Prepared in cooperation with the U.S. Army Corps of Engineers, Kansas City District

Characteristics of Sediment Data and Annual Suspended-Sediment Loads and Yields for Selected Lower Missouri River Mainstem and Tributary Stations, 1976–2008

Data Series 530

U.S. Department of the Interior
U.S. Geological Survey

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Back Cover. Missouri River near Rocheport, Missouri. Photograph by Dale Blevins, U.S. Geological Survey, September 2000.

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By David C. Heimann, Patrick P. Rasmussen, Teri L. Cline, Lori M. Pigue,
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Data Series 530

**U.S. Department of the Interior
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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
Length		
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
Area		
square mile (mi ²)	2.590	square kilometer (km ²)
Volume		
cubic foot (ft ³)	0.02832	cubic meter (m ³)
gallon (gal)	3.785	liter (L)
Flow rate		
cubic foot per second (ft ³ /s)	0.02832	cubic meter per second (m ³ /s)
Mass		
tons	907.18	Kilograms (Kg)
ton per square mile (ton/mi ²)	0.35026	metric ton per square kilometer (tonne/km ²)
ton per year (ton/yr)	0.9072	metric ton per year (tonne per year)
ounce, avoirdupois (oz)	28.35	gram (g)

Characteristics of Sediment Data and Annual Suspended-Sediment Loads and Yields for Selected Lower Missouri River Mainstem and Tributary Stations, 1976–2008

By David C. Heimann, Patrick P. Rasmussen, Teri L. Cline, Lori M. Pigue, and Holly R. Wagner

Abstract

Suspended-sediment data from 18 selected surface-water monitoring stations in the lower Missouri River Basin downstream from Gavins Point Dam were used in the computation of annual suspended-sediment and suspended-sand loads for 1976 through 2008. Three methods of suspended-sediment load determination were utilized and these included the subdivision method, regression of instantaneous turbidity with suspended-sediment concentrations at selected stations, and regression techniques using the Load Estimator (LOADEST) software. Characteristics of the suspended-sediment and streamflow data collected at the 18 monitoring stations and the tabulated annual suspended-sediment and suspended-sand loads and yields are presented.

Introduction

Before impoundment and bank-stabilization projects, the Missouri River had the largest sediment loads of any large river in the United States and contributed more than 75 percent of the sediment delivered to the Gulf of Mexico by the Mississippi River (Meade, 1995). This continual supply of sediment kept the vast wetlands near the mouth of the Mississippi above sea level and protected inland areas against damage from hurricanes. The Missouri River carried over 320 million tons of suspended-sediment per year (U.S. Army Corps of Engineers, 1980) before the dam construction period of 1953–67. Since the construction of a stabilized navigation channel and the closure of several large reservoirs on the Missouri River in the early 1950s, suspended-sediment concentrations (SSCs) have decreased at least 75 percent (Blevins, 2006) in the lower Missouri River (that portion of the river downstream from Gavins Point Dam; fig. 1). The Missouri River still accounts for nearly one-half the sediment delivered to the Gulf of Mexico (Meade, 1995).

The post-reservoir sediment decrease has had numerous effects on aquatic ecosystems, channel-bed elevations, and sediment delivery to receiving water bodies. Decreased SSCs have resulted in decreased turbidities of 60 to 80 percent in the lower Missouri River (Blevins, 2006), which may be responsible for, or contribute to, the decline of the endangered pallid sturgeon (U.S. Fish and Wildlife Service, 2003) and other native species. Channel degradation of 10 to 15 feet in reaches just below Gavins Point Dam and near Kansas City, Missouri (Jacobson and Galat, 2006; fig. 1) may be the result of post-reservoir sediment deficits in the lower Missouri River Basin. A complicating factor in the sediment dynamics of the lower Missouri River is commercial dredging for sand and fine gravel. It is unclear to what extent removed dredging materials may affect the occurrence of bed degradation but there appears to be a correlation between the two processes (Jacobson and others, 2009).

Sediment augmentations and other management activities have been proposed in response to these sediment-related issues in the lower Missouri River; however, evaluation of these activities needs to be put in the context of both historical and modern sediment loads. To do so, sediment budgets can be used to assess the impacts of proposed sediment-management activities on sediment transport within the Missouri River and sediment delivery to the Mississippi River, and can account for changing sediment contributions from tributaries.

The U.S. Geological Survey (USGS) collects and analyzes suspended-sediment data in the Missouri River Basin as part of the Sediment Data Program with the U.S. Army Corps of Engineers (USACE). Additional SSC data have been collected as part of the USGS National Stream Quality Accounting Network (NASQAN; Hooper and others, 1997), and other USGS cooperative-study programs with State and local agencies. To address the need for additional sediment information on the lower Missouri River, the USGS, in cooperation with the USACE, conducted a study to determine suspended-sediment characteristics and suspended-sediment loads at selected streamgaging stations. All available

Figure 1. Location of selected sediment-sampling stations in the lower Missouri River Basin for which data are presented (see table 1 for station names corresponding to station identifiers).

suspended-sediment data were compiled and combined for use in the computation of annual suspended-sediment and suspended-sand loads for selected Missouri River mainstem and tributary stations in the lower Missouri River Basin (fig. 1).

Purpose and Scope

This report describes characteristics of sediment data, load estimation techniques, and annual suspended-sediment loads and yields for 18 stations within the lower Missouri River Basin (fig. 1). At each station, annual suspended-sediment and suspended-sand loads are presented using available data for water years 1976 through 2008 (defined as the 12-month period from October 1 through September 30 and is designated by the year the period ends). The data analyzed for suspended-sediment loads are stored in the USGS National Water Information System (NWIS) database. The data characteristics examined include computed suspended-sediment loads, SSC, sediment particle size, turbidity, and streamflow.

Characteristics of Sediment Data

The USGS NWIS database provides for the acquisition, processing, and long-term storage of streamflow and water-quality data that are collected and analyzed by the USGS. The suspended-sediment data contained in the NWIS database were collected for numerous projects and were analyzed at several USGS or USACE laboratories. Long-term sediment data in the NWIS database include data collected as part of the USGS cooperative data program and the USGS NASQAN program. Data used in the determination of suspended-sediment loads included existing published and unpublished sediment loads, suspended-sediment concentration, sediment particle size, turbidity, and streamflow. The period of sediment and streamflow record varied at each of the 18 USGS streamgaging stations used in the analyses (table 1).

Suspended-Sediment Loads

Published and unpublished computed suspended-sediment and suspended-sand loads were available for some stations and some years in the selected 1976 through 2008 report period. Suspended-sediment and suspended-sand loads were computed for those stations and years within the 1976 through 2008 period for which loads had not been previously determined, and sufficient data were available. The data used for determination of annual suspended-sediment and suspended-sand loads were retrieved from the USGS NWIS database (U.S. Geological Survey, 2009) and USGS data archives (U.S. Geological Survey, unpub. data, 1976–2008).

Daily suspended-sediment loads computed by the USGS were available in NWIS for Missouri River stations at Sioux City, Iowa (station 06486000); Omaha (station 06610000), and Nebraska City (station 06807000), Nebraska and the Nodaway River at Clarinda, Iowa (station 06817000) (U.S. Geological Survey, 2009). Unpublished daily suspended-sediment and suspended-sand loads also were available for 1975–81 at the Missouri River stations at Saint Joseph (station 06818000), Kansas City (station 06893000), and Hermann (station 06934500), Missouri (U.S. Army Corps of Engineers, unpub. data, 1975–81). The daily computed suspended-sediment and suspended-sand loads were compiled and reported as annual values in this report.

Suspended-Sediment Concentration and Particle Size

Depth-integrated samples [continuous samples obtained from the entire vertical water column and from multiple sample locations (verticals) along a river transect] and point samples (samples obtained from selected depths or points in the water column at multiple verticals) were used in the collection of SSC and particle-size data. All suspended-sediment samples were obtained isokinetically (stream water entering the sampler nozzle did not differ in velocity from that of the water column). The spacing of the sampled verticals generally was based on equal-discharge increment (EDI) divisions or equal-width increments (EWI; Edwards and Glysson, 1999), although samples also were designated as “multiple vertical” when samples were collected using multiple verticals but did not meet the criteria for EDI or EWI sampling (table 2). Concurrent depth-integrated and point-sample data were available at some Missouri River mainstem stations and these samples were collected at the same verticals. The number of sampled verticals varied by station but generally was three to five. Suspended-sediment samples collected at Missouri River mainstem stations, for the period of record presented in this report, generally were collected with a US P-61 sampler (used to sample depth-integrated or point samples), US D-95, or the US D-96 depth-integrated sampler (table 2). Suspended-sediment sampling at smaller Missouri River tributary stations was conducted using a variety of suspended and hand-held samplers (table 2). A description of the types of isokinetic depth-integrating samplers are provided in Szalona (1982), Ward and Harr (1990), Edwards and Glysson (1999), and Federal Interagency Sedimentation Project at http://fisp.wes.army.mil/Catalog_Index.htm (accessed May 27, 2010).

When available, the stored composite SSCs and sand-(suspended material greater than 0.0625 millimeters) percentage values were used in determining load estimates; otherwise the arithmetic average of sediment data from multiple-verticals was computed and used in load determinations. The multiple depth-integrated or point

Table 1. Summary characteristics of selected suspended-sediment sampling stations in the lower Missouri River Basin.[ft³/s, cubic feet per second; mi², square miles]

Station name	Station identifier	Period of suspended-sediment record ^a	Period of streamflow record ^b	Period of record used in sediment-load analyses ^b	Long-term mean annual streamflow (ft ³ /s) ^c	Period of record used in determination of long-term mean annual streamflow ^c	Drainage area (mi ²)
Missouri River at Yankton, South Dakota	06467500	1939–69, 2001–09	1931–95, 2001–10	2001–08	26,000	1976–95	279,500
James River at Scotland, South Dakota	06478500	1975–95, 2007	1928–2010	1976–95	624	1929–2008	20,653
Big Sioux River at Akron, Iowa	06485500	1940–51, 1967, 1970–94, 2002, 2004–08	1929–2010	1976–94	1,280	1929–2008	8,424
Missouri River at Sioux City, Iowa	06486000	1955–2001, 2004–10	1929–2010	1976–2008	28,800	1953–2008	314,600
Missouri River at Omaha, Nebraska	06610000	1939–2010	1928–2010	1976–2008	32,300	1953–2008	322,800
Platte River at Louisville, Nebraska ^e	06805500	1939–71, 1973–2010	1953–2010	1976–2008	7,000	1953–2008	85,370
Missouri River at Nebraska City, Nebraska	06807000	1951–2010	1929–2010	1976–2008	38,500	1953–2008	410,000
Nishnabotna River at Hamburg, Iowa	06810000	1939–51, 1978–93, 1998, 2004–09	1922–2010	1982–93, 2004–08	1,290	1922–2008	2,806
Nodaway River at Clarinda, Iowa ^f	06817000	1970–74, 1976–92, 2008	1918–2010	1976–92	386	1919–2009	762
Missouri River at St. Joseph, Missouri	06818000	1948–2010	1929–2010	1976–2008	45,400	1948–2009	426,500
Platte River at Sharps Station, Missouri	06821190	1979–93, 1995	1979–2010	1980–92	1,700	1979–2008	2,380

Table 1. Summary characteristics of selected suspended-sediment sampling stations in the lower Missouri River Basin—Continued

[ft³/s, cubic feet per second; mi², square miles]

Station name	Station identifier	Period of suspended-sediment record ^a	Period of streamflow record ^b	Period of record used in sediment-load analyses ^b	Long-term mean annual streamflow (ft ³ /s) ^c	Period of record used in determination of long-term mean annual streamflow ^c	Drainage area (mi ²)
Kansas River at DeSoto, Kansas ^g	06892350	1948–92, 1999–2005, 2007	1917–2010	1976–91	7,320	1918–2009	59,756
Missouri River at Kansas City, Missouri	06893000	1948–76, 1988–2010	1929–2010	1976–2008	54,900	1958–2008	484,100
Grand River at Sumner, Missouri	06902000	1974–86, 1988–93, 1995	1925–2010	1976–93	4,170	1925–2008	6,880
Chariton River at Prairie Hill, Missouri ^h	06905500	1970–74, 1978–86	1929–2010	1979–86	1,260	1929–2008	1,870
Osage River at St. Thomas, Missouri ⁱ	06926510	1943–51, 1972–94	1931–96 ^j	1976–94	11,700	1996–2008	14,584
Gasconade River at Jerome, Missouri	06933500	1942–51, 1978–93	1903–2010	1978–93	2,600	1903–2008	2,840
Missouri River at Hermann, Missouri	06934500	1948–2010	1929–2010	1976–2008	86,200	1949–2008	522,500

^a Source: U.S. Geological Survey (2009) and Keown (1981)

^b Source: U.S. Geological Survey (2010)

^c Source: U.S. Geological Survey annual water data report accessed through U.S. Geological Survey (2009)

^d Source: United States Army Corps of Engineers, written communication (2009).

^e Sediment information from 1939–52 is from Platte River at Ashland, Nebraska (station 06801000).

^f Sediment information from 1970–74 is from Nodaway River at Burlington Junction, Missouri (station 06817500).

^g Sediment information from 1948–73 is from Kansas River at Bonner Springs, Kansas (station 06892500).

^h Sediment information from 1970–74 is from Chariton River near Rathbun, Iowa (station 06903900) .

ⁱ Sediment information from 1943–51 is from Osage River at Osceola, Missouri (station 06920500).

^j Streamflow information from Osage River below St. Thomas, Missouri (station 06926500).

6 Characteristics of Sediment Data and Annual Suspended-Sediment Loads and Yields—Missouri River

Table 2. Summary characteristics of annual suspended-sediment and streamflow data for selected stations in the lower Missouri River Basin, 1976–2008.

