

Appendix 1.17. Model Archive Summary for Sulfate Concentration at U.S. Geological Survey site 07143672; Little Arkansas River at Highway 50 near Halstead, Kansas, during May 1998 through December 2019

This model archive summary summarizes the sulfate model developed to compute hourly or daily sulfate. Model development methods follow U.S. Geological Survey (USGS) guidance from Office of Surface Water/Office of Water Quality Technical Memoranda and USGS Techniques and Methods, book 3, chap. C4 (Rasmussen and others, 2009).

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Site and Model Information

Site Number: 07143672

Site Name: Little Arkansas River at Highway 50 near Halstead, Kansas

Location: Latitude 38°01'43", longitude 97°32'25" referenced to North American Datum of 1927, in NW 1/4 NE 1/4 NE 1/4 sec.28, T.23 S., R.2 W., Harvey County, Kansas, hydrologic unit 11030012.

Equipment: A Sutron Satlink II High Data Rate Collection Platform and a Design Analysis Water Log H350/355 nonsubmersible pressure transducer transfers real-time stage and water-quality data via satellite. The primary reference gage is a Type-A wire-weight gage located on the downstream bridge guardrail. Check-bar elevation is 33.396 feet. The orifice tube is enclosed in 1.25-inch steel conduit trenched into the ground down to the edge of water, where the orifice emerges from the bank and culminates in a 2-inch open-end orifice tethered to a steel fencepost near the left edge of water. Gage height was measured during May 1998 through December 2019. A YSI 6600 water-quality monitor equipped with water temperature, specific conductance, pH, dissolved oxygen, and turbidity (a YSI Model 6026 [December 1998 through December 2006] and YSI Model 6136 [July 2004 through December 2017]) sensors collected data during May 1998 through December 2017. A YSI EXO2 water-quality monitor equipped with water temperature, specific conductance, pH, dissolved oxygen, turbidity, and fluorescent dissolved organic matter sensors collected data during January 2017 through December 2019. A Hach Nitratex monitor collected nitrate data during February 2017 through December 2019.

Date model was developed: June 1, 2020

Model calibration data period: May 12, 1998 through December 10, 2019

Model Data

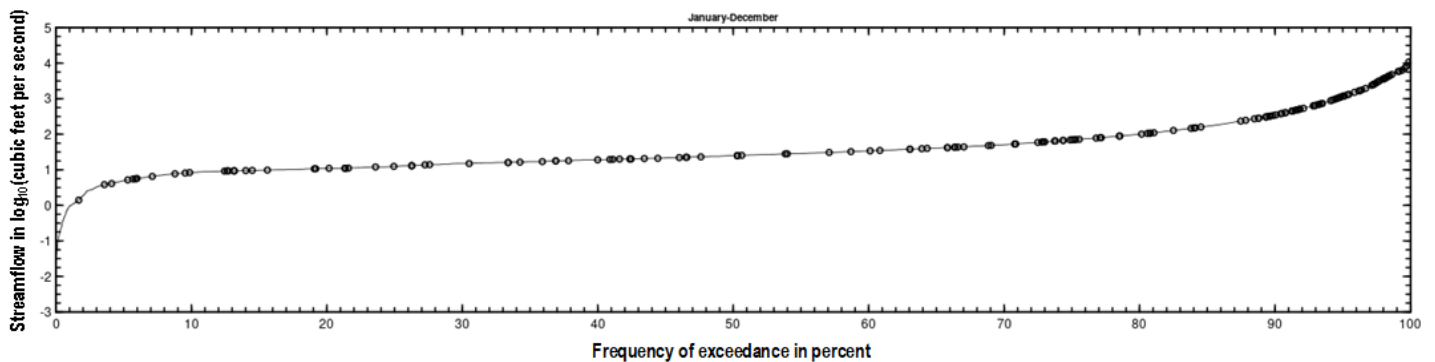
All data were collected using USGS protocols (U.S. Geological Survey, variously dated; Wagner and others, 2006; Sauer and Turnipseed, 2010; Turnipseed and Sauer, 2010) and are stored in the National Water Information System (NWIS) database (U.S. Geological Survey, 2021). Explanatory variables were evaluated individually and in combination. Potential explanatory variables included streamflow, water temperature, specific conductance, pH, dissolved oxygen, YSI EXO2 turbidity, nitrate, and fluorescent dissolved organic matter. Seasonal components (sine and cosine variables) also were evaluated as explanatory variables.

