Hydrologic Benchmark Network Stations in the West-Central U.S. 1963-95 (USGS Circular 1173-C)

Abstract and Map Index	List of all HBN Stations	Introduction to Circular	Analytical Methods

Little Vermillion River near Salem, South Dakota (06478540)

This report details one of the approximately 50 stations in the Hydrologic Benchmark Network (HBN) described in the four-volume U.S. Geological Survey Circular 1173. The suggested citation for the information on this page is:

Mast, M.A., and Turk, J.T., 1999, Environmental characteristics and water quality of Hydrologic Benchmark Network stations in the West-Central United States, 1963–95: U.S. Geological Survey Circular 1173–C, 105 p.

All of the tables and figures are numbered as they appear in each circular. Use the navigation bar above to view the abstract, introduction and methods for the entire circular, as well as a map and list of all of the HBN sites. Use the table of contents below to view the information on this particular station.

Table of Contents

Site Characteristics and Land Use

The Little Vermillion River HBN Basin lies in the Western Lake section of the Central Lowland physiographic province (Fenneman, 1946) in eastern South Dakota (Figure 23. *Map showing study area in Little Vermillion River Basin and photograph of the Little Vermillion River in the upper basin*). The HBN station is about 8 km northeast of Salem, S. Dak., at a latitude of 43×47'39" and a longitude of 97×22'02". The Little