[EDI, equal-discharge increment; EWI, equal-width increment; DI, depth-integrated sample; PS, point sample; mg/L, milligrams per liter; ft³/s, cubic feet per second; --, no data or not applicable]

Year	Number of annual suspended-sediment concentrations ^a	Primary method of suspended-sediment data collection (EDI, EWI, multiple vertical/ DI, PS)	Primary Sampler type	Streamflow-weighted mean suspended-sediment concentration (mg/L) ^b	Annual mean streamflow (ft ³ /s) ^c
06467500 Missouri River at Yankton, South Dakota					
2001	8	EWI/DI	D-77	14	20,100
2002	8			11	22,100
2003	8	EWI/DI	D-95	11	22,300
2004	8			13	21,700
2005	7			17	17,300
2006	8			12	18,200
2007	7			11	14,800
2008	4			11	14,300
06478500 James River at Scotland, South Dakota					
1976	10	EWI, EDI, multiple verticals	DH-59, D-74, DH-76, DH-48	155	175
1977	10			126	116
1978	10			117	867
1979	12			125	525
1980	12			122	106
1981	13			158	14
1982	8			163	257
1983	3			188	696
1984	4			167	1,690
1985	10			159	410
1986	10			158	2,040
1987	7			113	992
1988	9			89	156
1989	9			42	322
1990	7			162	57
1991	4			166	213
1992	4			157	146
1993	4			98	1,960
1994	4			97	1,670
1995	4			117	3,180

Table 2. Summary characteristics of annual suspended-sediment and streamflow data for selected stations in the lower Missouri River Basin, 1976–2008—Continued

[EDI, equal-discharge increment; EWI, equal-width increment; DI, depth-integrated sample; PS, point sample; mg/L, milligrams per liter; ft³/s, cubic feet per second; --, no data or not applicable]

Year	Number of annual suspended-sediment concentrations ^a	Primary method of suspended-sediment data collection (EDI, EWI, multiple vertical/ DI, PS)	Primary Sampler type	Streamflow-weighted mean suspended-sediment concentration (mg/L) ^b	Annual mean streamflow (ft ³ /s) ^c
06485500 Big Sioux River at Akron, Iowa					
1976	12			276	365
1977	12			279	231
1978	10			350	1,480
1979	12			325	1,970
1980	11			562	1,110
1981	12			868	240
1982	5			471	794
1983	--			429	3,790
1984	3			743	4,270
1985	4	EDI/DI	DH-76, DH-48	369	2,170
1986	3			623	3,930
1987	4			395	1,770
1988	3			367	664
1989	5			372	404
1990	4			451	449
1991	3			360	460
1992	5			409	1,510
1993	4			758	6,270
1994	4			499	2,890

8 Characteristics of Sediment Data and Annual Suspended-Sediment Loads and Yields—Missouri River

Table 2. Summary characteristics of annual suspended-sediment and streamflow data for selected stations in the lower Missouri River Basin, 1976–2008—Continued

[EDI, equal-discharge increment; EWI, equal-width increment; DI, depth-integrated sample; PS, point sample; mg/L, milligrams per liter; ft³/s, cubic feet per second; --, no data or not applicable]

Year	Number of annual suspended-sediment concentrations ^a	Primary method of suspended-sediment data collection (EDI, EWI, multiple vertical/ DI, PS)	Primary Sampler type	Streamflow-weighted mean suspended-sediment concentration (mg/L) ^b	Annual mean streamflow (ft ³ /s) ^c
06486000 Missouri River at Sioux City, Iowa					
1976	30	EDI, EWI/DI	US P-61	497	39,690
1977	10			396	29,500
1978	9			414	33,900
1979	8			512	38,300
1980	10	EDI, EWI, multiple verticals/DI, PS	US P-61	312	34,500
1981	12			389	28,500
1982	7			307	26,100
1983	8			452	34,600
1984	12			518	36,900
1985	11			474	32,600
1986	10			366	33,600
1987	5	EDI/DI,PS	US P-61	297	33,800
1988	5			292	28,400
1989	5			253	24,900
1990	6			172	21,400
1991	6			190	21,000
1992	63			222	21,400
1993	65			361	24,500
1994	70			224	29,300
1995	78			275	35,800
1996	77			340	44,800
1997	78			378	55,900
1998	85			319	38,500
1999	81			253	38,200
2000	88			218	32,500
2001	--			--	27,100
2002	--			--	24,300
2003	4			--	23,900
2004	76			186	23,800
2005	47			188	20,400
2006	44			194	21,900
2007	45			249	20,100
2008	42			241	18,700

Table 2. Summary characteristics of annual suspended-sediment and streamflow data for selected stations in the lower Missouri River Basin, 1976–2008—Continued

[EDI, equal-discharge increment; EWI, equal-width increment; DI, depth-integrated sample; PS, point sample; mg/L, milligrams per liter; ft³/s, cubic feet per second; --, no data or not applicable]

Year	Number of annual suspended-sediment concentrations ^a	Primary method of suspended-sediment data collection (EDI, EWI, multiple vertical/ DI, PS)	Primary Sampler type	Streamflow-weighted mean suspended-sediment concentration (mg/L) ^b	Annual mean streamflow (ft ³ /s) ^c
06610000 Missouri River at Omaha, Nebraska					
1976	23	EDI,EWI/DI, PS	US P-61	535	41,000
1977	5			480	30,500
1978	12			690	36,200
1979	13			772	42,500
1980	12			603	34,500
1981	12			500	30,500
1982	7			491	30,400
1983	11			807	45,200
1984	11			784	46,100
1985	11			641	38,500
1986	10			705	40,500
1987	5			564	40,700
1988	5			379	31,600
1989	5			310	27,300
1990	6			381	24,600
1991	6			474	25,500
1992	--	EDI,EWI/DI	US P-61	406	26,800
1993	--			787	36,400
1994	--			465	35,400
1995	--			423	41,800
1996	12			555	51,600
1997	--			531	62,200
1998	--			532	43,900
1999	4			396	44,600
2000	89			276	35,900
2001	92			524	30,800
2002	96			261	26,300
2003	105			376	26,600
2004	15			368	27,000
2005	14			352	23,400
2006	13			243	24,300
2007	13			426	24,800
2008	13			512	24,600

10 Characteristics of Sediment Data and Annual Suspended-Sediment Loads and Yields—Missouri River

Table 2. Summary characteristics of annual suspended-sediment and streamflow data for selected stations in the lower Missouri River Basin, 1976–2008—Continued

[EDI, equal-discharge increment; EWI, equal-width increment; DI, depth-integrated sample; PS, point sample; mg/L, milligrams per liter; ft³/s, cubic feet per second; --, no data or not applicable]

Year	Number of annual suspended-sediment concentrations ^a	Primary method of suspended-sediment data collection (EDI, EWI, multiple vertical/ DI, PS)	Primary Sampler type	Streamflow-weighted mean suspended-sediment concentration (mg/L) ^b	Annual mean streamflow (ft ³ /s) ^c
06805500 Platte River at Louisville, Nebraska					
1976	13	EDI,EWI, multiple verticals/DI	D-49, DH-59, D-77, DH-48	555	3,860
1977	22			923	4,710
1978	24			2,340	6,550
1979	19			1,260	5,700
1980	21			1,210	6,680
1981	22			639	3,770
1982	8			2,010	7,990
1983	4			2,340	13,700
1984	4			3,600	16,200
1985	4			1,220	8,840
1986	4			1,330	9,950
1987	4			1,700	12,100
1988	4			450	5,850
1989	4			704	5,140
1990	4			2,170	5,720
1991	7			2,900	5,250
1992	74	EDI,EWI, multiple verticals/DI	DH-48, D-77, DH-81	837	6,410
1993	16			5,600	14,700
1994	13			828	8,390
1995	8			1,940	10,600
1996	4			1,590	9,730
1997	15	EDI,EWI, multiple verticals/DI	D-77, D-95, DH-81	1,130	8,840
1998	18			1,780	11,300
1999	15			2,250	11,600
2000	15			745	6,610
2001	9			1,360	7,210
2002	18			634	4,500
2003	17			714	4,450
2004	10			1,000	4,530
2005	6			1,440	5,140
2006	6			569	4,160
2007	16			1,340	8,290
2008	17			1,740	10,600

Table 2. Summary characteristics of annual suspended-sediment and streamflow data for selected stations in the lower Missouri River Basin, 1976–2008—Continued

[EDI, equal-discharge increment; EWI, equal-width increment; DI, depth-integrated sample; PS, point sample; mg/L, milligrams per liter; ft³/s, cubic feet per second; --, no data or not applicable]

Year	Number of annual suspended-sediment concentrations ^a	Primary method of suspended-sediment data collection (EDI, EWI, multiple vertical/ DI, PS)	Primary Sampler type	Streamflow-weighted mean suspended-sediment concentration (mg/L) ^b	Annual mean streamflow (ft ³ /s) ^c
06807000 Missouri River at Nebraska City, Nebraska					
1976	26	EDI/DI, PS	US P-61	585	44,400
1977	12			697	35,000
1978	5			779	43,300
1979	5			830	48,000
1980	5			495	40,200
1981	5			497	33,500
1982	5			708	37,600
1983	5			1,250	57,200
1984	5			1,450	61,700
1985	5			973	45,500
1986	6			814	47,900
1987	5			998	51,200
1988	5			434	35,600
1989	6			404	30,700
1990	3			591	28,000
1991	5			680	28,700
1992	--	EDI/DI	US P-61	632	30,400
1993	74			986	47,500
1994	76			648	41,100
1995	83			606	48,800
1996	71			913	57,200
1997	78			629	66,500
1998	77			755	52,100
1999	80			604	53,000
2000	85			363	39,700
2001	73			615	38,000
2002	78			372	30,600
2003	86			485	30,800
2004	81			527	31,400
2005	84			510	28,500
2006	78			335	28,300
2007	82			674	33,300
2008	78			984	34,900

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Table 2. Summary characteristics of annual suspended-sediment and streamflow data for selected stations in the lower Missouri River Basin, 1976–2008—Continued

[EDI, equal-discharge increment; EWI, equal-width increment; DI, depth-integrated sample; PS, point sample; mg/L, milligrams per liter; ft³/s, cubic feet per second; --, no data or not applicable]

Year	Number of annual suspended-sediment concentrations ^a	Primary method of suspended-sediment data collection (EDI, EWI, multiple vertical/ DI, PS)	Primary Sampler type	Streamflow-weighted mean suspended-sediment concentration (mg/L) ^b	Annual mean streamflow (ft ³ /s) ^c
06810000 Nishnabotna River at Hamburg, Iowa					
1982	4	EDI	DH-76, DH-48	3,660	1,720
1984	4			5,750	2,580
1985	4			594	943
1986	4			2,580	1,940
1987	4			6,170	3,060
1988	5			341	796
1989	6			5,860	771
1990	6			5,250	1,520
1991	5			3,310	1,560
1992	5			764	1,410
1993	5			5,400	5,060
2004	9	EDI, multiple verticals	D-95, DH-81	2,870	1,360
2005	11			1,980	1,050
2006	13			362	539
2007	12			1,870	2,670
2008	12			2,330	3,620
06817000 Nodaway River at Clarinda, Iowa					
1976	11	EDI	DH-59, DH-76, DH-48	1,840	738
1977	7			8,400	294
1978	13			6,280	697
1979	3			6,200	405
1980	6			5,970	194
1981	7			2,430	85
1982	8			7,670	775
1983	9			2,090	667
1984	10			4,010	701
1985	9			2,770	166
1986	16			5,470	656
1987	12			4,000	830
1988	9			108	150
1989	9			9,790	278
1990	10			4,820	339
1991	8			7,430	559
1992	9			3,210	402

Table 2. Summary characteristics of annual suspended-sediment and streamflow data for selected stations in the lower Missouri River Basin, 1976–2008—Continued

[EDI, equal-discharge increment; EWI, equal-width increment; DI, depth-integrated sample; PS, point sample; mg/L, milligrams per liter; ft³/s, cubic feet per second; --, no data or not applicable]

Year	Number of annual suspended-sediment concentrations ^a	Primary method of suspended-sediment data collection (EDI, EWI, multiple vertical/ DI, PS)	Primary Sampler type	Streamflow-weighted mean suspended-sediment concentration (mg/L) ^b	Annual mean streamflow (ft ³ /s) ^c
06818000 Missouri River at St. Joseph, Missouri					
1976	19			705	48,000
1977	11			555	39,000
1978	11			732	51,900
1979	10			683	55,500
1980	10			828	45,000
1981	12	EDI,EWI/DI, PS	US P-61 US P-61	634	36,700
1982	6			1,170	47,200
1983	5			1,820	68,300
1984	12			1,620	72,100
1985	12			698	51,100
1986	10			1,060	57,300
1987	14			1,190	63,800
1988	10			498	39,600
1989	14			693	33,900
1990	13			1,020	32,900
1991	11			897	32,700
1992	16			803	37,300
1993	8			2,060	67,000
1994	6			573	47,700
1995	7			570	56,800
1996	7	EDI/DI, PS	US P-61 US P-61	600	65,700
1997	10			809	76,100
1998	7			772	62,800
1999	7			995	62,800
2000	7			370	42,800
2001	10			875	43,400
2002	8			428	32,300
2003	7			631	33,300
2004	12			769	34,600
2005	7			528	31,000
2006	7			392	29,800
2007	7	EDI/DI	US P-61 US P-61	749	39,600
2008	7			891	44,800

14 Characteristics of Sediment Data and Annual Suspended-Sediment Loads and Yields—Missouri River

Table 2. Summary characteristics of annual suspended-sediment and streamflow data for selected stations in the lower Missouri River Basin, 1976–2008—Continued

[EDI, equal-discharge increment; EWI, equal-width increment; DI, depth-integrated sample; PS, point sample; mg/L, milligrams per liter; ft³/s, cubic feet per second; --, no data or not applicable]

