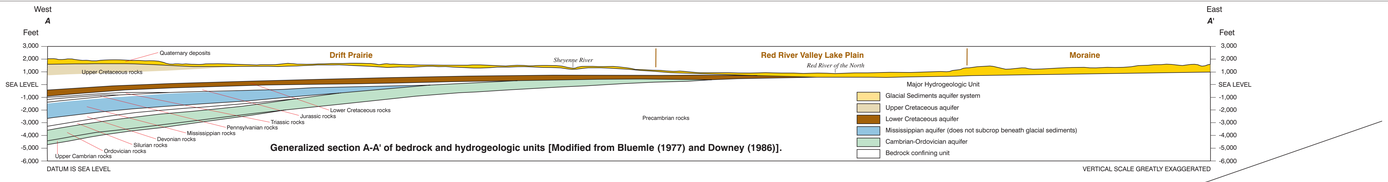
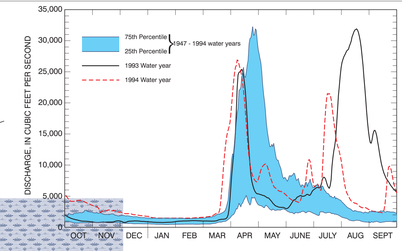


Generalized section A-A' of bedrock and hydrogeologic units [Modified from Bluemle (1977) and Downey (1986)].



Daily discharge at Red River at Emerson, Man.

Table 4. Coverage of sampling sites within the environmental framework and stratification, 1993-95.

Percent of study unit in this physiographic area-soil group framework. Numbers do not total 100 percent because open water was not included.

Sampling sites in stratum:

3 (c)
ECO-1
SW-5
SUS, LUS

Major land cover and land use:

(a) cropland and pasture
(c) forest
(d) wetland

SW-ECO-n, n is the number of co-located indicator chemistry and ecological sites.
SW-n, n is the number of indicator chemistry sites.
ECO-n, n is the number of ecological sites.
LUS, the wells used for land-use study.
SUS, the wells used for study unit survey.

Physiographic area	Soil group					
	1	2	3	4	5	6
A	12 (a) SW-ECO-3 ECO-3	12 (a) SW-ECO-3	0	0	6 (a) SUS	0
B	26 (a)	0	0	17 (a) SW-ECO-1 LUS SUS	2 (a)	0
C	0	0	5 (d)	2 (c) SW-ECO-1 ECO-1	0	0
D	2 (a) SW-.5	5 (a) ECO-1	0	1 (c) ECO-1.5	3 (c) SW-ECO-1 SW-1 ECO-1.5	3 (c) ECO-1 SW-5 SUS, LUS

[1] Two sites represent A1, 2 sites represent A2, and there are 2 sites that represent characteristics common to A1 and A2, averaging 3 sites to each stratum.

[2] This site represents D1 and D5.

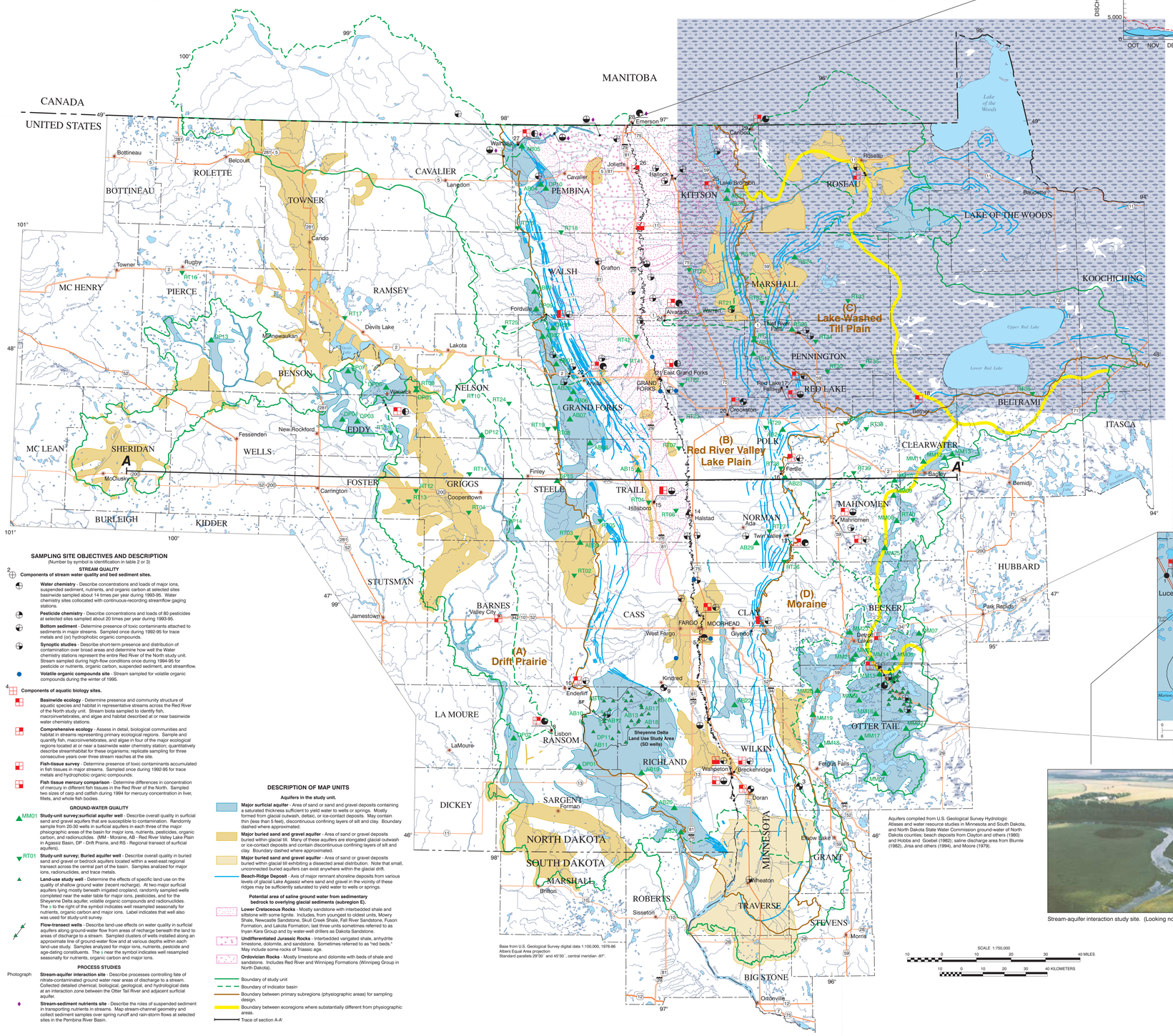
[3] One site represents D4 exclusively and 1 site represents D4 and D5, averaging 1.5 ecological sites for this stratum.

