

Memorandum

To: Papio-Missouri River Natural Resources District Programs Projects and Operations Subcommittee
From: Paul W. Woodward, PE, Groundwater Management Engineer
Date: August 7, 2020
Re: Review and Recommendation on City of Springfield Nebraska Environmental Trust Grant Application for Enhanced Well Seals and Decommissioning

Following the success of enhanced decommissioning and municipal aquifer well seals in Tekamah, Groundwater Solutions Group has also consulted with the City of Springfield in the hopes of reducing nitrates and improving their municipal well drinking water quality. The Springfield area has similar semi-confined Dakota Sandstone geology to that of Tekamah.

The City of Springfield is interested in pursuing a NET grant to rehabilitate two of their municipal wells, Wells #1 and #2 shown in Figure 1. Well #1 has already tested high in nitrates over 10 ppm and has been capped and not used by the city since 2011. If a primary aquifer seal can be placed in this well, it is anticipated that nitrate levels may be reduced enough to reinstall a pump and keep Well #1 as an emergency backup well. If nitrate levels in Well #1 do not recover following the installation of the aquifer seal, the well will be fully abandoned to help protect the groundwater supply. Springfield's municipal Well #2 has been climbing to over 6 ppm in nitrates over the past several years, see Figure 2. This well is actively pumping drinking water for the City, so the intent is to pull its pump and then drill through its casing to pressurize grout outside the casing at known clay or shale layers, cutting off any contaminants from travelling down the outside of the well.

Based on the enclosed proposal for this work, the estimated construction cost is \$80,000. The City of Springfield is asking the District to provide a letter of support for the NET grant and up to \$15,000 in local cost-share toward the project. The City of Springfield has agreed to pay for any required engineering necessary for permits to modify each municipal well, estimated at approximately \$15,000.

The total cost for the grant will be spent during a one-year grant period ending by October 2021 as follows:

Year	NET	Springfield	NRD	TOTAL
1	\$ 65,000	\$ 15,000	\$ 15,000	\$ 95,000

Staff recommends that the subcommittee recommend to the Board of Directors that the General Manager be authorized to submit a letter of support for the City of Springfield's Nebraska Environmental Trust grant application and provide matching funds up to \$15,000 for an Enhanced Well Seals and Decommissioning project, subject to changes deemed necessary by the General Manager and approval as to form by District Legal Counsel.

