

Memorandum

To: Judie Zimomra, City Manager
From: James Evans, Environmental Biologist
Subject: Update on Sanibel River Water Quality
Date: 6/13/2011

This report provides an update on the status and trends of water quality in the Sanibel River. The period of record for this report is January 2002 through December 2010. This report includes only those stations located within the Sanibel River (San-WQ-3 through San-WQ-8) and does not include the City's estuarine monitoring sites located within Clam Bayou, Dinkins Bayou and Blind Pass (Fig. 1). All data were collected either by Natural Resource Department staff or by the City's contractor, Johnson Engineering.

A seasonal *Kendall* trend test was used to evaluate trends in the data. Station median values for each parameter were compared to the 'typical' Florida waterbody values published by Joe Hand (FDEP 2008) to evaluate their status relative to other Florida waterbodies (Table 1). Percentile distributions were grouped in the following categories: 10–30 = below average, 31–69 = average, 70–90 = above average (Duffey et al. 2007).

Overall, water quality within the Sanibel River remains relatively poor compared to other Florida Freshwater streams. Median nutrient concentrations for ammonia nitrogen, total Kjeldahl nitrogen, total nitrogen, and chlorophyll-*a*, a proxy for phytoplankton, were "above average" compared to other Florida freshwater streams. Inorganic nitrogen in the form of nitrate was relatively low and exhibited decreasing trends at all stations. Total phosphorus and ortho phosphorus were also relatively low, with total phosphorus exhibiting decreasing trends at some stations and ortho phosphorus exhibiting slight increasing trends at all stations.

Below is a brief summary of the status and trends results. At the end of the summary I have included a map showing the monitoring station locations and tables with the summary statistics and results of the status and trends analysis.

Salinity values were generally higher at the stations located near the water quality structures, with mean salinities of 5.06 psu at San-WQ-5 and mean salinities of 2.99 psu at San-WQ-8 (Fig. 1). Salinity values were "above average" compared to other Florida freshwater streams, with all stations ranking within the 80th percentile. This suggests that the Sanibel River is not a true "freshwater" body; rather it is estuarine in nature and criteria developed for freshwater streams may not be directly comparable. Salinity exhibited an increasing trend at stations San-WQ-3, 4, and 5, with salinities increasing, on average, 0.22 psu per year.

Dissolved oxygen (DO) values were relatively low compared to other Florida freshwater streams, with all stations ranking within the 10th percentile. Mean DO values ranged between 2.41–4.32 mg/l, with lower values associated with San-WQ-3 and San-WQ-6 (Tables 2 and 5). Stations San-WQ-6, 7 and 8 exhibited an increasing trend, with DO increasing 0.23 mg/l per year. Values > 4 mg/l are desired to maintain a healthy and well-balanced assemblage of fish and wildlife.

Ammonia nitrogen was relatively consistent among stations, with mean values varying less than 0.09 mg/l. Ammonia concentrations were relatively high at all stations, with median values at all stations ranking within the 90th percentile compared to other Florida freshwater streams. San-WQ-4 had the highest median values at 0.15 mg/l. Ammonia exhibited an increasing trend at station San-WQ-3, with ammonia increasing at 0.0054 mg/l per year.

Nitrate and nitrite nitrogen concentrations were relatively low compared to other Florida freshwater streams, with nitrate and nitrite at all stations ranking within the 10th percentile. Nitrate nitrogen also exhibited decreasing trends at all stations, with concentrations decreasing on average 0.003 mg/l per year.

Total Kjeldahl nitrogen (TKN) was relatively high at all stations, with median concentrations ranking within the 80th and 90th percentile compared to other Florida freshwater streams. Mean concentrations were higher at stations San-WQ-4 and 7 and lowest at stations San-WQ-3, 5, and 8. TKN exhibited increasing trends at all stations, with TKN increasing on average 0.112 mg/l per year.

