Mobile Bay

Water Quality Model Intensive Surveys Report

July 2000/May 2001

US EPA - SESD

Project #01-0546/
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EPA appreciates the extensive field support provided by the Alabama DEM in conducting these surveys.

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Introduction

The Mobile River/Bay is a 303(d) listed water body with impairment resulting from depressed dissolved oxygen (DO) levels. In addition, the State water quality criteria for DO for the Mobile River, Chickasaw Creek, and Three Mile Creek has been disapproved by EPA. As part of TMDL development being coordinated by EPA Region 4's Water Management Division (WMD), the Science and Ecosystem Support Division (SESD) was requested to conduct water quality studies of Mobile Bay designed specifically to provide instream data for use by WMD in development and calibration/verification of a 3-dimensional time-variable water quality model. To obtain adequate data for model calibration and verification, two intensive surveys were conducted on Mobile Bay.

The first SESD Mobile Bay intensive water quality survey was conducted in July 2000, followed by a second intensive survey in May 2001. By design, one survey dataset is intended to serve as a model calibration dataset, while the other is intended for model verification. While the 2000 and 2001 intensive survey study plans are very similar with respect to the type of data targetted, the surveys were conducted during different seasonal conditions in order to provide comparable data across a range of conditions. In addition, dissolved oxygen, salinity and temperature (DST) profiling during the 2001 survey was expanded to obtain more measurements east-west along the bay. It should also be noted that WMD indicated at the outset of the project that considerable hydrodynamic data exists for Mobile Bay and that SESD activities should be more focussed on water quality measurements and kinetics. This report describes and summarizes the results of the 2000 and 2001 calibration/verification surveys.

Study Objectives

The purpose of the 2000 and 2001 intensive surveys was to provide the necessary water quality data along with supplemental hydrodynamic information to enable calibration and verification of a 3-dimensional, time-varying water quality model for Mobile Bay. The studies were designed to provide water quality data, oxygen dynamics, and meteorologic data , and limited hydrodynamic data throughout the study area including the modeled system boundaries and several representative calibration points. In addition, the surveys were designed to provide instream data over a range of seasonal and tidal conditions so that the calibrated model could be applied in a predictive mode over a wide range of conditions.

Study Area

Mobile Bay is a very large bay stretching approximately 30 miles from top to bottom and encompassing an area of approximately 400 square miles. The Mobile Bay study area includes the entire bay from its mouth at the Mississippi Sound/Gulf northward into the Mobile River at its confluence with Chickasaw Creek (Figure 1). The Mobile Bay study area also includes Three Mile Creek, Chickasaw Creek, and Dog River. In addition, a headwater sampling station was located in the Mobile River at a public boat ramp near Mt. Vernon, Alabama. Finally, in order to aid in potential future model development or expansion, insitu water quality data was collected in Oyster Bay, Weeks Bay, Magnolia River, and the Intracoastal Waterway.

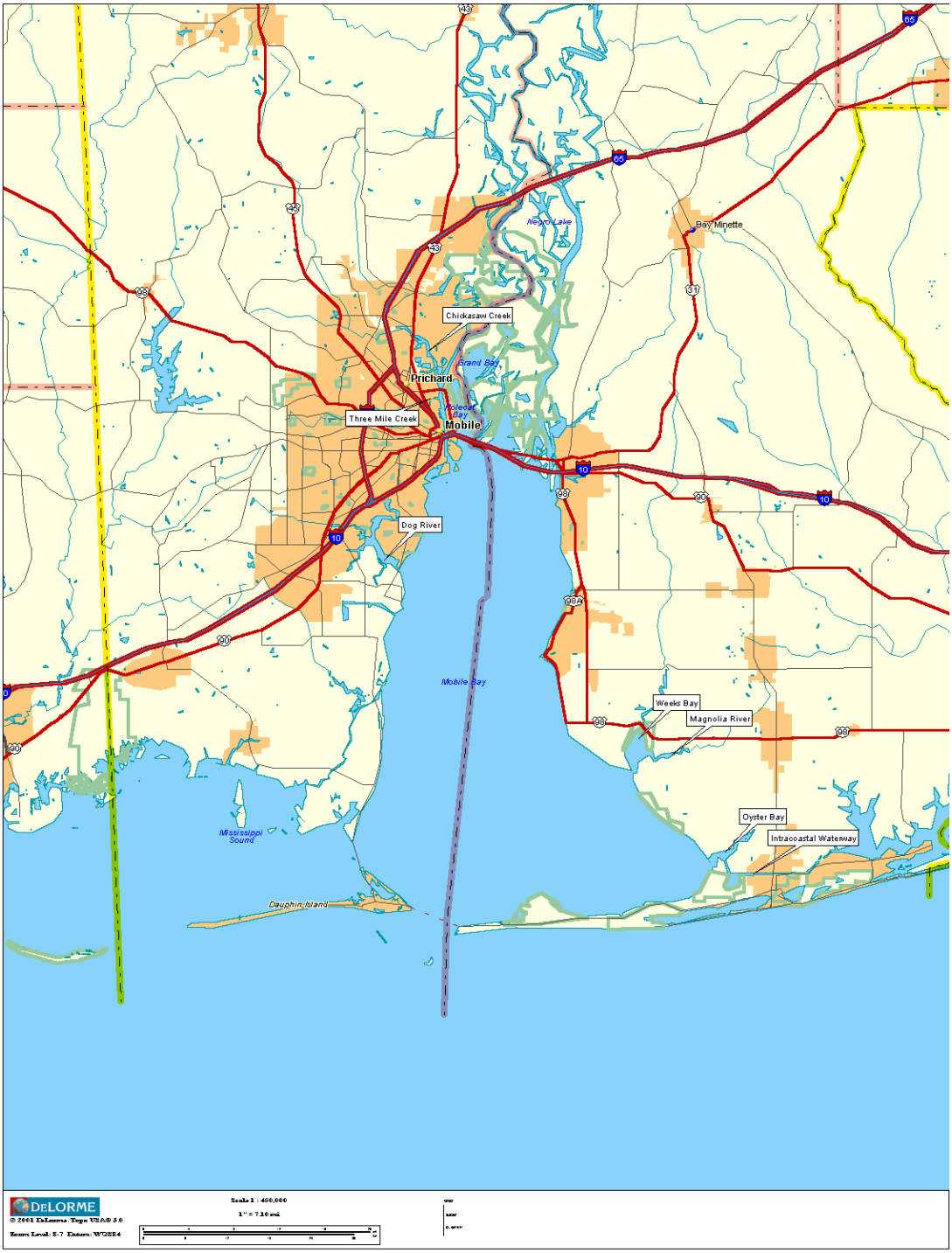

Figure 1 - Mobile Bay Study Area

Survey Components/Results

The 2000 survey includes eight separate study components. For the 2001 survey, dissolved oxygen/salinity/temperature (DST) profiling and water quality sampling were broken into separate components (Table 1).

Table 1 - Study Components

Module	2000 Survey	2001 Survey
1	Tide-phased WQ Sampling/ DST Profiling	DST Profiling
2	Continuous DO Monitoring	Tide-phased WQ Sampling
3	Photosynthesis/Respiration	Continuous DO Monitoring
4	Diffusion	Photosynthesis/Respiration
5	Reaeration	Diffusion
6	Hydrologic/Meteorologic	Reaearation
7	SOD	Hydrologic/Meteorologic
8	Point Source Sampling	SOD
9	-	Point Source Sampling

DST Profiling

In 2000, DO, salinity, and temperature (DST) profiling was conducted throughout the bay during a 6 day period from July 11 to July 16. On July 11, preliminary profiling was conducted at several stations in association with the deployment of other instrumentation (e.g., current meters, stage recorders) In addition, one crew profiled the upper tributaries (Chickasaw Creek and Three Mile Creek) and upper Ship Channel near station SC1. On July 12 and 14, profiling was conducted by several crews in association with water quality sample collection. Water quality

sampling station locations/crews are shown in Table 2 and Figure 2. (Due to a storm, stations SC4, MB3, and MS0 were not profiled during the July 14 sample collection.) Profiling during these events provided information on stratification necessary for proper sampling at each of the water quality sampling stations. The July 12 event represents a high slack tide event while the July 14 event occurred during an ebbing tide. Also during the July 14 effort, profiling was conducted above and below three major effluent dischargers including International Paper, Kimberly Clark, and Mobile WWTP. The remaining profiling efforts were designed to provide significant coverage of bay salinity and DO for use in model setup and calibration. These events included lower bay profiling on July 13, middle bay profiling on July 15, and profiling throughout the Ship Channel on July 16. Figure 3 shows the areal extent of DST profiling conducted in July 2000.

Table 2 - Water Quality Sampling Stations

Station	Sampling Crew	Description	Latitude	Longitude
MR1	1 - Headwater	Upstream Boundary - Mobile River	31° 05.27'	87° 58.60'
CC	2 - River/Tribs	Chickasaw Creek near mouth	30° 44.37'	88° 02.75'
TMC	2 - River/Tribs	Three Mile Creek near mouth	30° 43.62'	88° 02.92'
DR	3 - Middle Bay	Dog River near mouth	30° 34.2'	88° 05.7'
SC1	2 - River/Tribs	Mobile Ship Channel - Station 1	30° 43.0'	88° 02.5'
SC2	3 - Middle Bay	Mobile Ship Channel - Station 2	30° 36.0'	88° 02.0'
SC3	3 - Middle Bay	Mobile Ship Channel - Station 3	30° 28.8'	88° 01.0'
SC4	4 - Lower Bay	Mobile Ship Channel - Station 4	30° 22.8'	88° 01.3'
SC5	4 - Lower Bay	Mobile Ship Channel - Station 5	30° 15.5'	88° 02.3'
MB1	3 - Middle Bay	Upper Bay near Montrose	30° 36.0'	87° 58.0'
MB2	3 - Middle Bay	Middle Bay near Point Clear	30° 28.3'	87° 58.0'
MB3	4 - Lower Bay	West Bay below Fowl River	30° 22.0'	88° 04.0'
MB4	4 - Lower Bay	Bon Secour Bay	30° 19.0'	88° 53.0'
MS0	4 - Lower Bay	Mississippi Sound	30° 17.5'	88° 07.1'
GULF	4 - Lower Bay	Gulf of Mexico east of Bay inlet	30° 08.7'	88° 02.2'

