



National Park Service, Fire Island National Seashore

and

Dowling College, Department of Earth and Marine Sciences

**Summer Water Quality Monitoring Program
2010**

FINAL REPORT

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1. Summary:

Fire Island National Seashore (FINS) has identified 13 locations in Great South Bay to monitor for total and fecal coliform, chlorophyll-a, conductivity, dissolved oxygen (DO), nitrates, pH, phosphates, salinity, clarity, and temperature. These parameters are critical in determining long-term water quality conditions park-wide, with emphasis on summer season conditions

Methodology for monitoring parameters are provided by National Park Service (NPS) Director's Order #83 (NPS 1999), and the *Standard Methods for the Examination of Water and Wastewater*.

Criteria for determining water quality conditions in marine eco-systems are based on the type of contact (uses) people have with the water system. The United States Environmental Protection Agency (EPA) guidelines for primary contact (bathing) uses are employed by the National Park Service as criteria to monitor water quality. Public health risk and environmental health issues are both addressed in NPS Director's Order #83, which is currently implemented for water quality programs (i.e. recreation, boating, etc.)

2. Introduction:

2.1 Background:

Samples retrieved from locations identified by FINS are to be analyzed on a weekly basis for the following parameters: water temperature, pH, salinity, top and bottom water dissolved oxygen (DO), clarity, and chlorophyll-a, and total coliform counts (TCC), and fecal coliform counts (FCC).

Coliform analysis at all sites was performed using the standard membrane filter technique: Millipore Filtration System, as described in *Standard Methods for the Examination of Water and Wastewater*, 20th ed., 1998. Coliform bacteria are a group of specific micro-organisms whose concentration densities can be related quantitatively to contact recreation related health

hazards. Health concerns are related to possible exposure to infectious enteric diseases, such as cholera, typhoid fever and hepatitis, whose etiologic agents are excreted in feces and spread by water with fecal wastes (Cabelli et al., 1979 and 1983). Acceptable normal TCC of less than 2,400 colonies/100mL and FCC of less than 200 colonies/100mL are both used by the NPS and the EPA as maximum levels for primary contact recreational water quality (USEPA, 1994, 1998, a,b, 1997, 1995).

All data presented in this document will be available on the Internet for public access via <http://www.nature.nps.gov/im/gis/ftp/ftparchive.cfm> and the FINS Annual Water Quality Monitoring program. A GPS (Global Positioning System) receiver was used in 2009 to provide locations (site coordinates). The coordinates were entered into FINS GIS (Geographical Information System) database developed at Dowling College. All Water Quality data collected at FINS from the previous years have been incorporated into the GIS database to be developed by Dowling College (META DATA). [See Appendix A, Long Island South Shore Estuary Map with Sampling Stations.]

2.2 Study Area History:

Director's Order #83, enacted in 1999, states that the NPS (at FINS) is, "To ensure these facilities and services are operated in a safe and healthful manner, and according to existing public health laws and regulations, the NPS Public Health Program conducts health risk and environmental compliance assessments." Water Quality data is collected at FINS for the following purposes:

- (1) to monitor bacterial levels at public facilities under FINS jurisdiction for compliance with county, state, and federal, public health standards for primary contact recreation;
- (2) to monitor bacterial levels and other traditional water quality monitoring parameters at various sites within the Park and to determine trends in water quality; and

(3) to provide these data for the evaluation and review of FINS Resources Management Plan regarding fish and wildlife management, as well as for visitor public health and safety.

FINS initiated the long-term monitoring of several preliminarily identified sampling stations within the Great South Bay, Long Island, New York. These sites are to be monitored for physical and biological parameters utilized for assessment of water quality conditions in its estuarine waters. Water Quality parameters are monitored on a weekly basis from a period commencing approximately Memorial Day to Labor Day, annually. Methodology for monitoring parameters are provided by NPS Director's Order #83 (NPS, 1999) and the EPA and U.S. Public Health Administration (USPHA) approved Standard Methods for Examination of Water and Wastewater (20th Edition, 1998; American Public Health Water Environment Federation).

The EPA establishes criteria to determine conditions appropriate for “contact recreational” uses and consumptive uses of the estuary. These monitoring protocols are also critical in determining trends in ecosystem overall health. Sample locations were established in conjunction with FINS Natural Resources staff, for the purpose of obtaining information on the water quality conditions within the boundaries of FINS. Specific sample locations associated with “public health” concerns within park boundaries are those sites that are designated as boat recreation locations (i.e. docking, pump out facilities, etc.) or potential residential discharge locations (i.e. visitor centers and concession operations). All sites are “general monitoring” sites.

