

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

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Subcommittee on Groundwater, Network Design & Objectives

BACKGROUND

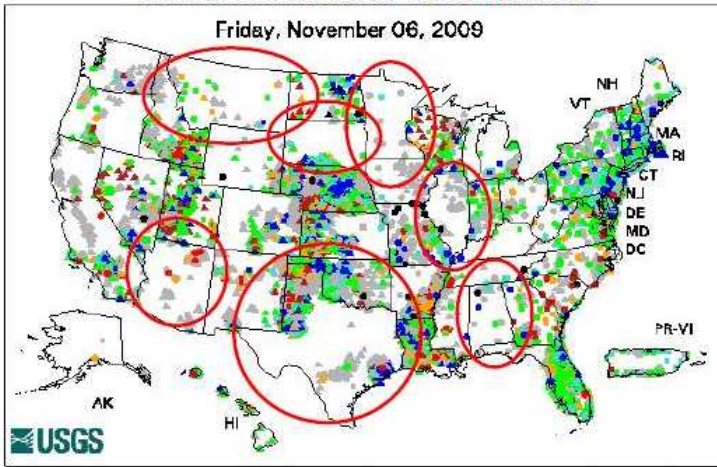
Existing Nationwide Coverage

Wells operated by USGS

Groundwater Watch

Active Groundwater Level Network

Friday, November 06, 2009



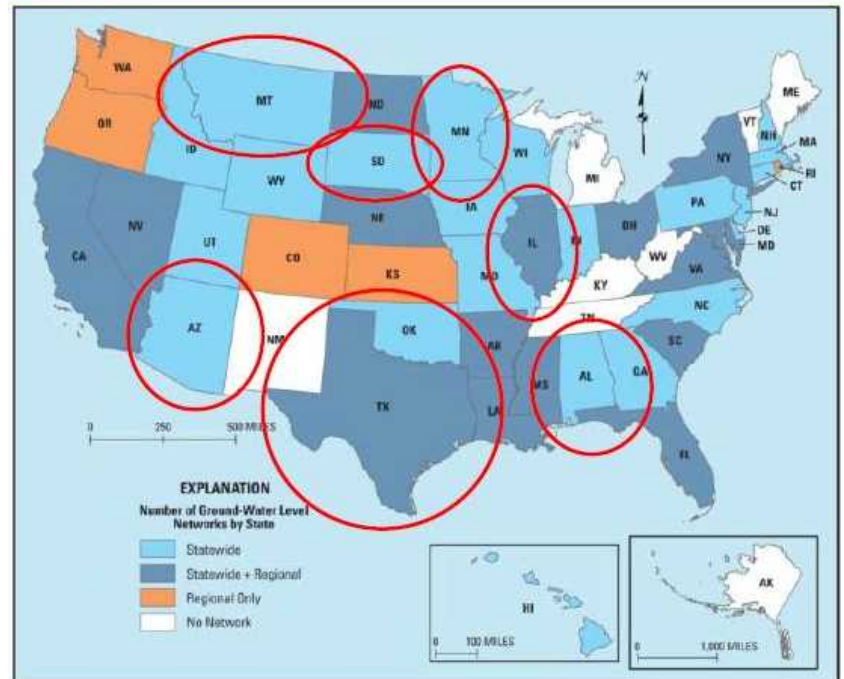
Explanation - Percentile classes (symbol color based on most recent measurement)								○ Real Time		□ Continuous		△ Periodic	
● New	● <10	● 10-24	● 25-75	● 76-90	● >90	● New High	● Not Ranked						
Low	Below Normal	Below Normal	Normal	Above Normal	High Above Normal								

Active Well Count

Real-Time: 1,175 Daily: 1,142 Periodic: 23,777

Wells operated by States

Results from survey of State networks



EXPLANATION
Number of Ground-Water Level Networks by State

- Light Blue: Statewide
- Dark Blue: Statewide + Regional
- Orange: Regional Only
- White: No Network



National Ground Water Monitoring Network

- Framework Report approved by Advisory Committee on Water Information - 2009
- Available at <http://acwi.gov/sogw/pubs>

**A National Framework for Ground-Water Monitoring
in the United States**

Prepared by

The Subcommittee on Ground Water
of the
The Advisory Committee on Water Information

Final Version approved by the Advisory Committee on Water Information

June 2009



Network Purpose & Scope

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

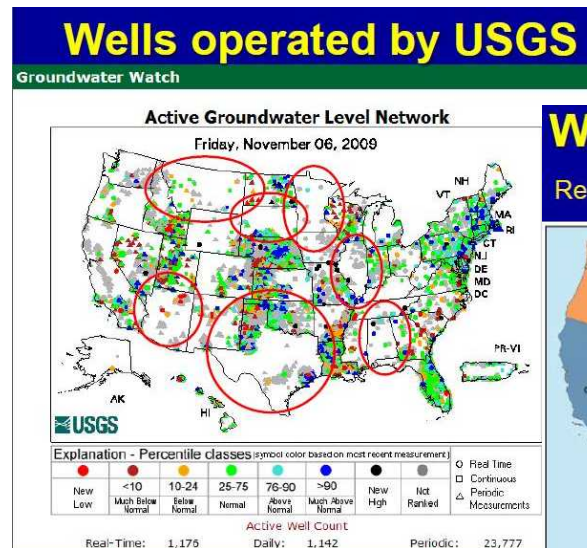
- Determine “current picture” of groundwater monitoring
- Consensus network design principles
- Consensus field methods and data standards
- Determine approach for compiling data & making it available
- Consensus on implementation plan

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



Wells operated by States

Results from survey of State networks



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

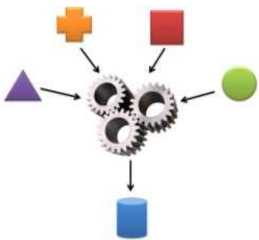
Hub Components:



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



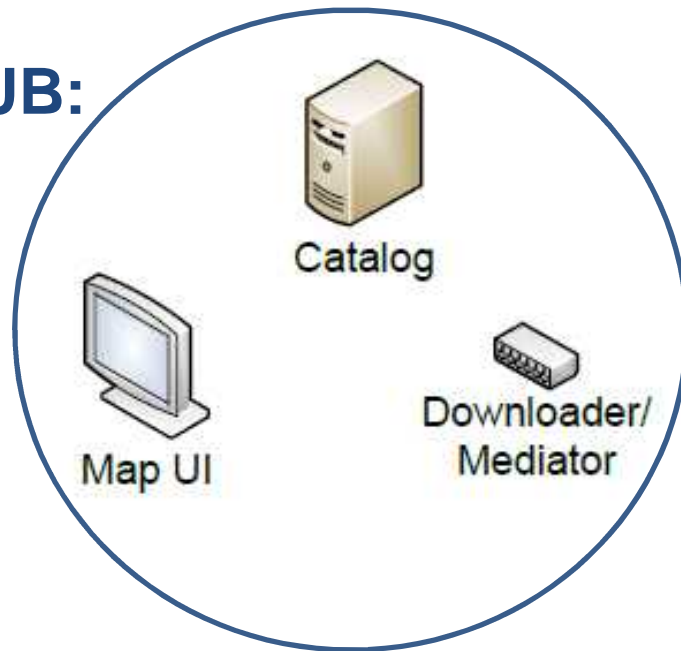
Data Mediator - Collects data from each node and mediates independent formats to common ones