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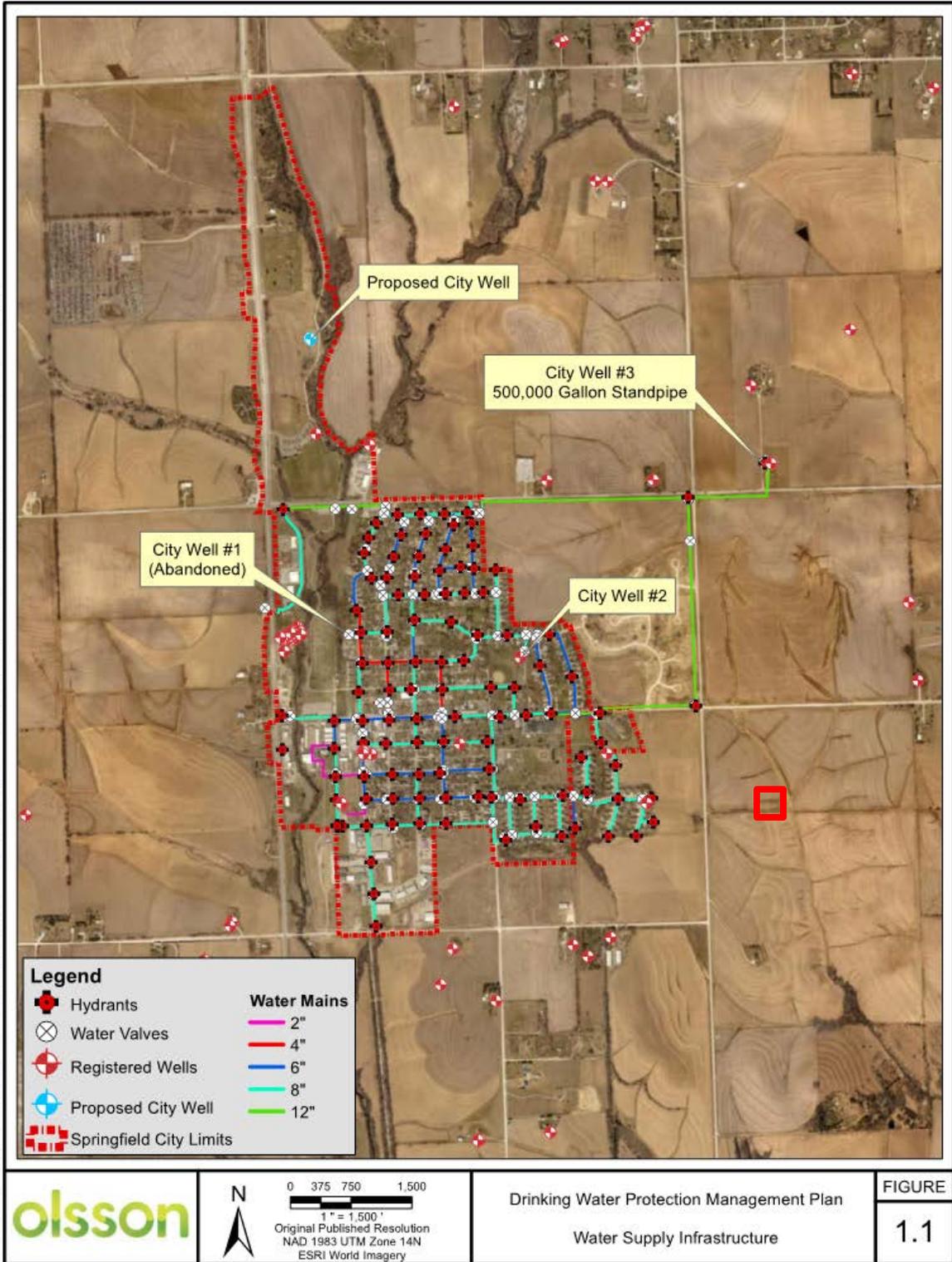


