National Ground-Water Monitoring Network Data Portal Strategic Plan

Providing Direction for the National Ground-Water Monitoring Network Data Portal for the next five years (FY2019-FY2023)

NGWMN Mission

The National Ground-Water Monitoring Network (NGWMN) works with volunteer data providers to build a collaborative network of groundwater level and groundwater quality data of known quality in a consistent format at the principal and major aquifer scale. The NGWMN was established because there wasn't a consistent source of groundwater data that could be used to address national groundwater availability questions. Data providers to the NGWMN are any agency or other organization that collects groundwater-level or groundwater-quality data and is willing to share that data through the NGWMN Data Portal. Data providers select sites that can be used to determine the status and trends of groundwater availability and provide documentation on the methods used to collect and manage the data. Data from the NGWMN are available for anyone to use and are intended to support groundwater management decisions at national, regional, interstate, and even international scales. Leadership of the NGWMN is shared between the Advisory Committee on Water Information (ACWI) Subcommittee on Ground Water (SOGW), the NGWMN Program Board, and the United States Geological Survey (USGS).

NGWMN Data Portal Mission

The NGWMN Data Portal is the mechanism by which data are gathered from NGWMN data providers and served to users. Web services are used to retrieve data from data providers and convert the data into a common format to provide seamless access through the user interface or web services. The user interface of the NGWMN Data Portal provides basic tools for data analysis. Users can select sites of interest using data discovery tools through the NGWMN Data Portal and view data in graphs or tables. Users can also select and download data for more detailed analysis.

NGWMN Data Portal Scope

The NGWMN Data Portal serves groundwater data from sites selected by data providers.
The sites are selected to build a network designed to answer groundwater availability questions. The NGWMN Data Portal is not intended to be a warehouse that contains groundwater data for all sites, but instead a network of key monitoring sites designed to build a National Network. Water-level, water-quality, well construction, lithology, spring discharge, and other relevant data may be served through the NGWMN Data Portal. For each monitoring site, links to original data sources are provided so that any additional site data are accessible. The NGWMN maintains 'Data Provider Pages' that describe the source and history of the data, and information on data collection and data management so that the NGWMN provides 'data of known quality.' The addition of basic tools for data analysis are planned. For more detailed analysis, users can access the NGWMN data using web services or the 'R' dataRetrieval package to meet specific needs.

Background of the NGWMN and the NGWMN Data Portal

The NGWMN is a voluntary, collaborative effort by a variety of partners to build a network with data appropriate to address groundwater availability issues at a national, regional, interstate, or even international scale using groundwater data. The NGWMN may be thought of as an aggregation of wells selected from existing Federal, multistate, State, Tribal, local, and commercial groundwater monitoring networks across the Nation. The NGWMN provides data that can be used to assess baseline conditions and long-term trends in water levels and water quality in important aquifers.