Strategy:

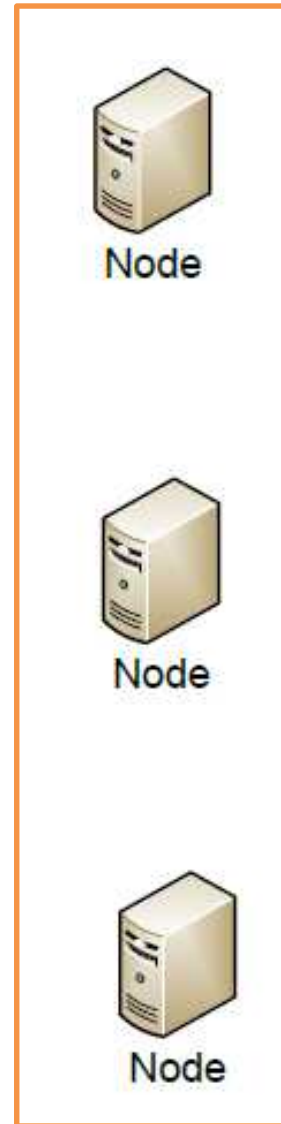
- A centrally managed well registry (**hub**) contains a minimum set of data elements for all wells
- Mediator (**hub**) transforms data from native to common format and aggregates into a single dataset
- Access state and national datasets (**nodes**) using standard protocols and mediate to common formats

Architecture Continued:

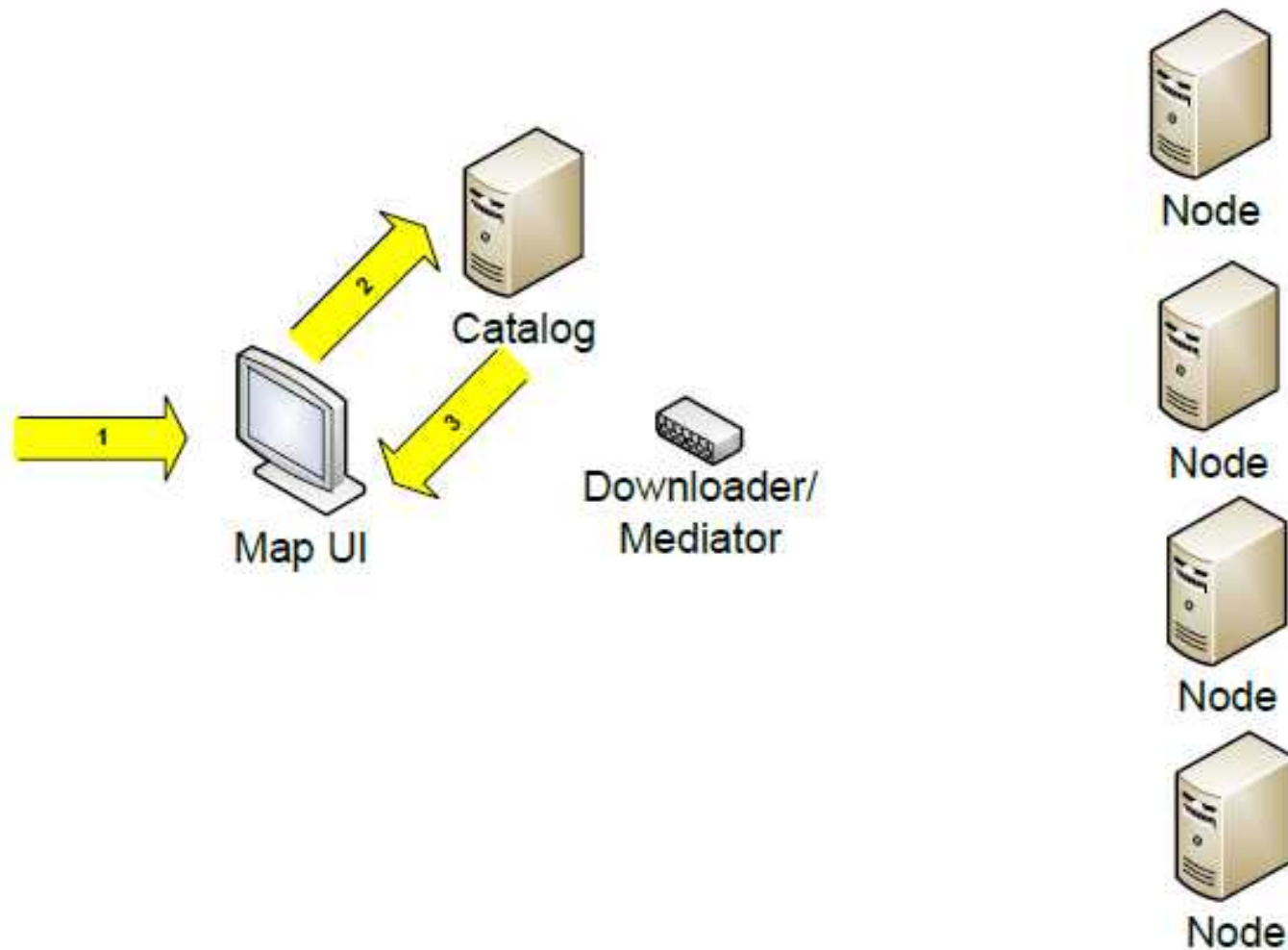
HUB:



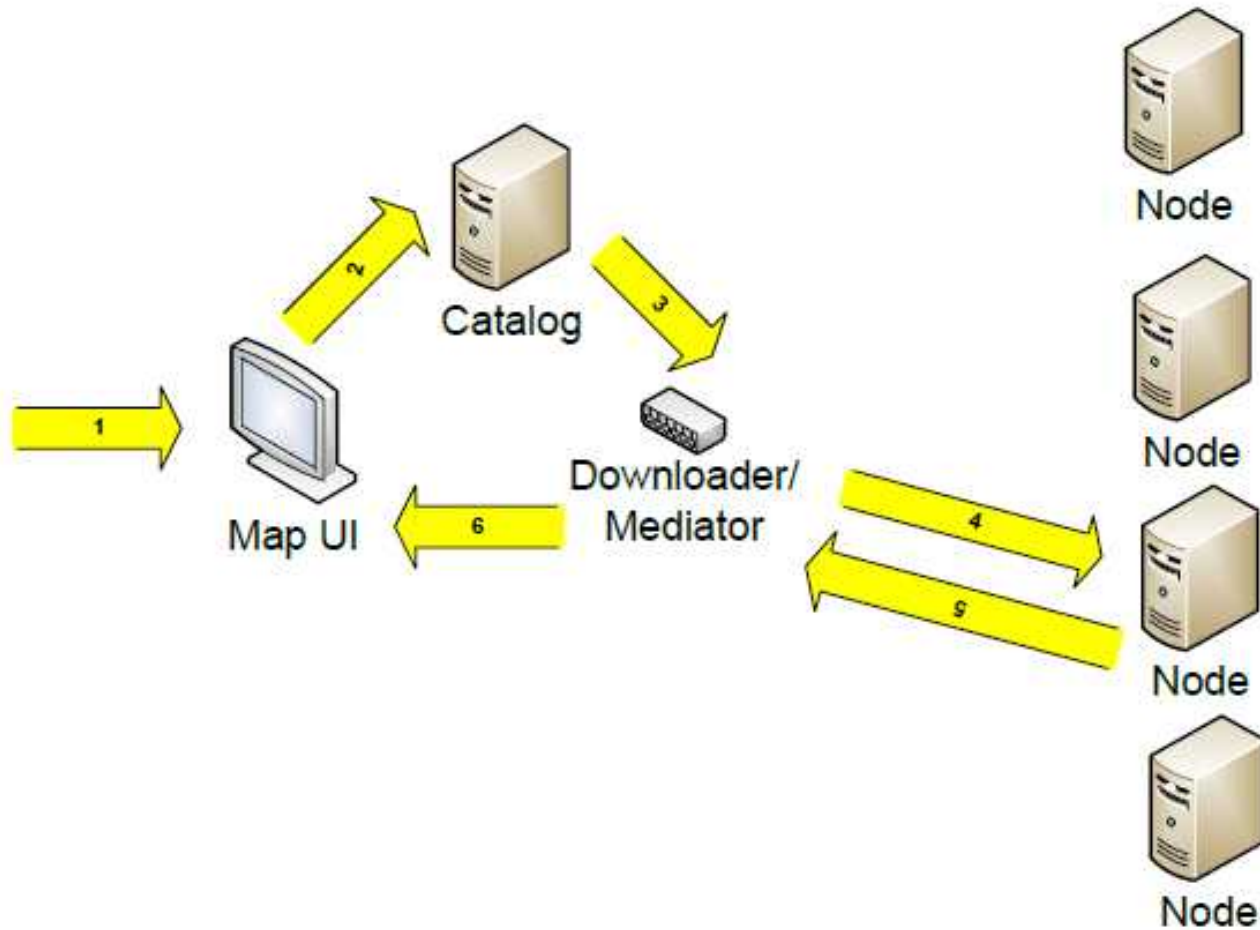
NODES:



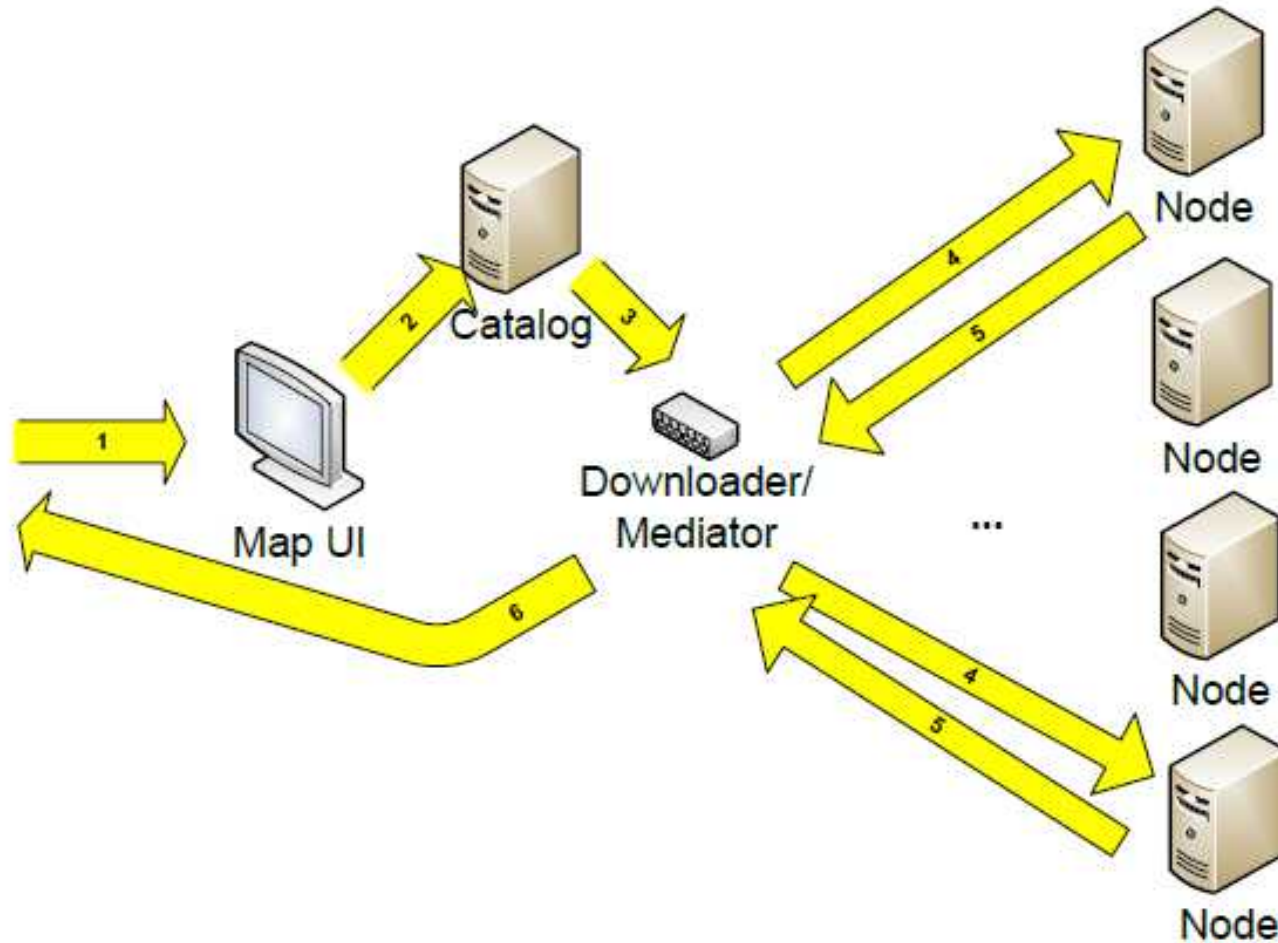
Map Request Workflow:



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

	Water Levels	Well Log				Water Quality
		General	Construction		Lithology	
			Casing	Screen		
IL	Import/WFS	NA	Import/WFS		Import/WFS	Import/WFS
IN	NWIS	NWIS				NWIS
MT	WFS	NA	WFS	WFS	WFS	NA
MN	WFS	WFS			NA	STORET
NJ	NWIS	NWIS				NWIS
TX	SOAP	NA	SOAP	NA	NA	NA

National Ground Water Monitoring Network Data Portal (BETA)

Filter Map Data

Agency Contributing Data
ctrl + click to select more than one

- All Organization IDs
- ARKANSAS SOIL & WATER CONSERVATION COMMIS
- IL Env'tl Protection Agency
- IL State Water Survey
- MT Bureau of Mines and Geology

U.S. Principal Aquifer Name
ctrl + click to select more than one

- All National Aquifers
- Ada-Vamoosa aquifer
- Alluvial aquifers
- Arbuckle-Simpson aquifer
- Biscayne aquifer

Water Level Network
ctrl + click to select more than one

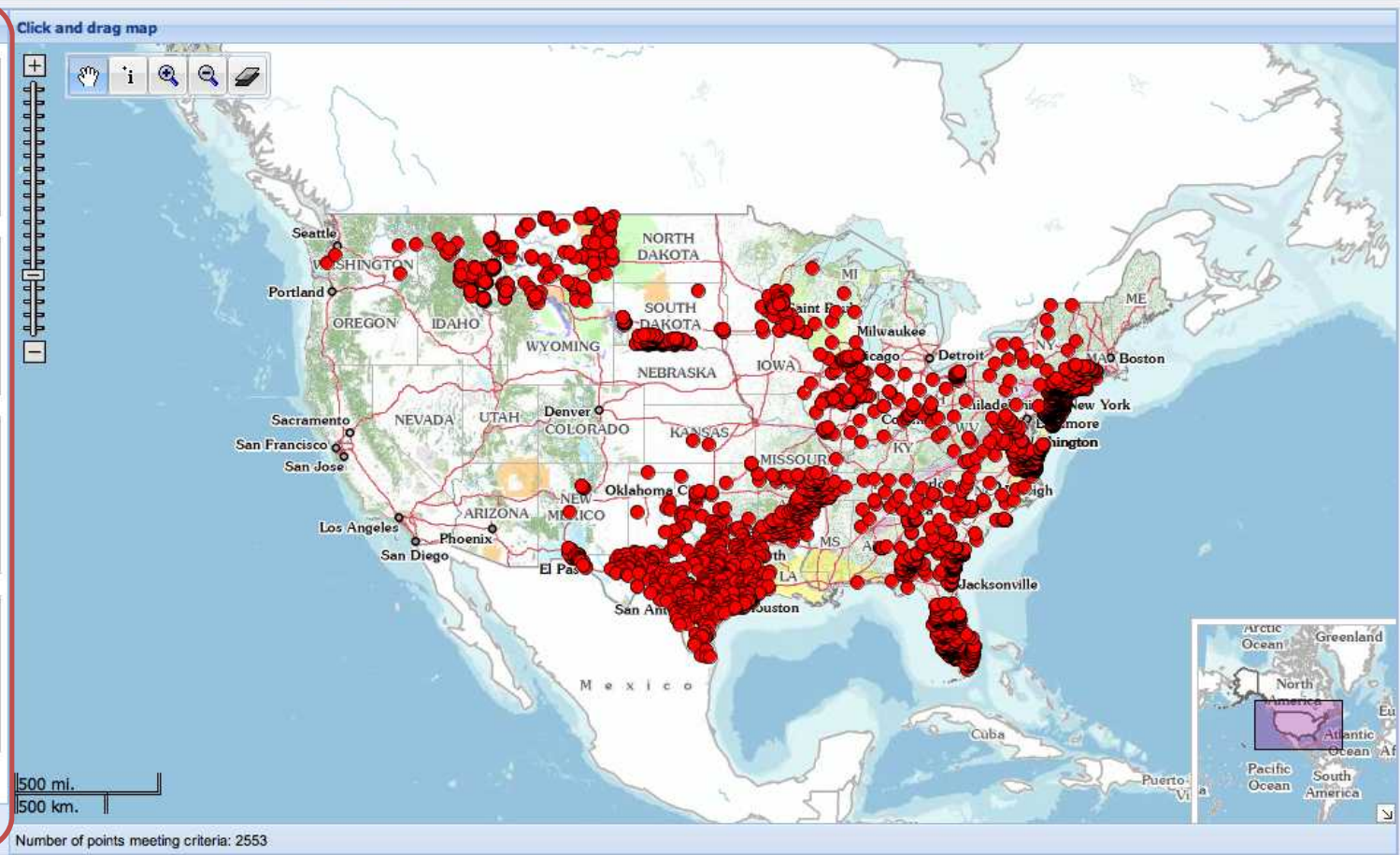
- All Water Level Sub Networks
- Surveillance - Background
- Surveillance - Suspected / Anticipated Changes
- Surveillance - Known Changes
- Trend -

Water Quality Network
ctrl + click to select more than one

- All Water Quality Sub Networks
- Surveillance - Background
- Surveillance - Known Changes
- Trend - Background
- Trend - Known Changes

Map

Click and drag map



500 mi.
500 km.

Number of points meeting criteria: 2553

User uses filters on LHS of the screen and maps the wells by clicking on the "Map" button.

Filter Map Data

Agency

ctrl + click to select more than one

- All Organization IDs
- IN Dept. of Natural Resources
- IL State Water Survey
- MT Bureau of Mines and Geology
- MN Dept. of Natural Resources

National Aquifer Name

ctrl + click to select more than one

- All National Aquifers
- Alluvial aquifers
- Cambrian-Ordovician aquifer system
- Coastal lowlands aquifer system
- Early Mesozoic basin aquifers

Water Level Network

ctrl + click to select more than one

- All Water Level Sub Networks
- Surveillance - Targeted
- Surveillance - Unstressed
- Trend - Targeted
- Trend - Unstressed

Water Quality Network

ctrl + click to select more than one

- All Water Quality Sub Networks
- Surveillance - Targeted
- Surveillance - Unstressed
- Trend - Targeted
- Trend - Unknown

Map

Click on map to identify a point of interest

Base Map Layers

Vector Fills

Description: Vector fills is a dynamic map service with the vector base map polygon area fills, i.e. the green national forest areas or the blue water areas. The fills have been split into separate services: `_Small`, which has tiles for the small scales cached, down through 1:289,000; and `_Large`, which is dynamic and covers scales 1:144,000 and larger.

