

AWARD NUMBER: G18AC00080

AGENCY: Maryland Department of Natural Resources, Maryland Geological Survey

PROJECT TITLE: Filling Gaps in Information and Performing Well Maintenance at MGS NGWMN sites

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PROJECT SUMMARY: This was a one year project to do site-information gap filling (Objective 3) and well maintenance (Objective 4). Work under Objective 3 consisted primarily of compiling and collecting data to fill information gaps related to well construction and lithology, and conducting GPS surveys to collect more accurate altitude and coordinate data. Work under Objective 4 consisted of recorder shelter removal and well head repair, in addition to well integrity investigations using borehole camera surveys, well sounding, and slug testing.

DESCRIPTION OF WORK DONE TO SUPPORT THE NGWMN AS A DATA PROVIDER

Tasks performed under this grant comprised Objective 3 (site information gap filling) and Objective 4 (well maintenance). Objective 3 tasks included compiling and collecting information to fill gaps in metadata for NGWMN well sites including lithologic information and well-construction data; and performing GPS surveys to collect more accurate altitude and coordinate data for wells that are in the NGWMN site registry. Objective 4 tasks included repairing wells with known problems, including removal of deteriorated shelters and installation of locking caps; performing borehole camera surveys to visually inspect wells and well depth measurements to identify sediment accumulation or obstructions; and performing slug tests to identify clogged screens and to establish a baseline for future comparison.

A total of 112 wells are included in this project, 90 in the coastal plain and 22 in the fractured rock aquifers of Maryland (fig. 1).