Year	Number of annual suspended-sediment concentrations ^a	Primary method of suspended-sediment data collection (EDI, EWI, multiple vertical/ DI, PS)	Primary Sampler type	Streamflow- weighted mean suspended-sediment concentration (mg/L) ^b	Annual mean streamflow (ft ³ /s) ^c
06821190 Platte River at Sharps Station, Missouri					
1980	10	EWI/DI	D-74, DH-48	2,030	767
1981	6			2,100	833
1982	6			8,230	3,380
1983	4			2,160	2,200
1984	4			4,320	2,540
1985	4			1,190	842
1986	4			2,210	3,320
1987	4			1,050	2,540
1988	3			572	526
1989	4			1,350	464
1990	4	1,070	1,440		
1991	4	983	1,010		
1992	4	EWI/DI	D-74, DH-81	1,290	1,730
06892350 Kansas River at DeSoto, Kansas					
1976	23	EDI/DI, PS	D-74	1,170	3,740
1977	18			3,330	5,890
1978	173			757	8,640
1979	108			1,470	9,100
1980	128			1,070	6,340
1981	136			1,140	4,150
1982	144	EDI/DI	D-74	1,840	12,100
1983	6			699	9,040
1984	7			1,380	12,700
1985	6			547	7,650
1986	7			1,020	11,700
1987	6			1,390	16,900
1988	14			201	2,910
1989	17			1,640	2,700
1990	8			1,470	5,530
1991	6			594	2,650

Table 2. Summary characteristics of annual suspended-sediment and streamflow data for selected stations in the lower Missouri River Basin, 1976–2008—Continued

[EDI, equal-discharge increment; EWI, equal-width increment; DI, depth-integrated sample; PS, point sample; mg/L, milligrams per liter; ft³/s, cubic feet per second; --, no data or not applicable]

Year	Number of annual suspended-sediment concentrations ^a	Primary method of suspended-sediment data collection (EDI, EWI, multiple vertical/ DI, PS)	Primary Sampler type	Streamflow-weighted mean suspended-sediment concentration (mg/L) ^b	Annual mean streamflow (ft ³ /s) ^c
06893000 Missouri River at Kansas City, Missouri					
1976	--			1,030	52,600
1977	--			555	45,900
1978	--			837	62,600
1979	--			827	66,600
1980	--			905	51,400
1981	--			745	40,900
1982	--			--	60,500
1983	--			--	77,200
1984	--			--	87,700
1985	--			--	60,200
1986	--			--	74,100
1987	--			--	84,800
1988	4			446	43,300
1989	11			670	36,100
1990	10	EDI/DI, PS	US P-61	1,170	39,200
1991	11			933	35,600
1992	11			811	44,100
1993	7			1,620	102,000
1994	6			636	56,900
1995	7			869	69,000
1996	6			568	71,900
1997	10			1,150	82,700
1998	8			954	73,100
1999	7			1,450	79,900
2000	7			378	45,100
2001	7			823	53,300
2002	8			448	35,400
2003	7			499	35,200
2004	12			757	41,200
2005	7			789	38,900
2006	10	EDI/DI	US P-61	447	34,100
2007	10			1,150	49,900
2008	10			1,030	58,200

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Table 2. Summary characteristics of annual suspended-sediment and streamflow data for selected stations in the lower Missouri River Basin, 1976–2008—Continued

[EDI, equal-discharge increment; EWI, equal-width increment; DI, depth-integrated sample; PS, point sample; mg/L, milligrams per liter; ft³/s, cubic feet per second; --, no data or not applicable]

Year	Number of annual suspended-sediment concentrations ^a	Primary method of suspended-sediment data collection (EDI, EWI, multiple vertical/ DI, PS)	Primary Sampler type	Streamflow- weighted mean suspended-sediment concentration (mg/L) ^b	Annual mean streamflow (ft ³ /s) ^c
06902000 Grand River at Sumner, Missouri					
1976	12	EWI, multiple verticals/DI	D-74, DH-48	5,530	2,480
1977	12			1,990	1,310
1978	12			2,810	8,040
1979	12			3,530	5,070
1980	12			7,770	1,610
1981	12			6,960	3,240
1982	6			3,760	7,280
1983	4			964	5,460
1984	12			1,540	5,860
1985	11			912	2,440
1986	10			2,810	6,730
1987	--			1,890	6,380
1988	5			1,130	1,560
1989	4			1,490	737
1990	4			1,770	4,360
1991	4			3,100	4,490
1992	4	EWI, multiple verticals/DI	D-74, DH-48	3,010	5,290
1993	3			5,840	17,400
06905500 Chariton River at Prairie Hill, Missouri					
1979	9	EWI/DI	D-74, DH-81	1,520	1,170
1980	10			3,040	867
1981	5			1,270	2,080
1982	6			2,310	2,730
1983	6			1,810	2,400
1984	6			1,790	1,680
1985	6			2,170	1,400
1986	6			2,370	2,590

Table 2. Summary characteristics of annual suspended-sediment and streamflow data for selected stations in the lower Missouri River Basin, 1976–2008—Continued

[EDI, equal-discharge increment; EWI, equal-width increment; DI, depth-integrated sample; PS, point sample; mg/L, milligrams per liter; ft³/s, cubic feet per second; --, no data or not applicable]

Year	Number of annual suspended-sediment concentrations ^a	Primary method of suspended-sediment data collection (EDI, EWI, multiple vertical/ DI, PS)	Primary Sampler type	Streamflow-weighted mean suspended-sediment concentration (mg/L) ^b	Annual mean streamflow (ft ³ /s) ^c
06926510 Osage River at St. Thomas, Missouri					
1976	12	EWI, multiple verticals/DI	D-74, DH-48	75	5,440
1977	11			133	4,900
1978	11			132	8,770
1979	6			116	8,110
1980	8			261	4,830
1981	11			153	7,830
1982	6			107	11,800
1983	6			46	14,800
1984	6			36	15,200
1985	6			32	20,100
1986	6			23	15,100
1987	6			27	20,400
1988	6			24	11,600
1989	5			27	6,770
1990	5			67	16,300
1991	6			26	4,510
1992	2	EWI, multiple verticals/DI	D-74, DH-81	32	6,200
1993	4			38	25,200
1994	2			46	23,200
06933500 Gasconade River at Jerome, Missouri					
1978	8	EDI, multiple verticals/ DI	D-74	158	2,260
1979	10			139	3,340
1980	9			176	1,430
1981	6			178	1,590
1982	6			61	2,030
1983	6			96	3,950
1984	6			29	4,170
1985	6			26	6,490
1986	6			18	2,860
1987	11			33	2,320
1988	11			25	3,180
1989	9			53	2,450
1990	5			75	3,570
1991	6			70	2,910
1992	5			58	1,900
1993	3			--	4,330

18 Characteristics of Sediment Data and Annual Suspended-Sediment Loads and Yields—Missouri River

Table 2. Summary characteristics of annual suspended-sediment and streamflow data for selected stations in the lower Missouri River Basin, 1976–2008—Continued

[EDI, equal-discharge increment; EWI, equal-width increment; DI, depth-integrated sample; PS, point sample; mg/L, milligrams per liter; ft³/s, cubic feet per second; --, no data or not applicable]

Year	Number of annual suspended-sediment concentrations ^a	Primary method of suspended-sediment data collection (EDI, EWI, multiple vertical/ DI, PS)	Primary Sampler type	Streamflow-weighted mean suspended-sediment concentration (mg/L) ^b	Annual mean streamflow (ft ³ /s) ^c
06934500 Missouri River at Hermann, Missouri					
1976	45	EDI/DI, PS	US P-61, US P-63	545	68,900
1977	38			477	56,700
1978	49			694	97,200
1979	41			791	91,300
1980	52			605	63,000
1981	50			960	65,700
1982	15			1,250	100,000
1983	15			1,290	120,000
1984	20			1,060	127,000
1985	22			747	106,000
1986	23			747	112,000
1987	21			960	127,000
1988	21			480	66,000
1989	16	EWI, EDI/DI, PS	US P-61, US P-63	504	52,000
1990	14			1,460	78,700
1991	17			602	55,700
1992	10			811	67,100
1993	17			989	182,000
1994	12			538	110,000
1995	15			844	124,000
1996	24			650	99,200
1997	25			799	122,000
1998	28			653	117,000
1999	27			826	136,000
2000	30			248	57,800
2001	31			826	85,200
2002	29			712	63,900
2003	22			259	45,100
2004	30			601	68,500
2005	15	EWI, EDI/DI	D-96	718	73,400
2006	14			216	41,700
2007	14			465	79,100
2008	12			783	115,000

^a Number of samples based on data available in USGS NWIS database as of 5/20/2010.

^b Annual streamflow-weighted mean suspended-sediment concentration calculated by dividing annual suspended-sediment load (table 3) by annual mean streamflow.

^c Source: U.S. Geological Survey (2009).

samples comprising a sample were averaged to obtain a single mean concentration and particle-size fraction (if available) for a given sample date. Suspended-sand concentrations were determined by multiplying the suspended-sediment load by the corresponding sand fraction. If concurrent depth-integrated and point sample data were available for the same sample date only the depth-integrated samples were used in sediment-load computations. The computed point sample averages only were used to supplement missing depth-integrated data.

Depth-integrated sample averages were computed using a simple arithmetic average, whereas the method of determining the average of the point-sample concentrations and size fractions varied by site. Point samples were available for the Missouri River mainstem stations at Sioux City, Iowa (station 06486000) ; Omaha, Nebraska (station 06610000), Nebraska City, Nebraska (station 06807000); Saint Joseph (station 06818000), Kansas City (station 06893000), and Hermann (station 06934500), Missouri; and for the Kansas River near Desoto, Kansas (station 06892350). When available, a comparison of concurrent depth-integrated and point-sample SSCs was used to determine the method (for example, discharge weighted, area weighted, velocity weighted, arithmetic average, or average of samples collected at 20, 50, and 80 percent fractions of total depths) that provided the best agreement [lowest root mean square error (RMSE)] between the averaged point sample values and the depth-integrated values. Archived sediment records from the USACE indicated that the velocity-weighted (U.S. Army Corps of Engineers, unpub. data, 1966) and discharge-weighted (U.S. Army Corps of Engineers, unpub. data, 1973–75) approaches historically had been used in comparisons of point-sample and depth-integrated SSCs. A sub-sample of SSCs from 100 concurrent depth-integrated and point-sampled verticals from the Missouri River at Saint Joseph (station 06818000; 1951–2004), Kansas City (station 06893000; 1948–2004), and Hermann (station 06934500; 1972–2004), Missouri stations, were used to determine the averaging method that provided the best agreement between depth-integrated and point-sample SSC averages. The velocity-weighted average of point samples provided the best agreement with depth-integrated samples at the Missouri River at Saint Joseph [station 06818000; lowest RMSE of 374 milligrams per liter (mg/L)] and Kansas City, Missouri (station 06893000; lowest RMSE of 237 mg/L) stations, whereas the average of the point samples collected at the 20, 50, and 80-percent fractions of total depth provided the best agreement (lowest RMSE of 129 mg/L) at Hermann, Missouri (station 06934500; except for concentrations greater than 2,000 mg/L in which case the velocity-weighted samples provided the best agreement). Concurrent depth-integrated and point-sample SSCs were not available for the Missouri River stations at Sioux City, Iowa, Omaha, Nebraska, Nebraska City, Nebraska (1977–91) or the Kansas River near Desoto, Kansas (1976–82) and, therefore, the velocity-weighted averaging approach was selected to determine average point-sample SSCs at these stations.

Turbidity and Streamflow

Additional USGS NWIS data used in the computation of suspended-sediment and suspended sand loads included instantaneous turbidity values and daily streamflow. Turbidity data were collected using submersible-type nephelometric sensors and the methods used in the collection of these data are described in Wagner and others (2006). Daily mean streamflows also were retrieved from NWIS and used in the computation of annual suspended-sediment and suspended-sand loads. Instantaneous (usually hourly) turbidity and streamflow values were used in the computation of annual suspended-sediment loads at five stations and these data were available in the NWIS database (US Geological Survey, 2009) and at <http://nrtwq.usgs.gov>.

Methods of Sediment Load Estimation

Annual suspended-sediment and suspended-sand loads provided in this report were determined using three techniques: (1) the subdivision method; (2) regression of instantaneous turbidity with SSC values at select stations; or (3) by the Load Estimator (LOADEST) regression technique (Runkel and others, 2004). A description of the methods used in the determination of total suspended-sediment and suspended-sand loads follows.

Subdivision Method

The subdivision (Porterfield, 1972) or “day to day” method was used for the computation of all reported published and unpublished sediment loads provided in this report. Suspended sediment loads were computed using the subdivision method by the USGS at the Missouri River Sioux City, Iowa (station 06486000) ; Omaha, Nebraska (station 06610000), Nebraska City, Nebraska (station 06807000); (Joseph Gorman, U.S. Geological Survey, written commun., 2010). The sediment loads at the Nodaway River at Clarinda, Iowa station from 1976–92 also were computed by the USGS using the subdivision method. In this method a daily observed or estimated SSC is multiplied by the corresponding daily streamflow to obtain a daily load. A continual trace of SSCs is developed for the period of interest using sampled SSCs and estimates of SSCs for intervals between times of sample collection. These estimates were made using a relation of discharge to SSC known as a sediment-rating (sediment transport) curve as described by Horowitz (2003). From 1998–2001 the computation of sediment loads at these stations was facilitated using the software Sediment-Record Calculations (SEDCALC; Koltun and others, 1994) and for 2002–08 the suspended-sediment loads were determined using the software Graphical Constituent Loading Analysis System (GCLAS; Koltun and others, 2006). The method used by the USACE for the 1976–81 suspended-sediment

and suspended-sand loads at the Missouri River at Saint Joseph (station 06818000), Kansas City (station 06893000), and Hermann (station 06934500), Missouri stations was not specified but likely was the subdivision method as it was used in load calculations by the USACE between 1937–1974 (U.S. Army Corps of Engineers, 1951, 1957, 1965, 1970, 1972, 1976).

Regression of Turbidity with Suspended Sediment

A second method used in the computation of annual suspended-sediment loads for five Missouri River mainstem stations for 2006–08 was a regression model determined from instantaneous turbidity and SSC values. Missouri River stations for which turbidity record was used in load computation included Yankton, South Dakota, Council Bluffs, Iowa (station 06610505), Nebraska City, Nebraska (station 06807000), Saint Joseph (station 06818000), and Hermann (station 06934500), Missouri. A detailed description of the

technique is provided in Rasmussen and others (2009). A linear regression model was developed between observed instantaneous turbidity data and SSC values collected during 2006 through 2008. Outliers in the turbidity–SSC relation were identified as any data point with a regression residual greater than 1.5 times the interquartile range (central 50th percentile of the data distribution) of all the residuals. After identification, the outlier was evaluated for leverage. If an outlier significantly affected the slope or intercept of a regression, it was removed (filtered) from the regression analysis (fig. 2).