The quality of estuarine waters of Great South Bay over the last 25 years has been impacted by surface run-off from the land, wastewater discharges and atmospheric deposition from precipitation events. Water quality values in estuarine waters can fluctuate considerably due to tidal mixing, vertical water column mixing due to currents, winds and depth of water, bioturbation of bottom sediments, precipitation events, biological oxygen demand (BOD) loading, photosynthesis

intensity (bloom conditions) and seasonal water temperatures. For example, it has been demonstrated that total and FCC in coastal waters are consistently higher following precipitation events requiring the closure of shellfish harvesting areas as well as contact recreational beaches on Long Island (Cardenas, R. et.al, 1983).

3. Objectives:

Water Quality programs, even the most extensive, cannot detect all possible changes, or for that matter be an early warning system to unforeseen episodic emergencies such as oil spills. However, properly planned and extensive water quality programs can establish baseline/reference data points from which changes, whether anomalous or condition-based, such as seasonal perturbations, can be compared over time. In this capacity, Water Quality monitoring is a means by which the conditions of the resource can be maintained or improved. The NPS established Inventory and Monitoring (I&M) protocols to do just that; establishment of a means for understanding the conditions of aquatic resources so that critical questions about long-term trends of degradation, or, about the effectiveness of existing pollution abatement and resource management programs, can be addressed.

The Cooperative Agreement between NPS-FINS and Dowling College, Department of Earth and Marine Sciences (DEMS) has initiated this long-term process by designing its Water Quality activities around the basic academic services that, if conducted by professional analytical laboratories or contractors, would be prohibitively expensive.

4. Sampling Frequency:

All 13 sample sites within FINS are sampled approximately once per week. The actual day of that week is subject to weather and sea conditions, but remain centered around mid-day for relative consistency within the photosynthetic oxygen evolution daily cycle. The peak summer

visitation “season” is the main time period for this program (Between Memorial Day and Labor Day).

5. Data Management:

2010 Water Quality data will be made available for uploading to the USEPA – STORET system; a National water quality database upon approval by the FINS staff.

**FINS WQ-10
Summer 2010**

Water Quality Schedule

JUNE	JULY	AUGUST	SEPTEMBER
Wed., Jun. 2	Wed., Jul. 7	Tues., Aug. 3	Thurs., Sept. 2
Mon., Jun. 7	Tues., Jul. 13	Mon., Aug. 9	
Mon., Jun. 21	Tues., Jul. 27	Tues., Aug. 17	
Tues., Jun. 29		Thurs., Aug. 26	

6. Methods:

The quality of estuarine waters of Great South Bay, as well as the Atlantic Ocean waters surrounding FINS is determined largely by pollutant inputs such as treated and untreated sewage from recreational boats, residential buildings, industrial effluents, sewage sludge, other toxic waste leachates, and runoff from landfills. Concentrations of pollutants are controlled by chemical, physical, and biological processes in the marine environment (Dyer, 1973). Depending on a variety of environmental factors, water quality will fluctuate at any given time (Fleischer, J. and McFadden, R., 1979). These factors may include: tidal mixing, vertical mixing in the water column (by sun, wind and wave), bioturbation of bottom sediments, precipitation events (intensity and duration), BOD, photosynthesis by phytoplankton, and water temperature.

Precipitation is a known cause of intermittent corruption of water quality. Shock loads of pollutants from storm waters enter area waters via storm drains. TCC and FCC have been consistently higher following rainfall in local waters (Lettau, B., et.al, 1979).

Tidal currents and tidal flushing account for much of the transport and dilution in estuaries (Dyer, 1973). Sampling of all locations within FINS is performed irrespective of the tidal state.

Water Quality Parameters Measured

Total Coliform Counts (TCC)
Fecal Coliform Counts (FCC)
Chlorophyll-a
Depths
Dissolved Oxygen (DO)
pH
Salinity
Clarity
Water Temperature

Water Quality Parameter Methodologies

Total and Fecal Coliform Counts methodology

A 100ml sample is passed through a 47mm 0.45µm filter under a vacuum. The resulting filter is placed in a Petri dish that has had a 2mL ampoule of m-ColiBlue is dispensed onto the absorbent pad. The filter is then transferred to the Petri dish, covered and then cultured at 35 ± 0.5 °C for 24 hours.