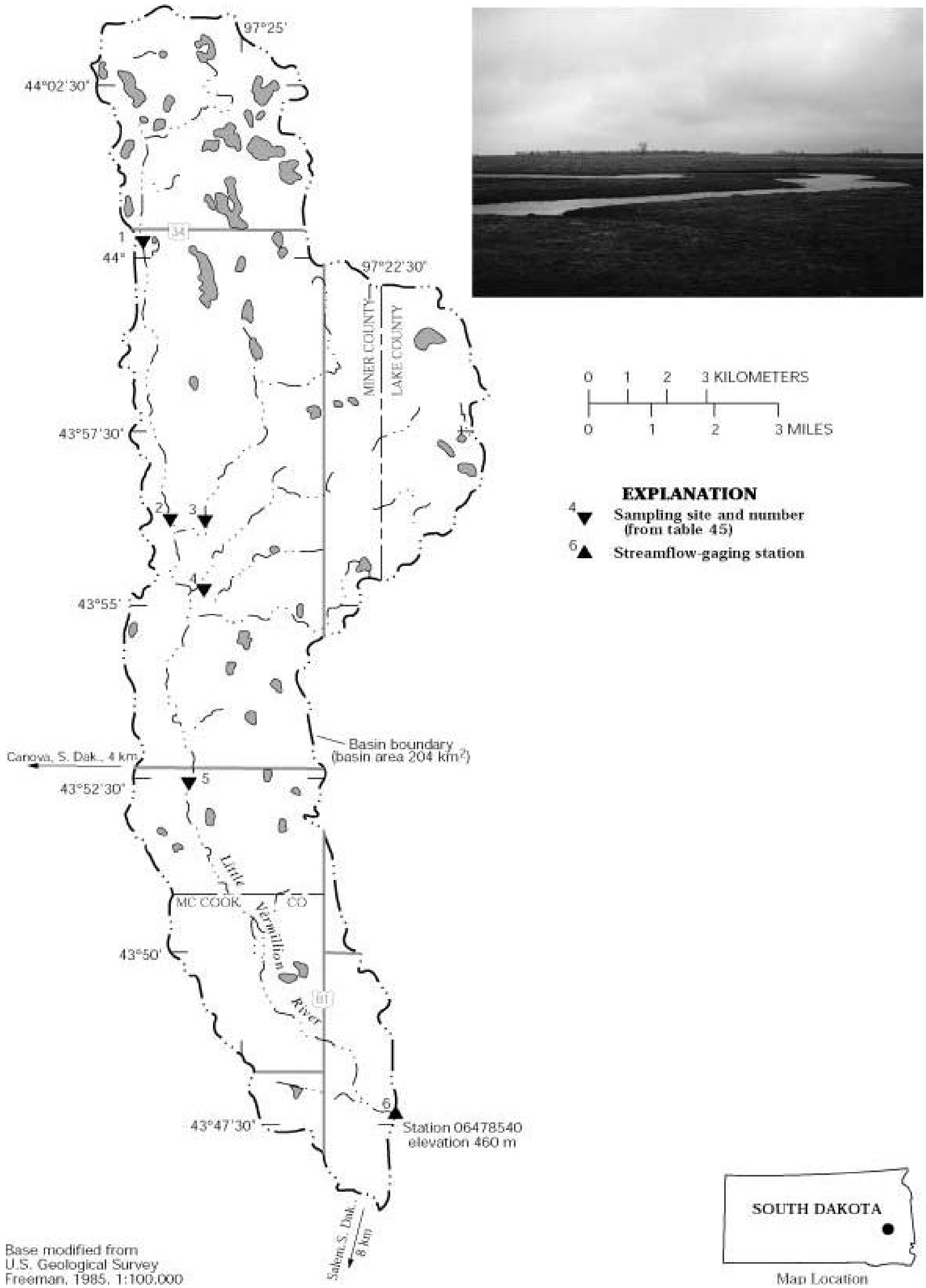

Figure 23. *Map showing study area in Little Vermillion River Basin and photograph of the Little Vermillion River in the upper basin*

Vermillion River drains about 204 km^2 of glaciated plain and is tributary to East Fork Vermillion River in the Lewis and Clark River Basin. The basin is rather flat, with elevations that range from 460 to 497 m, and has numerous shallow lakes. The slope of the main channel is about 1 m/km. The basin is in the transition region between the Great Plains Steppe Province and the Prairie Parkland (Temperate) Province (Bailey, 1995). About 90 percent of the basin is under cultivation, and the remaining area is covered with a moderately dense growth of prairie grass (Cobb and Biesecker, 1971). Trees are planted as shelterbelts around farmsteads.

The Little Vermillion River is an intermittent stream. No flow occurs for many days each year, primarily during fall and winter. Mean monthly discharge ranges from 0.001 m^3/s in January to 0.51 m^3/s in July (Burr and others, 1996). Average annual precipitation at the Salem weather station, about 17 km southwest of the site, is 64 cm. Most of the precipitation occurs as rain in spring and summer. Average annual runoff is only about 3 cm (Burr and others, 1996). The mean monthly temperatures ranged from about -11.9×C in January to 24.0×C in August during the period of record, 1969–72 (National Climatic Data Center, 1996).

The surface of the Little Vermillion HBN Basin is mantled by deposits of Pleistocene age. Outwash and alluvium are near the stream channel. Glacial deposits of outwash, oxidized till, and unoxidized till show evidence of three intervals of glaciation (Schroeder, 1988). Glacial deposits are composed of silty, pebbly clays, sands, and gravel. Average thickness of these deposits is about 50 m. Bedrock geology underlying the glacial deposits includes Pierre Shale and Niobrara Formation of Jurassic age and the Sioux Quartzite of Proterozoic age (Darton, 1951, pl. 1). The Pierre Shale is dark gray with abundant bentonite. The Niobrara Formation is a light-brown to dark- brown speckled marl with some pyrite, gypsum, and shell fragments. The Sioux Quartzite is pink to red, massive orthoquartzite (Schroeder, 1988). Basin soils are described as well-drained to somewhat poorly drained, level to moderately sloping loamy soils (U.S. Department of Agriculture, 1980; 1984a).

The Little Vermillion River HBN Basin is in Miner and McCook Counties. Land ownership is private except for rights-of-way along public roads. Railroad tracks and a network of roads, including unimproved, improved, and highways, provide access to the basin year round. Nearly the entire basin is used for agriculture. Crops, including corn and soybeans, are grown on about 90 percent of the land, and the remaining area is used for grazing cattle. During the 1980's, much of the area occupied by row crops was returned to grassland under the Conservation Reserve Program (Darrell Campbell, Farm Service Agency, oral commun., 1997). In the 1990's, some of the set-aside grassland was returned to row crops (M.J. Burr, U.S. Geological Survey, oral commun., 1997). Rural residences and stock ponds are present throughout the basin, and several lakes lie in the upper basin where waterfowl production is managed. Gravel pits are constructed in the basin, primarily along the main channel of the Little Vermillion River (Koch and McGarvie, 1988).

