USGS National Groundwater Monitoring Network Cooperative Agreement
Final Technical Report

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Agency Name:	Missouri Department of Natural Resources, Missouri Geological Survey
Title:	Missouri Geological Survey's proposal to add wells to the portal, fill data gaps, and perform aquifer pump tests.

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Description of work done to support the NGWMN

The Missouri Department of Natural Resources' Missouri Geological Survey has been collecting groundwater level data from wells since 1956. This data collection project was developed in response to extreme drought condition of the 1950s. What started out as approximately 20 observation wells has grown to 150 wells currently operated across Missouri. These wells monitor water level in one or more of 13 different major aquifers within five USGS principal aquifers including the Ozark Plateaus Aquifer System, Mississippi River Valley Alluvial Aquifer, Cambrian-Ordovician Aquifer System, Mississippian Aquifer, and the sand/gravel aquifers. MGS routinely considers the addition of new sites to the network and selects additional wells based on strategic geographic and aquifer location.

Four tasks are associated with this agreement. The first is adding 13 wells to the network portal. These wells are currently used by MGS to collect water level data but have not previously been included in the portal. The second project is filling data gaps for 81 wells. This includes location, well depth, casing depth, screen interval, aquifer monitored, stratigraphy, etc. A third project is performing downhole video inspections for 16 wells. These videos determine or confirm total depth, casing depth, and screen interval for the wells. In addition, the inspections identify potential issues with the well. Finally, performing aquifer pump tests on four wells. This task verifies the well's connectivity to the aquifer as well as its ability to provide accurate water level data.

The data management plan for Missouri's groundwater level data is a cooperation between MGS and USGS. A combination of pressure transducers and float encoders are deployed to measure groundwater levels. At each observation well location, MGS collects water level data every 30 minutes, and MGS transmits the data to USGS via the GOES satellite network where it is permanently stored. USGS' Central Midwest Water Science Center (CMWSC) processes this data to ensure it meets all established quality assurance protocols and to ensure USGS standards are maintained. MGS partners with CMWSC to make this data available in near real-time on the internet.

Description of Data Collection Activities

Adding wells to the network

MGS staff have previously reviewed Missouri data in the NGWMN portal and identified 13 wells that are currently being operated as groundwater observation wells and collecting water level data but not included in the portal. MGS currently operates 150 observations wells, but only 139 are listed in the portal. However, two of these 139 wells have been decommissioned meaning there are now 13 wells not included in the portal.

These 13 wells all currently are being operated by MGS to collect water level data and have been in service varying amounts of time from three years at Pineville to 63 years at Osceola. Some wells are located close to others, monitoring different aquifers or groundwater decline, while others are the only well in the county. The wells added to the portal can be found in Table 1.

Filling data gaps

MGS staff previously reviewed Missouri data in the NGWMN portal and identified numerous data gaps related to construction details such as total depth, casing depth, and well screen length. MGS currently operates 150 observations wells and submits water level data to USGS as part of NWIS, but only 139 are listed in the portal. Two of these 139 wells have been decommissioned. Of the remaining 137, construction information is complete for only 56 leaving 81 missing data.

MGS reviewed various sources such as well logs, databases, and downhole well videos to fill in data for the 81 sites missing casing and screen information. In addition, MGS staff reviewed data currently residing in the portal for accuracy. All new, or more accurate data, found was provided to the CMWSC to be entered into NWIS where it will be made available to the portal. Well information such as location, well depth, casing depth, screen interval, aquifer monitored, stratigraphy, etc. were added or reconciled. MGS then followed up with CMWSC and portal administrators to ensure the data is corrected, entered into NWIS, and transferred to the portal (Table 2).

Description of Well Maintenance Activities

Downhole camera inspection

MGS obtained a previous NGWMN grant to conduct downhole camera investigations for several of the state's groundwater observation wells in order to verify well construction details previously missing. Because these videos were successful in identifying well integrity issues, MGS proposed to conduct investigations on 16 additional wells which did not have a video well log. Two wells identified in the proposal were unable to be videoed, Joplin and Warrensburg. These wells were substituted with Carthage and Valley Park. In addition to inspecting well integrity, these videos also confirmed well total depth, casing depth, and screen length (if present). Any discrepancies with existing data were corrected and provided to CMWSC (Table 3).

Aquifer pump test

In order for an observation well to be able to accurately measure the water level of an aquifer, the well must be in communication with the water producing formation. Missouri has both wells constructed with screens and with open borehole below the bottom of the casing. In both cases the porosity, whether through the screen or bedrock itself, can become plugged with

mineralization, siltation, or organic material. This can especially be a problem for wells that are strictly observation wells and not actively being pumped and moving water through the aquifer. Water level data is more accurate if the well bore is in free communication with the aquifer and not obstructed. Producing water from these wells as proposed will clean out the porosity of the formation and well screen, if present, and thus increase the accuracy of the collected data.