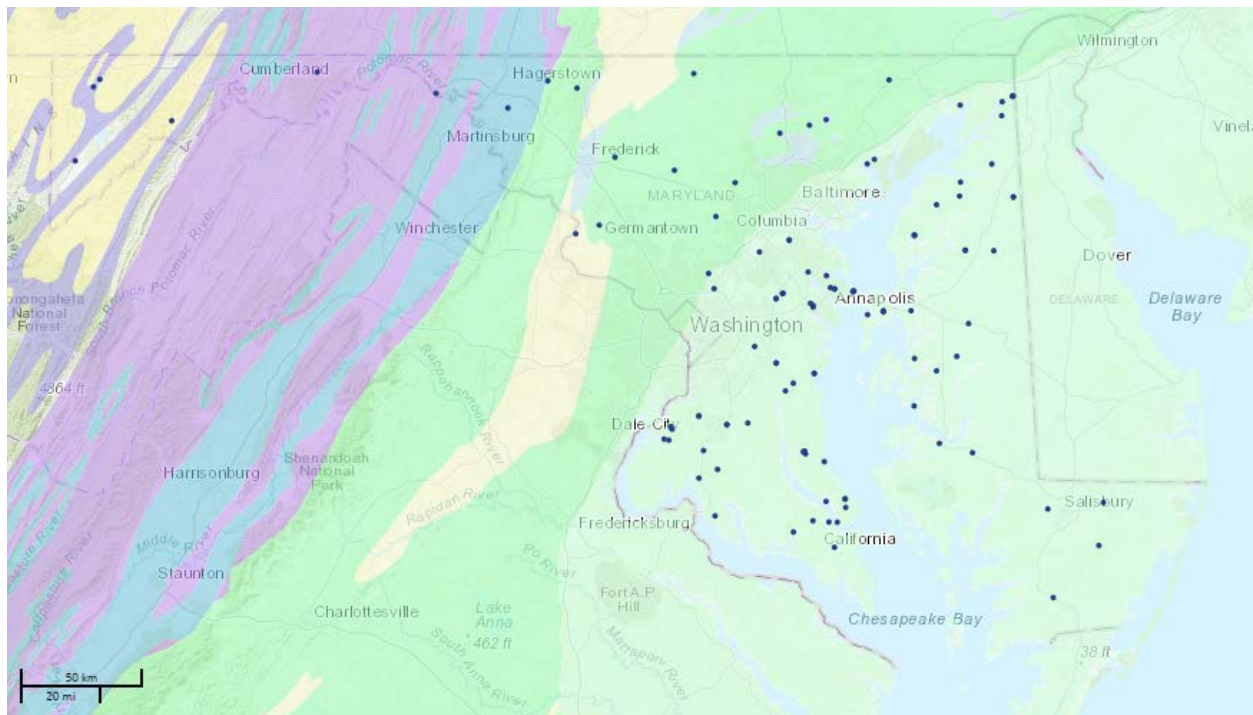


Figure 1. Map of NGWMN wells in Maryland

Objective 3 - Filling Gaps in Information at MGS NGWMN Wells

Lithology and Well-Construction Metadata

For Maryland's network of NGWMN wells, all 112 wells (fig. 1; App. A) were lacking metadata related to lithology and 36 wells were missing one or more types of well-construction data. We compiled the available missing data primarily from Maryland State well completion reports, which are required to be submitted upon completion of well construction. From the well completion reports we were able to determine lithology by depth interval from the driller's log. In addition, well construction data elements (well depth, and casing and screen diameter, depths, and material types) are listed in the reports and were compiled for this project. Some of the monitoring wells were originally drilled as part of MGS or USGS scientific studies, and thus have lithology (and hydrostratigraphy) that has been interpreted to a more professional level. If these data existed, they superseded the data found on drillers' completion reports. Many of the wells were constructed prior to the requirements for well completion reports to be filed upon construction or otherwise lacked documentation in Maryland files. As such, there were 16 wells for which a completion report or agency technical report could not be located or does not exist to provide data to fill an information gap for lithology or well construction.

GPS Surveys

For this grant period, we had identified 66 NGWMN wells that would benefit from more accurate GPS altitude and coordinate surveys; all were completed along with an additional well (67 total). During the grant performance period, 58 wells were surveyed by a 20-minute to 2.5-hour static GPS occupation (App. A). We also completed surveys by GPS total station (rover) at 9 wells that were either too heavily forested to receive reliable satellite transmissions or were located inside a roofed pumphouse.

At each well that was surveyed using a static GPS occupation, a dual frequency (L1/L2) GPS receiver with fixed-height range pole was set up over the observation well measuring point or land surface datum at the well location. Continuous GPS signals were recorded and the data were processed using the National Geodetic Survey's Online Positioning User Service (OPUS) to determine orthometric heights and latitude/longitude (Rydland and Densmore, 2012). Coordinate (vertical and horizontal)

accuracy is generally expected to be within a few centimeters for these types of survey (Schwarz et. al., 2009). For sites that were obscured by forests or pumphouses, we established three temporary GPS benchmarks in adjacent cleared areas, and used a total station survey to shoot to a prism positioned on the measuring point of the obscured well to determine its elevation and coordinates.

Objective 4 - Well Maintenance at MGS NGWMN Wells

Well Repairs

A number of monitoring wells required repairs to the wellheads to make the wells more secure, safe, or structurally sound. Wellhead repairs fell into three categories:

- 1) Using a casing cutter to remove the uppermost section of casing which included a flange plate, and installing a locking aluminum well cap.
- 2) Adding a section of casing (using flange plates to mate the new section) in order to increase the height of the casing, and installing a locking aluminum well cap.
- 3) Removing metal recorder shelter boxes (and casing flange plate base), and installing a locking aluminum well cap

Sixteen shelter removals and 5 casing modifications were identified as necessary prior to the grant application. Throughout the grant period we conducted a total of 18 shelter removals and 5 casing modifications.

During the grant performance period we identified 3 additional wells (AA Cc 115, AA Cc 116, and AA Cc 117) that would benefit from shelter removals and arranged for this work to be completed. One well that was tasked to have a shelter removed was actually an instrumented real-time USGS well (SO Cf 2), so the work was not performed at this site. One well that was tasked for a casing modification (CE Bf 144) did not have sufficient clearance above the land surface to cut the casing, so this work was not performed. As a replacement, we identified an alternate well (AA Cg 24) that would benefit from a casing modification, and the work was performed on this well.

Camera Surveys and Well-Depth Sounding

Twenty-eight camera surveys were tasked for the grant and we ultimately performed 29 during the course of the grant performance period. The additional well (MO Eh 20) was surveyed using the

borehole camera to investigate possible integrity issues that were brought to our attention following the start of the grant period.