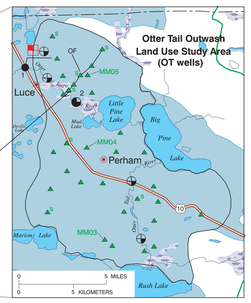
[4] Two sites represent D5 and D6, averaging 1 ecological site for this stratum.

[5] Two sites represent this stratum, another one represents D1 and D5, and the other represents D5 and D6.

[6] This site represents D5 and D6, averaging .5 sites for this stratum.

[7] Three ecological sites represent this stratum, another one represents D4, and 2 represent D6, averaging 1.5 sites for this stratum.





Stream-aquifer interaction study site. (Looking northeast)

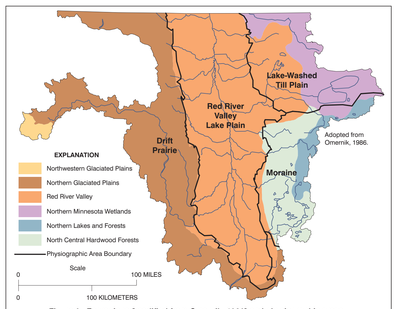


Figure 6. Ecoregions [modified from Omernik, 1986] and physiographic areas of the Red River of the North Basin Study Unit

SAMPLING SITE OBJECTIVES AND DESCRIPTION

(Number by symbol is identification in table 2 or 3)

STREAM QUALITY

2 **Components of stream water quality and bed sediment sites.**

Water chemistry - Describe concentrations and loads of major ions, suspended sediment, nutrients, and organic carbon at selected sites basinwide sampled about 14 times per year during 1993-95. Water chemistry sites collocated with continuous-recording streamflow gaging stations.

Pesticide chemistry - Describe concentrations and loads of 80 pesticides at selected sites sampled about 20 times per year during 1993-95.

Bottom sediment - Determine presence of toxic contaminants attached to sediments in major streams. Sampled once during 1992-95 for trace metals and (or) hydrophobic organic compounds.

Synoptic studies - Describe short-term presence and distribution of contamination over broad areas and determine how well the Water chemistry stations represent the entire Red River of the North study unit. Stream sampled during high-flow conditions once during 1994-95 for pesticide or nutrients, organic carbon, suspended sediment, and streamflow.

Volatile organic compounds site - Stream sampled for volatile organic compounds during the winter of 1995.

4 **Components of aquatic biology sites.**

Basinwide ecology - Determine presence and community structure of aquatic species and habitat in representative streams across the Red River of the North study unit. Stream biota sampled to identify fish, macroinvertebrates, and algae and habitat described at or near basinwide water chemistry stations.

Comprehensive ecology - Assess in detail, biological communities and habitat in streams representing primary ecological regions. Sample and quantify fish, macroinvertebrates, and algae in four of the major ecological regions located at or near a basinwide water chemistry station; quantitatively describe stream habitat for these organisms; replicate sampling for three consecutive years over three stream reaches at the site.

Fish-tissue survey - Determine presence of toxic contaminants accumulated in fish tissues in major streams. Sampled once during 1992-95 for trace metals and hydrophobic organic compounds.