Total nitrogen (TN) was relatively high, with all of the stations ranking between the 60th and 80th percentiles compared to other Florida freshwater streams. Mean concentrations were higher at stations San-WQ-4 and 7 and lowest at stations San-WQ-3, 5, and 8. Total nitrogen exhibited increasing trends at all stations, with TN increasing on average 0.112 mg/l per year. Concentrations and trends paralleled those of total Kjeldahl nitrogen suggesting that a majority of the TN pool in the Sanibel River is made up of organic nitrogen.

Ortho phosphorus was relatively low, with all stations “below average” and ranking between the 10th and 20th percentiles. Ortho phosphorus concentrations were generally higher at the eastern stations with stations San-WQ-7 and 8 having the highest mean values. All stations exhibited increasing trends, with concentrations increasing on average 0.003 mg/l per year.

Total phosphorus concentrations were relatively low and were “below average” or “average” for all stations, except for San-WQ-7. Stations San-WQ-3 and 5 had the lowest concentrations; while San-WQ-7 and 8 had the highest concentrations. Total phosphorus exhibited decreasing trends at stations San-WQ-7 and 8, with concentrations decreasing 0.007 mg/l per year.

Chlorophyll-a is a measure of primary productivity and can be used as a proxy for phytoplankton (microalgae). Chlorophyll-a was “above average” at all stations. Mean chlorophyll-a concentrations were greatest at the eastern stations, with San-WQ-7 and 8 having the highest values. All stations exhibited increasing trends, with concentrations increasing on average 2.89 mg/m³ per year. Increases in chlorophyll-a can result from increased nutrient inputs, increased light available to phytoplankton, and/or changes in the residence time. Reductions in inorganic nitrogen (nitrate) and total phosphorus may be the result of uptake by phytoplankton within the river.

Figure 1. Map of Sanibel showing water quality monitoring locations

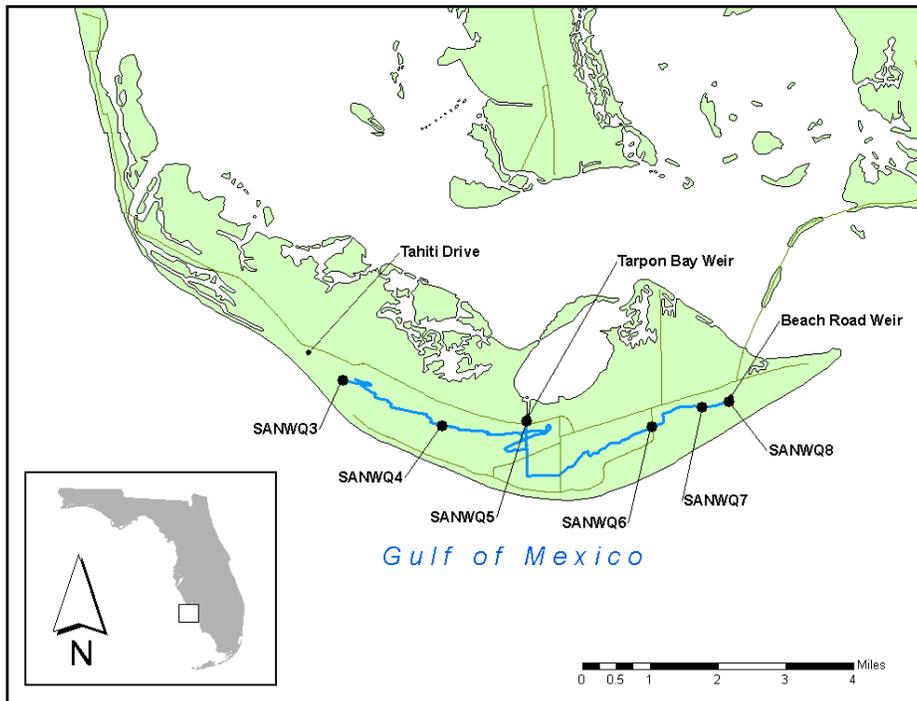


Table 1. 'Typical' Florida stream water quality percentile distributions (Hand 2008)