Figure 1 – Map of Springfield Municipal Wells

Historic Nitrate Test Results

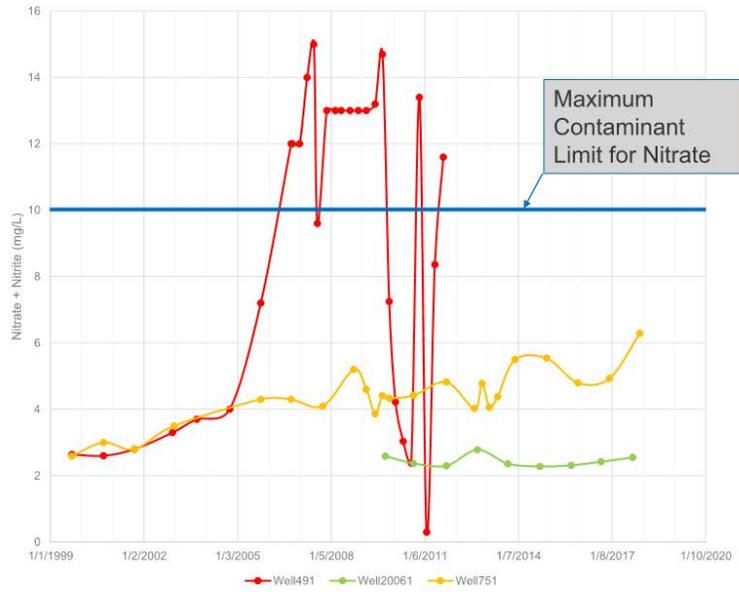


Figure 2. Well #1 (491) and Well #2 (751) nitrate level results

Springfield's Well

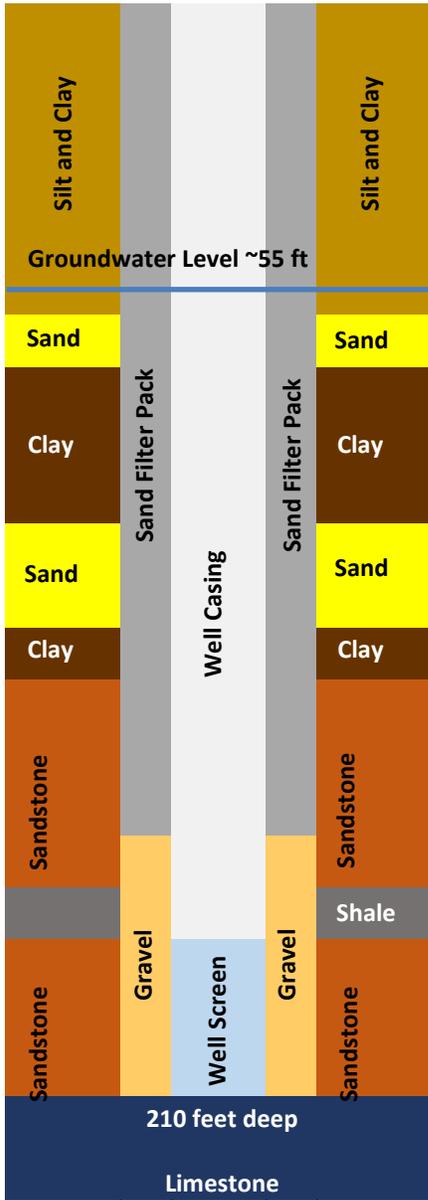


Figure 3. City Well #2. Primary aquifer seal can be placed at clay layer between sand and sandstone.

