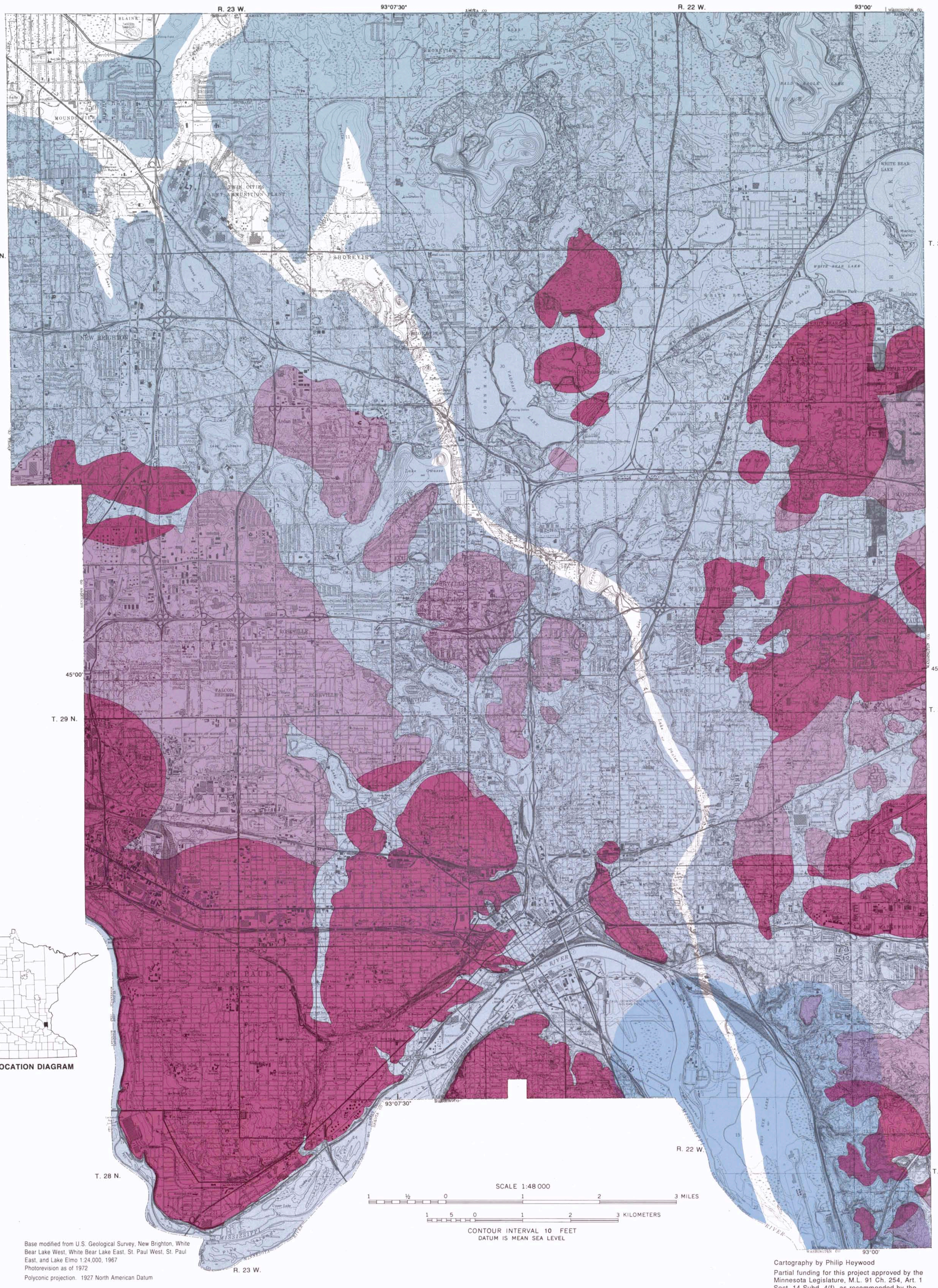
Prepared and Published with the Support of
RAMSEY SOIL AND WATER CONSERVATION DISTRICT, RAMSEY COUNTY BOARD OF COMMISSIONERS,
SELECT WATER MANAGEMENT ORGANIZATIONS, THE MINNESOTA DEPARTMENT OF NATURAL RESOURCES, DIVISION OF WATERS,
AND THE MINNESOTA ENVIRONMENT AND NATURAL RESOURCES TRUST FUND



