

# Project Technical Summary

Title	Identification of naturally-occurring fluoride and selected metals in northwest Wisconsin groundwater
Project Identification	DNR-235
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Period of Contract	01 July 2018 to 30 June 2020
Background	<p>Northwest Wisconsin, encompassing the 11 counties of Ashland, Barron, Bayfield, Burnett, Douglas, Iron, Polk, Price, Rusk, Sawyer, and Washburn, has a large proportion of the population who obtain their drinking water from groundwater. There are over 56,000 public and private wells within this region of the state, however, the region is understudied in terms of groundwater quality relative to other areas in Wisconsin. Groundwater in northwestern Wisconsin may not be as impacted by anthropogenic contaminants as in other areas of the state, but within the last decade commercial interest in the region's natural resources have led to actual and proposed large-scale land-use changes that have the potential to impact groundwater quality. A comprehensive set of baseline data are needed in order to measure long-term groundwater quality changes. In a survey of residents within four northwest Wisconsin counties conducted by Northland College (Ashland, WI) in May and June 2016, 29% of respondents were unsure of the source of their drinking water and 84% had never searched for information on their drinking water quality. It is increasingly important to reverse this trend, and to expand residents' overall awareness of groundwater quality.</p> <p>Fluoride and the metals iron, manganese, aluminum, arsenic, and lead, if present at high enough concentrations in groundwater, could impact public health. Little is known regarding baseline concentrations of these potential contaminants in northwestern Wisconsin aquifers. Fluoride is a naturally-occurring inorganic ion, which has a narrow range of therapeutic concentrations. Iron, manganese, aluminum, and arsenic are naturally-occurring metals that could be present in groundwater depending upon the underlying geology and water quality of the aquifer. Lead is introduced to well water most commonly by corrosion of lead-containing plumbing, fixtures, or well components, but may also be leached from lead-containing minerals naturally occurring in aquifers when groundwater has pH &lt;6 or pH &gt;11 with little to no carbonate present.</p>
Objectives	<p>The objectives of this study, known as the <i>Northwest Wisconsin Groundwater Monitoring Project</i>, were to monitor naturally-occurring fluoride concentrations in groundwater samples collected from 11 counties in northwestern Wisconsin, determine concentrations of iron, manganese, aluminum, arsenic, and lead in a subset of these samples, foster public awareness among residents of the region about the need for regular private well testing, and increase the publicly-available groundwater data within the region.</p>
Methods	<p>This monitoring study used a random sample design, and targeted 704 fluoride samples and 115 metals samples total. All of the samples were collected by volunteers who were recruited to participate in the project through a combination of social media postings, press releases, and outreach events. Sample kits containing sample bottles, instructions for collection, sample collection form, and a pre-paid shipping label were assembled and delivered to each of 26 distribution sites located throughout the 11-county study area. Samples were collected into 125-mL, wide-mouth containers that were pre-cleaned to meet or exceed EPA requirements for drinking water. Volunteers were asked to collect a</p>

	<p>sample into the provided bottle(s) after running cold water at a high flow rate for at least five minutes, and return the collected sample(s) to UWS-LSRI within 14 days of collection. Upon receipt of sample kits at LSRI, a sample receipt checklist was completed by project staff and metals samples were preserved using trace metal grade nitric acid to pH&lt;2. An attempt was made to locate the well record for each of the sample(s) received. Fluoride analysis was conducted using High Performance Ion Chromatography following U.S. EPA Method 300.0 (1993). Analysis of the five metals studied for this project was conducted using Atomic Absorption Spectrometry. Samples analyzed for iron and manganese were analyzed by flame, while aluminum, arsenic, and lead were analyzed by graphite furnace. Data were summarized using MS Excel and mapped using ArcGIS Online. Results were reported to volunteers, and were presented at a series of public presentations held throughout the study area.</p>
<p><b>Results and Discussion</b></p>	<p>The data from 450 of 704 fluoride and 80 of 115 metals samples were reported. Samples were collected from all 11 counties in the study area, and were largely collected from drilled wells constructed 26 – 50 years ago, with a depth of 51 – 100 feet. None of the samples collected and analyzed for fluoride exceeded the state Enforcement Standard of 4.0 mg/L and less than 1% exceeded the Preventative Action Limit of 0.8 mg/L (Wis. Adm. Code Ch. NR 140). Iron concentrations were high in a number of samples, with 20% of samples collected exceeding the 0.3 mg/L Enforcement Standard. In 5% of samples collected, the Enforcement Standard for manganese, 300 µg/L, was exceeded. Overall, aluminum concentrations were low throughout the study area, but one sample exceeded the Enforcement Standard of 200 µg/L. The maximum arsenic concentration measured in this study was 10.0 µg/L, which is the state Enforcement Standard. However, 38.8% of samples had an arsenic concentration at or above the Preventative Action Limit (1 µg/L). There was a single sample that exceeded the Enforcement Standard for lead (15 µg/L) and 11.3% of samples had a lead concentration at or above the 1.5 µg/L Preventative Action Limit.</p>
<p><b>Conclusions and Recommendations</b></p>	<p>To the authors' knowledge, this study represents the first baseline groundwater monitoring effort encompassing the northwest Wisconsin region. With the exception of fluoride and arsenic, the Enforcement Standard was exceeded for all parameters measured in this study in at least one sample collected within the study area. Based on the results from this study, most children residing in northwest Wisconsin whose primary drinking water source is groundwater would need fluoride supplementation for the prevention of dental caries. However, higher levels of fluoride were measured in Ashland, Douglas, and Iron counties, and it is recommended that families residing in those counties have the fluoride concentration in their private wells tested. This study utilized a random sample design, and the next logical step is to conduct targeted sampling of areas with contaminant-level metals concentrations in groundwater samples. Due to the number of fluoride samples collected in this study, additional fluoride sampling is not necessary. However, it is highly recommended that additional, targeted sampling of iron, manganese, aluminum, arsenic and lead be conducted on wells for which a well record exists so that correlations may be made between well characteristics and sample analysis results. It may be beneficial to target additional naturally-occurring compounds, such as radium and radon.</p>
<p><b>Key Words</b></p>	<p>Fluoride, iron, manganese, aluminum, iron, lead, northwest Wisconsin, citizen science</p>
<p><b>Funding</b></p>	<p>Funding for this work was provided by the Wisconsin Department of Natural Resources via the Wisconsin Groundwater Coordinating Council.</p>