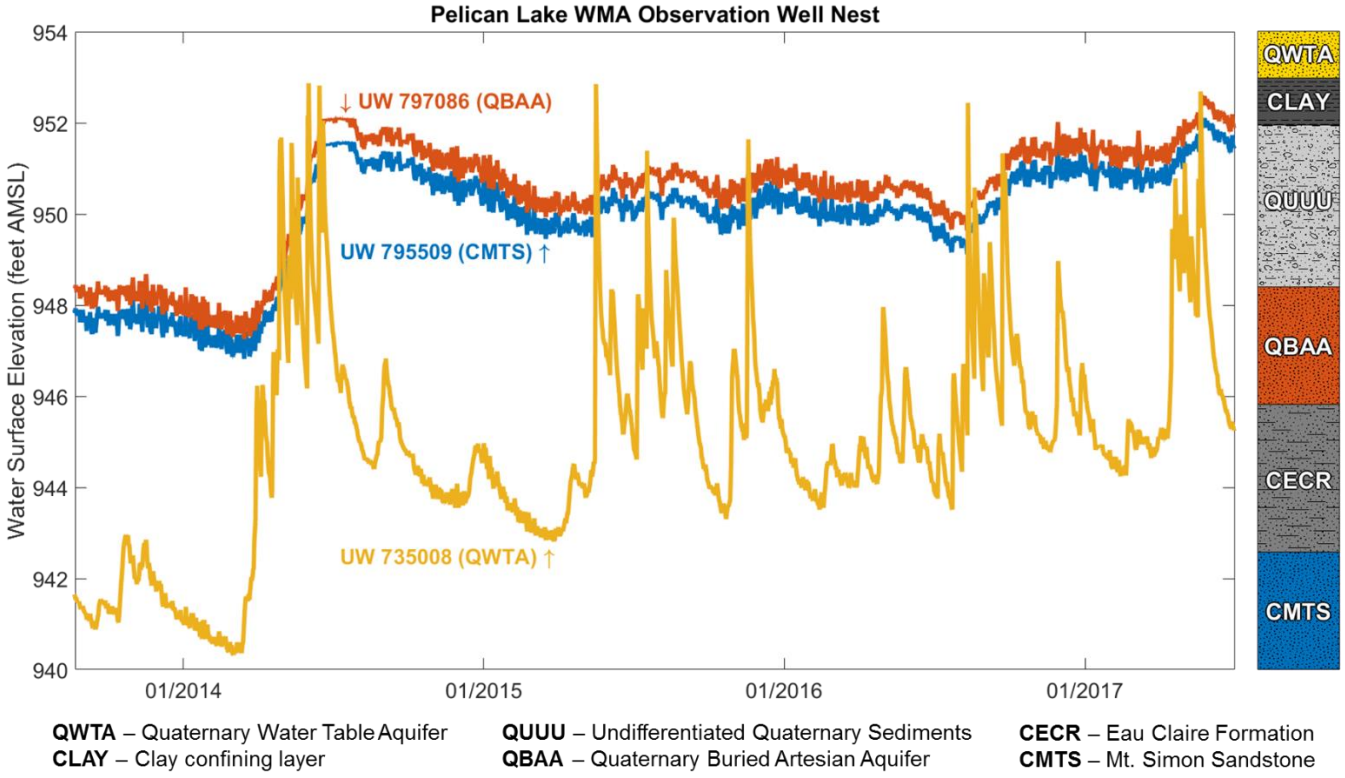


Figure A25: Hydrograph and generalized stratigraphic column for the Pelican Lake WMA observation well nest near Saint Michael. Stratigraphic column shows position and relative thickness of hydrostratigraphic units present, stratigraphic elevations do not correspond to the water surface elevations portrayed on the hydrograph axis.