LOCATION DIAGRAM

Base modified from U.S. Geological Survey, New Brighton, White Bear Lake West, White Bear Lake East, St. Paul West, St. Paul East, and Lake Elmo 1:24,000, 1967
Photorevision as of 1972
Polyconic projection. 1927 North American Datum

WELLS AND WELL CONSTRUCTION

By

Douglas S. Edson and Bruce M. Olsen
Minnesota Department of Health

1992

EXPLANATION

Platteville Formation

Permitted — Not permitted
for potable supply

Prairie du Chien Group

Permitted — Not permitted
for potable supply

Prairie du Chien absent

INTRODUCTION

Ground water is a major source of drinking water for Ramsey County and the principal source of water for the county's industry and commerce. The communities of New Brighton, North St. Paul, Shoreview, Vadnais Heights, White Bear Lake, and White Bear Township obtain all of their water from wells. Three quarters of the water used by the city of St. Paul and the communities it serves are supplied by surface water and one quarter by ground water. Thousands of homes are served by private wells.

The sequence of aquifers in Ramsey County is shown in Figure 1. Most high-capacity wells draw water from bedrock aquifers, particularly the Prairie du Chien–Jordan. Domestic wells typically draw from the uppermost aquifer, which varies from location to location because of differences in the bedrock (Plate 2) and surficial geology (Plate 3).

All of the county's aquifers have been used since the turn of the century; water levels in the bedrock aquifers have declined over time due to pumping. Although large supplies of ground water exist (see Plate 6, Surficial hydrogeology, and Plate 7, Bedrock hydrogeology), they may be sensitive to contamination from unwise land-use and waste-disposal practices; and from improper methods of well construction, maintenance, and sealing. Plates 8 and 9 show the vulnerability of the water-table system and Prairie du Chien–Jordan aquifer to land use. This plate shows construction and sealing practices that can prevent wells from serving as pathways for contaminants to enter Ramsey County's ground-water supplies.

WATER-WELL REGULATION

The Minnesota Department of Health was directed by state law in 1971 to license water-well contractors and to regulate the construction, repair, and sealing of wells. Well-construction regulations were implemented in 1974. Before regulation, well-construction practices were highly variable; they did not always protect ground-water resources or meet sanitation requirements. The regulations set standards for isolation distances from contamination sources, construction materials, and installation procedures. A water-sample analysis is required to confirm potability. Licensing is required for construction and repair of wells, sealing of (abandoned) wells, installation of monitoring wells, drilling of geologic and engineering test holes, and construction of elevator shafts. Records of well construction and sealing must be submitted to the Minnesota Department of Health. Though property owners are permitted to install their own wells, all well-construction regulations apply. Only licensed or registered well contractors may seal a well.

ROCK UNIT	HYDROGEOLOGIC PROPERTIES
QUATERNARY (GLACIAL) DEPOSITS	AQUIFER
DECORAH SHALE	CONFINING UNIT
PLATTEVILLE FORMATION	AQUIFER
GLENWOOD FORMATION	CONFINING UNIT
ST. PETER SANDSTONE	AQUIFER
SHALY BASE	CONFINING UNIT
PRAIRIE DU CHIEN GROUP	FORM A SINGLE AQUIFER
JORDAN SANDSTONE	
ST. LAWRENCE FORMATION	CONFINING UNIT
FRANCONIA FORMATION	FORM A SINGLE AQUIFER
IRONTON, GALESVILLE SANDSTONES	
EAU CLAIRE FORMATION	CONFINING UNIT
MT. SIMON SANDSTONE	AQUIFER
OLDER BEDROCK	UNKNOWN

Figure 1. ***Aquifers and their confining units in Ramsey County.***

WELL-CONSTRUCTION PRACTICES

Variations in drilling, aquifer conditions, and well construction occur throughout Ramsey County because of differences in the bedrock and glacial geology. The data bases on Plate 1 can be used to determine how a well should be constructed on a specific property. All new wells must be located the required isolation distances from contamination sources. Any future changes in the location of such sources, including the installation of a new on-site sewage disposal system, require that the isolation distances from the well be maintained. Furthermore, all wells (including monitoring wells) to be constructed through contamination zones require special construction practices to ensure that they do not serve as conduits to spread contamination to deeper aquifers.