Percentile	Temp (°C)	DO (mg/l)	Salinity (psu)	Spc Cond (mS/cm)	pH (units)	Ammonia (mg/l)	Nitrate (mg/l)	Nitrite (mg/l)	Nitrate + Nitrite (mg/l)	TKN (mg/l)
10	21.90	3.11	0.025	0.04	5.73	0.0120	0.0141	0.0028	0.0060	0.308
20	24.00	4.10	0.07	0.07	6.30	0.0182	0.0288	0.0040	0.0118	0.460
30	24.93	4.76	0.10	0.11	6.68	0.0240	0.0400	0.0048	0.0200	0.585
40	25.55	5.42	0.13	0.18	6.94	0.0300	0.0628	0.0060	0.0300	0.710
50	26.60	5.82	0.185	0.25	7.11	0.0370	0.0944	0.0080	0.0510	0.825
60	27.00	6.23	0.23	0.35	7.24	0.0440	0.1553	0.0100	0.0805	0.960
70	27.70	6.76	0.32	0.48	7.37	0.0551	0.2130	0.0100	0.1400	1.100
80	28.38	7.31	0.56	0.65	7.49	0.0738	0.3360	0.0110	0.2225	1.325
90	29.40	8.04	6.59	1.26	7.70	0.1176	0.7910	0.0173	0.4510	1.706
No. of Waterbodies	325	1394	871	1352	1397	1295	280	284	1297	1292

Percentile	TN (mg/l)	Ortho P (mg/l)	TP (mg/l)	Chl-a (mg/m3)	Color (CU)	Fecal Strep (CFU)	TOC (mg/l)	TSS (mg/l)	Turbidity (NTU)
10	0.470	0.055	0.015	1.00	21.25	16	3.90	3.00	1.10
20	0.616	0.064	0.025	1.00	40.00	36	5.70	4.00	1.60
30	0.760	0.092	0.040	1.00	49.80	62	8.40	4.00	2.00
40	0.879	0.148	0.058	1.20	57.50	91	10.40	4.30	2.54
50	1.004	0.178	0.076	1.89	70.00	150	12.75	5.00	3.00
60	1.146	0.224	0.101	2.90	80.00	260	15.20	5.00	3.84
70	1.312	0.338	0.138	4.14	103.50	390	17.83	6.50	4.65
80	1.555	0.546	0.209	6.30	150.00	610	22.00	9.00	6.00
90	1.978	1.615	0.395	15.00	205.00	1000	30.00	15.00	8.60
No. of Waterbodies	1313	67	1317	1222	1287	117	1111	1124	1320

Table 2. SAN-WQ-3 descriptive statistics and percentile distributions relative to 'typical' Florida waterbodies (Hand 2008)

