Development of a Ground Water Data Portal for Interoperable Data Exchange and Mediation within the National Ground Water Monitoring Network (NGWMN)

Jessica Lucido¹, Nathaniel Booth¹, I-Lin Kuo¹, Jessica Thompson¹ and William Cunningham²

¹US Geological Survey, Middleton, Wis., USA
²US Geological Survey, Reston, Va., USA
Existing Nationwide Coverage

Wells operated by USGS

Active Groundwater Level Network
Friday, November 06, 2000

Wells operated by States
Results from survey of State networks
National Ground Water Monitoring Network

- Framework Report approved by Advisory Committee on Water Information - 2009
- Available at http://acwi.gov/sogw/pubs
Purpose: The overall goal is to develop and encourage implementation of a nationwide, long-term ground-water quantity and quality monitoring framework that would provide information necessary for the planning, management, and development of ground-water supplies to meet current and future water needs, and ecosystem requirements.

Scope: This national framework for ground-water monitoring and collaboration will be developed to assist in assessments of the quantity of U.S. ground-water reserves, as constrained by ground-water quality.
Pilot Network Approach

- Determine “current picture” of groundwater monitoring
- Consensus network design principles
- Consensus field methods and data standards
- Determine approach for compiling data & making it available
- Consensus on implementation plan
Goal of Portal

To create a single publically accessible, automated data portal to relay groundwater levels, groundwater-quality data and associated lithological and well construction information from distributed databases through a national map interface.
Portal Objectives:

• Integrate National, State and Local GW data
• Make all data available through a single web portal
• Automated data transfer from data providers, through portal, to public user
• Dynamically access data from original source
• Real-time or near real-time data available
• Data Available
  – Well characteristics
  – Water levels
  – Water-quality
Distributed Network, Open Standards & Mediation

ARCHITECTURE & STRATEGY
Principles:

**Distributed** → Data stays with owner

**Seamless** → Acts as one virtual database

**Multi-access** → Multiple portals, tools

**Standards Based** → OGC’s WFS & SOS, EPA’s WQX, WaterML, GWML, GeoSciML
Strategy:

- A centrally managed well registry (hub) contains a minimum set of data elements for all wells.
- Mediator (hub) transforms data from native to common format and aggregates into a single dataset.
Hub Components:

**Web Portal** - Provides mapping interface to display and search wells

**Well Registry** - Harvests metadata to power web portal searching and intelligent parceling of search to nodes

**Data Mediator** - Collects data from each node and mediates independent formats to common ones
Strategy:

- A centrally managed well registry (hub) contains a minimum set of data elements for all wells.
- Mediator (hub) transforms data from native to common format and aggregates into a single dataset.
- Access state and national datasets (nodes) using standard protocols and mediate to common formats.
Architecture Continued:

**HUB:**
- Catalog
- Map UI
- Downloader/Mediator

**NODES:**
- Node
- Node
- Node
Map Request Workflow:
Site Detail Workflow:
Data Retrieval Workflow:
Strategy:

- A centrally managed well registry (hub) contains a minimum set of data elements for all wells
- Mediator (hub) transforms data from native to common format and aggregates into a single dataset
- Access state and national datasets (nodes) using standard protocols and mediate to common formats
- Incorporate OGC web service standards for data exchange
Strategy:

• A centrally managed well registry (hub) contains a minimum set of data elements for all wells
• Mediator (hub) transforms data from native to common format and aggregates into a single dataset
• Access state and national datasets (nodes) using standard protocols and mediate to common formats
• Incorporate OGC web service standards for data exchange
• Leverage existing data models: GWML, WQX, WaterML2.0
Architecture Advantages:

• Common, inexpensive and well-supported software components for data providers
• Data providers maintain ownership of dataset and have control over which data is exposed
• Allows data providers some flexibility for implementation
• Data providers can re-purpose web services
• Integration with international groundwater community
Agency Collaboration, Data Portal & Challenges to Overcome

PILOT OUTCOMES
What We Learned:

• Data provider technical capabilities vary
• Complicated organizational structures
• Some missing data elements (minimal)
• Structure of well log data varies greatly
• Some spatial and temporal data gaps
Pilot Results:

- 5 Pilot provided data (from 6 states)
- 9 Agencies provided data
- 17 Web Services created to serve data

<table>
<thead>
<tr>
<th></th>
<th>Water Levels</th>
<th>General</th>
<th>Well Log Construction</th>
<th>Lithology</th>
<th>Water Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL</td>
<td>Import/WFS</td>
<td>NA</td>
<td>Import/WFS</td>
<td>Import/WFS</td>
<td>Import/WFS</td>
</tr>
<tr>
<td>IN</td>
<td>NWIS</td>
<td>NA</td>
<td>NWIS</td>
<td>NA</td>
<td>NWIS</td>
</tr>
<tr>
<td>MT</td>
<td>WFS</td>
<td>NA</td>
<td>WFS</td>
<td>WFS</td>
<td>NA</td>
</tr>
<tr>
<td>MN</td>
<td>WFS</td>
<td>WFS</td>
<td>NA</td>
<td>NA</td>
<td>STORET</td>
</tr>
<tr>
<td>NJ</td>
<td>NWIS</td>
<td>NA</td>
<td>NWIS</td>
<td>NA</td>
<td>NWIS</td>
</tr>
<tr>
<td>TX</td>
<td>SOAP</td>
<td>NA</td>
<td>SOAP</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>
User uses filters on LHS of the screen and maps the wells by clicking on the "Map" button.
Map layer can be toggled on and off.
User then clicks the identify button and then a well of interest. If multiple wells are selected a pop-up with the list of wells is displayed.
When a single well is chosen from the list the site information will be displayed for that well in a new pop-up.
The well’s lithology and construction information is pulled via web services from NWIS and displayed in the figure and in the tables below.
The water level time-series are displayed in tabular and graphical form.
The water quality data is also displayed in tabular form.
All of the data about the well may be exported in a tabbed excel spreadsheet
Scaling Up, Well Registry Management & Advanced Features

NEW DEVELOPMENT
Well Registry Management

- Data Providers can manage well information
- Logging of changes to well classification
- Review of well data for managers
Addition of USGS Wells

- USGS wells added to network
- Collaboration with WSC scientists
- Well data pulled from NWIS directly
New Development

• Scale-up infrastructure to support full implementation
  – Performance
  – Reliability
  – Stability
• Multi-site download
• Advanced querying
Summary:

• Distributed data accessible in a single location & format
• Data providers maintain ownership
• Standards based architecture for interoperability
• Final Product: Integrated state and federal network
• Underlying mediated services made available
• Distributed architecture can be re-used for other applications & data types
Acknowledgements:
Join the Network!

Contact:
Bill Cunningham
Acting Chief, Office of Groundwater
411 National Center
Reston, VA 20175
703-648-5005
wcunning@usgs.gov
Questions?

http://cida.usgs.gov/gw_data_portal