Fish tissue mercury comparison - Determine differences in concentration of mercury in different fish tissues in the Red River of the North. Sampled two sizes of carp and catfish during 1994 for mercury concentration in liver, fillets, and whole fish bodies.

GROUND-WATER QUALITY

MM01 **Study-unit survey;surficial aquifer well** - Describe overall quality in surficial sand and gravel aquifers that are susceptible to contamination. Randomly sample from 20-30 wells in surficial aquifers in each three of the major phsiographic areas of the basin for major ions, nutrients, pesticides, organic carbon, and radionuclides. (MM - Moraine, AB - Red River Valley Lake Plain in Agassiz Basin, DP - Drift Prairie, and RS - Regional transect of surficial aquifers).

RT01 **Study-unit survey; Buried aquifer well** - Describe overall quality in buried sand and gravel or bedrock aquifers located within a west-east regional transect across the central part of the basin. Samples analized for major ions, radionuclides, and trace metals.

Land-use study well - Determine the effects of specific land use on the quality of shallow ground water (recent recharge). At two major surficial aquifers lying mostly beneath irrigated cropland, randomly sampled wells completed near the water table for major ions, pesticides, and for the Sheyenne Delta aquifer, volatile organic compounds and radionuclides. The n to the right of the symbol indicates well resampled seasonally for nutrients, organic carbon and major ions. Label indicates that well also was used for study-unit survey.

Flow-transect wells - Describe land-use effects on water quality in surficial aquifers along ground-water flow from areas of recharge beneath the land to areas of discharge to a stream. Sampled clusters of wells installed along an approximate line of ground-water flow and at various depths within each land-use study. Samples analyzed for major ions, nutrients, pesticide and age-dating constituents. The n near the symbol indicates well resampled seasonally for nutrients, organic carbon and major ions.

Photograph **Stream-aquifer interaction site** - Describe processes controlling fate of nitrate-contaminated ground water near areas of discharge to a stream. Collected detailed chemical, biological, geological, and hydrological data at an interaction zone between the Otter Tail River and adjacent surficial aquifer.

Stream-sediment nutrients site - Describe the roles of suspended sediment in transporting nutrients in streams. Map stream-channel geometry and collect sediment samples over spring runoff and rain-storm flows at selected sites in the Pembina River Basin.

DESCRIPTION OF MAP UNITS

Aquifers in the study unit.

Major surficial aquifer - Area of sand or sand and gravel deposits containing a saturated thickness sufficient to yield water to wells or springs. Mostly formed from glacial outwash, deltaic, or ice-contact deposits. May contain thin (less than 5 feet), discontinuous confining layers of silt and clay. Boundary dashed where approximated.

Major buried sand and gravel aquifer - Area of sand or gravel deposits buried within glacial till. Many of these aquifers are elongated glacial outwash or ice-contact deposits and contain discontinuous confining layers of silt and clay. Boundary dashed where approximated.

Major buried sand and gravel aquifer - Area of sand or gravel deposits buried within glacial till exhibiting a dissected areal distribution. Note that small, unconnected buried aquifers can exist anywhere within the glacial drift.

Beach-Ridge Depoait - Axis of major remnant shoreline deposits from various levels of glacial Lake Agassiz where sand and gravel in the vicinity of these ridges may be sufficiently saturated to yield water to wells or springs.

Potential area of saline ground water from sedimentary bedrock to overlying glacial sediments (subregion E).

Lower Cretaceous Rocks - Mostly sandstone with interbedded shale and siltstone with some lignite. Includes, from youngest to oldest units, Mowry Shale, Newcastle Sandstone, Skull Creek Shale, Fall River Sandstone, Fuson Formation, and Lakota Formation; last three units sometimes referred to as Inyan Kara Group and by water-well drillers as Dakota Sandstone.

Undifferentiated Jurassic Rocks - Interbedded varigated shale, anhydrite limestone, dolomite, and sandstone. Sometimes referred to as "red beds." May include some rocks of Triassic age.

Ordovician Rocks - Mostly limestone and dolomite with beds of shale and sandstone. Includes Red River and Winnipeg Formations (Winnipeg Group in North Dakota).

Boundary of study unit
Boundary of indicator basin
Boundary between primary subregions (physiographic areas) for sampling design.
Boundary between ecoregions where substantially different from physiographic areas.
Trace of section A-A'

Base from U.S. Geological Survey digital data 1:100,000, 1976-86
Albers Equal Area projection
Standard parallels 29°30' and 45°30' , central meridian -97°.

Aquifers compiled from U.S. Geological Survey Hydrologic Atlases and water resource studies in Minnesota and South Dakota, and North Dakota State Water Commission ground-water of North Dakota counties; beach deposits from Clayton and others (1980) and Hobbs and Goebel (1982); saline discharge area from Blumle (1982), Jirsa and others (1994), and Moore (1979).

SCALE 1:750,000

Figure 5. Sampling sites and generalized section in the Red River of the North Basin study unit.