SAN-WQ-3	n	Mean	Median	Min	Max	Standard Deviation	Median compared to Typical FL Stream Percentiles (Hand 2008)	Status Relative to Typical FL Streams	Seasonal Kendall Trend Results ($\alpha=0.05$)	Slope (units/yr)
Water Temperature (°C)	94	23.53	24.22	11.74	31.18	4.71	20	Below Average	No Trend	
Dissolved Oxygen (mg/l)	94	2.41	2.07	0.21	7.07	1.54	10	Below Average	No Trend	
Salinity (psu)	92	1.68	1.54	0	7.65	0.88	80	Above Average	Increasing	0.1274
Specific Conductance (mS/cm)	93	3.11	2.83	0.007	13.39	1.54	90	Above Average	Increasing	0.2187
pH (units)	94	7.73	7.69	6.51	9.21	0.40	90	Above Average	No Trend	
Ammonia (mg/l)	94	0.13	0.124	0.005	0.70	0.12	90	Above Average	Increasing	0.0054
Nitrate (mg/l)	94	0.03	0.007	0.002	0.35	0.06	10	Below Average	Decreasing	-0.0031
Nitrite (mg/l)	94	0.01	0.003	0.002	0.04	0.01	10	Below Average	No Trend	
Nitrate + Nitrite (mg/l)	94	0.03	0.009	0.002	0.35	0.06	10	Below Average	Decreasing	-0.0028
Total Kjeldahl Nitrogen (mg/l)	94	1.39	1.45	0.30	3.47	0.52	80	Above Average	Increasing	0.1177
Total Nitrogen (mg/l)	94	1.42	1.47	0.30	3.48	0.52	60	Average	Increasing	0.1166
Ortho Phosphorus (mg/l)	94	0.03	0.028	0.001	0.101	0.02	10	Below Average	Increasing	0.0009
Total Phosphorus (mg/l)	94	0.09	0.069	0.01	1.11	0.12	40	Average	No Trend	
Chlorophyll-a (mg/m ³)	94	18.96	10.15	0.02	161	25.84	80	Above Average	Increasing	1.529
Color (CU)*	36	61.28	52.00	12.00	192	34.00	30	Below Average	No Trend	
Fecal Streptococci (cfu)*	32	73.91	30.5	4.00	616	120	10	Below Average	No Trend	
Total Organic Carbon (mg/l)	94	28.13	25.3	0.50	162	18.46	80	Above Average	Increasing	1.241
Total Suspended Solids (mg/l)	94	7.78	5.00	0.25	75.40	11.27	40	Average	No Trend	
Turbidity (NTU)	94	2.90	1.80	0.26	50.00	5.43	20	Below Average	Increasing	0.2383

* Color and Fecal Streptococci sampling was discontinued April 27, 2005.

Table 3. SAN-WQ-4 descriptive statistics and percentile distributions relative to 'typical' Florida waterbodies (Hand 2008)

SAN-WQ-4	n	Mean	Median	Min	Max	Standard Deviation	Median compared to Typical FL Stream Percentiles (Hand 2008)	Status Relative to Typical FL Streams	Seasonal Kendall Trend Results ($\alpha=0.05$)	Slope (units/yr)
Water Temperature (°C)	93	24.48	25.39	13.20	31.93	4.54	30	Below Average	No Trend	
Dissolved Oxygen (mg/l)	93	4.32	3.80	0.18	15.47	2.98	10	Below Average	No Trend	
Salinity (psu)	91	2.08	1.86	0.60	10.14	1.26	80	Above Average	Increasing	0.1612
Specific Conductance (mS/cm)	92	3.93	3.54	1.34	17.19	2.25	90	Above Average	Increasing	0.3048
pH (units)	93	7.83	7.81	6.41	9.13	0.51	90	Above Average	No Trend	
Ammonia (mg/l)	93	0.22	0.152	0.01	2.03	0.29	90	Above Average	No Trend	
Nitrate (mg/l)	93	0.04	0.008	0.002	0.59	0.09	10	Below Average	Decreasing	-0.0030
Nitrite (mg/l)	93	0.01	0.004	0.001	0.12	0.02	10	Below Average	No Trend	
Nitrate + Nitrite (mg/l)	93	0.05	0.011	0.002	0.59	0.09	10	Below Average	Decreasing	-0.0030
Total Kjeldahl Nitrogen (mg/l)	93	1.98	1.83	0.05	6.36	1.12	90	Above Average	Increasing	0.1793
Total Nitrogen (mg/l)	93	2.02	1.86	0.09	6.37	1.11	80	Above Average	Increasing	0.1780
Ortho Phosphorus (mg/l)	93	0.04	0.033	0.001	0.15	0.03	10	Below Average	Increasing	0.0015
Total Phosphorus (mg/l)	93	0.11	0.082	0.006	0.75	0.11	50	Average	No Trend	
Chlorophyll-a (mg/m ³)	93	33.00	17.8	0.01	297	44.71	90	Above Average	Increasing	3.154
Color (CU)*	35	87.51	80	45.00	240	41.95	60	Average	Increasing	13.72
Fecal Streptococci (cfu)*	31	40.77	32	1.00	264	51.44	10	Below Average	No Trend	
Total Organic Carbon (mg/l)	93	34.63	33.65	0.50	77.10	13.69	90	Above Average	No Trend	
Total Suspended Solids (mg/l)	93	12.08	4.8	0.60	300	31.97	40	Average	No Trend	
Turbidity (NTU)	93	4.77	2.1	0.18	50	7.13	20	Below Average	Increasing	0.2402

* Color and Fecal Streptococci sampling was discontinued April 27, 2005.