Transformation of the variables was explored to ensure that the residuals met the assumed characteristics of linear regression. This was determined by the distribution of the data on an plot of turbidity and SSC. Regressions developed from log-log transformed data often were skewed negatively for high turbidity values. Despite heteroscedastic residual distribution, and in some cases, a slightly larger estimate of error, a single site-specific model was developed from non-transformed data to better represent the high end of the turbidity–SSC relation (fig. 2).

Figure 2. Comparison of turbidity to suspended-sediment concentration in water from U.S. Geological Survey streamgauge on Missouri River at Hermann (station 06934500), Missouri, October 2004–October 2009.

For periods when turbidity values were unavailable or were truncated [values greater than 1200 Formazin Nephelometric Units (FNU)] as a result of high SSC values, SSC was estimated using a sediment rating developed from streamflow. Streamflow-estimated SSC typically has a greater estimated uncertainty (Walling, 1977) and rarely matches with turbidity-estimated SSC. To account for this, a shift was applied to the streamflow-estimated SSC to match the turbidity-estimated SSC value at the start and end points of the missing periods. This estimation method is very similar to the subdivision method described in Porterfield (1972).

Resulting SSC models and model calibration data developed from the observed turbidity-SSC pairs can be found at http://nrtwq.usgs.gov/explore/modelinfo?site_no=06467500&pcode=99409SED15&period=2009_all×tep=uv for the Missouri River at Yankton, South Dakota (station 06467500); http://nrtwq.usgs.gov/explore/modelinfo?site_no=06610505&pcode=99409SED15&period=2009_all×tep=uv for the Missouri River near Council Bluffs, Iowa (station 06610505), http://nrtwq.usgs.gov/explore/modelinfo?site_no=06807000&pcode=99409SED15&period=2007_all×tep=uv for the Missouri River at Nebraska City, Nebraska (station 06807000), http://nrtwq.usgs.gov/explore/modelinfo?site_no=06818000&pcode=99409SED15&period=2007_all×tep=uv for the Missouri River at St. Joseph, Missouri (station 06818000), and http://nrtwq.usgs.gov/explore/modelinfo?site_no=06934500&pcode=99409SED15&period=2007_all×tep=uv for the Missouri River at Hermann, Missouri (station 06934500). Station-specific hourly SSC, and hourly, monthly, and annual suspended-sediment loads also are provided.

Load Estimator (LOADEST)

A third method of the determination of suspended-sediment and suspended-sand loads was by means of regression techniques using the computer program LOADEST (Runkel and others, 2004). More specifically, the S-LOADEST version of the program written for the commercial statistical package TIBCO Spotfire S+ (TIBCO Software Inc., version 8.1) was used in the sediment load estimates. LOADEST incorporates explanatory variables of streamflow (either a linear or quadratic relation), time (either a linear or quadratic relation), and season into one of nine predefined regression models. These models were fit to observed streamflow-SSC or streamflow-suspended sand concentration data pairs using adjusted-maximum-likelihood-estimation (AMLE) techniques (Cohn, 1988) or, more specifically, the maximum likelihood estimation (MLE) method since the dataset was uncensored (Cohn and others, 1992). Streamflow, suspended-sediment and suspended-sand concentration data used in the LOADEST models are summarized by site in [appendix 1](#). Model fit was judged using the Akaike Information Criterion (AIC) (Judge and others, 1988). Both the AMLE and MLE methods are contingent

upon the assumption that model residuals were normally distributed and this was assessed by means of the Turnbull-Weiss likelihood ratio (Turnbull and Weiss, 1978) within S-LOADEST. About 14 percent of models selected using the AIC did not meet the normality assumption and in these cases the Least Absolute Deviation (LAD) model technique was used in lieu of the AMLE technique as LAD load estimates are not dependent on the normality assumption. Once a model was selected, loads were determined using a specified time series of daily streamflow. LOADEST output consisted of a mean load, 95-percent confidence-interval estimates of mean load, standard error of prediction, and total load for any specified time interval. In addition to the standard LOADEST statistical output, the coefficient of variation (CV) or “relative variability” for each LOADEST model also was computed as the ratio of the standard error of prediction and mean load. A dimensionless value expressed as a percent, the model CV provides an indication of the relative error in model prediction. The lower the CV computed, the lower the relative error in model prediction. LOADEST output for the LAD models did not include the 95-percent confidence interval estimates of mean load or standard error of prediction, and, therefore, CV values were not determined for the LAD models.

Rather than developing a single model to estimate loads for the range of available sediment concentrations at a particular station, sediment-load models were developed using a moving window approach. The load model for a given year was computed using 3, 5, or 7 years of total suspended-sediment or suspended-sand concentration data centered about the year of interest. The computation window interval varied depending on sediment data availability. The minimum computation window of 3 years was used whenever possible. This approach allowed for the incorporation of short term (3 to 7 year) changes in the sediment transport-streamflow relation, while including sufficient model-calibration data from adjacent years to meet LOADEST minimum data input requirements, and extend the range of streamflows represented by the observed suspended-sediment concentrations.

Annual Suspended-Sediment Loads and Yields

Annual suspended-sediment and suspended-sand load estimates (in tons) at 18 selected stations in the lower Missouri River Basin for the period encompassing 1976–2008 are presented in table 3. Annual suspended-sediment and suspended-sand yield estimates, computed as load per unit area (tons per square mile), are given in table 4. The time periods used for the summary statistics of the annual load estimates vary by station because they are limited to available data. The time periods can be inferred by inspecting data availability in table 1.

Table 3. Annual suspended-sediment and suspended-sand loads, and annual LOADEST model characteristics, for selected sediment stations in the lower Missouri River Basin, 1976-2008.

[r², regression model coefficient of determination; --, no data or not applicable; >, greater than; mm, millimeters]

Water Year	Load (tons)	LOADEST model r ²		Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06467500 Missouri River at Yankton, South Dakota											
2001	271,000	78	20	179,000	393,000	--	--	--	--	--	--
2002	231,000	78	14	174,000	302,000	--	--	--	--	--	--
2003	241,000	75	15	177,000	320,000	--	--	--	--	--	--
2004	284,000	82	17	199,000	392,000	--	--	--	--	--	--
2005	282,000	71	22	182,000	419,000	--	--	--	--	--	--
2006	220,000 [222,000] ^c	57	16	158,000	299,000	--	--	--	--	--	--
2007	163,000 [214,000] ^c	53	15	120,000	216,000	--	--	--	--	--	--
2008	153,000 [183,000] ^c	53	15	113,350	203,000	--	--	--	--	--	--
06478500 James River at Scotland, South Dakota											
1976	26,700	98	6	21,800	27,800	--	--	--	--	--	--
1977	14,400	98	8	12,200	16,800	--	--	--	--	--	--
1978	100,000	98	9	84,700	118,000	--	--	--	--	--	--
1979	64,700	98	8	55,400	75,100	--	--	--	--	--	--
1980	12,700	95	10	10,300	15,400	--	--	--	--	--	--
1981	2,170	93	12	1,690	2,740	--	--	--	--	--	--
1982	41,100	94	25	24,500	64,900	--	--	--	--	--	--
1983	129,000	--	--	--	--	--	--	--	--	--	--
1984	278,000	92	23	174,000	422,000	--	--	--	--	--	--

Water Year	Load (tons)	LOADEST model r ²	LOADEST model coefficient of variation ^a (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06478500 James River at Scotland, South Dakota—Continued											
1985	64,300	--	--	--	--	--	--	--	--	--	--
1986	317,000	--	--	--	--	--	--	--	--	--	--
1987	110,000	--	--	--	--	--	--	--	--	--	--
1988	13,700	96	19	9,290	19,600	--	--	--	--	--	--
1989	13,400	93	22	8,660	20,000	--	--	--	--	--	--
1990	9,090	94	18	6,250	12,800	--	--	--	--	--	--
1991	34,800	94	21	22,400	51,500	--	--	--	--	--	--
1992	22,500	96	16	16,200	30,600	--	--	--	--	--	--
1993	189,000	--	--	--	--	--	--	--	--	--	--
1994	160,000	96	15	118,000	211,000	--	--	--	--	--	--
1995	366,000	93	27	212,000	591,000	--	--	--	--	--	--
06485500 Big Sioux River at Akron, Iowa											
1976	99,200	95	18	69,200	138,000	--	--	--	--	--	--
1977	63,500	93	19	42,800	90,800	--	--	--	--	--	--
1978	510,000	94	19	348,000	717,000	--	--	--	--	--	--
1979	629,000	--	--	--	--	--	--	--	--	--	--
1980	614,000	--	--	--	--	--	--	--	--	--	--
1981	205,000	--	--	--	--	--	--	--	--	--	--
1982	368,000	77	39	163,000	721,000	--	--	--	--	--	--
1983	1,600,000	74	95	242,000	5,570,000	--	--	--	--	--	--

Table 3. Annual suspended-sediment and suspended-sand loads, and annual LOADEST model characteristics, for selected sediment stations in the lower Missouri River Basin, 1976-2008—Continued

[r², regression model coefficient of determination; --, no data or not applicable; >, greater than; mm, millimeters]

Water Year	Load (tons)	LOADEST model r ²	LOADEST model coefficient of variation ^a (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06485500 Big Sioux River at Akron, Iowa—Continued											
1984	3,120,000	88	44	1,240,000	6,550,000	--	--	--	--	--	--
1985	788,000	86	33	402,000	1,400,000	--	--	--	--	--	--
1986	2,410,000	87	45	957,000	5,070,000	--	--	--	--	--	--
1987	688,000	86	33	350,000	1,220,000	--	--	--	--	--	--
1988	240,000	86	33	141,000	383,000	--	--	--	--	--	--
1989	148,000	91	24	91,100	228,000	--	--	--	--	--	--
1990	199,000	91	24	121,000	308,000	--	--	--	--	--	--
1991	163,000	93	21	106,000	240,000	--	--	--	--	--	--
1992	608,000	93	21	400,000	888,000	--	--	--	--	--	--
1993	4,680,000	93	34	2,320,000	8,480,000	--	--	--	--	--	--
1994	1,420,000	93	23	881,000	2,170,000	--	--	--	--	--	--
06486000 Missouri River at Sioux City, Iowa											
1976	19,400,000 ^d	--	--	--	--	--	--	--	--	--	--
1977	11,500,000	--	--	--	--	--	--	--	--	--	--
1978	13,800,000	62	15	10,100,000	18,400,000	--	--	--	--	--	--
1979	19,300,000	--	--	--	--	--	--	--	--	--	--
1980	10,600,000	75	8	9,040,000	12,500,000	--	--	--	--	--	--

Water Year	Load (tons)	LOADEST model r ²	LOADEST model coefficient of variation ^a (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06486000 Missouri River at Sioux City, Iowa—Continued											
1981	10,900,000	61	11	8,750,000	13,400,000	64	7,010,000	69	9	5,830,000	8,370,000
1982	7,880,000	61	10	6,500,000	9,460,000	73	5,740,000	69	12	4,540,000	7,180,000
1983	15,400,000	--	--	--	--	62	9,570,000	79	8	8,110,000	11,200,000
1984	18,800,000	--	--	--	--	50	9,410,000	80	6	8,280,000	10,700,000
1985	15,200,000	77	11	11,200,000	20,100,000	57	7,450,000	85	8	6,370,000	8,660,000
1986	12,100,000	75	6	10,600,000	13,600,000	61	7,400,000	80	7	6,480,000	8,410,000
1987	9,890,000	70	5	8,970,000	10,900,000	78	7,690,000	73	12	6,040,000	9,650,000
1988	8,190,000	62	7	7,130,000	9,350,000	68	5,540,000	--	--	--	--
1989	6,200,000	76	6	5,540,000	6,910,000	62	3,840,000	--	--	--	--
1990	3,630,000	76	4	3,340,000	3,930,000	61	2,220,000	--	--	--	--
1991	3,930,000	76	3	3,720,000	4,140,000	54	2,120,000	--	--	--	--
1992	4,680,000 ^d	--	--	--	--	--	--	--	--	--	--
1993	8,700,000 ^d	--	--	--	--	--	--	--	--	--	--
1994	6,460,000 ^d	--	--	--	--	--	--	--	--	--	--
1995	9,700,000 ^d	--	--	--	--	--	--	--	--	--	--
1996	15,000,000 ^d	--	--	--	--	--	--	--	--	--	--
1997	20,800,000 ^d	--	--	--	--	--	--	--	--	--	--
1998	12,100,000 ^d	--	--	--	--	--	--	--	--	--	--
1999	9,530,000 ^d	--	--	--	--	--	--	--	--	--	--

Table 3. Annual suspended-sediment and suspended-sand loads, and annual LOADEST model characteristics, for selected sediment stations in the lower Missouri River Basin, 1976-2008—Continued

[r², regression model coefficient of determination; --, no data or not applicable; >, greater than; mm, millimeters]

Water Year	Load (tons)	LOADEST model r ²	LOADEST model coefficient of variation ^a (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06486000 Missouri River at Sioux City, Iowa—Continued											
2000	6,970,000 ^d	--	--	--	--	--	--	--	--	--	--
2004	4,350,000 ^d	--	--	--	--	--	--	--	--	--	--
2005	3,780,000 ^d	--	--	--	--	--	--	--	--	--	--
2006	4,180,000 ^d	--	--	--	--	--	--	--	--	--	--
2007	4,920,000 ^d	--	--	--	--	--	--	--	--	--	--
2008	4,440,000 ^d	--	--	--	--	--	--	--	--	--	--
06610000 Missouri River at Omaha, Nebraska											
1976	21,600,000 ^d	--	--	--	--	79.	17,000,000	--	--	--	--
1977	14,400,000	73	10	11,900,000	17,400,000	74	10,600,000	--	--	--	--
1978	24,600,000	73	9	20,800,000	29,000,000	54	13,400,000	63	8	11,500,000	15,600,000
1979	32,300,000	73	10	26,500,000	38,900,000	58	18,600,000	91	6	16,400,000	21,000,000
1980	20,500,000	77	11	16,500,000	25,200,000	54	11,100,000	94	5	10,100,000	12,200,000
1981	15,000,000	79	10	12,200,000	18,200,000	54	8,160,000	--	--	--	--
1982	14,700,000	79	11	11,900,000	17,900,000	55	8,030,000	--	--	--	--
1983	35,900,000	78	12	28,300,000	44,900,000	52	18,800,000	--	--	--	--
1984	35,600,000	71	10	29,000,000	43,200,000	55	19,700,000	--	--	--	--