Chlorophyll-a methodology

A 100ml sample is passed through a 47mm glass fiber TCLP filter under a vacuum to collect the pigment. The resulting filter is placed in a Teflon/Glass tissue grinder along with 5 ml 90% aqueous acetone solution and then it is macerated at 500rpm for 1-2 minutes. The resulting material is then transferred to a screw cap centrifuge with the total volume adjusted to 15ml using the 90% aqueous acetone solution and then the sample is allowed to steep for at least 2 hours at 4°C. The resulting sample is then centrifuged for 30min at 500g. The extract is transferred to a 1-cm cuvette and the optical density is read at 750 and 664 nm from an Unico 1100 Spectrophotometer. The sample is then acidified with 0.1 mL 0.1N HCl and the optical density is read again at 750 and 665 nm. The concentration of chlorophyll a µg/L is calculated.

Salinity methodology

YSI Model 30 - Salinity Conductivity Temperature Sensor

Temperature methodology

YSI Model 30 - Salinity Conductivity Temperature Sensor

Clarity methodology

12 inch Secchi Disk

Dissolved Oxygen (DO) methodology

YSI model 58 Dissolved Oxygen Meter

pH methodology

Orion model 230a pH Meter with low maintenance pH probe

7. Results: Summary

Dowling College FINS Great South Bay WQ Averages 2010

Sample Site	Salinity (ppt)	Temp (C°)	pH	DO (top)	DO (bot)	Total Coliform Average	Fecal Coliform Average	Clarity (in)
				(mg/L)				
1	29.3	25.1	8.10	6.9	6.8	44	1	50
2	28.9	25.5	8.07	6.7	6.0	73	3	33
3	27.6	25.5	8.10	6.0	5.2	118	6	31
4	27.2	25.8	8.19	7.3	7.3	31	1	34
5	27.1	25.8	8.18	7.2	7.0	35	0	31
6	26.6	25.4	8.00	5.3	4.9	150	9	28
7	26.7	26.1	8.07	7.2	6.0	56	1	28
8	26.3	25.4	7.92	6.1	4.0	87	3	33
9	26.3	25.9	8.19	7.1	7.2	46	3	33
10	26.5	25.8	8.06	6.0	4.2	92	10	32
11	26.2	25.8	8.13	7.2	7.2	87	1	31
12	25.6	25.8	8.05	7.1	6.4	34	2	30
13	27.8	25.8	8.12	7.1	7.0	31	0	34

8. Discussion and Conclusion:

The 2010 Water Quality Sampling Program year incorporated a laboratory area established at Dowling College exclusively for FINS weekly water sample analysis (Bordner, R. and J. Winter, 1978). The general State-of-the-Bay regarding temperature, salinity, and pH are characteristic of the Northeast Atlantic estuarine waters off Long Island (Duedall, et. al., 1979, O'Conner, D.J. 1977). The present monitored parameters are within the range which translates into a "normal" condition for such waters. Excessive values, if detected, could be indicative of waste discharges from point sources (i.e. boat basins, pump out stations, etc.)

The top/bottom dissolved oxygen values (DO) were robust and indicative of good oxygen saturation in top and bottom waters. Such values would contribute to fostering healthy estuarine biota (Pokryfki, T.D. and R.E. Randall, 1987).

The 2010 water quality-sampling year reflects a fully QA/QC, comprehensive sampling program. Bacteriological and chlorophyll-a values were tabulated and results tabulated. Dowling student(s) were trained and oriented as to boat operations and sampling procedures. Sampling DATA-SHEETS were prepared and are included as "raw data."

9. References:

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- . 1997. Method 1600: Membrane Filter Test Method for Enterococci In Water. Office of Water. <http://www.epa.gov/OST/beaches/entero.html> EPA # 821-R-97-004.
- . 1995 Update. Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water: EPA # 820/B-96-001.

10. Acronyms Used in 2009 Report:

ATL = Atlantic

BOD = Biological Oxygen Demand

Chl-a = chlorophyll-a

CFU = colony forming units, (number of colonies (coln) that are counted on a bacteriologic growth plate.)