MGS proposed to pump four existing wells that have been constructed with a screened interval. The process followed USGS guidance as outlined in *USGS Techniques and Methods 1-A1: Groundwater Technical Procedures of the U.S. Geological Survey* and included measuring the beginning static water level, pumping level, and drawdown during the pumping event plus the water level recovery after the pumping. This data was then used to determine the well's specific capacity or well efficiency. The data obtained from this activity is archived at MGS to be used as a comparison for future pumping events plus provided to the CMWSC to be added to NWIS. Three of these wells have been selected because they were constructed in the specifically for the purpose of measuring water level fluctuations and have never been used as production wells. These three wells are over 60 years old and have not been pumped since they were constructed. The exception is the Hermann well which was constructed in 1995 by the USGS as part of a study of the Missouri River alluvial valley. MGS staff developed the pumping protocol and oversaw the project. The actual pumping and testing of the wells was performed by a contractor hired by MGS (Table 4, Appendix A).

TABLES

Table 1: Observation wells to be added to the portal under Task 1

Site Number	Site Name	County	Total Depth	Casing Depth	Screen Interval	Aquifer
403501091420401	Battle of Athens	Clark	209	28	NA	Mississippian
383707092311701	California	Moniteau	800	80	NA	Ozark
390150090542801	Cuivre River	Lincoln	875	450	NA	Cambrian-Ordovician
392321092153901	Middle Grove	Monroe	260	160	NA	Mississippian
373559090082901	National Lead	Perry	1,526	923	NA	Ozark
380229093464701	Osceola	St. Clair	875	20	NA	Ozark
363550094232601	Pineville	McDonald	1,400	455	NA	Ozark
384832093192501	Sedalia	Pettis	1,410	432	NA	Ozark
384147093101901	Sedalia East	Pettis	330	100	NA	Ozark
402627095220601	Tarkio 1	Atchison	49	34	34-49	Alluvial
402618095222701	Tarkio 2	Atchison	165	125	125-165	Glacial Drift
371548093144701	Valley Water Mill 1	Greene	100	63	NA	Springfield
371548093144702	Valley Water Mill 2	Greene	600	168	NA	Ozark

Table 2: Observation wells with data gaps to be filled under Task 2

Map ID	Site Number	Site Name	County	Aquifer
1	372153091322301	Akers	Shannon	Ozark
2	390207092570801	Arrow Rock	Cooper	Springfield
3	372202094370202	Asbury - Ozark	Barton	Ozark
4	372202094370201	Asbury - Springfield	Barton	Springfield
5	391236094170201	Atherton	Jackson	Alluvial
6	383628090411901	Babler State Park	St. Louis	Ozark
7	365654091001301	Big Spring	Carter	Ozark
8	370354093325901	Billings	Christian	Ozark
9	373955091065901	Bixby	Iron	Ozark
10	380900091153901	Bourbon	Crawford	Ozark
11	363855093134701	Branson	Taney	Ozark
12	364453093543602	Butterfield - Ozark	Barry	Ozark
13	364453093543601	Butterfield - Springfield	Barry	Springfield
14	371036094171301	Carthage	Jasper	Ozark/St. Francois
15	364059093520001	Cassville	Barry	Ozark
16	391149092072901	Centralia	Boone	Cambrian-Ordovician
17	392147090541901	Clarksville	Pike	Cambrian-Ordovician
18	385718092234201	Columbia	Boone	Cambrian-Ordovician
19	363728093150401	Cooper Creek	Taney	Ozark
20	365415093342301	Crane	Stone	Ozark
21	383906090511401	Daniel Boone Home	St. Charles	Cambrian-Ordovician
22	380501090335501	De Soto	Jefferson	Ozark/St. Francois
23	401057091494501	Deer Ridge CA	Marion	Mississippian
24	382745091275701	Drake	Gasconade	Ozark
25	384455093201001	Dresden R-12	Pettis	Ozark
26	371800092094801	Fairview	Texas	Ozark
27	381405090260301	Festus	Jefferson	Ozark
28	395355095051601	Forest City #7	Holt	Alluvial
29	372338094052801	Golden City	Barton	Ozark
30	385432091343201	Graham Cave State Park	Montgomery	Cambrian-Ordovician
31	373701093151601	Halfway	Polk	Ozark
32	390651092125101	Hallsville	Boone	Cambrian-Ordovician
33	384258091243001	Hermann #4	Warren	Alluvial
34	401920092130301	Indian Hill CA	Scotland	Mississippian
35	372521089362401	Jackson	Cape Girardeau	Ozark
36	370224094320201	Joplin	Newton	Ozark

