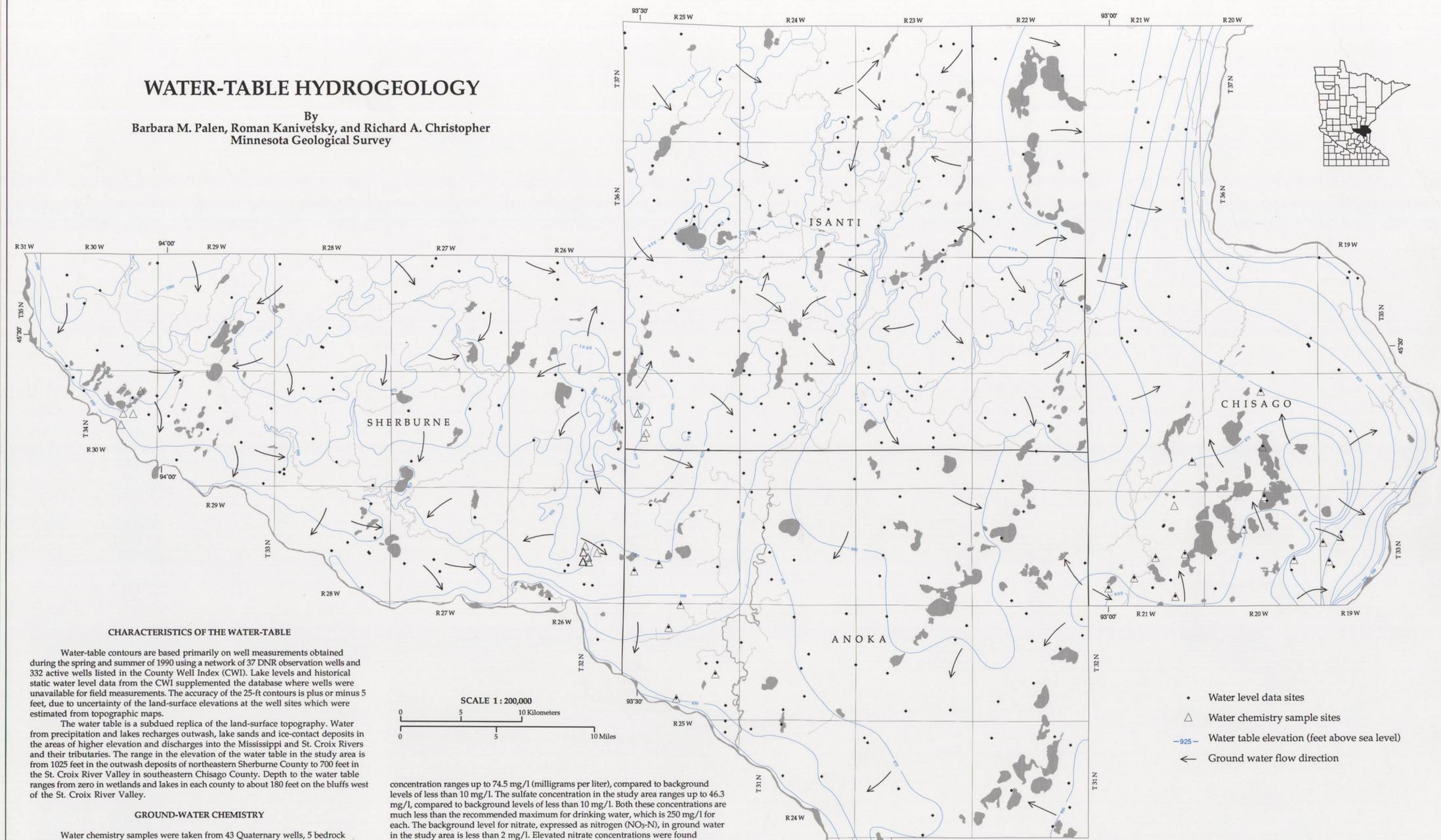


WATER-TABLE HYDROGEOLOGY

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CHARACTERISTICS OF THE WATER-TABLE

Water-table contours are based primarily on well measurements obtained during the spring and summer of 1990 using a network of 37 DNR observation wells and 332 active wells listed in the County Well Index (CWI). Lake levels and historical static water level data from the CWI supplemented the database where wells were unavailable for field measurements. The accuracy of the 25-ft contours is plus or minus 5 feet, due to uncertainty of the land-surface elevations at the well sites which were estimated from topographic maps.