For the camera surveys, we used an Aries Explorer portable borehole camera, which is a high-resolution 1.75 inch diameter color video camera with adjustable LED lights, has rotating forward and side viewing capabilities, and has 1,200 feet of cable. Video from camera surveys was recorded to digital files via a portable USB drive connected to the camera unit. This video was analyzed (during the survey and later) to identify well casing and screen integrity, scaling, sediment accumulation, bacteria, and physical obstructions. Debris in wells that prevented the camera from reaching total depth was removed from the well (to the extent possible) using a steel measuring tape with a treble hook clamped to the end or a grappling device attached to wire line as described in USGS GWPDP 6—“Recognizing and removing debris from a well” (Cunningham and Schalk, 2011). Wells that exhibited significant scaling, sedimentation, and blockage of screen openings were flagged and will be targeted for additional investigation (such as slug testing) or rehabilitation (debris removal, pumping, or redevelopment) at a future date beyond the performance period of this proposal. Wells with more serious problems such as holes in the casing were flagged for abandonment. Finally, well construction details (casing and screen diameter, materials, and intervals) were noted from the camera surveys and compared to the reported data. Any inconsistencies in well construction data were recorded to be corrected in the USGS NWIS database.

Well-depth measurements were performed in addition to the camera surveys. Well integrity could be compromised and additional investigation may be warranted if sounded depth differs significantly from the reported depth of a well. Sounding was performed using a Solinst tag line with 1,500 ft cable.

Slug Tests

MGS was tasked to perform slug tests in 42 NGWMN wells and ultimately performed 45 slug tests during the grant performance period. We performed 3 extra slug tests (MO Eh 20, CE Bf 143, and CE Bf 144) due to concerns of well integrity that were not anticipated before the grant application.

We conducted slug tests using the procedures recommended in GWPDP 17—“Conducting an Instantaneous Change in Head (Slug) Test with a Mechanical Slug and Submersible Pressure Transducer” (Cunningham and Schalk, 2011). For each test, a 15 psi In-Situ Level TROLL pressure transducer with vented cable was installed in the well below the level to which the slug will be lowered. The transducer

was set to collect data in “Fast Linear” mode, recording each data point every half second. A PVC slug able to displace water in the casing by at least 1 foot was lowered beneath the static water level. The water level was allowed to recover to pre-test static level, which was confirmed using a Heron Dipper-T electric water level tape. Following the recovery to static water level, the slug was removed and the water levels were recorded until water levels again reached pre-test static level. This slug-in/slug-out cycle was repeated, when possible, in order to collect a total of 2 slug-in datasets and 2 slug-out datasets.

Data collected from slug tests were analyzed using standard solutions such as Bouwer and Rice (1976) and Hvorslev (1951). Test data which exhibited oscillatory response were analyzed using the Butler (1998) solution for wells in a confined aquifer with high hydraulic conductivity which exhibit an inertial effect. Due to the large number of tests performed in this task and for the sake of consistency of analysis, slug test data were analyzed using AQTESOV software.

Most of the monitoring wells targeted for slug testing have historical hydraulic data in the form of either constant-rate aquifer tests or specific capacity pump tests. We identified wells with slug-test data that show slow response (low hydraulic conductivity) or were anomalous considering prior hydraulic testing. These wells were flagged for further investigation (well camera surveys) or redevelopment to clean out the screen openings and reestablish hydraulic connection of the well to the aquifer sediments (App. A). Data from all slug tests performed during this grant period will serve as an important baseline for future slug testing.

QUALITY ASSURANCE OF COLLECTED DATA

We conducted a rigorous and comprehensive Quality Control/Quality Assurance (QA/QC) check of the metadata in both our internal database and the metadata to be submitted to the national systems (USGS NWIS and the NGWMN portal). Queries and sorting of the database were used to check for duplicate records, errors and omissions. The QA/QC process was valuable in two key ways: (1) the process forced a familiarity with the well data; and (2) the process revealed errors with regards to consistency in data nomenclature, measurement units, datums and text descriptors (e.g. lithology/hydrostratigraphic unit naming conventions) that otherwise may not have been noticed.