On/Off:

Opacity (-/+):

Vectors

Description: This is the beta version of new The National Map, in the Web Mercator projection. There are 20 scales total, from 1:591,657,527 (global) down through 1:1,128. The Vector base map service has been split into two services: `_Small`, with tiles cached for the small scales, down through 1:268,000; and `_Large`, a dynamic service for 1:144,000 down through 1:128. *Note: Survey National Atlas - small scales*

Close

500 mi.
500 km.

Number of points meeting criteria: 1763

Map layer can be toggled on and off.

National Ground Water Monitoring Network Data Portal (BETA)

Filter Map Data

Agency Contributing Data
ctrl + click to select more than one

- MT Bureau of Mines and Geology
- MN Dept. of Natural Resources
- MN Pollution Control Agency
- TX Water Development Board
- USGS NWIS**

U.S. Principal Aquifer Name
ctrl + click to select more than one

- All National Aquifers**
- Alluvial aquifers
- Cambrian-Ordovician aquifer system
- Coastal lowlands aquifer system
- Denver Basin aquifer system

Water Level Network
ctrl + click to select more than one

- All Water Level Sub Networks**
- Surveillance - Background
- Surveillance - Known Changes
- Surveillance - Unknown
- Trend - Background

Water Quality Network
ctrl + click to select more than one

- All Water Quality Sub Networks**
- Surveillance - Background
- Surveillance - Known Changes
- Trend - Background
- Trend - Known Changes

Click on map to identify a point of interest

5 sites were identified nearby. Select one...

Site Name	Ntl Aquifer Name	Agency
SC00107021BDA	Denver Basin aquifer system	USGS
SC00107001AAB	Denver Basin aquifer system	USGS
SB00107025CDA	Denver Basin aquifer system	USGS
SB00106930CCB	Denver Basin aquifer system	USGS
SB00106906AAB	Denver Basin aquifer system	USGS

Show Summary For Site

250 mi.
250 km.

Number of points meeting criteria: 1134

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.

National Ground Water Monitoring Network Data Portal (BETA)

Filter Map Data

Agency Contributing Data

ctrl + click to select more than one

- MT Bureau of Mines and Geology
- MN Dept. of Natural Resources
- MN Pollution Control Agency
- TX Water Development Board
- USGS NWIS**

U.S. Principal Aquifer Name

ctrl + click to select more than one

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ctrl + click to select more than one

- All Water Level Sub Networks**
- Surveillance - Background
- Surveillance - Known Changes
- Surveillance - Unknown
- Trend - Background

Water Quality Network

ctrl + click to select more than one


- All Water Quality Sub Networks**
- Surveillance - Background
- Surveillance - Known Changes
- Trend - Background
- Trend - Known Changes

Map

Click on map to identify a point of interest

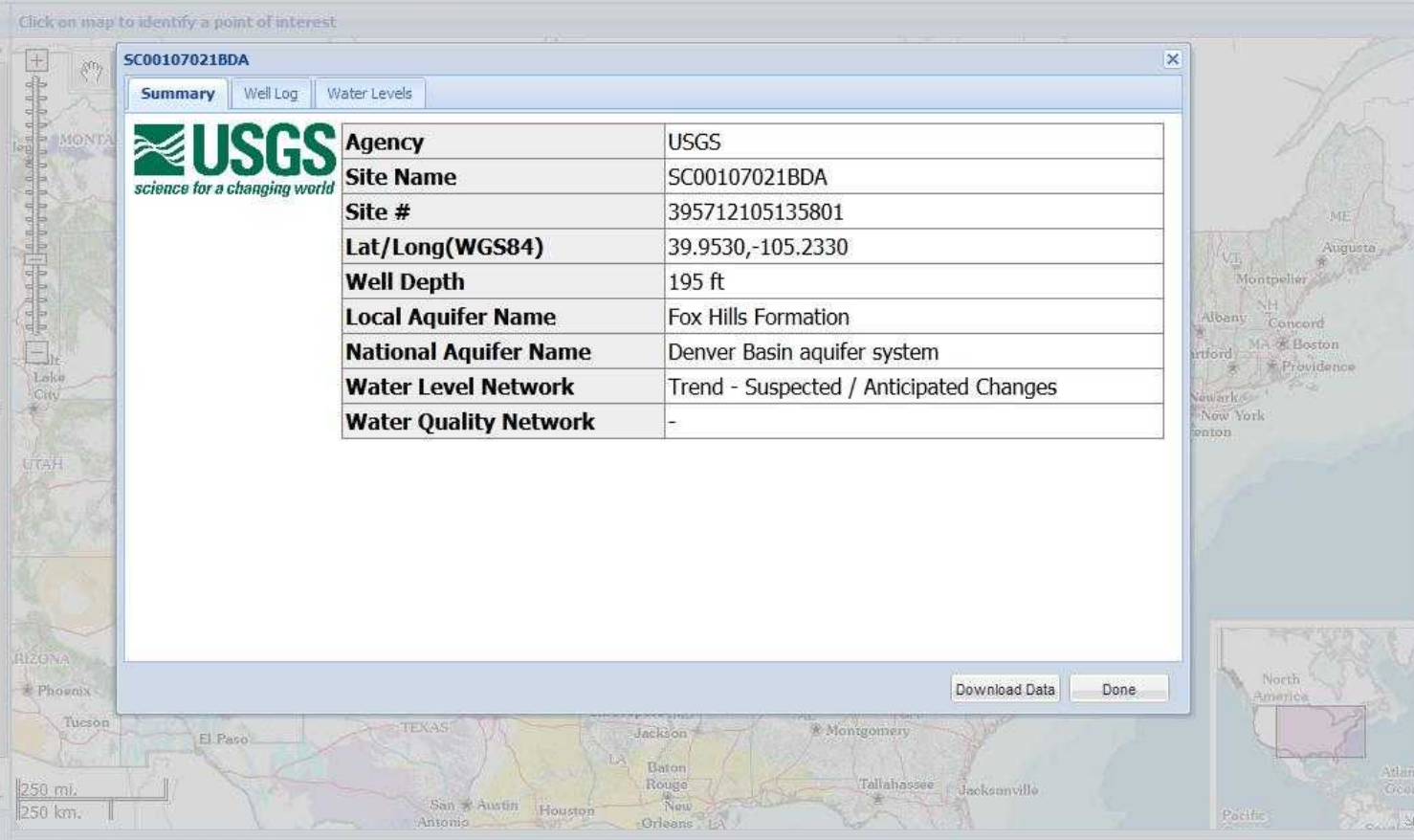
SC00107021BDA

Summary | Well Log | Water Levels

	Agency	USGS
	Site Name	SC00107021BDA
	Site #	395712105135801
	Lat/Long(WGS84)	39.9530,-105.2330
	Well Depth	195 ft
	Local Aquifer Name	Fox Hills Formation
	National Aquifer Name	Denver Basin aquifer system
	Water Level Network	Trend - Suspected / Anticipated Changes
	Water Quality Network	-

Download Data Done

Number of points meeting criteria: 1134



When a single well is chosen from the list the site information will be displayed for that well in a new pop-up.

