

COVER PAGE

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SPONSORING ORGANIZATION: Utah Geological Survey

PROJECT TITLE: WATER QUALITY SITE SELECTION AND DATABASE MANAGEMENT OF WELLS AND SPRINGS IN UTAH FOR THE NATIONAL GROUND-WATER MONITORING NETWORK

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MAJOR GOALS: The primary goal of this project was to connect data from selected wells and springs in the UGS water-quality network to the NGWMN.

PROJECT SUMMARY: The UGS provided the USGS quality assurance procedures for data management of 80 initial sites to the NGWMN, maintaining a database for connection to the NGWMN, and creating a continuous flow of data to the NGWMN, within a one-year time frame. We established and continue to maintain water-quality and water-level databases as part of the UGS Water-Quality Network for integration into the NGWMN web portal.

OVERVIEW OF WORK

The Utah Geological Survey (UGS) established a flow of data from the UGS Water-Quality Network to the National Groundwater Monitoring Network (NGWMN). With EPA sampling support, the UGS established a monitoring network ([figure 1](#)) consisting of approximately 45 wells and 25 springs, where water quality is regularly measured; the goal of which is to document changes in water quality over time (annually or every other year, depending on funding). This project linked our data from collected water-quality sampling sites to the NGWMN Data Portal to provide information to an internet audience interested in Utah's water resources documented through an authoritative database; the UGS successfully reached our goal of integrating our state-level data with the national-level database via the Portal.

EXISTING NETWORK

Before being involved in the “Pilot Project”, the UGS groundwater program had only a few sites in the state that we regularly monitored, Snake Valley, Castle Valley, and the Uinta Basin—based on a need and funding basis; some of these sites have been monitored since 2006, some sporadically and some regularly. The Snake Valley area has about 35 monitor wells (some with nested piezometers) and 6 spring sites (monitoring began in 2008), Castle Valley has 6 monitor wells established in 2006, and the number of Uinta Basin sites we have sampled since 2009 has varied from 2 to 5 wells.

The UGS has been a fortunate recipient of funding to expand our monitoring network, and hence, we were able to include many sites we have sampled during past research. Due to the U.S. Environmental Protection Agency (EPA) providing no-cost laboratory chemistry analysis for

water samples, we have created a Utah monitoring network that extends to all principal aquifers (as defined by the U.S. Geological Survey, 2003) and represents a widespread distribution of wells and springs throughout the state; we expanded to previously studied areas as well as areas of the state not previously visited. In all, we attempted to include all counties and major watersheds within Utah.

SITE SELECTION

For the UGS Network, we selected wells and springs in the principal aquifers of Utah (Basin and Range basin-fill aquifers, Basin and Range carbonate-rock aquifers, and Colorado Plateau aquifers) and “other aquifers” that support withdrawals of regionally significant quantities of water. Three important areas that fall into the “other aquifers” on the national aquifer map (U.S. Geological Survey, 2003) are the Navajo Sandstone aquifer in the St. George region (significant also as a state-bounding aquifer), the karst aquifers of the southern Uinta Mountains in Ashley National Forest, and the valley-fill aquifers in the Middle Rocky Mountain Physiographic Province (intermontane basins), which provide much of the water to steadily growing rural “Wasatch Back” (a local term for communities situated east of the more populous Wasatch Front of the Middle Rocky Mountains) water users (similar to the National aquifer system of the Northern Rocky Mountain Intermontane Basins in Montana). We also sampled springs and wells (some of which are monitor wells established by the U. S Geological Survey during the 1970s) in the Uinta Basin, which is within the Colorado Plateau aquifer system and an active hydrocarbon-producing and hydraulic fracturing region.

We chose to include wells and springs from the existing UGS Network. To ensure future accessibility, most of the wells in this network are regularly pumped; they include privately held water sources for consumptive use, irrigation wells from farms and ranches, and public water sources for fish hatcheries. We chose wells with lithologic logs or sufficient aquifer information to ensure that they are representative of the aquifer of interest. We only incorporate a public water supply source into the network if it was the only representative, accessible well in the area or sampled infrequently for limited water quality chemistry (i.e., just nitrate and/or sulfate every few years), and only if the location is widely publicly known and allowed to be disclosed.

Most of the sites selected for the Basin and Range carbonate-rock aquifers are springs because they are the major water source emanating from these aquifers. Much of western Utah and the Wasatch Front, the most populous region of the state, are occupied by Basin and Range basin-fill aquifers, so we selected two representative water quality sites from each basin. For the Colorado Plateau aquifers, we tried to select at least one site per populated region (especially around popular and heavily traveled destinations such as Moab—an area that caters to two national parks) or per region of perceived ecological value.