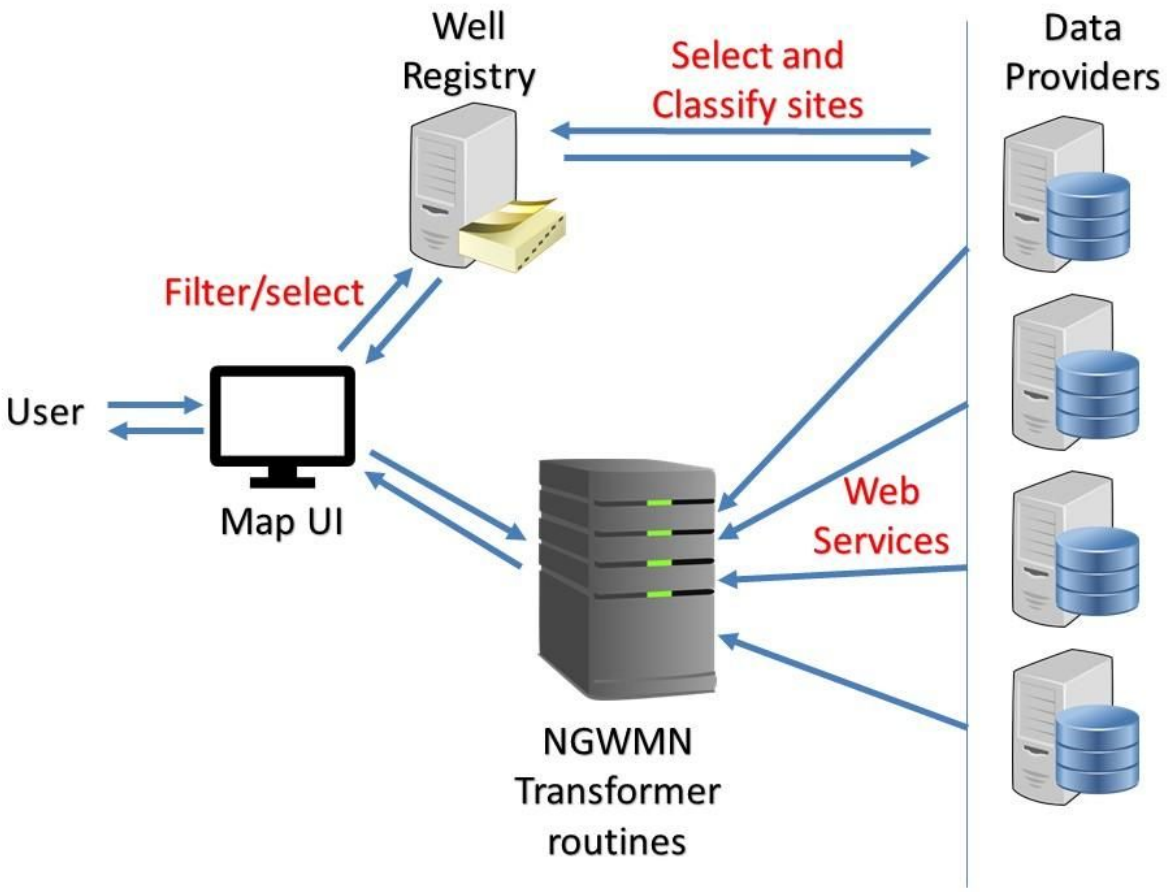
The NGWMN is a product of the ACWI SOGW. In 2006, Heinz stated that existing groundwater data were 'inadequate for national reporting'. The National Ground Water Association (NGWA) White Paper recognized the need for a national groundwater monitoring network effort and suggested that the ACWI and its National Water Quality Monitoring Council design a National Monitoring Network, which was to include a groundwater component. At the time, there was limited focus on groundwater in existing ACWI subcommittees. Thus, the SOGW was formed in 2007 with the single goal of developing a nationwide framework for a monitoring network that could provide groundwater data necessary for the planning and management of groundwater resources.

The SOGW produced the NGWMN Framework Document in 2009. It outlined the background and need for the NGWMN; it described the network design, data collection and data management requirements; and it suggested an implementation plan. The NGWMN was authorized as part of the SECURE Water Act of 2009. A pilot phase was initiated in 2010 to test the feasibility of the NGWMN and to commence development of a pilot data portal. Six states participated in the pilot phase and a pilot NGWMN Data Portal was successfully released. The initial framework document was revised based on input from the pilot studies and a new Framework Document was completed in 2013. Funding to support the NGWMN was appropriated beginning in 2015 and full implementation began at that time.

The NGWMN is focused on the principal aquifers of the Nation (U.S. Geological Survey, 2003), which have been identified by the USGS as the most significant water-use aquifers, and other major aquifers of regional importance identified by contributors. Information on the principal aquifers is available in the Groundwater Atlas of the United States.

Data providers are critical to the success of the NGWMN. The NGWMN is not just a concatenation of all contributing data providers but rather consists of selected wells chosen by the data providers to enable a coherent national assessment. Contributing data providers select appropriate representative wells for the NGWMN and assure the quality of the data contributed to the network. Any organization that collects groundwater data according to the guidelines in the Framework Document may contribute data to the NGWMN.

