# USGS National Ground-Water Monitoring Network Cooperative Agreement

## Final Technical Report

Award #G22AC00114-00- Minnesota Department of Natural Resources

*Figure 1: A site photograph of a newly installed GOES satellite telemetry setup at an observation well nest in Stearns Co, MN.*

Project Title: Groundwater Level Monitoring Network Enhancement to Telemetric Data Transfer

Project Term: 07/15/2022 through 06/30/2024

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Background

In December 2020, the Minnesota Department of Natural Resources (MN DNR) applied for a USGS National Ground-Water Monitoring Network (NGWMN) grant to upgrade groundwater level data collection devices. The upgrades would allow data to be transmitted to the MN DNR database via GOES satellite and cellular telemetry. The goal was to upgrade 26 wells that are currently in the NGWMN network to provide real-time, hourly data. The NGWMN awarded MN DNR up to $56,544.85 for telemetry equipment purchases. MN DNR committed to funding salaries, travel expenses, and hardware for equipment installations.

Summary of Accomplishments

The project began on July 15, 2022, and ended on June 30, 2024. All work supported Objective 6 of the NGWMN program: *purchase equipment for continuous water level data collection*. MN DNR committed to funding a 30% match through in-kind contributions of equipment, staff time, and travel expenses. Ultimately, MN DNR match ended up as 32% ($26,707.93) of total equipment expenses ($56,328.76).

- Eight observation well nests (21 wells) were upgraded to GOES satellite delivered data.
- Five standalone observation wells were upgraded with cellular telemetry (Table 1).

Data from upgraded wells are available on the MN DNR's Cooperative Groundwater Network website.

*Table 2: Summary of MN DNR and NGWMN observation well equipment upgrades.*

| Nest or standalone well | Site number | Principle aquifer | Equipment upgrade |
|---|---|---|---|
| Nest 02N6 | 114319 | Cambrian-Ordovician | Pressure transducer and GOES telemetry |
| | 816912 | Sand and gravel | |
| | 817621 | Cambrian-Ordovician | |
| Nest 29N3 | 243392 | Sand and gravel | Pressure transducer and GOES telemetry |
| | 243870 | Sand and gravel | |
| | 272084 | Sand and gravel | |
| Nest 29N8 | 149511 | Sand and gravel | Pressure transducer and GOES telemetry |
| | 243373 | Sand and gravel | |
| Nest 27N2 | 708368 | Sand and gravel | Pressure transducer and GOES telemetry |
| | 769457 | Cambrian-Ordovician | |
| | 782117 | Cambrian-Ordovician | |
| Nest 28N1 | 231846 | Cambrian-Ordovician | Pressure transducer and GOES telemetry |
| | 231847 | Cambrian-Ordovician | |
| | 231848 | Cambrian-Ordovician | |
| Nest 50N1 | 810697 | Upper carbonate | Pressure transducer and GOES telemetry |
| | 810698 | Upper carbonate | |
| | 810699 | Upper carbonate | |
| Nest73N3 | 805892 | Sand and gravel | Pressure transducer and GOES telemetry |
| | 805893 | Sand and gravel | |
| Nest 82N1 | 595649 | Cambrian-Ordovician | Pressure transducer and GOES telemetry |
| | 834170 | Sand and gravel | |
| Standalone | 139190 | Sand and gravel | Pressure transducer and cellular telemetry |
| Standalone | 243739 | Sand and gravel | |
| Standalone | 243315 | Sand and gravel | |
| Standalone | 243489 | Sand and gravel | |

| | | | |
|---|---|---|---|
| Standalone | 453624 | Sand and gravel | |

Description of Work

Two categories of observation wells were prioritized for upgrades.

1. Wells in remote locations, far from roads.
2. Wells in areas with intensive groundwater use.

This strategy provided a balanced spatial distribution of upgraded wells across Minnesota (Figure 2). Real-time data made it possible to monitor water levels and maintenance needs from the office.