Although the Pacific Northwest basin-fill aquifers and the Pacific Northwest volcanic-rock aquifers are present in the far northwest corner of Utah, they are not aquifers of significant use in the state. Therefore, we did not target these aquifers as part of the sampling network.

ASSIGNING SUBNETWORKS AND MONITORING CATEGORIES

For the Basin and Range basin-fill aquifers, we assigned subnetworks on a basin-by-basin basis. Many of the Basin and Range basin-fill aquifers have undergone hydrologic research, much of

which is published and freely available. The USGS, in cooperation with the Utah Division of Water Rights (UDWRi), produces a yearly report summarizing the water-level status of the areas of groundwater development (Burden, 2015). We assigned subnetworks based on these published reports and focused on the three major principal aquifers that exist in Utah.

Most of the sites in the UGS Water-Quality Network are designated for trend monitoring, where samples are collected on a yearly basis. If funds allow or interests require, we may increase sample frequency to twice per year. However, due to snow and irrigation pumping, access to many of the sites in our network is limited to a single season. We will attempt to sample each site during the season of greatest use and will resample the sites at the same time each year. The USGS conducts routine surveillance monitoring with a subset of wells in Utah; we anticipate they will continue this surveillance monitoring process (hence, we avoided repetition by recognizing their targeted subset of wells).

FIELD TECHNIQUES

Water Quality

For water quality sampling, the UGS administers the following Quality Assurance Project Plans (QAPPs) and field technique documents which are available online:

- The UGS follows the procedures outlined in its Unita Basin study:
http://files.geology.utah.gov/emp/UBwater_study/pdf/qapp.pdf
- The UGS also adheres to practices outlined by the Utah Division of Water Quality (Johnson and Harris, 2014):

http://www.deq.utah.gov/Compliance/monitoring/water/docs/2014/05May/DWO_QAPP_5.1.14_Rev0.pdf

- For criteria not covered by the above documents, the UGS defers to the NGWMN framework document (chapter 5.2 and appendix 5):
http://acwi.gov/sogw/ngwmn_framework_report_july2013.pdf

Water-Level Measurements

For water-level measurements, the UGS follows the guidelines of the following documents:

- NGWMN framework document (chapter 5.1 and appendix 5):
http://acwi.gov/sogw/ngwmn_framework_report_july2013.pdf
- USGS Technical Procedures: <http://pubs.usgs.gov/tm/1a1/>

DATA QUALITY AND QUALITY ASSURANCE PROCESSES

To assure high-quality data, we follow the procedures outlined by the Utah Department of Environmental Quality QAPP:

http://www.deq.utah.gov/Compliance/monitoring/water/docs/2014/05May/DWO_QAPP_5.1.14_Rev0.pdf

- Water quality analyses are conducted only by EPA-certified laboratories. This includes compliance with the Federal Safe Drinking Water Act, Federal Clean Water Act, and the Federal Resource Conservation and Recovery Act.

- Each sampling trip consists of one field blank and one duplicate to ensure that laboratory standards are high. The EPA Region 8 Laboratory and the Utah Epidemiology and Laboratory Services also conduct in-lab quality assurance.
- Before water quality data are uploaded into the EPA Water Quality Exchange Database (WQX), they are automatically checked for charge balance.
- Each data submission is reviewed by at least two geologists before the data are submitted.
- Where applicable, site information is rechecked during each field visit.

Analyte list used for sampling network

General chemistry (Ca, Mg, Na, K, Cl, bicarbonate, carbonate, and S); dissolved filtered metals (As, Ba, Cd, Cr, Cu, Fe, Mn, Pb, Se, Ag, Zn); nutrients (nitrite + nitrate, phosphate, ammonia).

List of Labs and Analytical Capabilities

The U.S. Environmental Protection Agency Region 8 performed most chemical analysis during this fiscal year. The Utah Epidemiology and Laboratory Services conducted analysis on nutrient and some total dissolved solids and arsenic samples for select stations.

Sample Analysis by EPA

All sample results were reported on an as-received basis except as noted in the “Analyst Comments” of all EPA reports delivered to the UGS. All samples were analyzed within holding times except as noted in EPA’s monthly reports in their appendix A. All analyses met QC acceptance criteria except as noted in the “Analyst Comments” or appendix A (via EPA reports delivered to UGS for 6 different sampling events, available upon request).