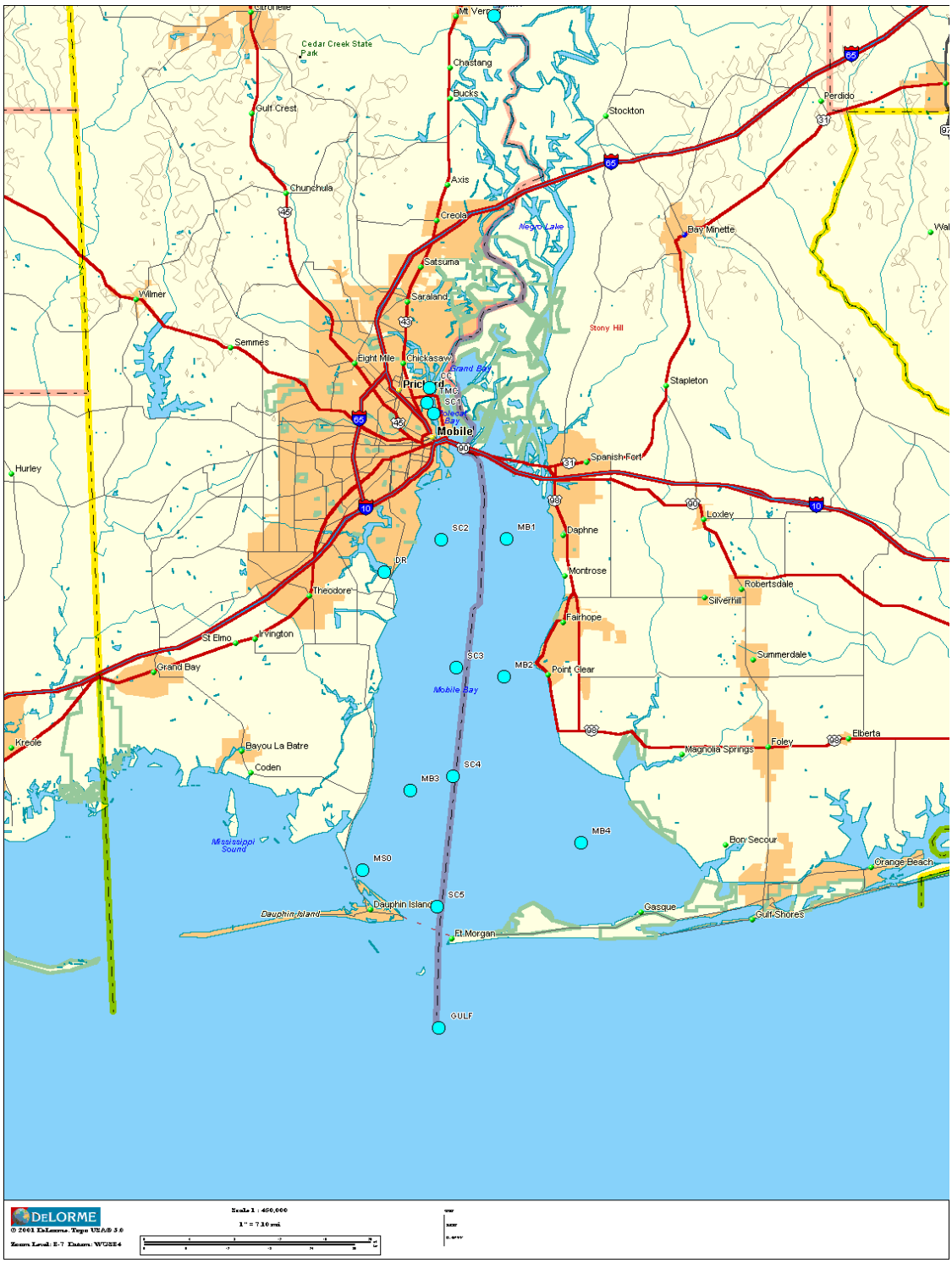

Figure 2 - Water Quality Sampling Stations

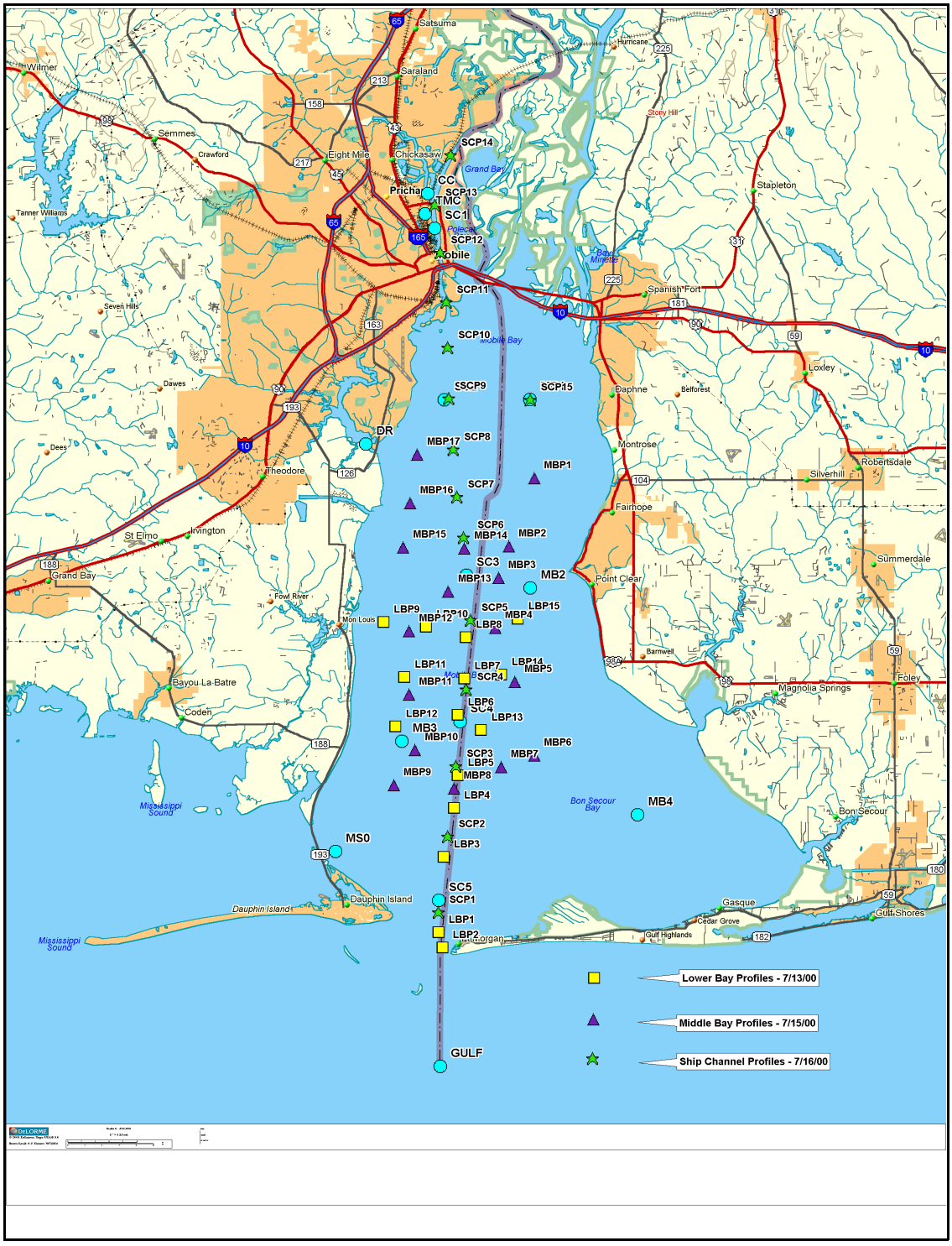

Figure 3 - July 2000 DST Profiling Locations

The three profiles conducted at the upstream boundary station MR1 support its suitability as the upstream boundary sampling location. This location was consistently freshwater when profiled with all measured DO levels greater than the 5 mg/l EPA Fish & Wildlife DO criteria. In general, data for all profiles showed DO above 5 mg/l in the upper water column (depth $\leq$ 3') with significant reductions in DO with depth at many locations especially in the upper bay and tributaries. With respect to calibration, it should be noted that the DO end check of the meter used during the July 15 middle bay profiles indicated a DO reading above the Winkler titration standard (+ 0.38 mg/l) slightly outside EAB tolerances for this parameter ($\pm$ 0.2 mg/l). Heating of the DO chamber between Winkler titration and meter recording may have occurred resulting in the difference. Since this meter was used throughout the rest of the survey period without calibration problems and the error is relatively small versus the measured Bay DO range, SESD believes the profiling data to be acceptable for the purposes of model development and calibration.

In 2001, significant DST profiling was again conducted. On May 15 and 16, profiling was again conducted in association with water quality sampling. In addition, on May 16 profiling was conducted in Weeks Bay and the Magnolia River while Oyster Bay and the Intracoastal Waterway were profiled on May 17. Finally, on May 17 and 18 a profiling crew conducted profiles laterally across the bay to enhance the 3-dimensional water quality "picture" of the bay. The locations of the May 2001 DST profiling stations are shown in Figure 4.

Again in 2001, DO at the headwater station MR1 was consistently well above 5 mg/l. DO in the bay and tributaries again exceeded 5 mg/l in the upper layers (3' - 6') with DO decreasing with depth frequently below 5 mg/l. With the exception of the bottom reading at one Magnolia River station, all DO measurements in profiles for Weeks Bay, Magnolia River, Oyster Bay, and

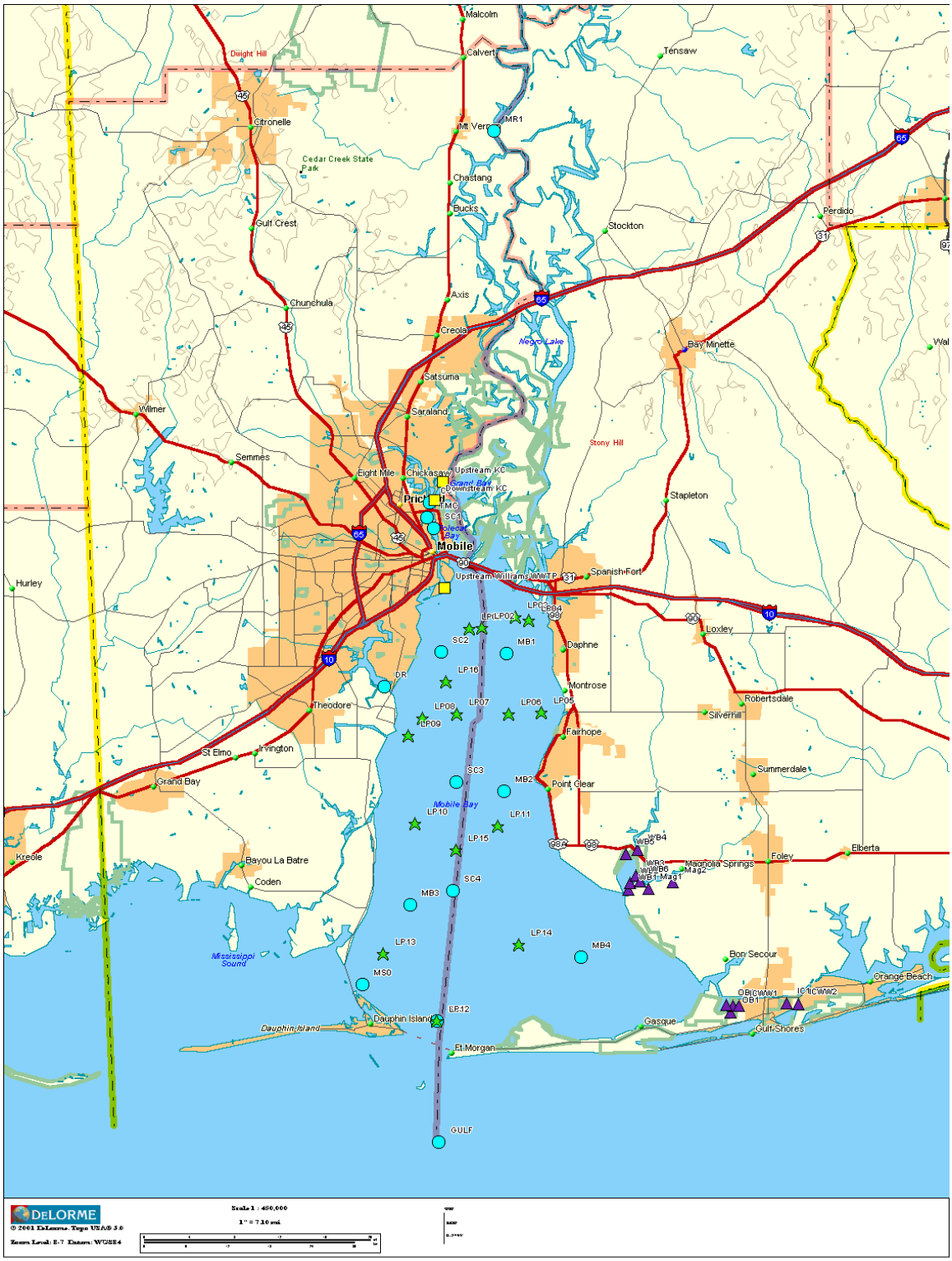

Figure 4 - May 2001 DST Profiling Locations

the Intracoastal Waterway exceeded 5 mg/l.

In addition to DO, salinity, and temperature profiling, the 2001 profiling included some turbidity measurements. In general, the data show turbidity levels decreasing from the north end of the bay to the bay outlet. The following calibration information should be considered during any application of the data to a model. Specifically, the turbidity meter used by the river/tributaries sampling team during the first water quality sampling run (5/15) read a 10.0 NTU standard at only 8.3 NTU, while the same unit when used for the Weeks Bay/Magnolia River profiling (5/16) read a 10.0 NTU standard as 12.6 NTU.

Tide-phased Water Quality Sampling

Water quality sampling locations for the both the 2000 and 2001 surveys are shown in Figure 2 (p.6). Measured water quality parameters during these studies include ultimate biological oxygen demand (BODu - 120 day test), carbonaceous 5-day biological oxygen demand (CBOD5), dissolved phosphorus (Diss-P), total phosphorus (Tot P), total kjeldahl nitrogen (TKN), ammonia nitrogen (NH3-N), nitrate/nitrite (NO2/NO3), and total organic carbon (TOC). In addition, limited samples were collected for total suspended solids (TSS) analysis during the 2001 survey. Where pronounced stratification in either temperature, salinity, or dissolved oxygen was observed during profiling, samples were collected in an upper layer of the water column and a lower layer. Upper layer samples are denoted for the 2000 survey by the letter T while lower layer samples are denoted by the letter B (eg, MB3-B). For 2001, the designators are A and B for upper and lower layer samples, respectively. Where no stratification was observed a middepth sample was collected. Also, due to laboratory constraints, long-term BOD analysis was generally

not conducted on lower layer samples. In July 2000, samples were collected for the suite of parameters during a high slack tide period and an ebbing tide period at the stations in Table 2. The selection of the sampling period was based in part on ensuring that holding times would not be exceeded during transport from the Mobile area to the SESD laboratory in Athens, Georgia. In 2001, traditional slack tide sampling was employed with the first of two sampling efforts occurring during a high slack tide and the second taking place on the following low slack tide.

The sampling results for the 2000 survey are shown in Tables 3 and 4 while results for the 2001 survey are provided in Tables 5 and 6. For both the 2000 and 2001 surveys, the BODu values reported in Tables 3 - 6 represent **total** ultimate BOD reported by the laboratory. For the 2000 survey, CBOD5 concentrations were < 2 mg/l for most of the stations during both events. Slightly higher concentrations were observed in the ship channel (SC2 & SC4). For the 2001 survey, CBOD5 concentrations were again generally below 2 mg/l with all stations below 3 mg/l. In 2000, only limited TOC sampling was conducted and then only for the high slack event. Results of this limited sampling showed a maximum TOC of 6.2 mg/l at the headwater station and a minimum concentration of 1.8 mg/l at the downstream boundary (GULF). The remaining ten TOC values are in a narrow range from 2.7 to 3.6 mg/l. More extensive TOC sampling was conducted during the 2001 survey. Due to instrument malfunctions during analysis, holding times for a few TOC samples on the low slack tide event were missed and the analytical results flagged as estimated (See Table 6). The reported TOC data for the 2001 survey again show little variation throughout the bay during either sampling event with concentrations slightly lower during the low slack tide period. Nearly all ammonia and nitrate/nitrite concentrations were

Table 3 - Water Quality Sampling Results
July 12, 2000 - High Slack Tide

Station	Time	BODu (mg/l)	CBOD5 (mg/l)	TOC (mg/l)	NH3-N (mg/l)	NO2/NO3 (mg/l)	TKN (mg/l)	Tot P (mg/l)	Diss P (mg/l)	Sample Depth (ft)
MR1	1600	7.53	2.0 UJ	6.2	0.050 U	0.050 U	0.480	0.077	0.041	10
CC	1130	5.36	2.0 UJ	3.4	0.118	0.050 U	0.540	0.710	0.020 U	7
TMC	1200	8.46	2.0 UJ	3.6	0.253	0.323	1.46 J	0.191	0.125	7
TMC (d)	1200	9.02	2.0 UJ	-	-	-	-	-	-	7
SC1T	1015	5.18	2.0 UJ	-	0.154 A	0.050 U	0.489 J	0.084 A	0.084 A	8
SC1B	1030	-	2.0 UJ	-	0.272	0.050 U	0.494 J	0.096	0.061 A	28
SC2	1145	23.7	6.8 J	-	0.050 U	0.050 U	0.714	0.090	-	4
SC2 (d)	1145	-	3.1 J	-	-	-	-	-	-	4
SC3T	0950	6.24	2.0 UJ	2.8	0.050 U	0.050 U	0.417 A	0.072	0.020 U	3
SC3T (d)	0950	6.14	-	-	-	-	-	-	-	3
SC3B	1000	-	2.0 UJ	-	0.050 U	0.050 U	0.398 A	0.045 A	0.046	9
DR	1230	10.8	2.0 UJ	3.6	0.050 U	0.050 U	0.506	0.064	0.023 AJ	12
MB1	1115	8.23	2.0 UJ	3.4	0.050 U	0.050 U	0.414	0.069	-	6
MB2	1030	5.97	2.0 UJ	2.9 AJ	0.050 U	0.050 U	0.502	0.059	0.02 U	6
SC4T	1450	12.4	5.8 J	-	0.050 U	0.050 U	0.590 J	0.044	0.038	5
SC4T (d)	1450	10.9	-	-	-	-	-	-	-	5
SC4B	1500	3.75	2.0 UJ	-	0.050 U	0.050 U	0.350 J	0.043	0.029	20
SC5T	1200	5.04	2.0 UJ	2.7 AJ	0.050 U	0.050 U	0.335 J	0.046 AJ	0.020	5
SC5T (d)	1200	4.56	2.0 UJ	-	-	-	-	-	-	5
SC5B	1210	3.68	2.0 UJ	-	0.050 U	0.050 U	0.292 J	0.058	0.020 U	26
MB3T	1430	9.42	2.2 J	3.2	0.050 U	0.050 U	0.580 J	0.066	0.041	3
MB3B	1420	5.05	2.0 UJ	-	0.050 U	0.050 U	0.394 J	0.084	0.020 A	11
MB4	1300	5.56	2.0 UJ	2.8	0.050 U	0.050 U	0.442 J	0.077	0.059	6
MS0	1400	8.90	2.0 UJ	3.0	0.050 U	0.050 U	0.562 J	0.040	0.020 U	6
MS0 (d)	1400	8.81	2.0 UJ	-	-	-	-	-	-	6
GULFT	1110	2.71	2.0 UJ	1.8	0.050 U	0.050 U	0.292 A	0.020 U	0.020 U	5
GULFB	1100	1.41	2.0 UJ	-	0.050 U	0.050 U	0.107	0.020 U	0.020 U	26
GULFB (d)	1100	1.35	-	-	-	-	-	-	-	26

A - Average Value; J - Estimated Value; U - Material analyzed for but not detected (number is minimum quantitation limit); (d) - QA duplicate sample

