Appendix 2.17. Model Archive Summary for Sulfate Concentration at U.S. Geological Survey site 07144100; Little Arkansas River near Sedgwick, 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: 07144100

Site Name: Little Arkansas River near Sedgwick, Kansas

Location: Latitude 37°52'59", longitude 97°25'27" referenced to North American Datum of 1927, in NE 1/4 NW 1/4 NW 1/4 sec.15, T.25 S., R.1 W., Sedgwick 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 handrail. Check-bar elevation is 33.614 feet. The orifice is enclosed in a well-screen and attached to a concrete pier on the left downstream side of the bridge. 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 [September 1998 through December 2006] and YSI Model 6136 [July 2004 through March 2015]) sensors collected data during April 1998 through March 2015. 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 September 2014 through December 2019. A Hach Nitratax monitor collected nitrate data during March 2012 through December 2019.

Date model was developed: June 1, 2020

Model calibration data period: May 1, 1998 through December 11, 2019

Model Data

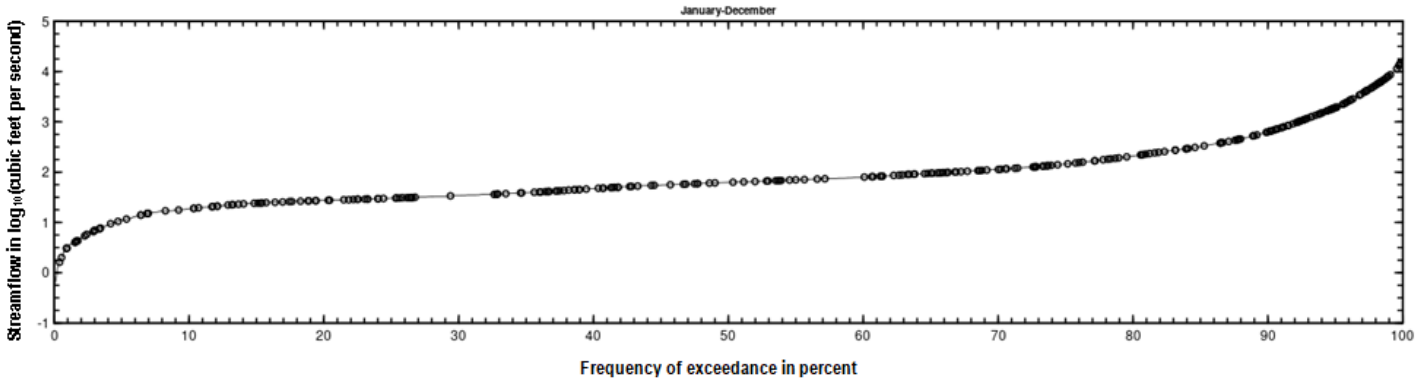
All data were collected using USGS protocols (U.S. Geological Survey, variously dated; Wagner and others, 2006; Sauer and Turnipseed, 2010; Turnipseed and Sauer, 2010) and are stored in the National Water Information System (NWIS) database (U.S. Geological Survey, 2021). Explanatory variables were evaluated 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 325 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. Ten 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.

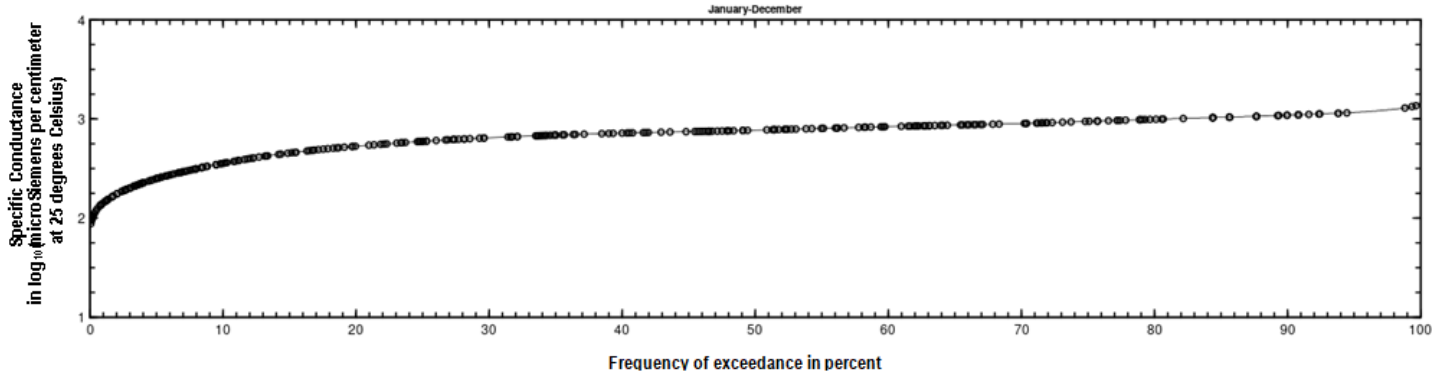
Sulfate

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 25 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 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 07144100:

Sulfate-based model:

$$\log_{10}(SO4) = 1.257 \times \log_{10}(SC) - 1.897$$

where,

$\log_{10}$ = logarithm base 10;
SO4 = sulfate, in milligrams per liter (mg/L); and
SC = specific conductance, in microsiemens per centimeter at 25 degrees Celsius (µS/cm)

The log-transformed model may be retransformed to original units so that SO4 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 1.03. The retransformed model, accounting for BCF is:

$$SO4 = 0.0131 \times SC^{1.257}$$

Model Statistics, Data, and Plots

Model

LOGSO4 = + 1.257 * LOGSC – 1.897

Variable Summary Statistics

	SO4	SC
Minimum	<5	90.17
1st Quartile	17.2	316
Median	45.8	661.53
Mean	42.18	610.02
3rd Quartile	63	852.81
Maximum	174	1383.33

Explanatory Variables

```
Coefficients:
            Estimate Std. Error z-score p-value
(Intercept)   -1.897    0.06207  -30.57       0
logSC          1.257    0.02271   55.34       0
```