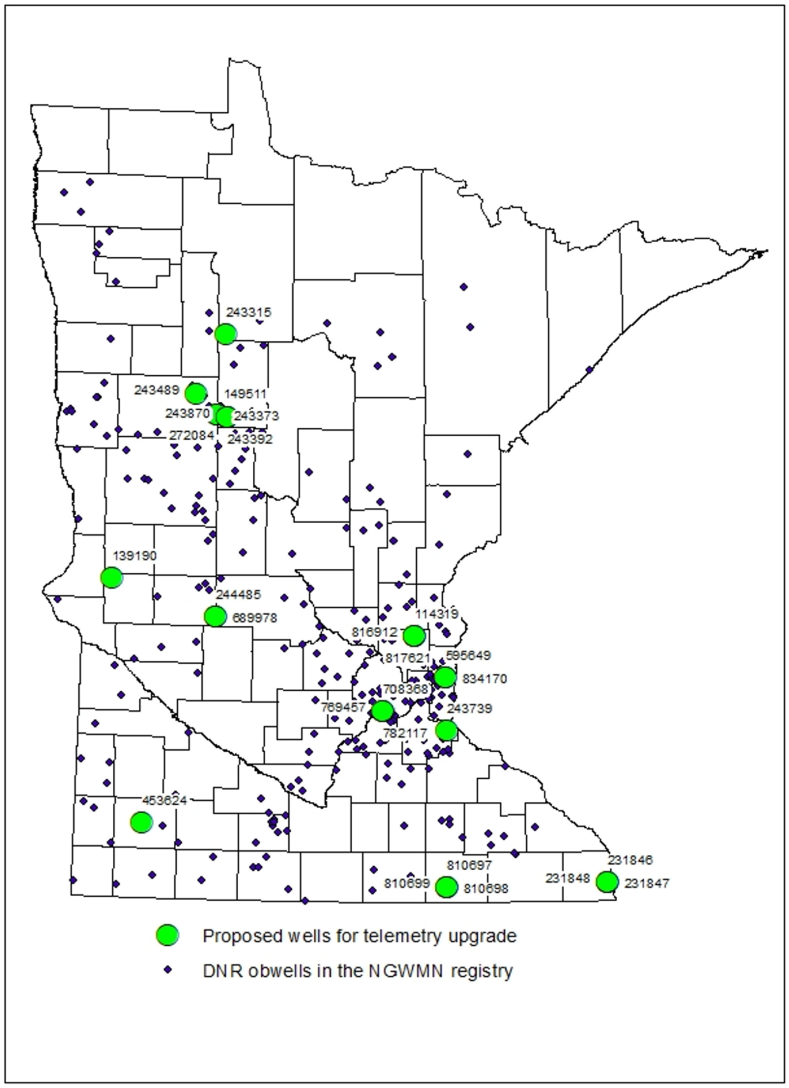


*Figure 2: Proposed locations of MN DNR and NGWMN observation well equipment upgrades.*

Designing enclosures to house and protect the new equipment was a new task for MN DNR (Figure 1). The work required landowner permission and utility clearance prior to installation. For example, nested sites 805892 and 805893 (Table 1) replaced the preliminary nest of sites 244485 and 689978 (Figure 2)

because the landowner did not grant permission to install an enclosure. All other upgrades proceeded as proposed.

Each nest upgrade required approximately six hours in the field by a two-person crew and an additional six hours of preparation work in the office and workshop. Equipment programming and database connectivity testing were generally straightforward, but tree cover posed challenges to continuous satellite transmissions. Signal strength varied with foliage density. Figures 3 and 4 illustrate the difference between clear and obstructed transmissions. Although tree cover occasionally disrupted transmissions (Figure 4), complete data is stored in the loggers' internal files.

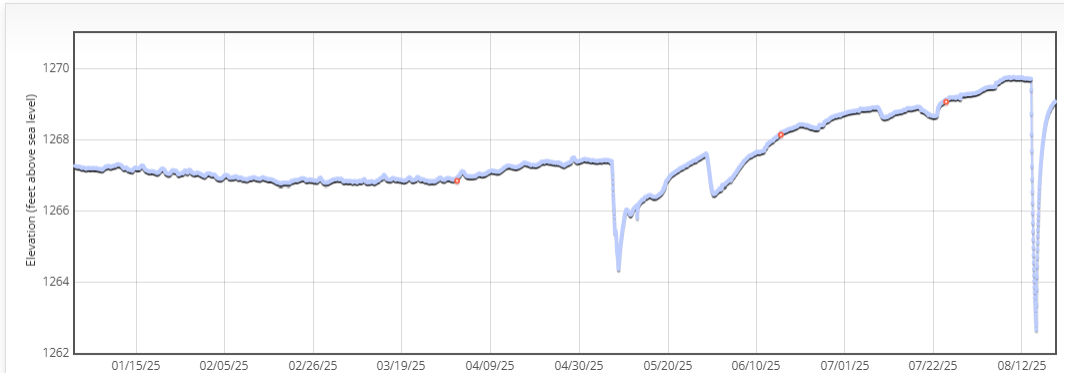


*Figure 3: GOES satellite transmitted data from site 805892 unimpacted by trees.*

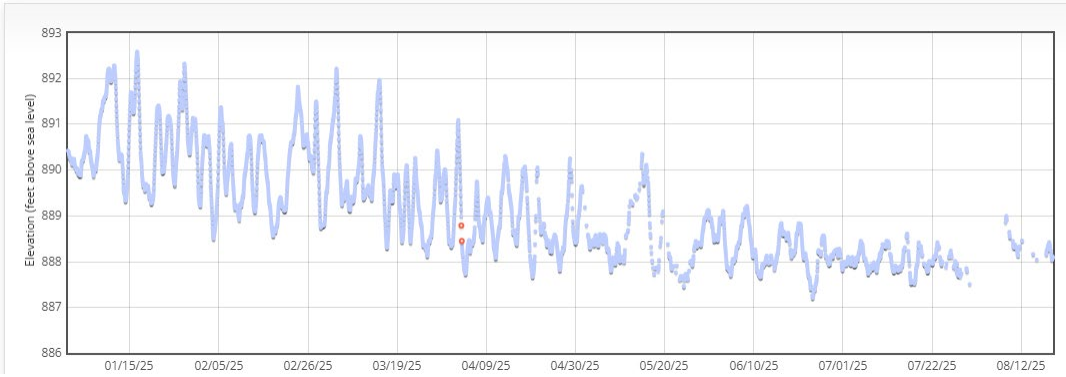


*Figure 4: GOES satellite transmitted data from site 231848 impacted by trees especially during summer months.*

Cellular telemetry presented different challenges:

- Fit limitations: Several observation wells had smaller-diameter casings, preventing the all-in-one loggers from fitting beneath the locking cap. Modifications were required to accommodate the units.
- New transmission method: Unlike GOES satellite systems, cellular telemetry was new for MN DNR. Data plans had to be established, and equipment tested before deployment.
- Variable service strength: Cellular signal varied widely. Protective well covers and lids sometimes interfered with connectivity, requiring modifications and antenna adjustments.

One major benefit of real-time groundwater level data was enhancing MN DNR's monthly Hydrologic Conditions Report. Traditionally, staff had to physically visit wells to obtain data for this report. With

telemetry, groundwater levels are automatically reported, providing a more accurate and timely statewide picture of hydrologic conditions.