Wells in Unconsolidated Deposits. Many wells in Ramsey County obtain their water from unconsolidated layers of sand and gravel. These wells are usually constructed with a slotted section of pipe or screen attached to the bottom of the casing, to prevent sand from being pumped into the well. The well casing must be adequately sealed or grouted to prevent the entry of contaminants into the well. Screened, steel-cased wells in unconsolidated aquifers need not be grouted with cement if (1) the casing is tightly sealed when driven into the borehole or (2) the annular space between the casing and borehole is sealed with grout or a fine-grained material such as clay to retard the vertical movement of potential contaminants (Fig. 2).

Bedrock Wells. Wells that penetrate only the uppermost bedrock aquifer must have the casing firmly seated into the well by use of a hardened steel collar called a drive shoe or by cement grouting. Wells that penetrate more than one bedrock aquifer must be cement grouted, and the well must not allow water entry from more than one aquifer. The inside casing must extend at least 15 feet into the aquifer being used.

Wells completed in bedrock aquifers must not be extended into underlying confining units. For example, wells completed in the Platteville Formation must not extend through the Glenwood Formation, as this would hydrologically connect the Platteville limestone and the St. Peter Sandstone.

The Platteville Formation and the Prairie du Chien Group are karstic bedrock aquifers. That is, the carbonate rock that makes up these formations is solution-weathered and exhibits enlarged fracture systems, innumerable small cavities, and even large cavities such as caves. Ground water moves quickly through such features, with little filtering of contaminants. The Platteville Formation and the Prairie du Chien Group (Fig. 3) may not be used for potable supply in areas where the minimum 50 feet of unconsolidated deposits, sandstone, or shale does not cover the carbonate rock at the well site and for a one-mile radius around the well site.

Well Depth and Isolation Distances. A well with less than 50 feet of casing must be located twice the normally required isolation distance from cesspools, subsurface disposal fields, manure storage piles, and similar contamination sources unless the well penetrates at least 10 feet of an impermeable material such as clay. Small lots or existing features such as septic systems may require the well to be completed with more than 50 feet of casing.

Grouted Wells. Wells drilled through bedrock must have the casing sealed into the borehole with cement grout. This ensures that the well does not interconnect aquifers along the annulus between the casing and borehole. Figures 3 and 4 summarize the methods of properly completing wells in specific bedrock aquifers; they also show methods that are no longer permitted.

Cartography by Philip Heywood

Partial funding for this project approved by the Minnesota Legislature, M.L. 91 Ch. 254, Art. 1 Sect. 14 Subd. 4(f), as recommended by the Legislative Commission on Minnesota Resources from the Minnesota Environment and Natural Resources Trust Fund

Every possible effort has been made to ensure the accuracy of the factual data on which this map interpretation is based; however, the Minnesota Geological Survey does not warrant or guarantee that there are no errors. Users may wish to verify critical information; sources include both the references listed here and information on file at the offices of the Minnesota Geological Survey in St. Paul. In addition, every effort has been made to ensure that the interpretation conforms to sound geologic and cartographic principles. No claim is made that the interpretation shown is rigorously correct, however, and it should not be used to guide engineering-scale decisions without site-specific verification.

IMPROPERLY CONSTRUCTED WELLS

No county-wide standards for casing or other materials used to construct wells were enforced before implementation of the Minnesota water-well code in 1974. Exceptions to this general lack of regulation were the standards for municipal wells enforced by the Minnesota Department of Health. Most well-construction practices before 1974 were determined by cost, rather than by the need to protect ground-water resources.

Ungrouted wells provide pathways for contaminated ground water to pass into deeper aquifers (Figs. 3 and 4). This is particularly true for bedrock aquifers. Pumping has lowered water levels, and the hydrology of these aquifers has caused each to have a lower head than the overlying aquifer. As a result, wells that interconnect aquifers can channel contaminated ground water to deeper aquifers.

