

APPENDIX B

NEW PILOT WELL TESTING PROTOCOL

INTRODUCTION

The program to install a new municipal well includes:

- 1) Site Selection – selecting a site for a new municipal well includes identifying, evaluating and recommending the new well site and receiving the Department of Natural Resources (DNR) approval according to Wisconsin Administrative Code section NR 811, including any appropriate variances. The site selection process will likely become more detailed than it has been in the past, and will include technical analyses of alternative sites regarding potential contaminants, geologic and groundwater flow conditions, and will also include close communication and collaboration with community stakeholders. It is also likely that the site selection process will be expanded to include evaluation of geologic and water quality characteristics of the proposed well site as determined during the pilot wells drilling and testing program, meaning that site selection will not be complete until pilot test well results have been evaluated and final DNR approval for the well site is obtained
- 2) Pilot Well – constructing and testing a pilot test well and sampling, testing and analyzing data to determine the aquifer’s production capacity and water quality, as described in the following section of this protocol;
- 3) DNR Approval for completion of the municipal well–following review and analysis of the test well data, and confirmation of acceptable expected performance, the Utility will apply for DNR approval for the new municipal well according to NR 811; and
- 4) Install and Start-Up Testing Production Well – installing the supply well, and sampling, testing and analyzing data to confirm productivity and water quality. In addition, Will startup will include startup of the monitoring program , as identified in the site selection pilot well and DNR application process, for off-site environmental variables such as monitoring wells, river or lake gauge observations, or other environmental issues identified is important to long-term operation of the water supply well.

The objectives of this recommended sampling and testing program are to complete the Pilot Test Well step listed above.

PILOT WELL INSTALLATION

The pilot test well is used to describe the site geology, delineate aquifer hydraulic properties, determine the existence and location of preferential zones of groundwater inflow, and to assess the quality of the groundwater supply.

Construction of the test well shall use similar construction techniques, although smaller diameter, as expected for the final production well, to the extent practicable. In particular, the pilot well must be installed to the same total depth, with the same length of steel casing and seals, as will be expected for the production well. Aquifer performance testing shall be conducted to establish the aquifer characteristics and verify production objectives. Several good protocols for pumping tests already exist and can be tailored for the site hydrogeology and objectives. Installation and monitoring of an observation well or utilizing nearby existing wells for monitoring water levels during the pumping test should be considered to provide additional data for analysis of hydraulic properties.

It is strongly suggested that the pilot well not be abandoned after installation, but rather remain in place, adjacent to the final production well. Having the pilot well available near the production well will allow more detailed analysis of aquifer hydraulics following completion of the production well, and will also provide an additional location, unaffected by production well installation, for water quality testing. A decision on final abandonment of the pilot well installation according to procedures in NR 811 should be made after the production well has been completed, startup procedures accomplished, and the well is in normal long-term operation.

PILOT WELL SAMPLING AND ANALYSIS

In addition to the requirement of s. NR 809, Wisconsin Administrative Code, that the groundwater at the test well be sampled for inorganic, volatile organic, synthetic organic, and radionuclide water quality parameters, we recommend the following testing program.

1. Video and Geophysical Logging – Log the well using video and geophysical logging (natural gamma, resistivity, and spontaneous potential).
2. Vertical Flow Meter – A vertical flow meter should be run with no pumping and while pumping the test well. The vertical flow meter log while at rest would be used to determine natural vertical flow in the well and would help to determine the competence of the seal if installed through a confining layer (e.g., the Eau Claire Shale). The vertical flow meter while pumping would identify the zones producing water to the pumped well. The pumping rate should be set at a rate equivalent to a pumping rate desired from the final production well. The equivalency between the pilot test pumping rate and

the final production well should be based on the actual and planned diameters of the two wells.

Have a detailed geologic log prepared using visual and microscopic evaluation (e.g., by the WGNHS) in a manner consistent with the Larkin test well. This should specifically

3. identify the presence of fresh or oxidized sulfide minerals (typically pyrite) and zones with sand grains with oxide coatings and those with no coatings on the sand grains. Based on the detailed evaluation and the downhole video, collect and analyze rock samples for metals, sulfur, and sulfides. The composite interval should be selected so that sufficient detail is available to determine if there are zones of anomalously low or high manganese or iron.
4. Based on the results of the flow meter, rock sample analyses, and video and geophysical logs, conduct water quality sampling at selected intervals in the borehole. This sampling should consist of installing a double packer and pumping from the target zone. Sampled intervals should include zones with high sulfides, high manganese or low Fe(OH)₃/MnO₂ ratios in the rock analyses, and zones with high flow based on the vertical flow meter results during pumping. Sampling and analysis should include:
 - a. Use a flow through cell to collect field parameters (pH, dissolved oxygen (DO), redox, conductivity, and temperature) while pumping from the isolated interval on a recording data logger. After stabilization of field parameters, collected samples for lab analysis.
 - b. General Water Chemistry analyses:
 - i. Major ions – Ca, Mg, Na, K, Cl, Alkalinity, SO₄
 - ii. Total Organic Carbon (TOC) – to assess potential man made and natural sources of carbon
 - iii. TDS – general character and to help in ion balance
 - iv. Redox parameters – Mn, Fe, NO₃, Nitrate-N, Total Kjeldahl-N, and ammonia-N,
 - c. Others – Low detection level bromide and iodide to assist in source characterization,
 - d. VOCs – Low level 8260B. Low detection limits to look for very low concentrations of man made or petroleum sources not detected in routine analyses,
 - e. Age Dating – low level tritium (detection limit of 1 tritium unit or less) to provide a range on the possible age of the water in the aquifer,
 - f. Isotope Characterization – δD and δ¹⁸O to characterize the source of the water.

The above data will be analyzed to evaluate:

- Well construction and development, geologic conditions, and availability of manganese for dissolution

- Existing water quality of the aquifer and potential for manganese or other constituents to impact water quality
- Preferential flow paths and zones of high hydraulic conductivity
- General age and history of the water to determine if the water supply is isolated from near-surface condition and likelihood that near-surface conditions will affect the water quality

If any water quality issues are identified, the test results will be useful for deciding on a plan of action for further assessment. More detailed groundwater and hydraulic analyses may be conducted, depending upon the results of the pilot well testing, and of the issues identified during the well site selection process.

REPORTING

The results of installation, water quality testing, and analysis of the pilot test well should be collected into a report format that includes all observational data available. This report should form the basis of confirmation or modification of the site selection process for the production well. In addition, the drilling observations, water quality, and hydraulic characteristics determined in the pilot test well will prove a valuable resource to the Utility in the future, as additional pilot test wells are constructed and analyzed.