The water table is a subdued replica of the land-surface topography. Water from precipitation and lakes recharges outwash, lake sands and ice-contact deposits in the areas of higher elevation and discharges into the Mississippi and St. Croix Rivers and their tributaries. The range in the elevation of the water table in the study area is from 1025 feet in the outwash deposits of northeastern Sherburne County to 700 feet in the St. Croix River Valley in southeastern Chisago County. Depth to the water table ranges from zero in wetlands and lakes in each county to about 180 feet on the bluffs west of the St. Croix River Valley.

GROUND-WATER CHEMISTRY

Water chemistry samples were taken from 43 Quaternary wells, 5 bedrock wells, 12 surface water bodies, and 2 precipitation sites during the period December 1990 to July 1991. The results were used to evaluate recharge mechanisms and verify the pollution sensitivity map. Water chemistry reports for these sites are available in CWI. The table summarizes the analyses of ground water from wells in Quaternary deposits.

The natural characteristics of ground water in Quaternary deposits in the four-county area are quite similar. Rainwater and melted snow infiltrating into the ground take on mainly calcium, magnesium, and bicarbonate ions from the soil. Consequently, unpolluted ground water is of the calcium-magnesium bicarbonate type. As water moves through the ground, chemical reactions take place that involve the exchange of ions between these dissolved minerals, the Quaternary deposits, and contaminants such as chloride.

The ground water in the study area contains total dissolved solids (TDS) ranging from 173 to 910 ppm (parts per million); the recommended maximum for drinking water is 500 ppm, although less than 300 ppm is desirable for some manufacturing processes. Some shallow wells contain chloride, sulfate, and nitrate concentrations higher than typical background levels, indicating pollution. Background levels represent ground-water conditions prior to human development. The chloride

concentration ranges up to 74.5 mg/l (milligrams per liter), compared to background levels of less than 10 mg/l. The sulfate concentration in the study area ranges up to 46.3 mg/l, compared to background levels of less than 10 mg/l. Both these concentrations are much less than the recommended maximum for drinking water, which is 250 mg/l for each. The background level for nitrate, expressed as nitrogen (NO₃-N), in ground water in the study area is less than 2 mg/l. Elevated nitrate concentrations were found primarily in wells sited in the terrace, outwash, and ice-contact deposits of Sherburne and Isanti Counties. One well, with a concentration of 28.8 mg/l, exceeded the drinking water standard for nitrate-nitrogen of 10 mg/l.

Stable isotopes of hydrogen and oxygen were used to confirm recharge rates and sources. Tritium is an isotope of hydrogen (³H) with a half-life of 12.43 years. Trace amounts occur naturally in the atmosphere, but large amounts were introduced into the environment as a result of atmospheric nuclear testing in the 1950's and 1960's. Tritium (T) > 2 Tritium Units (T.U.) in ground water indicates recharge from precipitation after 1953. The steep potentiometric gradient in upland outwash in northeastern Sherburne County rapidly drives recharge deep into Quaternary deposits, shown by the presence of tritium in nearby wells up to 240 feet deep. The presence of tritium in all sampled wells less than 131 feet deep confirmed the generally higher sensitivity ratings of the water-table aquifer throughout much of the Anoka Sand Plain. The absence of tritium (T < 0.8 T.U.) in ground water from sampled wells greater than 130 feet deep in southern Chisago County confirmed the low or medium sensitivity ratings for buried sands within till and mixed till deposits. Ground-water recharge from lakes in southern Chisago County and western Sherburne County was shown by similar ratios of isotopes of hydrogen and oxygen (²H/¹H)/(¹⁸O/¹⁶O) in lakes and in nearby wells.