GROUNDWATER SOLUTIONS GROUP LLC PROPOSAL FOR SERVICES

For Groundwater Protection-Well Augmentation

City of Springfield Public Water Supply Wells G-028617, and G-034831

August 4, 2020

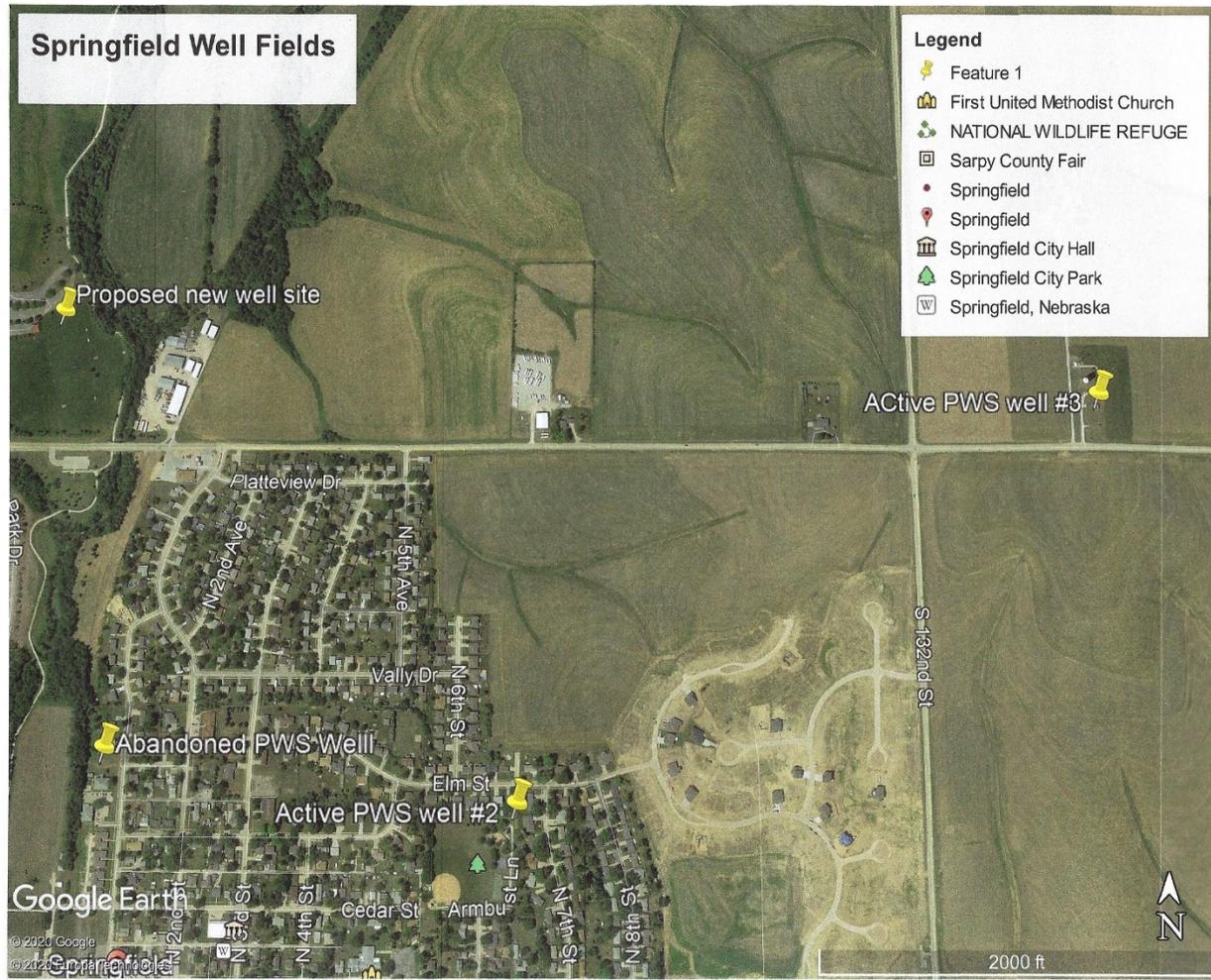
OVERVIEW

Groundwater Solutions Group LLC is submitting this proposal to the City of Springfield, NE to assist them in their desire to improve water quality from their PWS water wells. Groundwater Solutions Group LLC is a network of groundwater professionals experienced and committed to improving groundwater qualities by applying enhanced grouting techniques to existing high capacity water wells. .

The Objective

The City of Springfield currently has two (2) active Public Water Supply Wells (PWS) and one (1) decommissioned PWS well. The decommissioned well had a history of being impacted by nitrate contamination. A review of the recorded well logs for these two (2) PWS wells indicate they share a common trait. Each well location has an upper zone of water separated by a substantial clay layer from a lower production zone of ground water. Nitrate concentrations tend to be higher in the upper zone than the maximum contaminate level of 10.5 parts per million (PPM) for nitrates. It has been documented that contaminants such as nitrates can migrate from an upper zone in the aquifer to a lower aquifer if the borehole of a well is drilled through the separating clay layer and is not adequately grouted.

In November of 2011 the City of Springfield hired Layne-Western a division of Layne Christensen CO to decommission PWS well G-028617 with the desired result to lower and maintain nitrate results below 10 parts per million (PPM) in the groundwater reservoir. The decommissioning included filling the inner casing with chlorinated gravel from 105 feet below ground surface (BGS) to 16 feet BGS. A 5-foot interval of chip bentonite was placed on top of the gravel pack with the remained of the casing filled with cement. This was consistent with the State of Nebraska regulation Title 178 NAC 12-012 for decommissioning water wells.



The Opportunity

Due to the success of similar projects designed to reduce nitrate in municipal PWS wells, the City of Springfield is exploring funding to re-grout one (1) PWS water well G-034831 and excavate the previously decommissioned PWS well G-028617 and re-grout it for the intended purpose of returning the well to service.

The regrouting of G-034831 and the excavation and regrouting of G-028617 PWS wells are of vital interest to the City of Springfield to try and improve the water quality and provide increased capacity from their existing system.

- Registered Public Water Supply Well G-028617 was completed in 1967 and has been identified as being a well that was constructed without adequate environmental seals between the well casing and the borehole. This well is located at NW/NW ¼, Section 24, Township 13, Range 11 East, of Sarpy County. The well log states total depth of 107 below ground surface (BGS), the source of water for this well is the Dakota Sandstone. The geological log found on the water well registration indicates a substantial clay layer from 19 to 56 feet BGS. This will need to be verified by an electronic logging (e-log) inspection.
- Registered Public Water Supply Well G-0034831 was completed in 1971 and has been identified as being a well that was constructed without adequate environmental seals between the well casing and the borehole. This well is located at SW/NE ¼, Section 24, Township 131, Range 11 East, of Sarpy County. The well log states total depth of 195 below ground surface (BGS), the source of water for this well is Dakota Sandstone. The geological

log found on the water well registration indicates a substantial clay layer from 83 to 103 feet BGS. This will need to be verified by an electronic logging (e-log) inspection. Records indicate this well was relined in 2013 due to holes in the 12- inch steel casing. To install an adequate environmental seal both the liner and the outer well casing must be perforated to inject grouting materials into the old borehole.