The regression model is based on 190 concomitant values of discretely collected sulfate and continuously measured specific conductance during May 1998 through December 2019. Discrete samples were collected over a range of streamflow and specific conductance conditions. Seven samples had concentrations that were below the minimum reporting level (<5 mg/L) and a Tobit regression model was developed to compute estimates of sulfate using the absolute maximum likelihood estimation approach (Hald, 1949; Cohen, 1950; Tobin, 1958; Helsel and others, 2020). Summary statistics and the complete model-calibration dataset are provided below. Outliers and influential points were identified using methods described in Rasmussen and others (2009), including leverage and Cook's distance (Cook's D; Cook, 1977) values. Outliers in previously published versions of this model (Christensen and others, 2003; Rasmussen and others, 2016) were examined and retained in the dataset if there were no clear issues, explanations, or conditions that would cause a result to be invalid for model calibration. All samples were retained in the dataset.

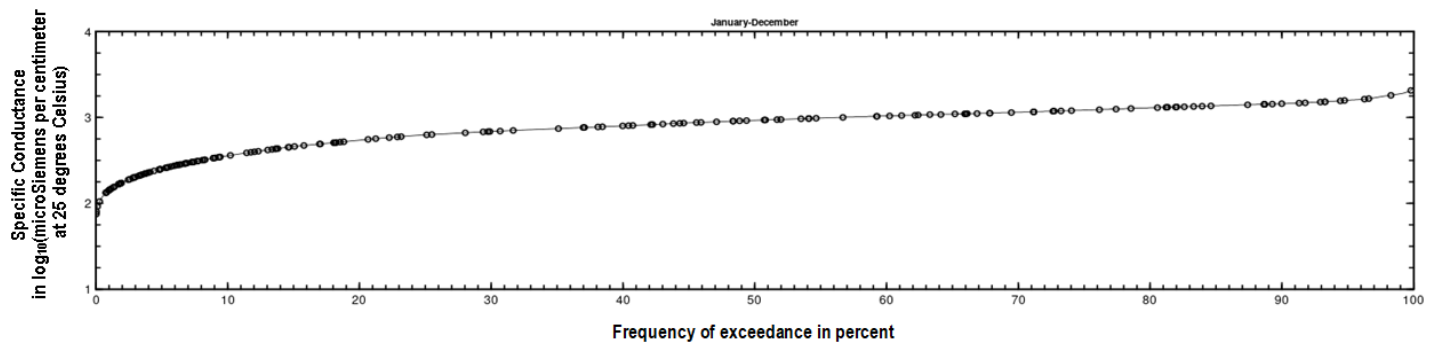
Sulfate

Discrete samples were collected from the downstream side of the bridge or instream within 50 feet of the bridge using equal-width-increment, multi-vertical, single vertical or grab-dip methods following U.S. Geological Survey (variously dated) and Rasmussen and others (2014). Discrete samples were collected on a semifixed to event-based schedule ranging from 4 to 13 samples per year with a FISP US DH-95 or D-95 with a Teflon bottle, cap, and nozzle depth-integrating sampler, a DH-81 with a Teflon bottle, cap, and nozzle hand sampler or a grab sample with a Teflon bottle depending on sample location. Samples were analyzed for sulfate by the Wichita Municipal Water and Wastewater Laboratory in Wichita, Kansas, or the USGS National Water Quality Laboratory according to standard methods (American Public Health Association and others, 1995).

Sulfate Samples Plotted on Streamflow Duration Curve



Sulfate Samples Plotted on Specific Conductance Duration Curve



Continuous Data

Concomitant specific conductance values were time interpolated. If no concomitant continuous data were available within 2 hours of sample collection, the sample was not included in the dataset.

Model Development

Tobit regression models were developed using absolute maximum likelihood estimation methods using the *smwrQW* (v.0.7.9) package in R (version 4.0.0) programming language (R Core Team, 2020).

Specific conductance was selected as the best predictor of sulfate based on residual plots, a larger pseudo coefficient of determination (pseudo R^2) and a low estimated residual standard error (RSE). Specific conductance was positively related to sulfate because it measures water's capacity to conduct an electrical current and is related to the concentration of ionized substances in water (Hem, 1992).

Model Summary

Summary of final sulfate regression analysis at site number 07143672:

Sulfate-based model:

$$\log_{10}(SO_4) = 0.9763 \times \log_{10}(SC) - 1.2927$$

where,

\log_{10} = logarithm base 10

SO_4 = sulfate, in milligrams per liter (mg/L); and

SC = specific conductance, in microsiemens per centimeter at 25 degrees Celsius ($\mu\text{S}/\text{cm}$)

The log-transformed model may be retransformed to original units so that SO_4 can be calculated directly. The retransformation introduces a bias in the calculated constituent. This bias may be corrected using Duan's bias correction factor (BCF; Duan, 1983). Extracted model residuals used for BCF computation included censored residuals that were replaced by their expected values. For this model, the calculated BCF is 1.05. The retransformed model, accounting for BCF is:

$$SO_4 = 0.0535 \times SC^{0.9763}$$

Model Statistics, Data, and Plots

Model

$$\text{LOGSO}_4 = 0.9763 * \text{LOGSC} - 1.2927$$

Variable Summary Statistics

	S04	SC
Minimum	<5	75.25
1st Quartile	12	279.5
Median	27.15	609.04
Mean	31.92	706.04
3rd Quartile	47	1080
Maximum	312	2060