Field Measurements

All field measurements by the UGS staff met quality control (QC) acceptance criteria except as noted in the “Analyst Comments” or appendix A of EPA’s results documents that are available upon request.

EPA Quality Assurance/Quality Control on UGS Data

The EPA conducts the following quality assurance/control (QA/QC) during their analysis: reporting limit units, spike level, source, result %REC, %REC, limits RPD, RPD, analyte limit, inorganic chemistry parameters - method blanks (1400166-BLK2), nitrate as N < 5.0 5.0 ug/L, nitrite as N < 5.0, orthophosphate as P < 5.0. High failure: All detections for failing analytes for all samples are qualified as estimated. Low failure: All failing analytes for all samples are qualified as estimated. All detections for failing analytes for all associated samples where the concentration in the blank is greater than 1/10 the amount measured in the sample or the blank contamination otherwise affects the sample results are qualified as estimated. All detections for failing analytes for all samples where the concentration in the blank is greater than 1/10 the amount measured in the sample OR the blank contamination otherwise affects the sample results are qualified as estimated.

MINIMUM DATA ELEMENTS

The UGS followed guidelines outlined in appendix 5 of the Framework Document (Subcommittee on Ground Water, 2013) to meet the requirements of the minimum data

elements. Quality assurance requires that minimum data elements are provided via the “Well Registry” or web services.

Precursor data elements were assembled from the Utah Division of Water Rights (UDWRi) and the USGS National Water Information System (NWIS) databases. For every site, we have a site name that follows the USGS naming scheme, prefixed with a “UT”. Information from the UDWRi includes well construction data, screened intervals, well completion, and lithologic information (and some hydrostratigraphy; older well logs may lack complete data, including water levels). For each newly established site, we documented measuring points (including sample access), as well as other data elements that we could not compile from other sources. When possible, we collected information on sites and field data using ESRI Collector software, that allows for field constraints and requires certain data elements to establish a sampling event.

Basic location information is provided to the NGWMN portal via the well registry ([figure 2](#)). Detailed well-construction and lithology information is provided to the NGWMN via a web service. Currently, the UGS provides the basic location information as a web service, but the NGWMN has not mapped or implemented this service yet

MISSING DATA ELEMENTS

Sites with missing data elements were generally avoided during site selection process. In some cases, the site location and ease of site access made the site desirable to sample, despite missing specific data elements. These sites were sampled on the premise that we can determine the

missing elements (usually well depth and construction information) using field measurements at a later time.

WEB SERVICES

Working closely with the USGS, the UGS provided data to the NGWMN via Web Feature Services (WFS) published through ArcGIS Server. Services include lithology, casing, screen, and other well construction information. Results are manually uploaded to the EPA WQX database through CDX and accessed by the NGWMN through the WQX ([figure 2](#)).

We built software interfaces to enter data while in the field and in the office. From our database, we created a WFS (REST-based) connection using ESRI products to allow for direct connection to our chemical database. All of the data we transmit and services we provide follow existing federal schemas, specifically the WQX schema. We provide services that contain the following tables:

- Stations
 - unique identification is the station identification number (LocationID)
 - contains minimum data requirements for sites
- Projects
 - contains a list of projects
 - connected to results table via project identification number
- Lithology
 - lithology describes the geology from the well driller's record
 - multiple intervals for each station

- connected to the station table via the LocationID
- Casing
 - this table includes completion and well construction
 - derived from the Utah Division of Water Rights database
 - connected to the monitoring locations table via the LocationID
- Screen
 - includes open intervals of well casing
 - derived from the Utah Division of Water Rights database
 - connected to the monitoring locations table via the LocationID

REFERENCES

Burden, C.B., *editor*, 2015, Groundwater conditions in Utah, Spring of 2015: U.S. Geological Survey Cooperative Investigations Report no. 56, 150 p., online:

<http://ut.water.usgs.gov/publications/GW2015.pdf>

Johnson, T. and Harris, J., 2014, Utah Division of Water Quality Quality Assurance Program Plan (QAPP) for Environmental Data Operations: Utah Division of Water Quality, accessed online:

http://www.deq.utah.gov/Compliance/monitoring/water/docs/2014/05May/DWQ_QAPP_5.1.14_Rev0.pdf