- PWS well G-028617 was decommissioned in 2011 in compliance with State of Nebraska Title 178 NAC 12-012 regulations for decommissioning. These regulations fail to address the preferential pathway of contamination entering the groundwater reservoir by transport through the gravel pack annulus between the borehole wall and the well casing. Instead the regulations focus on filling the inside of the screen and casing to prevent point source contamination through and open pipe. Enhanced decommissioning address both filling the inside of the well and grouting the outside of the well to achieve an environmentally sound aquifer seal.
- After excavating the well casing decommissioning materials, the well will be evaluated by downhole video camera. If the well is determined to be viable the well casing will be re-grouted with the intention of conducting a pumping test to determine if the well can be brought back on-line.
- According to construction records the above identified active public water supply wells have a full-length gravel packed borehole and needs to be augmented to achieve separation of waters from the upper sand and gravel zone from the lower production Dakota Sandstone. This will be accomplished by perforating the steel casing adjacent to an existing clay layer, and re-grouted with bentonite slurry. To restore the natural filtration of the ground water reservoir both the active and decommissioned PWS wells must be grouted and tested.

The Solution

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It is important to identify the source of high nitrates at each well site by drilling an accurate test hole and e-logging each hole. The e-log will help identify the exact location of protective clay layers and will provide an indication of water quality within the borehole. Monitoring wells will be established both deep in the aquifer and shallow in subsurface to map the concentrations of nitrates.

Because of the existence of nitrates in two of the three well locations it can be assumed shallow perched water is present underneath the City of Springfield. Because this perched water table contains high nitrate ground water its important that any borehole penetrating this zone of perched water will be sealed to prevent nitrate and dissimilar water qualities from migrating downward through the gravel packed annulus of the borehole. We propose a two-year project to achieve such protection. To achieve this we intend to perform the following;

- Identify which PWS boreholes that penetrate the established clay barrier between upper and lower water bearing zone within the aquifer.
- Evaluate which wells are most viable and good candidates for borehole augmentation. Should a well be discovered to having deteriorated beyond useful repair, it will be identified as being a candidate for enhanced decommissioning and replacement.

Re-establish a separation between zones of dissimilar water qualities in the City's PWS water supply wells with a grout seal adjacent to existing clay layers and the steel well casing material.

Our Proposal-Year #1

Phase #1 Test hole-e-logs- monitoring wells- water sampling

To determine the proper placement of the well seals needed to ensure these wells are properly decommissioned we propose the following:

- Drill a test hole to verify potential aquitards needed to bind with the grout materials at each site the test hole properties will be recorded by a geophysical log known as e-logging and drill cutting samples preserved for analysis.
- The deep test hole will be developed into a segregated monitoring well for future validation of the well seal. Additional monitoring wells will be completed to document nitrate levels in zones throughout the borehole at each site.
- A representative water sample (nitrates and 13 parameter) will be obtained from the project well and segregated monitoring wells to establish baseline water quality at each site

Phase #2 Excavate Abandoned PWS well G-028617

- The existing decommissioning material will be removed from the well casing.
- The well will be inspected with a down-hole video camera. This inspection will verify the integrity of the casing, depth to static water, depth to the top of the screened openings, total depth of the well.
- The well will be cleaned in the areas of grouting and perforation of the casing.
- Perforations will be made at the interval(s) prescribed by the test hole and e-log results. The integrity of the perforations will be documented by a downhole video inspection
- Grout the perforated zone with bentonite or neat cement slurry until backpressure on the grouter indicates a sufficient seal has been placed. Grout will be allowed to set undisturbed for 24 hours
- Grout interval will be inspected with downhole video camera
- Well will be cleaned and debris removed from the well
- Well will be disinfected with 200 PPM Chlorine solution
- Test pump will be installed, and pump tested for capacity
- 6-hour pump test will be conducted to compare against original baseline data.