Water Year	Load (tons)	LOADEST model r ²	LOADEST model coefficient of variation ^a (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06610000 Missouri River at Omaha, Nebraska—Continued											
1985	24,300,000	68	9	20,300,000	28,900,000	67	16,200,000	--	--	--	--
1986	28,100,000	67	14	21,300,000	36,400,000	46	12,800,000	--	--	--	--
1987	22,600,000	68	13	17,400,000	29,000,000	62	13,900,000	--	--	--	--
1988	11,800,000	--	--	--	--	62	7,360,000	86	17	5,240,000	10,100,000
1989	8,330,000	59	7	7,220,000	9,570,000	48	4,040,000	75	9	3,390,000	4,780,000
1990	9,230,000	59	15	6,830,000	12,200,000	33	3,080,000	75	8	2,650,000	3,560,000
1991	11,900,000	59	21	7,800,000	17,400,000	29	3,450,000	75	7	2,980,000	3,990,000
1992	10,700,000 ^d	--	--	--	--	--	--	--	--	--	--
1993	28,200,000 ^d	--	--	--	--	--	--	--	--	--	--
1994	16,200,000 ^d	--	--	--	--	--	--	--	--	--	--
1995	17,400,000 ^d	--	--	--	--	--	--	--	--	--	--
1996	28,200,000 ^d	--	--	--	--	--	--	--	--	--	--
1997	32,500,000 ^d	--	--	--	--	--	--	--	--	--	--
1998	23,000,000 ^d	--	--	--	--	--	--	--	--	--	--
1999	17,400,000 ^d	--	--	--	--	--	--	--	--	--	--
2000	9,750,000 ^d	--	--	--	--	--	--	--	--	--	--
2001	15,900,000 ^d	--	--	--	--	--	--	--	--	--	--
2002	6,760,000 ^d	--	--	--	--	--	--	--	--	--	--
2003	9,850,000 ^d	--	--	--	--	--	--	--	--	--	--

Table 3. Annual suspended-sediment and suspended-sand loads, and annual LOADEST model characteristics, for selected sediment stations in the lower Missouri River Basin, 1976-2008—Continued

[r², regression model coefficient of determination; --, no data or not applicable; >, greater than; mm, millimeters]

Water Year	Load (tons)	LOADEST model r ²	LOADEST model coefficient of variation ^a (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06610000 Missouri River at Omaha, Nebraska—Continued											
2004	9,780,000	--	--	--	--	--	--	--	--	--	--
2005	8,100,000	81	14	6,100,000	10,600,000	--	--	--	--	--	--
2006	5,800,000	90	12	4,530,000	7,310,000	--	--	--	--	--	--
2007	10,400,000	90	18	7,250,000	14,500,000	--	--	--	--	--	--
2008	12,400,000	--	--	--	--	--	--	--	--	--	--
	[5,870,000] ^c										
	[8,010,000] ^c										
	[10,500,000] ^c										
06805500 Platte River at Louisville, Nebraska											
1976	2,110,000	88	13	1,610,000	2,720,000	--	--	--	--	--	--
1977	4,280,000	89	16	3,070,000	5,820,000	--	--	--	--	--	--
1978	15,100,000	85	32	7,740,000	26,500,000	--	--	--	--	--	--
1979	7,080,000	85	19	4,820,000	10,000,000	--	--	--	--	--	--
1980	7,960,000	76	20	5,250,000	11,600,000	--	--	--	--	--	--
1981	2,370,000	82	16	1,710,000	3,200,000	--	--	--	--	--	--
1982	15,800,000	84	32	8,170,000	27,700,000	--	--	--	--	--	--
1983	31,500,000	90	31	16,500,000	54,800,000	--	--	--	--	--	--
1984	57,400,000	89	42	23,900,000	117,000,000	--	--	--	--	--	--
1985	10,600,000	83	19	7,170,000	15,100,000	--	--	--	--	--	--
1986	13,000,000	87	22	8,360,000	19,300,000	--	--	--	--	--	--
1987	20,300,000	87	39	9,060,000	39,600,000	--	--	--	--	--	--

Water Year	Load (tons)	LOADEST model r ²	LOADEST model coefficient of variation ^a (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06805500 Platte River at Louisville, Nebraska—Continued											
1988	2,590,000	--	--	--	--	--	--	--	--	--	--
1989	3,560,000	86	42	1,500,000	7,190,000	--	--	--	--	--	--
1990	12,200,000	--	--	--	--	--	--	--	--	--	--
1991	15,000,000	82	44	5,960,000	31,500,000	--	--	--	--	--	--
1992	5,280,000	83	14	3,940,000	6,930,000	--	--	--	--	--	--
1993	81,100,000	82	39	36,400,000	157,000,000	--	--	--	--	--	--
1994	6,840,000	84	20	4,520,000	9,940,000	--	--	--	--	--	--
1995	20,200,000	80	36	9,580,000	37,600,000	--	--	--	--	--	--
1996	15,200,000	80	17	10,700,000	20,900,000	--	--	--	--	--	--
1997	9,820,000	79	17	6,940,000	13,500,000	--	--	--	--	--	--
1998	19,800,000	80	17	13,900,000	27,300,000	--	--	--	--	--	--
1999	25,700,000	81	20	17,100,000	37,100,000	--	--	--	--	--	--
2000	4,850,000	86	12	3,780,000	6,140,000	--	--	--	--	--	--
2001	9,690,000	81	24	5,870,000	15,100,000	--	--	--	--	--	--
2002	2,810,000	78	18	1,950,000	3,920,000	--	--	--	--	--	--
2003	3,130,000	73	24	1,930,000	4,800,000	--	--	--	--	--	--
2004	4,480,000	82	31	2,380,000	7,690,000	--	--	--	--	--	--
2005	7,300,000	88	31	3,880,000	12,600,000	--	--	--	--	--	--
2006	2,330,000	84	11	1,850,000	2,890,000	--	--	--	--	--	--
2007	10,900,000	87	16	7,810,000	14,700,000	--	--	--	--	--	--
2008	18,200,000	87	21	11,900,000	26,700,000	--	--	--	--	--	--

Table 3. Annual suspended-sediment and suspended-sand loads, and annual LOADEST model characteristics, for selected sediment stations in the lower Missouri River Basin, 1976-2008—Continued

[r², regression model coefficient of determination; --, no data or not applicable; >, greater than; mm, millimeters]

[illegible]

Water Year	Load (tons)	LOADEST model r ²	LOADEST model coefficient of variation ^a (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06807000 Missouri River at Nebraska City, Nebraska—Continued											
1994	26,200,000 ^d	--	--	--	--	--	--	--	--	--	--
1995	29,100,000 ^d	--	--	--	--	--	--	--	--	--	--
1996	51,400,000 ^d	--	--	--	--	--	--	--	--	--	--
1997	41,200,000 ^d	--	--	--	--	--	--	--	--	--	--
1998	38,700,000 ^d	--	--	--	--	--	--	--	--	--	--
1999	31,500,000 ^d	--	--	--	--	--	--	--	--	--	--
2000	14,200,000 ^d	--	--	--	--	--	--	--	--	--	--
2001	23,000,000 ^d	--	--	--	--	--	--	--	--	--	--
2002	11,200,000 ^d	--	--	--	--	--	--	--	--	--	--
2003	14,700,000 ^d	--	--	--	--	--	--	--	--	--	--
2004	16,300,000 ^d	--	--	--	--	--	--	--	--	--	--
2005	14,300,000 ^d	--	--	--	--	--	--	--	--	--	--
2006	9,330,000 ^d [7,780,000] ^c	--	--	--	--	--	--	--	--	--	--
2007	22,100,000 ^d [17,200,000] ^c	--	--	--	--	--	--	--	--	--	--
2008	33,800,000 ^d [18,000,000] ^c	--	--	--	--	--	--	--	--	--	--
06810000 Nishnabotna River at Hamburg, Iowa											
1982	6,190,000	94	39	2,750,000	12,100,000	--	--	--	--	--	--
1984	14,600,000	94	42	6,090,000	29,800,000	--	--	--	--	--	--
1985	551,000	92	21	357,000	812,000	--	--	--	--	--	--
1986	4,930,000	94	35	2,390,000	9,070,000	--	--	--	--	--	--

Table 3. Annual suspended-sediment and suspended-sand loads, and annual LOADEST model characteristics, for selected sediment stations in the lower Missouri River Basin, 1976-2008—Continued

[r², regression model coefficient of determination; --, no data or not applicable; >, greater than; mm, millimeters]

[illegible]

Water Year	Load (tons)	LOADEST model r ²	LOADEST model coefficient of variation ^a (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06817000 Nodaway River at Clarinda, Iowa—Continued											
1980	1,140,000 ^d	--	--	--	--	--	--	--	--	--	--
1981	203,000 ^d	--	--	--	--	--	--	--	--	--	--
1982	5,850,000 ^d	--	--	--	--	--	--	--	--	--	--
1983	1,370,000 ^d	--	--	--	--	--	--	--	--	--	--
1984	2,770,000 ^d	--	--	--	--	--	--	--	--	--	--
1985	453,000 ^d	--	--	--	--	--	--	--	--	--	--
1986	3,530,000 ^d	--	--	--	--	--	--	--	--	--	--
1987	3,270,000 ^d	--	--	--	--	--	--	--	--	--	--
1988	15,900 ^d	--	--	--	--	--	--	--	--	--	--
1989	2,680,000 ^d	--	--	--	--	--	--	--	--	--	--
1990	1,610,000 ^d	--	--	--	--	--	--	--	--	--	--
1991	4,090,000 ^d	--	--	--	--	--	--	--	--	--	--
1992	1,270,000 ^d	--	--	--	--	--	--	--	--	--	--
06818000 Missouri River at St. Joseph, Missouri											
1976	(33,300,000) ^e	--	--	--	--	50	(16,600,000) ^e	--	--	--	--
1977	(21,300,000) ^e	--	--	--	--	59	(12,500,000) ^e	--	--	--	--
1978	(37,400,000) ^e	--	--	--	--	51	(19,100,000) ^e	--	--	--	--
1979	(37,300,000) ^e	--	--	--	--	46	(17,000,000) ^e	--	--	--	--
1980	(36,700,000) ^e	--	--	--	--	30	(10,900,000) ^e	--	--	--	--
1981	(22,900,000) ^e	--	--	--	--	36	(8,920,000) ^e	--	--	--	--

Table 3. Annual suspended-sediment and suspended-sand loads, and annual LOADEST model characteristics, for selected sediment stations in the lower Missouri River Basin, 1976-2008—Continued

[r², regression model coefficient of determination; --, no data or not applicable; >, greater than; mm, millimeters]

Water Year	Load (tons)	LOADEST model r ²	LOADEST model coefficient of variation ^a (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06818000 Missouri River at St. Joseph, Missouri—Continued											
1982	54,400,000	79	17	38,800,000	74,200,000	50	27,200,000 ^f	43	22	17,300,000	40,600,000
1983	122,000,000	--	--	--	--	37	45,200,000	54	50	16,100,000	102,000,000
1984	115,000,000 ^f	48	57	35,200,000	281,000,000	24	28,100,000 ^f	12	84	5,140,000	89,900,000
1985	35,100,000	--	--	--	--	40	14,300,000 ^f	42	30	7,770,000	24,200,000
1986	60,000,000 ^f	39	26	34,900,000	96,500,000	34	20,600,000	--	--	--	--
1987	74,600,000	51	24	45,900,000	115,000,000	34	25,500,000	--	--	--	--
1988	19,400,000	55	11	15,500,000	24,000,000	57	11,100,000	--	--	--	--
1989	23,100,000	--	--	--	--	42	9,680,000	58	13	7,460,000	12,400,000
1990	33,000,000	78	22	20,900,000	49,800,000	22	7,350,000	73	9	6,160,000	8,700,000
1991	28,900,000	85	18	19,900,000	40,700,000	21	6,000,000	79	6	5,300,000	6,770,000
1992	29,500,000	78	14	22,300,000	38,400,000	27	7,930,000	82	7	6,910,000	9,040,000
1993	136,000,000	82	34	67,500,000	246,000,000	16	21,500,000	82	17	15,100,000	29,700,000
1994	26,900,000	88	10	21,800,000	32,700,000	33	8,880,000	92	5	7,980,000	9,850,000
1995	31,900,000	84	13	24,400,000	41,100,000	33	10,600,000	--	--	--	--
1996	38,800,000	87	9	32,700,000	45,600,000	38	14,800,000	91	6	13,100,000	16,700,000
1997	60,600,000	83	11	48,700,000	74,600,000	38	22,800,000	89	7	19,700,000	26,200,000
1998	47,700,000	86	11	38,100,000	58,900,000	31	14,700,000	92	7	12,800,000	16,700,000
1999	61,500,000	87	14	46,500,000	79,900,000	22	13,300,000	--	--	--	--