The NGWMN Data Portal is hosted and maintained by the USGS in support of the NGWMN. The NGWMN Data Portal is the access point for data discovery and download from the NGWMN. Data are provided to the NGWMN by data providers who establish or repurpose web services to serve water-level data, water-quality data, well-construction information, and lithology for NGWMN sites. The source data remain with the data provider in their database so that data providers maintain control of what data are made available to the network. The figure below shows a schematic of user interaction with the NGWMN Data Portal and the flow of data from data providers.



The process begins with data providers establishing web services to serve their data. Subsequently, each data provider works with the NGWMN Data Portal staff to map their data to the NGWMN required data elements. Data are retrieved by the NGWMN Data Portal nightly and mediated into the common format. Data providers enter their sites into the NGWMN Well Registry (after they have selected their sites) so that selected data can be retrieved, and the data can be used to plot and filter the sites in the Map User Interface. Data are only stored temporarily by the NGWMN Data Portal (to facilitate timely retrieval of data) so that the data provider maintains ownership of their data. Any updates made to the data provider databases are reflected in the NGWMN Data Portal on the day following the update.

Users interact with the NGWMN through the NGWMN website and the NGWMN Data Portal. In the user interface, users can select sites by filtering on several criteria including principal aquifer, state, contributing agency, and availability of data. Data can be viewed site by site or a group of sites can be selected for download. When sites are viewed individually, the user can view site information, NGWMN designations, water-level data tables and hydrographs, water-quality data in a table, and lithology for wells.

NGWMN Data Portal Strategy

The main goal of this document is to provide a plan for NGWMN Portal development staff for the five-year period. This will be used as the basis for developing detailed plans for ongoing improvements on the NGWMN Data Portal based on current needs. These needs are likely to change over time, and if so, the strategy will be updated. Other work in the realm of ongoing outreach and continued

maintenance related to the NGWMN Data Portal is routinely performed; such activities as in the following list will continue to take place during the planning period, but they are not the specific emphasis of this document.

- Collaboration, cooperation, and coordination with other similar data efforts.
- Outreach to increase the exposure of the NGWMN Data Portal through meetings and articles describing the Portal

This document sets strategic goals that will enhance the ability of the NGWMN Data Portal to meet the needs of data providers and data users while enabling growth and utilization of the NGWMN. These goals for the NGWMN Data Portal development in the next five years are grouped into the following categories.

1. Support NGWMN Data Providers
2. Improve System Performance
3. Enhance the Display of Data in the Portal User Interface
4. Promote Standards Driven Data Exchange
5. Increase Support for Data Analysis
6. Expand the Types of Data Available

These categories are described below, including specific objectives related to each strategic goal. This is followed by a section on priorities in which each goal is ranked as “ongoing”, “short-term”, or “long-term”. The priority ranking will be used to conduct detailed planning and implementation of the NGWMN Data Portal development efforts.

1. Support NGWMN Data Providers

NGWMN Data Portal staff will map new database connections, identifying connectivity issues, and foster collaboration and coordination between data providers. As stated in the framework document, minimal effort will be required on the part of data providers to participate in managing the data flow. Maintaining the source of the data (data provenance) is important and will be a consideration in any updates or new development.

a) Data provider support

Continue to provide support to data providers who are setting up web services to contribute data to the NGWMN. Maintain focus on providing tools to data providers to support data exchange and improving functionality for monitoring data upload status. Create a dashboard to indicate the status of data loading for data providers.

b) Enhance the Well Registry Management System

Replace the Well Registry Management System with one that is easier to use. Add the capability for data providers to use web services to provide data to the Well Registry in addition to a user interface. Enhance metadata fields for accommodating data from spring sites that will be added to the well registry. Add a category to the Well Registry to differentiate the major aquifers (sub-groupings of prinicipal and major aquifers) described in the Ground Water Atlas of the U.S.

c) *Address issues with site identifiers used for NGWMN sites*
Encourage collaboration between data provides by allowing multiple data providers to contribute various elements of data for the same site using different site identifiers. Develop protocol for replacement wells or sites to extend the data record.