Basic Model Statistics

```
Estimated residual standard error (Unbiased) = 0.11
Distribution: normal
Number of observations = 325, number censored = 10 (3.1 percent)

Loglik(model) = 242.4 Loglik(intercept only) = -148.4
  Chi-square = 781.6, degrees of freedom = 1, p-value = <0.0001

Computation method: AMLE

Pseudo R-squared: 0.9108

  AIC: -478.8
  BIC: -467.4
```

Outlier Test Criteria

```
Test criteria
leverage   cooksD
0.009231 0.694632
```

Flagged Observations

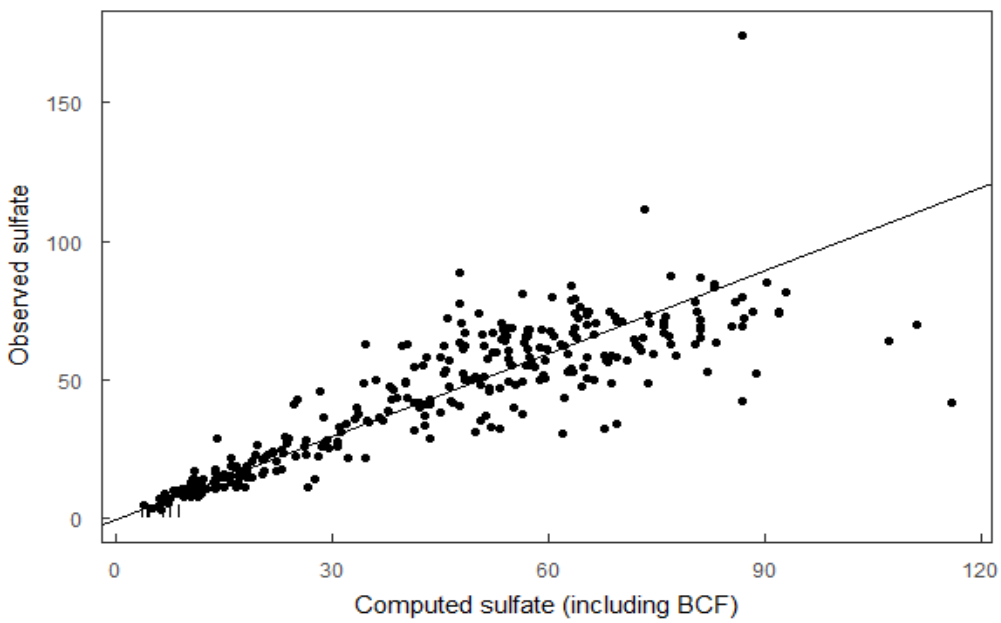
	logSO4	ycen	yhat	resids	leverage	cooksD
8	1.0414	FALSE	1.0009	0.04048	0.0096	0.000663
14	0.699	TRUE	0.5599	-0.022	0.025752	0.000543
15	0.699	TRUE	0.6237	-0.04608	0.022815	0.002097
17	0.9031	FALSE	1.0056	-0.10252	0.00948	0.004198
22	1.8451	FALSE	2.0322	-0.18706	0.009884	0.014581
25	1.1139	FALSE	1.0036	0.11034	0.009531	0.004889
30	1	FALSE	0.9304	0.06957	0.011527	0.00236
31	0.9542	FALSE	0.8267	0.1275	0.014815	0.010256
53	0.699	FALSE	0.5894	0.10958	0.024369	0.012705
54	1	FALSE	0.8956	0.10445	0.012573	0.005814
58	0.7782	FALSE	0.8053	-0.02713	0.015563	0.000489
71	1.8062	FALSE	2.0166	-0.21039	0.009483	0.017681
81	1	FALSE	0.9782	0.02182	0.010194	0.000205
89	0.8451	FALSE	0.7792	0.06586	0.016501	0.003058
106	0.699	TRUE	0.9253	-0.26665	0.011678	0.035133
108	0.699	TRUE	0.8679	-0.21656	0.013447	0.026779
120	0.9294	FALSE	0.9907	-0.06128	0.009864	0.001561
123	0.8451	FALSE	0.873	-0.0279	0.013282	0.000439
138	0.8808	FALSE	0.8117	0.06913	0.015337	0.003125
139	0.699	TRUE	0.6343	-0.05116	0.022343	0.002529
140	0.699	TRUE	0.6413	-0.05465	0.022037	0.002845