The use of multiple casings that were neither grouted into the borehole nor grouted between each other was common in wells constructed before 1974. Smaller casings were sleeved into larger casings with only a small overlap, giving the construction the configuration of an extended telescope. This is not permitted because such casings cannot be adequately sealed to prevent the movement of water between them. Multiple sets of casing in new wells must be separated from each other to accommodate cement grout. Each casing must extend to the land surface, and the grout must be installed under pressure.

Other wells were cased only to the uppermost bedrock and left as open boreholes to the bottom. Many high-capacity wells, and even domestic wells in some areas, were constructed in this manner, connecting two or more bedrock aquifers. Some of these wells were later recased because soft sandstone and shale caved in and interfered with pumping. The downward movement of ground water caused by the interconnection of aquifers is a cause of borehole erosion and subsequent well failure. Sections of casing that were installed in eroding areas to remedy this situation were rarely grouted in place; they now present additional problems because they must be either removed or perforated to properly seal the well.

SEALING ABANDONED WELLS

Sealing unused (abandoned) wells is a major concern of property owners in Ramsey County, as many parcels have one or more wells on them. Wells no longer in use that do not have maintenance permits must be sealed according to procedures specified by the Minnesota Department of Health. Following the sealing of each well by a licensed well contractor, an abandoned-well record must be submitted to the Minnesota Department of Health. The Groundwater Protection Act of 1989 also requires that the locations of all wells be disclosed at the time of property transfer. Many neighborhoods or businesses that once used individual wells are now serviced by community water systems. These wells may not be properly sealed or may not meet present construction standards. Unsealed or improperly sealed wells may have an adverse impact on the quality of ground water because of their potential to funnel contamination underground.

Unused wells present problems to property owners in terms of the expense and inconvenience of sealing them properly. Debris fills some wells; the pumping equipment has been dropped into others; owners may have attempted to seal wells using procedures unacceptable today; and wells may be difficult to locate and access. Property transfers or new construction may be held up while responsibility for well sealing is determined.

It is important to determine the construction and condition of a well prior to sealing. Geologic conditions and the type of well construction determine how a well must be sealed. For example, ungrouted casings must be removed or perforated to permit proper sealing of bedrock confining units. Check valves, pumps, and debris must be removed before sealing to ensure that the entire length of the well is filled. The water-well information collected for this atlas (Plate 1) gives some indication of how wells were constructed locally.

Sealing Platteville Limestone and St. Peter Sandstone Wells. Thousands of domestic wells constructed into these aquifers may now pose sealing problems for their owners (Fig. 3). Where the Platteville did not supply enough water, it was common practice in pre-1974 wells to extend the borehole into the St. Peter Sandstone. Extra casing, and even a screen in some cases, were added to hold the borehole open and to prevent sand from being pumped. The extra casing can be difficult to remove if it has deteriorated or become sandlocked in the St. Peter. This casing must now be removed or perforated to properly seal the well across the Glenwood Formation confining unit.

Sealing Deeper Bedrock Wells. Prior to 1974, wells completed in aquifers below the St. Peter Sandstone had no standardized construction method (Fig. 4). Wells completed in the Jordan Sandstone were typically cased to the top of the Prairie du Chien Group. If cased to the Jordan, they were rarely grouted. Wells drilled below the Jordan were usually cased only into the Prairie du Chien Group and left as open boreholes, or were of telescoping, ungrouted construction.

Wells of open borehole construction can be sealed in a relatively straightforward manner by pressure grouting from bottom to top. Wells in which the casing was not grouted require that the casing be removed or perforated and the well grouted.

ADDITIONAL INFORMATION

For information about the sealing or construction of wells, contact:

Minnesota Department of Health
Well Management Unit
Minneapolis, MN 55440

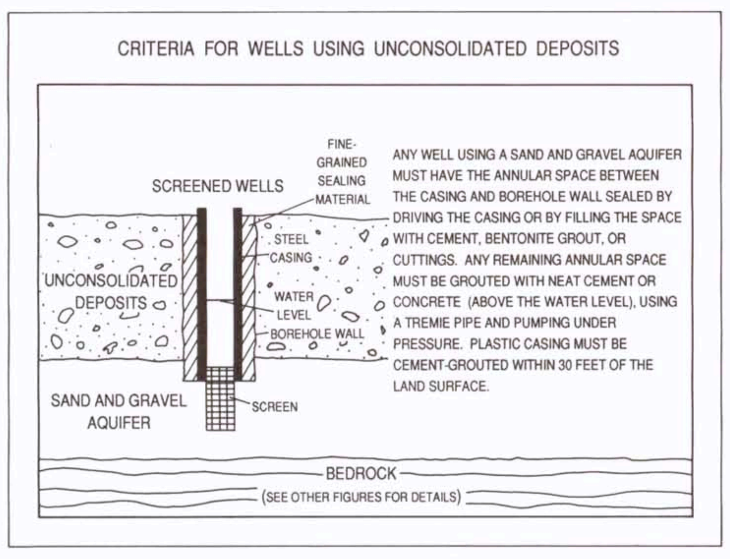


Figure 2. *Criteria for wells using unconsolidated deposits.*

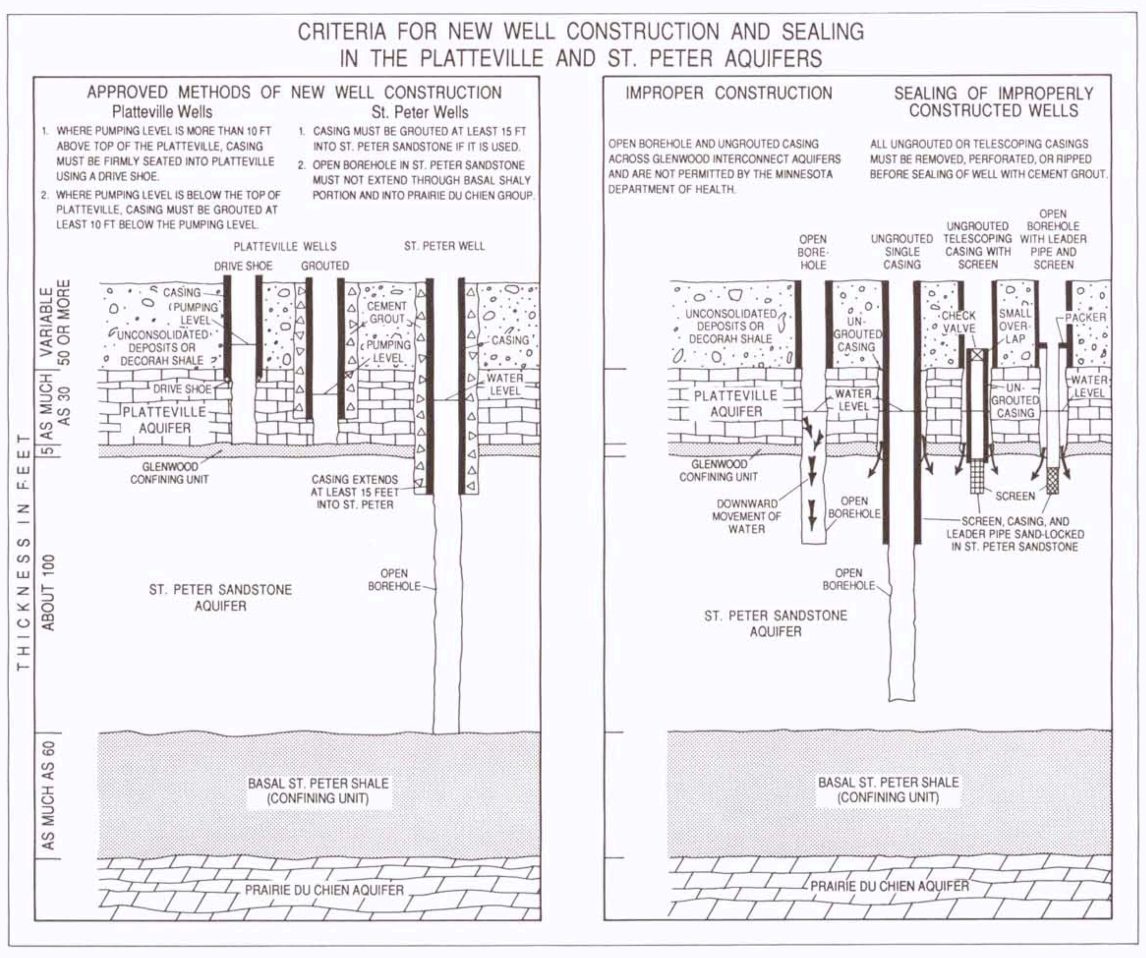


Figure 3. *Criteria for new well construction and sealing in the Platteville and St. Peter aquifers.*