2. Improve System Performance

Maintaining optimal performance of the NGWMN Data Portal is critical and involves both hardware (e.g. servers) and software considerations. It is essential that the NGWMN Data Portal structure remains fully functional and up-to-date. Proposed updates will improve the NGWMN Data Portal's speed, overall system performance, and efficiency while maintaining or reducing operating costs.

a) *Keep software current*
Modernize the software to allow for a secure and stable system that retrieves and delivers data quickly. This will allow for maintaining system performance, reduce risk to the system, and reduce the cost of responding to future needs. Update software as required so that the NGWMN Data Portal complies with mandated security requirements.

b) *Implement a service-oriented architecture to improve performance*
Revise the system architecture to use services. Rewrite parts of the application with a services-oriented focus that will allow for increased system stability and flexibility while promoting interoperability. This will allow parts of the code (such as the statistics service) to be separated from the main code; such services will reduce risk to the system and allow for the code to be decoupled so that updates of the various parts of the application can be made separately.

3. Enhance the Display of Data in the Portal User Interface

Increase usability of the NGWMN Data Portal with a focus on accommodating a variety of users. The NGWMN Data Portal interface will be upgraded with a contemporary look and feel that will allow for intuitive navigation, place-based searching, additional filters, and display of monthly statistics. Revise the structure of the NGWMN web pages to help users access information about the network more intuitively.

a) *Develop site pages*
Create a web page for each site to make data more easily readable, accessible, and discoverable for end users. The current pop-up that is generated when a user clicks on a site will be replaced with a page containing information for that station that opens in a separate browser tab. Site pages will have unique URLs to make it easier to access specific sites and will be optimized for search engines. The current tabs (summary, water levels, water quality, and well log) will be maintained.

b) *Upgrade the user map interface*
The User Interface is the mostly common way of accessing data from the NGWMN. The interface will be upgraded with a contemporary look and feel. Most current features

will be maintained. Will investigate dropping features that are not being used. New filters will be added so that users can select desired data in a variety of ways, including by location and the period of record. Water-level statistics will be displayed so that users can understand current conditions in the context of historical measurements.

c) *Enhance content on site pages*
Improve content that is being served on site pages for ease of use and to improve access to data. Update the hydrograph display by including breaks in lines where there are gaps in data and making the image produced more useable for other applications. Add well construction information to the graphical display of the well log (lithology). Include monthly water-level statistics on site pages. Display a summary of available water-quality information.

d) *Improve NGWMN web pages*
Revise the structure of the NGWMN web pages so that users may more easily find desired content. Update the URL of the NGWMN web page so that it can be permanently maintained regardless of organizational changes.

4. Promote Standards Driven Data Exchange

Move towards use of standards to increase efficiency and facilitate data exchange. Utilization of WaterML2 and GWML2 will improve system performance by standardizing data parsed from data providers. Data output will be standardized and will follow conventions used worldwide, allowing NGWMN data to be integrated into other data systems, such as the International Groundwater Resources Assessment Centre (IGRAC). Provide resources to data providers (both new and current) to help them utilize standards.

a) *Support data providers' use of standards to provide their data*
Encourage use of standards for data exchange to promote efficiency of data coming into the NGWMN. Work with current data providers and key professional and technical organizations to determine an approach for connecting data to the NGWMN Data Portal using the WaterML2 standard. Pilot the use of data standards with select data providers and work to develop reference implementation and tools to support data providers wishing to utilize the standards. Produce guidance documents and tip sheets for using the WaterML2 standard to deliver data to the NGWMN.

b) *Promote communication with other systems*
Utilization of the WaterML2 and GWML2.0 standards on outgoing web services will improve communication with other water data systems. The NGWMN Data Portal would like to integrate data with systems such as the Water Quality Portal, the International Groundwater Resources Assessment Center's database, and other data products that serve and use water data. The NGWMN Data Portal will explore becoming a data node for EPA's WQX so that NGWMN data may be more easily integrated into the Water Quality Portal.

