Navy Canal Stormwater Facility Performance Efficiency Evaluation

Final Report

February 2010

Prepared for:

Seminole County, Florida

Prepared by:

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SECTION 1

INTRODUCTION

This document provides a summary of work efforts conducted by Environmental Research & Design, Inc. (ERD) for Seminole County (County) to conduct a performance efficiency evaluation of the Navy Canal stormwater facility. This facility was constructed by the County to reduce pollutant loadings discharging through the Navy Canal watershed into Lake Jesup. The Navy Canal stormwater system consists of an off-line wet detention pond adjacent to the historical flow path of Navy Canal to provide retrofit water quality treatment.

Section 303(d) of the Clean Water Act requires states to submit lists of surface waterbodies that do not meet applicable water quality standards. These waterbodies are defined as “impaired waters” and total maximum daily loads (TMDLs) must be established for these waters on a prioritized schedule. Lake Jesup (WBID #2981) has been designated as an “impaired water” due to elevated nutrient and TSI values. A nutrient TMDL was developed by FDEP during 2005 which was adopted into rule on August 3, 2006. The Navy Canal stormwater facility was constructed to assist in reducing nutrient loadings to Lake Jesup in an effort to improve in-lake nutrient concentrations.

General location maps for the Navy Canal stormwater facility are given on Figure 1-1. The project site is located in Seminole County, approximately 1500 ft south of East Lake Mary Blvd., east of Brisson Avenue, and west of Sipes Avenue.

1.1 Project Description

The Navy Canal stormwater project was constructed as an off-line wet detention pond along the historical flow path of Navy Canal in Seminole County to provide retrofit water quality treatment. This facility receives inflow from the 820-acre Navy Canal sub-basin located along the north shore of Lake Jesup. Although the drainage basin area for the pond is 820 acres, 633 acres are associated with future development that will be required to have stormwater treatment systems. Therefore, this system provides water quality treatment only for the 187 acres of existing development which does not have stormwater management systems. Design criteria for the stormwater facility are given in Table 1-1 (CDM, 2003).

Figure 1-1. Location Maps for the Navy Canal Stormwater Facility.

TABLE 1-1

DESIGN CRITERIA FOR THE NAVY CANAL STORMWATER FACILITY

PARAMETER	INFORMATION
Treatment System Type	Off-line wet detention pond
Pond Area	4.7 acres at NWL
Drainage Basin Area to Pond	820 acres, only 187 acres included in water quality calculations
Drainage Basin Land Use	Transportation and wetlands
Basin Soil Hydrologic Groups	Mostly B/D and D, some A and C
Basin Impervious Area	112.1 acres (60%), based on a retrofit basin area of 187 acres
Treatment Volume (based on 187 acre retrofit area)	0.6" over basin area 1.1" over impervious area
Permanent Pool Volume	46.0 ac-ft below NWL
Pond Depth a. Maximum b. Mean	 a. 12 ft b. 9.8 ft (46.0 ac-ft/4.7 ac)
Treatment Volume Recovery	50% of treatment volume released in 24-30 hours
Pond Residence Time	22 days (wet season conditions)
Littoral Zone	Approximately 30% of pond area

An aerial overview of the Navy Canal stormwater facility is given on Figure 1-2 and a schematic of system components is given in Figure 1-3. The treatment process consists of a 4.7-acre wet detention pond which was constructed off-line from the Navy Canal. A diversion weir was constructed along Navy Canal to force low flows into the wet detention pond for treatment, and a peninsula was added to the pond to increase the flow path for inputs from Navy Canal. The pond discharges through an outfall structure located at the northwest corner of the pond and returns to the Navy Canal through an underground stormsewer system to a point downstream of the weir structure. Under high flow conditions, the canal flow can discharge directly over the diversion weir into downstream portions of Navy Canal.

A photograph of Navy Canal immediately upstream from the treatment pond is given on Figure 1-4. Navy Canal is a meandering earthen channel with heavily vegetated shoreline areas throughout the majority of its length. Navy Canal enters the treatment pond through two 6-ft x 6-ft concrete box culverts (CBC) which pass beneath a private driveway. A photograph of the box culvert inflows to the treatment pond is given on Figure 1-5.

Photographs of the diversion weir/overflow spillway structure are given on Figure 1-6. This structure is approximately 50 ft in length. Erosion control and energy dissipation is provided both upstream and downstream from the diversion weir structure using rock-filled gabion structures. A photograph of the 24-inch RCP outfall for the treatment pond is given on Figure 1-7. This discharge occurs into Navy Canal downstream from the diversion weir structure and constitutes the primary point of discharge for inputs into the pond under normal flow conditions.

Figure 1-2. Aerial Overview of the Navy Canal Stormwater Facility.