Explanatory Variables

Coefficients:

	Estimate	Std. Error	z-score	p-value
(Intercept)	-1.2927	0.08873	-14.57	0
logSC	0.9763	0.03211	30.40	0

Basic Model Statistics

Estimated residual standard error (Unbiased) = 0.144

Distribution: normal

Number of observations = 190, number censored = 7 (3.7 percent)

Loglik(model) = 88.93 Loglik(intercept only) = -82.41

Chi-square = 342.7, degrees of freedom = 1, p-value = <0.0001

Computation method: AMLE

Pseudo R-squared: 0.8392

AIC: -171.9

BIC: -162.1

Outlier Test Criteria

leverage	cooksD
0.01579	0.69570

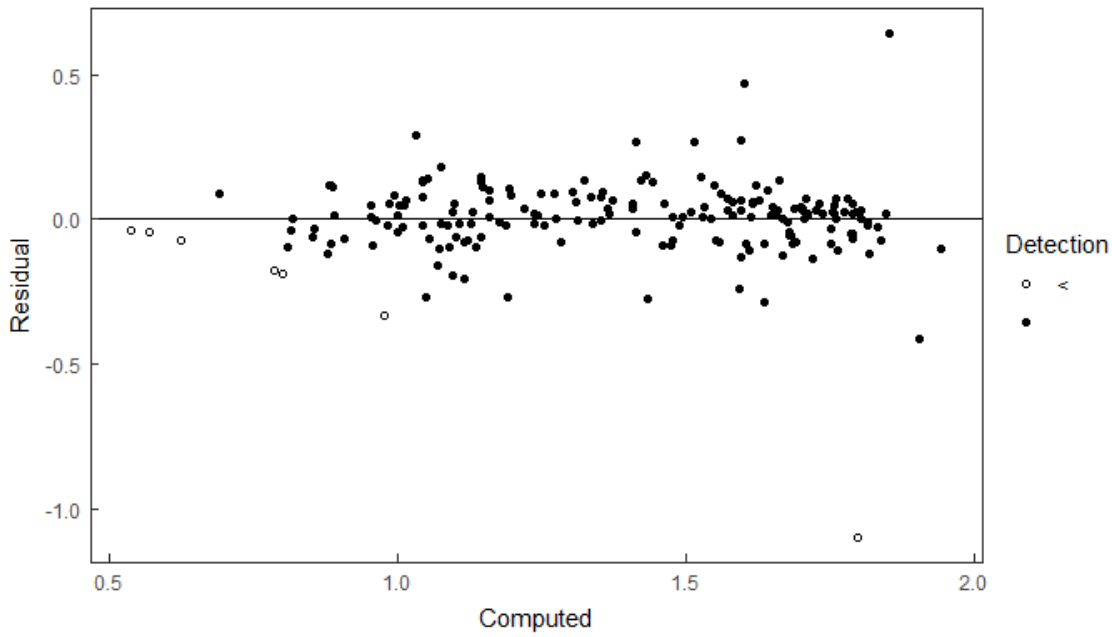
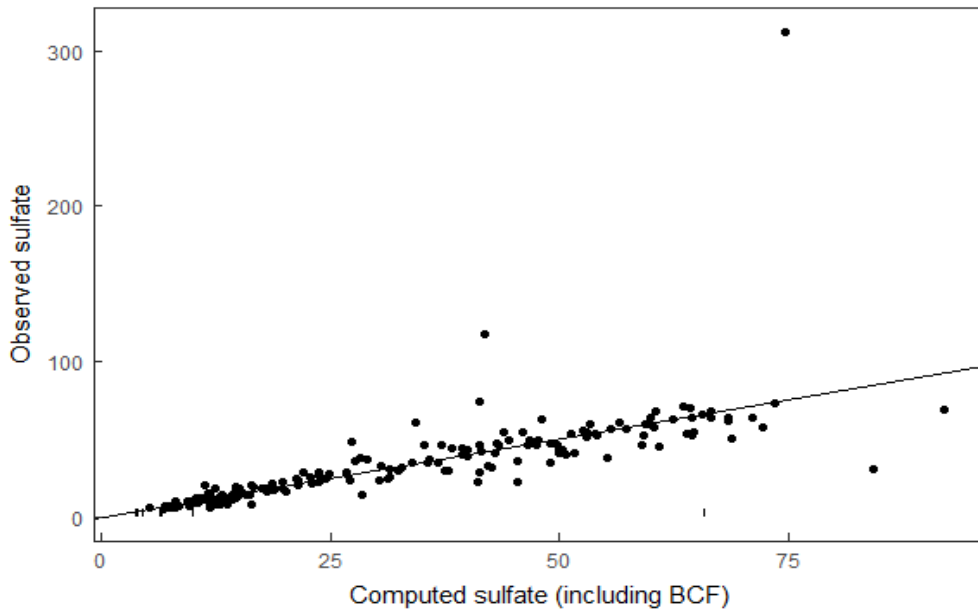
Flagged Observations