Should the 6-hour pump test reveal the well is not practical to be placed back into service then;

- The screen area will be filled with gravel to within 5 feet of the lower grout interval.
- A 5-foot chip seal of bentonite will be placed adjacent to the perforation area. Any remaining well casing will be filled to within 10 feet of the surface with bentonite grout mixed at 23% active solids or neat cement. The grout will remain undisturbed for 24 hours.
- The well casing will be filled with bentonite chips to within 5 feet of the surface and the remaining steel casing will be filled with neat cement from 5 below grade to the surface in accordance with Title 178 NAC12-012 regulations.
- The well decommissioning notice filed with the DNR will be modified to indicate the enhanced decommissioning used on this well.

Proposal -Year #2

WELL BOREHOLE AUGMENTAION G-034831

This well will be worked on only if another well is available to serve as a back-up while this procedure take place on G-034831. The procedure is as follows

- 13 parameter water quality samples taken from PWS well and related monitoring wells.
- Pump will be removed and evaluated for wear
- Downhole video of well casing and screened intervals will be performed to determine the integrity of 8 inch steel well liner.
- Well casing and screen will be cleaned by brushing and airlifting to remove debris
- Well will be perforated in designated areas to establish separation of the upper and lower zones of the aquifer. Based on past experiences up to more than one perforation and grout intervals may be needed to achieve separation of waters of dissimilar water qualities within the borehole. Downhole video inspection will be made to confirm perforation location and condition
- The grout interval will be sealed with a bentonite clay mixed to manufacturer's specification to achieve a 23% active solids content for a interval determined by the test hole and e-log results. The grout will be allowed to remain undisturbed for 6 hours. The alternative material for grout will be a neat cement grout consisting of 94 pounds of Portland cement to 5.5 gallons of water. The neat cement grout interval will sit undisturbed for 24 hours.
- Downhole video inspection will be performed to validate the integrity of the seal
- Well will be airlifted and cleaned of debris and disinfected with 200 PPM disinfectant
- Pump will be re-installed, and test pumped 6 hours for volume capacity

- 13 parameter water samples will be taken from PWS well and subsequent monitoring wells to establish a baseline.

Proposal Year #2

Project Report-

The final report will consist of analysis of the installed grout seal integrity and sealing materials installed in these wells. The report will document water quality changes in the PWS wells and identify other water quality parameters changes over the course of the project.

The final report will not include an estimate of well longevity of any of the wells involved within the project. It is understood that these well were constructed from 1968 to 1970 and are aged from normal wear and tear of a well casing. By augmenting the grout seal of these older wells at this time, enhanced decommissioning of the well casing will not be needed when it comes time to safely replace the wells in the future. Enhanced decommissioning of abandoned wells and the restoration of existing public water supply wells is more cost effective than abandonment and replacement of existing well sites.

Execution Strategy

Our execution strategy incorporates proven methodologies, extremely qualified personnel, and a highly responsive approach to well decommissioning and grout seal augmentation. Following is a description of our methodology, including how the project will be developed, a proposed timeline of events, and reasons for why we suggest developing the project as described.

Timeline for Execution

Key project timelines are outlined below. Days are best-guess estimates for completing enhanced decommissioning for 4 wells and Augment PWS well G-028228

Description- Site evaluation and assessment- Year #1	Phases	Duration
Meet with the City of Springfield	Prestart	
Drill test hole and e-logging and monitoring well construction	1	15 days
Baseline water samples	1	3 days
Excavation of Decommissioning well- Year #1		
Remove decommissioning fill materials	2	2 days
Downhole video inspection of PWS well G-028617	2	1 day
Clean and brush well casing in perforation intervals	2	2 days
Perforate Casing in lower interval	2	3 days
Pressure grout lower seal	2	1 day
Air lift and remove debris- test pump- downhole video inspection	2	2 days
Disinfect well, install pump, test pump, obtain water samples	2	3days
G-028617 report of findings filing modification paperwork with DNR	3	5 days