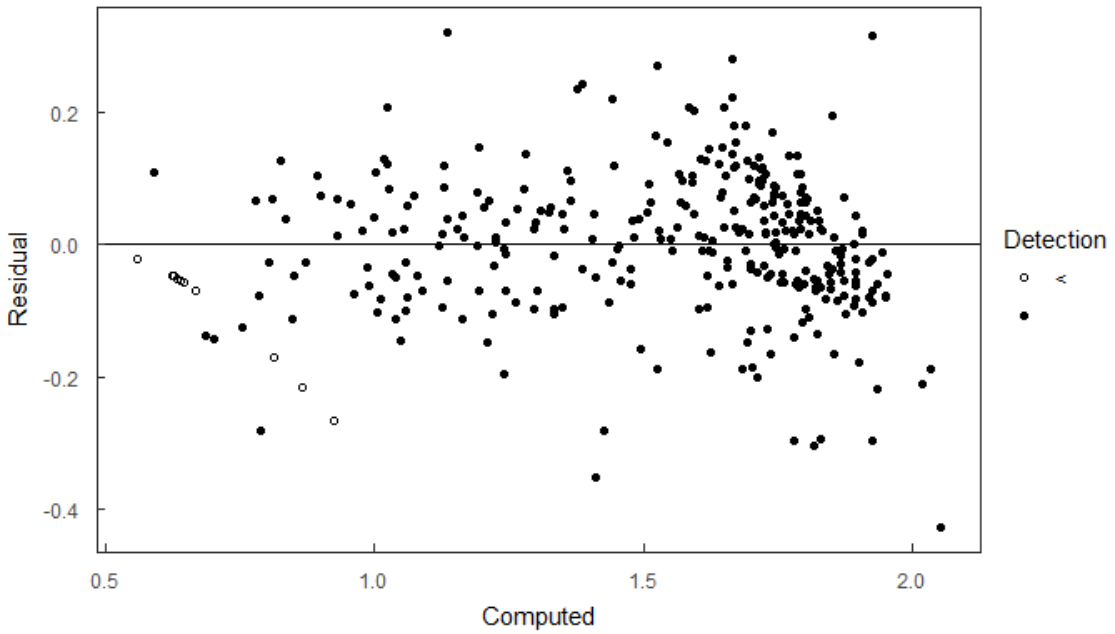
```
141    0.699     TRUE   0.6668    -0.06836  0.020943   0.00422
142   0.8865    FALSE    0.962    -0.07551  0.010633   0.00256
143   0.9294    FALSE   1.0118     -0.0824  0.009324  0.002666
144    0.699     TRUE   0.6272    -0.04776  0.022656  0.002236
191    1.622    FALSE   2.0505    -0.42845  0.010371  0.080341
193    0.699     TRUE   0.8136    -0.17146   0.01527  0.019136
194    0.699     TRUE    0.647    -0.05754  0.021793  0.003117
195   0.5075    FALSE   0.7883    -0.28083  0.016171  0.054459
212   0.7358    FALSE   0.8486    -0.11274  0.014078  0.007608
219   0.8727    FALSE   0.8341     0.03862  0.014563  0.000925
249   0.9474    FALSE   0.9327     0.01471  0.011461  0.000105
252   0.7084    FALSE   0.7853    -0.07686   0.01628  0.004108
257   0.9544    FALSE   0.9879     -0.0335  0.009936   0.00047
295   0.8035    FALSE   0.8504    -0.04683  0.014019  0.001307
296   0.9749    FALSE   0.9013     0.07363  0.012398  0.002848
299   0.5497    FALSE    0.688    -0.13822  0.020059  0.016494
313   0.5617    FALSE   0.7037      -0.142  0.019416  0.016827
316   0.6305    FALSE   0.7554    -0.12491  0.017388  0.011613
320   1.0182    FALSE   0.9565     0.06176  0.010786  0.001738
```

95% Confidence Intervals

```
                 2.5 %    97.5 %
(Intercept) -2.019047 -1.775738
logSC        1.212401  1.301427
```

Plots

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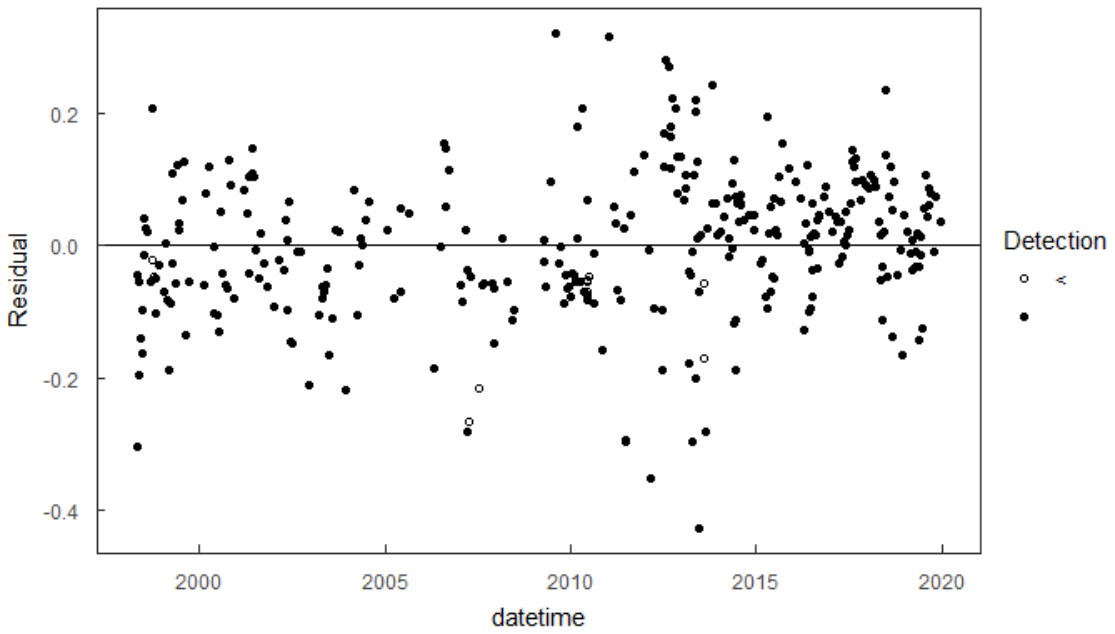
-0.4
0.5
1.0
1.5
2.0
Computed
Detection
<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2020
datetime
Detection
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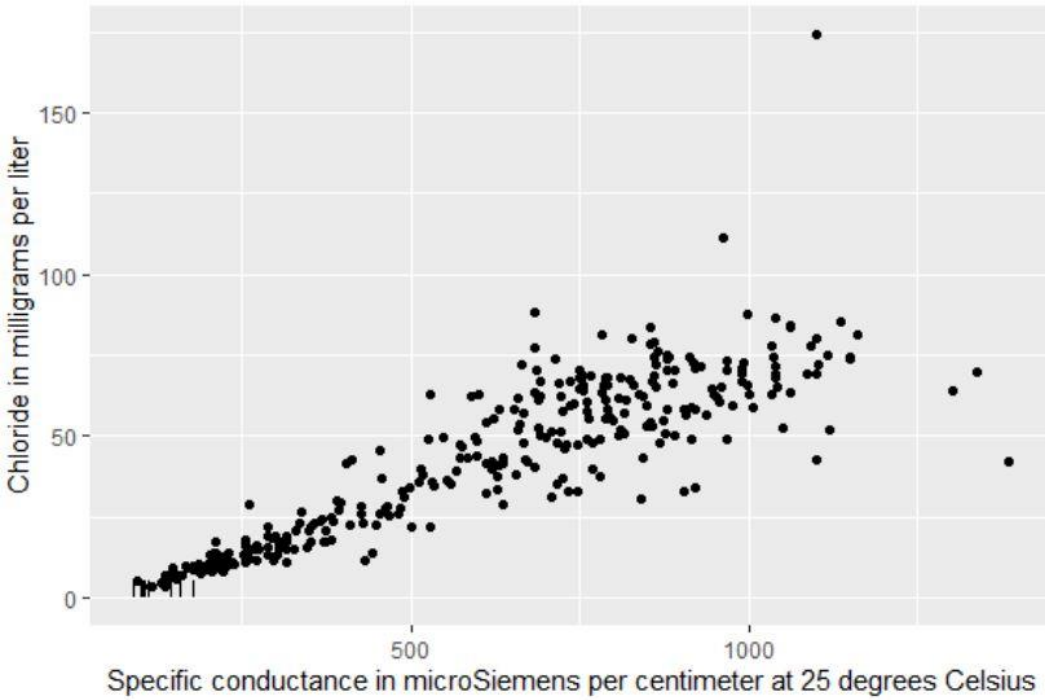