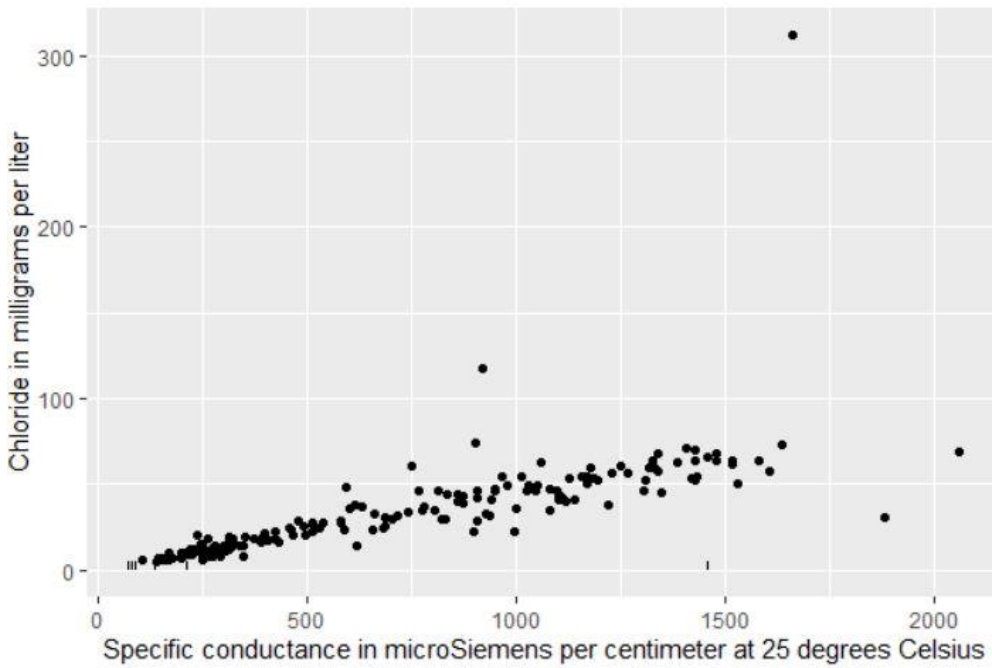
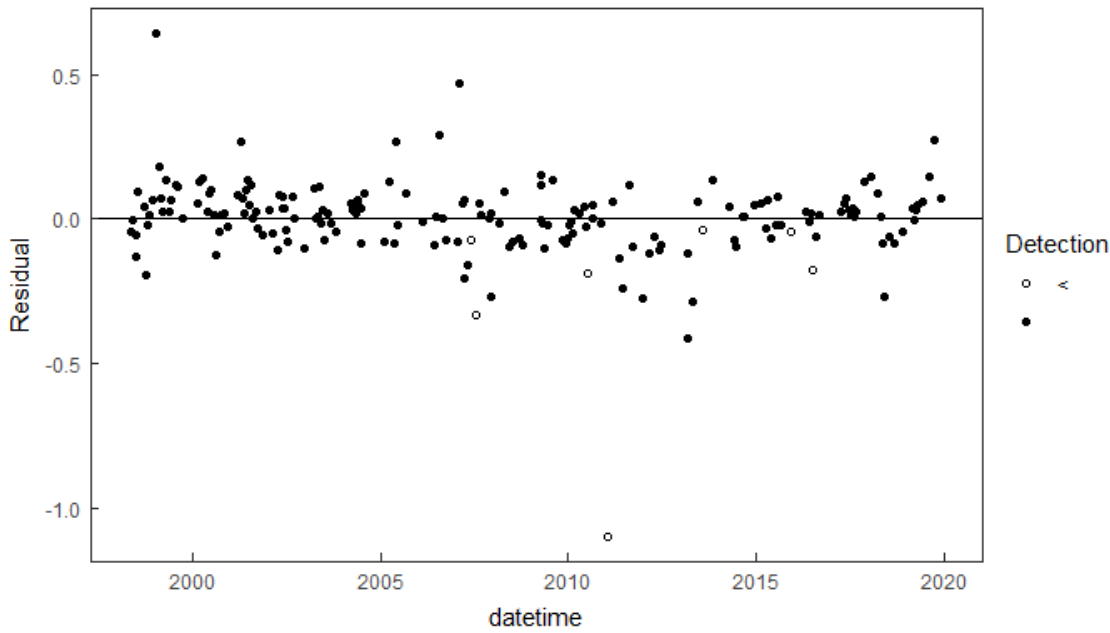
	logS04	ycen	yhat	resids	leverage	cooksD
9	0.9031	FALSE	0.8899	0.013236	0.01696	7.41E-05
11	2.4942	FALSE	1.8521	0.642014	0.01632	1.68E-01
18	1	FALSE	0.8822	0.117816	0.01733	6.01E-03
19	1	FALSE	0.8874	0.112619	0.01708	5.40E-03
20	0.8195	FALSE	0.8189	0.000635	0.02061	2.09E-07
37	1.8633	FALSE	1.8452	0.018118	0.016	1.31E-04
44	0.8261	FALSE	0.8561	-0.030011	0.01864	4.20E-04
53	0.7782	FALSE	0.816	-0.037833	0.02077	7.47E-04
57	1.8388	FALSE	1.9427	-0.10381	0.02094	5.68E-03
75	0.7782	FALSE	0.6925	0.085617	0.02833	5.30E-03
95	0.699	TRUE	0.6245	-0.072098	0.03314	4.44E-03
125	0.699	TRUE	0.7995	-0.185667	0.02169	1.88E-02
133	1	FALSE	0.8843	0.115729	0.01723	5.76E-03
136	0.7634	FALSE	0.8799	-0.116449	0.01744	5.91E-03
141	1.4942	FALSE	1.9046	-0.410487	0.0189	7.98E-02
144	0.699	TRUE	0.5393	-0.035889	0.0398	1.34E-03
148	0.7135	FALSE	0.8086	-0.095094	0.02118	4.82E-03
155	0.8414	FALSE	0.9068	-0.065409	0.01616	1.72E-03
159	0.699	TRUE	0.5697	-0.0471	0.03735	2.16E-03
163	0.699	TRUE	0.7871	-0.176313	0.0224	1.76E-02
180	0.7911	FALSE	0.8539	-0.062797	0.01875	1.85E-03
181	0.7998	FALSE	0.8849	-0.085072	0.0172	3.11E-03

