Defining background conditions of water quality is important for water and land managers in assessing the effects of human activities, such as land use, on water resources. The background dissolved solids in rivers and ground water in the Red River Basin Study Unit include the major cations (calcium, magnesium, sodium, and potassium), the major anions (bicarbonate, chloride, and sulfate), trace elements (including iron and manganese), and radionuclides (uranium, radium, and radon). The most common ions in ground water from surficial and buried glacial aquifers are calcium, magnesium, and bicarbonate, all of which are at fairly low concentrations. Median dissolved solids are about 400 milligrams per liter (mg/L) for surficial glacial aquifers and 500 mg/L for buried glacial aquifers. Common ions in deeper bedrock aquifers are sodium and chloride (the components of table salt) and are at much higher concentrations (median dissolved-solids concentration about 1,900 mg/L).

Ground-water studies in the Study Unit demonstrated that water quality in surficial aquifers in the west and central subregions is significantly different than that in the southeast subregion (Cowdery, in press). These differences are in the concentrations of dissolved solids, sodium, sulfate, silica, potassium, uranium, and radium. The west and central subregions have higher concentrations of all of these ions except radium, which is higher in the east. Variations in water quality are related to natural differences in geology and hydrology. Saline sedimentary bedrock aquifers exist mostly in the western part of the Study Unit (fig. 6). Most of the eastern part is underlain by crystalline rocks that do not readily transmit water and were not considered for this study. The sedimentary bedrock aquifers slope gently upward to the east, in the direction of regional ground-water flow. Saline water from these aquifers is primarily discharged in the north-central part of the Study Unit. Saline ground water from deep aquifers seeping into some shallow buried and surficial aquifers in the west and central subregions can affect the quality and use of water in these aquifers. This saline ground water also can discharge into streams and degrade water quality in the northwestern part of the Study Unit. This effect can be greatest during periods of extremely low streamflow.

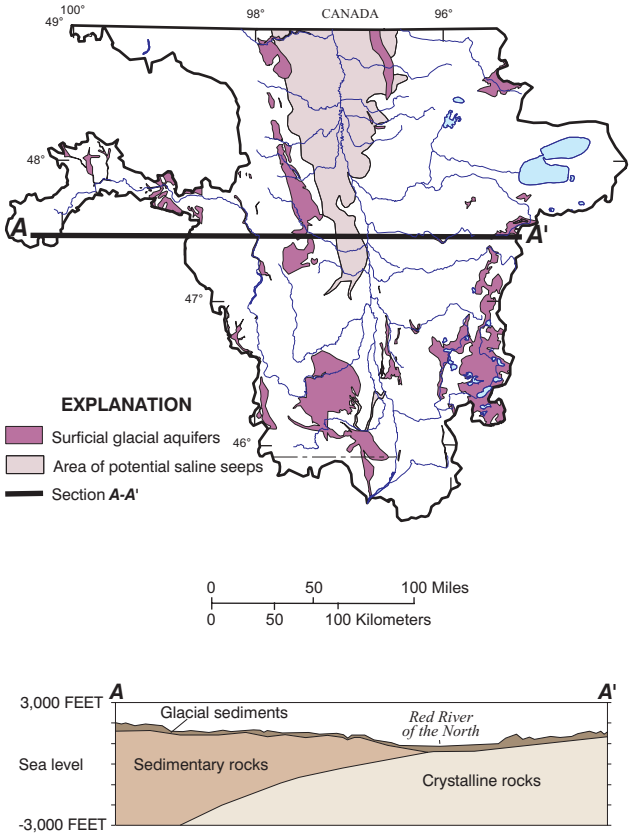

Figure 6. Surficial aquifers are in glacial sediments throughout the Study Unit. Saline ground water in sedimentary rocks can seep to the land surface.

The middle part of the Wild Rice River in Minnesota shows the relatively common undisturbed land in the southeastern subregion.

Most water in the Red River Basin Study Unit is safe to drink according to U.S. Environmental Protection Agency (USEPA) standards for natural constituents (dissolved solids, major ions, and radionuclides).

Some constituents of ground water in the Study Unit exceeded USEPA drinking-water standards (table1). These standards were exceeded in concentrations of primarily naturally occurring substances. Iron and manganese, which commonly occur in soluble minerals within glacial sediments, result in numerous exceedances of secondary maximum contaminant levels for these constituents in ground water. Radon concentrations were relatively consistent across the Study Unit. There is now no standard for radon in drinking water. USEPA withdrew the previous standard of 300 picocuris per liter (pCi/L) pending further review. More shallow ground water in the west and central subregions exceeds standards than does ground water in the southeast subregion (table 1). More water from buried sand and gravel aquifers exceeds standards than does water in surficial aquifers. In fact, more than 50 percent of the water in buried sand and gravel aquifers sampled exceeded the dissolved-solids standard and ranked among the highest nationally (p. 21). Although nitrate does occur naturally in ground water, background concentrations were not established in this study. Ground-water nitrate concentrations ranked among the lowest nationally (p. 20).

The distribution and concentration of major ions in streams appeared related to subregions in the Red River Basin Study Unit (Tornes and others, 1997). Historically, water in the Red River had mean dissolved-solids concentrations of 347 mg/L near the headwaters and 406 mg/L at the international boundary near Emerson, Manitoba (Stoner and others, 1993). The median dissolved-solids concentration at Emerson, Manitoba, was 419 mg/L during 1993–95 (Tornes and others, 1997), a period of relatively high streamflow conditions. With limited area of undisturbed land in the Red River Basin Study Unit, background conditions in stream-water quality were not definable.

Fish communities and stream habitat can be indicators of overall stream quality. For example, greater fish species diversity and abundance coincide with higher quality streams. Fish diversity and abundance in the streams of the Study Unit are influenced by human and natural factors (Goldstein and others, 1996b). Three factors explain about 60 percent of the variability in fish distribution: (1) the abundance and diversity of fish habitat within a stream, (2) the variability in the amount of water in the stream, and (3) the amount of relatively undisturbed land (forest or wetland) within about a mile of a stream. Habitat and stream variability are mostly natural factors, although both are influenced by human activities. Other factors considered in this study, such as number of dams, amount of drainage ditches, or width of riparian buffer zones, appear to have less effect on variability in fish distribution and abundance (Goldstein and others, 1996b).

Table 1. Some U.S. Environmental Protection Agency drinking-water standards and health advisories were exceeded frequently in ground water in the Red River Basin Study Unit

[Green area, maximum contaminant level; yellow area, secondary maximum contaminant level; mg/L, milligrams per liter; pCi/L, picocuries per liter]

Constituent	U.S. Environmental Protection Agency standards and health advisories	Percentage of ground-water samples exceeding standard or advisory				
		Glacial aquifer type		Subregion		
		Buried	Surficial	West	Central	Southeast
Dissolved solids, in mg/L	500	52	23	33	38	0
Sodium, in mg/L	[1]20	82	21	27	33	4
Chloride, in mg/L	250	9	0	0	0	0
Sulfate, in mg/L	500	6	3	7	4	0
Sulfate, in mg/L	250	12	5	7	7	0
Fluoride, in mg/L	[2]2	0	0	0	0	0
Iron, in mg/L	0.3	82	48	13	52	64
Manganese, in mg/L	0.05	82	79	80	85	72
Uranium, in mg/L	[3]0.02	0	5	7	8	0
Radium, in mg/L	[3]0.005	0	0	0	0	0
Radon, in pCi/L	[4]300	50	66	60	64	64

[1]Health advisory.
[2]Under review.
[3]Proposed.
[4]Historical, under review.