Table 4 - Water Quality Sampling Results
July 14, 2000 - Ebbing Tide

Station	Time	BODu (mg/l)	CBOD5 (mg/l)	TOC (mg/l)	NH3-N (mg/l)	NO2/NO3 (mg/l)	TKN (mg/l)	Tot P (mg/l)	Diss P (mg/l)	Sample Depth (ft)
MR1	1635	-	2.0 UJ	-	0.050 U	0.050 U	0.392	0.044	0.036	11
CC	1335	-	2.0 UJ	-	0.120	0.050 U	0.465 J	0.036	0.038	9
TMC	1405	-	2.0 UJ	-	0.162	0.050 U	0.503 J	0.079	0.050	8
IPU	1215	5.69	2.0 UJ	-	0.173	0.050 U	0.499 A	0.105	0.045	8
IPD	1240	5.98	2.0 UJ	-	0.155	0.050 U	0.484 J	0.151	0.071	9
KCD	1305	6.23	2.0 UJ	-	0.133	0.050 U	0.466 J	0.054	0.022	8
MTPU	1515	5.22	2.0 UJ	-	0.166	0.050 U	0.443 J	0.088	0.046	11
MTPD	1600	14.7	2.3 J	-	0.103	0.050 U	0.432 J	0.049	0.049 AJ	9
SC1T	1430	5.96	2.0 UJ	-	0.176 A	0.050 U	0.462 J	0.086 AJ	0.043	10
SC1T (d)	1430	5.83	-	-	-	-	-	-	-	10
SC1B	1435	-	2.0 UJ	-	0.294	0.050 U	0.450 J	0.072	0.049	29
SC2	1130	-	6.9 LJ	-	0.050 U	0.050 U	0.737 J	0.098	0.078	3
SC2 (d)	1130	-	5.0 LJ	-	-	-	-	-	-	3
SC3T	0910	5.72	2.0 UJ	-	0.050 U	0.050 U	0.396 J	0.076	0.057	3
SC3B	0915	-	2.0 UJ	-	0.061	0.050 U	0.435 J	0.068	0.056 AJ	10
DRT	1230	-	3.5 J	-	0.050 U	0.050 U	0.595 J	0.073	0.064	2
DRB	1235	-	2.0 UJ	-	0.050 U	0.050 U	0.592 J	0.078 A	0.068	15
MB1T	1050	9.54	2.2 J	-	0.050 U	0.050 U	0.455 J	0.077	0.067	4
MB1B	1055	-	2.0 UJ	-	0.050 U	0.050 U	0.465 J	0.115	0.080	10
MB2	0940	6.03	2.0 UJ	-	0.050 U	0.050 U	0.409 J	0.068	0.032	6
SC4T	1610	-	2.0 UJ	-	0.050 U	0.050 U	0.396	0.033	0.046	5
SC4B	1620	-	2.0 UJ	-	0.056	0.050 U	0.396J	0.037	0.417	30
SC5T	1340	9.42	2.0 UJ	-	0.050 U	0.050 U	0.337 J	0.055	0.029	5
SC5B	1330	3.71	2.0 UJ	-	0.050 U	0.050 U	0.301	0.020 U	0.025	30
MB3T	1630	7.55	2.0 UJ	-	0.050 U	0.050 U	0.433	0.039	0.033	3
MB3B	1640	-	2.0 UJ	-	0.050 U	0.050 U	0.418 A	0.028	0.033	11
MB4	1415	6.72	2.0 UJ	-	0.050 U	0.050 U	0.487	0.092 AJ	0.052	5
MB4 (d)	1415	6.93	-	-	-	-	-	-	-	5
GULF	1245	3.75	2.0 UJ	-	0.050 U	0.050 U	0.286 A	0.020 U	0.020 U	5

A - Average Value; J - Estimated Value; U - Material analyzed for but not detected (number is minimum quantitation limit); (d) - QA duplicate sample;
L - Actual value known to be higher than value given.

Table 5 - Water Quality Sampling Results
May 15, 2001 - High Slack Tide

Station	Time	BODu (mg/l)	CBOD5 (mg/l)	TOC (mg/l)	NH3-N (mg/l)	NO2/NO3 (mg/l)	TKN (mg/l)	Tot P (mg/l)	Diss P (mg/l)	TSS (mg/l)	D (ft)
MR1	1530	5.01	1.0 U	6.6	0.050 U	0.050 U	0.36	0.039	0.027	5.5	< 1
CC-A	1645	-	1.0 U	3.9	0.090	0.050 U	0.49	0.036	0.021	5.0	6
CC-A (d)	1645	-	1.0 U	4.4	0.10	0.050 U	0.41	0.034	0.020 U	-	6
CC-B	1650	-	1.0 U	4.7	0.18	0.050 U	0.31	0.058	0.048	12	20
TMC-A	1730	-	2.4	5.3	0.050 U	0.48	0.68	0.097	0.068	10	3
TMC-B	1735	-	1.0 U	4.6	0.18	0.052	0.48	0.052	0.043	9.5	11
SC1-A	1755	4.34	1.0 U	3.3	0.13	0.098	0.48	0.051	0.033	-	3.5
SC1-B	1800	-	1.0 U	4.7	0.15	0.050 U	0.41	0.077	0.035	-	31
SC2-A	1910	4.49	1.0 U	4.0	0.050 U	0.050 U	0.38	0.033	0.023	-	2
SC2-B	1920	-	1.2	4.3	0.063	0.050 U	0.37	0.046	0.031	-	16
SC3-A	1540	6.70	1.4	3.9	0.050 U	0.050 U	0.40	0.028	0.020 U	-	4
SC3-B	1550	-	1.0 UJ	4.3	0.050 U	0.050 U	0.33	0.037	0.022	-	13
DR	2010	-	1.4	3.9	0.050 U	0.050 U	0.42	0.038	0.033	-	11
DR (d)	2010	-	1.3	4.2	0.050 U	0.050 U	0.33	0.035	0.026	-	11
MB1-A	1800	6.59	1.6	4.0	0.050 U	0.050 U	0.32	0.032	0.020 U	-	3
MB1-B	1810	-	2.7	4.8	0.065	0.050 U	0.52	0.084	0.054	-	9
MB2-A	1640	7.20	1.9	3.5 AJ	0.050 U	0.050 U	0.37	0.034	0.030	-	3
MB2-B	1650	-	2.2	4.7	0.050 U	0.050 U	0.52	0.070	0.063	-	10
SC4-A	1710	4.60	1.1	3.2 AJ	0.050 U	0.050 U	0.51	0.029	0.020 U	-	7
SC4-A (d)	1710	-	1.2	3.8	0.050 U	0.050 U	0.52	0.026	0.020 U	-	7
SC4-B	1715	-	1.0 U	4.7	0.050 U	0.050 U	0.28	0.034	0.020 U	-	35
SC5-A	1505	3.83	1.2	3.7	0.050 U	0.050 U	0.28	0.024	0.020 U	-	5
SC5-B	1510	-	1.0 U	4.7	0.050 U	0.050 U	0.23	0.028	0.020 U	-	25
MB3	1625	4.87	1.5	3.9	0.050 U	0.050 U	0.36	0.020 U	0.020 U	-	5
MB4	1750	-	2.1	4.1	0.050 U	0.050 U	0.45	0.032	0.032	-	3
MS0	1555	6.09	1.9 AJ	4.2	0.050 U	0.050 U	0.40	0.042	0.020 U	-	3
GULF-A	1435	6.93 A	1.0 U	4.7	0.050 U	0.050 U	0.12	0.020 U	0.020 U	-	10
GULF-B	1430	-	1.0 U	4.7	0.050 U	0.091	0.10 U	0.028	0.020 U	-	40

A - Average Value; J - Estimated Value; U - Material analyzed for but not detected (number is minimum quantitation limit); (d) - QA duplicate sample;

Table 6 - Water Quality Sampling Results
May 16, 2001 - Low Slack Tide

Station	Time	BODu (mg/l)	CBOD5 (mg/l)	TOC (mg/l)	NH3-N (mg/l)	NO2/NO3 (mg/l)	TKN (mg/l)	Tot P (mg/l)	Diss P (mg/l)	TSS (mg/l)	D (ft)
MR1	0915	6.16	1.2	6.2	0.050 U	0.050 U	0.34	0.049	0.031	10	< 1
CC-A	1100	5.03 A	1.0 U	4.1	0.11	0.077	0.50	0.044	0.030	10	9
CC-B	1105	-	1.0 UJ	3.7	0.28	0.050 U	0.49	0.057	0.046	22	25
TMC-A	1015	7.98 A	1.3	2.8 J*	0.11	0.74	0.61	0.15	0.110	9.0	4.5
TMC-A (d)	1015	-	1.3	3.0 J*	0.11	0.72	0.61	0.14	0.091	12	4.5
TMC-B	1025	-	1.0 U	1.6 J*	0.51	0.25	0.72	0.12	0.080	8.0	11
SC1-A	0945	4.64	1.0 U	4.4	0.11	0.059	0.38	0.043	0.033	-	6.5
SC1-B	0800	-	1.0 U	2.8 AJ	0.24	0.050 U	0.36	0.054	0.038	-	35
SC2-A	0840	6.62	1.5	3.1	0.052	0.050 U	0.38	0.044	0.030	-	4
SC2-B	0850	-	1.0 UJ	3.4	0.13	0.050 U	0.29	0.033	0.030	-	19
SC3-A	1050	5.57	1.5	3.3	0.050 U	0.050 U	0.30	0.024	0.021	-	4
SC3-B	1100	-	1.0 U	3.1	0.053	0.095	0.18	0.023	0.020 U	-	20
DR	1140	6.11	1.7	3.9	0.45 J	0.050 U	0.38	0.037	0.023	-	9
MB1-A	0920	8.32	2.9	3.9	0.075 J	0.050 U	0.38	0.032	0.020	-	4
MB1-A (d)	0920	7.48	2.2	3.8	0.050 U	0.050 U	0.41	0.031	0.029 J	-	4
MB1-B	0930	-	1.9	3.6	0.075	0.050 U	0.56	0.054	0.048	-	9
MB2	1010	8.05	2.5	3.3	0.050 U	0.050 U	0.45	0.038	0.027	-	5
SC4-A	1145	6.21	2.0	2.9	0.050 U	0.050 U	0.30	0.021	0.020 U	-	5
SC4-B	1150	-	1.0 U	2.9	0.050 U	0.050 U	0.19	0.020 U	0.020 U	-	30
SC5-A	1010	4.69	1.0	2.9	0.050 U	0.050 U	0.23	0.020 U	0.020 U	-	5
SC5-B	1015	-	1.0 U	1.0 UJ*	0.050 U	0.050 U	0.17	0.020 U	0.020 U	-	25
MB3-A	1105	4.95	1.1	3.2	0.050 U	0.050 U	0.27	0.020 U	0.020 U	-	3
MB3-B	1110	-	1.5	3.0	0.050 U	0.050 U	0.29	0.020	0.020	-	8
MB4	0750	7.95	1.8	3.2	0.050 U	0.050 U	0.52	0.093	0.033	-	4
MB4 (d)	0750	8.17	1.8	3.1	0.050 U	0.050 U	0.47	0.092	0.054	-	4
MS0	1035	5.49	1.2	3.3	0.050 U	0.050 U	0.36	0.088	0.060	-	3
GULF	0920	2.48	1.0	3.2	0.091 J	0.050 U	0.28	0.020 U	0.020 U	-	20
Pres. Blank		-	-	1.0 U	0.050 U	0.050 U	0.10 U	0.020 U	-	4.0 U	

A - Average Value; J - Estimated Value; U - Material analyzed for but not detected (number is minimum quantitation limit); (d) - QA duplicate sample;
* - holding time exceeded due to instrument malfunction

less than detection (0.05 mg/l) in 2000 except near point sources where concentrations were still less than 0.2 mg/l. Again in 2001, ammonia and nitrate/nitrite concentrations were generally less than detection except in the tributaries (CC, TMC, and DR) and in the upper ship channel (SC1, SC2, and SC3). Higher 2001 ammonia concentrations in tributaries and the upper ship channel may be due to greater freshwater discharge into the Bay during May than July resulting in more nitrogen loading from upstream swamps. TKN concentrations were somewhat higher during the ebb tide sampling in 2000 than during the high slack tide possibly due to TKN input to the bay from Chickasaw Creek and Three Mile Creek. It should be noted that some of the reported 2000 TKN concentrations are flagged as estimated due to recovery problems encountered during analysis. With a few exceptions, TKN concentrations in 2001 were higher in the upper layer of the water column than in the lower layer at the same station. Total phosphorus concentrations in 2000 and 2001 generally varied throughout the bay from less than detection (0.020 mg/l) to less than 0.1 mg/l. In 2000, only stations TMC and CC exceeded 0.1 mg/l total phosphorus during the slack tide sampling while total phosphorus exceeded 0.1 mg/l only at MB1 and above and below International Paper during ebb tide sampling. In 2001, 0.1 mg/l total phosphorus was exceeded only at station TMC during the low slack tide sampling. Finally, TSS samples were collected in 2001 at the headwater station (MR1), Chickasaw Creek (CC), and Three Mile Creek (TMC) during both slack tide events. With the exception of the lower layer sample in Chickasaw Creek (22 mg/l), the remaining TSS concentrations were in a fairly narrow range from 5 - 12 mg/l.

Continuous DO Monitoring

In both 2000 and 2001, continuous recording DO meters were deployed at ten locations in the bay and tributaries. Each meter was deployed from a floating buoy to maintain a probe depth of approximately five feet (5') and recorded dissolved oxygen, salinity, pH, and temperature in 30 minute intervals throughout the deployment period. In addition, turbidity measurements were recorded during the 2001 deployments at stations MR1, CC, DR, MB1, MB3, and MB4. Table 7 summarizes the continuous DO monitoring data for the two surveys.

Table 7 - Continuous DO Monitoring Summary

Station	July 2000		Number of Hours Deployed	May 2001		Number of Hours Deployed
	Min.-Max	Ave		Min.-Max.	Ave	
MR1	7.50 - 10.29	8.43	67.1	8.33 - 12.10	9.29	53.2
CC	3.91 - 23.52	12.51	74.0	5.75 - 7.38	6.43	69.9
TMC	2.47 - 13.02	6.97	74.2	5.59 - 9.24	7.06	69.5
DR	0.73 - 9.13	5.22	69.8	3.45 - 7.88	6.07	69.8
SC1	No Data - Meter Lost		-	4.98 - 7.33	5.99	64.7
MB1	5.46 - 7.89	6.13	72.1	No Data - Probe Malfunction		72.3
MB2	5.38 - 7.10	6.06	70.3	5.68 - 7.73	6.71	66.8
MB3	No Data - Meter Lost		-	2.55 - 8.14	5.96	71.8
MB4	5.15 - 6.74	5.79	69.2	6.15 - 8.52	6.98	66.1
GULF	No Data - Meter Lost		-	No Data - Meter Lost		-
Upper West Bay (UWB)	1.70 - 7.14	4.62	72.9	4.47 - 8.07	6.28	62.4

As shown in Table 7, there is tremendous daily variability in DO in the bay tributaries

(Dog River, Three Mile Creek, and Chickasaw Creek). During portions of the day in 2000, individual DO measurements at these stations fell well below 5 mg/l, while the overall average DO levels at these stations during both surveys was above 5 mg/l; however, this average is significantly affected by the supersaturated conditions also experienced during portions of the deployment. Only the Upper West Bay station during the 2000 survey exhibited an average DO for the monitoring period less than 5 mg/l (4.62 mg/l). With the exception of MB3, the ship channel (SC1) and Mobile Bay stations (MB1, MB2, and MB4) exhibited a relatively narrow range of DO over the monitoring period from about 5 mg/l to 8.5 mg/l. Observed DO was as low as 2.55 mg/l at MB3.