Table 4. SAN-WQ-5 descriptive statistics and percentile distributions relative to 'typical' Florida waterbodies (Hand 2008)

SAN-WQ-5	n	Mean	Median	Min	Max	Standard Deviation	Median compared to Typical FL Stream Percentiles (Hand 2008)	Status Relative to Typical FL Streams	Seasonal Kendall Trend Results ($\alpha=0.05$)	Slope (units/yr)
Water Temperature (°C)	92	24.06	24.18	11.82	31.02	4.76	20	Below Average	No Trend	
Dissolved Oxygen (mg/l)	92	3.78	3.57	0.22	8.80	2.19	10	Below Average	No Trend	
Salinity (psu)	90	5.06	2.59	0	28.92	5.38	80	Above Average	Increasing	0.3701
Specific Conductance (mS/cm)	90	10.05	4.61	0.007	98.60	13.65	90	Above Average	Increasing	0.6225
pH (units)	92	7.70	7.68	6.68	8.66	0.37	80	Above Average	No Trend	
Ammonia (mg/l)	92	0.15	0.111	0.008	0.59	0.14	90	Above Average	No Trend	
Nitrate (mg/l)	92	0.04	0.009	0.002	0.43	0.08	10	Below Average	Decreasing	-0.0029
Nitrite (mg/l)	94	0.01	0.003	0.002	0.06	0.01	20	Below Average	No Trend	
Nitrate + Nitrite (mg/l)	94	0.04	0.012	0.002	0.43	0.08	10	Below Average	Decreasing	-0.0024
Total Kjeldahl Nitrogen (mg/l)	92	1.49	1.50	0.20	3.20	0.54	90	Above Average	Increasing	0.0883
Total Nitrogen (mg/l)	94	1.49	1.53	0.03	3.20	0.57	70	Above Average	Increasing	0.0884
Ortho Phosphorus (mg/l)	92	0.03	0.027	0.001	0.12	0.03	10	Below Average	Increasing	0.0016
Total Phosphorus (mg/l)	92	0.07	0.059	0.002	1.26	0.13	40	Average	No Trend	
Chlorophyll-a (mg/m ³)	92	10.47	5.76	0.01	62	12.34	70	Above Average	Increasing	0.5515
Color (CU)*	34	76.38	70	28.00	192	27.85	50	Average	No Trend	
Fecal Streptococci (cfu)*	30	26.93	9.00	1.00	206	43.40	10	Below Average	No Trend	
Total Organic Carbon (mg/l)	92	43.76	34.00	0.50	793	80.25	90	Above Average	No Trend	
Total Suspended Solids (mg/l)	92	3.39	2.40	0.25	19.00	3.73	10	Below Average	Decreasing	-0.1817
Turbidity (NTU)	92	1.71	0.98	0.09	13.43	2.05	20	Below Average	No Trend	

* Color and Fecal Streptococci sampling was discontinued April 27, 2005.

Table 5. SAN-WQ-6 descriptive statistics and percentile distributions relative to 'typical' Florida waterbodies (Hand 2008)