Maryland Geological Survey collected and/or generated 25.6 gigabytes of data from fieldwork during the grant performance period. This included many hours of well camera surveys, dozens of slug

test data sets and analyses, photographs of well heads, and GPS survey datasets. Data that were collected and compiled during the grant were archived on MGS servers, and backed up regularly. The data will be transmitted to the USGS Baltimore MD-DE-DC Water Science Center to be entered into the USGS NWIS database, which will then be available to migrate to the NGWMN portal.

PROBLEMS ENCOUNTERED DURING OBJECTIVE 4 FIELDWORK

Through the course of the grant work, we found nine wells with poor hydraulic response (flat-lining water levels with no recovery to static) or low hydraulic conductivity during slug tests, and noted the likely causes of the poor response:

- AA Cc 115 – sediment filled casing above expected total depth - collapse?
- AA Ce 117 – heavily-encrusted screens
- AA Cf 137 – sediment filled casing above expected total depth - collapse?
- CA Fd 51 – poorly developed
- CE Bf 58 – sediment filled casing above expected total depth - collapse?
- CE Bf 144 – unknown cause, camera survey will be done in future to determine problem
- HA Ec 46 – no apparent problem (possibly completed in clay interval)
- KE Cb 97 – completed in wrong interval (clay)
- SM Ce 43 – unknown cause, camera survey will be done in 2019/2020 to determine problem

Additionally, visual inspection during camera surveys and site visits have found certain wells to be:

- Collapsed (AA Cc 115, AA Cf 137, CE Bf 58)
- Poorly developed (CA Fd 51, SM Dd 50)
- Constructed wrong – completed in wrong interval (clay) (KE Cb 97)
- Fatally compromised – hole in casing leaking water from shallower horizon (CH Bf 134)
- Damaged at wellhead – broken measuring tube (QA Ef 29)

EXPECTED CHANGES TO MARYLAND'S NGWMN WELL NETWORK

Based on a the discovery of a leaking casing in CH Bf 134 that was discovered during a camera survey, we will have to abandon this well and drop it from our network and from the NGWMN.

REFERENCES

Bouwer, Herman, and Rice, R.C., 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, *Water Resources Research*, vol. 12, no. 3, pp. 423-428.

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Hvorslev, M.J., 1951. Time Lag and Soil Permeability in Ground-Water Observations, *Bull. No. 36*, *Waterways Exper. Sta. Corps of Engrs, U.S. Army*, Vicksburg, Mississippi, pp. 1-50.

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APPENDIX A – List of Tasks Completed During Project Period

Appendix A - List of Tasks Completed During Project Period

Well Name	USGS Site Number	Objective 3				Objective 4				Hydraulic Conductivity from Slug Test	Problem identified	description of problem
		Well construction metadata	lithology metadata	GPS	GPS (total station)	Slug Test	Camera - Sounding	Shelter Removal	Cut & Cap			
AA Ad 90	391032076385902	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	K = 7.276 ft/day		
AA Ad 102	391032076385904		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			K = 20.36 ft/day		
AA Bb 87	390826076454802		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>				K = 18.65 ft/day		
AA Cc 89	390010076415703		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>				
AA Cc 102	390004076420001	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>				
AA Cc 115	390103076402601		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	✓		poor response	Yes	sediment filled casing above expected total depth - collapse?
AA Cc 116	390103076402602		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	✓		K = 31.23 ft/day		
AA Cc 117	390103076402603		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	✓		K = 24.83 ft/day		
AA Ce 117	390450076343402		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	K = 0.8997 ft/day	Yes	heavily-encusted screens
AA Ce 133	390410076302401		<input checked="" type="checkbox"/>									
AA Cf 98	390150076283003	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			K = 1.884 ft/day		
AA Cf 99	390150076283002		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			K = 20.13 ft/day		
AA Cf 137	390205076292702	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			K = 0.3564 ft/day	Yes	sediment filled casing above expected total depth - collapse?
AA Cg 22	390123076241601		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>				K = 27.21 ft/day		
AA Cg 23	390123076241602		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>				K = 27.21 ft/day		
AA Cg 24	390123076241603		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>			✓	K = 42.99 ft/day		
AA Cg 25	390127076240301		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			K = 1.08 ft/day		
AA De 1	385915076340401		<input type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>					
AA De 95	385853076333001	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	✓	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		K = 104.1 ft/day		
AA De 206	385833076332801		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	K = 1.24 ft/day		
AA Fc 34	384833076415601		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		K = 39.55 ft/day		
AA Fc 35	384833076415602		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		K = 8.1 ft/day		
AA Fe 92	384644076331201		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		K = 20.33 ft/day		
AA Fe 93	384644076331202		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		K = 45.06 ft/day		
AL Ah 1	394024078273401	<input type="checkbox"/>	<input type="checkbox"/>									
AL Ca 20	393148079010601	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>									
BA Ce 21	393102076341801	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>									
BA Dc 444	392931076410301	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>									
BA Ea 18	392045076512501	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>									
CA Bb 23	384458076375501		<input checked="" type="checkbox"/>	<input type="checkbox"/>	✓							
CA Bb 27	384333076394701		<input checked="" type="checkbox"/>									
CA Db 47	383239076354201		<input checked="" type="checkbox"/>									
CA Db 65	383216076351401		<input checked="" type="checkbox"/>									
CA Db 96	383244076354201		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>				K = 115.9 ft/day		
CA Dc 35	383050076305501		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
CA Fc 13	382343076302901		<input checked="" type="checkbox"/>									