During the 2001 deployment, turbidity concentrations at MR1 ranged from 10 to 32 NTU with an average of 20 NTU. Turbidity at CC and DR was in a slightly more narrow range of 11 - 20 NTU (16 NTU average) and 5 - 13 NTU (8 NTU average), respectively. Turbidity in the middle bay was around the same level as in the tributaries. Specifically, at MB1 turbidity ranged from 5 - 25 NTU with an average of 11 mg/l while MB3 ranged from 4 - 17 NTU with a 7 NTU average. Turbidity in the lower bay (MB4) was significantly higher ranging from 6 - 64 NTU with an average of 31 NTU. Turbidity data for stations MB3 and MB4 were also plotted against water level (tidal stage) at Fowl River and wind speed to determine if turbidity levels in the bay are related to either tides or wind. As shown in Figures 5 and 6, higher turbidity levels occur during lower tide stage. While it was expected that higher wind speed would correlate with higher turbidity levels due to potential resuspension of bottom sediments, the effects of tide stage on turbidity masks any influence by wind.

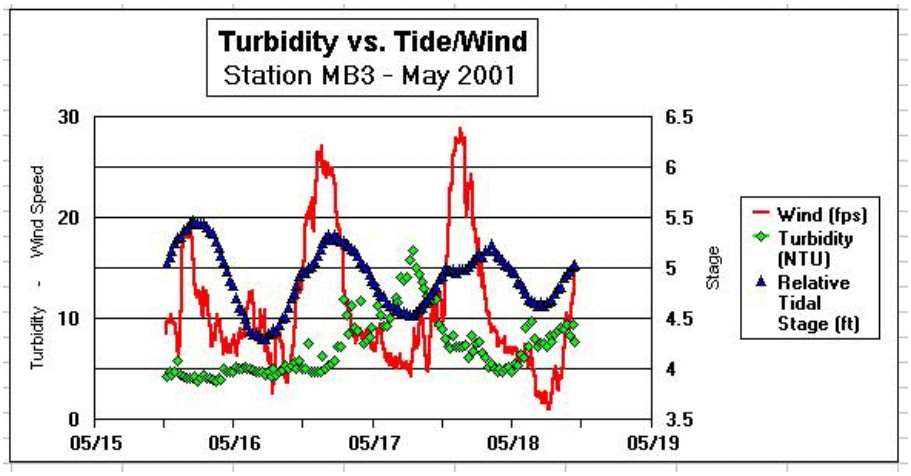

Figure 5 - MB3 Turbidity vs. Tide/Wind

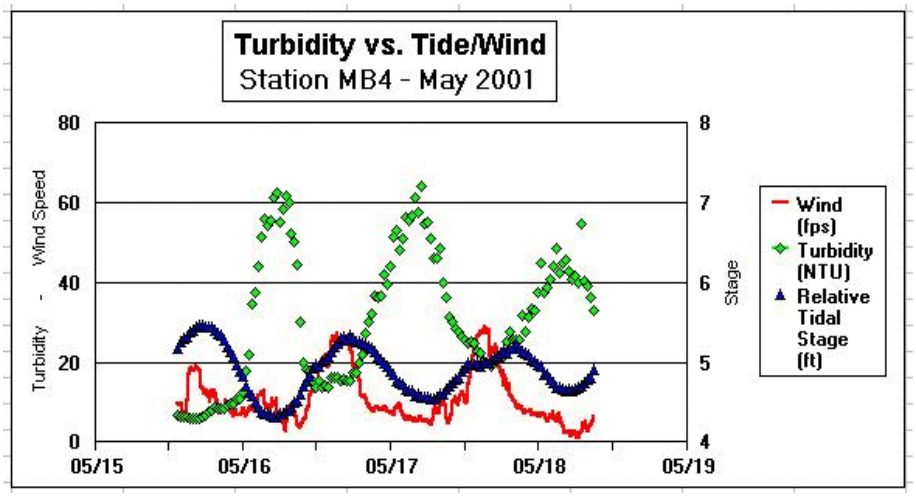

Figure 6 - MB4 Turbidity vs. Tide/Wind

Overall, calibration of continuous recording instruments was successful for both surveys; however, difficulties for specific parameters on a few instruments were encountered. Following the 2001 survey deployment, the instrument at MR1 read 7.90 mg/l for a 7.45 mg/l Winkler

titration standard. The difference, 0.45 mg/l, exceeds the EAB tolerance for dissolved oxygen calibration of 0.2 mg/l. Comparisons between DO reading from this meter and DST profiling DO data at MR1 at approximately the same time and depth show the continuous meter also reading approximately 0.25 mg/l - 0.45 mg/l higher than the profiling meter. Similarly, the instrument at Three Mile Creek read the same Winkler standard (7.45 mg/l) at 7.15 mg/l resulting in a difference of 0.3 mg/l versus EAB tolerance of 0.2 mg/l. Comparisons with DST profile data confirm this slight underreading by the continuous meter. Also following the 2001 deployment, the turbidity probes at stations DR and MB1 read a 100 NTU turibidity standard as 69.6 NTU and 84.9 NTU, respectively. Though of less importance to model development, it should be noted that the pH probes at stations MB2 and MB4 following the 2001 deployment read a 7 pH standard as 8.04 and 7.68 SU, respectively.

Following the 2000 deployment, several meters failed to measure the Winkler DO titration standard within the EAB tolerance possibly due to growth on the instrument DO membrane. Specifically, the instrument at MR1 was off by +1.48 mg/l. There is fairly close agreement between the final continuous DO reading at MR1 and a profiling measurement taken a short time later (difference of 0.22 mg/l); however, for model development and calibration, the modeling team is recommended to rely on the DST profiling data for dissolved oxygen information for the 2000 survey at station MR1. Similarly, the meters at stations CC, TMC, DR, and MB1 deviated from the Winkler standard by +0.60 mg/l, +0.39 mg/l, +0.45 mg/l, and -0.58 mg/l, respectively. While the continuous DO data for these stations may be useful for evaluating the variation in DO throughout a diurnal period, the DST profiling data is the recommended source of field data for model setup and calibration.

Due to tidal effects and stratification, the Diel Curve Method was not applied to the Mobile Bay continuous DO data.

Production/Respiration

In order to determine production and respiration rates, light and dark bottle deployments were conducted in both 2000 and 2001 at six stations including two bay stations (MB2 and MB3), two ship channel stations (SC2 and SC5) and two tributary stations (CC and TMC). Tables 8 and 9 show the result gross primary production and respiration measurement results for 2000 and 2001, respectively.

Table 8 - July 2000 Production/Respiration

Station	Date	Incubation Period	Gross Primary Production (GPP) (g O2/m2/day)	Respiration (R) (g O2/m2/mday)	GPP:R Ratio
SC2	7/13/00	0900-1300	2.77	1.77	1.56
SC5	7/12/00	1415-1715	5.14	5.64	0.91
MB2	7/13/00	1140-1520	1.12	1.04	1.08
MB3	7/14/00	0915-1315	2.05	1.28	1.60
CC	7/15/00	1100-1500	0.62	0.73	0.85
TMC	7/15/00	1240-1600	3.96	2.50	1.59

During the 2000 and 2001 light/dark bottle experiments, samples were collected at multiple depths (3 - 4 depths in the euphotic zone based on marine photometer light profiles) for chlorophyll analysis for the purpose of providing instream chlorophyll data for model calibration. In 2001, chlorophyll samples were also collected at MB4. Tables 10 and 11 show the results of chlorophyll *a* sampling for the 2000 and 2001 surveys, respectively.

Table 9 - May 2001 Production/Respiration

Station	Date	Incubation Period	Gross Primary Production (GPP) (g O2/m2/day)	Respiration (R) (g O2/m2/mday)	GPP:R Ratio
MB2	5/16/01	0840 - 1250	4.23	7.42	0.57
SC2	5/16/01	1000 - 1400	6.80	5.93	1.15
MB3	5/17/01	0920 - 1330	3.73	3.97	0.94
SC5	5/17/01	1105 - 1510	5.64	5.94	0.95
MB4	5/17/01	1225 - 1640	4.74	4.80	0.99
TMC	5/18/01	0900 - 1330	5.04	1.55	3.25
CC	5/18/01	1035 - 1435	5.54	2.40	2.31

In general, chlorophyll concentrations were much higher in 2000 than in 2001, presumably because the 2000 study, conducted in July, took place in the middle of the growing season whereas the growing season was just beginning in 2001. While concentrations for all stations except Three Mile Creek were generally below 12 ug/l in 2001, only station MB2 exhibited concentrations below 12 u/gl at depths less than five feet in 2000. For both survey periods, Three Mile Creek exhibited some of the highest chlorophyll concentrations ranging from 12.1 to 14.6 ug/l in 2000 and from 13 - 40 ug/l in 2001. Concentrations at station SC-2, well downstream of Three Mile Creek, were as high in 2000 as in Three Mile Creek with a range of 37 - 43 ug/l above five feet. Concentrations in the high teens and twenties were observed as far down in the bay as MB3.

Algal Growth Potential Tests (AGPT) were also run on samples collected at the P/R stations in the Mobile Bay study area in order to determine the potential for algal enrichment of the system. AGPT results for each survey are included in Tables 10 and 11. In general, a dry

Table 10 - July 2000 Chlorophyll/AGPT

Date	Station (AGPT, Dry Weight mg/l)) (Limiting Nutrient)	Depth (ft)	Chl *a* (ug/l)
7/12/00	**SC5**	0.5	12
	(2.4)	0.5 (Duplicate)	12
	(Nitrogen)	2.0	12
		5.0	13
		11.0	13
7/13/00	**SC2**	0.5	37
	(3.9)	1.0	43
	(Nitrogen)	2.5	39
		5.5	8
7/13/00	**MB2**	0.5	7.5
	(2.4)	1.5	8.2
	(Nitrogen)	3.0	8.4
		7.0	8.3
		7.0 (Duplicate)	8.2
7/14/00	**MB3**	0.5	24
	(6.0)	1.5	26
	(Nitrogen)	3.0	18
		3.0 (Duplicate)	16
		7.5	19
7/15/00	**TMC**	0.5	29
	(10.3)	1.5	37
	(Nitrogen)	3.0	40
		7.0	13
7/15/00	**CC**	0.5	14
	(2.5)	1.5	15
	(Nitrogen)	3.5	23
		9.0	5.6
		9.0 (Duplicate)	5.3

Table 11 - May 2001 Chlorophyll/AGPT

Date	Station (AGPT, mg/l) (Lim. Nut.)	Depth (ft)	Chl *a* (ug/l)	Date	Station (AGPT, mg/l) (Lim. Nutrient)	Depth (ft)	Chl *a* (ug/l)
5/16/01	**MB2**	0.5	8.7	**5/17/01**	**SC5 -Continued-**	3	3.7
	(2.4)	1	5.8		(1.5)	6.5	6.1
	(Nitrogen)	3	8.0		(Nitrogen)	13	8.7
		8	11.9	**5/17/01**	**MB4**	0.5	5.4
5/16/01	**SC2**	0.5	7.1		(1.4)	1.5	6.8
	(1.1)	0.5 (Duplicate)	7.1		(Nitrogen)	1.5 (Duplicate)	7.0
	(Nitrogen)	1.5	5.9			2.5	8.3
		4	7.8			6	9.0
		8	4.8	**5/18/01**	**TMC**	0.5	12.1
		8 (Duplicate)	5.0		(25.0)	1	13.1
5/17/01	**MB3**	0.5	4.4		(Nitrogen)	2	14.6
	(1.5)	1.5	4.2			4	12.4
	(Not determined)	1.5 (Duplicate)	4.2			4 (Duplicate)	13.4
		2.5	4.6	**5/18/01**	**CC**	1	12.8
		5.5	10.1		(8.2)	0.5	9.1
		5.5 (Duplicate)	9.4		(Nitrogen)	1	9.3
		10.5	11.6			3	8.4
		10.5 (Duplicate)	11.1			6.5	7.6
5/17/01	**SC5**	0.5	2.8			6.5 (Duplicate)	7.7

weight AGPT greater than 10 mg/l is considered an indication of enrichment in marine waters. For both the 2000 and 2001 surveys, AGPT exceeded 10 mg/l only at the Three Mile Creek station (TMC) with the remaining stations all below 10 mg/l indicating little enrichment in the Mobile Ship Channel or Bay. For all stations, nitrogen was determined to be the limiting nutrient.

Diffusion/Reaeration

As part of the July 2000 survey, diffusion measurements were made at two locations in order to determine an equivalent reaeration rate. Diffusion measurements for the Mobile surveys utilized SESD/EAB's floating dome technique. The first measurement was made on July 14, 2000 in Dog River about two miles upstream of its mouth with a resulting reaeration rate of 0.15 1/day. The second measurement took place on July 16, 2000 in Chickasaw Creek about 1.25 miles upstream from its mouth. Using a depth of 7 meters based on observed stratification, the resulting reaeration rate is 3.5 1/day; however, if a calculation is made using the entire water depth at the measurement location of 10 meters, the resulting rate is 2.5 1/day.

In addition to dome method diffusion measurements, two gas/tracer reaeration studies were conducted in Mobile Bay on July 13 south of SC-2 and on July 15, 2000 at MB1 (See Figure 7). Utilizing krypton gas and Rhodamine WT dye, water samples were collected for krypton analysis from the observed peak of the dye cloud over a period in excess of 4 hours. The resulting gas reaeration rates were 1.82 1/day at 20^{o} C on July 13 and 5.74 1/day at 20^{o} C on July 15. Figures 8 and 9 show the prevailing currents and winds during the July 2000 gas/tracer reaeration measurements.

During the May 2001 survey, a gas/tracer reaeration measurement was again made in Mobile Bay southwest of SC-2 (See Figure 7). The resulting reaeration rate was found to be 2.37 1/day at 20^{o} C. Prevailing wind/current vectors during this effort are shown in Figure 10. Also, concurrent with the gas reaeration measurement, a floating dome diffusion measurement was made in the same portion of the bay. The resulting rate of 3.86 1/day (at ambient temperature) was in good agreement with the calculated reaeration rate at ambient temperature (3.20 1/day at 32.7^{o} C).