SAN-WQ-6	n	Mean	Median	Min	Max	Standard Deviation	Median compared to Typical FL Stream Percentiles (Hand 2008)	Status Relative to Typical FL Streams	Seasonal Kendall Trend Results ($\alpha=0.05$)	Slope (units/yr)
Water Temperature (°C)	92	23.69	24.21	11.15	35.07	5.07	20	Below Average	No Trend	
Dissolved Oxygen (mg/l)	92	2.63	2.22	0.24	7.98	2.04	10	Below Average	Increasing	0.2634
Salinity (psu)	90	1.88	1.70	1.00	4.52	0.76	80	Above Average	No Trend	
Specific Conductance (mS/cm)	91	3.55	3.27	1.98	8.15	1.31	90	Above Average	No trend	
pH (units)	92	7.82	7.78	6.96	9.76	0.50	90	Above Average	Increasing	0.0398
Ammonia (mg/l)	92	0.17	0.121	0.02	1.30	0.20	90	Above Average	No trend	
Nitrate (mg/l)	92	0.03	0.006	0.002	0.44	0.07	10	Below Average	Decreasing	-0.0032
Nitrite (mg/l)	94	0.01	0.003	0.002	0.03	0.01	10	Below Average	No Trend	
Nitrate + Nitrite (mg/l)	94	0.03	0.006	0.002	0.44	0.07	10	Below Average	Decreasing	-0.0030
Total Kjeldahl Nitrogen (mg/l)	92	1.83	1.80	0.40	3.95	0.66	90	Above Average	Increasing	0.0863
Total Nitrogen (mg/l)	94	1.82	1.83	0.03	3.95	0.70	80	Above Average	Increasing	0.0815
Ortho Phosphorus (mg/l)	92	0.04	0.044	0.001	0.15	0.03	10	Below Average	Increasing	0.0037
Total Phosphorus (mg/l)	92	0.13	0.102	0.02	0.98	0.15	60	Average	No Trend	
Chlorophyll-a (mg/m ³)	92	34.55	24.3	0.01	151	33.06	90	Above Average	Increasing	3.703
Color (CU)*	34	56.09	52	18	144	23.85	30	Below Average	No Trend	
Fecal Streptococci (cfu)*	29	97.28	54	14	560	118	20	Below Average	No Trend	
Total Organic Carbon (mg/l)	92	28.92	27.2	0.50	74.60	13.99	80	Above Average	No Trend	
Total Suspended Solids (mg/l)	92	10.55	6.7	0.80	93.60	12.34	70	Above Average	No Trend	
Turbidity (NTU)	92	7.86	5.62	0.50	38	7.20	70	Above Average	Increasing	0.5583

* Color and Fecal Streptococci sampling was discontinued April 27, 2005.

Table 6. SAN-WQ-7 descriptive statistics and percentile distributions relative to 'typical' Florida waterbodies (Hand 2008)

SAN-WQ-7	n	Mean	Median	Min	Max	Standard Deviation	Median compared to Typical FL Stream Percentiles (Hand 2008)	Status Relative to Typical FL Streams	Seasonal Kendall Trend Results ($\alpha=0.05$)	Slope (units/yr)
Water Temperature (°C)	92	25.08	25.62	13.23	33.97	4.99	50	Average	No Trend	
Dissolved Oxygen (mg/l)	92	3.36	2.89	0.28	12.12	2.43	10	Below Average	Increasing	0.2325
Salinity (psu)	90	1.99	1.8	0	5.21	0.84	80	Above Average	No Trend	
Specific Conductance (mS/cm)	91	3.77	3.47	0.005	9.33	1.51	90	Above Average	No trend	
pH (units)	92	7.9	7.8	7.19	9.06	0.42	90	Above Average	Increasing	0.0339
Ammonia (mg/l)	92	0.17	0.121	0.005	1.32	0.20	90	Above Average	No Trend	
Nitrate (mg/l)	92	0.03	0.008	0.002	0.36	0.07	20	Below Average	Decreasing	-0.0031
Nitrite (mg/l)	94	0.01	0.003	0.002	0.025	0.01	10	Below Average	No Trend	
Nitrate + Nitrite (mg/l)	94	0.04	0.010	0.002	0.36	0.07	10	Below Average	Decreasing	-0.0030
Total Kjeldahl Nitrogen (mg/l)	92	1.97	2.00	0.05	4.16	0.76	90	Above Average	Increasing	0.1033
Total Nitrogen (mg/l)	94	1.95	2.00	0.03	4.16	0.80	80	Above Average	Increasing	0.1038
Ortho Phosphorus (mg/l)	92	0.04	0.40	0.002	0.13	0.03	10	Below Average	Increasing	0.0030
Total Phosphorus (mg/l)	92	0.16	0.139	0.02	1.07	0.13	70	Above Average	Decreasing	-0.0077
Chlorophyll-a (mg/m ³)	92	44.88	38.7	0.06	134	34.76	90	Above Average	Increasing	5.836
Color (CU)*	34	54.82	50	20	108	19.68	40	Average	No Trend	
Fecal Streptococci (cfu)*	29	115	85	36	460	94	30	Below Average	No trend	
Total Organic Carbon (mg/l)	92	29.08	27.95	0.50	81.20	12.98	80	Above Average	Decreasing	-0.9842
Total Suspended Solids (mg/l)	92	12.01	8.9	1.2	50	8.49	80	Above Average	No Trend	
Turbidity (NTU)	92	7.64	5.48	0.69	37	6.35	70	Above Average	Increasing	0.53