290813-- Holly Lake 6

Summary **Well Log** Water Levels

Longitude: -74.3467
 Latitude: 39.5860
 Elevation: 19.95 ft.
 Well Depth: 339.11 ft.
 Resource: [USGS NWIS Database](#)

Depth From (ft)	Depth To (ft)	Lithology
299.21	332.13	Sand and gravel
332.13	345.09	Clay

Depth From (ft)	Depth To (ft)	Screen/Casing
306.19	336.12	Stainless steel

Download Data Done

The well's lithology and construction information is pulled via web services from NWIS and displayed in the figure and in the tables below.

Filter Map Data

Agency
ctrl + click to select more than one
All Organization IDs
IL Env't Protection Agency
IL Dept. of Natural Resources
IL State Water Survey
MT Bureau of Mines and Geology

National Aquifer Name
ctrl + click to select more than one
All National Aquifers
Alluvial aquifers
Cambrian-Ordovician aquifer system
Coastal lowlands aquifer system
Early Mesozoic basin aquifers

Water Level Network
ctrl + click to select more than one
All Water Level Sub Networks
Surveillance - Targeted
Surveillance - Unstressed
Trend - Targeted
Trend - Unstressed

Water Quality Network
ctrl + click to select more than one
All Water Quality Sub Networks
Surveillance - Targeted
Surveillance - Unstressed
Trend - Targeted
Trend - Unknown

Map

116824--Wabash 4 (WB 4)

Summary Well Log **Water Levels** Water Quality

Depth to water level, feet below land surface

Month/Year

Date created: 02/15/2011 17:02:01

Date	Time	Value	Unit
03-23-2010	17:30-05:00		feet
10-07-2003	12:31-05:00	48.91	feet
10-06-2003	00:00-05:00	48.9575004577637	feet
10-05-2003	00:00-05:00	48.9539566040039	feet
10-04-2003	00:00-05:00	48.903751373291	feet
10-03-2003	00:00-05:00	49.0943758103516	feet
10-02-2003	00:00-05:00	49.4610404968262	feet
09-30-2003	00:00-05:00	49.4289586928223	feet
09-29-2003	00:00-05:00	49.2679176330566	feet

Download Data Done

The water level time-series are displayed in tabular and graphical form.

Filter Map Data

Agency
ctrl + click to select more than one

- All Organization IDs
- IL Env't Protection Agency
- IN Dept. of Natural Resources
- IL State Water Survey
- MT Bureau of Mines and Geology

National Aquifer Name
ctrl + click to select more than one

- All National Aquifers
- Alluvial aquifers
- Cambrian-Ordovician aquifer system
- Coastal lowlands aquifer system
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Water Level Network
ctrl + click to select more than one

- All Water Level Sub Networks
- Surveillance - Targeted
- Surveillance - Unstressed
- Trend - Targeted
- Trend - Unstressed

Water Quality Network
ctrl + click to select more than one

- All Water Quality Sub Networks
- Surveillance - Targeted
- Surveillance - Unstressed
- Trend - Targeted
- Trend - Unknown

Map

116824--Wabash 4 (WB 4)

Summary Well Log Water Levels **Water Quality**

Export as CSV

Characteristic Name	Detection Condition	Measure Value	Units	Value Type
Alkalinity		351	mg/l CaCO3	Actual
Specific conductance		754	uS/cm @25C	Actual
Depth to water level below land surface		38.66	ft	Actual
Phosphate		0.01	mg/l as P	Actual
Total dissolved solids		0.59	tons/ac ft	Calculated
Total dissolved solids		433	mg/l	Calculated
Depth, from ground surface to well wat		11.8	m	Calculated
Iron		470	ug/l	Actual
Sulfate		67.0	mg/l	Actual
Chloride		2.7	mg/l	Actual
Potassium		2.40	mg/l	Actual
Sodium, percent total cations		20	%	Calculated
Sodium adsorption ratio		0.89	None	Calculated
Sodium		37.0	mg/l	Actual
Magnesium		39.0	mg/l	Actual
Calcium		67.0	mg/l	Actual
Total hardness -- SDWA NPDWR		328	mg/l CaCO3	Calculated
Phosphate-phosphorus		0.031	mg/l	Calculated
Nitrate-nitrite	Not Detected	Not Detected		Actual
Total solids		462	mg/l	Actual
Alkalinity		363	mg/l CaCO3	Actual
Carbon dioxide		25	mg/l	Calculated
pH, lab		7.7	std units	Actual
pH		7.5	std units	Actual
Oxygen		1.1	mg/l	Actual
Hydrogen ion		0.00004	mg/l	Calculated
Specific conductance		734	uS/cm @25C	Actual

Download Data Done



The water quality data is also displayed in tabular form.

116824--Wabash 4 (WB 4)

Summary | Well Log | Water Levels | **Water Quality**

Export as CSV

Characteristic Name	Detection Condition	Measure Value	Units	Value Type
Alkalinity		351	mg/l CaCO3	Actual
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Depth, from ground surface to well wat		11.8	m	Calculated
Iron		470	ug/l	Actual
Sulfate		67.0		
Chloride		2.7		
Potassium		2.40		
Sodium, percent total ca				
Sodium adsorption ratio				
Sodium				
Magnesium				
Calcium				
Total hardness -- SDWA				
Phosphate-phosphorus				detected
Nitrate-nitrite				
Total solids				
Alkalinity		363		
Carbon dioxide		25		
pH, lab		7.7	std units	Actual
pH		7.5	std units	Actual
Oxygen		1.1	mg/l	Actual
Hydrogen ion		0.00004	mg/l	Calculated
Specific conductance		734	uS/cm @25C	Actual

Download Data Done

Downloading Site Data...

Please wait...

Cancel

Opening export

You have chosen to open

export
which is a: application/octet-stream
from: http://cida.usgs.gov

What should Firefox do with this file?

Open with Browse...

Save File

Do this automatically for files like this from now on.

