

SITE NUMBER—07144100

SITE NAME—Little Arkansas River near Sedgwick

DATE CREATED—3/18/2013

MODEL DEVELOPMENT DATA PERIOD—7/27/2004 – 9/22/2011

MODEL-CALIBRATION DATASET—All data were collected using U.S. Geological Survey (USGS) protocols and are stored in National Water Information System (NWIS) database. The regression model is based on 69 concurrent measurements of turbidity and fecal coliform bacteria (*FCB*) samples collected from 07-27-2004 through 09-22-2011. Samples were collected throughout the range of continuously observed hydrologic conditions. Summary statistics and complete model-calibration dataset are provided. No fecal coliform bacteria values were deemed outliers.

MODEL DEVELOPMENT— Regression analysis was done using S-PLUS, R, and a spreadsheet macro that examined turbidity as an explanatory variable for estimating *FCB*. Different combinations of untransformed and \log_{10} -transformed data were evaluated. *FCB* and turbidity were selected as the best model based on residual plots, model standard percentage error (*MSPE*), adjusted R^2 , prediction error sum of squares (PRESS), and Mallows' C_p . Model spreadsheet is archived and can be found at <http://nrtwq.usgs.gov/ks> for review, and contains all relevant sample data and more in-depth statistical information.

MODEL SUMMARY—Summary of final regression analysis for fecal coliform bacteria at site number 07144100.

Turbidity-based model:

$$\log_{10}(FCB) = 1.26 \times \log_{10}(Turb) + 0.539,$$

where

FCB = fecal coliform bacteria, in colonies per 100 milliliters; and

Turb = turbidity, in formazin nephelometric units.

The use of turbidity as an explanatory variable makes sense both physically and statistically. It makes physical sense because *FCB* are mobilized by the same hydrologic forces that mobilize particles associated with turbidity. In addition, the sediment particles associated with turbidity provide an attachment point for the bacteria and the nutrients that help sustain them. Turbidity makes statistical sense as an explanatory variable because it resulted in a model with low Mallows' C_p and PRESS values, and high adjusted R^2 values.

FECAL COLIFORM BACTERIA RECORD— The record is computed using the regression model in the National Real-Time Water Quality (NRTWQ) website. Data are computed at hourly intervals. The record is complete for the year except as noted. A more in-depth description of the water quality record can be found at –

<http://nrtwq.usgs.gov/ks>

REMARKS—

- Site location, equipment, and other stream-gaging station information can be found in the Site Information Management System (SIMS).

Computed: Aaron King

Reviewed: Patrick Rasmussen

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Model Form

$$\log(\text{FCB}) = 1.26 * \log(\text{Turb}) + 0.539$$

Explanatory variable summary statistics

	<u>log(Turb)</u>	<u>Turb</u>
Minimum	0.5185	3.30
1st Quartile	1.362	23.0
Median	2.146	140
Mean	1.897	188
3rd Quartile	2.380	240
Maximum	3.025	1060

Notes:

Dependent variable summary statistics

	<u>log(FCB)</u>	<u>FCB</u>
Minimum	0.6021	4.00
1st Quartile	2.000	100
Median	3.146	1400
Mean	2.935	5170
3rd Quartile	3.763	5800
Maximum	4.792	62000

Notes:

Model Calibration

Basic Data

Number of Measurements:	69
Standard Error:	0.5145
MSPE (Upper)	+226.96
MSPE (Lower)	-69.42
R ²	0.74
Adj R ²	0.74
Duan BCF:	1.9

Explanatory Variables

Variable	Value	Standard Error
Intercept	0.539	0.184
log(Turb)	1.26	0.0912

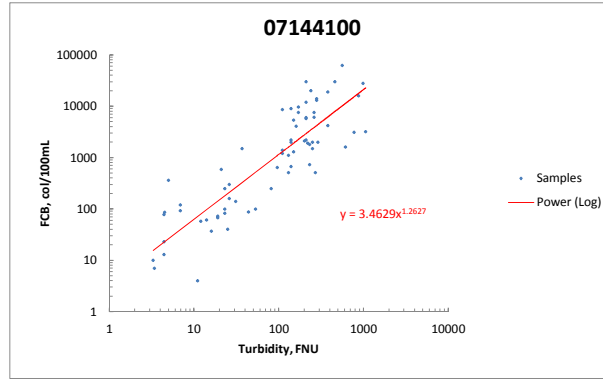
Notes:

Covariance Matrix

	<u>Intercept</u>	<u>log(Turb)</u>
Intercept	1	-0.942
log(Turb)	-0.942	1

Test Criteria

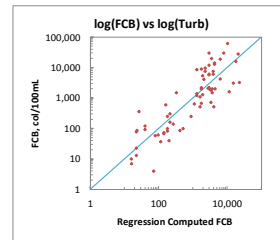
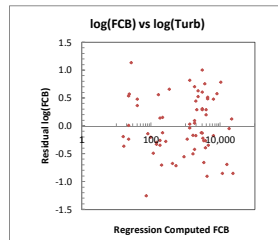
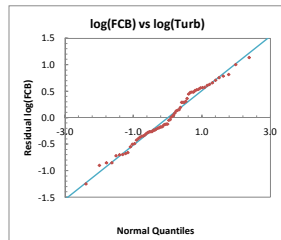
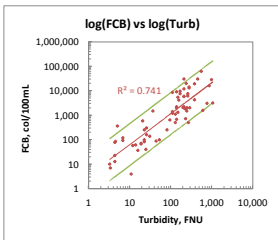
	<u>Leverage</u>	<u>Cook's D</u>	<u>DFITS</u>
	0.0870	0.797	0.341



Observations exceeding at least one test criterion

Observation	<u>Observed log(FCB)</u>	<u>Predicted log(FCB)</u>	<u>Residuals</u>	<u>Standardized Residuals</u>	<u>Studentized Residuals</u>	<u>Leverage</u>	<u>Cook's D</u>	<u>DFITS</u>
5	3.51	4.36	-0.854	-1.71	-1.73	0.0545	0.0840	-0.416
21	2.56	1.42	1.13	2.27	2.35	0.0596	0.164	0.591
23	3.20	4.06	-0.852	-1.69	-1.71	0.0393	0.0584	-0.347
43	0.602	1.85	-1.25	-2.48	-2.58	0.0375	0.120	-0.510

Notes:



Date	Turbidity		Streamflow		Regression					90% P.I.	
	<u>FNU</u>	<u>ft³/sec</u>	<u>FCB, col/100mL</u>	<u>log(FCB)</u>	<u>log(Turb)</u>	<u>Computed FCB</u>	<u>Residual log(FCB)</u>	<u>Normal Quantiles</u>	<u>Lower</u>	<u>Upper</u>	
7/27/2004	200	5855	2100	3.32	2.30	2786	-0.123	-0.036	386.2	20096.7	
1/27/2005	81.0	172	250	2.40	1.91	890	-0.551	-1.09	123.4	6418.5	
3/23/2005	260	5855	7600	3.88	2.42	3880	0.292	0.490	537.9	27988.2	
5/10/2005	170	203	9700	3.99	2.23	2269	0.631	1.23	314.6	16367.3	
5/27/2005	1060	743	3200	3.51	3.03	22880	-0.854	-1.78	3171.9	165043.7	
6/6/2005	290	1957	2000	3.30	2.46	4454	-0.348	-0.754	617.5	32128.7	
6/9/2005	380	11797	19000	4.28	2.58	6266	0.482	0.707	868.7	45199.5	
8/31/2005	96.0	112	640	2.81	1.98	1103	-0.236	-0.371	152.9	7956.4	
1/10/2007	6.90	13.8	120	2.08	0.839	39.7	0.481	0.661	5.5	286.3	
3/12/2007	23.0	19.1	82.0	1.91	1.36	182	-0.345	-0.707	25.2	1309.2	
3/21/2007	26.0	51.0	300	2.48	1.42	212	0.151	0.332	29.4	1528.5	
3/27/2007	250	164	2000	3.30	2.40	3693	-0.266	-0.490	512.0	26639.3	
4/2/2007	380	2886	4200	3.62	2.58	6266	-0.174	-0.219	868.7	45199.5	
4/18/2007	130	861	510	2.71	2.11	1617	-0.501	-1.02	224.2	11664.1	
5/24/2007	560	5253	62000	4.79	2.75	10220	0.783	1.63	1416.8	73721.4	
5/25/2007	210	10926	5800	3.76	2.32	2963	0.292	0.449	410.8	21373.4	
7/11/2007	210	1927	6000	3.78	2.32	2963	0.306	0.531	410.8	21373.4	
8/16/2007	26.0	59.3	160	2.20	1.42	212	-0.122		29.4	1528.5	
9/6/2007	23.0	25.5	250	2.40	1.36	182	0.139	0.294	25.2	1309.2	
11/26/2007	4.40	28.9	78.0	1.89	0.644	22.5	0.540	0.908	3.1	162.2	
12/6/2007	5.00	29.5	360	2.56	0.699	26.4	1.13	2.38	3.7	190.7	
12/13/2007	260	2740	6100	3.79	2.42	3880	0.197	0.371	537.9	27988.2	
3/6/2008	610	979	1600	3.20	2.79	11390	-0.852	-1.63	1579.0	82161.2	
4/14/2008	230	484	730	2.86	2.36	3324	-0.658	-1.15	460.8	23977.5	
5/29/2008	230	2895	1800	3.26	2.36	3324	-0.266	-0.531	460.8	23977.5	
6/30/2008	210	877	2200	3.34	2.32	2963	-0.129	-0.073	410.8	21373.4	
8/5/2008	31.0	24.9	140	2.15	1.49	265	-0.277	-0.573	36.7	1908.7	
9/16/2008	170	1716	7600	3.88	2.23	2269	0.525	0.854	314.6	16367.3	
4/6/2009	53.0	187	100	2.00	1.72	521	-0.717	-1.50	72.2	3756.8	
4/13/2009	140	851	1200	3.34	2.15	1776	0.093	0.219	246.2	12811.1	
4/28/2009	280	9190	23000	4.11	2.45	4261	0.484	0.754	590.7	30736.5	
6/16/2009	870	661	16000	4.20	2.94	17830	-0.047	0.036	2471.8	128615.8	
7/30/2009	210	523	12000	4.08	2.32	2963	0.607	1.15	410.8	21373.4	
9/9/2009	210	3141	30000	4.48	2.32	2963	1.01	1.99	410.8	21373.4	
9/24/2009	770	333	3100	3.49	2.89	15280	-0.693	-1.31	2118.3	110221.5	
11/3/2009	140	328	670	2.83	2.15	1776	-0.423	-0.908	246.2	12811.1	
11/19/2009	6.90	65.0	92.0	1.96	0.839	39.7	0.365	0.573	5.5	286.3	
12/1/2009	4.40	54.7	13.0	1.11	0.644	22.5	-0.238	-0.410	3.1	162.2	
12/17/2009	3.40	58.7	7.00	0.845	0.532	16.2	-0.365	-0.803	2.3	117.1	
1/6/2010	3.30	94.5	10.0	1.00	0.519	15.6	-0.194	-0.256	2.2	112.8	
1/19/2010	4.50	79.7	86.0	1.93	0.653	23.1	0.570	1.02	3.2	166.8	