* Color and Fecal Streptococci sampling was discontinued April 27, 2005.

Table 7. SAN-WQ-8 descriptive statistics and percentile distributions relative to 'typical' Florida waterbodies (Hand 2008)

SAN-WQ-8	n	Mean	Median	Min	Max	Standard Deviation	Median compared to Typical FL Stream Percentiles (Hand 2008)	Status Relative to Typical FL Streams	Seasonal Kendall Trend Results ($\alpha=0.05$)	Slope (units/yr)
Water Temperature (°C)	92	23.90	24.42	11.24	32.35	5.18	20	Below Average	No Trend	
Dissolved Oxygen (mg/l)	92	3.06	2.48	0.13	13.89	2.22	10	Below Average	Increasing	0.195
Salinity (psu)	90	2.99	2.38	0	11.62	2.10	80	Above Average	No Trend	
Specific Conductance (mS/cm)	91	5.46	4.48	0.02	19.7	3.59	90	Above Average	No Trend	
pH (units)	92	7.73	7.71	7.12	8.86	0.37	80	Above Average	Increasing	0.0340
Ammonia (mg/l)	92	0.16	0.127	0.003	1.15	0.17	90	Above Average	No Trend	
Nitrate (mg/l)	92	0.03	0.006	0.002	0.30	0.06	10	Below Average	Decreasing	-0.0025
Nitrite (mg/l)	94	0.01	0.003	0.002	0.03	0.01	10	Below Average	No Trend	
Nitrate + Nitrite (mg/l)	94	0.03	0.009	0.002	0.30	0.06	10	Below Average	Decreasing	-0.0023
Total Kjeldahl Nitrogen (mg/l)	92	1.50	1.50	0.05	2.58	0.54	80	Above Average	Increasing	0.0994
Total Nitrogen (mg/l)	94	1.49	1.52	0.03	2.58	0.58	70	Above Average	Increasing	0.1029
Ortho Phosphorus (mg/l)	92	0.05	0.060	0.001	0.36	0.04	20	Below Average	Increasing	0.0045
Total Phosphorus (mg/l)	92	0.14	0.116	0.02	0.74	0.10	60	Average	Decreasing	-0.0063
Chlorophyll-a (mg/m ³)	92	42.17	24.10	0.06	747	82.47	90	Above Average	Increasing	2.567
Color (CU)*	34	64.29	60	40	112	19.36	40	Average	No Trend	
Fecal Streptococci (cfu)*	30	79.43	53	1	348	77.9	20	Below Average	No Trend	
Total Organic Carbon (mg/l)	92	26.83	23.65	0.5	76.80	12.81	80	Above Average	No Trend	
Total Suspended Solids (mg/l)	92	7.64	6	0.50	43.60	6.98	60	Above Average	No Trend	
Turbidity (NTU)	92	3.96	2.67	0.62	27	4.33	50	Average	Increasing	0.2845

* Color and Fecal Streptococci sampling was discontinued April 27, 2005.