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EXECUTIVE SUMMARY OF THE DUNN COUNTY GROUNDWATER RESOURCE INVESTIGATION

by

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EXECUTIVE SUMMARY

of the

Dunn County Groundwater Resource Investigation

a joint project of
Wisconsin Geological and Natural History Survey
and the
Dunn County Board

prepared by
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INTRODUCTION

This report summarizes a cooperative project between Dunn County and the Wisconsin Geological and Natural History Survey (WGNHS) designed to inventory groundwater quality, distribution, and flow direction and to assess soil and/or geologic characteristics that might affect the impact of surface land-use activities on the groundwater system. The results of this work do not in any way represent a comprehensive groundwater-management plan but should be viewed as background information for whatever groundwater-planning strategy the county chooses to pursue. The results should not be viewed as static; the county should use the values reported as a database to which new information can be added on an on-going basis.

Most human activities have the potential for affecting the groundwater resource. Therefore, a groundwater-management plan must include as complete an inventory as possible of those activities in a form that can be related to the soil, geologic, and hydrologic characteristics of the county.

DUNN COUNTY MAPS

WGNHS has published maps at a scale of 1:100,000 and provided other information at the same scale on clear, plastic material so that they can easily be overlaid on printed maps. For example, elevated levels of nitrate or chloride in the groundwater can be related to areas where the soil's ability to attenuate contaminants is limited or to recharge areas for municipal wells. As needs arise, additional maps such as those depicting the locations of abandoned landfills or underground storage tanks should be developed.

The **soil-attenuation potential map** (printed) depicts the ability of the soil to reduce the movement of contaminants that result from surface land-use activities to the groundwater. It is based on an evaluation of the soil physical and chemical characteristics that affect the infiltration and percolation of water through the soil. The map contains a detailed discussion of how the soils were evaluated and describes the distribution of soils in the county.

The **water-table elevation map** (printed and clear plastic) is based on well constructor's reports as well as elevations of streams, lakes, and rivers taken from the 1:24,000 United States Geological Survey quadrangle maps. It presents a generalized picture of shallow groundwater flow within the county. Likewise, the **depth-to-bedrock map** (clear plastic) was developed from well constructor's reports, the county soil survey reports, and information available in the files of the WGNHS. **Aquifer-potential maps** (clear plastic) were prepared to illustrate the potential yields from and distribution of both the sand-and-gravel and the sandstone aquifers in Dunn County.

Chemical parameter maps, that is, those showing chemical concentrations determined from specific well samples, are clear plastic and are designed to be overlaid on the soil-attenuation or the water-table elevation map to demonstrate the relationship between groundwater contamination and soils or flow directions. Land-use activities may need to be reviewed in an area of sandy soils where the groundwater shows elevated levels of nitrate or chloride, particularly if that area provides recharge for a municipal well field. The maps are designed to be "stacked" in a variety of ways to show the relationship between groundwater quality and soil and/or geologic characteristics.

With these data in hand and with an eye toward ultimately developing a comprehensive groundwater-management plan, the county needs to organize its own resources to meet the challenges of groundwater protection. The various agencies and departments of county government have different responsibilities when it comes to the management of groundwater-pollution problems. Roles need to be spelled out and goals and objectives defined for all who have a part to play. Provision must be made for institutional and intergovernmental cooperation between and among all agencies involved.

GEOLOGY AND AQUIFERS IN DUNN COUNTY

Dunn County is underlain by sandstone of Cambrian age, except in a small area in the west-central part of the county where Ordovician age dolomite overlies the sandstone. Glaciers moved across the county many thousands of years ago, leaving behind characteristic deposits of till (a poorly sorted mixture of sand, silt, and boulders) and outwash (sand and gravel deposited by meltwater streams). The last glacier of the Pleistocene Epoch did not cover Dunn County but meltwaters from that ice cut through the county from north to south, forming a major drainageway. Those waters exited the county via the Chippewa River, which cuts across the southeast corner of the county. In addition, following the disappearance of the ice, silt-sized material called loess was deposited by the wind over much of the county.