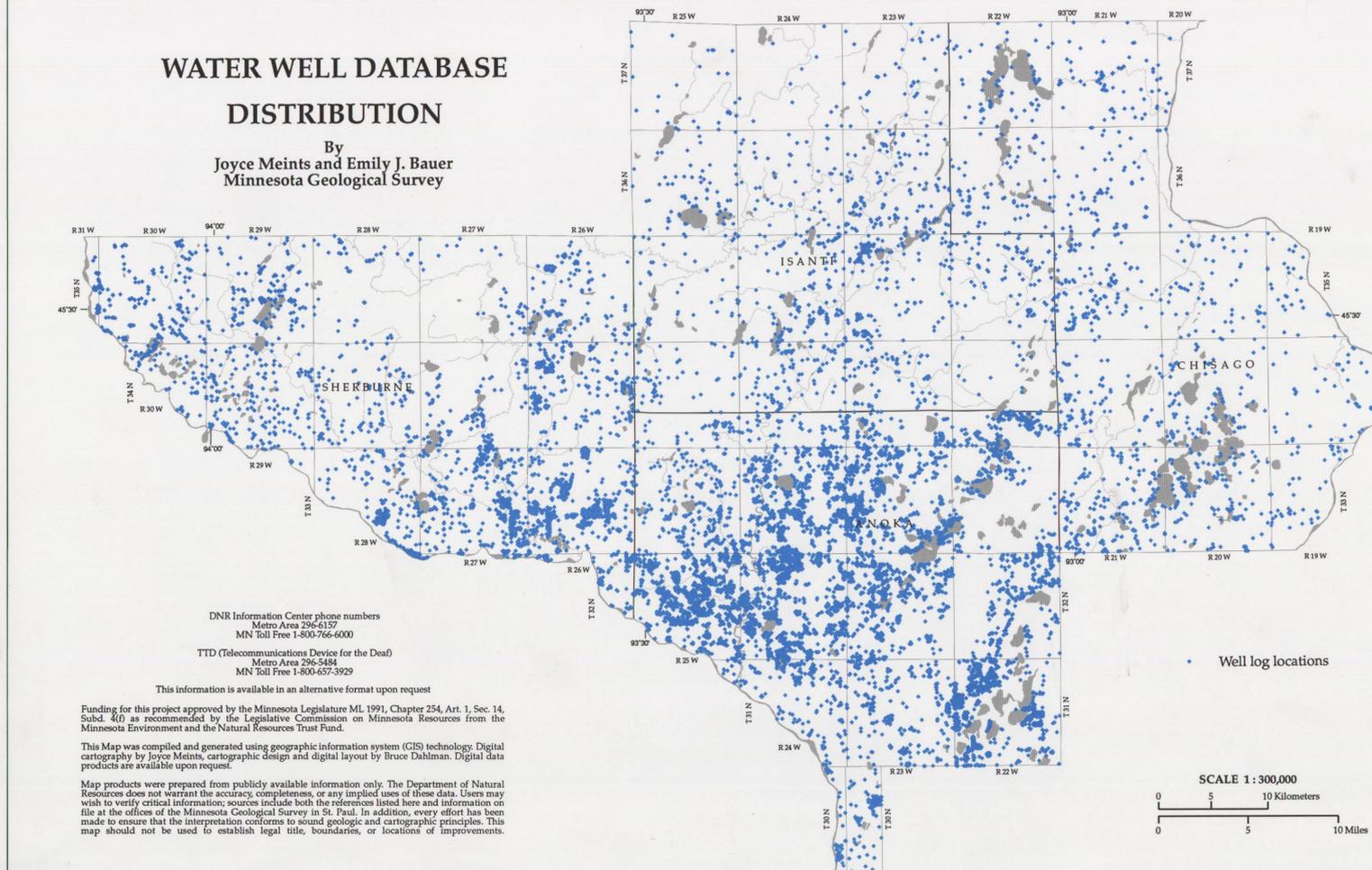
Ground-water Chemistry of the Quaternary Aquifer