5. **Increase Support for Data Analysis**

Add basic tools to analyze NGWMN data. The NGWMN Data Portal should serve data in a variety of formats that will support studies that allow users to address regional, national, interstate, and international groundwater questions.

a) *Improve availability of data through external web services*
Expand web services to make all NGWMN data (water-quality, lithology, well construction, and Well Registry information) available to users through web services. Use established WaterML2 and GWML2.0 standards to do this.

b) I*mprove the tools in the free statistics package 'R' for analysis of NGWMN data*
Develop tools and scripts in 'R' to facilitate analysis of NGWMN data. Improve the 'dataRetrieval' package to pull all data types from NGWMN Data Portal, including additional site attributes to facilitate development of tools to perform more detailed data analysis. Increase the ability to refine data retrieved by list of sites, date range, and site ID. Include access to monthly water-level statistics and associated calculations.

6. **Expand the Types of Data Available**

The NGWMN Data Portal now serves water level, well log, and water quality data; however, additional types of data could also be served. Spring discharge data will be served through the portal. Will also consider serving water-use data for principal aquifers and continuous water-quality data through the portal.

a) *Serve spring discharge data*
Spring discharge information is measured by several agencies and is an important component in understanding groundwater-surface water interactions. Spring discharge data could be added to the NGWMN. It is important that data providers serve spring discharge information in the same format, following standard methods for measurement and providing sufficient metadata to understand how spring discharge explains groundwater resources.

b) *Display water-use data for principal aquifers*
Water use data will soon be available from USGS compilations of water use at the principal aquifer scale for each U.S. County. The NGWMN Data Portal will interact with a working group of water-use experts and the SOGW to determine how to include this county groundwater withdrawal data on the NGWMN map interface.

c) *Evaluate need to serve continuous water-quality data*
Since very little continuous water-quality data are currently available to be served through the NGWMN, setting up connections to that data are a lower priority. However, an EPA workgroup is currently developing methods to serve continuous water-quality data. Also, the use of continuous monitoring for groundwater is growing. As the EPA workgroup progresses and if there is an increase in continuous water-quality data available at NGWMN sites, the priority of serving this data will be reassessed.

Prioritization/work plan

To help set priorities for the NGWMN Data Portal development, goals are grouped into "ongoing", "short-term", or "long-term" work efforts. Short term goals will be those prioritized for work in the next 1-3 years. Long-term goals are those that we would like to see completed in the next three to five years. In several cases, the goals have been split into a short-term component that often involves planning and a long-term component that deals with implementation.

Ongoing

1. a) Data Provider Support

2. a) Keep Software current

One to three years

1. b) Enhance the Well Registry Management System

2. b) Implement service-oriented architecture to improve performance

3. a) Develop site pages

3. b) Upgrade user map interface

3. c) Enhance content on site pages

3. d) Improve NGWMN web pages

4. a) Support data providers' use of standard services to provide their data

    Determine approach, develop reference implementation, provide tools

5. a) Improve availability of data through external web services

6. a) Serve spring discharge data

    Work with SOGW to determine approach, capture metadata, and update the Well Registry management system to include springs

6. b) Display water-use data for principal aquifers

    Work with SOGW new directions work group and water-use staff to determine how to best serve water-use data through the NGWMN Data Portal.

Four to five years

1. c) Address issues with site identifiers used for NGWMN sites

4. a) Support data providers' use of standard services to provide their data

    Implementation, require that new data providers use standards, provider support to current data providers to convert to standards

4. b) Promote communication with other systems

5. b) Improve the tools in 'R" for analysis of NGWMN data

6. a) Serve spring discharge data

Begin serving spring discharge data

6. b) Display water-use data for Principal aquifers

Implementation

6. c) Evaluate need to serve continuous water-quality data