Historical Water-Quality Data

Samples for chemical analyses have not been collected routinely at the Little Vermillion HBN station. The data set analyzed for this report for the Little Vermillion River HBN station includes 121 measurements of instantaneous discharge and 113 measurements of specific conductance for the period February 1976 to August 1995. The entire period of record for discharge is from 1966 to 1997. Median values and ranges of discharge and specific conductance are shown in table 44. Discharge ranged from less than 0.001 to 18 m^3/s with a median discharge of 0.34 m^3/s. The range of specific conductance for the period was 140 to 1,970 mS/cm, with a median value of 860 mS/cm. Specific conductance is an indicator of dissolved solids. Based on the range of specific-conductance values, dissolved solids generally are high at this site. Streams in basins with fine-grained sediments and low annual runoff tend to have high dissolved-solids concentrations (Biesecker and Leifeste, 1975). Specific conductance had an inverse relation with discharge. The Spearman rank correlation coefficient was -0.716 and was significant for an a of 0.01.

Table 44. Minimum, first quartile, median, third quartile, and maximum values of physical properties measured at the Little Vermillion River, South Dakota, 1976—95

[Discharge in cubic meters per second; specific conductance in microsiemens per centimeter at 25 degrees Celsius; n, number of stream samples; <, less than]

Parameter	Stream Water					
	Minimum	First quartile	Median	Third quartile	Maximum	n
Discharge	<0.001	0.04	0.34	1.8	18	121
Specific conductance, field	140	520	860	1,180	1,970	113

Synoptic Water-Quality Data

Results of a surface-water synoptic sampling conducted April 8, 1993, in the Little Vermillion River Basin are presented in table 45, and locations of the sampling sites are shown in figure 23. Discharge at the HBN station (site 6) was 2.3 m^3/s compared to the mean monthly discharge of 0.46 m^3/s for the month of April (Burr and others, 1996). The water type at the Little Vermillion River HBN station is a calcium- magnesium sulfate type. The sum of ions at the HBN station is 20,000 meq/L. The specific conductance of 958 mS/cm was higher than the median but less than the third quartile for the period of record, 1976–95. The dominant cations, calcium (43 percent) and magnesium (39 percent), contributed 82 percent of the total cation concentration. Potassium concentrations were high, which probably reflect the weathering of the clay materials in the basin (Deer and others, 1966). Sulfate contributed 64 percent and bicarbonate contributed 33 percent of total anion concentration. Bicarbonate was the primary contributor to alkalinity at this station. Annual precipitation and runoff data indicated that evapotranspiration can account for about a twentyfold increase in stream-water concentrations compared to precipitation. Sulfate and chloride concentrations were higher than can be accounted for by evapotranspiration of precipitation at the South Dakota NADP stations, indicating that there is a source for these constituents within the basin. The percent difference of cations and anions was about 2 percent, indicating that unmeasured ions do not substantially contribute to the ionic content of the Little Vermillion River.

Table 45. Physical properties and major-ion concentrations in surface-water samples collected at sites in the Little Vermillion River Basin, April 8, 1993

[Site locations shown in fig. 23; Q, discharge in cubic meters per second; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; pH in standard units; Ca, calcium; Mg, magnesium; Na, sodium; K, potassium; Alk, alkalinity; SO_4, sulfate; Cl, chloride; NO_3, nitrate; SiO_2, silica; concentrations in microequivalents per liter, except silica is in micromoles per liter; --, not measured; <, less than; criteria used in selection of sampling sites: BG = bedrock geology, TRIB = major tributary, LU = land use]

Site	Identification number	Q	SC	pH	Ca	Mg	Na	K	Alk	SO_4	Cl	NO_3	SiO_2	Criteria
1	440027097265200	--	1,020	7.8	4,500	4,300	1,600	510	3,400	7,300	310	<0.4	280	BG
2	435609097260800	--	1,120	7.9	4,800	4,900	2,000	510	3,000	8,100	420	54	250	TRIB
3	435609097253600	--	884	7.8	3,900	3,400	1,200	490	2,300	6,000	450	140	220	TRIB
4	435516097254000	--	840	7.9	3,800	3,300	1,000	410	2,400	5,800	370	61	220	TRIB
5	435238097254800	--	979	7.8	4,400	4,000	1,500	460	2,400	7,500	340	79	220	LU
6	06478540	2.3	958	7.9	4,200	3,800	1,300	440	3,300	6,500	340	6.8	160	--

The waters at the remaining synoptic sites (sites 1–5) are calcium-magnesium sulfate. The sum of ions in tributary and upper-basin main-stem sites ranged from about 17,000 meq/L (site 4) to about 24,000 meq/L (site 2). The specific conductance on the main stem (site 2) in the upper basin was 1,120 mS/cm, which was higher than the specific conductance measured downstream at sites 5 (979 mS/cm) and 6 (958 mS/cm). This sampling was conducted on the rising limb of the hydrograph, and this dilution effect is not typical of base-flow conditions for this station. Nitrate concentrations in samples that were collected from several synoptic sites (sites 2, 3, 4, and 5) were higher than concentrations in most of the other HBN basins and undeveloped sites in other studies (Mueller and others, 1995). This may indicate that there is a source for some nitrogen in the basin, possibly fertilizer or animal waste; however, evapotranspiration rates also are high in this basin.