Groundwater in the county is drawn primarily from the sandstone bedrock and the glacially derived sand and gravel. Wells are not finished in the dolomite or in the silty loess. The materials that yield water in Dunn County have different characteristics, which affect how water and contaminants move through them and, in turn, how much water can be derived from them.

GROUNDWATER QUALITY

For the purposes of this inventory, county staff collected 600 samples, primarily from domestic wells of participating residents and homemakers. After the samples were frozen, they were transported to a laboratory in the Soil Science Department at University of Wisconsin-Madison, where they were analyzed for electrical conductivity, hardness, nitrate (expressed as NO_3-N), chloride (Cl), lab pH and iron (Fe). Nitrate and chloride are particularly useful as indicators of degraded water quality because the occurrence of nitrate in nature is relatively rare; chloride occurs naturally in only a few very deep aquifers. Elevated levels of either one in groundwater in Dunn County is interpreted as the result of land-use activities. A summary of the results is presented in table 1.

Table 1. Summary of chemical characteristics of 600 groundwater samples from Dunn County, 1986

Parameter	Values		
	Maximum	Minimum	Mean
Nitrate (mgNO_3-N/L)	33	0	3
Conductivity (micromhos/cm)	920	40	278
Hardness (mg/L as $CaCO_3$)	460	1	129
Chloride (mg/L Cl)	187	0	9
Lab pH	9.4	6.0	7.9
Iron (mg/L reactive Fe)	43.0	0.0	--

A state and national standard of 10 mg/L of ***nitrate*** *(NO_3-N) has been established* for drinking water on the basis of the amount of nitrate that can cause methemoglobinemia, a potentially serious blood disorder in young infants. Greater levels of nitrate (the exact number is not known) can cause health problems for livestock. In most instances, it does not appear that the nitrate in the water is solely responsible for such problems, but rather that the problems result from the cumulative effects of nitrate in both the water and the feed being used. Fifty-five, or 9.1 percent, of the wells sampled in the county had nitrate values in excess of the established standard. Major sources of nitrate are agricultural fertilizers, animal wastes, and septic system effluent.

As a part of the comprehensive groundwater legislation enacted by the state of Wisconsin, the Department of Natural Resources (DNR) has established standards for drinking water for public health and welfare and so-called Preventive Action Limits (PALS). PALS are values lower than those established as standards that are taken to mean that the quality of the groundwater has been affected and that remedial measures should be initiated to lessen those impacts if possible. The PAL for nitrate is 2 mg/L; 327 (54.3%) wells tested in the county exceed this value. The normal or natural background *level for nitrate in groundwater is generally less than 0.2 mg/L.*

Chloride ions are unreactive; once they are in solution, they are usually unaffected by chemical processes as they percolate through the soil and underlying geologic material to the groundwater. Because the rocks that underlie the state are low in chloride, background levels in most of Wisconsin's groundwater are usually less that 5 mg/L. *Levels much above that value suggest that land-use activities may be affecting ground*water. Major sources of chloride include road salt, chemical fertilizers, human and animal wastes, and discharges from home water softeners. The average value for chloride for all samples tested in the county was 8.8 mg/L. The standard for chloride in drinking water is 250 mg/L; this is based on taste, not on health effects.

Electrical conductivity *is a measure of the ability of a solution to conduct an electric* current. Pure water will not conduct a current, but water that contains dissolved solids, such as calcium, magnesium, and bicarbonate, will. These dissolved solids are common constituents of Wisconsin's groundwater; their amounts vary depending on the host material of the aquifer from which water is derived.

Hardness *of water is a measure of the dissolved calcium and magnesium that it* contains. Some of the water sampled in the county would be classified as moderately hard with values ranging from 60 to 120 mg/L (as $CaCO_3$). The majority of samples had values in excess of 120 mg/L; such water would be considered to be hard.

pH values of 7 are considered to be neutral, those greater than 7 are alkaline, and those below are acidic. Lab pH values, as reported in this study, are somewhat higher than values recorded immediately after a sample is taken because of chemical transformations that occur during transport and storage prior to analysis. When the pH is below 7 and the hardness below about 50, the water is corrosive and can be harmful to plumbing systems. It can also be a health hazard if lead-based solder was used in the plumbing system. Corrosive water may dissolve lead, which is toxic to humans and animals. People who have corrosive water should have it tested for lead content.