Model-Calibration Dataset

	datetime	logSO4	logSC	SO4	SC	Computed logSO4	Computed SO4
1	5/1/1998 13:05	1.51	2.96	32.6	902.5	1.818	67.82
2	5/6/1998 12:10	1.71	2.91	51.8	810.8	1.76	59.27
3	5/11/1998 10:30	1.77	2.96	58.8	913.5	1.825	68.86
4	5/14/1998 9:25	1.05	2.5	11.1	314.2	1.242	18
5	5/27/1998 14:25	1.64	2.93	43.5	842.8	1.781	62.22
6	6/16/1998 11:20	1.7	2.94	50.6	877	1.802	65.42
7	6/24/1998 11:05	1.46	2.8	29	634.5	1.626	43.55
8	7/10/1998 10:45	1.04	2.31	11	202.2	1.002	10.35
9	7/13/1998 14:00	1.23	2.5	17	316	1.245	18.13
10	7/20/1998 12:40	1.59	2.75	39	567.7	1.565	37.87
11	8/6/1998 9:40	1.79	2.91	61	816.7	1.763	59.81
12	9/15/1998 9:50	1.73	2.93	54	853.2	1.787	63.19
13	9/22/1998 10:15	1.23	2.32	17	210.5	1.023	10.88
14	9/25/1998 10:10	<0.699	1.96	<5	90.2	0.56	3.75
15	10/5/1998 10:20	<0.699	2.01	<5	101.3	0.624	4.34
16	10/22/1998 11:25	1.36	2.63	23	427.8	1.411	26.54
17	11/5/1998 13:40	0.903	2.31	8	204	1.006	10.46
18	12/4/1998 10:40	1.67	2.86	47	728.3	1.701	51.8
19	1/12/1999 10:30	1.86	3.04	72	1101.5	1.927	87.12
20	2/1/1999 11:00	1.23	2.49	17	306	1.228	17.41
21	2/19/1999 12:20	1.81	3.02	65	1041.3	1.896	81.18
22	3/16/1999 13:40	1.85	3.13	70	1337.7	2.033	111.21
23	3/23/1999 13:55	1.84	3.04	69	1099.6	1.926	86.93
24	4/7/1999 13:55	1.41	2.66	26	454.2	1.443	28.61
25	4/16/1999 11:15	1.11	2.31	13	203.2	1.004	10.41
26	5/5/1999 14:00	1.7	2.91	50	806	1.756	58.83
27	5/24/1999 13:05	1.15	2.32	14	211.1	1.025	10.92
28	6/18/1999 11:00	1.28	2.5	19	316	1.245	18.13
29	6/21/1999 13:40	1.08	2.35	12	223	1.055	11.7
30	7/20/1999 10:45	1	2.25	10	177.8	0.931	8.8
31	8/3/1999 11:45	0.954	2.17	9	147	0.827	6.93