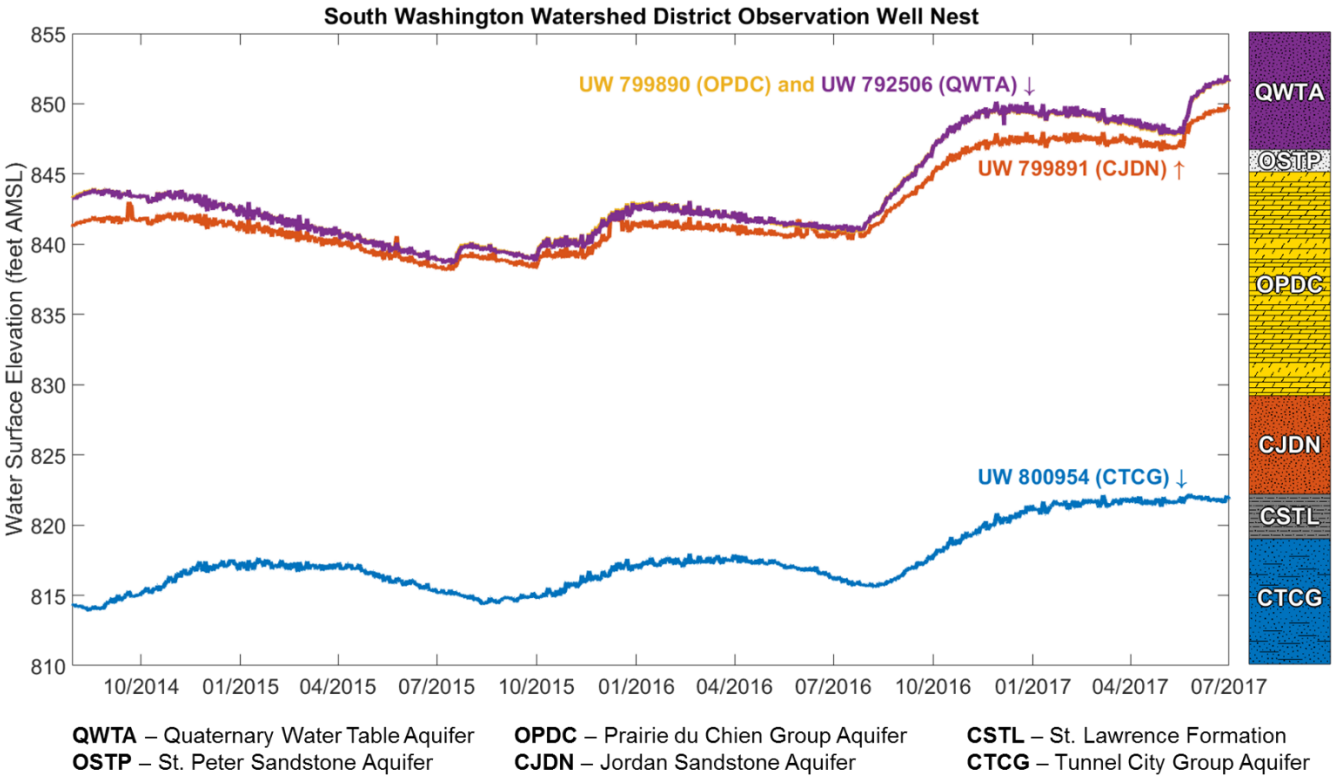


Figure A26: Hydrograph and generalized stratigraphic column for the South Washington Watershed District observation well nest near Woodbury. Stratigraphic column shows position and relative thickness of hydrostratigraphic units present, stratigraphic elevations do not correspond to the water surface elevations portrayed on the hydrograph axis.