Water Year	Load (tons)	LOADEST model r ²	LOADEST model coefficient of variation ^a (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06818000 Missouri River at St. Joseph, Missouri—Continued											
2000	15,600,000	91	10	12,900,000	18,800,000	39	6,120,000	89	11	4,920,000	7,520,000
2001	37,400,000	76	20	24,900,000	53,900,000	20	7,400,000	74	11	5,920,000	9,130,000
2002	13,600,000	77	12	10,700,000	17,200,000	28	3,790,000	79	9	3,190,000	4,470,000
2003	20,700,000	--	--	--	--	19	3,910,000	83	5	3,520,000	4,330,000
2004	26,200,000	--	--	--	--	18	4,840,000	--	--	--	--
2005	16,100,000	85	10	13,300,000	19,400,000	18	2,860,000	--	--	--	--
2006	11,500,000 [9,630,000] ^c	75	7	9,890,000	13,200,000	--	--	--	--	--	--
2007	29,200,000 [40,300,000] ^c	93	9	24,300,000	34,700,000	--	--	--	--	--	--
2008	39,300,000 [41,200,000] ^c	93	11	31,600,000	48,200,000	--	--	--	--	--	--
06821190 Platte River at Sharps Station, Missouri											
1980	1,530,000	--	--	--	--	9	135,000	--	--	--	--
1981	1,720,000	--	--	--	--	10	177,000	--	--	--	--
1982	27,400,000	--	--	--	--	4	1,040,000	62	151	67,900	4,870,000
1983	4,670,000	79	102	631,000	17,100,000	9	419,000	79	66	108,000	1,140,000
1984	10,800,000	75	113	1,210,000	42,200,000	4	453,000	78	74	99,000	1,330,000
1985	989,000	75	89	166,000	3,300,000	13	82,300	77	60	23,800	209,000
1986	7,230,000	81	101	976,000	26,400,000	11	410,000	84	59	122,000	1,030,000
1987	2,620,000	83	83	485,000	8,370,000	20	205,000	88	51	70,600	470,000
1988	296,000	82	61	83,300	765,000	20	26,600	88	36	12,600	49,700
1989	619,000	91	65	162,000	1,660,000	17	30,600	88	58	9,140	76,600

Table 3. Annual suspended-sediment and suspended-sand loads, and annual LOADEST model characteristics, for selected sediment stations in the lower Missouri River Basin, 1976-2008—Continued

[r², regression model coefficient of determination; --, no data or not applicable; >, greater than; mm, millimeters]

Water Year	Load (tons)	LOADEST model r ²	LOADEST model coefficient of variation ^a (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06821190 Platte River at Sharps Station, Missouri—Continued											
1990	1,520,000	90	46	583,000	3,260,000	18	84,300	88	43	34,500	174,000
1991	977,000	90	46	374,000	2,100,000	18	55,800	88	43	23,100	114,000
1992	2,200,000	90	54	719,000	5,230,000	17	110,000	88	48	40,300	244,000
06892350 Kansas River at DeSoto, Kansas											
1976	4,330,000	85	27	2,460,000	7,070,000	10	419,000	77	37	197,000	789,000
1977	19,300,000	85	26	11,300,000	30,900,000	8	1,640,000	77	37	760,000	3,110,000
1978	6,440,000	85	12	5,080,000	8,060,000	13	810,000	79	25	485,000	1,270,000
1979	13,200,000	87	13	10,100,000	16,900,000	26	3,460,000	78	32	1,800,000	6,040,000
1980	6,700,000	91	16	4,840,000	9,070,000	19	1,290,000	92	43	532,000	2,640,000
1981	4,640,000	92	17	3,280,000	6,360,000	7	306,000	92	47	115,000	663,000
1982	21,900,000	92	14	16,500,000	28,400,000	--	--	--	--	--	--
1983	6,220,000	90	18	4,330,000	8,670,000	--	--	--	--	--	--
1984	17,200,000	94	30	9,260,000	29,400,000	--	--	--	--	--	--
1985	4,120,000	93	24	2,490,000	6,430,000	--	--	--	--	--	--
1986	11,800,000	89	36	5,620,000	22,100,000	--	--	--	--	--	--
1987	23,100,000	93	29	12,700,000	38,700,000	--	--	--	--	--	--
1988	577,000	94	16	414,000	782,000	--	--	--	--	--	--
1989	4,360,000	90	48	1,600,000	9,620,000	--	--	--	--	--	--

Water Year	Load (tons)	LOADEST model r ²	LOADEST model coefficient of variation ^a (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06892350 Kansas River at DeSoto, Kansas—Continued											
1990	8,000,000	90	44	3,200,000	16,700,000	--	--	--	--	--	--
1991	1,550,000	90	35	749,000	2,850,000	--	--	--	--	--	--
06893000 Missouri River at Kansas City, Missouri											
1976	(53,400,000) ^c	--	--	--	--	35	(18,700,000) ^c	--	--	--	--
1977	(25,100,000) ^c	--	--	--	--	62	(15,600,000) ^c	--	--	--	--
1978	(51,600,000) ^c	--	--	--	--	58	(29,900,000) ^c	--	--	--	--
1979	(54,200,000) ^c	--	--	--	--	38	(20,800,000) ^c	--	--	--	--
1980	(45,800,000) ^c	--	--	--	--	34	(15,600,000) ^c	--	--	--	--
1981	(30,000,000) ^c	--	--	--	--	33	(9,880,000) ^c	--	--	--	--
1988	19,000,000	92	26	11,000,000	30,500,000	56	10,700,000	82	12	8,330,000	13,400,000
1989	23,800,000	92	20	15,900,000	34,200,000	32	7,650,000	82	10	6,290,000	9,210,000
1990	45,300,000	93	16	32,500,000	61,500,000	20	9,250,000	86	6	8,290,000	10,300,000
1991	32,700,000	91	16	23,700,000	44,100,000	22	7,320,000	84	5	6,580,000	8,120,000
1992	35,200,000	--	--	--	--	27	9,520,000	--	--	--	--
1993	163,000,000	81	32	83,800,000	287,000,000	17	27,900,000	77	13	21,700,000	35,400,000
1994	35,600,000	83	10	29,100,000	43,100,000	33	11,900,000	69	5	10,700,000	13,200,000
1995	59,000,000	88	16	42,600,000	79,800,000	24	14,200,000 ^f	44	7	11,500,000	1,530,000
1996	40,200,000	94	11	32,100,000	49,800,000	52	20,700,000	--	--	--	--
1997	94,000,000	89	14	71,400,000	122,000,000	33	31,200,000	--	--	--	--
1998	68,500,000	80	12	54,300,000	85,200,000	26	18,000,000	--	--	--	--

Table 3. Annual suspended-sediment and suspended-sand loads, and annual LOADEST model characteristics, for selected sediment stations in the lower Missouri River Basin, 1976-2008—Continued

[r², regression model coefficient of determination; --, no data or not applicable; >, greater than; mm, millimeters]

Water Year	Load (tons)	LOADEST model r ²	LOADEST model coefficient of variation ^a (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06893000 Missouri River at Kansas City, Missouri—Continued											
1999	114,000,000	85	17	80,200,000	157,000,000	14	16,500,000	--	--	--	--
2000	16,800,000	91	7	13,600,000	20,500,000	32	5,380,000	--	--	--	--
2001	43,200,000	83	11	31,300,000	58,200,000	14	6,000,000	51	11	4,820,000	7,390,000
2002	15,600,000	--	--	--	--	22	3,480,000	58	10	2,860,000	4,200,000
2003	17,300,000	94	8	14,800,000	20,200,000	20	3,550,000	75	7	3,100,000	4,040,000
2004	30,700,000	95	9	25,400,000	36,700,000	18	5,400,000	82	14	4,040,000	7,060,000
2005	30,200,000	--	--	--	--	14	4,300,000	82	14	3,240,000	5,610,000
2006	15,000,000	85	8	12,800,000	17,600,000	--	--	--	--	--	--
2007	56,300,000	88	22	36,200,000	83,600,000	--	--	--	--	--	--
2008	59,200,000	--	--	--	--	--	--	--	--	--	--
06902000 Grand River at Sumner, Missouri											
1976	13,500,000	89	82	2,560,000	42,500,000	15	983,000	73	84	181,000	3,140,000
1977	2,570,000	93	49	926,000	5,750,000	16	551,000	75	80	109,000	1,700,000
1978	22,200,000	95	35	10,600,000	41,200,000	13	3,210,000	--	--	--	--
1979	17,600,000	92	50	6,170,000	39,900,000	21	3,040,000	73	84	551,000	9,770,000
1980	12,300,000	--	--	--	--	13	401,000	--	--	--	--
1981	22,200,000	95	36	10,600,000	41,200,000	7	1,430,000	--	--	--	--
1982	26,900,000	88	72	6,180,000	77,300,000	13	3,980,000	61	93	622,000	13,700,000

Water Year	Load (tons)	LOADEST model r ²	LOADEST model coefficient of variation ^a (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06902000 Grand River at Sumner, Missouri—Continued											
1983	5,180,000	94	39	2,320,000	10,100,000	17	1,370,000	76	53	452,000	3,210,000
1984	8,900,000	89	52	3,060,000	20,500,000	10	1,380,000	82	60	401,000	3,500,000
1985	2,190,000	91	47	834,000	4,730,000	24	515,000	83	88	88,000	1,700,000
1986	18,600,000	--	--	--	--	9	1,120,000	78	62	309,000	2,930,000
1987	11,900,000	92	67	2,960,000	32,700,000	15	1,760,000	88	79	350,000	5,400,000
1988	1,730,000	93	53	578,000	4,050,000	49	854,000	93	115	92,600	3,390,000
1989	1,080,000	92	67	271,000	2,980,000	23	254,000	83	146	17,800	1,160,000
1990	7,600,000	92	55	2,450,000	18,300,000	18	1,360,000	83	108	165,000	5,180,000
1991	13,700,000	95	46	5,300,000	29,400,000	9	1,170,000	84	101	158,000	4,270,000
1992	15,700,000	95	45	6,200,000	33,100,000	5	738,000	84	90	121,000	2,490,000
1993	100,000,000	95	54	32,400,000	238,000,000	2	2,360,000	84	116	251,000	9,440,000
06905500 Chariton River at Prairie Hill, Missouri											
1979	1,750,000	88	41	750,000	3,480,000	18	200,000	87	76	42,400	597,000
1980	2,590,000	91	86	461,000	8,430,000	25	591,000	87	102	78,600	2,170,000
1981	2,590,000	90	76	554,000	7,710,000	35	1,570,000	87	61	444,000	4,040,000
1982	6,200,000	90	38	2,800,000	12,000,000	40	2,500,000	88	45	975,000	5,310,000
1983	4,280,000	93	42	1,800,000	8,650,000	52	2,250,000	89	65	592,000	6,040,000
1984	2,960,000	93	43	1,210,000	6,110,000	40	1,220,000	90	62	341,000	3,150,000
1985	2,990,000	93	47	1,140,000	6,450,000	21	651,000	90	70	156,000	1,830,000
1986	6,040,000	93	42	2,520,000	12,300,000	16	966,000	90	73	218,000	2,800,000

Table 3. Annual suspended-sediment and suspended-sand loads, and annual LOADEST model characteristics, for selected sediment stations in the lower Missouri River Basin, 1976-2008—Continued

[r², regression model coefficient of determination; --, no data or not applicable; >, greater than; mm, millimeters]

Water Year	Load (tons)	LOADEST model r ²	LOADEST model coefficient of variation ^a (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06926510 Osage River at St. Thomas, Missouri											
1976	402,000	75	29	221,000	673,000	40	160,000	57	48	58,600	352,000
1977	642,000	72	52	217,000	1,490,000	41	266,000	55	75	57,900	786,000
1978	1,140,000	82	32	588,000	2,010,000	49	566,000	68	44	228,000	1,180,000
1979	930,000	--	--	--	--	49	460,000	66	32	238,000	805,000
1980	1,240,000	71	57	377,000	3,050,000	52	651,000	67	63	176,000	1,720,000
1981	1,180,000	56	67	294,000	3,250,000	63	758,000	66	71	154,000	1,900,000
1982	1,240,000	72	64	331,000	3,280,000	46	577,000	61	89	97,300	1,920,000
1983	669,000	89	25	397,000	1,060,000	59	401,000	86	46	155,000	859,000
1984	539,000	81	23	335,000	823,000	41	223,000	74	47	83,900	484,000
1985	627,000	78	31	330,000	1,090,000	27	170,000	--	--	--	--
1986	347,000	66	36	163,000	653,000	32	114,000	72	30	62,000	194,000
1987	550,000	72	44	220,000	1,150,000	29	133,000	--	--	--	--
1988	270,000	81	34	133,000	491,000	28	77,700	87	31	41,200	134,000
1989	179,000	89	24	110,000	277,000	57	102,000	--	--	--	--
1990	1,070,000	--	--	--	--	26	283,000	71	79	57,200	866,000

Water Year	Load (tons)	LOADEST model r ²	LOADEST model coefficient of variation ^a (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06926510 Osage River at St. Thomas, Missouri—Continued											
1991	114,000	93	19	77,500	163,000	44	51,700	72	53	17,400	121,000
1992	193,000	93	19	131,000	274,000	39	75,900	72	52	25,800	176,000
1993	949,000	93	22	600,000	1,430,000	47	450,000	72	65	119,000	1,210,000
1994	1,060,000	93	24	645,000	1,660,000	40	435,000	72	69	104,000	1,220,000
06933500 Gasconade River at Jerome, Missouri											
1978	352,000	55	67	88,700	964,000	20	72,500 ^f	30	59	21,600	181,000
1979	456,000 ^f	42	98	65,800	1,620,000	16	107,000 ^f	30	75	22,800	317,000
1980	247,000	73	57	76,400	606,000	31	46,100 ^f	30	40	19,900	91,700
1981	278,000	80	75	60,700	821,000	23	40,100	--	--	--	--
1982	122,000	60	34	60,100	222,000	29	41,100 ^f	38	56	13,000	99,300
1983	373,000	74	92	59,600	1,270,000	20	88,000	--	--	--	--
1984	117,000	--	--	--	--	61	30,400	--	--	--	--
1985	163,000	55	61	46,300	421,000	42	57,600 ^f	19	127	5,240	243,000
1986	51,500 ^f	38	77	10,700	155,000	31	16,700 ^f	11	51	5,800	38,100
1987	75,000 ^f	40	79	15,000	230,000	28	17,800 ^f	15	32	9,170	31,400
1988	77,700 ^f	40	61	21,800	201,000	28	16,800 ^f	22	33	8,440	30,200
1989	127,000	65	46	48,800	272,000	21	30,000	52	66	7,680	81,100
1990	263,000	65	70	62,300	743,000	43	104,000	66	172	5,230	521,000
1991	200,000	74	72	45,700	579,000	30	61,700	51	147	4,220	285,000
1992	109,000	74	52	36,900	252,000	29	32,200	51	82	6,060	102,000
1993	--	--	--	--	--	--	--	--	--	--	--