CONF = Confluent (unable to distinguish total counts of prescribed bacteria)

CSO = Combined Sewer Outflows

DO = Dissolved Oxygen

FCC = Fecal Coliform Counts

NYS = New York State

NTU's = Nephelometric Turbidity Units

TCC = Total Coliform Counts

TNTC = Too-Numerous-To-Count

11. Appendices:

A – Long Island South Shore Estuary map with Sampling Stations

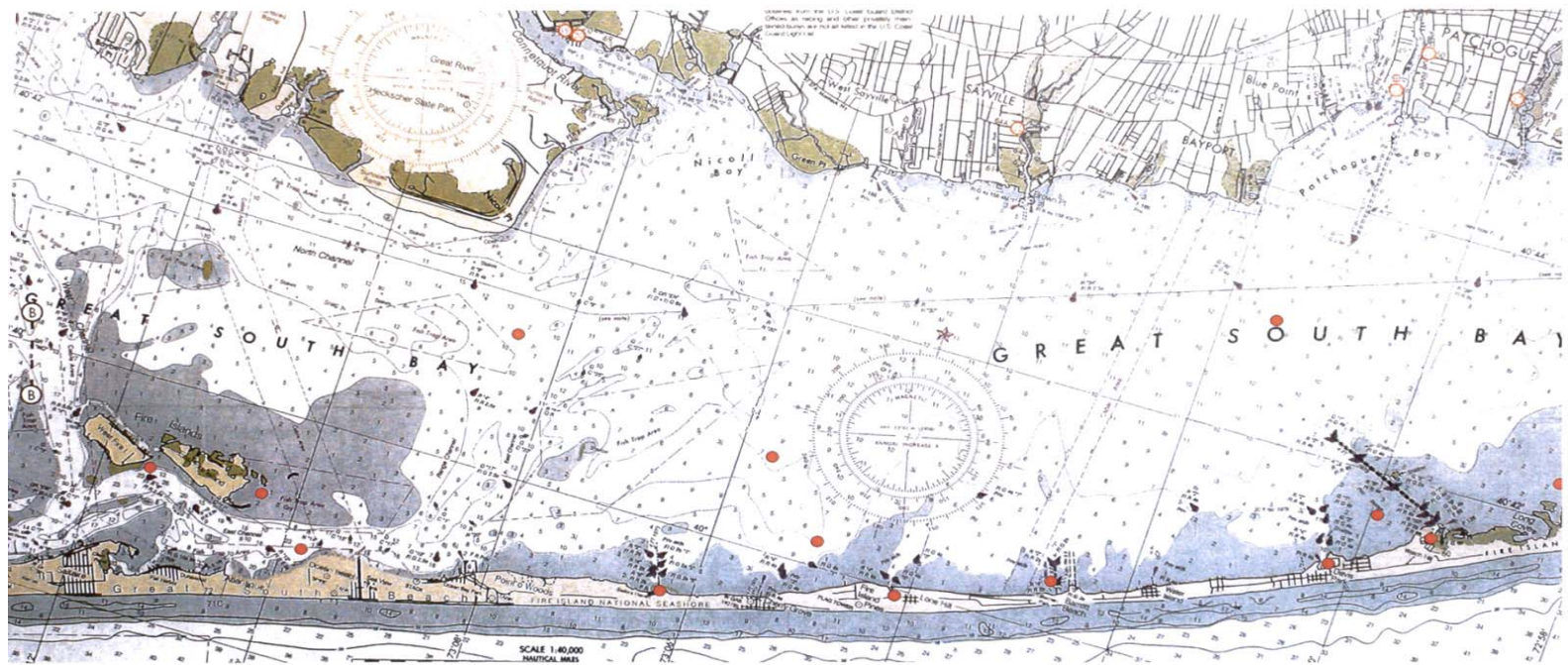
B – Data Summary

C – Average Value Charts

D – Tables of Averages and Ranges

Appendix A

Long Island South Shore Estuary Map with Sampling Stations



Appendix B

Data summary

NPS &
EPA
maximum exceedance

Site 1	clarity	salinity	T-bot	T-top	pH	DO-bot	DO-top	FC	TC	Chl-a
	(in)	(ppt)	(oC)	(oC)		(mg/L)	(mg/L)	col/100mL	col/100mL	(ug/L)
2-Jun	92	27.7	22.0	22.0	7.98	6.7	6.7	0	56	-
7-Jun	68	27.4	21.4	22.0	8.10	6.8	6.4	0	36	-
21-Jun	52	27.9	24.8	25.1	8.08	6.6	6.8	0	220	-
29-Jun	57	29.2	25.3	27.0	8.13	6.3	7.2	0	0	0
7-Jul	48	29.1	27.7	27.9	8.22	6.8	6.9	0	8	10
13-Jul	48	29.7	26.9	27.0	8.08	6.4	6.2	0	6	31
27-Jul	-	30.1	26.8	27.0	-	7.0	7.4	0	6	-
3-Aug	33	30.4	25.3	25.2	-	7.1	6.8	0	62	12
9-Aug	43	30.5	27.2	27.4	8.10	6.9	7.0	0	40	62
17-Aug	42	30.5	24.8	24.8	8.02	6.5	6.5	2	40	72
26-Aug	36	29.2	23.3	23.4	8.17	7.7	7.9	0	42	48
6-Sep	35	29.9	22.7	22.7	8.14	7.1	7.1	4	10	53