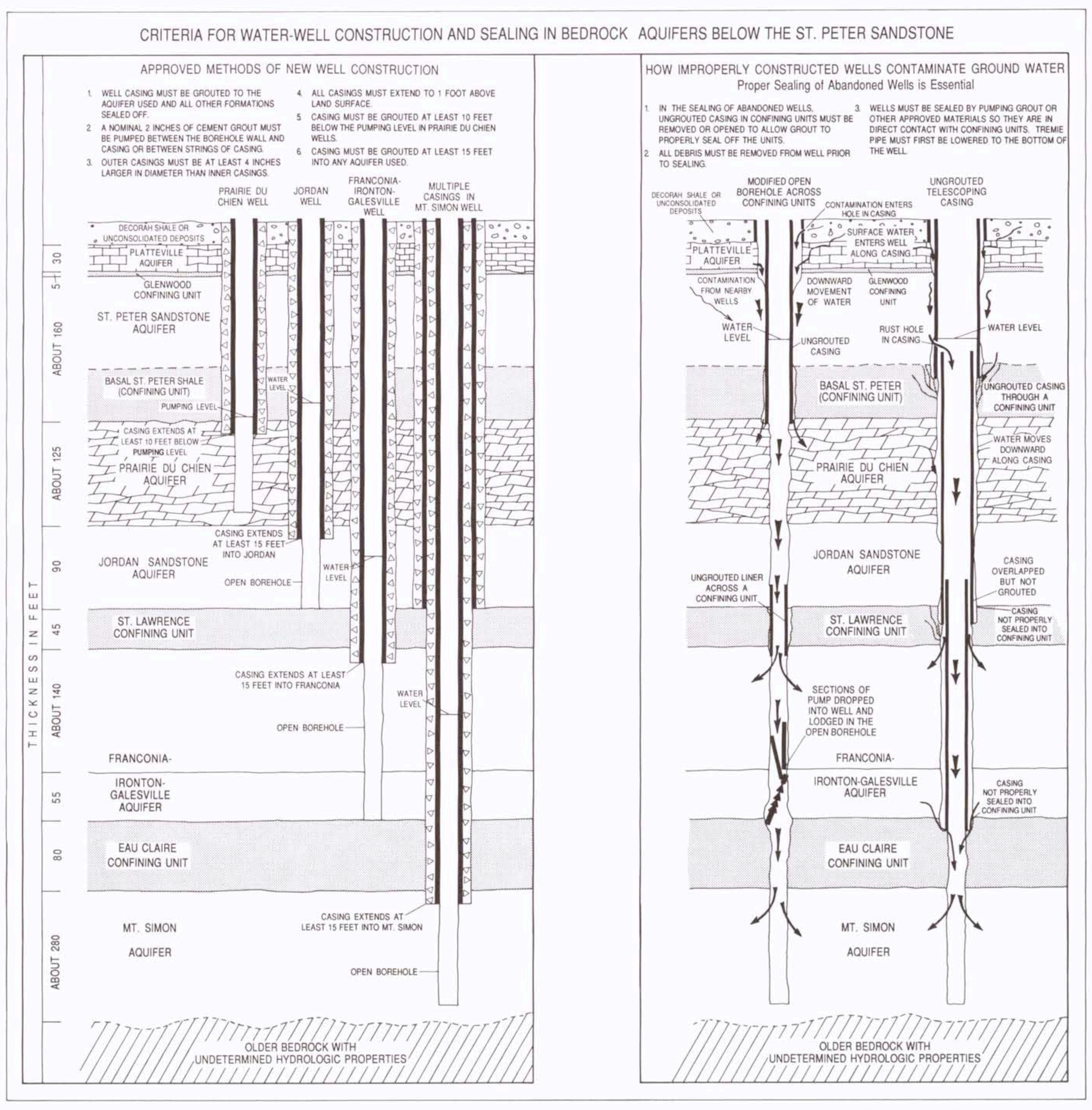


Figure 4. *Criteria for water-well construction and sealing in bedrock aquifers below the St. Peter Sandstone.*