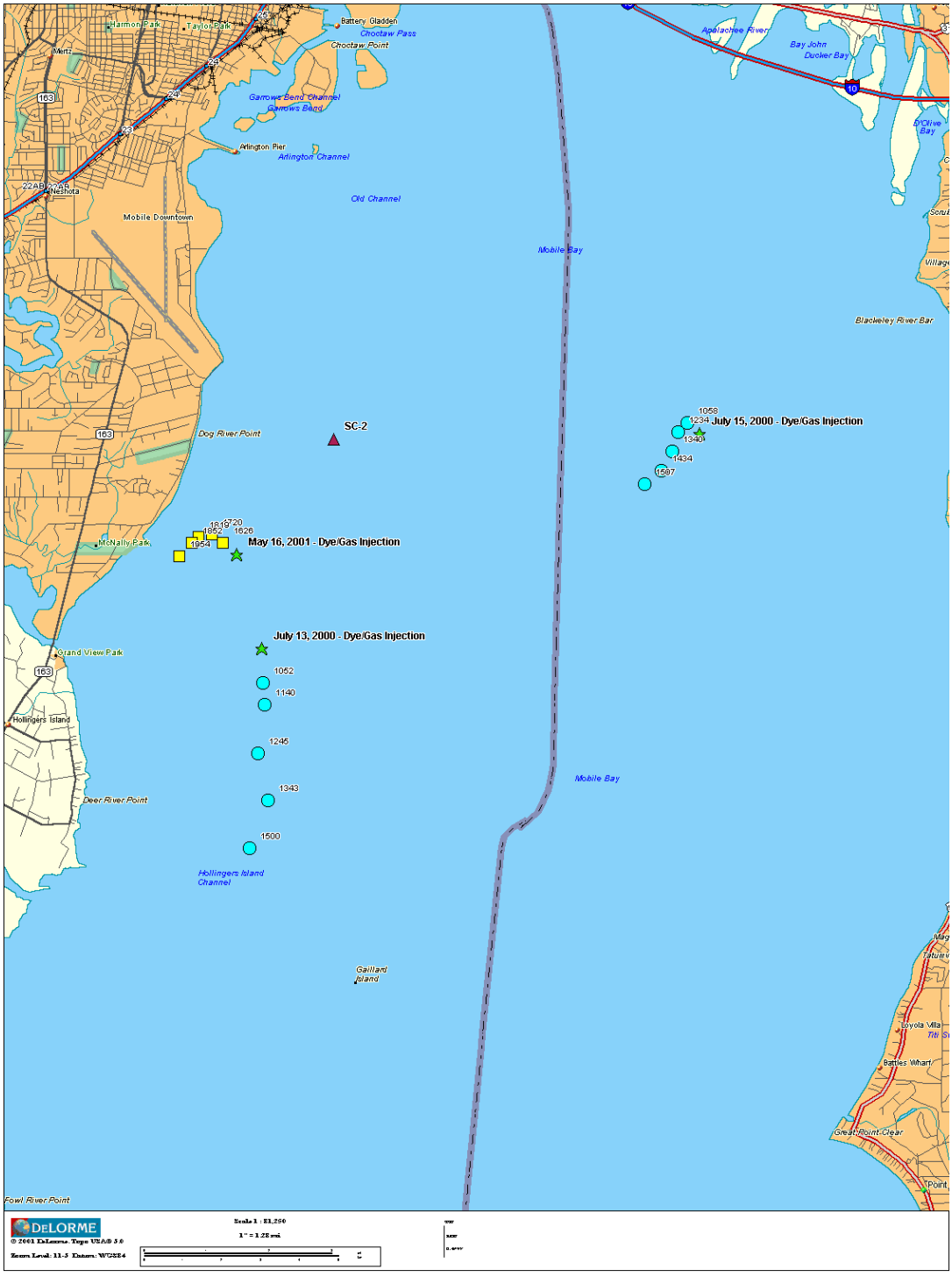

Figure 7 - Gas/Tracer Study Locations

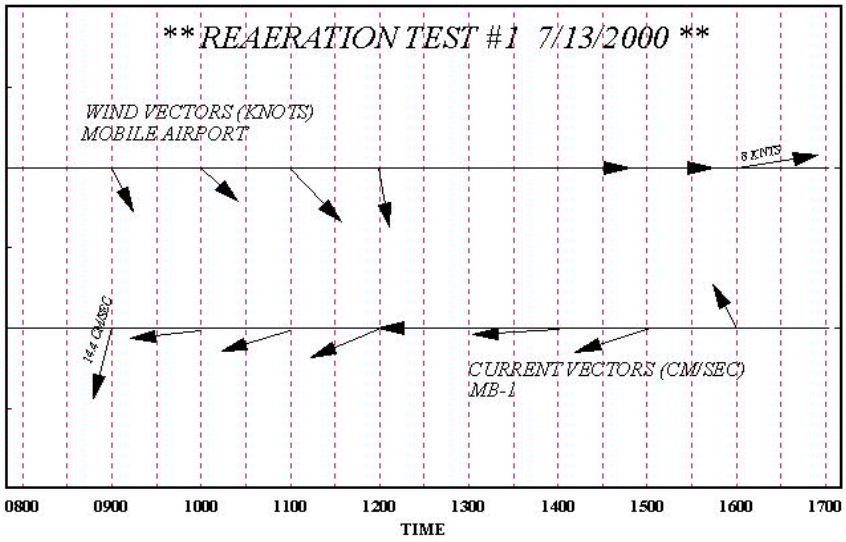

Figure 8 - 7/13/00 Reaeration Wind/Current Vectors

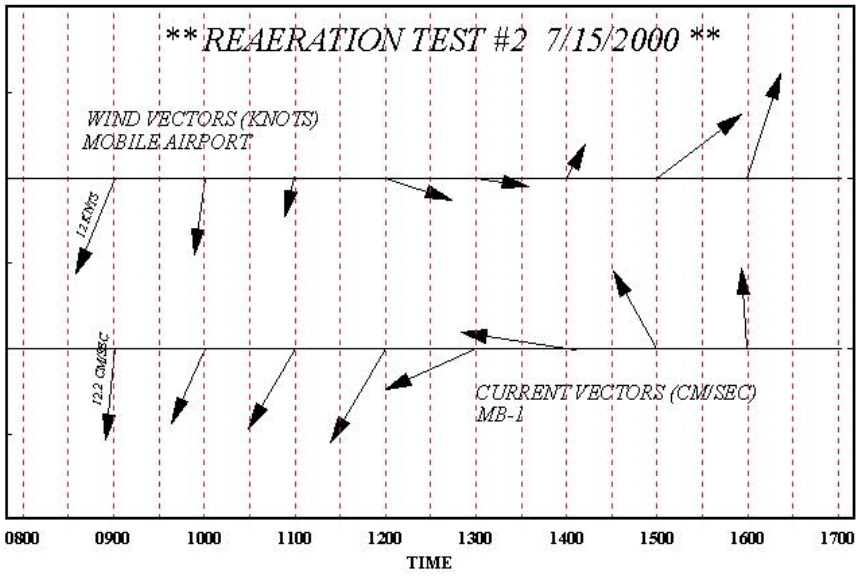

Figure 9 - 7/15/00 Reaeration Wind/Current Vectors

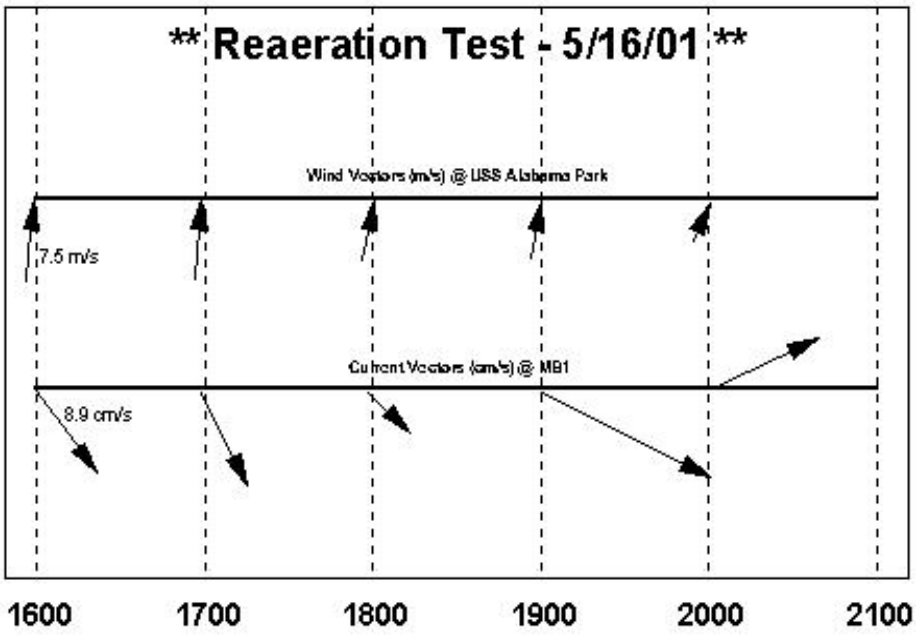

Figure 10 - 5/16/01 Reaeration Wind/Current Vectors

Hydrological/Meteorological Data

At the planning stage for this project, the Water Management Division indicated that sufficient data existed for the development of a hydrodynamic model of the bay and only limited hydrodynamic data would be needed to link the water quality datasets to a hydrodynamic model. In addition, NOAA provides tide stage and current data for several locations in Mobile Bay which could provide supplemental information for hydrodynamic modeling. As a result, only limited hydrological data was collected during the 2000 and 2001 surveys. Hydrological data collected during these surveys includes current direction/velocity and stage (water level). Meteorological data includes wind speed/direction, and solar radiation collected in association with production/respiration measurements.

In 2000, bay current speed and direction was measured at 10 minute intervals over a 3 day

period at stations MB3 and MB4 and over a 5 day period at station MB1. At each station, the current meter was deployed at middepth in the water column. In 2001, current meters were again deployed at these stations at middepth over a 3 day period with a 10 minute measurement interval. Also in 2001, a meter was located at middepth at station MS0. Figures 11-17 provide oyster plots of current speed and direction as well as time series plots including temperature and salinity for each station.

For both the 2000 and 2001 surveys, water level recorders were deployed at the Dog River and Fowl River Marinas for the duration of the studies. Graphs of the water level data are provided in Figures 18-21. Water level elevations at the Fowl River Marina are referenced to National Geodetic Vertical Datum (NGVD) through a NOAA tidal benchmark located at the marina. No benchmark was available at the Dog River location, therefore these elevations are reported relative to the mean water level for the record period.

In 2000 and 2001, wind speed and direction was measured at ten minute intervals at the USS Alabama park located in the north portion of the Bay. Wind data are shown graphically in Figures 22 and 23.

Problems were encountered with the EPA rain gage during the 2000 survey; however, data obtained from the Mobile airport indicates 0.59" of rain fell on the afternoon of July 11 followed by 0.82" on the afternoon of July 16, 2000. No rainfall occurred at the SESD rain gage during the 2001 survey.

Finally, solar radiation was measured on each day of production/respiration measurement by recording pyroheliometer. A planimeter was then used to determine the amount of incident solar radiation recorded on chart paper for each day of deployment. Table 12 provides the daily solar radiation in Langleys for each production/respiration measurement.