Site 2	clarity	salinity	T-bot	T-top	pH	DO-bot	DO-top	FC	TC	Chl-a
	(in)	(ppt)	(oC)	(oC)		(mg/L)	(mg/L)	col/100mL	col/100mL	(ug/L)
2-Jun	57	26.9	23.1	23.7	7.90	6.8	7.2	0	117	-
7-Jun	49	27.3	22.5	22.5	7.97	7.0	6.8	5	56	74
21-Jun	38	27.4	25.3	25.7	8.05	5.9	6.9	22	277	5
29-Jun	4	28.6	26.5	26.9	8.12	5.4	6.2	0	0	99
7-Jul	35	28.8	27.5	28.0	8.21	5.5	6.5	0	6	38
13-Jul	38	29.1	27.6	27.8	8.12	3.6	5.4	0	20	12
27-Jul	-	29.9	26.4	26.5	-	6.0	6.7	0	0	14
3-Aug	23	30.2	26.1	26.5	-	6.3	6.8	0	120	111
9-Aug	32	30.2	26.7	26.8	8.06	6.3	6.7	0	100	5
17-Aug	32	29.8	25.4	25.8	8.07	6.4	7.2	0	54	-
26-Aug	30	28.7	22.1	22.7	8.08	6.3	7.1	14	114	-
6-Sep	30	29.8	22.6	22.9	8.09	6.8	7.1	0	10	-

Site 3	clarity	salinity	T-bot	T-top	pH	DO-bot	DO-top	FC	TC	Chl-a
	(in)	(ppt)	(oC)	(oC)		(mg/L)	(mg/L)	col/100mL	col/100mL	(ug/L)
2-Jun	42	25.1	23.7	23.9	7.86	5.5	5.7	1	385	-
7-Jun	48	26.5	21.3	21.1	7.97	6.5	6.5	2	194	-
21-Jun	29	25.9	25.6	26.6	8.04	6.3	6.6	0	360	15
29-Jun	30	26.2	27.2	27.3	8.18	5.3	5.3	0	0	22
7-Jul	30	28.3	29.0	29.0	8.17	4.8	5.2	0	0	5
13-Jul	29	27.0	28.5	28.5	8.26	4.6	5.1	0	30	53
27-Jul	-	29.7	25.2	25.3	-	5.6	6.2	0	40	60
3-Aug	24	28.4	25.6	26.3	-	3.5	5.8	0	160	17
9-Aug	28	29.4	27.2	27.9	8.14	1.6	5.9	0	60	10
17-Aug	28	28.2	25.4	25.6	8.08	5.2	5.7	64	164	-
26-Aug	19	27.2	22.0	22.0	8.10	6.7	6.8	0	20	-
6-Sep	35	29.4	22.4	23.0	8.18	6.9	7.2	0	4	-

