USGS National Groundwater Monitoring Network Cooperative Agreement
Final Technical Report

Award Number:	G19AC00181
Agency Name:	Missouri Department of Natural Resources, Missouri Geological Survey
Title:	Missouri Department of Natural Resources' Missouri Geological Survey proposal to pump existing groundwater observation wells in order to improve the well's connectivity to the aquifer and to reconstruct one existing observation well in order to prevent shallow water from entering the well.
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Description of work done to support the NGWMN

The Missouri Geological Survey (MGS) has been collecting groundwater level data for over 60 years and is an existing data provider to USGS. MGS currently operates 150 groundwater observation wells. Hydrographs for these wells are inspected weekly and checked for abnormalities. By conducting this weekly review, MGS staff were able to identify three wells whose hydrographs showed spikes in the water level following precipitation events in two wells and the third occasionally would have a flat line graph. A downhole camera investigation was conducted in these wells that revealed holes in the casing. MGS successfully repaired these wells under previous iterations of the NGWMN grant.

With the success of well reconstruction projects funded by previous grants, MGS proposed to conduct a video inspection for 118 of the 150 statewide observation wells utilizing funds obtained from previous NGWMN project. This inspection identified casing that had been compromised at the Rich Hill observation well. This proposal included a plan to reconstruct the well to seal out shallow groundwater from entering the well and result in a more accurate measure of the water level in the aquifer.

Additionally, this proposal included a project to pump nine observation well in Missouri's Bootheel to determine the well's connectivity to the aquifer. Eight of these wells were completed in the shallow Mississippi Alluvial Plain Aquifer with one well in the Wilcox Aquifer. All wells were pumped and the contractor provided a summary of their findings with any suggested future remediation.

Describe well maintenance activities

Description of Rich Hill Reconstruction Project

The Rich Hill groundwater observation well was originally drilled in 1952 to a depth of 800 feet and had 197 feet of casing. The casing sealed out the shallow Pennsylvanian units. Geologic units from both the Springfield Plateau Aquifer and the underlying Ozark Aquifer (both of which are part of the USGS Ozark Plateau Principle Aquifer) were open and contributing to the water level measured in this well. The planned reconstruction project proposed to install a PVC liner into the well to serve two purposes, eliminate shallow groundwater from entering the well from the leaking casing and to extend the seal to a depth of 450 feet which would result in the well only measuring water level from the deeper Ozark Aquifer.

On June 9, 2020 contractors arrived at the site to commence reconstruction activities. One hundred feet of 2-inch PVC screen and 700 feet of 2-inch PVC liner were successfully installed and the team began installing gravel pack material. Depth to the gravel was continuously measured using a tag line. When the material reach a depth of 690 feet, it ceased rising despite the addition of gravel pack material. The site was left to sit overnight.

When staff returned the gravel had fallen to 656 feet. Additional gravel was then installed which resulted in a bridge at a depth of 181 feet and no further gravel could be placed in the well. MGS staff conducted a downhole camera investigation and verified the bridge between the PVC liner and bottom of the original steel casing.

It was decided to proceed with grouting the annular space to the surface using both a bentonite slurry and bentonite pellets. This project ultimately resulted in the well being sealed from a depth of 181 feet to the surface leaving the Springfield Plateau Aquifer and Ozark Aquifer open to contribute to the well as it was originally constructed.

Description of Bootheel Well Pumping Project

MGS staff contracted with Brotcke Well and Pump to perform pump test on nine groundwater observation wells in southeast Missouri's Bootheel region. Eight of these wells are completed in the shallow Mississippi Alluvial Plain Aquifer and the other monitors the Wilcox Aquifer. The goal of the project was to determine the suitability of the wells for continued use as monitoring wells for both the state-wide and national groundwater monitoring networks. The process would involve pumping the wells to test their efficiency and to determine if the wells were in good communication with the surrounding aquifer. The pumping project took place in August 2020.

At each site the monitoring equipment (Sutron SatLink™ logger/transmitter, encoder, float, cables, flat tape, counterweight, battery and wiring) was removed from the recorder boxes and wells and a static water level was measured and recorded. To begin the test, either a two-inch or four-inch pump was installed to a depth sufficient for it to remain submerged during the test in anticipation of creating 20 feet of drawdown in the well. The pump rate was selected to be 10 gallons per minute (gpm) at all the eight shallow alluvial well sites and 100 gpm at the deeper Caruthersville well. At the start of each pump test, minor adjustments were made to bring the pump yield to the desired rate. Water level measurements were taken at specified intervals until the water level stabilized for four hours. Following stabilization the pump was turned off and recovery readings were made for two hours. Following completion of the well test, the pump was removed from the well, the well was disinfected, and the monitoring equipment reinstalled.

The test showed that the wells at Caruthersville, Duck Creek, East Prairie, Malden, Naylor, Sikeston and Steele are in good communication with the aquifer. Specific capacities for these wells varied widely from 0.84 to 71.4.

The tests at Delta and Qulin indicated a very slow response to pumping and recharge. Historic water level measurements indicate an annual water level fluctuations in both wells that have been consistent over the period of record and not been minimized due to issues with aquifer communication. These sites are located in areas of fine grained alluvial deposits as is indicated by local rice farming. Rice fields require soils with very low permeability to minimize water loss during flooding. At these two sites the test quickly dewatered the well which did not experience any significant recharge (one foot in 20 minutes at Delta and one inch in 30 minutes

at Qulin) which corresponds to the expected low permeability. Because of the quick drawdown and lack of recharge the specific capacity could not be calculated for these two wells.

The table below provides details from the tests. Note that in many cases the measured total depth was less than the original construction total depth. Based on this, the contractor recommended well rehabilitation utilizing air lifting to remove sediment that has filled the bottom of the well in the screened interval. Even though, in some cases, the screen is filled with sediment, the pump test along with the historic water level data, does not indicate that the material was limiting the communication of the well with the aquifer. Future NGWMN grant proposals may include cleaning out of the wells which have accumulated sediment in the screened interval.

Site Number	Site Name	Aquifer	Pumping Rate	Specific Capacity	Construction TD	Measured TD
361145089394101	Caruthersville	Wilcox	100	30.2	1,388	N/A
371125089445301	Delta	MAP*	10	#	75	60
370248090042601	Duck Creek	MAP*	10	1.5	75	75
364643089212301	East Prairie	MAP*	10	3.8	118	116
362955089581801	Malden	MAP*	10	71.4	108	104
363442090364301	Naylor	MAP*	10	2.2	65	53
363551090152801	Qulin	MAP*	10	#	81	81
365319089331001	Sikeston	MAP*	10	0.8	146	142
360425089485001	Steele	MAP*	10	9.8	131	131

* Mississippi Alluvial Plain Aquifer

Well was dewatered during pumping and had little production