32	8/19/1999 10:15	1.69	2.96	49	914	1.825	68.91
33	9/28/1999 10:50	1.08	2.41	12.1	259.5	1.138	14.16
34	2/9/2000 10:45	1.87	3.05	74.8	1115.2	1.934	88.49
35	3/7/2000 10:20	1.27	2.46	18.7	287.3	1.193	16.09
36	3/28/2000 12:45	1.25	2.41	17.7	255.5	1.129	13.88
37	5/19/2000 9:45	1.8	3.03	63.7	1062.2	1.907	83.24
38	5/31/2000 11:30	1.45	2.67	28.3	464	1.455	29.39
39	6/28/2000 10:05	1.23	2.57	17	372.4	1.335	22.29
40	7/20/2000 10:40	1.57	2.86	37	725	1.698	51.5
41	7/28/2000 10:45	1.36	2.55	23	356.5	1.311	21.1
42	8/16/2000 10:40	1.67	2.87	47	745	1.713	53.29
43	9/8/2000 9:50	1.72	2.93	53	849.3	1.785	62.83
44	9/25/2000 11:25	1.72	2.93	53	857	1.79	63.55
45	10/26/2000 11:35	1.15	2.32	14	208.5	1.018	10.75
46	11/8/2000 9:35	1.6	2.71	40	514.6	1.511	33.47
47	12/4/2000 10:10	1.84	3.04	69	1085.8	1.919	85.57
48	3/14/2001 10:40	1.36	2.53	23	335.3	1.278	19.54
49	4/13/2001 9:55	1.56	2.71	36	512.5	1.509	33.3
50	4/26/2001 12:45	1.83	3	67	988.7	1.868	76.06
51	5/8/2001 9:50	1.76	2.82	57	666.3	1.652	46.32
52	6/4/2001 10:00	1.34	2.46	22	288	1.194	16.14
53	6/6/2001 10:10	0.699	1.98	5	95.2	0.59	4.01
54	6/23/2001 11:15	1	2.22	10	166.8	0.896	8.12
55	7/11/2001 10:00	1.76	2.91	57	815	1.762	59.66
56	8/2/2001 8:45	1.68	2.89	48	769.5	1.731	55.5
57	8/28/2001 9:50	1.76	2.9	58	789.7	1.745	57.34
58	9/20/2001 10:20	0.778	2.15	6	141.3	0.806	6.59
59	10/31/2001 9:40	1.72	2.93	53	853	1.787	63.18
60	1/10/2002 10:45	1.8	3.01	63	1032.5	1.891	80.32
61	2/21/2002 9:50	1.9	3.04	80	1100	1.926	86.97
62	4/9/2002 10:05	1.81	2.98	65	957.9	1.851	73.09
63	4/22/2002 11:00	1.18	2.41	15	259	1.137	14.12
64	5/13/2002 11:15	1.51	2.78	32	609.5	1.604	41.41
65	5/22/2002 11:00	1.41	2.63	26	425	1.407	26.32
66	6/6/2002 9:00	1.43	2.59	27	393	1.364	23.85
67	6/13/2002 9:30	0.903	2.34	8	220.5	1.049	11.53
68	7/9/2002 11:50	1.54	2.86	35	716.7	1.692	50.75
69	8/15/2002 10:00	1.6	2.79	40	618.1	1.611	42.14
70	9/19/2002 10:10	1.68	2.86	48	716.5	1.692	50.74
71	12/18/2002 10:30	1.81	3.11	64	1300	2.017	107.29
72	3/20/2003 10:20	1.11	2.48	13	301.3	1.219	17.08
73	4/17/2003 10:15	1.87	3.06	74	1150	1.95	91.97
74	4/23/2003 9:50	1.58	2.82	38	653.6	1.642	45.21
75	5/14/2003 10:00	1.18	2.5	15	316	1.245	18.13
76	5/29/2003 10:00	1.41	2.68	26	482	1.476	30.83
77	6/11/2003 10:25	1.62	2.83	42	672.9	1.658	46.89
78	6/24/2003 10:55	1.69	2.99	49	967.2	1.856	73.99
79	7/30/2003 12:20	1.7	2.95	50	888.7	1.81	66.51
80	9/3/2003 10:25	1.18	2.43	15	267.4	1.154	14.7
81	10/14/2003 11:00	1	2.29	10	194	0.979	9.82
82	12/11/2003 11:30	1.72	3.05	52	1120	1.936	88.96
83	3/9/2004 9:50	1.11	2.33	13	212.8	1.029	11.03
84	3/30/2004 9:50	1.77	3	59	1006.3	1.877	77.77
85	4/26/2004 12:00	1.84	3	69	989	1.868	76.09
86	5/13/2004 12:40	1.18	2.44	15	273.7	1.167	15.13
87	5/26/2004 11:45	1.89	3.01	78	1032.5	1.891	80.32

88	6/22/2004 9:10	1.18	2.41	15	259.3	1.137	14.14
89	7/27/2004 9:45	0.845	2.13	7	134.8	0.78	6.21
90	1/27/2005 11:20	1.32	2.54	21	348.7	1.299	20.52
91	3/23/2005 10:20	0.982	2.35	9.6	226.3	1.063	11.92
92	5/27/2005 9:40	1.12	2.46	13.3	288.3	1.195	16.16
93	6/6/2005 10:15	1.26	2.47	18.2	292.8	1.203	16.47
94	8/31/2005 11:30	1.37	2.56	23.6	366	1.325	21.81
95	5/2/2006 13:05	1.52	2.86	32.9	731.8	1.704	52.11
96	6/26/2006 12:40	1.19	2.46	15.5	287	1.193	16.07
97	7/27/2006 11:15	1.83	2.84	67.2	692.2	1.673	48.59
98	8/15/2006 9:10	1.79	2.82	62	658.2	1.646	45.6
99	8/23/2006 13:25	1.64	2.77	43.5	582.2	1.579	39.09
100	9/27/2006 11:00	1.83	2.88	67.9	750	1.717	53.74
101	1/10/2007 11:25	1.74	2.94	54.9	872.6	1.8	65.01
102	2/5/2007 9:30	1.78	2.99	59.6	974	1.86	74.64
103	3/12/2007 12:05	1.71	2.85	51.2	707.9	1.685	49.97
104	3/21/2007 12:05	1.66	2.86	46	728.1	1.701	51.77
105	3/27/2007 11:40	1.15	2.65	14	441.7	1.428	27.62
106	4/2/2007 11:50	<0.699	2.25	<5	176.1	0.926	8.69
107	4/18/2007 12:00	1.03	2.37	10.8	233.9	1.081	12.43
108	7/11/2007 12:10	<0.699	2.2	<5	158.5	0.868	7.62
109	8/16/2007 9:25	1.61	2.83	40.4	683.6	1.666	47.83
110	9/6/2007 9:35	1.79	2.98	61.9	954.1	1.848	72.73
111	11/26/2007 10:40	1.7	2.91	50.5	814.7	1.762	59.63
112	12/6/2007 11:45	1.75	2.96	56.9	905.5	1.82	68.1
113	12/13/2007 10:15	1.06	2.47	11.5	296.3	1.21	16.72
114	3/6/2008 10:30	1.24	2.48	17.2	305	1.226	17.34
115	4/14/2008 12:10	1.4	2.67	25.3	466.7	1.458	29.6
116	5/29/2008 11:45	0.929	2.34	8.5	217.8	1.042	11.35
117	6/30/2008 12:05	1.2	2.54	15.8	347.1	1.296	20.4
118	4/6/2009 13:00	1.63	2.83	42.6	670	1.655	46.64
119	4/13/2009 11:40	1.54	2.73	34.7	534.7	1.532	35.12
120	4/28/2009 10:05	0.929	2.3	8.5	198.5	0.991	10.11
121	6/16/2009 12:50	1.46	2.6	29.1	395	1.367	24
122	7/30/2009 10:35	1.46	2.41	28.8	259.5	1.138	14.16
123	9/9/2009 12:00	0.845	2.2	7	160	0.874	7.71
124	9/24/2009 11:15	1.12	2.4	13.1	251.5	1.12	13.61
125	11/3/2009 9:20	1.18	2.51	15	326.7	1.263	18.9
126	11/19/2009 11:40	1.69	2.89	49.3	780	1.738	56.46
127	12/1/2009 12:40	1.76	2.96	58	920.7	1.829	69.54
128	12/17/2009 12:00	1.83	3.02	68.2	1040	1.895	81.05
129	1/6/2010 11:50	1.87	3.06	74.6	1150	1.95	91.97
130	1/19/2010 10:00	1.85	3.02	71.4	1040	1.895	81.05
131	2/4/2010 10:40	1.8	2.98	63	948.7	1.845	72.21
132	2/23/2010 12:50	1.82	3	65.6	997	1.872	76.86
133	3/10/2010 9:10	1.87	2.85	73.9	713.3	1.69	50.46
134	3/11/2010 9:20	1.62	2.79	41.8	618.7	1.612	42.19
135	4/14/2010 9:05	1.84	3.02	69.3	1040	1.895	81.05
136	4/23/2010 10:00	1.79	2.77	62.1	590	1.586	39.75
137	5/13/2010 10:15	1.23	2.55	17.1	351.5	1.303	20.73
138	6/9/2010 9:45	0.881	2.16	7.6	143	0.812	6.69
139	6/13/2010 15:20	<0.699	2.01	<5	103.3	0.635	4.45
140	6/13/2010 19:20	<0.699	2.02	<5	104.7	0.642	4.52
141	6/14/2010 9:40	<0.699	2.04	<5	109.7	0.667	4.79
142	6/15/2010 9:20	0.886	2.27	7.7	188.3	0.963	9.46
143	6/16/2010 9:10	0.929	2.31	8.5	206.3	1.012	10.61