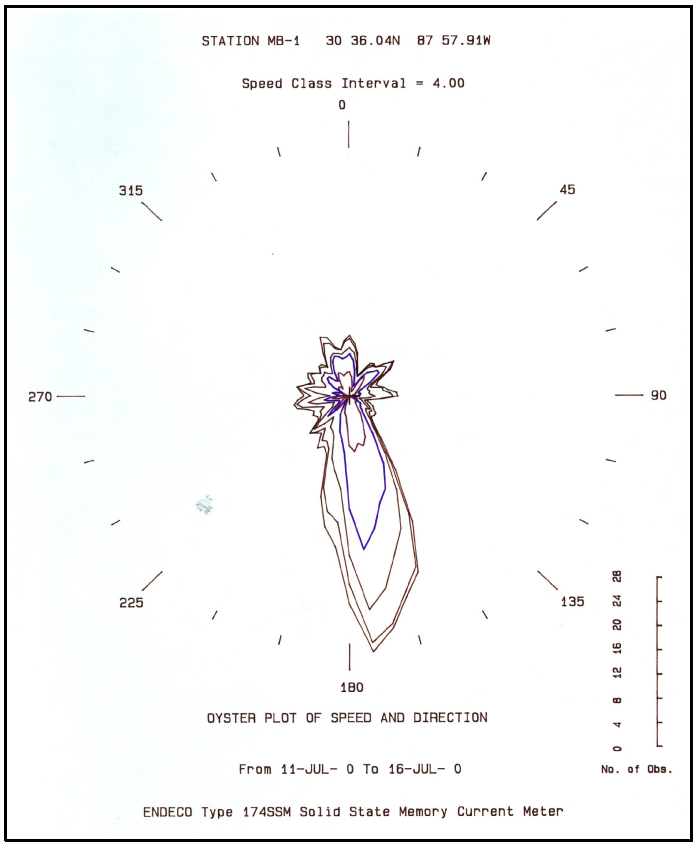

Figure 11a - July 2000 - MB1 Oyster Plot

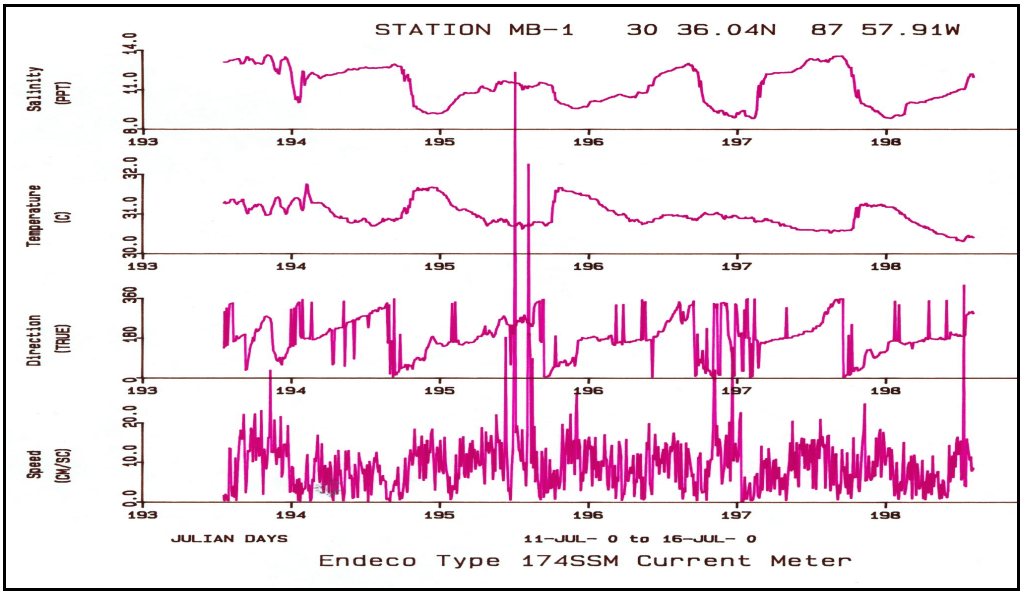

Figure 11b - July 2000 - MB1 Time Series Plots

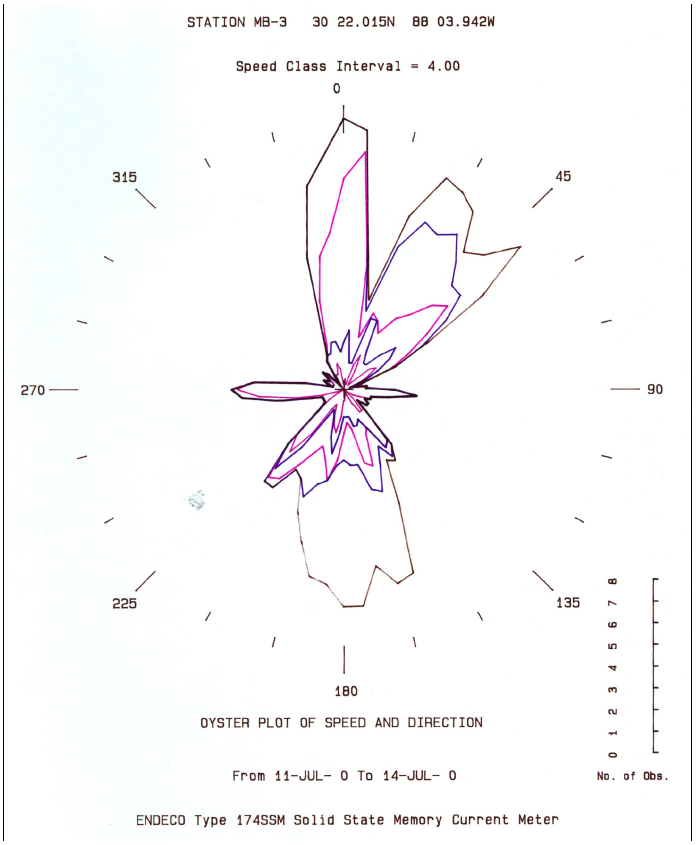

Figure 12a - July 2000 - MB3 Oyster Plot

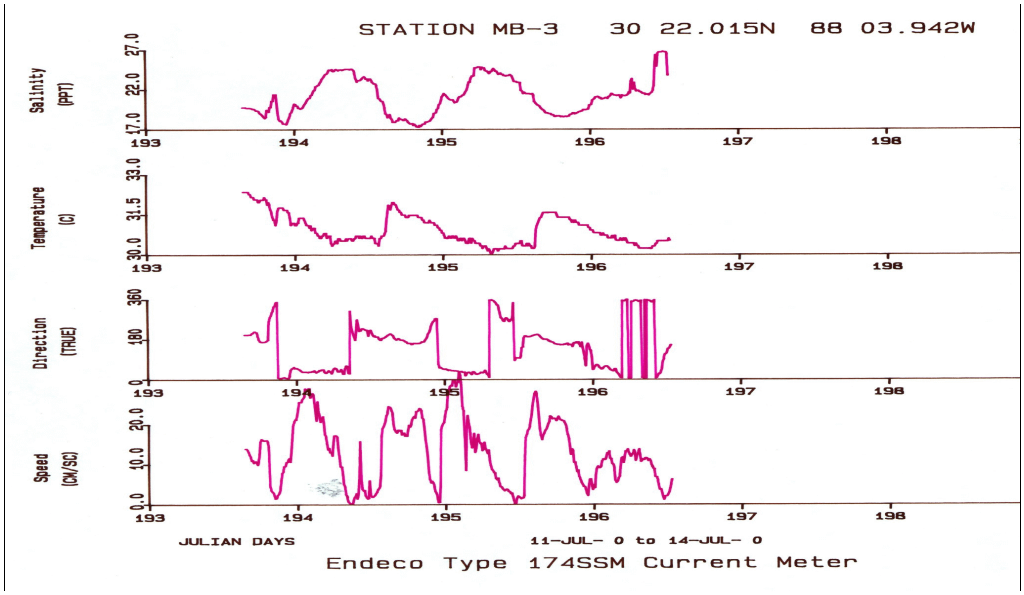

Figure 12b - July 2000 - MB3 Time Series Plot

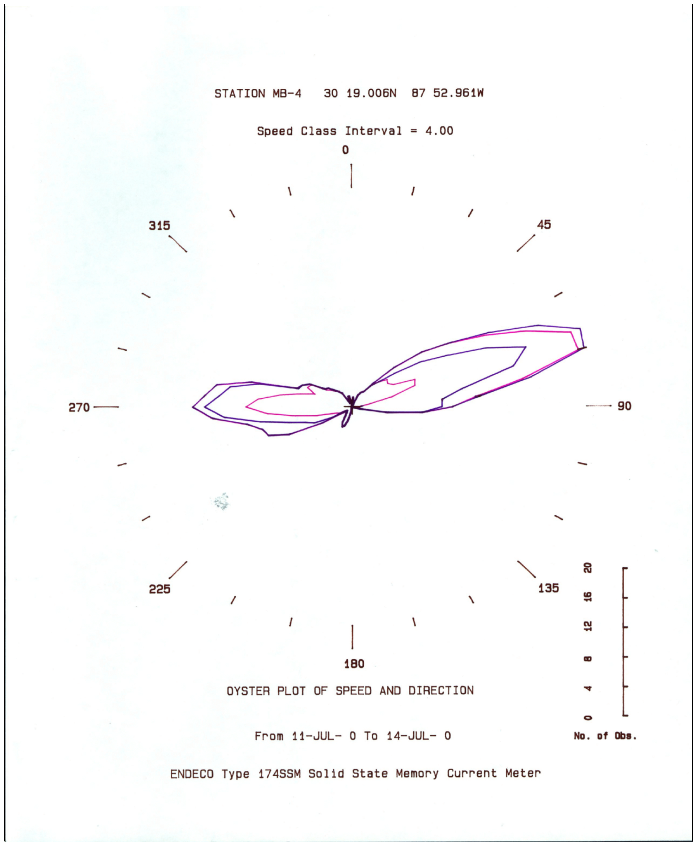

Figure 13a - July 2000 - MB4 Oyster Plot

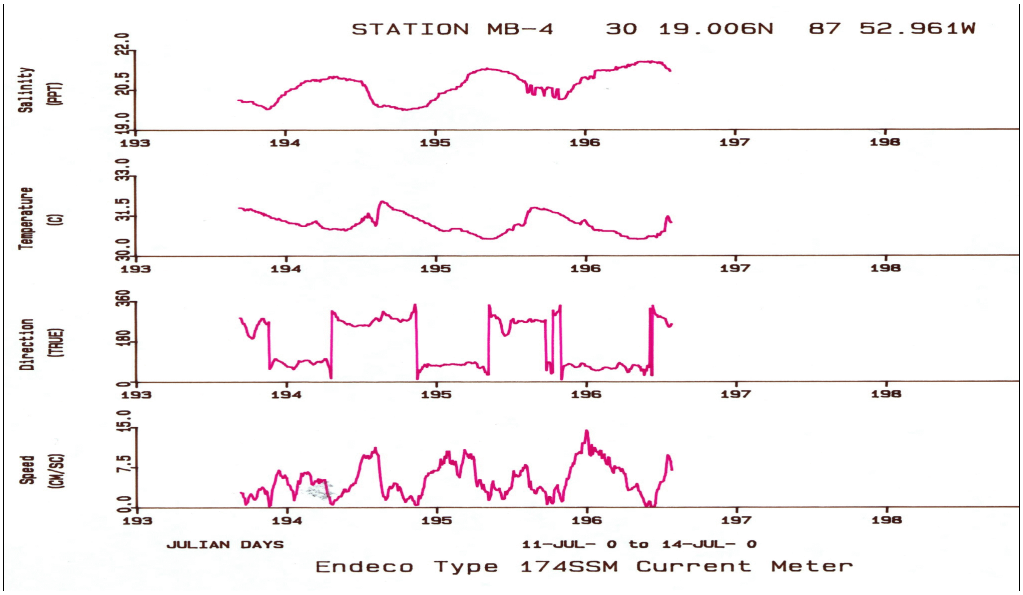

Figure 13b - July 2000 - MB4 Time Series Plot

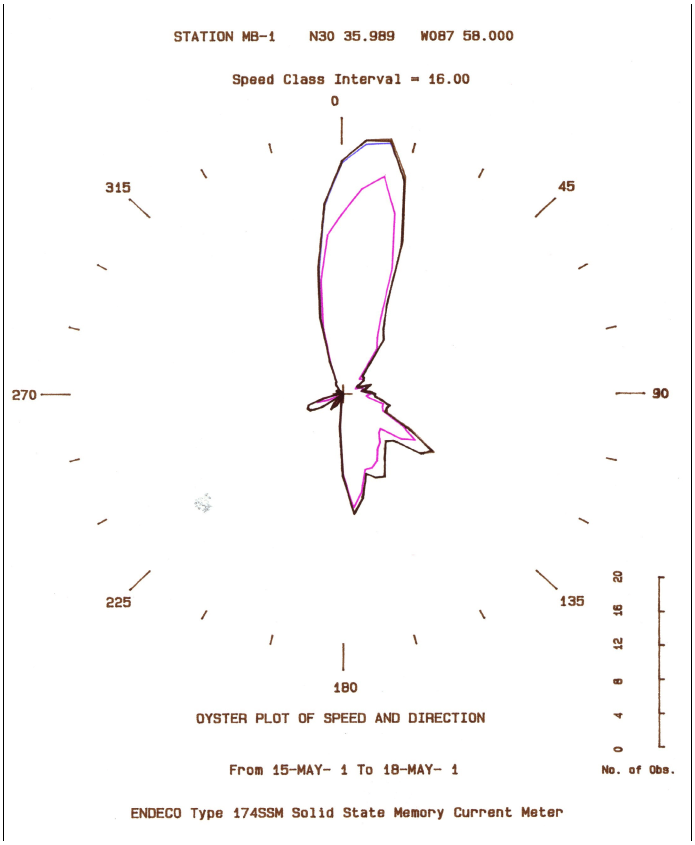

Figure 14a - May 2001 - MB1 Oyster Plot

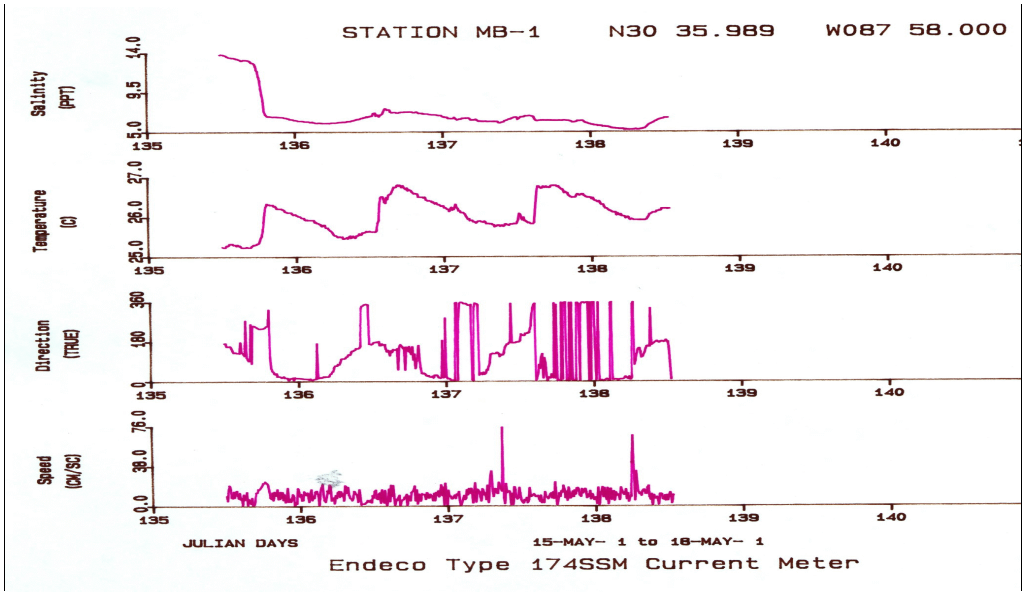

Figure 14b - May 2001 - MB1 Time Series Plot

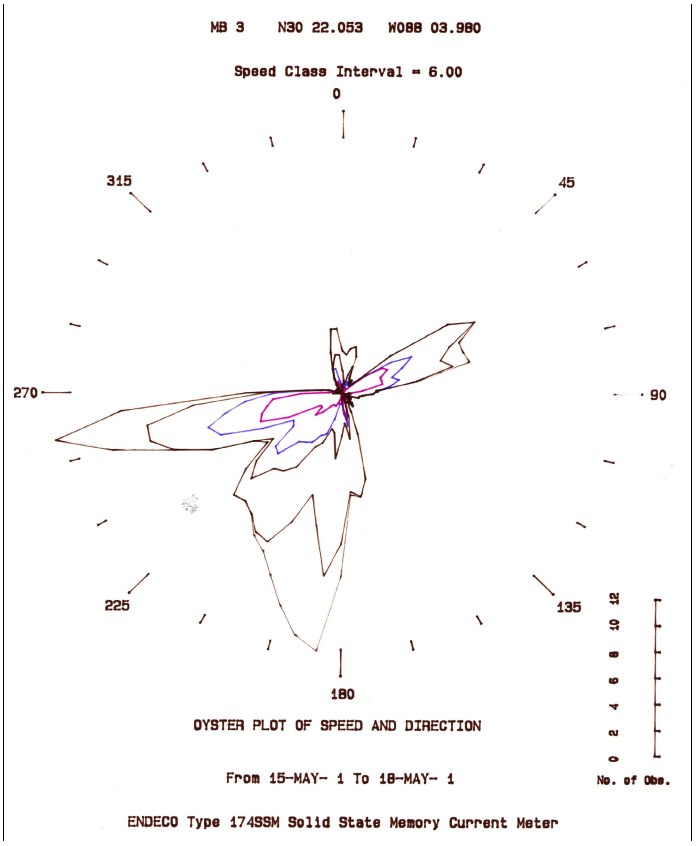

Figure 15a - May 2001 - MB3 Oyster Plot

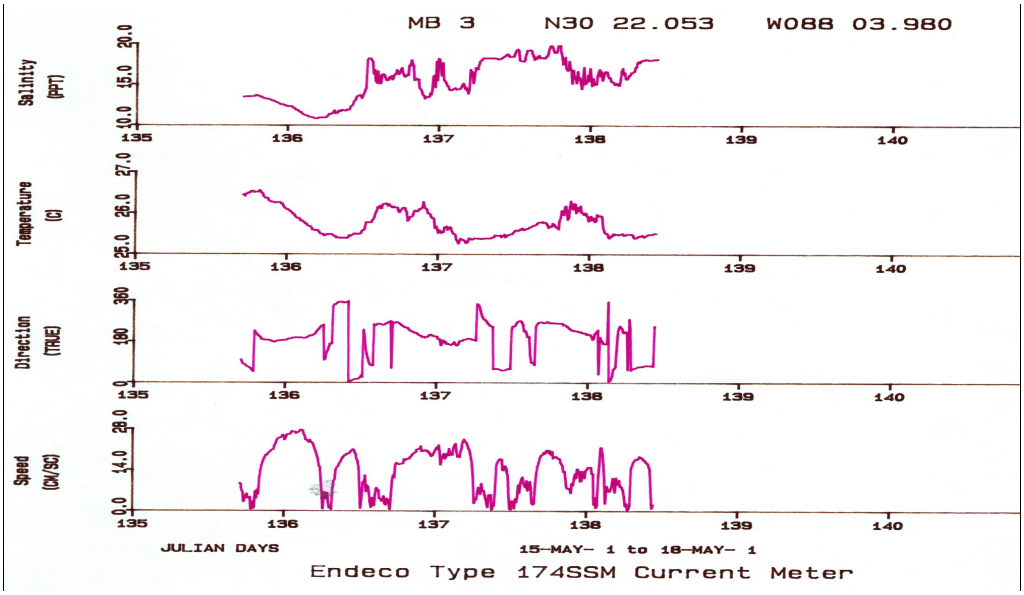

Figure 15b - May 2001 - MB3 Time Series Plot

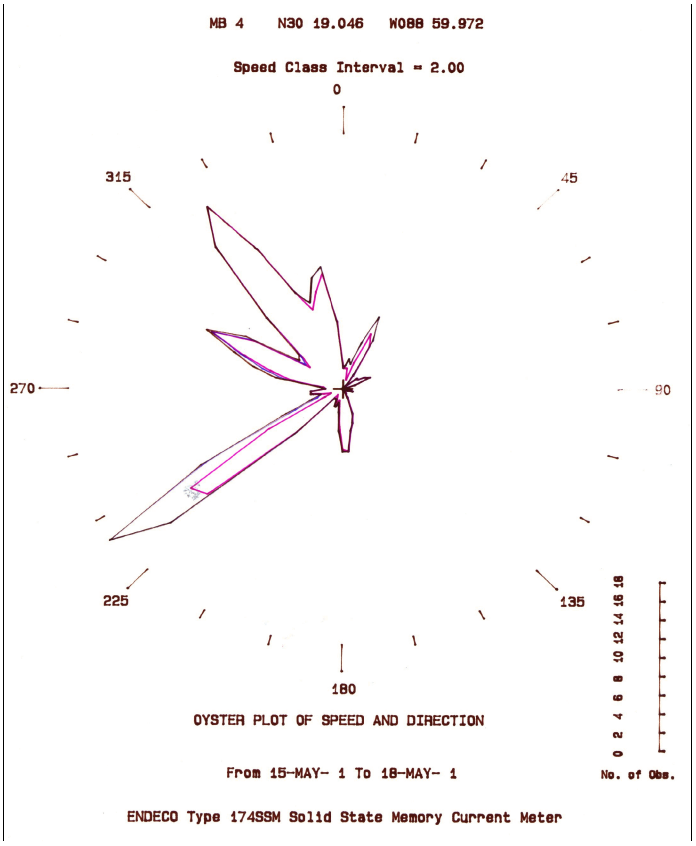

Figure 16a - May 2001 - MB4 Oyster Plot

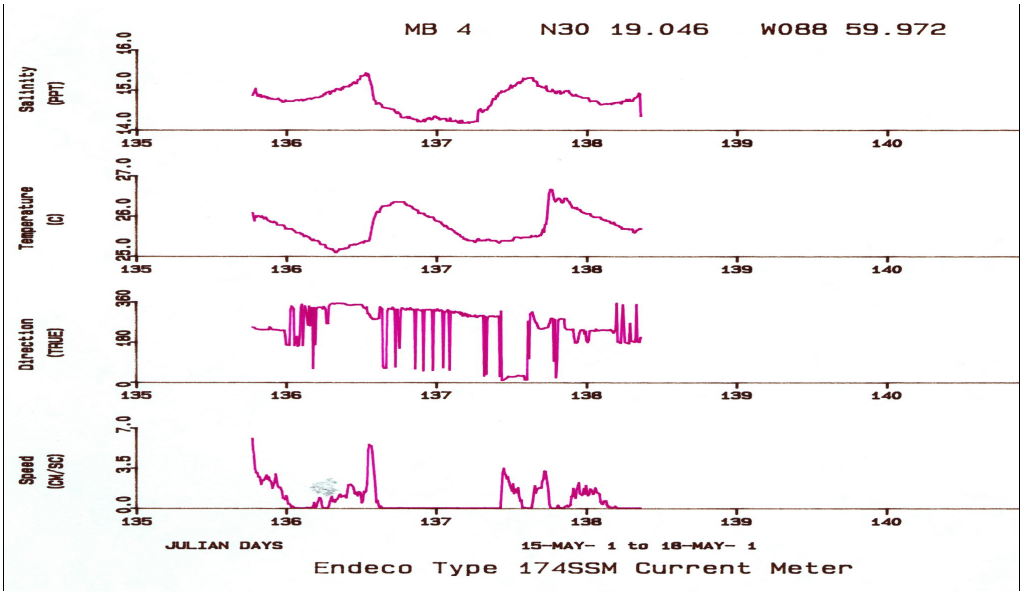

Figure 16b - May 2001 - MB4 Time Series Plot

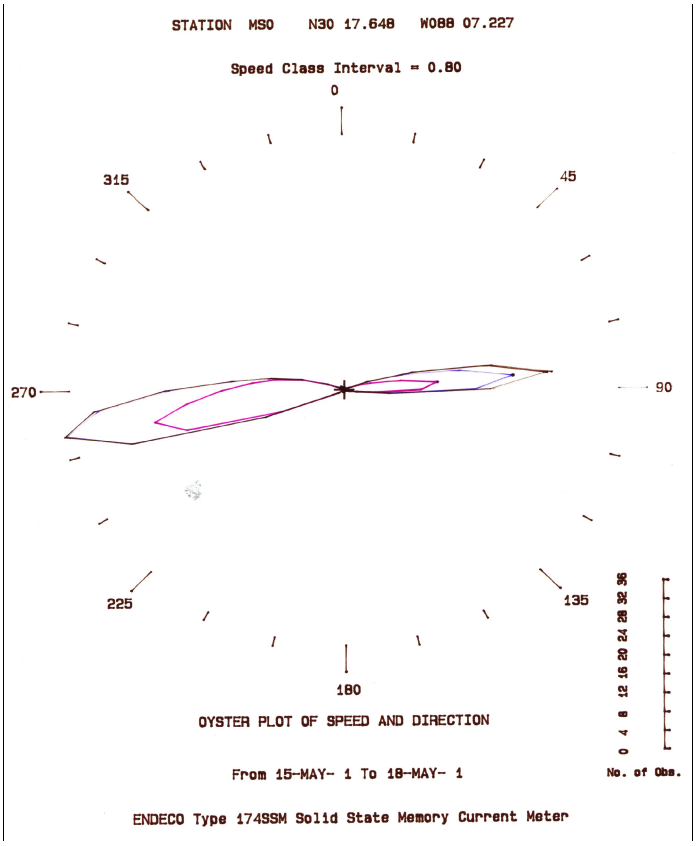

Figure 17a - May 2001 - MS0 Oyster Plot

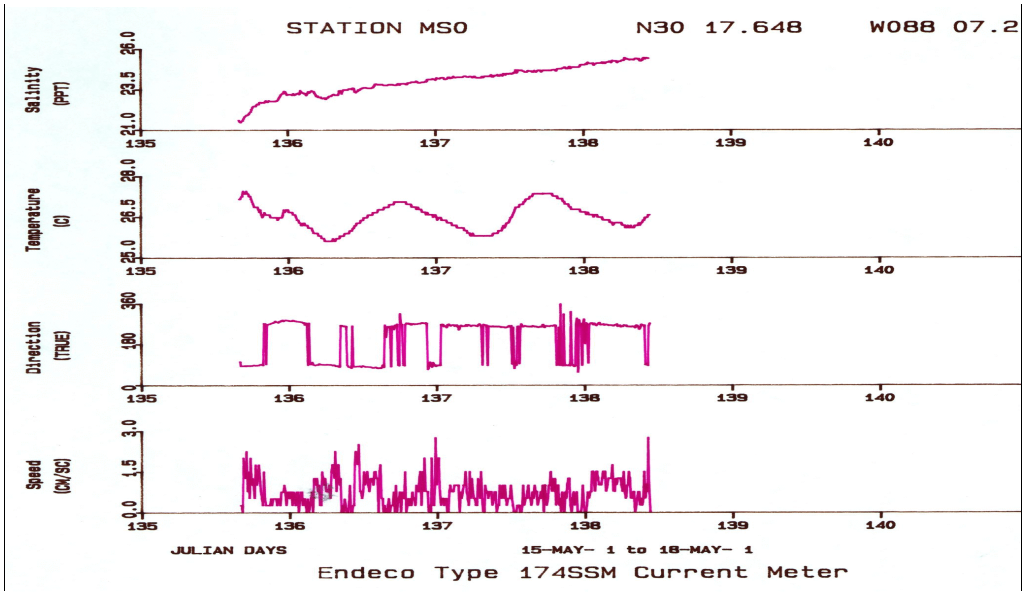

Figure 17b - May 2001 - MS0 Time Series Plot

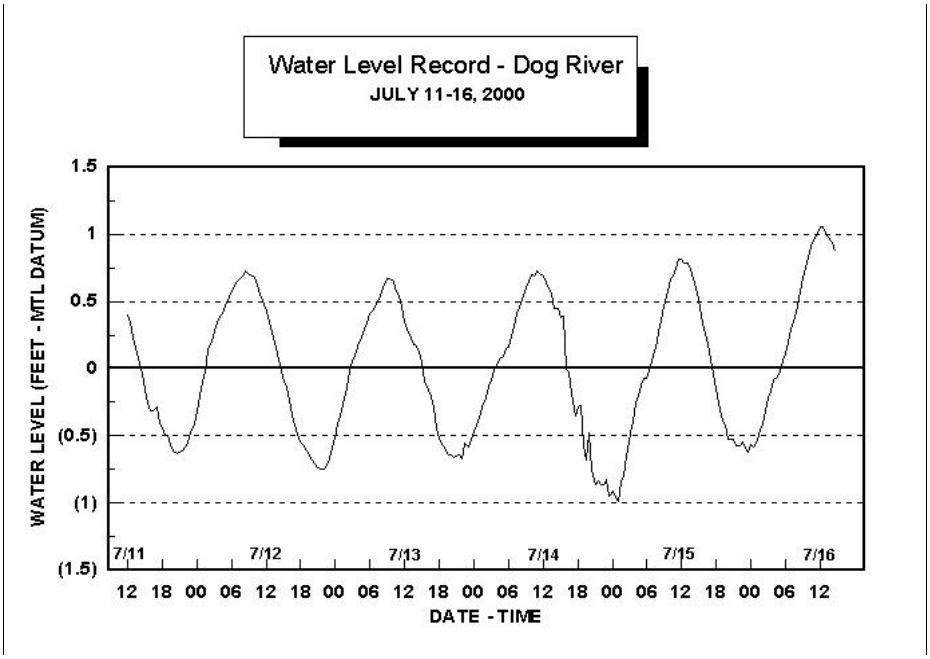

Figure 18 - July 2000 Water Level - Dog River

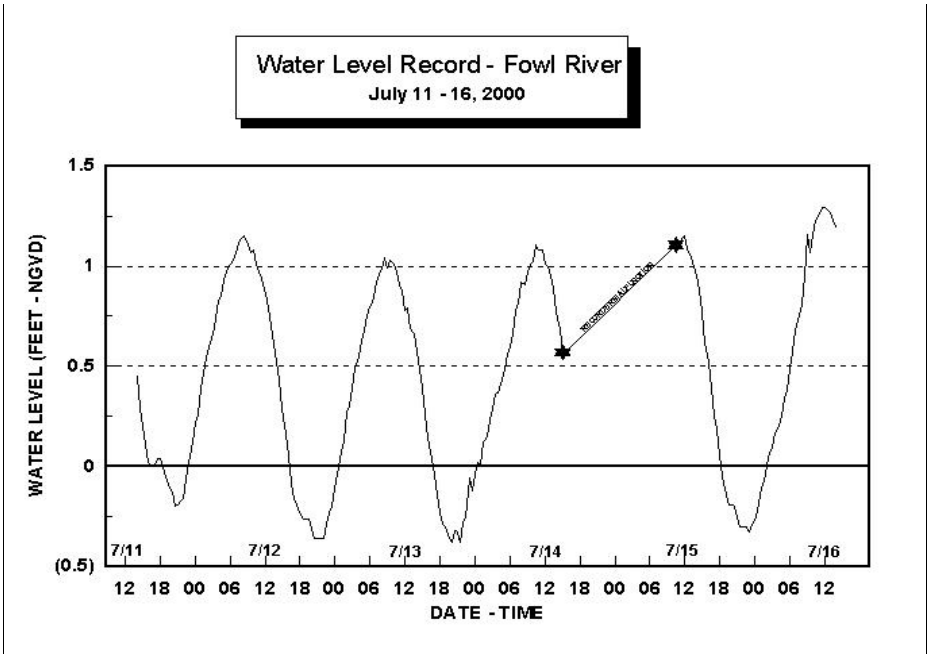

Figure 19 - July 2000 Water Level - Fowl River

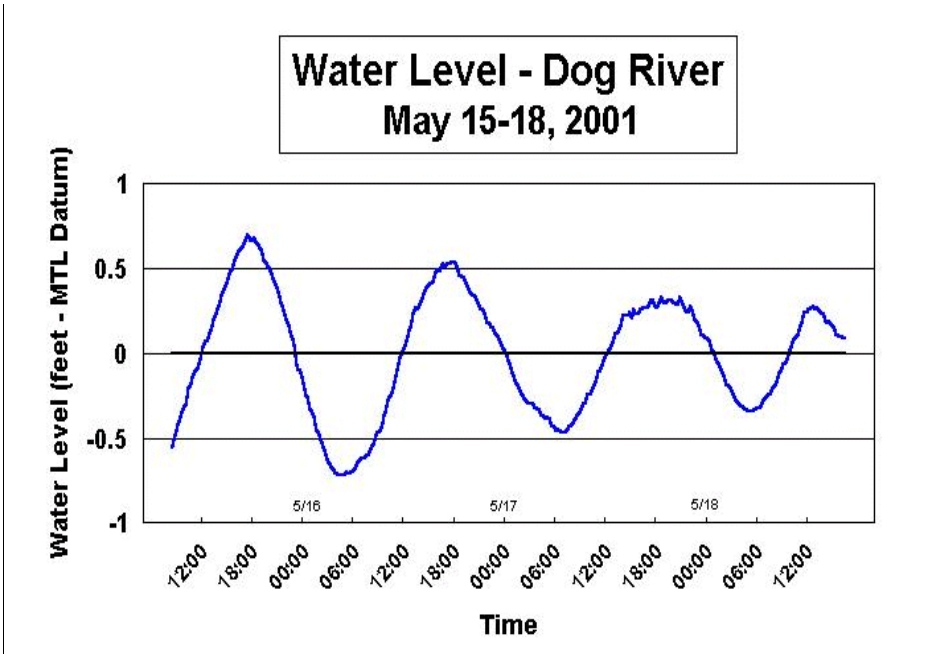

Figure 20 - May 2001 Water Level - Dog River

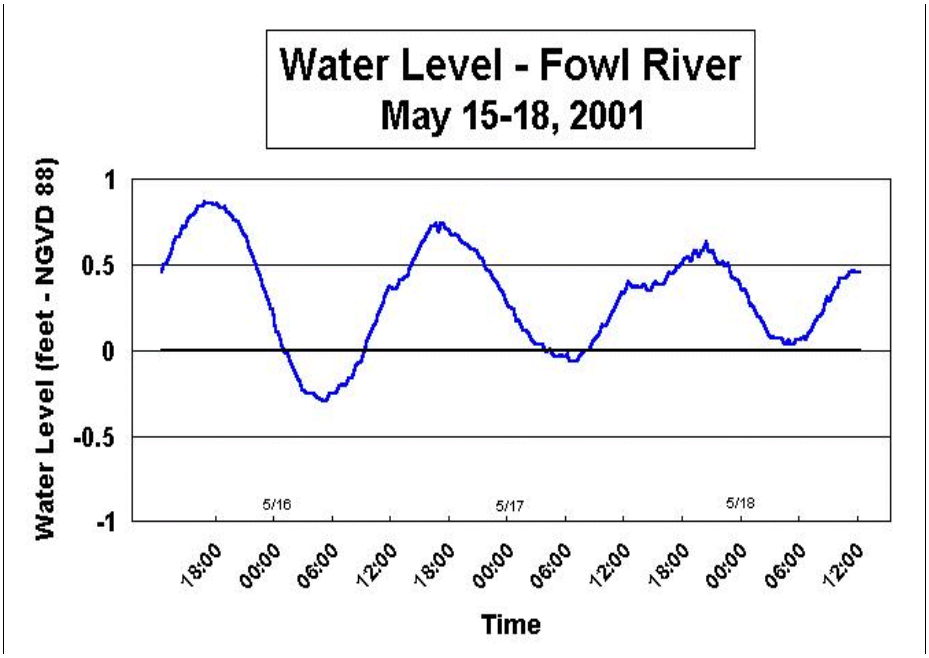

Figure 21 - May 2001 Water Level - Fowl River

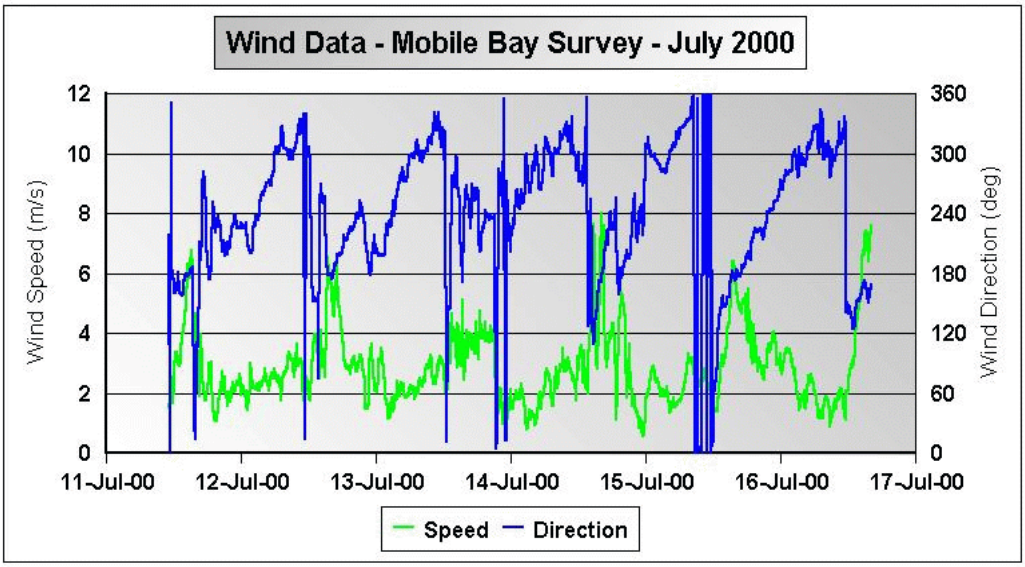

Figure 22 - July 2000 Wind

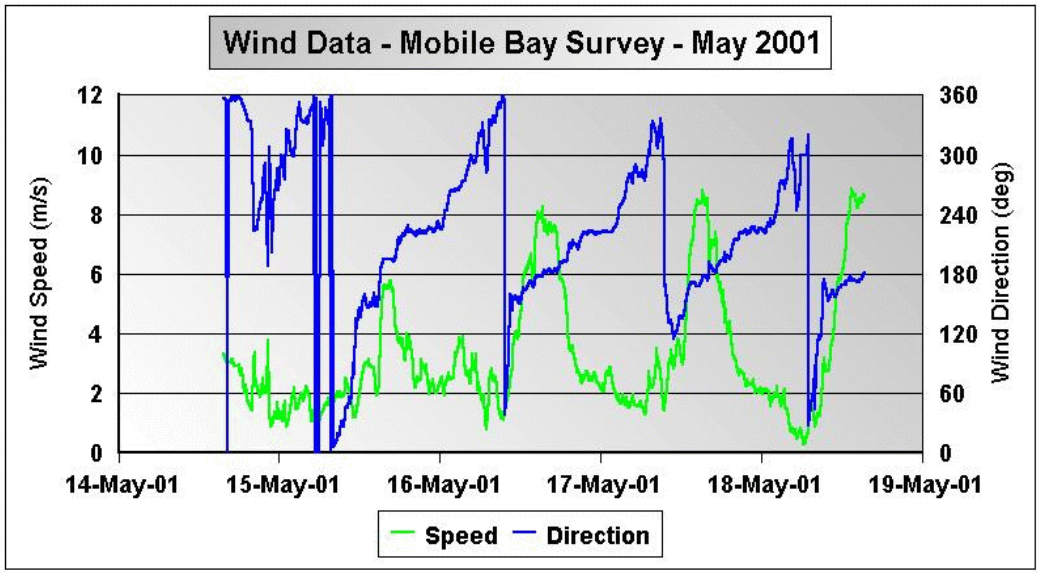

Figure 23 - May 2001 Wind

Table 12 - Solar Radiation

Date	Radiation (Langleys)
7/12/00	489
7/13/00	526
7/14/00	399
7/1500	609
5/16/01	567
5/17/01	579
5/18/01	366

Sediment Oxygen Demand

During the July 2000 survey, sediment oxygen demand (SOD) measurements were made at five locations in the Mobile Bay study area. In 2001, SOD rates were measured at seven locations. SOD measurements were made using four replicate chambers at each station and an average SOD was determined for each station. Table 13 provides the resulting SOD rate for each station. These rates are corrected for water column respiration, which is also measured using two replicate chambers, and are reported at ambient temperature.

As shown in Table 13, SOD rates were measured at the four Mobile Bay water quality sampling stations and in the bay near the entrance to Dog River in 2000. SOD rates for the bay water quality stations were in a fairly narrow range from approximately 1.5 to 3.0 $gO_2/m^2/day$ with rates slightly higher in the lower bay (MB3 and MB4) than in the upper bay (MB1 and MB2). The station near Dog River also fell in this range with a rate of 1.7 $gO_2/m^2/day$. In addition to these stations, stations were added in Mobile Bay near the entrance to Fowl River and

Table 13 - SOD Rates

Station	Date	SOD ($gO_2/m^2/day$)	Temperature (°C)	Diver Observations
Mobile Bay near Dog River entrance	7/11/2000	1.70	31.5	11' Deep Fine Sandy Muck
MB1	7/12/2000	1.84	30.8	13' Deep Fine Sandy Muck
MB2	7/12/2000	1.53	30.6	13' Deep Fine Sandy Muck
MB3	7/13/2000	3.00	30.4	15' Deep Mucky Fine Sediment
MB4	7/13/2000	2.66	31.1	13' Deep Mucky Fine Sediment
Mobile Bay near Dog River entrance	5/18/2001	1.27	27.3	12' Deep Silty Clay w/ Shell Fragments
Mobile Bay near Fowl River entrance	5/17/2001	1.31	25.6	14' Deep Brown Silt
Mobile Bay near Mobile River mouth	5/16/2001	3.15	27.7	8' Deep Sandy Silt
MB1	5/18/2001	1.47	26.2	13' Deep Brown Silty Clay
MB2	5/17/2001	1.97	25.7	13' Deep Brown Silt
MB3	5/16/2001	1.35	25.6	14' Deep Grey Mucky Fine Sediment
MB4	5/15/2001	1.83	25.2	12' Deep Brown Flock over Grey Mucky Fine Sediment