OK Cancel

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

The screenshot displays the 'Well Registry Management Interface' for USGS employees. At the top right, there are navigation links for 'Home', 'View Well Registry', and 'Import Wells from NWIS', along with a 'Logout' link. Below the navigation bar, the page is identified as 'Page 1'. A prominent header reads 'Welcome to the Well Registry Management Interface: (USGS Employees Only)'. On the left side, a 'Menu' section contains links for 'View Well Registry', 'Import from NWIS', and 'User Documentation'. The main content area provides an overview of the application's purpose and includes detailed 'Well Classification Definitions' for 'WL Sub-Network', 'WL Well Purpose', 'WL Well Type', 'WL Baseline', and 'WL Well Characteristics'.

Page 1

Welcome to the Well Registry Management Interface: (USGS Employees Only)

Menu

- [View Well Registry](#)
- [Import from NWIS](#)
- [User Documentation](#)

In this application you can view the wells and their respective metadata that are currently part of the NGWMN network. You may also turn wells on and off by changing the 'display' designation without having to remove them from the system. Lastly, you are able to add new wells and edit existing ones. For a detailed description of the well registry fields, see the [Well Registry Guidance Document](#) and the [User Documentation](#). For more information on well selection and well classification see the [Framework Document](#).

Well Classification Definitions:

WL Sub-Network:

Is the well part of the WL network (default is "Yes")? All wells marked as "Yes" will be included in the NGWMN WL network. This is not too important now, but will become more important when Water Quality wells from NWIS are also added to the Network. A well could be a QW site, but not a WL site, etc.

WL Well Purpose:

A two category classification of the well to document the well's original purpose (a) 'Dedicated Monitoring/Observation', or (b) 'Other' (i.e. not a dedicated monitoring well).

WL Well Type:

Three choices are possible; Trend, Surveillance, or Special Studies. 'Trend' wells have a monitoring frequency appropriate to determine long-trends and seasonal variability (typically quarterly at least), 'Surveillance' wells are 'synoptic' snapshots of data used to tie together the 'Trend' wells. 'Special Studies' wells are likely to be local areas of depletion or impairment.

WL Baseline:

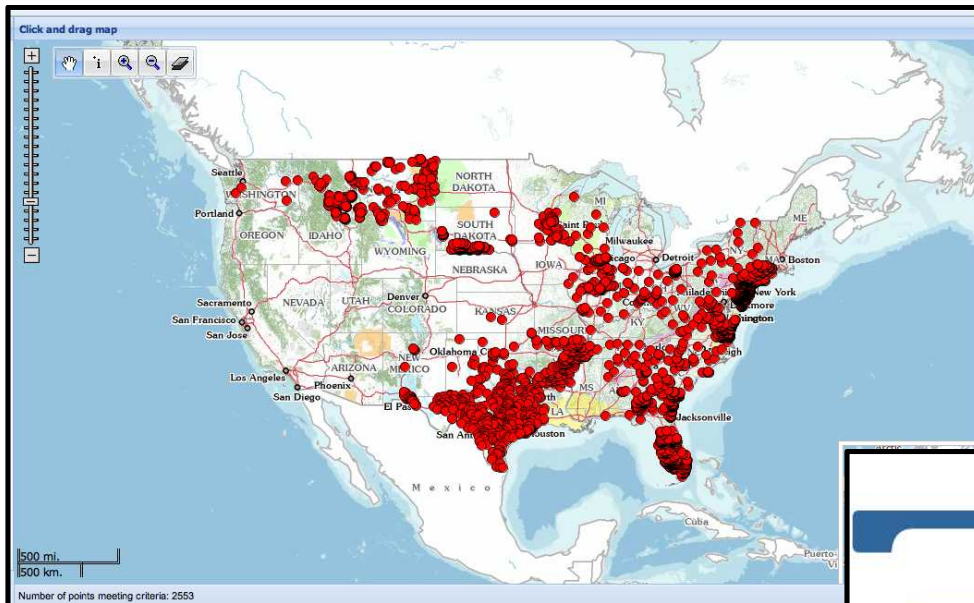
A 'baseline' period of at least 5 years of data must be available to achieve the 'baseline period' for a well or spring. Has the baseline period for water-levels been satisfied (are there 5 years of data) (Y/N)? All wells that are classified as 'Baseline' wells need to have the WL_Well_Characteristics field populated.

WL Well Characteristics:

The characteristics of the aquifer that the well represents: 'Background', 'Suspected/Anticipated Changes', or 'Known Changes'. This column is required if the WL_Baseline_Flag is set to 'Yes'. Wells that represent background conditions and have not changed substantially over time can be classified as 'Background'. Wells that have definitely been affected can be classified as demonstrating 'Known changes'. The final category is for wells for which clear changes cannot be identified or for which changes are expected. These wells can be classified as 'Suspected / Anticipated Changes'.

Addition of USGS Wells

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



Logout

Home View Well Registry Import Wells from NWIS

STEP 1: Choose Filter Criteria Reset Cancel

State

Site Number Min # of Water Level Measurements

National Aquifer

Local Aquifer

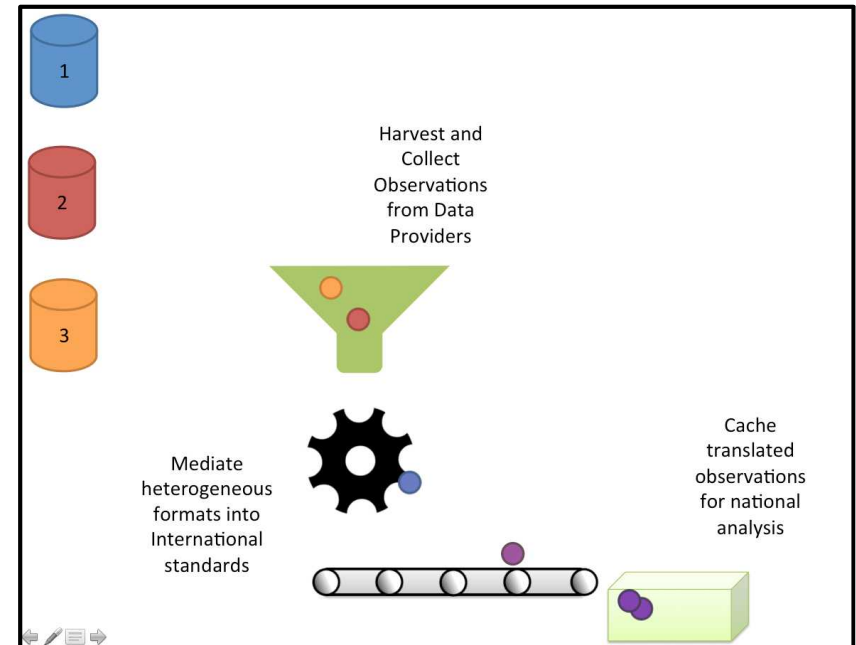
Agency NWIS Host

Search

The figure shows a web-based form for filtering well data. The form is titled 'STEP 1: Choose Filter Criteria' and has a 'Reset' button and a 'Cancel' button. It contains several input fields: a dropdown menu for 'State' with the value '-Choose One-', a text input for 'Site Number', a text input for 'Min # of Water Level Measurements', a dropdown menu for 'National Aquifer' with the value '-Choose One-', a dropdown menu for 'Local Aquifer' with the value '-Choose One-', a dropdown menu for 'Agency' with the value '-Choose One-', and a text input for 'NWIS Host' with the value '-Choose One-'. A 'Search' button is located at the bottom right of the form. The form is part of a larger web application with a navigation bar at the top containing 'Home', 'View Well Registry', and 'Import Wells from NWIS', and a 'Logout' link at the top right.

