



## WATER RESOURCES RESEARCH GRANT PROPOSAL

**Title:** An Assessment of Factors Indicating Well Vulnerability in Nebraska

**Focus Category:** GW, WQL, WS, WU

**Keywords:** 62. Disinfection, 101. Groundwater Quality, 261. Viruses, 276. Water Quality Standards

**Duration:** Aug. 17, 1999 to August 16, 2001

**Federal Funds:** \$29, 000.00

**Non-Federal Funds:** \$77,591.00

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**Congressional District:** Nebraska First District

### Statement of Critical Regional or State Water Problem

Nebraska, like most other Midwestern states, has a large number of small (< 10,000 population) communities. Most small communities rely on untreated groundwater as a source of drinking water in Nebraska, where surface water supplies are limited and groundwater resources are plentiful. For example, there are 608 small community water systems in Nebraska, nearly all of which rely on untreated groundwater as a public water supply (NHHSS, 1997). There are also 719 non-community systems in Nebraska which face the same issues as community systems. The Nebraska State Department of Health and Human Services Regulation and Licensure considers groundwater quality issues for these small communities to be of critical importance (see attached letter of support). In the past, untreated groundwater was considered a safe and adequate source of drinking water. Changing federal regulatory perspectives may impact the state of drinking water treatment in Nebraska. The proposed Ground Water Rule may require all communities, regardless of size, to disinfect the water prior to distribution (Macler and Pontius, 1997). The justification behind a disinfection requirement for groundwater is the unknown risk of microbial contamination of the groundwater. Pedley and Howard (1997) note that "the microbiological contamination of groundwater has profound and severe implications for public health, particularly in small communities..." but also acknowledge that virus survival in groundwater is not well understood. Although there are few published studies on virus occurrence in groundwater, the limited data available from some states seem to

indicate that groundwaters in karst formations may be vulnerable to contamination and may contain pathogens (Abbaszadegan et al., 1998). Nebraska does not have karst geology or other formations which seem at extra risk for contamination. The presence of human pathogens such as viruses in well waters has not been studied sufficiently, and no general consensus on the presence of viruses can be reached at the present time.

The U.S. EPA has suggested that disinfection may not be required for all drinking water systems with groundwater as their source, but only for those systems which are most vulnerable to microbial contamination (King, 1998; Macler, 1996). The determination of which systems are most vulnerable to contamination might be left to each state; at this time Nebraska (and surrounding states with similar geology) has no consistent method for determining which wells or communities would be most likely to experience microbial contamination problems, and no virus testing of public wells has been done. To begin the process of assessing the vulnerability of Nebraska drinking water wells to pathogen contamination, a study of well integrity factors or 'well vulnerability' is proposed. The project will include data collection and analysis on well and water system features, as well as virus and bacteriophage testing. This information may be used to determine which, if any, Nebraska communities need to consider disinfection or other pathogen barriers for their public drinking water systems.

### **Statement of Results or Benefits**

The proposed research is of national interest and benefit to the drinking water industry. Research on the presence of viruses in groundwater is limited, and has generally not focused on specific geological formations, but instead has tended to be 'survey' research which is of little value in understanding the complexities of groundwater systems (e.g., Abbaszadegan et al., 1998). Due to the lack of focus of the available research, very little attempt has been made to correlate the presence of viruses with specific features of the water system or well, or with controllable environmental factors (such as the proximity of waste treatment facilities.) Without sound scientific data that can be used to characterize water systems that may be at risk, public health authorities will be forced to implement very conservative groundwater disinfection regulations. These regulations may require disinfection (and the associated capital and operation and maintenance costs) in communities where disinfection is not truly needed to protect public health. A well designed, focused, yet comprehensive study of well vulnerability will provide invaluable information to the scientific community that studies groundwater, to the communities that use groundwater, and to the regulatory agencies that intend to protect and guide the communities.

The proposed project will also provide valuable information for the State of Nebraska. Information is needed for researchers studying small community planning, water resources, groundwater, water treatment, and waste treatment. All of these areas of study potentially impact or are impacted by groundwater quality. The proposed research will develop a methodology for data collection and analysis which can be built upon in the future during additional studies. A consistent methodology and a body of data will greatly

aid decision making activities that have a major impact on the future of small communities in Nebraska.