37	384545093331601	Knob Noster	Johnson	Ozark
38	380717092395401	Lake of the Ozarks SP	Camden	Ozark
39	373906092385201	Lebanon	Laclede	Ozark
40	372715090510701	Lesterville	Reynolds	St. Francois
41	382836091502301	Linn	Osage	Ozark
42	364313094121101	Longview	Newton	Springfield
43	391222093185501	Marshall	Saline	Alluvial
44	393544093075601	Mendon	Chariton	Glacial Drift
45	390945091494001	Mexico	Audrain	Cambrian-Ordovician
46	365451093555501	Monett #10	Barry	Ozark
47	390750093233401	Mt. Leonard	Saline	Glacial Drift
48	370539093494001	Mt. Vernon - Ozark	Lawrence	Ozark
49	370539093494002	Mt. Vernon - Springfield	Lawrence	Springfield
50	364818094185302	Neosho - Ozark	Newton	Ozark
51	364818094185301	Neosho - Springfield	Newton	Springfield
52	383644091124901	New Haven	Franklin	Ozark
53	365559092030001	Noblett Lake	Howell	Ozark
54	373620093470301	North Hawker Point	Cedar	Ozark
55	370624092244701	Norwood	Wright	Ozark
56	380322091142601	Onondaga State Park	Crawford	Ozark
57	370005093122401	Ozark	Christian	Ozark
58	375429092300701	Ozark Fisheries	Camden	Ozark
59	365141090304001	Poplar Bluff	Butler	Ozark
60	375617090465401	Potosi	Washington	St. Francois
61	384713091474301	Reform	Callaway	Cambrian-Ordovician
62	380545094213501	Rich Hill	Bates	Springfield/Ozark
63	375625091480401	Rolla Ramada Inn	Phelps	Ozark
64	380435090281301	South Jefferson City	Jefferson	Ozark
65	371435093134701	Springfield	Greene	Ozark
66	370907093144101	Springfield - Valley Park	Greene	Ozark
67	384737090372001	St. Peters	St. Charles	Cambrian-Ordovician
68	381217091104501	Sullivan	Franklin	Ozark
69	363436092391001	Theodosia	Ozark	Ozark
70	385837090594701	Troy 2	Lincoln	Cambrian-Ordovician
71	391825091285101	Vandalia	Audrain	Cambrian-Ordovician
72	403452092292901	Vandike Farms	Schuyler	Glacial Drift
73	372853091061801	Viburnum #6	Reynolds	Ozark
74	381045091564801	Vienna	Maries	Ozark
75	384534093431101	Warrensburg	Johnson	Ozark

76	370828094274101	Webb City #6	Jasper	Ozark
77	364324091515001	West Plains	Howell	Ozark
78	392336094550403	Weston	Platte	Alluvial
79	383302090420201	Wildwood	St. Louis	Ozark
80	371801093260401	Willard	Greene	Ozark
81	373653091330101	Wofford Farm	Dent	Ozark

Table 3: Observation wells to perform downhole video inspection under Task 3 (bold values are updated)

Site Number	Site Name	County	Total Depth	Casing Depth	Screen Interval	Aquifer
363855093134701	Branson	Taney	1,002	393	NA	Ozark
364453093543601	Butterfield-1	Barry	304	85	NA	Springfield
364453093543602	Butterfield-2	Barry	803	357	NA	Ozark
384849090092001	Columbia Bottoms	St. Louis	**103**	**99**	**99-103**	Alluvial
363728093150401	Cooper Creek	Taney	1,400	380	NA	Ozark
365415093342301	Crane	Stone	1,120	177	NA	Ozark
372338094052801	Golden City	Barton	893	400	NA	Ozark
384258091243001	Hermann	Warren	80	**60**	**60-80**	Alluvial
~~370224094320201~~	~~Joplin~~	~~Newton~~	~~1,500~~	~~500~~	~~NA~~	~~Ozark~~
385428091265001	New Florence	Montgomery	1,030	323	NA	Cambrian-Ordovician
380229093464701	Osceola	St. Clair	875	20	NA	Ozark
370655093035301	Rogersville	Greene	1,635	325	NA	Ozark
371435093134701	Springfield	Greene	565	252	NA	Ozark
372853091061801	Viburnum	Reynolds	**269**	210	NA	Ozark
~~384534093431101~~	~~Warrensburg~~	~~Johnson~~	~~1,001~~	~~410~~	~~NA~~	~~Ozark~~
370828094274101	Webb City	Jasper	1,015	418	NA	Ozark
371036094171301	Carthage	Jasper	1,825	498	NA	Ozark
370907093144101	Valley Park	Greene	685	403	NA	Ozark

Table 4: Observation wells to perform aquifer pump test on under Task 4

Site Number	Site Name	County	Total Depth	Casing Depth	Screen Interval	Aquifer
384849090092001	Columbia Bottoms	St. Louis	104	100	100-104	Alluvial
383550092094201	Jefferson City	Callaway	95	91	91-95	Alluvial
395043091262601	Hannibal	Marion	85	81	81-85	Alluvial
384258091243001	Hermann	Warren	80	60	60-80	Alluvial

Appendix A

Pump test information and results:

Well	Depth New	Top of Casing Total Depth	Casing Above Ground Level	Depth Below Ground Level	Fill in Well
Columbia Bottoms	104	112.5	8.7	103	0.2
Hannibal	85	81	8.3	72.7	12.3
Hermann	80	81.6	2	79.6	0.4
Jefferson City	95	98.7	7.6	91.1	3.9

Results of Well Cleaning:

Observation Well	Specific Capacity in 2023 Before Cleaning	Specific Capacity in 2024 After Cleaning	Percent Increase
Hannibal	2.63	3.99	51.70%
Jefferson City	0.80	1.81	100.00%