144	7/6/2010 9:00	<0.699	2.01	<5	102	0.628	4.38
145	8/19/2010 12:15	1.62	2.8	41.3	636.8	1.628	43.75
146	8/25/2010 11:00	1.35	2.65	22.4	449	1.437	28.2
147	11/16/2010 12:25	1.34	2.7	21.8	500.7	1.496	32.34
148	1/19/2011 11:40	2.24	3.04	174	1100	1.926	86.97
149	3/7/2011 11:40	1.78	2.88	60.6	759	1.723	54.55
150	3/16/2011 9:05	1.79	2.91	61.8	808	1.758	59.01
151	4/6/2011 9:30	1.78	2.98	60.6	956	1.849	72.91
152	5/2/2011 9:05	1.75	2.97	56.8	935.9	1.838	70.98
153	6/7/2011 8:30	1.7	2.84	50.1	692	1.673	48.57
154	6/21/2011 10:00	1.53	2.96	34.2	920	1.828	69.47
155	6/22/2011 10:20	1.48	2.92	30.4	840.7	1.779	62.03
156	8/15/2011 10:45	1.39	2.58	24.8	382	1.349	23.01
157	9/22/2011 9:45	1.47	2.59	29.7	390	1.36	23.62
158	12/20/2011 11:15	1.42	2.53	26.3	338.5	1.283	19.77
159	2/6/2012 10:15	1.45	2.66	27.9	461.5	1.452	29.19
160	3/1/2012 12:00	1.06	2.63	11.5	430	1.413	26.71
161	4/7/2012 10:25	1.25	2.58	17.9	382.4	1.349	23.05
162	6/18/2012 12:15	1.24	2.57	17.2	371.8	1.334	22.24
163	6/19/2012 9:00	1.34	2.72	21.7	529	1.526	34.65
164	7/5/2012 12:35	1.82	2.87	66.8	735.6	1.706	52.44
165	7/12/2012 10:15	1.91	2.89	81.2	781.5	1.739	56.59
166	7/19/2012 10:15	1.95	2.83	88.4	683	1.666	47.78
167	8/30/2012 8:15	1.8	2.72	62.7	529	1.526	34.65
168	9/6/2012 13:15	1.69	2.72	48.9	526.5	1.524	34.45
169	9/11/2012 10:15	1.85	2.84	70.2	685.5	1.668	48
170	9/18/2012 11:20	1.84	2.88	68.7	755.3	1.721	54.22
171	9/26/2012 9:20	1.89	2.83	77.4	683.3	1.666	47.81
172	10/24/2012 9:30	1.86	2.82	72	662.5	1.649	45.98
173	11/7/2012 11:10	1.9	2.92	80.1	825.8	1.77	60.66
174	11/14/2012 9:20	1.87	2.93	74.2	859.7	1.791	63.8
175	12/12/2012 10:00	1.92	2.93	83.7	854	1.788	63.27
176	1/16/2013 9:30	1.87	2.94	74.5	880.5	1.805	65.75
177	1/29/2013 10:05	1.83	2.9	68	791	1.746	57.46
178	2/13/2013 9:30	1.9	2.93	79.2	860	1.792	63.83
179	3/12/2013 11:00	1.76	2.94	58.1	878	1.803	65.51
180	3/13/2013 9:15	1.72	3.02	52.7	1050	1.901	82.03
181	3/27/2013 11:35	1.91	3.06	81.4	1160	1.955	92.98
182	4/11/2013 10:15	1.61	2.8	41.1	630.8	1.622	43.23
183	4/15/2013 9:00	1.63	3.04	42.5	1100	1.926	86.97
184	4/24/2013 9:30	1.68	2.76	47.4	571	1.568	38.14
185	5/6/2013 11:00	1.51	2.87	32.6	745	1.713	53.29
186	5/15/2013 9:10	1.8	2.78	62.8	599.2	1.594	40.52
187	5/21/2013 9:00	1.66	2.66	45.8	453	1.442	28.51
188	5/28/2013 10:50	1.82	2.86	66.2	718.2	1.693	50.89
189	6/5/2013 9:00	1.49	2.69	31.2	489	1.483	31.39
190	6/13/2013 9:20	1.75	2.96	56.3	906.7	1.821	68.21
191	6/24/2013 9:40	1.62	3.14	41.9	1383.3	2.051	116.01
192	7/9/2013 9:30	1.71	2.86	51.3	721	1.695	51.14
193	7/29/2013 10:30	<0.699	2.16	<5	143.5	0.814	6.72
194	8/7/2013 9:45	<0.699	2.02	<5	105.8	0.648	4.58
195	8/15/2013 9:10	0.507	2.14	3.22	137	0.789	6.34
196	8/29/2013 8:20	1.68	2.82	47.6	665.3	1.652	46.23
197	10/24/2013 9:20	1.87	2.94	73.6	877.7	1.803	65.48
198	10/30/2013 10:20	1.63	2.61	42.8	410.8	1.388	25.22
199	11/25/2013 9:10	1.86	2.94	72.1	863	1.794	64.11