### **Nature, Scope, and Objectives of the Research**

The overall goal of the proposed research is to determine the relationship between the microbial quality of groundwater and the well, water system, and surrounding environment. A large amount of data on groundwater quality and on small water systems is needed to determine this relationship. Statistical relationships between factors may be defined based on an evaluation of the data.

The objective of this project is to develop a methodology for data collection and analysis that can be used to accomplish the goal stated above. The objective of this project will be met by completing an initial study of well vulnerability in Nebraska. The following specific activities will be completed to meet the project objective (and are described further below):

- Select four to eight small communities (representing approximately fifteen wells) to participate in the study.
- Determine the factors which will be studied, and identify sources of information.
- Collect data, and conduct field sampling for virus testing and general water quality testing.
- Summarize data and methodology approach, as a basis for future research projects.

To meet the overall goal of this research, it is anticipated that future projects will be initiated using other funding sources. The work described in this proposal is considered to be "Phase I" of a larger study. A second, larger study will be needed to provide sufficient data for statistical analysis. Other funding opportunities (such as the U.S. EPA or the Nebraska Mandates Management Initiative) will be pursued for "Phase II" of the research.

Communities will be selected for participation in the study based on the advise and support of the project advisory committee. Prior to the development of this proposal, the P.I.s have obtained the input and support of the Nebraska drinking water industry. In particular, the State Department of Health and Human Services Regulation and Licensure, of local consulting firms (e.g., Miller and Associates), and independent programs (such as the Groundwater Guardian program) have verbally indicated support for this research, and have indicated a willingness to work with the P.I.s in identifying communities and providing input through the advisory committee. With the assistance of the advisory committee, four to eight small communities (representing about fifteen separate wells) will be selected to participate in the study. For logistical reasons, it is anticipated that most of the small communities studied in this phase of the research will be located within the eastern half of the State of Nebraska, but within that limitation towns will represent a variety of groundwater conditions and geological formations. Future work will include communities located throughout the State of Nebraska.

Data collection will be guided by an advisory committee comprised of regulatory personnel, consulting engineers, small water system representatives, and researchers. The advisory committee will provide insight on the type of information available, the most important factors influencing water quality and water system operation, and the selection of communities to participate in the study. Data collection will involve obtaining information from regulatory agency files, from community files, from local water system personnel, and from field inspection of the water system. The Nebraska Department of Health and Human Services Regulation and Licensure actively supports this proposal and will assist researchers in the procurement of public information, as noted in the letter of support attached to this proposal.

Data collection will focus on information which describes the well and water system, and the environment surrounding the well and water system. Some of the factors likely to be evaluated include: well depth, well construction (including grouting depth), well age, water system age, proximity of sewer lines and septic systems to the well, land use near the well, and soil type. Other factors may also be important, including water quality information which will be determined during the field sampling activities.

Field sampling activities are needed to determine local groundwater quality. Field samples will be obtained for virus and bacteriophage analyses, and for other water quality parameter analyses. Human viruses are the primary pathogen of regulatory interest in groundwater systems, and will be the main focus of the field testing. Samples will also be analyzed for bacteriophages. Bacteriophages are not pathogens, but are thought to have similar transport characteristics to viruses. The existence of bacteriophages in groundwater may indicate vulnerability of the well system, but does not necessarily indicate the presence of pathogens. Other water quality parameters to be measured include metals, alkalinity, pH, total organic carbon, dissolved oxygen, common anions (chloride, bromide, nitrate, phosphate, and sulfate), and total coliform. These parameters are important because they may indicate the interaction of surface water and groundwater, or the influence of surface activities on the groundwater. For example, elevated levels of nitrate in groundwater may indicate the influence of wastewater facilities on groundwater quality, or may indicate a short travel time for surface water to reach the groundwater.

Data analysis will begin as soon as possible after information has been gathered. The study of four to eight communities will not provide a statistically significant body of data, but will provide sufficient information for researchers to focus future research activities. The research outcome will be a small body of data and a developed methodology which can be applied to future research. This study is a necessary pilot study for a larger research project, which will result in a statistically significant assessment of factors affecting well vulnerability and the occurrence of viruses in those wells.