Contents

Abstract 1
Introduction 1
Environmental setting 1
Use and sources of nutrients, sediment, and pesticides 5
Purpose and scope 9
Method of data review 10
Data sources 11
Acknowledgments 11
Nutrients 11
Surface water 14
Nitrogen 14
Phosphorus 24
Seasonality of nutrient concentrations 27
Nutrient loading 27
Ground water 32
Suspended sediment 35
Pesticides 37
Surface water 39
Ground water 53
Fish tissues 56
Summary 58
References 59

Illustrations

Figure 1-5. Maps showing:

1. Red River of the North Basin and physiographic areas 2
2. Major surficial and buried sand and gravel aquifers in glacial drift in the Red River of the North Basin 4
3. Estimated total nitrogen applied as fertilizer for counties in and near the Red River of the North Basin 7
4. Estimated total phosphorus applied as fertilizer for counties in and near the Red River of the North Basin 7
5. Stream sampling sites and atmospheric deposition monitoring sites in the Red River of the North Basin 15

6-14. Graphs showing:

6. Distribution of sample-collection dates for selected U.S. Geological Survey stream sites in the Red River of the North Basin 18
7. Distribution of total nitrogen concentrations for selected U.S. Geological Survey stream sites in the Red River of the North Basin 19

Illustrations--Continued

6-14. Graphs showing (continued):

8. Distributions of (A) nitrite plus nitrate nitrogen, (B) ammonia nitrogen, and (C) total ammonia plus organic nitrogen concentrations for selected U.S. Geological Survey stream sites in the Red River of the North Basin 20

9. Distributions of (A) total nitrogen, (B) nitrite plus nitrate nitrogen, (C) ammonia plus organic nitrogen (TKN), and (D) nitrogen ammonia concentrations for selected U.S. Environmental Protection Agency STOrage and RETrieval stream sites in the Red River of the North Basin..... 22

10. Distributions of (A) total phosphorus and (B) dissolved phosphorus concentrations for selected U.S. Geological Survey stream sites in the Red River of the North Basin..... 25

11. Distribution of total phosphorus concentrations for selected U.S. Environmental Protection Agency STOrage and RETrieval stream sites in the Red River of the North Basin..... 26

12. Distributions of (A) total nitrogen, (B) nitrite plus nitrate nitrogen, and (C) total ammonia nitrogen concentrations for the Red River of the North at Emerson, Manitoba..... 28

13. Ammonia nitrogen concentrations in the Roseau River at Caribou, Minnesota and Gardenton, Manitoba..... 29

14. Monthly distribution of total phosphorus concentrations for Environment Canada stream sites for (A) Red River at Emerson and (B) Roseau River at Gardenton, Manitoba..... 30

15. Map showing water wells sampled for nutrient concentrations in or near the Red River of the North Basin..... 33

16-21. Graphs showing:

16. Nitrate nitrogen concentrations in water wells in North Dakota counties in the Red River of the North Basin 34

17. Distribution of nitrate nitrogen concentrations in water wells in Minnesota counties in the Red River of the North Basin for (A) U.S. Environmental Protection Agency STOrage and RETrieval data and (B) U.S. Geological Survey data 35

18. Distribution of nitrate nitrogen concentrations for shallow and deep water wells..... 36

19. Relation between suspended-sediment and suspended-solids concentrations 37

20. Distribution of suspended-sediment concentrations for selected stream sites in the Red River of the North Basin..... 38

Illustrations--Continued

16-21. Graphs showing (continued):

21. Distributions of 2,4-D concentrations for selected U.S. Geological Survey stream sites in the Red River of the North Basin (1968-82): (A) all sites, (B) Red River and tributaries, and (C) by month 40

22. Map showing stream sampling sites for Minnesota Pollution Control Agency survey of pesticides in water and bottom sediments, 1977-79 43

23-26. Graphs showing:

23. Distribution of 2,4-D concentrations for Environment Canada stream sites (1975-90) (A) by month at the Red River of the North at Emerson, Manitoba, and (B) by month at the Roseau River at Gardenton, Manitoba, and (C) both sites 48

24. Distributions of (A) gamma-hexachlorocyclohexane (γ-HCH) and (B) alpha-hexachlorocyclohexane (α-HCH) for the Red River of the North at Emerson, Manitoba and Roseau River at Gardenton, Manitoba; monthly distribution of α-HCH concentrations for (C) Red River of the North at Emerson, Manitoba and (D) Roseau River at Gardenton, Manitoba, Environment Canada sites (1975-90) 49

25. Concentrations of alpha-hexachlorocyclohexane (α-HCH) versus time for the Environment Canada (1975-1990) stream sites at the (A) Red River of the North at Emerson, Manitoba, and (B) Roseau River at Gardenton, Manitoba 50

26. Atrazine concentrations for Environment Canada stream sites at the Red River of the North at Emerson (1986-90) and Roseau River at Gardenton, Manitoba (1988-90): (A) distribution at both sites, and concentration by month, (B) Red River of the North, and (C) Roseau River 52

27. Map showing water wells sampled for pesticide concentrations in or near the Red River of the North Basin 54

28. Graph showing tissue concentrations of *p,p'*-DDT and its degradation products *p,p'*-DDE and *p,p'*-DDD in sauger *(Stizostedion canadense)* from the Red River of the North at Noyes, Minnesota 57

Tables

Table 1. Estimates of nitrogen and phosphorus application for counties in the Red River of the North Basin 6

2. Pesticide applications in North Dakota for 1989 8

3. Relative area of herbicide and insecticide applications for Minnesota counties in the Red River of the North Basin, 1989 9

Tables--Continued

4. Sources of water-quality data for the Red River of the North Basin 12

5. Stream sites sampled for analysis of nutrients, suspended sediment, and pesticides..... 16

6. Average annual distance-weighted load of ammonia and nitrate nitrogen to the geographic center of the Red River of the North Basin study unit, 1984-90..... 24

7. Estimated total dissolved nitrogen and total phosphorus loads at Red River of the North at Emerson, Manitoba (Environment Canada data) 31

8. Summary of U.S. Geological Survey pesticide data from all surface-water sites, in the Red River of the North Basin, 1968-82..... 41

9. Summary of Minnesota Pollution Control Agency pesticide data from all surface-water sites in the Red River of the North Basin (from STORET data base), 1967-79..... 42

10. Summary of pesticide data for treated and untreated stream water from four drinking-water treatment plants in the Red River of the North Basin; data from U.S. Environmental Protection Agency Drinking Water Survey, February 1975..... 44

11. Summary of Environment Canada pesticide data for the Red River of the North at Emerson, Manitoba..... 46

12. Summary of Environment Canada pesticide data for the Roseau River at Garden, Manitoba 47

13. Summary of U.S. Geological Survey pesticide data for ground-water samples in the Red River of the North Basin, 1979-90..... 55

14. Minnesota Pollution Control Agency pesticide concentration data for ground-water samples collected in and near the Red River of the North Basin 55

15. Pesticides and their reporting limits for Minnesota Department of Health community well water system survey, 1986-91 55

16. Pesticides and reporting limits for ground water pesticide surveys in Minnesota by (A) Minnesota Department of Health, (B) Minnesota Department of Agriculture, and (C) Minnesota Department of Health 56

Conversion Factors

Multiply	By	To obtain
inch (in.)	25.4	millimeter
foot (ft)	.3048	meter
square mile (mi^2)	2.590	square kilometer
cubic foot per second (ft^3/s)	.02832	cubic meter per second
quart (qt)	.9464	liter
ounce, fluid (fl. oz)	.2957	liter
pound, avoirdupois (lb)	4.536	kilogram

Temperatures given in this report in degrees Fahrenheit (°F). Celsius (°C) can be converted to degrees Fahrenheit as follows:

$$°C = (°F - 32)/1.8$$