Subcommittee on Ground Water, 2013, A national framework for ground water monitoring in the United States: Prepared by The Subcommittee on Ground Water of The Advisory Committee on Water Information, accessed online

http://acwi.gov/sogw/ngwmn_framework_report_july2013.pdf

U.S. Geological Survey, 2003, Principal aquifers: U.S. Geological Survey Map 101514, scale 1:5,000,000, online: <http://water.usgs.gov/ogw/aquifer/101514-wall-map.pdf>

114°0'0"W

112°0'0"W

110°0'0"W

42°0'0"N

42°0'0"N

40°0'0"N

40°0'0"N

38°0'0"N

38°0'0"N

Utah NGWMN 2014 Monitoring Locations

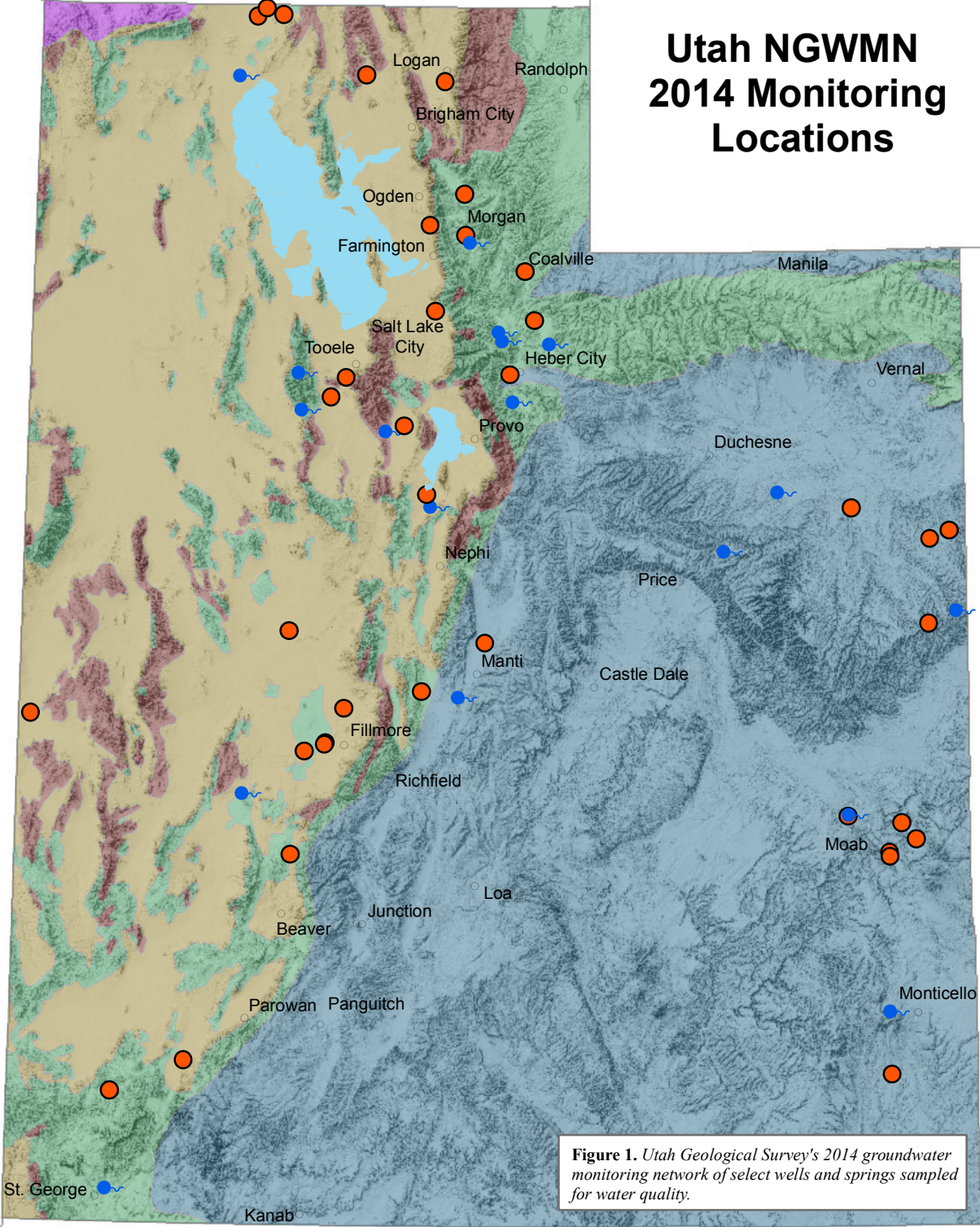
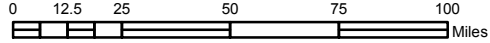


Figure 1. Utah Geological Survey's 2014 groundwater monitoring network of select wells and springs sampled for water quality.