95% Confidence Intervals

	2.5 %	97.5 %
(Intercept)	-1.4666448	-1.118838
logSC	0.9133857	1.039258

Plots





Model-Calibration Dataset

	datetime	logS04	logSC	S04	SC	Computed logS04	Computed S04
1	5/12/1998 12:05	1.63	3.04	42.9	1104	1.678	50.03
2	5/14/1998 11:40	0.959	2.31	9.1	204.3	0.963	9.64
3	6/15/1998 12:40	1.62	3.04	41.6	1102.7	1.678	49.97
4	6/25/1998 10:30	1.46	2.96	29	907	1.595	41.3
5	7/13/1998 10:05	1.4	2.66	25	457.8	1.305	21.18
6	9/14/1998 10:05	1.69	3.01	49	1031.1	1.649	46.8
7	10/1/1998 11:20	0.903	2.45	8	278.7	1.094	13.05
8	10/22/1998 13:15	1.23	2.61	17	406.2	1.254	18.85
9	11/6/1998 11:30	0.903	2.24	8	172	0.89	8.15
10	12/3/1998 11:25	1.69	2.99	49	978.2	1.627	44.46
11	1/6/1999 10:50	2.49	3.22	312	1664	1.852	74.68
12	2/1/1999 13:35	1.26	2.42	18	265.6	1.074	12.45
13	2/19/1999 10:15	1.83	3.13	68	1340.8	1.761	60.48