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2/4/2010	4.40	63.9	23.0	1.36	0.644	22.5	0.010	0.109	3.1	162.2
2/23/2010	11.0	69.3	4.00	0.602	1.04	71.5	-1.25	-2.38	9.9	515.9
3/10/2010	150	547	1300	3.11	2.18	1937	-0.173	-0.182	268.5	13972.4
4/14/2010	12.0	52.7	58.0	1.76	1.08	79.8	-0.139	-0.109	11.1	575.8
4/23/2010	110	228	8600	3.93	2.04	1310	0.817	1.78	181.6	9449.6
5/13/2010	460	544	30000	4.48	2.66	7975	0.575	1.09	1105.6	57527.2
6/9/2010	990	2448	28000	4.45	3.00	20990	0.125	0.256	2909.8	151410.3
6/10/2010	160	3345	4100	3.61	2.20	2102	0.290	0.410	291.4	15162.7
6/13/2010	280	11316	14000	4.15	2.45	4261	0.517	0.803	590.7	30736.5
6/14/2010	150	15162	5400	3.73	2.18	1937	0.445	0.617	268.5	13972.4
6/15/2010	250	6480	1500	3.18	2.40	3693	-0.391	-0.854	512.0	26639.3
6/16/2010	220	4806	1900	3.28	2.34	3142	-0.219	-0.332	435.6	22664.7
7/6/2010	140	13387	9000	3.95	2.15	1776	0.705	1.40	246.2	12811.1
8/19/2010	37.0	60.8	1500	3.18	1.57	331	0.657	1.31	45.9	2386.2
8/25/2010	240	770	20000	4.30	2.38	3507	0.756	1.50	486.2	25297.6
11/16/2010	140	262	2000	3.30	2.15	1776	0.052	0.182	246.2	12811.1
1/19/2011	21.0	83.3	590	2.77	1.32	162	0.562	0.964	22.4	1167.1
3/7/2011	14.0	50.8	61.0	1.79	1.15	97.0	-0.201	-0.294	13.4	699.6
3/16/2011	19.0	48.0	72.0	1.86	1.28	143	-0.297	-0.617	19.8	1028.6
4/6/2011	16.0	37.6	37.0	1.57	1.20	115	-0.492	-0.964	15.9	828.1
4/18/2011	19.0	32.8	67.0	1.83	1.28	143	-0.328	-0.661	19.8	1028.6
5/2/2011	25.0	28.8	40.0	1.60	1.40	202	-0.703	-1.40	28.0	1455.0
5/16/2011	23.0	26.8	100	2.00	1.36	182	-0.259	-0.449	25.2	1309.2
6/7/2011	44.0	21.9	87.0	1.94	1.64	412	-0.675	-1.23	57.1	2970.5
6/21/2011	110	110	1200	3.08	2.04	1310	-0.038	0.073	181.6	9449.6
6/22/2011	130	46.2	1100	3.04	2.11	1617	-0.167	-0.145	224.2	11664.1
8/15/2011	270	25.5	510	2.71	2.43	4070	-0.902	-1.99	564.2	29358.7
9/22/2011	110	42.9	1400	3.15	2.04	1310	0.029	0.145	181.6	9449.6