114°0'0"W

112°0'0"W

110°0'0"W



Sample Source

- Spring
- Well

USGS Aquifer Type

- | | | | |
|--|---|--|---------------------------------------|
| | Basin and Range basin-fill aquifers | | Other aquifers |
| | Basin and Range carbonate-rock aquifers | | Pacific Northwest basin-fill aquifers |
| | Colorado Plateau aquifers | | |

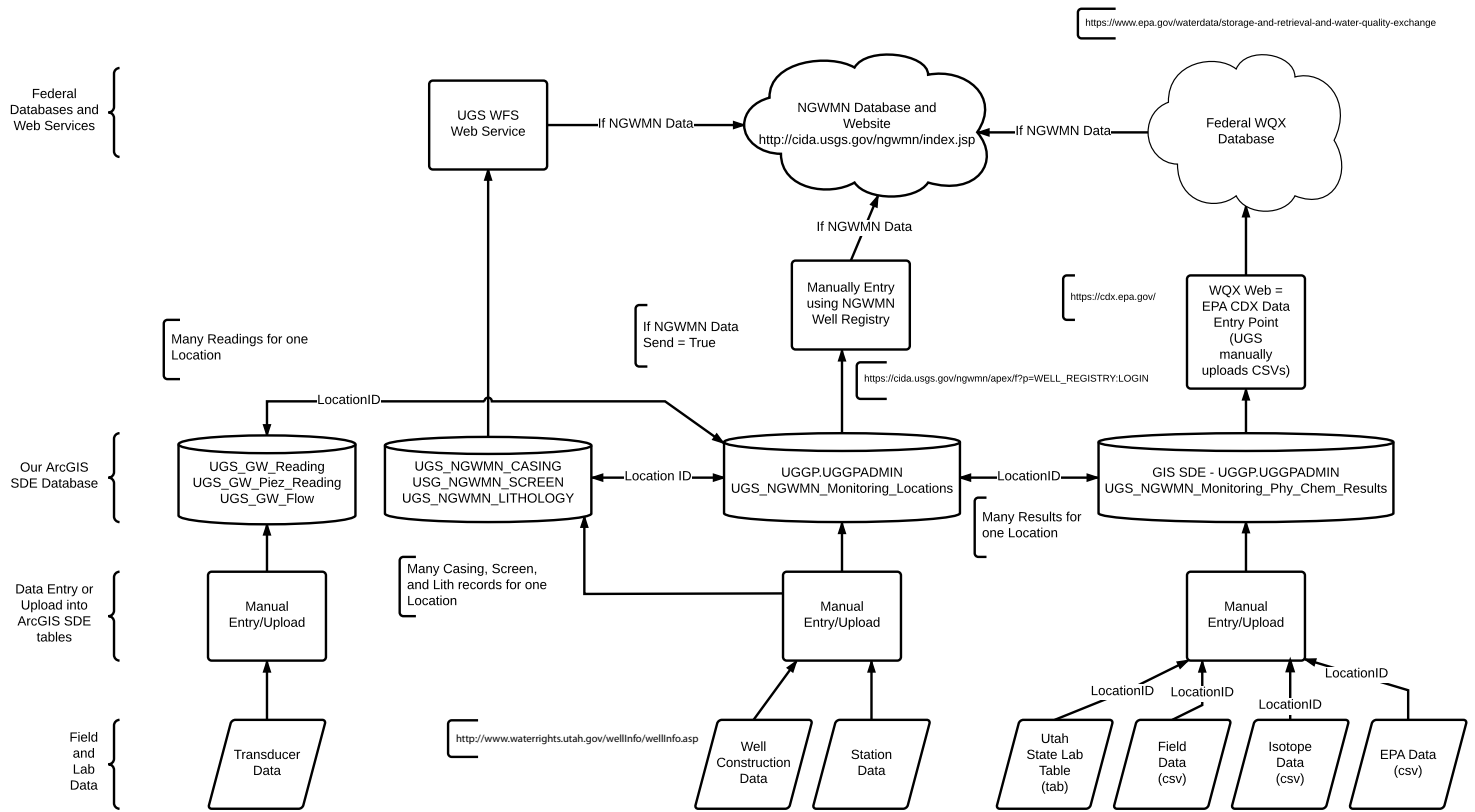


Figure 2. Current data flow from the field to the NGWMN.