14	3/11/1999 11:10	1.82	3.16	66	1457.3	1.796	65.61
15	4/7/1999 10:55	1.56	2.78	36	603.1	1.422	27.73
16	5/20/1999 12:30	1.68	3.02	48	1045	1.655	47.42
17	5/24/1999 10:05	1.08	2.36	12	230.5	1.014	10.84
18	7/19/1999 13:05	1	2.23	10	168.9	0.882	8
19	8/4/1999 10:35	1	2.23	10	171	0.887	8.1
20	9/28/1999 10:30	0.82	2.16	6.6	145.5	0.819	6.92
21	2/8/2000 11:55	1.84	3.15	69.7	1428.6	1.787	64.35
22	3/6/2000 10:30	1.17	2.39	14.9	247.5	1.044	11.62
23	3/27/2000 10:40	1.19	2.4	15.5	252	1.052	11.83
24	5/19/2000 10:15	1.78	3.12	60	1317.8	1.753	59.47
25	5/30/2000 10:25	1.36	2.63	23	424.4	1.273	19.68
26	6/26/2000 10:30	1.26	2.51	18	323.5	1.158	15.09
27	7/19/2000 10:45	1.66	3.01	46	1026.5	1.647	46.6
28	7/27/2000 12:40	1.26	2.6	18	394.3	1.242	18.31
29	8/15/2000 10:45	1.54	3.03	35	1080	1.669	48.97
30	9/7/2000 11:10	1.63	3.04	43	1108.6	1.68	50.24
31	9/25/2000 10:25	1.72	3.08	53	1196.1	1.712	54.1
32	10/27/2000 10:15	1.26	2.59	18	389.5	1.236	18.09
33	11/30/2000 11:10	1.81	3.2	64	1582.3	1.831	71.1
34	3/13/2001 11:15	1.28	2.55	19	354.8	1.197	16.52
35	4/12/2001 11:50	1.68	2.77	48	592.8	1.415	27.27
36	4/26/2001 10:10	1.85	3.15	71	1408.7	1.781	63.47
37	5/9/2001 9:55	1.86	3.21	73	1637	1.845	73.5
38	6/1/2001 10:25	1.74	3.01	55	1013.2	1.642	46.01
39	6/11/2001 10:55	1.18	2.39	15	246.8	1.043	11.59
40	6/22/2001 10:35	1	2.3	10	199.6	0.953	9.42
41	7/12/2001 9:15	1.74	2.99	55	968	1.622	44.01
42	8/1/2001 10:00	1.76	3.13	58	1339	1.76	60.41
43	8/30/2001 9:45	1.8	3.14	63	1385	1.774	62.43
44	9/18/2001 12:05	0.826	2.2	6.7	158.8	0.856	7.54
45	10/30/2001 10:55	1.62	3.05	42	1110	1.68	50.3
46	1/9/2002 9:50	1.83	3.17	68	1480	1.802	66.61
47	2/20/2002 10:55	1.73	3.15	54	1420.8	1.785	64.01
48	4/10/2002 9:55	1.65	3.13	45	1350	1.763	60.89
49	4/22/2002 11:35	1.08	2.34	12	220.6	0.995	10.39
50	5/14/2002 10:05	1.4	2.72	25	526.4	1.364	24.28
51	5/23/2002 10:30	1.43	2.71	27	513	1.353	23.68
52	6/6/2002 12:00	1.74	3.07	55	1170	1.703	52.95
53	6/17/2002 9:15	0.778	2.16	6	144.5	0.816	6.87
54	7/9/2002 9:30	1.48	2.92	30	830	1.557	37.87
55	8/20/2002 10:10	1.41	2.69	26	492.5	1.336	22.75
56	9/18/2002 10:15	1.71	3.07	51	1172.5	1.704	53.06
57	12/17/2002 10:10	1.84	3.31	69	2060	1.943	91.99
58	3/24/2003 10:05	1.3	2.55	20	351.4	1.193	16.36
59	4/16/2003 11:30	1.81	3.17	64	1480	1.802	66.61
60	4/22/2003 10:10	1.51	2.86	32	717.7	1.496	32.86
61	5/15/2003 10:30	1.26	2.5	18	315	1.146	14.71
62	5/28/2003 10:30	1.32	2.7	21	495.5	1.338	22.89
63	6/10/2003 10:35	1.6	2.94	40	862.1	1.573	39.3
64	6/24/2003 9:25	1.76	3.21	58	1607.5	1.837	72.21
65	7/30/2003 9:20	1.76	3.1	57	1270	1.738	57.37
66	9/2/2003 11:30	1.11	2.48	13	302	1.129	14.11
67	10/15/2003 10:50	0.954	2.35	9	223.2	1	10.51
68	3/9/2004 12:00	1.04	2.33	11	216	0.986	10.18
69	3/29/2004 10:00	1.73	3.07	54	1170	1.703	52.95