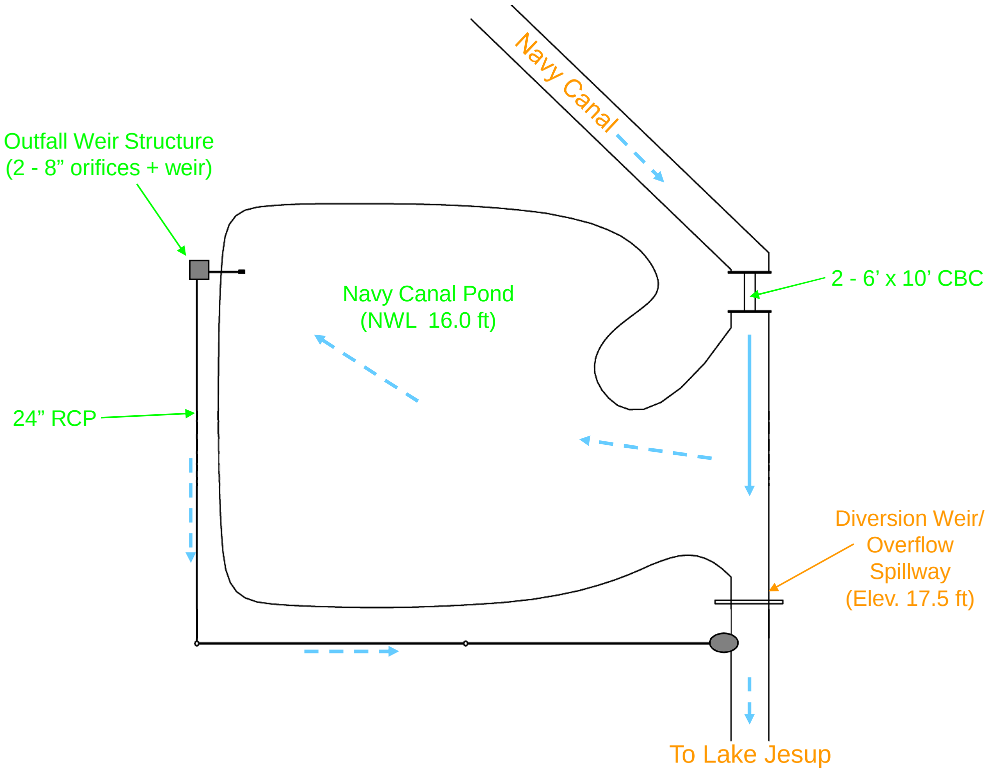


Figure 1-3. Schematic of System Components of the Navy Canal Stormwater Facility.

Figure 1-4. Navy Canal Upstream from the Treatment Pond.

Figure 1-5. Box Culvert Inflows to Treatment Pond.

Figure 1-6. Diversion Weir/Overflow Spillway.

Figure 1-7. Pond Outfall through 24-inch RCP.

A schematic of the outfall structure for the Navy Canal treatment system is given on Figure 1-8. The outfall structure and associated weirs are located underground on the northwest side of the pond and are connected to the pond by a 24-inch RCP with a mitered end section. The outfall structure contains a concrete weir with a top elevation of 17.5 ft which corresponds to the overflow elevation for the spillway weir structure. The weir inside the outfall structure contains two 8-inch orifices which are used to slowly bleed-down the pond elevation between significant events. The weir structure also contains a 5-inch rectangular notch with a bottom elevation of 16.0 ft, corresponding to the design normal water level (NWL) for the pond. This rectangular slot is designed to provide controlled discharge for common storm events. During extreme event conditions, water can discharge over both the 7.67-inch weir in the outfall structure as well as the 50-ft long diversion weir structure located at the southeast corner of the pond. Discharges from the outfall structure enter the 24-inch RCP which discharges downstream from the spillway structure directly into Navy Canal (Figure 1-7).

An overview of the drainage basin upstream from the wet detention pond is given on Figure 1-9. The entire drainage area upstream of the pond covers approximately 820 acres. However, approximately 633 acres are currently undeveloped and will be required to have constructed stormwater treatment systems as these areas become developed. The remaining 187 acres within the drainage basin consist of existing developed areas which do not currently have stormwater treatment facilities. The Navy Canal stormwater facility was designed to provide treatment specifically for these currently untreated areas. As indicated on Table 1-1, approximately 60% of the currently developed areas are impervious.

A summary of existing land use within the Navy Canal tributary area is given in Table 1-2 (CDM, 2003). Approximately 48.7% of the basin area is covered by transportation, communication, and utilities, much of which is associated with the Sanford/Orlando Airport. Most of the remaining portions of the watershed are undeveloped or in agriculture.