Iron (Fe) occurs commonly in soils, glacial materials, and rocks in Wisconsin. It is also fairly common in groundwater even though most iron compounds are not very soluble in water. When iron is present in drinking water in amounts in excess of 0.3 mg/L, it can cause problems, such as staining porcelain fixtures. Amounts beyond those levels may require special treatment not only to reduce aesthetic, taste, and odor problems but also to alleviate problems with plumbing systems. About 22 percent of the samples taken in the county contained ferrous iron (the form of Fe found in groundwater) in excess of 0.3 mg/L.

Chemical data from the well samples taken in Dunn County clearly suggest that current and past land-use activities are affecting groundwater quality. Elevated levels of NO_3-N and Cl found in many samples attest to this. Maps showing the spatial distribution of chemical values show areas in the county where that degradation of groundwater quality is most apparent. Immediate consideration should be given to reviewing land-use activities in those areas and remedial measures to lessen those impacts should be developed.

As part of the sampling procedure, efforts were made to obtain samples from wells for which well constructor's reports were on file with the WGNHS. Information about the depth of the well or the type of geologic materials from which water is being withdrawn is helpful when piecing together the hydrogeologic picture of the county. Unfortunately, this approach biases the sample results somewhat because most of the wells sampled are deep. Shallow (driven or dug) wells, which may be more contaminated, are only rarely sampled. As a result, the values presented in this report for the various chemical parameters should be taken as conservative estimates of groundwater quality.

Threats to groundwater come from improper waste disposal, agricultural activities, uncovered storage of chemicals on the land surface, and spills and leaks of toxic and hazardous substances. Overuse of pesticides, chemical fertilizers, and animal wastes are of concern, particularly in areas of coarse-textured soils where the water table is close to the land surface. The use of irrigation in these areas also serves to exacerbate groundwater degradation problems.

ADDITIONAL INFORMATION AVAILABLE

In the context of this report, it is not necessary to review all the options available to the county to meet the challenges of groundwater protection and management. Two recent publications from the WGNHS, *A Guide to Groundwater Quality Planning and*

Management for Local Governments, by S.M. Born, D.A. Yanggen, and A. Zaporozec (Special Report 9, 1987), and *Wellhead-Protection Districts in Wisconsin: An Analysis and Test Applications*, by S.M. Born, D.A. Yanggen, A.R. Czecholinski, R.J. Tierney, and R.G. Hennings (Special Report 10, 1988), describe in detail the variety of actions that a county can take to meet the challenges of groundwater management and protection. In addition, the printed maps generated by this project, that is, those depicting water-table elevations and soil-attenuation potential, contain descriptive texts that indicate the information used to make the map and provide some insight as to what the maps show

Some additional publications available from the WGNHS should be of interest to the county. *Groundwater Quality Atlas of Wisconsin*, by P.A. Kammerer (Information Circular 39, 1981), summarizes water-quality data for a variety of chemical parameters on a statewide basis. The origin and behavior of these constituents of the state's groundwater are discussed; sources of contamination are also indicated.

Groundwater Protection Principles and Alternatives for Rock County, Wisconsin, by A. Zaporozec (Special Report 8, 1985), discusses in detail potential sources of groundwater contamination as well as the ability of soil and geologic materials to attenuate contaminants. Institutional alternatives for groundwater management and protection are also reviewed.

With the information generated by this cooperative study, the county is now in a position to organize its resources to deal with the wide variety of land-use and groundwater-quality problems A plan should be developed that identifies existing pollution sources as well as areas of already affected groundwater Management strategies should be developed and the local agencies with implementation responsibilities identified. Most importantly, the existing database should be incorporated into a county planning system and provision made for the incorporation of new data as it is developed. A comprehensive groundwater protection program should be viewed as a long-term commitment on the part of the agencies involved.