References Cited

Bailey, Robert G., 1995, Descriptions of the ecoregions of the United States: U.S. Department of Agriculture, Forest Service, Miscellaneous Publication 1391, 108 p.

Biesecker, J.E., and Leifeste, D.K., 1975, Water quality of hydrologic benchmarks—An indicator of water quality in the natural environment: U.S. Geological Survey Circular 460–E, 21 p.

Burr, M.J., Teller, R.W., and Neizert, K.M., 1996, Water resources data, South Dakota, water year 1995: U.S. Geological Survey Water-Data Report SD–95–1, 379 p.

Cobb, E.D., and Biesecker, J.E., 1971, The National Hydrologic Bench-Mark Network: U.S. Geological Survey Circular 460–D, 38 p.

Darton, N.H., 1951, Geologic map of South Dakota: U.S. Geological Survey, 1 pl.

Deer, W.A., Howie, R.A., and Zussman, J., 1966, An introduction to the rock-forming minerals: England, Longman Group Limited, 528 p.

Fenneman, N.M., 1946, Physical divisions of the United States: Washington, D.C., U.S. Geological Survey special map, scale 1:7,000,000.

Koch, N.C., and McGarvie, S.D., 1988, Water resources of Miner County, South Dakota: U.S. Geological Survey Water-Resources Investigations Report 86–4035, 37 p.

Mueller, D.K., Hamilton, P.A., Helsel, D.R., Hitt, K.J., and Ruddy, B.C., 1995, Nutrients in ground water and surface water of the United States—An analysis of data through 1992: U.S. Geological Survey Water-Resources Investigations Report 95–4031, 74 p.

National Climatic Data Center, 1996, Summary of the day, CD-ROM: Boulder, Colorado, EarthInfo Incorporated.

Schroeder, Wayne, 1988, Geology and water resources of Miner County, South Dakota: Department of Water and Natural Resources, South Dakota Geological Survey Bulletin 31, 38 p.

U.S. Department of Agriculture, 1980, Soil survey of McCook County, South Dakota: U.S. Department of Agriculture, Soil Conservation Service, 123 p.

U.S. Department of Agriculture, 1984a, Soil survey of Miner County, South Dakota: U.S. Department of Agriculture, Soil Conservation Service, 116 p.

Appendix A. List of Map References

a. U.S. Geological Survey topographic maps:

- Oldham SW, South Dakota (1:24,000), 1968
- Canova East, South Dakota (1:24,000), 1971
- Unityville, South Dakota (1:24,000), 1971
- Winfred, South Dakota (1:24,000), 1971
- Winfred SE, South Dakota (1:24,000), 1971, streamflow-gaging station

b. Geologic maps:

- Darton, N.H., 1951, Geologic map of South Dakota: U.S. Geological Survey, 1 pl.
- Schroeder, W., 1988, Geology and water resources of Miner County, South Dakota: Department of Water and Natural Resources, South Dakota Geological Survey Bulletin 31, 38 p.

c. Soil surveys:

- U.S. Department of Agriculture, 1980, Soil survey of McCook County, South Dakota: U.S. Department of Agriculture, Soil Conservation Service.
- U.S. Department of Agriculture, 1984, Soil survey of Miner County, South Dakota: U.S. Department of Agriculture, Soil Conservation Service.

Appendix B. NWIS Site-Identification Numbers

Table B–1. NWIS site-identification numbers and site names for water-quality sampling sites.

Site	Identification Number	Site Name
1	440027097265200	UPPER WEST BRANCH LITTLE VERMILLION RIVER
2	435609097260800	WEST BRANCH LITTLE VERMILLION RIVER
3	435609097253600	UPPER EAST BRANCH LITTLE VERMILLION RIVER
4	435516097254000	LOWER EAST BRANCH LITTLE VERMILLION RIVER
5	435238097254800	LITTLE VERMILLION RIVER AT HIGHWAY NEAR CANOVA
6	06478540	LITTLE VERMILLION RIVER NEAR SALEM, SOUTH DAKOTA