Well Augmentation -PWS G-034831- Year #2	Phase for each site	Per Site
Pull pumping equipment and inspect pump	2	2 days
Downhole video inspection of PWS well G-028229	2	1 day
Clean and brush well casing in perforation intervals	2	2 days
Perforate Casing in lower interval	2	3 days
Pressure grout lower seal	2	1 day
Air lift and remove debris- test pump- downhole video inspection	2	2 days
Disinfect well, install pump, test pump, obtain water samples	3	3days
G-028617 report of findings filing modification paperwork with DNR	3	5 days

EXPECTED RESULTS

By removing the un-grouted areas of the borehole around the abandoned PWS well G-028617 and G-034831 we expect to reduce and eliminate the preferential pathway for contamination to transport to the ground water reservoir. As a result, the nitrate concentrations in water samples of PWS wells should stabilize and reduce. We expect this proposed solution to be of value to the City of Springfield, NE to assist them in their desire to improve water quality from their PWS water wells. and benefit the City by providing the following results:

- Reduction of nitrate concentrations in water samples from the PWS well
- Provide protection of the lower production zone of the aquifer
- Elimination of a potential point sources contamination
- Enhanced protection of the City's groundwater supply
- Development of best management plans for addressing future contamination concerns

PRICING

The prices listed in the following table are an estimate for the services discussed. This summary is not a warranty of final price. Estimates are subject to change if project specifications are changed or unforeseen site conditions cause unexpected expense, or costs for outsourced services change before a contract is executed. **Prices do not include costs for Engineering services to obtain a permit from the Department of Health and Human Services – Engineering Section for Title 179 – Public Drinking Water**

The following table details the costs of excavating decommissioning materials out of PWS#1-G028617, regrouting PWS#1-G028617, and test pumping the well to see if it is viable. In the event the well is not viable the cost of decommissioning the well is included.	Year	
Phase 1- PWS #1	1	
Site research and site inspection	1	\$750.00
1- 6-inch test holes, e-log,	1	\$4,000.00
2- 3-inch monitoring wells 107 feet and 88feet deep,	1	\$3,000.00
Baseline sampling of MW#1 and MW#2samples for	1	\$1,250.00
Phase 2- PWS #1		
Drill out decommissioned material	1	\$2,500.00
Video Inspection for well casing integrity validation	1	\$600.00
Brushing the well in areas of perforation	1	\$750.00
Perforating the well casing	1	\$4,000.00
Video Inspection to verify perforations	1	\$600.00
Grouting the perforation Zone	1	\$2,500.00
Video the grouted zones	1	\$600.00
Clean the well from grouting debris	1	\$825.00
Phase 3- PWS #1		
Deploy and retrieve data loggers in MW #1 and MW#2	1	\$600.00
Install test pump	1	\$1,500.00
6-Hour Test pump and sampling	1	\$ 2,625.00
Remove test pump	1	\$1,500.00
Write Report and submit Deliverables- includes water sampling, analytics, data logging, and results	1	\$6,500.00
Sub total cost for PWS #1		\$34,100.00
<ul style="list-style-type: none"> • <i>Fill material for Decommissioning G-028617 If Needed</i> 		\$ 3,000.00
Total G-028617 costs		\$ 37,100.00

The following table details the costs for, regrouting PWS#2 G-034831, and test pumping the well to see determine water quality.		
Phase 1-PWS #2		
Site research and site inspection	1	\$ 750.00
1- 6-inch test hole, e-log,	1	\$ 4,000.00
2- 3-inch monitoring wells, 195 feet and 75 feet deep	1	\$ 3,000.00
Baseline water samples for MW#1 and MW#2, and G-034831	1	\$ 2,625.00
Phase 2- PWS #2		
Pull Pump	2	\$ 2,500.00
Video inspection to determine the well casing integrity	2	\$ 600.00
Brush the well in area of perforation	2	\$ 750.00
Perforate the well casing and 8-inch steel liner	2	\$ 9,500.00
Video inspection to validate perforations	2	\$ 600.00
Grout the areas of perforations	2	\$ 4,500.00
Video inspection of the grouted zones for validation	2	\$ 600.00
Cleaning the well of grouting debris	2	\$ 825.00
Re-install pump, Chlorinate and disinfect well	2	\$ 2,500.00
Phase 3- PWS #2		
Deploy and retrieve data loggers	2	\$ 600.00
6-hour pump test MW#1, MW#2, and PWS#2	2	\$ 2,625.00
File report, submit deliverables- includes 2 years water sampling, analytics, data logging, and results	2	\$6,500.00
Total Cost Year #2		\$42,475.00
Project total		\$79,575.25