200	12/11/2013 11:10	1.92	3.03	83.6	1060	1.906	83.01
201	1/14/2014 10:20	1.93	3.03	84.5	1060	1.906	83.01
202	2/20/2014 10:10	1.94	3.02	86.8	1040	1.895	81.05
203	3/17/2014 9:00	1.94	3	87.7	998	1.873	76.96
204	4/9/2014 12:30	1.85	2.99	71	988.5	1.868	76.04
205	4/14/2014 11:20	1.87	2.99	73.4	967	1.856	73.96
206	5/14/2014 13:20	1.69	2.78	48.6	597	1.592	40.34
207	5/15/2014 10:30	1.74	2.9	55.2	791	1.746	57.46
208	5/29/2014 10:20	1.68	2.94	47.9	868.7	1.797	64.64
209	6/3/2014 10:10	1.74	2.79	54.4	611.7	1.606	41.59
210	6/5/2014 10:40	1.5	2.85	31.4	707	1.685	49.9
211	6/9/2014 13:30	1.15	2.36	14	230.5	1.073	12.2
212	6/12/2014 11:40	0.736	2.18	5.44	153	0.849	7.29
213	6/24/2014 10:00	1.63	2.76	43.1	573	1.57	38.31
214	7/10/2014 9:40	1.72	2.82	52	657	1.645	45.5
215	7/15/2014 13:40	1.76	2.88	57.4	760	1.724	54.64
216	7/24/2014 9:10	1.8	2.89	63.7	783.2	1.741	56.74
217	8/4/2014 9:15	1.83	2.92	67.4	823	1.768	60.4
218	8/7/2014 9:10	1.82	2.9	65.7	785.8	1.742	56.99
219	9/3/2014 12:00	0.873	2.17	7.46	149	0.835	7.05
220	10/16/2014 10:10	1.64	2.78	43.5	598	1.593	40.43
221	12/9/2014 10:45	1.82	2.92	65.7	828.8	1.771	60.93
222	12/15/2014 9:40	1.85	2.96	71	921	1.829	69.57
223	2/11/2015 9:20	1.89	3.04	78.2	1090	1.921	85.98
224	2/25/2015 11:20	1.87	3.02	74.5	1036.7	1.894	80.72
225	4/6/2015 12:35	1.8	3	62.6	999	1.873	77.05
226	4/16/2015 9:50	2.05	2.98	111	960.3	1.852	73.32
227	4/22/2015 14:30	1.52	2.8	33.4	627	1.619	42.91
228	5/5/2015 9:50	1.75	2.88	55.6	762.8	1.726	54.9
229	5/20/2015 13:15	1.12	2.35	13.2	226.2	1.063	11.91
230	5/27/2015 11:50	1.02	2.38	10.5	238	1.09	12.7
231	6/10/2015 9:00	1.57	2.8	37.3	627	1.619	42.91
232	6/17/2015 10:40	0.99	2.34	9.77	217.3	1.041	11.33
233	6/29/2015 8:50	1.78	2.87	59.7	734.7	1.706	52.36
234	7/13/2015 12:30	1.38	2.59	23.8	385.5	1.354	23.28
235	8/3/2015 8:30	1.74	2.88	55.2	763.5	1.727	54.96
236	8/17/2015 9:30	1.69	2.77	49.4	595.5	1.591	40.21
237	8/27/2015 10:40	1.28	2.47	19	298.3	1.214	16.87
238	9/8/2015 10:00	1.7	2.74	49.8	546	1.544	36.06
239	11/17/2015 10:10	1.78	2.84	60.9	687.3	1.669	48.16
240	1/19/2016 11:10	1.82	2.88	65.6	755	1.721	54.19
241	3/16/2016 10:10	1.87	2.94	74.8	878	1.803	65.51
242	4/20/2016 10:40	1.75	2.9	56.2	792.7	1.747	57.61
243	4/21/2016 11:30	1.6	2.88	40	767	1.729	55.28
244	5/3/2016 13:20	1.33	2.54	21.6	350	1.301	20.62
245	5/18/2016 9:50	1.76	2.82	58	653.5	1.642	45.2
246	5/26/2016 12:10	1.24	2.5	17.2	314.2	1.242	18
247	5/31/2016 12:00	0.959	2.35	9.1	225	1.06	11.83
248	6/7/2016 10:30	1.55	2.75	35.1	557.5	1.555	37.01
249	6/17/2016 12:10	0.947	2.25	8.86	178.5	0.933	8.84
250	6/21/2016 10:20	1.03	2.41	10.7	254.3	1.127	13.8
251	6/28/2016 9:40	1.58	2.71	37.8	517.7	1.515	33.72
252	7/6/2016 11:15	0.708	2.13	5.11	136.2	0.786	6.3
253	7/13/2016 10:00	1.35	2.61	22.3	409	1.386	25.08
254	7/25/2016 10:30	1.7	2.84	49.7	698	1.678	49.1
255	8/11/2016 11:35	1.14	2.41	13.9	254.8	1.127	13.83