70	4/26/2004 10:30	1.81	3.16	64	1430	1.788	64.41
71	5/13/2004 11:15	1.46	2.76	29	581.5	1.406	26.76
72	5/26/2004 10:35	1.66	2.96	46	907.2	1.595	41.31
73	6/16/2004 9:45	1.52	2.97	33	928.5	1.605	42.25
74	6/21/2004 9:10	1.26	2.57	18	375.3	1.221	17.45
75	7/26/2004 10:20	0.778	2.03	6	108	0.693	5.17
76	1/28/2005 10:45	1.2	2.64	16	435.5	1.284	20.18
77	3/25/2005 10:00	1.27	2.5	18.6	313	1.144	14.62
78	5/11/2005 9:40	1.66	3.12	46.1	1308.3	1.75	59.06
79	5/26/2005 12:00	1.78	2.88	60.6	751	1.515	34.35
80	6/7/2005 9:15	1.16	2.54	14.6	346.8	1.187	16.15
81	6/14/2005 8:40	0.959	2.33	9.1	214	0.982	10.08
82	8/31/2005 9:10	1.34	2.6	21.7	399.7	1.247	18.55
83	2/7/2006 11:15	1.66	3.04	46.2	1100	1.677	49.86
84	6/8/2006 9:35	1.39	2.83	24.3	683	1.475	31.31
85	6/26/2006 10:30	1.16	2.51	14.6	324	1.158	15.12
86	7/28/2006 9:25	1.32	2.38	20.9	240.1	1.031	11.28
87	8/23/2006 11:10	1.27	2.63	18.8	425.2	1.274	19.71
88	9/27/2006 9:40	1.4	2.84	25.4	686.3	1.477	31.46
89	1/10/2007 9:55	1.61	3.06	40.9	1140	1.692	51.63
90	1/30/2007 13:50	2.07	2.96	118	919.8	1.601	41.87
91	3/12/2007 10:15	1.51	2.82	32.7	663.2	1.462	30.42
92	3/21/2007 10:05	1.44	2.73	27.3	538.4	1.374	24.82
93	3/27/2007 10:05	0.908	2.47	8.1	292.2	1.115	13.67
94	4/18/2007 10:20	0.908	2.42	8.1	263	1.07	12.33
95	5/25/2007 10:20	<0.699	1.96	<5	92	0.625	4.42
96	7/11/2007 10:10	<0.699	2.33	<5	211.8	0.978	9.98
97	8/13/2007 11:00	1.67	2.98	46.4	952	1.615	43.3
98	9/5/2007 10:15	1.67	3.02	46.6	1047.5	1.656	47.53
99	11/27/2007 10:05	1.67	3.03	47	1080	1.669	48.97
100	12/4/2007 10:00	1.73	3.08	53.2	1190	1.71	53.84
101	12/12/2007 11:30	0.778	2.4	6	251	1.05	11.78
102	3/4/2008 10:15	1.06	2.42	11.4	265.8	1.074	12.46
103	4/14/2008 10:00	1.45	2.71	28.2	515	1.355	23.77
104	5/29/2008 9:40	1.04	2.49	10.9	307.7	1.136	14.37
105	6/30/2008 9:50	1.04	2.47	10.9	292.7	1.115	13.69
106	9/16/2008 9:40	0.987	2.4	9.7	253.3	1.054	11.89
107	10/17/2008 9:50	0.869	2.31	7.4	202	0.958	9.53
108	4/1/2009 11:10	1.35	2.71	22.3	513.2	1.353	23.68
109	4/6/2009 10:40	1.66	2.91	46.1	813	1.548	37.11
110	4/13/2009 10:20	1.58	2.79	38.2	615	1.43	28.26
111	4/30/2009 10:05	1.09	2.46	12.4	287.4	1.108	13.45
112	5/12/2009 10:15	0.968	2.42	9.3	264.8	1.073	12.41
113	6/16/2009 10:20	1.06	2.44	11.6	273.7	1.087	12.82
114	7/30/2009 12:30	1.46	2.68	28.8	478.5	1.324	22.12
115	11/2/2009 10:10	1.05	2.47	11.2	296.3	1.12	13.86
116	12/1/2009 9:55	1.6	3.05	40	1120	1.684	50.74
117	12/17/2009 10:00	1.72	3.16	52.4	1430	1.788	64.41
118	1/6/2010 10:10	1.79	3.18	62.1	1520	1.814	68.37
119	1/19/2010 11:45	1.8	3.18	63.7	1520	1.814	68.37
120	2/11/2010 10:30	1.74	3.16	54.7	1435	1.789	64.63
121	2/23/2010 10:25	1.75	3.09	56.6	1230	1.724	55.6
122	4/13/2010 9:20	1.78	3.12	59.7	1330	1.757	60.01
123	6/1/2010 9:50	1.57	2.89	37.3	782.3	1.532	35.75
124	6/15/2010 10:00	0.982	2.36	9.6	228	1.009	10.73
125	7/7/2010 10:00	<0.699	2.14	<5	139	0.8	6.62