NPS &
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maximum

exceedance

Site 4	clarity (in)	salinity (ppt)	T-bot (oC)	T-top (oC)	pH	DO-bot (mg/L)	DO-top (mg/L)	FC col/100mL	TC col/100mL	Chl-a (ug/L)
2-Jun	53	25.3	23.3	24.3	7.97	7.5	7.1	0	28	-
7-Jun	40	25.3	23.0	23.1	8.06	7.3	7.2	0	14	-
21-Jun	34	25.3	24.6	26.0	8.06	7.8	7.3	0	29	2
29-Jun	34	27.2	27.2	27.3	8.23	6.5	7.7	0	0	-
7-Jul	34	26.2	28.3	28.4	8.32	7.4	7.4	0	4	-
13-Jul	27	27.0	28.1	28.1	8.30	6.5	6.2	0	40	-
27-Jul	-	28.2	26.4	27.2	-	7.0	7.6	0	10	-
3-Aug	29	28.2	26.3	26.4	-	7.5	7.5	0	106	10
9-Aug	35	28.6	27.2	27.3	8.21	6.8	6.8	0	54	-
17-Aug	30	28.9	25.0	25.6	8.27	7.3	7.8	0	56	-
26-Aug	25	27.6	22.3	22.3	8.25	8.1	8.1	6	26	24
6-Sep	37	28.8	22.9	23.0	8.27	7.4	7.4	0	10	36

Site 5	clarity (in)	salinity (ppt)	T-bot (oC)	T-top (oC)	pH	DO-bot (mg/L)	DO-top (mg/L)	FC col/100mL	TC col/100mL	Chl-a (ug/L)
2-Jun	49	24.6	22.5	23.4	7.95	5.8	7.0	0	31	-
7-Jun	37	24.5	22.6	22.7	8.01	7.4	7.4	0	7	24
21-Jun	25	25.4	26.2	26.4	8.06	7.9	7.6	0	42	65
29-Jun	30	26.1	27.3	27.4	8.24	6.6	6.6	0	0	17
7-Jul	36	26.6	28.7	28.7	8.32	6.9	7.0	0	30	231
13-Jul	27	26.7	28.0	28.0	8.28	5.9	6.2	0	16	48
27-Jul	-	29.0	27.1	27.3	-	7.3	7.4	0	0	24
3-Aug	24	28.1	26.3	26.3	-	6.8	6.8	0	92	31
9-Aug	33	28.4	27.5	27.7	8.23	6.9	7.0	0	120	48
17-Aug	34	28.7	25.2	26.0	8.22	7.0	7.7	0	60	46
26-Aug	21	27.1	22.1	22.2	8.23	7.9	7.8	0	8	46
6-Sep	26	29.4	23.2	23.2	8.26	8.1	8.2	2	10	-

Site 6	clarity (in)	salinity (ppt)	T-bot (oC)	T-top (oC)	pH	DO-bot (mg/L)	DO-top (mg/L)	FC col/100mL	TC col/100mL	Chl-a (ug/L)
2-Jun	42	23.9	22.3	23.3	7.82	5.9	5.4	10	423	-
7-Jun	20	24.8	21.9	21.9	7.88	6.0	6.4	4	234	60
21-Jun	30	24.7	25.0	25.5	7.93	5.3	5.6	0	20	7
29-Jun	28	25.4	26.9	27.2	8.09	4.0	5.0	2	2	-
7-Jul	31	26.7	28.1	28.6	8.02	2.6	4.4	0	40	36
13-Jul	27	25.9	28.3	28.3	8.10	3.4	3.6	0	50	31
27-Jul	-	29.0	25.1	25.6	-	4.8	5.6	0	60	24
3-Aug	22	27.4	26.5	26.5	-	4.5	4.8	0	200	-
9-Aug	24	27.9	27.4	27.5	8.04	4.8	4.8	0	400	108
17-Aug	27	27.7	25.5	25.5	8.08	5.4	5.8	34	154	7
26-Aug	29	26.5	21.8	22.3	7.94	6.2	6.7	6	22	-
6-Sep	24	28.9	22.2	22.4	8.09	6.3	5.9	52	196	14

NPS &
EPA
maximum

exceedance

Site 7	clarity	salinity	T-bot	T-top	pH	DO-bot	DO-top	FC	TC	Chl-a
	(in)	(ppt)	(oC)	(oC)		(mg/L)	(mg/L)	col/100mL	col/100mL	(ug/L)
2-Jun	5	24.3	23.3	25.1	7.97	5.5	6.7	1	186	-
7-Jun	37	25.1	21.9	22.0	8.10	6.8	7.1	0	114	26
21-Jun	34	24.2	25.5	25.9	8.04	4.9	6.9	0	50	-
29-Jun	33	25.7	27.4	27.7	8.20	5.9	6.6	5	5	17
7-Jul	30	27.0	29.4	29.9	8.29	4.7	6.6	0	6	14
13-Jul	28	26.1	28.1	28.1	8.28	5.9	6.3	0	10	62
27-Jul	-	28.9	26.4	27.5	-	5.6	7.5	0	36	-
3-Aug	24	27.3	26.0	26.8	6.97	6.5	7.2	0	120	29
9-Aug	31	27.9	27.6	27.9	8.17	5.6	6.8	0	80	74
17-Aug	25	27.9	24.9	26.8	8.23	5.4	8.2	4	12	-
26-Aug	28	27.2	22.1	22.1	8.21	7.1	7.8	0	40	17
6-Sep	35	29.2	23.0	23.0	8.26	8.1	8.3	2	8	5