☒=tasked and completed ; ☐=tasked but not completed ; ✓=not tasked but completed

Appendix A (continued)

Well Name	USGS Site Number	Objective 3				Objective 4				Hydraulic Conductivity from Slug Test	Problem identified	description of problem
		Well construction metadata	lithology metadata	GPS	GPS (total station)	Slug Test	Camera - Sounding	Shelter Removal	Cut & Cap			
CA Fd 51	382408076260401		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			poor response	Yes	poor development
CA Fd 54	382407076260301		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
CA Fd 85	382236076255401		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>				K = 88.45 ft/day		
CA Gd 61	381956076275301		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
CE Bf 58	393605075472302		<input checked="" type="checkbox"/>	✓		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		poor response	Yes	sediment filled casing above expected total depth - collapse?
CE Bf 143	393612075472702		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		✓		<input checked="" type="checkbox"/>		K = 4.579 ft/day		
CE Bf 144	393612075472701		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		✓			<input type="checkbox"/>	poor response	Yes	unknown - recommend camera survey
CE Bf 158	393509075495401		<input checked="" type="checkbox"/>									
CE Cd 52	393432075593602		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
CE Ce 55	393241075500201		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			K = 14.21 ft/day		
CE Ee 29	392403075521801		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>					
CH Bc 77	383644077055501		<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>				
CH Bc 81	383709077061002		<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>				
CH Be 72	383903076594301		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>				
CH Be 73	383903076594302		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
CH Bf 134	383728076531701		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>				Yes	hole in casing - well has been abandoned
CH Bf 158	383732076531902		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>					
CH Bg 12	383746076482901		<input checked="" type="checkbox"/>									
CH Cc 31	383455077074401		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>				
CH Cc 34	383441077063901		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		K = 6.823 ft/day		
CH Ce 56	383251076583901		<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>				
CH De 45	382927076552301		<input checked="" type="checkbox"/>									
CH De 52	382752076593601		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
CH Ee 16	382103076560201	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>								
CL Ad 47	394008077005601	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>									
CL Ec 75	392259077052401	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>									
DO Ce 15	383408076042402	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
DO Cf 36	383225075565002		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
FR Bd 96	393733077274801	<input type="checkbox"/>	<input type="checkbox"/>									
FR Df 35	392517077190401	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>									
GA Bc 1	393749079190301	<input type="checkbox"/>	<input type="checkbox"/>									
GA Bc 62	393908079173601	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>									
GA Eb 78	392439079231801	<input type="checkbox"/>	<input type="checkbox"/>									
HA Bd 31	393902076160001	<input type="checkbox"/>	<input type="checkbox"/>									
HA Ca 23	393158076302601	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>									
HA Ec 46	392408076210101		<input checked="" type="checkbox"/>	<input type="checkbox"/>	✓	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			poor response	Yes	problem unknown - possibly screened in clay interval