Units	Depth in Feet	Temperature °C	pH	Specific Conductance µmhos/cm	Dissolved Oxygen mg/l	Alkalinity as CaCO ₃ mg/l	Ca ²⁺ mg/l	Mg ²⁺ mg/l	Na+K mg/l	K ⁺ mg/l	Fe ²⁺ /3 mg/l	Sr ²⁺ mg/l	Cl ⁻ mg/l	F ⁻ mg/l	NO ₃ -N mg/l	NO ₂ -N mg/l	Total Dissolved Solids Calculation	Tritium T.U.	δ ¹⁸ O‰	δ ² H‰
Number of Wells	43	43	37	43	43	*41	*41	*41	*41	*41	*41	*41	*41	*41	*41	*41	34	28	28	
Minimum	52	5.6	6.97	190	<0.05	97	26.4	6.5	2.1	0.6	<0.06	0.08	0.96	0.05	0.005	173	<0.8	-10	-78.3	
Maximum	330	13.6	8.25	690	12.1	412	139	45.7	13.8	23.8	0.63	46.3	74.5	0.54	28.8	910	92	-1.92	-27.7	
Median	114	9.5	7.45	450	1.25	219	58.8	21.8	3.5	1.6	0.07	13.9	7.14	0.16	0.13	388	31.6	-7.5	-62.7	

* 2 wells excluded due to water softeners.

WATER WELL DATABASE DISTRIBUTION

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WELL LOG BASE MAP

The locations and density of well driller's logs used to prepare this regional assessment are shown on the well log base map. This map serves as a guide to the interpretation and use of the other maps in the study. Although nearly 13,000 well driller's logs were used for this assessment, distribution of the logs is uneven. Sixty percent of the logs are located in Anoka County, 23 percent in Sherburne County and nine and eight percent in Chisago and Isanti Counties, respectively. Where few logs are available to provide subsurface information, geologists interpreted the occurrence of surface and subsurface materials using the available logs and their knowledge of the area.

WELL DRILLER'S LOGS

A well driller's log is a record of the drilling and construction of a water well. It is the water well contractor's description of the geologic materials penetrated during drilling and construction materials used to complete the well. Well driller's logs are the primary source of subsurface geologic and hydrologic data for this regional assessment. Hydrologic data, such as the static water level and test-pumping results, are commonly included in well logs. Before any well driller's log was used as a source of data for the assessment the location of the well was verified by visiting the site of each well. After the location was field checked, a geologist reviewed each log and interpreted the geology from the driller's description.

COUNTY WELL INDEX

The data on the well driller's logs are available using a combined computer program and data base known as County Well Index. County Well Index (CWI) enables the storage, retrieval and manipulation of large amounts of well log data. Developed by the Minnesota Geological Survey, CWI is designed to run on IBM-compatible personal computers. Each well is assigned a six-digit unique number that is used to reference all data concerning the well. Unique numbers are used by local, state and federal agencies, as well as driller's and consultants, to refer unambiguously to a specific well. The location of each well was digitized from topographic maps. Elevation of the land surface at the well sites were also determined from these maps. This data are included with the well driller's log and any other available information, such as street address and water chemistry, in CWI. The CWI program allows easy access to the data through flexible interactive browsing and report generation.

DNR Information Center phone numbers
Metro Area 296-6157
MN Toll Free 1-800-766-6000
TTD (Telecommunications Device for the Deaf)
Metro Area 296-5484
MN Toll Free 1-800-657-3929
This information is available in an alternative format upon request

Funding for this project approved by the Minnesota Legislature ML 1991, Chapter 254, Art. 1, Sec. 14, Subd. 40 as recommended by the Legislative Commission on Minnesota Resources from the Minnesota Environment and the Natural Resources Trust Fund.

This Map was compiled and generated using geographic information system (GIS) technology. Digital cartography by Joyce Meints, cartographic design and digital layout by Bruce Dahlman. Digital data products are available upon request.

Map products were prepared from publicly available information only. The Department of Natural Resources does not warrant the accuracy, completeness, or any implied uses of these data. 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. This map should not be used to establish legal title, boundaries, or locations of improvements.