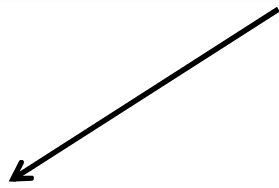
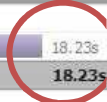
New Development

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





URL	Status	Domain	Size	Remote IP	Timeline
GET sort_desc.gif	200 OK	cida-wiWSC-javadevp.er.usgs.gov:8080	833 B	130.11.165.181:8080	7ms
GET iddata?request=wat...601&	200 OK	cida-wiWSC-javadevp.er.usgs.gov:8080	34.6 KB	130.11.165.181:8080	18.23s
2 requests			35.4 KB		



Filter Map Data

ctrl + click to select more than one

- MN Pollution Control Agency
- NJ Geological Survey
- TX Water Development Board
- USGS NWIS**
- null

U.S. Principal Aquifer Name

ctrl + click to select more than one

- All National Aquifers
- Alluvial aquifers
- Cambrian-Ordovician aquifer system
- Coastal lowlands aquifer system
- Denver Basin aquifer system

Water Level Network

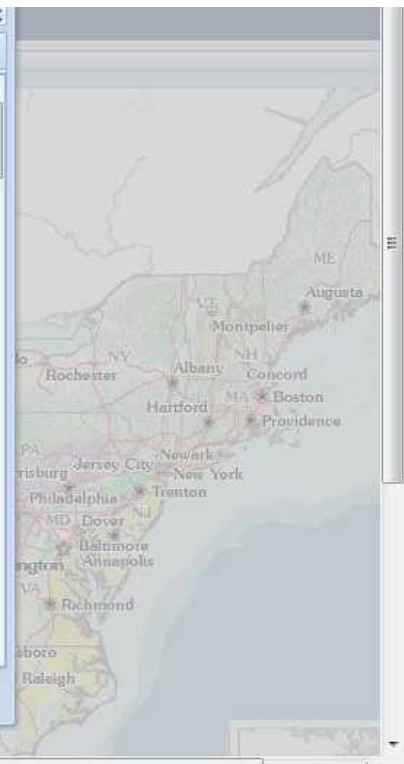
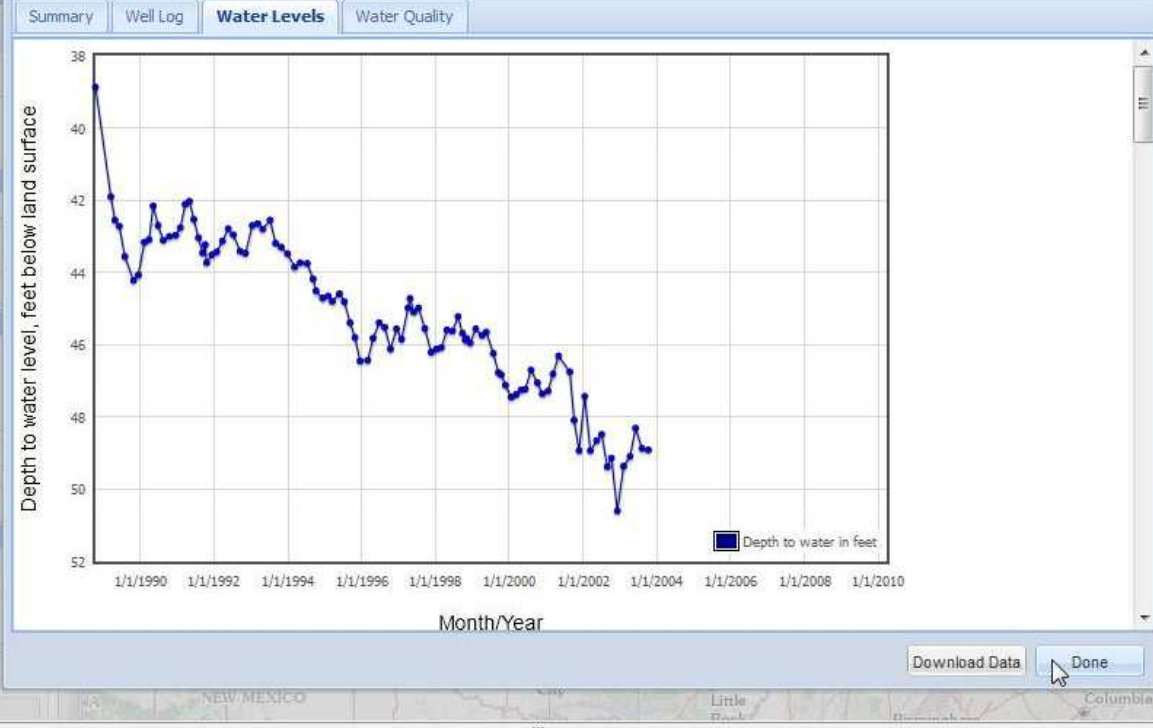
ctrl + click to select more than one

All Water Level Sub Networks

- Surveillance - Background
- Surveillance - Suspected / Anticipated
- Surveillance - Known Changes
- Surveillance - Unknown

Water Quality Network

ctrl + click to select more than one



Console HTML CSS Script DOM Net Cookies

Clear Persist All HTML CSS JS XHR Images Flash Media

URL	Status	Domain	Size	Remote IP	Timeline
GET indnrtitle.gif	200 OK	cida-wiwsc-javadevp.er.usgs.gov:8080	16.5 KB	130.11.165.181:8080	9ms
GET iddata?request=wat...601&	200 OK	cida-wiwsc-javadevp.er.usgs.gov:8080	34.6 KB	130.11.165.181:8080	95ms
2 requests			51.2 KB		104ms

9ms
95ms
104ms

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:



Minnesota
Pollution
Control
Agency



Join the Network!

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Questions?

http://cida.usgs.gov/gw_data_po