☒=tasked and completed ; ☐=tasked but not completed ; ✓=not tasked but completed

Appendix A (continued)

Well Name	USGS Site Number	Objective 3				Objective 4				Hydraulic Conductivity from Slug Test	Problem identified	description of problem
		Well construction metadata	lithology metadata	GPS	GPS (total station)	Slug Test	Camera - Sounding	Shelter Removal	Cut & Cap			
HA Ed 49	392455076192103		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
HO Cd 79	391445076555101		<input checked="" type="checkbox"/>									
KE Ae 71	392053075592901		<input checked="" type="checkbox"/>									
KE Bc 185	391650076050402		<input checked="" type="checkbox"/>									
KE Be 43	391823075594701		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>					
KE Bg 33	391815075472101		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>				K = 141. ft/day		
KE Bg 34	391815075472102	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			K = 18.11 ft/day		
KE Cb 97	391124076101001		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			K = 3.266 ft/day	Yes	Screened in confining unit - wrong target interval
KE Cb 100	391124076101004		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			K = 19.68 ft/day		
KE Cb 103	391124076101005		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			K = 6.404 ft/day		
MO Cb 26	391142077280601	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>									
MO Cc 14	391314077224201	<input type="checkbox"/>	<input type="checkbox"/>									
MO Eh 20	390434076573002	<input type="checkbox"/>	<input type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			K = 4.915 ft/day	Yes	extremely turbid, obstructions
PG Bc 16	390151076561501	<input type="checkbox"/>	<input type="checkbox"/>									
PG De 21	385130076465501	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
QA Cf 77	390845075582301		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>				K = 7.874 ft/day		
QA Cf 78	390845075582302		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>				K = 19.78 ft/day		
QA Cg 69	390839075515001		<input checked="" type="checkbox"/>									
QA Ea 27	385718076205501	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>								
QA Eb 110	385751076171603		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>				K = 42.92 ft/day		
QA Eb 111	385751076171601		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>				K = 45.35 ft/day		
QA Eb 112	385751076171602		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>				K = 23.59 ft/day		
QA Eb 113	385748076172001		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			K = 10.78 ft/day		
QA Ec 1	385756076105301	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>								
QA Ef 29	385534075573601	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>							Yes	wellhead repair necessary
SM Ce 43	382012076332901		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>				poor response	Yes	unknown - recommend camera survey
SM Dd 50	381807076380001		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			K = 11.1 ft/day	Yes	poor development
SM Df 71	381527076283101		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
SM Df 88	381955076293901		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>			
SO Cf 2	380616075380701		<input type="checkbox"/>	<input checked="" type="checkbox"/>				<input type="checkbox"/>				
TA Cc 35	384923076100601	<input type="checkbox"/>	<input type="checkbox"/>									
TA Cc 53	384946076002201		<input checked="" type="checkbox"/>									
TA Cd 57	384709076050301		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>				K = 9.404 ft/day		
TA Dc 54	384052076101201	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>							
WA Be 2	393638078001301	<input type="checkbox"/>	<input type="checkbox"/>									
WA Bk 25	393851077343001	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>									

☒=tasked and completed ; ☐=tasked but not completed ; ☒=not tasked but completed

Appendix A (continued)

Well Name	USGS Site Number	Objective 3				Objective 4				Hydraulic Conductivity from Slug Test	Problem identified	description of problem
		Well construction metadata	lithology metadata	GPS	GPS (total station)	Slug Test	Camera - Sounding	Shelter Removal	Cut & Cap			
WA Ci 82	393402077434201	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>									
WI Ce 327	382220075392301		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
WI Cg 20	382329075263701	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>								
WO Cc 3	381543075273802		<input checked="" type="checkbox"/>	<input type="checkbox"/>	✓	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			K = 42.56 ft/day		
wells tasked		36	112	63	3	42	28	16	5			
wells done		22	96	58	9	45	29	18	5			

☒=tasked and completed ; ☐=tasked but not completed ; ✓=not tasked but completed