below the mouth of the Mobile River for the 2001 survey. A planned measurement in the Mobile River above Chickasaw Creek could not be completed due to conditions at the time. Overall, SOD rates were lower in 2001 than in 2000. As in 2000, the bay water quality stations as well as the station near Fowl River fell in a narrow, though slightly lower, range from 1.3 to 2.0

$gO_2/m^2/day$. The bay station near Dog River was near this range at just below 1.3 $gO_2/m^2/day$. The station below the Mobile River, however, was somewhat higher than the other stations measured in 2001.

Point Source Sampling

For purposes of the model calibration/verification surveys, the Water Management Division identified three point sources of interest. Specifically, WMD requested sampling data for International Paper, Kimberly Clark, and Mobile/Clifton Williams WWTP. International Paper discharges to the Mobile River approximately 1.25 miles upstream of Chickasaw Creek while Kimberly Clark discharges to the Mobile River roughly 3/4 mile upstream of Chickasaw Creek. The Mobile WWTP outfall is located at the north end of Mcduffie Island and discharges to the Mobile River very near its mouth. Figure 24 shows these locations within the study area.

In addition to the facilities of interest to the Water Management Division, sampling was conducted at the Mobile/Three Mile Creek (W. Smith) WWTP and the Prichard WWTP to allow these facilities to be easily integrated into the water quality model if they were later determined to be of significance to wasteload allocation or total maximum daily load determinations. Sample collection and insitu measurements were performed by survey participants from the Alabama Department of Environmental Management's Mobile office. Tables 14 and 15 provide the results of the effluent sampling and insitu measurements for the 2000 and 2001 surveys, respectively.

Effluent samples collected were 24 hour composite samples. Flows reported in Tables 14 and 15 represent the flow from each facility over the 24 hour compositing period. According to ADEM, in December 2000 International Paper shut down its Mobile facility thus resulting in a decrease in flow between the 2000 and 2001 studies from 27.5 MGD to 0.69 MGD. Also, in

Figure 24 - Point Source Locations

Table 14 - July 2000 Point Source Sampling Results

	International Paper	Kimberly Clark	Mobile/ Williams WWTP	Mobile/ Smith WWTP	Prichard WWTP
NPDES #	AL0002780	AL0002801	AL0023086	AL0023094	AL0023205
Date	7/12/00	7/12/00	7/12/00	7/12/00	7/12/00
Time	1140	1325	1235	1130	1145
Flow (MGD)	27.5	34.4	20.6	10.2	1.0
DO (mg/l)	0.2	8.84	7.22	6.0	7.8
Temp. (^oC)	36.1	33	30.5	29.6	28.7
pH (SU)	7.7	8.4	6.6	6.7	7.4
Conductivity (uMho)	1960	735	12180	50700	52200
Total BODU (mg/l)	192.3	42.1	105.8	56.9	22.9
CBOD5 (mg/l)	25 J	4.7 J	2.0 UJ	6.8 J	2.0 UJ
NH3-N (mg/l)	0.566	3.20	15.6	2.82	1.36
NO2/NO3 (mg/l)	0.050 U	0.293	0.484	12.1	0.074
TKN (mg/l)	9.3	5.99	17.0	6.48	2.76 J
Tot. Phosphorus (mg/l)	3.09	1.42	2.62	3.28	1.60
Diss. Phosphorus (mg/l)	0.28	1.24	2.08	2.80	1.45

A - Average Value; J - Estimated Value; U - material analyzed for but not detected; BODU is corrected for dilution.

Table 15 two values are shown for ultimate BOD and CBOD5 results. The first number of each pair represents the analytical result corrected for dilution for a sample comprised of 10% effluent sample and 90% laboratory dilution water. The second value in the pair is the analytical result corrected for dilution for a 25% effluent sample. The time reported in each table is the end time for sample compositing and the time at which insitu measurements were made.

Table 15 - May 2001 Point Source Sampling Results

	International Paper	Kimberly Clark	Mobile/ Williams WWTP	Mobile/ Smith WWTP	Prichard WWTP
NPDES #	AL0002780	AL0002801	AL0023086	AL0023094	AL0023205
Date	5/16/01	5/16/01	5/16/01	5/16/01	5/16/01
Time	0840	0750	0740	0900	0800
Flow (MGD)	0.69	34.1	20.2	9.38	1.41
DO (mg/l)	6.9	10.6	7.5	7.7	8.2