Table 3. Annual suspended-sediment and suspended-sand loads, and annual LOADEST model characteristics, for selected sediment stations in the lower Missouri River Basin, 1976-2008—Continued

[r², regression model coefficient of determination; --, no data or not applicable; >, greater than; mm, millimeters]

Water Year	Load (tons)	LOADEST model r ²	LOADEST model coefficient of variation ^a (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06934500 Missouri River at Hermann, Missouri											
1976	36,000,000 (37,000,000) ^c	--	--	--	--	38	14,700,000 (14,000,000) ^c	80	7	13,200,000	16,200,000
1977	29,600,000 (26,600,000) ^c	85	8	25,400,000	34,300,000	38	10,300,000 (10,200,000) ^c	--	--	--	--
1978	89,300,000 (66,400,000) ^c	--	--	--	--	43	32,900,000 (28,700,000) ^c	--	--	--	--
1979	79,500,000 (71,100,000) ^c	83	7	68,500,000	91,800,000	32	29,900,000 (22,900,000) ^c	--	--	--	--
1980	40,900,000 (37,500,000) ^c	--	--	--	--	37	15,000,000 (13,700,000) ^c	76	7	13,000,000	17,300,000
1981	59,200,000 (62,100,000) ^c	--	--	--	--	23	14,900,000 (14,100,000) ^c	--	--	--	--
1982	123,000,000	90	11	98,700,000	151,000,000	24	29,700,000	81	11	24,000,000	36,300,000
1983	153,000,000	91	11	123,000,000	188,000,000	22	33,300,000	--	--	--	--
1984	132,000,000	--	--	--	--	25	33,200,000	--	--	--	--
1985	77,900,000	74	13	59,600,000	100,000,000	28	21,700,000	--	--	--	--
1986	82,400,000	66	14	62,100,000	107,000,000	27	22,400,000	--	--	--	--
1987	120,000,000	76	16	86,100,000	163,000,000	25	30,200,000	--	--	--	--
1988	31,200,000	86	9	26,100,000	37,000,000	45	13,900,000	--	--	--	--
1989	25,800,000	92	14	19,400,000	33,800,000	30	7,800,000	75	14	5,880,000	10,200,000
1990	113,000,000	92	16	82,800,000	152,000,000	17	19,300,000	87	14	14,700,000	24,900,000
1991	33,000,000	93	11	26,500,000	40,700,000	24	8,030,000	--	--	--	--
1992	53,600,000	94	12	42,100,000	67,300,000	17	9,040,000	96	11	7,250,000	11,100,000

Water Year	Load (tons)	LOADEST model r ²	LOADEST model coefficient of variation ^a (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)	Percent of total suspended-sediment load as sand (> 0.0625 mm) ^b	Annual suspended load (tons)	LOADEST model r ²	LOADEST model coefficient of variation (percent)	Lower 95-percent confidence interval of LOADEST load estimate (tons)	Upper 95-percent confidence interval of LOADEST load estimate (tons)
06934500 Missouri River at Hermann, Missouri—Continued											
1993	177,000,000	78	18	122,000,000	247,000,000	36	64,000,000	95	10	52,800,000	76,800,000
1994	58,300,000	89	14	43,500,000	76,400,000	36	20,900,000	96	10	16,900,000	25,400,000
1995	103,000,000	87	13	79,800,000	132,000,000	25	25,600,000	87	12	20,000,000	32,200,000
1996	63,500,000	88	9	53,500,000	74,700,000	23	14,400,000	89	7	12,500,000	16,500,000
1997	96,000,000	89	8	82,500,000	111,000,000	29	27,600,000	89	8	23,600,000	32,100,000
1998	75,200,000	83	8	64,400,000	87,300,000	28	21,000,000	--	--	--	--
1999	110,600,000	88	10	89,900,000	135,000,000	28	30,400,000	--	--	--	--
2000	14,100,000	91	7	12,200,000	16,200,000	33	4,700,000	--	--	--	--
2001	69,200,000	90	12	54,900,000	86,000,000	20	13,900,000	87	11	11,100,000	17,200,000
2002	44,700,000	89	15	33,100,000	59,000,000	18	8,290,000	84	13	6,380,000	10,600,000
2003	11,500,000	83	10	9,430,000	13,900,000	27	3,070,000	75	12	2,390,000	3,870,000
2004	40,500,000	82	13	31,100,000	51,900,000	22	8,920,000	76	20	5,980,000	12,800,000
2005	51,900,000	81	17	37,000,000	70,900,000	27	13,900,000	71	36	6,600,000	26,000,000
2006	8,880,000 [8,600,000] ^c	85	13	68,500,000	113,000,000	31	2,770,000	--	--	--	--
2007	36,200,000 [44,500,000] ^c	87	11	28,900,000	44,700,000	28	10,200,000	86	11	8,100,000	12,600,000
2008	88,600,000 [71,300,000] ^c	70	20	59,000,000	128,000,000	23	20,400,000	--	--	--	--

^a Coefficient of Variation determined by the ratio of the model daily standard error of the prediction and the mean daily model flux.

^b Determined as the ratio of total sand load to total annual load.

^c Suspended-sediment load values in brackets determined from regression models of instantaneous-turbidity data and suspended sediment concentration.

^d Sum of daily computed sediment loads obtained from U.S. Geological Survey (2009).

^e Value in parentheses obtained from daily computed sediment loads determined by the U.S. Army Corps of Engineers (U.S. Army Corps of Engineers, unpub. data, 1975-1981).

^f LOADEST model explains less than 50 percent of variation in predicted suspended-sediment concentrations used in load determination.

44 Characteristics of Sediment Data and Annual Suspended-Sediment Loads and Yields—Missouri River

Table 4. Annual suspended-sediment and suspended-sand yields for selected sediment stations in the lower Missouri River Basin, 1976–2008.

[tons/mi², tons per square mile; --, no data or not applicable]

Year	Suspended-sediment yield (tons/mi ²)	Suspended-sand yield (tons/mi ²)	Suspended-sediment yield based on area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi ²)	Suspended-sand yield based on drainage area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi ²)
06467500 Missouri River at Yankton, South Dakota				
2001	.97	--	--	--
2002	.83	--	--	--
2003	.86	--	--	--
2004	1.02	--	--	--
2005	1.01	--	--	--
2006	.79	--	--	--
2007	.58	--	--	--
2008	.55	--	--	--
06478500 James River at Scotland, South Dakota				
1976	1.29	--	--	--
1977	.70	--	--	--
1978	4.84	--	--	--
1979	3.13	--	--	--
1980	.61	--	--	--
1981	.11	--	--	--
1982	1.99	--	--	--
1983	6.25	--	--	--
1984	13.5	--	--	--
1985	3.11	--	--	--
1986	15.4	--	--	--
1987	5.33	--	--	--
1988	.66	--	--	--
1989	.65	--	--	--
1990	.44	--	--	--
1991	1.68	--	--	--
1992	1.09	--	--	--
1993	9.20	--	--	--
1994	7.75	--	--	--
1995	17.7	--	--	--
06485500 Big Sioux River at Akron, Iowa				
1976	11.8	--	--	--
1977	7.54	--	--	--
1978	60.5	--	--	--
1979	74.7	--	--	--
1980	72.9	--	--	--
1981	24.3	--	--	--
1982	43.7	--	--	--
1983	190	--	--	--

Table 4. Annual suspended-sediment and suspended-sand yields for selected sediment stations in the lower Missouri River Basin, 1976–2008—Continued[tons/mi², tons per square mile; --, no data or not applicable]

Year	Suspended-sediment yield (tons/mi ²)	Suspended-sand yield (tons/mi ²)	Suspended-sediment yield based on area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi ²)	Suspended-sand yield based on drainage area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi ²)
06485500 Big Sioux River at Akron, Iowa—Continued				
1984	370	--	--	--
1985	93.5	--	--	--
1986	286	--	--	--
1987	81.7	--	--	--
1988	28.5	--	--	--
1989	17.6	--	--	--
1990	23.6	--	--	--
1991	19.3	--	--	--
1992	72.2	--	--	--
1993	556	--	--	--
1994	169	--	--	--
06486000 Missouri River at Sioux City, Iowa				
1976	61.7	--	553	--
1977	36.6	--	328	--
1978	43.9	--	393	--
1979	61.4	--	550	--
1980	33.7	--	302	--
1981	34.6	22.3	311	200
1982	25	18.2	225	164
1983	49	30.4	439	273
1984	59.8	29.9	536	268
1985	48.3	23.7	433	212
1986	38.5	23.5	345	211
1987	31.4	24.4	282	219
1988	26	17.6	233	158
1989	19.7	12.2	177	109
1990	11.5	7.1	103	63.2
1991	12.5	6.7	112	60.4
1992	14.9	--	133	--
1993	27.6	--	248	--
1994	20.5	--	184	--
1995	30.8	--	276	--
1996	47.7	--	428	--
1997	66	--	592	--
1998	38.5	--	345	--
1999	30.3	--	271	--
2000	22.2	--	199	--
2004	13.8	--	124	--

Table 4. Annual suspended-sediment and suspended-sand yields for selected sediment stations in the lower Missouri River Basin, 1976–2008—Continued[tons/mi², tons per square mile; --, no data or not applicable]

Year	Suspended-sediment yield (tons/mi²)	Suspended-sand yield (tons/mi²)	Suspended-sediment yield based on area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi²)	Suspended-sand yield based on drainage area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi²)
06486000 Missouri River at Sioux City, Iowa—Continued				
2005	12	--	108	--
2006	13.3	--	119	--
2007	15.6	--	140	--
2008	14.1	--	127	--
06610000 Missouri River at Omaha, Nebraska				
1976	67	52.7	499	393
1977	44.6	32.8	333	245
1978	76.2	41.5	568	309
1979	100	57.6	746	430
1980	63.5	34.4	473	256
1981	46.5	25.3	346	188
1982	45.5	24.9	339	186
1983	111	58.2	829	434
1984	110	61	822	455
1985	75.3	50.2	561	374
1986	87.1	39.7	649	296
1987	70	43.1	522	321
1988	36.6	22.8	272	170
1989	25.8	12.5	192	93.3
1990	28.6	9.54	213	71.1
1991	36.9	10.7	275	79.7
1992	33.1	--	246	--
1993	87.4	--	650	--
1994	50.2	--	373	--
1995	53.9	--	401	--
1996	87.4	--	652	--
1997	101	--	752	--
1998	71.2	--	531	--
1999	53.9	--	401	--
2000	30.2	--	225	--
2001	49.3	--	367	--
2002	20.9	--	156	--
2003	30.5	--	227	--
2004	30.3	--	241	--
2005	25.1	--	187	--
2006	18	--	134	--

Table 4. Annual suspended-sediment and suspended-sand yields for selected sediment stations in the lower Missouri River Basin, 1976–2008—Continued[tons/mi², tons per square mile; --, no data or not applicable]

Year	Suspended-sediment yield (tons/mi ²)	Suspended-sand yield (tons/mi ²)	Suspended-sediment yield based on area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi ²)	Suspended-sand yield based on drainage area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi ²)
06610000 Missouri River at Omaha, Nebraska—Continued				
2007	32.2	--	240	--
2008	38.4	--	286	--
06805500 Platte River at Louisville, Nebraska				
1976	24.7	--	--	--
1977	50.13	--	--	--
1978	177	--	--	--
1979	82.9	--	--	--
1980	93.3	--	--	--
1981	27.8	--	--	--
1982	185	--	--	--
1983	369	--	--	--
1984	672	--	--	--
1985	124	--	--	--
1986	152	--	--	--
1987	238	--	--	--
1988	30.3	--	--	--
1989	41.7	--	--	--
1990	143	--	--	--
1991	176	--	--	--
1992	61.8	--	--	--
1993	950	--	--	--
1994	80.1	--	--	--
1995	237	--	--	--
1996	178	--	--	--
1997	115	--	--	--
1998	232	--	--	--
1999	301	--	--	--
2000	56.8	--	--	--
2001	113	--	--	--
2002	32.9	--	--	--
2003	36.7	--	--	--
2004	52.5	--	--	--
2005	85.5	--	--	--
2006	27.3	--	--	--
2007	128	--	--	--
2008	213	--	--	--

Table 4. Annual suspended-sediment and suspended-sand yields for selected sediment stations in the lower Missouri River Basin, 1976–2008—Continued[tons/mi², tons per square mile; --, no data or not applicable]

Year	Suspended-sediment yield (tons/mi ²)	Suspended-sand yield (tons/mi ²)	Suspended-sediment yield based on area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi ²)	Suspended-sand yield based on drainage area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi ²)
06807000 Missouri River at Nebraska City, Nebraska				
1976	62.3	--	233	--
1977	58.5	42.7	184	134
1978	81	51.2	254	161
1979	95.6	62.7	300	197
1980	47.8	37.1	150	116
1981	40	20.4	126	64.2
1982	63.9	29.8	201	93.5
1983	171	67.8	539	213
1984	215	81.5	674	256
1985	106	51.2	334	161
1986	93.6	45.9	294	144
1987	123	51.7	385	162
1988	37.1	23	116	72.3
1989	29.8	16.2	93.5	50.8
1990	39.8	13.9	125	43.8
1991	46.8	17	147	53.3
1992	46.1	--	145	--
1993	112	--	353	--
1994	63.9	--	201	--
1995	70	--	223	--
1996	125	--	394	--
1997	100	--	316	--
1998	94.4	--	296	--
1999	76.8	--	242	--
2000	34.6	--	109	--
2001	56.1	--	176	--
2002	27.3	--	86	--
2003	35.8	--	113	--
2004	39.8	--	125	--
2005	34.9	--	110	--
2006	22.8	--	71.5	--
2007	53.9	--	169	--
2008	82.4	--	259	--
06810000 Nishnabotna River at Hamburg, Iowa				
1982	2,210	--	--	--
1983	1,590	--	--	--
1984	5,220	--	--	--
1985	196	--	--	--
1986	1,760	--	--	--