Site 8	clarity	salinity	T-bot	T-top	pH	DO-bot	DO-top	FC	TC	Chl-a
	(in)	(ppt)	(oC)	(oC)		(mg/L)	(mg/L)	col/100mL	col/100mL	(ug/L)
2-Jun	43	24.1	23.0	23.9	7.89	4.6	5.7	0	300	-
7-Jun	46	24.2	21.5	21.7	8.06	6.2	6.2	0	146	5
21-Jun	38	24.6	24.7	25.5	7.20	2.8	6.3	4	29	-
29-Jun	32	25.0	26.5	27.4	8.06	1.9	5.7	0	0	-
7-Jul	33	26.0	27.8	28.8	8.29	1.8	5.9	0	4	41
13-Jul	26	26.4	28.2	28.1	8.22	2.8	5.2	0	24	41
27-Jul	-	-	-	-	-	-	-	0	0	0
3-Aug	33	27.0	25.4	26.1	6.97	1.4	6.0	0	72	-
9-Aug	25	27.1	26.8	27.2	8.06	5.0	5.9	0	200	34
17-Aug	27	28.1	25.1	25.8	8.13	5.2	6.1	14	56	2
26-Aug	32	27.8	22.7	22.7	8.10	6.0	6.7	20	140	19
6-Sep	29	29.0	21.7	22.1	8.13	6.5	7.1	0	72	-

Site 9	clarity	salinity	T-bot	T-top	pH	DO-bot	DO-top	FC	TC	Chl-a
	(in)	(ppt)	(oC)	(oC)		(mg/L)	(mg/L)	col/100mL	col/100mL	(ug/L)
2-Jun	53	24.1	24.3	24.3	7.96	8.2	7.5	0	86	-
7-Jun	38	24.0	22.2	22.2	8.22	7.6	7.8	1	52	46
21-Jun	33	24.2	25.7	26.1	8.20	8.5	7.4	30	100	-
29-Jun	31	25.0	27.5	27.6	8.10	7.1	6.9	0	0	12
7-Jul	33	26.4	30.0	30.0	8.43	8.2	8.3	0	30	2
13-Jul	28	26.3	28.3	28.3	8.17	4.9	5.1	0	6	70
27-Jul	-	26.6	27.0	27.0	-	6.9	7.0	0	30	-
3-Aug	24	27.0	26.8	26.8	8.27	6.9	6.8	0	140	-
9-Aug	32	27.2	27.4	27.5	8.07	6.2	6.3	0	40	41
17-Aug	32	28.4	25.2	25.5	8.18	6.8	6.4	0	30	-
26-Aug	29	28.1	22.5	22.5	8.23	7.5	7.5	0	26	14
6-Sep	27	28.7	23.0	23.0	8.23	7.7	7.8	4	8	-

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Site 10	clarity (in)	salinity (ppt)	T-bot (oC)	T-top (oC)	pH	DO-bot (mg/L)	DO-top (mg/L)	FC col/100mL	TC col/100mL	Chl-a (ug/L)
2-Jun	43	24.5	22.4	24.4	7.72	0.1	5.3	0	331	-
7-Jun	48	24.2	22.4	22.5	8.40	5.9	6.0	0	195	17
21-Jun	32	24.2	26.3	25.0	8.10	3.0	6.5	5	25	31
29-Jun	32	25.0	26.4	27.5	7.94	1.5	5.2	0	0	5
7-Jul	24	26.5	28.9	29.5	8.24	5.2	6.0	0	10	53
13-Jul	27	26.4	28.7	28.8	8.01	3.9	3.9	0	40	70
27-Jul	-	27.0	25.9	26.6	-	5.9	6.9	0	80	-
3-Aug	36	27.1	26.9	27.2	8.06	6.7	6.8	0	82	-
9-Aug	26	27.5	27.2	27.8	7.95	3.0	6.0	0	100	-
17-Aug	26	28.0	25.1	25.4	8.02	3.5	5.6	116	196	-
26-Aug	25	28.3	21.9	22.3	8.10	6.2	7.4	2	28	29
6-Sep	29	28.7	21.9	22.9	8.14	5.8	6.8	0	16	-