256	8/16/2016 9:30	1.53	2.7	33.9	496.5	1.492	32
257	8/29/2016 9:10	0.954	2.3	9	197.5	0.989	10.04
258	9/7/2016 9:20	1.45	2.63	28.5	425.7	1.408	26.37
259	9/13/2016 11:15	1.21	2.43	16.1	271.8	1.163	15
260	10/24/2016 10:10	1.82	2.9	65.8	789	1.745	57.28
261	11/15/2016 9:50	1.83	2.9	67.9	787	1.743	57.09
262	12/14/2016 10:20	1.87	2.96	74.7	911	1.823	68.62
263	1/10/2017 9:40	1.85	2.97	71.3	928	1.833	70.23
264	2/14/2017 11:10	1.85	2.94	70.1	877.7	1.803	65.48
265	3/14/2017 9:50	1.85	2.95	70.4	890.2	1.81	66.65
266	3/30/2017 13:45	1.03	2.35	10.8	225	1.06	11.83
267	4/11/2017 10:50	1.51	2.69	32.7	485.3	1.479	31.1
268	5/1/2017 11:00	1.32	2.57	20.8	373	1.336	22.33
269	5/15/2017 9:50	1.63	2.8	43.1	636.8	1.628	43.75
270	5/31/2017 10:50	1.74	2.9	55.4	786.3	1.743	57.03
271	6/5/2017 10:00	1.72	2.84	52.5	687	1.669	48.13
272	6/13/2017 9:50	1.82	2.95	66.6	886.2	1.808	66.28
273	6/28/2017 10:00	1.82	2.94	65.4	861.8	1.793	63.99
274	7/13/2017 9:40	1.76	2.86	57.8	725.3	1.699	51.53
275	7/31/2017 9:30	1.74	2.79	55.3	623	1.616	42.56
276	8/2/2017 9:50	1.77	2.8	58.4	630	1.622	43.16
277	8/16/2017 11:00	1.79	2.84	62	692	1.673	48.57
278	8/30/2017 9:10	1.85	2.87	70.4	748.3	1.716	53.59
279	9/6/2017 10:10	1.81	2.87	64.9	749.2	1.716	53.66
280	10/17/2017 10:10	1.78	2.87	60	740.3	1.71	52.87
281	11/15/2017 10:50	1.79	2.86	62.3	722.2	1.696	51.24
282	12/12/2017 9:40	1.81	2.87	64.4	749.3	1.716	53.68
283	1/18/2018 10:00	1.88	2.94	76.1	866	1.795	64.39
284	1/31/2018 10:10	1.84	2.88	68.5	765.3	1.728	55.12
285	3/6/2018 9:40	1.82	2.88	66	754.3	1.72	54.13
286	3/22/2018 10:50	1.81	2.88	64.3	753.3	1.719	54.04
287	4/18/2018 10:30	1.83	2.93	66.9	856	1.789	63.45
288	5/2/2018 10:00	1.8	2.93	62.5	844	1.781	62.34
289	5/9/2018 10:30	1.77	2.96	58.5	903.5	1.819	67.91
290	5/23/2018 10:40	1.81	2.98	64.8	945.3	1.843	71.89
291	6/1/2018 10:50	1.05	2.43	11.2	272.2	1.164	15.03
292	6/6/2018 10:00	1.55	2.73	35.5	531	1.528	34.82
293	6/20/2018 9:30	1.8	2.83	63.4	681.5	1.665	47.64
294	6/26/2018 9:40	1.62	2.61	41.3	404	1.379	24.69
295	7/19/2018 11:30	0.804	2.19	6.36	153.5	0.851	7.32
296	7/31/2018 10:30	0.975	2.23	9.44	168.5	0.902	8.23
297	8/16/2018 9:40	1.56	2.66	36.7	457.3	1.447	28.86
298	8/28/2018 10:40	1.32	2.52	20.9	328.7	1.267	19.05
299	9/6/2018 12:00	0.55	2.06	3.55	114	0.689	5.03
300	9/18/2018 9:50	1.67	2.76	46.7	576	1.573	38.57
301	10/16/2018 10:30	0.99	2.33	9.76	214.5	1.034	11.14
302	11/19/2018 11:00	1.86	3	72.9	991	1.869	76.28
303	12/4/2018 11:25	1.57	2.89	37.3	779.1	1.738	56.37
304	12/17/2018 10:30	1.84	2.93	68.8	859.5	1.791	63.78
305	1/29/2019 10:00	1.8	2.92	62.8	837	1.777	61.69
306	2/19/2019 10:30	1.93	3.05	85.4	1134.5	1.943	90.41
307	3/14/2019 13:30	1.44	2.68	27.4	482.5	1.476	30.87
308	3/19/2019 10:00	1.56	2.74	36.3	554	1.552	36.72
309	4/11/2019 10:50	1.69	2.88	49.2	760.2	1.724	54.66
310	4/16/2019 11:40	1.85	2.99	70.3	968.3	1.856	74.09
311	5/1/2019 13:10	1.05	2.33	11.3	214.3	1.033	11.13

312	5/15/2019 12:30	1.19	2.48	15.6	304	1.224	17.27
313	5/23/2019 12:20	0.562	2.07	3.64	117.3	0.704	5.22
314	6/5/2019 11:30	1.62	2.79	41.5	610.5	1.605	41.49
315	6/12/2019 10:50	1.74	2.9	54.6	798.8	1.751	58.17
316	6/24/2019 10:40	0.631	2.11	4.27	129	0.756	5.88
317	7/10/2019 10:40	1.38	2.57	24.2	368	1.328	21.96
318	7/30/2019 10:20	1.89	2.93	78.4	852.8	1.787	63.16
319	8/7/2019 9:40	1.79	2.9	61.1	787.2	1.743	57.11
320	8/20/2019 11:40	1.02	2.27	10.4	186.4	0.957	9.34
321	8/26/2019 10:50	1.21	2.41	16.4	255.4	1.129	13.87
322	9/11/2019 10:30	1.73	2.82	53.4	661.5	1.648	45.9
323	10/9/2019 11:50	1.77	2.93	59.5	847.5	1.784	62.66
324	11/6/2019 9:50	1.83	2.91	67.9	810	1.759	59.2
325	12/11/2019 11:10	1.86	2.96	72.8	918.7	1.828	69.35

Definitions

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SO4: Sulfate in mg/L (00945)
SC: Specific conductance in µS/cm @25C (00095)
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