DISCLAIMER

It is understood that well grout augmentation does not guarantee increased longevity of a well. Well casing materials age at a certain rate and will eventually need to be replaced. Steel well casing has an expected longevity of 60 to 90 years depending on water conditions at the site. PVC well casing by contrast has an undefined longevity as it is inert to corrosion but more susceptible to abrasion.

These City wells were constructed in 1968 (52 years), 1970 (50 years), and 2007 (13 years) are constructed out of steel well casing meaning two of these wells are approaching the early stages of the expected longevity span for steel wells. It is reasonable to expect however that due to the favorable water quality generally found in the groundwater underneath the City of Springfield, these steel cased wells have many useful years of service in the years to come.

Groundwater Solutions Group will utilize every tool to evaluate the integrity of the steel well casing. Should a well be determined to be unstable and not a candidate for grout seal augmentation, the well will be grouted as an enhanced decommissioning candidate.

QUALIFICATIONS

Groundwater Solutions Group is proven to be an industry leader for high quality products and services in the following ways;

- Groundwater Solutions Group offers cohesive access to the following professionals.
- Tom Christopherson is recognized by the National Ground Water Association as an expert in the field of groundwater and groundwater protection. He has been acknowledged by the NGWA as a member and leader of a research project in the area of groundwater protection earning a national award for the work done by the State of Nebraska in 2017. His background as a water well contractor for 20 years before serving the State of Nebraska in his role as a field inspection water supply specialist, and then later as manager of the water well standards program and project manager of the Nebraska Grout Task Force and subsequent research projects, insures Groundwater Solutions Group has what needed to lead a project and achieve its goals.
- GeoSpec Drilling has the latest diagnostic equipment available for the analysis of the borehole and cutting samples needed to identify aquitards critical to the success of the well grout augmentation process. Owner Bo Bonn has given several classes and seminars of the purpose and function of groundwater diagnostics and analysis; GeoSpec has been highly successful in noninvasive perforations of well casing and pressure grouting the borehole annulus of high capacity water wells.
- Bruce Manchon is a licensed professional geologist in the States of Nebraska, Colorado, and Texas. He is a nationally recognized expert in the areas of geophysics, groundwater contamination remediation, groundwater resource development and is a lecturer for the National Ground Water Association.
- AWS Well Co is licensed by the State of Nebraska as a Water Well Drilling/Pump Installation Contractor and has experienced personnel in planning, engineering, and construction of wells and installation of irrigation and domestic water well systems. Bryce Anderson is a licensed Professional Engineer (PE) with the State of Nebraska. Located in Saunders county of Nebraska AWS has personnel with over 75 years of combined experience of providing the citizens of the Lower Platte North, Lower Platte South, Papio/Missouri River, Lower Elkhorn, Lower Loup, Central Platte, and Little Blue NRDs with solutions to their ground water use needs.

Dave Hansen is a nationally recognized expert in well construction, water quality analysis, water chemistry and treatment. Dave has an extensive career in the groundwater industry beginning work with a private water well contractor in Minnesota, then moving on to Johnson Screen Works INC. where he contributed to the Ground Water and Wells second edition, then owning Design Water Technologies Inc.. He developed such products as unacid™ for well cleaning, steroline™ for well disinfection and Chloropal™ for well decontamination. He has served the National Ground Water Association in developing best management practices and served as the McElhenny lecturer for 2007.

CONCLUSION

We look forward to working with the City of Springfield, NE to assist them in their desire to improve water quality from their PWS water wells. to preserve groundwater quality for groundwater users throughout their district. We are confident that we can meet the challenges ahead and stand ready to partner with you in delivering an effective groundwater protection solution plan.

If you have questions you can contact me at cwcwaterpro55@gmail.com or by phone at (402) 881-5249 Thank you for your consideration,



Tom Christopherson
Groundwater Solutions Group