Site 11	clarity (in)	salinity (ppt)	T-bot (oC)	T-top (oC)	pH	DO-bot (mg/L)	DO-top (mg/L)	FC col/100mL	TC col/100mL	Chl-a (ug/L)
2-Jun	46	24.2	23.8	24.0	7.82	6.6	6.3	6	77	-
7-Jun	32	23.9	21.7	21.7	8.17	7.6	7.5	0	65	53
21-Jun	34	23.1	24.5	25.8	8.21	5.3	7.5	0	15	29
29-Jun	34	24.9	27.4	27.4	7.97	6.7	6.5	4	4	74
7-Jul	34	26.5	30.3	30.4	8.33	7.0	7.2	0	30	-
13-Jul	25	25.7	27.9	27.9	8.26	6.0	6.2	0	50	-
27-Jul	-	27.3	25.9	25.9	-	9.4	8.2	0	100	26
3-Aug	35	26.1	26.8	27.0	8.01	7.4	7.4	0	600	84
9-Aug	26	27.5	27.8	27.8	7.99	7.4	7.5	0	30	60
17-Aug	28	28.4	25.6	25.7	8.14	6.5	6.6	0	38	60
26-Aug	25	28.0	22.5	22.5	8.26	8.3	8.1	0	22	5
6-Sep	24	28.5	22.9	22.9	8.26	7.8	7.8	0	14	-

Site 12	clarity (in)	salinity (ppt)	T-bot (oC)	T-top (oC)	pH	DO-bot (mg/L)	DO-top (mg/L)	FC col/100mL	TC col/100mL	Chl-a (ug/L)
2-Jun	32	23.4	22.8	24.3	7.77	6.8	7.5	0	89	-
7-Jun	33	23.6	23.3	23.4	8.02	7.0	6.9	6	64	14
21-Jun	28	23.7	24.0	25.4	8.02	4.3	8.1	1	21	65
29-Jun	33	23.6	27.1	27.6	7.87	5.8	6.4	8	8	36
7-Jul	31	25.2	28.7	28.7	8.36	5.9	6.7	0	30	5
13-Jul	24	26.0	28.1	28.1	8.29	5.9	5.9	0	14	-
27-Jul	-	25.7	26.7	27.4	-	7.3	7.9	0	12	-
3-Aug	35	25.9	26.3	26.4	7.95	6.8	6.9	0	80	67
9-Aug	29	26.5	27.0	27.0	7.76	6.6	6.6	0	20	62
17-Aug	30	28.0	24.7	25.5	8.12	5.9	7.2	0	18	19
26-Aug	27	27.6	22.6	22.7	8.16	7.6	7.7	0	20	-
6-Sep	33	27.8	22.8	22.9	8.21	7.3	7.3	10	34	31

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Site 13	clarity (in)	salinity (ppt)	T-bot (oC)	T-top (oC)	pH	DO-bot (mg/L)	DO-top (mg/L)	FC col/100mL	TC col/100mL	Chl-a (ug/L)
2-Jun	40	24.6	24.6	24.7	7.97	7.6	7.7	0	41	-
7-Jun	46	25.6	23.4	23.5	8.01	7.2	7.2	0	37	29
21-Jun	40	26.7	24.5	26.0	7.72	6.9	7.9	0	25	5
29-Jun	23	27.1	27.4	27.6	8.29	6.7	7.0	3	3	-
7-Jul	34	26.6	27.8	27.9	8.31	7.0	7.2	0	6	62
13-Jul	34	28.5	28.3	28.3	8.18	6.0	5.9	0	40	-
27-Jul	-	28.4	27.3	27.3	-	7.3	7.3	0	44	5
3-Aug	24	29.7	26.0	26.0	-	6.9	6.7	0	96	12
9-Aug	32	29.7	27.5	27.5	8.18	6.7	6.6	0	12	-
17-Aug	35	29.7	25.1	25.2	8.13	7.0	6.8	0	50	84
26-Aug	29	28.0	22.5	22.7	8.20	7.6	7.8	0	10	-
6-Sep	37	29.2	23.1	23.1	8.22	7.5	7.6	2	6	-