126	8/19/2010 9:20	1.55	2.91	35.2	805.7	1.545	36.79
127	8/25/2010 9:10	1.05	2.35	11.3	224.8	1.003	10.58
128	11/16/2010 9:55	1.22	2.59	16.6	390.8	1.238	18.15
129	1/19/2011 9:45	<0.699	3.16	<5	1460	1.797	65.73
130	3/7/2011 9:40	1.67	2.98	47.3	951	1.615	43.25
131	5/16/2011 9:20	1.58	3.09	38.2	1220	1.721	55.16
132	6/20/2011 10:00	1.35	2.95	22.4	901	1.592	41.03
133	8/11/2011 9:45	1	2.23	10	169.8	0.884	8.04
134	9/22/2011 10:30	0.996	2.44	9.9	275.5	1.09	12.9
135	12/21/2011 12:05	1.16	2.79	14.4	618.8	1.433	28.43
136	3/1/2012 10:00	0.763	2.23	5.8	168	0.88	7.96
137	4/18/2012 10:30	1.08	2.5	12.1	314.5	1.146	14.68
138	5/29/2012 11:05	1.5	2.97	31.6	936.2	1.608	42.6
139	6/18/2012 9:30	1.37	2.82	23.5	660	1.46	30.28
140	3/12/2013 9:30	1.7	3.18	50.1	1530	1.817	68.81
141	3/13/2013 11:50	1.49	3.27	31.2	1883.3	1.905	84.28
142	4/29/2013 11:00	1.35	3	22.3	999	1.636	45.38
143	6/3/2013 10:00	1.37	2.67	23.3	463	1.31	21.42
144	7/30/2013 10:15	<0.699	1.88	<5	75.2	0.539	3.63
145	10/30/2013 9:10	1.8	3.03	62.4	1060	1.661	48.09
146	4/9/2014 9:20	1.74	3.06	55.1	1160	1.699	52.51
147	6/4/2014 9:20	1.48	2.91	30.1	821.7	1.553	37.5
148	6/12/2014 9:30	0.713	2.15	5.17	142	0.809	6.76
149	8/28/2014 8:20	1.54	2.89	34.6	778.3	1.53	35.57
150	9/4/2014 11:30	0.963	2.3	9.18	200.5	0.955	9.46
151	12/10/2014 10:15	1.8	3.12	63.7	1327.5	1.756	59.9
152	2/25/2015 9:35	1.79	3.1	61.1	1252.9	1.732	56.61
153	4/7/2015 9:55	1.72	3.12	52.2	1310	1.751	59.13
154	4/20/2015 11:25	1.23	2.51	16.8	325.1	1.16	15.17
155	5/28/2015 10:00	0.841	2.25	6.94	179	0.907	8.47
156	7/14/2015 11:05	1.47	2.85	29.4	706.3	1.489	32.35
157	8/6/2015 10:20	1.12	2.39	13.2	247.3	1.044	11.61
158	8/27/2015 9:00	1.02	2.39	10.5	248	1.045	11.64
159	12/14/2015 10:35	<0.699	1.91	<5	80.8	0.57	3.9
160	5/2/2016 11:00	1.16	2.48	14.3	304	1.131	14.21
161	6/1/2016 10:20	1.17	2.53	14.7	338.7	1.177	15.78
162	6/16/2016 10:05	1.39	2.73	24.3	531.7	1.368	24.52
163	7/5/2016 10:00	<0.699	2.13	<5	135	0.787	6.43
164	8/10/2016 13:15	1.04	2.45	10.9	283.2	1.101	13.26
165	9/12/2016 10:05	1.01	2.35	10.3	222.9	1	10.49
166	3/30/2017 10:30	1.12	2.44	13.2	278.5	1.094	13.04
167	5/3/2017 10:15	1.15	2.45	14.2	282	1.099	13.2
168	5/30/2017 12:10	1.64	2.94	44.1	862.2	1.573	39.3
169	6/27/2017 10:35	1.69	3.02	49.1	1053	1.658	47.78
170	7/12/2017 9:40	1.59	2.94	39.3	875.6	1.58	39.9
171	8/1/2017 10:25	1.44	2.77	27.6	582.5	1.407	26.8
172	8/17/2017 10:05	1.49	2.84	30.7	686.9	1.477	31.48
173	9/5/2017 9:50	1.54	2.87	34.4	741.9	1.51	33.94
174	11/14/2017 10:30	1.57	2.8	37.2	632.4	1.442	29.04
175	1/30/2018 10:00	1.67	2.89	46.8	768.8	1.525	35.14
176	3/21/2018 10:10	1.65	2.92	44.7	838.2	1.561	38.24
177	5/1/2018 11:10	1.62	2.97	41.4	943	1.611	42.9
178	5/22/2018 9:35	1.55	3	35.7	1001.8	1.637	45.51
179	6/2/2018 9:20	0.919	2.54	8.3	349.7	1.191	16.28
180	7/18/2018 10:20	0.791	2.2	6.18	158	0.854	7.5
181	9/6/2018 10:00	0.8	2.23	6.31	170	0.885	8.05

182	12/3/2018 11:05	1.37	2.77	23.2	589.5	1.412	27.12
183	2/26/2019 11:40	1.73	3.05	53.3	1130.7	1.688	51.21
184	3/14/2019 10:20	1.31	2.67	20.3	465.7	1.312	21.54
185	4/10/2019 12:00	1.63	2.96	42.3	909	1.596	41.39
186	4/29/2019 13:05	1.06	2.36	11.5	230.1	1.013	10.82
187	6/11/2019 10:10	1.64	2.94	43.5	875.8	1.58	39.91
188	8/21/2019 11:20	1.29	2.5	19.5	314.3	1.146	14.68
189	10/8/2019 10:10	1.87	2.96	74	905.8	1.594	41.25
190	12/10/2019 11:30	1.78	3.07	60.1	1180.5	1.707	53.42

Definitions

S04: Sulfate in mg/L (00945)

SC: Specific conductance in $\mu\text{S}/\text{cm}$ @25C (00095)

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