Temp. (°C)	26	28	25	25	23
pH (SU)	7.8	8.5	6.6	6.7	7.5
TOC (mg/l)	47	14	29	17 J*	12
Total BODU (mg/l) (10%/25%)	22.1/26.0	42.3/39.8	135.1/134.5	24.4/36.1	20.4/19.0
CBOD5 (mg/l) (10%/25%)	12/6.3	12/8.6	19/18	15/11	8.8/7.6
NH3-N (mg/l)	0.47	2.20	20	1.3	0.46
NO2/NO3 (mg/l)	0.50	4.8	0.050 U	16	0.052
TKN (mg/l)	4.9	5.2	23	3.4	2.1
Tot. Phosphorus (mg/l)	1.3	0.92	3.0	2.3	0.96
Diss. Phosphorus (mg/l)	1.3	0.90	2.9	2.3	0.80

A - Average Value; J - Estimated Value; U - material analyzed for but not detected; * - Holding time exceeded due to instrument malfunction.

BODU results reported by the laboratory are corrected for dilution (% sample shown in paranthese).

According to EPA's Envirofacts Warehouse website, International Paper and Kimberly Clark have National Pollutant Discharge Elimination System (NPDES) permit limits for only two water quality parameters measured by EPA during the two intensive surveys. Both facilities must maintain a pH between 5 and 9 standard units while International Paper has an effluent temperature limit of 95 °F (35 °C) and Kimberly Clark has an effluent temperature limit of 100 °F

(37.8 °C). International Paper slightly exceeded the temperature limit in 2000; otherwise, the remaining measured temperatures and pH for these facilities were in compliance with NPDES limits. Of the parameters measured during these surveys, the Envirofacts site indicates that the Mobile/Williams WWTP is required to maintain a pH between 6 and 9 standard units and a BOD5 less than 30 mg/l. Both these limits were met during both surveys. Finally, the Envirofacts site shows effluent limitations on the Mobile/Smith WWTP and Prichard WWTP for BOD5 (15 mg/l), ammonia-nitrogen (5 mg/l), dissolved oxygen (5 mg/l), and pH (6 - 9 SU). These effluent limitations were met during both intensive surveys at both facilities.

Conclusion

The Mobile Bay water quality surveys conducted in July 2000 and May 2001 successfully obtained the necessary water quality data and information to enable the Water Management Division to calibrate and verify a 3-dimensional, dynamic water quality model of the bay. Significant profiling both longitudinally and laterally in the bay and tributaries coupled with extensive continuous meter coverage provides a comprehensive picture of dissolved oxygen, salinity, and temperature within the bay and tributaries. Comprehensive water quality sampling of ambient water and point sources along with specialized studies of bay oxygen dynamics including reaeration, production/respiration, and sediment oxygen demand provide a vast amount of data and information in support of model calibration and verification. In addition, appropriate hydrodynamic data collected to characterize tidal conditions (currents, tide heights) allows the modeling team to tie this water quality data to an existing hydrodynamic model. The surveys also met the objective of providing data over a range of conditions as demonstrated by the differences in chlorophyll concentrations and ambient water temperatures between the surveys. Finally,

supplemental information collected during the 2001 survey including DST profiling in Oyster Bay, Weeks Bay, Magnolia River, and the Intracoastal Waterway and water quality sampling of two additional point sources (collected both on both surveys) provides information to allow these systems to be added to the modeling framework, if necessary, while total suspended solids analyses of bay tributaries including Dog River, Three Mile Creek, and the Mobile River, and turbidity measurement at several continuous measurement stations provide a better understanding of solids concentrations within the study area.

It is recommended that the modeling team pay special attention to the discussions related to calibration of the continuous and profiling meters since some of the these meters fell out of calibration during deployment.