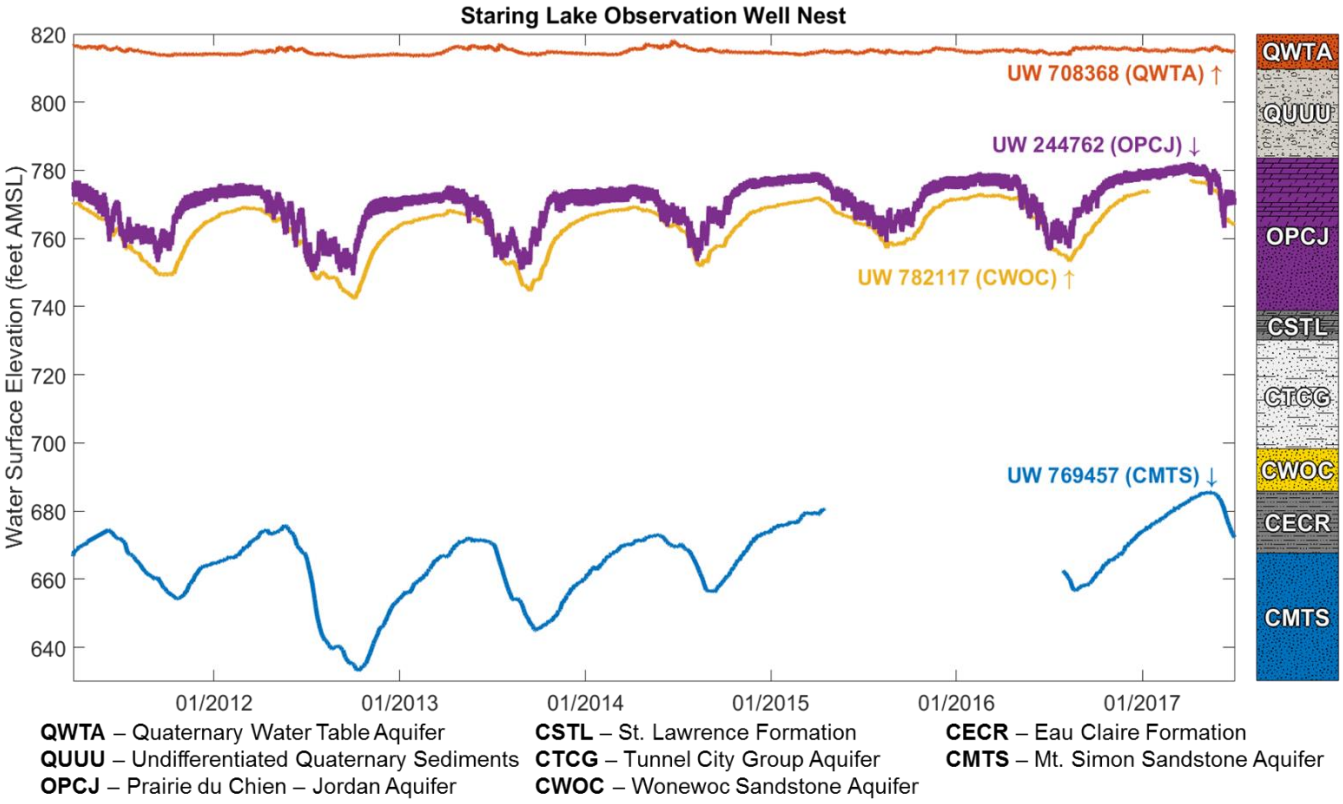


Figure A27: Hydrograph and generalized stratigraphic column for the Staring Lake observation well nest in Eden Prairie. Stratigraphic column shows position and relative thickness of hydrostratigraphic units present, stratigraphic elevations do not correspond to the water surface elevations portrayed on the hydrograph axis.

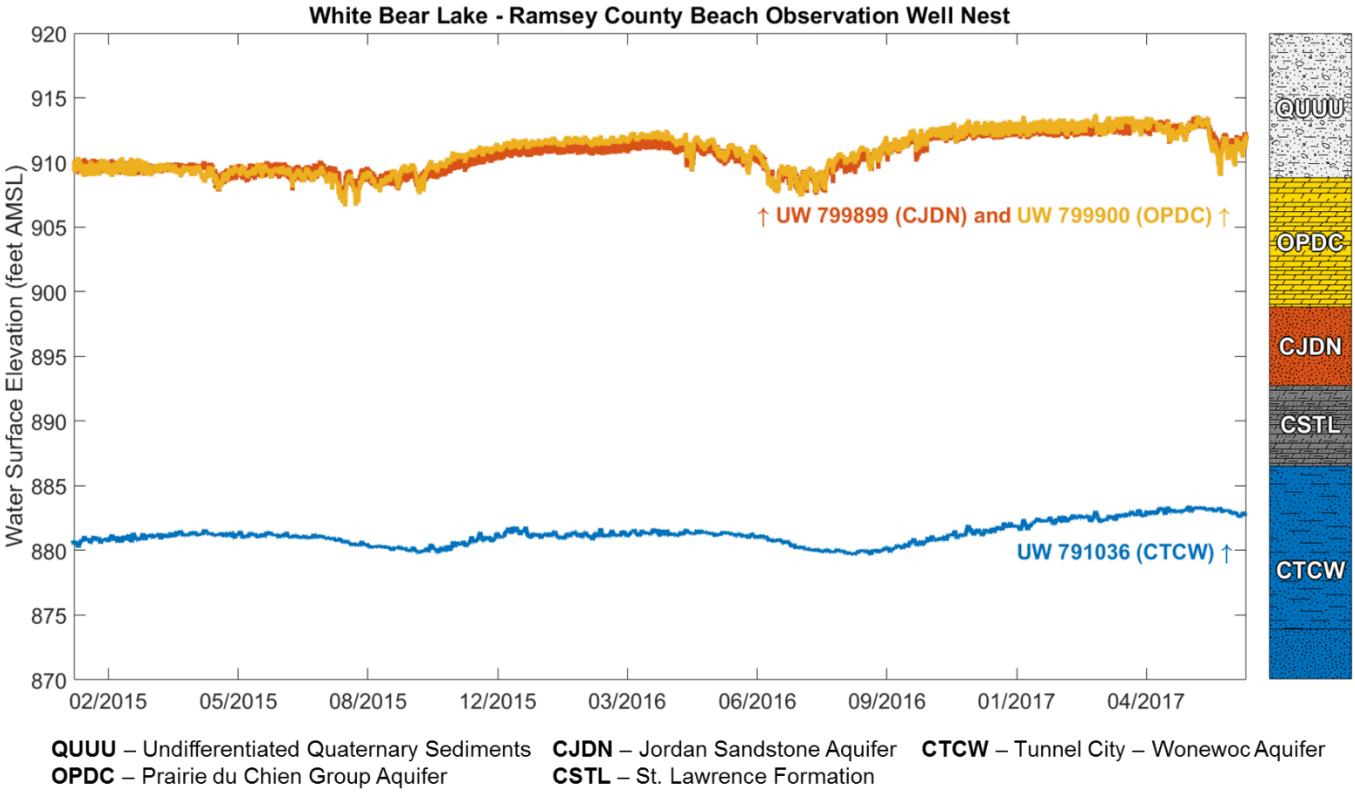


Figure A28: Hydrograph and generalized stratigraphic column for the White Bear Lake – Ramsey County Beach observation well nest. Stratigraphic column shows position and relative thickness of hydrostratigraphic units present, stratigraphic elevations do not correspond to the water surface elevations portrayed on the hydrograph axis.