Table 4. Annual suspended-sediment and suspended-sand yields for selected sediment stations in the lower Missouri River Basin, 1976–2008—Continued[tons/mi², tons per square mile; --, no data or not applicable]

Year	Suspended-sediment yield (tons/mi ²)	Suspended-sand yield (tons/mi ²)	Suspended-sediment yield based on area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi ²)	Suspended-sand yield based on drainage area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi ²)
06810000 Nishnabotna River at Hamburg, Iowa—Continued				
1987	6,630	--	--	--
1988	95.2	--	--	--
1989	1,590	--	--	--
1990	2,800	--	--	--
1991	1,810	--	--	--
1992	378	--	--	--
1993	9,590	--	--	--
--	--	--	--	--
2004	1,370	--	--	--
2005	731	--	--	--
2006	68.4	--	--	--
2007	1,750	--	--	--
2008	2,960	--	--	--
06817000 Nodaway River at Clarinda, Iowa				
1976	3,150	--	--	--
1977	3,330	--	--	--
1978	6,950	--	--	--
1979	3,750	--	--	--
1980	2,080	--	--	--
1981	231	--	--	--
1982	10,700	--	--	--
1983	2,390	--	--	--
1984	4,430	--	--	--
1985	606	--	--	--
1986	5,810	--	--	--
1987	7,370	--	--	--
1988	31.6	--	--	--
1989	5,250	--	--	--
1990	3,610	--	--	--
1991	14,700	--	--	--
1992	12,400	--	--	--
06818000 Missouri River at St. Joseph, Missouri				
1976	(78.1) ^a	(38.9) ^a	(227) ^a	(113) ^a
1977	(49.8) ^a	(29.3) ^a	(145) ^a	(85.0) ^a
1978	(87.7) ^a	(44.8) ^a	(255) ^a	(130) ^a
1979	(87.5) ^a	(39.9) ^a	(254) ^a	(116) ^a
1980	(86.2) ^a	(25.6) ^a	(250) ^a	(74.0) ^a
1981	(53.8) ^a	(20.9) ^a	(156) ^a	(60.7) ^a

Table 4. Annual suspended-sediment and suspended-sand yields for selected sediment stations in the lower Missouri River Basin, 1976–2008—Continued[tons/mi², tons per square mile; --, no data or not applicable]

Year	Suspended-sediment yield (tons/mi²)	Suspended-sand yield (tons/mi²)	Suspended-sediment yield based on area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi²)	Suspended-sand yield based on drainage area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi²)
06818000 Missouri River at St. Joseph, Missouri—Continued				
1982	128	63.7	370	185
1983	286	106	830	308
1984	270	65.8	782	191
1985	82.3	33.5	239	97.3
1986	141	48.3	409	140
1987	175	59.8	507	174
1988	45.6	26	132	75.5
1989	54.2	22.7	157	65.9
1990	77.5	17.2	225	50
1991	67.8	14.1	197	40.8
1992	69.3	18.6	201	53.9
1993	319	50.4	926	146
1994	63	20.6	183	59.9
1995	74.9	24.8	217	72.1
1996	90.9	34.7	264	101
1997	142	53.4	413	155
1998	112	34.4	324	100
1999	144	31.2	419	90
2000	36.6	14.3	106	41.6
2001	87.6	17.4	254	50.3
2002	32	8.89	92.8	25.8
2003	48.5	9.16	141	26.6
2004	61.4	11.3	178	32.9
2005	37.8	6.71	110	19.5
2006	26.9	--	77.9	--
2007	68.4	--	198	--
2008	92.1	--	267	--
06821190 Platte River at Sharps Station, Missouri				
1980	643	56.7	--	--
1981	723	74.4	--	--
1982	11,500	360	--	--
1983	1,970	183	--	--
1984	4,538	276.	--	--
1985	416	56.6	--	--
1986	3,040	349	--	--
1987	1,100	227	--	--

Table 4. Annual suspended-sediment and suspended-sand yields for selected sediment stations in the lower Missouri River Basin, 1976–2008—Continued[tons/mi², tons per square mile; --, no data or not applicable]

Year	Suspended-sediment yield (tons/mi ²)	Suspended-sand yield (tons/mi ²)	Suspended-sediment yield based on area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi ²)	Suspended-sand yield based on drainage area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi ²)
06821190 Platte River at Sharps Station, Missouri—Continued				
1988	124	25.9	--	--
1989	260	45.5	--	--
1990	638	117	--	--
1991	411	76.2	--	--
1992	925	159	--	--
06892350 Kansas River at DeSoto, Kansas				
1976	72.5	7.01	--	--
1977	323	27.4	--	--
1978	108	13.6	--	--
1979	221	57.9	--	--
1980	112	21.6	--	--
1981	77.6	5.11	--	--
1982	366	--	--	--
1983	104	--	--	--
1984	288	--	--	--
1985	69	--	--	--
1986	198	--	--	--
1987	386	--	--	--
1988	9.65	--	--	--
1989	73	--	--	--
1990	134	--	--	--
1991	25.9	--	--	--
06893000 Missouri River at Kansas City, Missouri				
1976	(110) ^a	(38.6) ^a	(261) ^a	(91.3) ^a
1977	(51.8) ^a	(32.2) ^a	(122) ^a	(76.1) ^a
1978	(107) ^a	(61.8) ^a	(252) ^a	(146) ^a
1979	(112) ^a	(43.0) ^a	(265) ^a	(102) ^a
1980	(94.7) ^a	(32.2) ^a	(224) ^a	(76.1) ^a
1981	(62.0) ^a	(20.4) ^a	(147) ^a	(48.3) ^a
--	--	--	--	--
1988	39.2	27.7	92.9	65.5
1989	49.2	17.3	116	40.8
1990	93.6	19.1	221	45.2
1991	67.5	15.1	160	35.8
1992	72.7	19.7	172	46.5
1993	337	57.7	797	136

Table 4. Annual suspended-sediment and suspended-sand yields for selected sediment stations in the lower Missouri River Basin, 1976–2008—Continued[tons/mi², tons per square mile; --, no data or not applicable]

Year	Suspended-sediment yield (tons/mi²)	Suspended-sand yield (tons/mi²)	Suspended-sediment yield based on area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi²)	Suspended-sand yield based on drainage area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi²)
06893000 Missouri River at Kansas City, Missouri—Continued				
1994	73.5	24.6	174	58.2
1995	122	29.4	288	69.5
1996	83	42.8	196	101
1997	194	64.4	459	152
1998	140	37.2	332	88
1999	235	34.1	557	80.6
2000	34.7	11.1	82.1	26.3
2001	89.2	12.4	211	29.3
2002	32.2	7.19	76.2	17
2003	35.7	7.32	84.6	17.3
2004	63.4	11.1	150	26.4
2005	62.4	8.88	148	21
2006	31	--	73.3	--
2007	116	--	275	--
2008	122	--	289	--
06902000 Grand River at Sumner, Missouri				
1976	1,960	143	--	--
1977	374	80.1	--	--
1978	3,230	467	--	--
1979	2,560	441	--	--
1980	1,790	58.3	--	--
1981	3,230	208	--	--
1982	3,910	579	--	--
1983	753	199	--	--
1984	1,290	201	--	--
1985	318	74.9	--	--
1986	1,900	163	--	--
1987	1,730	255	--	--
1988	251.6	124	--	--
1989	158	36.9	--	--
1990	1,110	198	--	--
1991	2,000	170	--	--
1992	2,280	107	--	--
1993	14,500	343	--	--

Table 4. Annual suspended-sediment and suspended-sand yields for selected sediment stations in the lower Missouri River Basin, 1976–2008—Continued[tons/mi², tons per square mile; --, no data or not applicable]

Year	Suspended-sediment yield (tons/mi ²)	Suspended-sand yield (tons/mi ²)	Suspended-sediment yield based on area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi ²)	Suspended-sand yield based on drainage area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi ²)
06905500 Chariton River at Prairie Hill, Missouri				
1979	1,385	316	--	--
1980	1385	840	--	--
1981	3,240	1,150	--	--
1982	3,320	1,340	--	--
1983	2,290	1,210	--	--
1984	1,580	651	--	--
1985	1,600	348	--	--
1986	3,230	517	--	--
06926510 Osage River at St. Thomas, Missouri				
1976	27.6	11	--	--
1977	44	18.2	--	--
1978	78.2	38.8	--	--
1979	63.8	31.5	--	--
1980	85	44.6	--	--
1981	80.9	52	--	--
1982	85	39.6	--	--
1983	45.9	27.5	--	--
1984	37	15.3	--	--
1985	43	11.7	--	--
1986	23.8	7.85	--	--
1987	37.7	9.12	--	--
1988	18.5	5.33	--	--
1989	12.3	6.99	--	--
1990	73.4	19.4	--	--
1991	7.85	3.55	--	--
1992	13.2	5.21	--	--
1993	65.1	30.9	--	--
1994	73	29.8	--	--
06933500 Gasconade River at Jerome, Missouri				
1978	124	25.5	--	--
1979	161	37.6	--	--
1980	87	16.2	--	--
1981	97.9	14.1	--	--
1982	43	14.5	--	--
1983	131	31	--	--
1984	41.2	10.7	--	--
1985	57.4	20.3	--	--

Table 4. Annual suspended-sediment and suspended-sand yields for selected sediment stations in the lower Missouri River Basin, 1976–2008—Continued[tons/mi², tons per square mile; --, no data or not applicable]

Year	Suspended-sediment yield (tons/mi ²)	Suspended-sand yield (tons/mi ²)	Suspended-sediment yield based on area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi ²)	Suspended-sand yield based on drainage area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi ²)
06933500 Gasconade River at Jerome, Missouri—Continued				
1986	18.1	5.9	--	--
1987	26.4	6.28	--	--
1988	27.1	5.9	--	--
1989	44.7	10.5	--	--
1990	93	36.6	--	--
1991	70.4	21.7	--	--
1992	38.3	11.3	--	--
1993	--	--	--	--
06934500 Missouri River at Hermann, Missouri				
1976	68.9 (70.8) ^a	28.1 (26.8) ^a	148 (152) ^a	60.5 (57.4) ^a
1977	56.7 (50.9) ^a	19.7 (19.5) ^a	121 (109) ^a	42.4 (42.1) ^a
1978	171 (127) ^a	63.0 (54.9) ^a	367 (273) ^a	135 (118) ^a
1979	152 (136) ^a	57.2 (43.8) ^a	327 (293) ^a	123 (94.4) ^a
1980	78.3 (71.8) ^a	28.7 (26.2) ^a	168 (154) ^a	61.7 (56.6) ^a
1981	113 (119) ^a	28.5 (27.0) ^a	244 (255) ^a	61.3 (58.0) ^a
1982	235	56.8	506	122
1983	293	63.7	629	137
1984	253	63.5	543	137
1985	149	41.3	320	89.3
1986	158	42.9	339	92
1987	230	57.8	494	124
1988	59.7	26.6	128	57.2
1989	49.4	14.9	106	32.1
1990	216	36.9	465	79.4
1991	63.2	15.4	136	33
1992	103	17.3	221	37.2
1993	339	122	728	263
1994	112	40	240	86
1995	197	49	424	105
1996	122	27.6	261	59.2
1997	184	52.8	395	114
1998	144	40.2	309	86.4
1999	212	58.2	455	125
2000	27	9	58	19.3
2001	132	26.6	285	57.2
2002	86	15.9	184	34.1

Table 4. Annual suspended-sediment and suspended-sand yields for selected sediment stations in the lower Missouri River Basin, 1976–2008—Continued[tons/mi², tons per square mile; --, no data or not applicable]

Year	Suspended-sediment yield (tons/mi ²)	Suspended-sand yield (tons/mi ²)	Suspended-sediment yield based on area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi ²)	Suspended-sand yield based on drainage area downstream of the Missouri River at Yankton (station 06467500), South Dakota (tons/mi ²)
06934500 Missouri River at Hermann, Missouri—Continued				
2003	22	5.88	47.3	12.6
2004	77.5	17.1	167	36.7
2005	99.3	26.6	214	57.2
2006	17	5.3	36.5	11.4
2007	69.3	19.5	149	42
2008	170	39	364	84

^a Values in parentheses were calculated from suspended sediment load estimates obtained from U.S. Army Corps of Engineers (unpub. data, 1975–81).

Summary

The U.S. Geological Survey collects and analyzes suspended-sediment data in the Missouri River Basin as part of the Sediment Data Program with the U.S. Army Corps of Engineers, as part of the U.S. Geological Survey National Stream Quality Accounting Network, and in association with other U.S. Geological Survey cooperative-study programs with State and local agencies. To address the need for additional sediment information on the lower Missouri River, the U.S. Geological Survey, in cooperation with the U.S. Army Corps of Engineers, conducted a study to determine suspended-sediment characteristics and suspended-sediment loads at selected streamgaging stations. This report describes sediment data, load estimation techniques, and suspended-sediment loads and yields for 18 stations within the lower Missouri River Basin that have sediment and streamflow record for water years 1976 through 2008.

Suspended-sediment and suspended sand loads were computed for those stations and years within the 1976–2008 period for which loads had not been previously determined and sufficient data were available. The data used for determination of annual suspended-sediment and suspended-sand loads were retrieved from the U.S. Geological Survey NWIS database and data archives. Data included suspended-sediment concentrations, sediment particle size, turbidity, and streamflow for variable periods of record at the 18 U.S. Geological Survey streamgaging stations.

Annual suspended-sediment and suspended-sand loads provided in this report were determined using three techniques. These included the subdivision method, regression of instantaneous turbidity with suspended-sediment concentrations at selected stations, or by means of regression techniques using the Load Estimator (LOADEST) software. Characteristics of the suspended-sediment and streamflow data collected at the 18 monitoring stations and the tabulated annual suspended-sediment and suspended-sand loads and yields are presented.

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Appendix 1.

The Excel spreadsheet *Appendix-1.xls* contains daily mean streamflow and suspended-sediment and suspended-sand concentration data used in LOADEST determinations of annual loads for selected Missouri River mainstem and tributary stations, 1976–2008.