The Navy Canal pond is designed to provide a treatment volume of approximately 0.6 inches over the 187-acre area or 1.1 inch over the impervious area. The pond was constructed with a maximum depth of approximately 12 ft and a mean depth of 9.8 ft. The calculated pond residence time is approximately 22 days, based on wet season conditions. According to calculations conducted by CDM (2003), the Navy Canal stormwater facility will provide an annual load reduction of approximately 56 lbs/yr (25.4 kg/yr) for total phosphorus and 218 lbs/yr (98.9 kg/yr) for total nitrogen. Copies of selected construction plans for the Navy Canal stormwater facility are given in Appendix A.

Construction for the Navy Canal stormwater facility was completed during August 2005. The primary funding for construction of the Navy Canal stormwater facility was provided by the Florida Department of Environmental Protection (FDEP) under Agreement No. S0341 in the amount of $500,000 through a Section 319 Water Quality Grant.

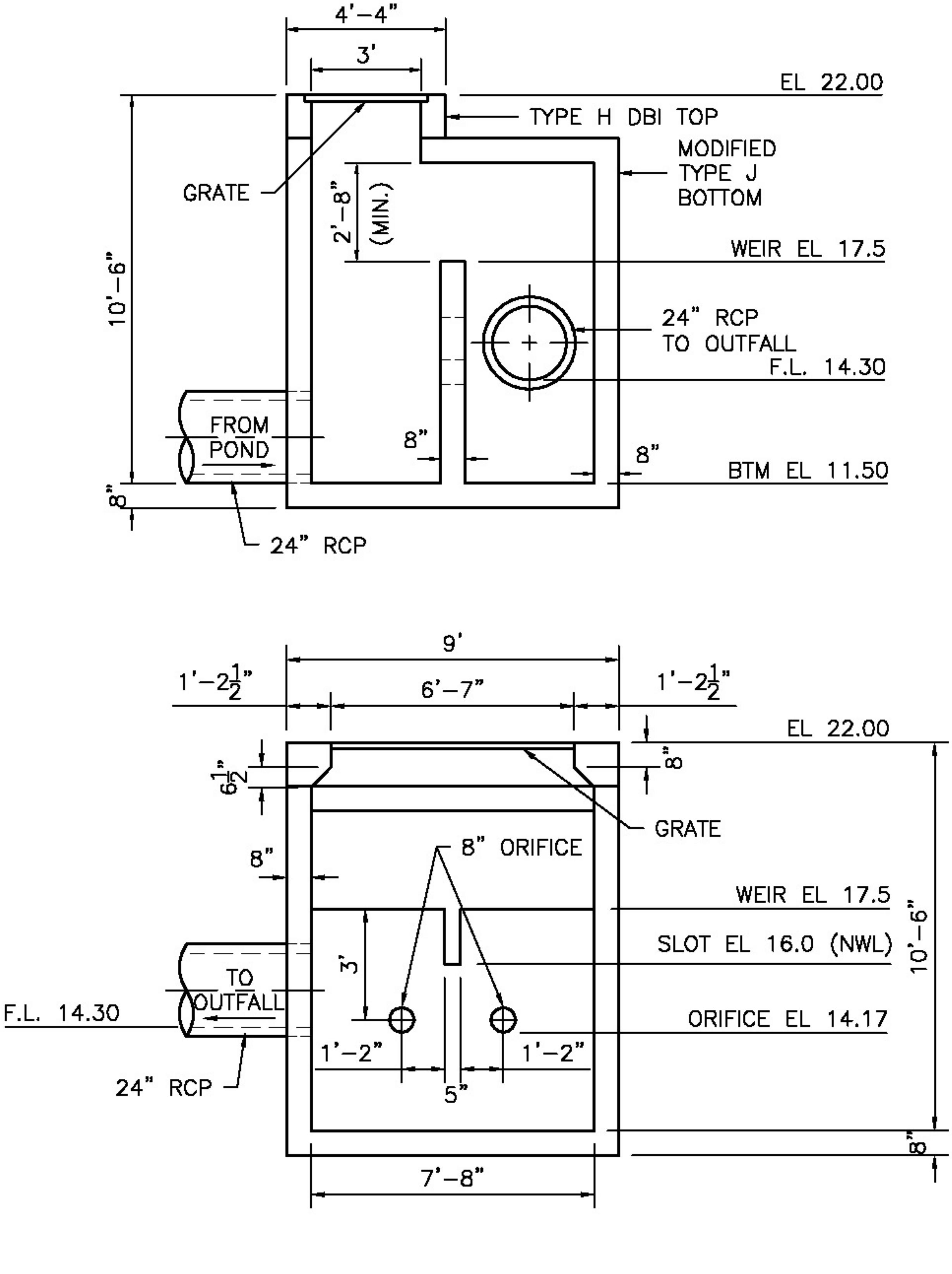


Figure 1-8. Schematic of the Navy Canal Pond Outfall Structure.

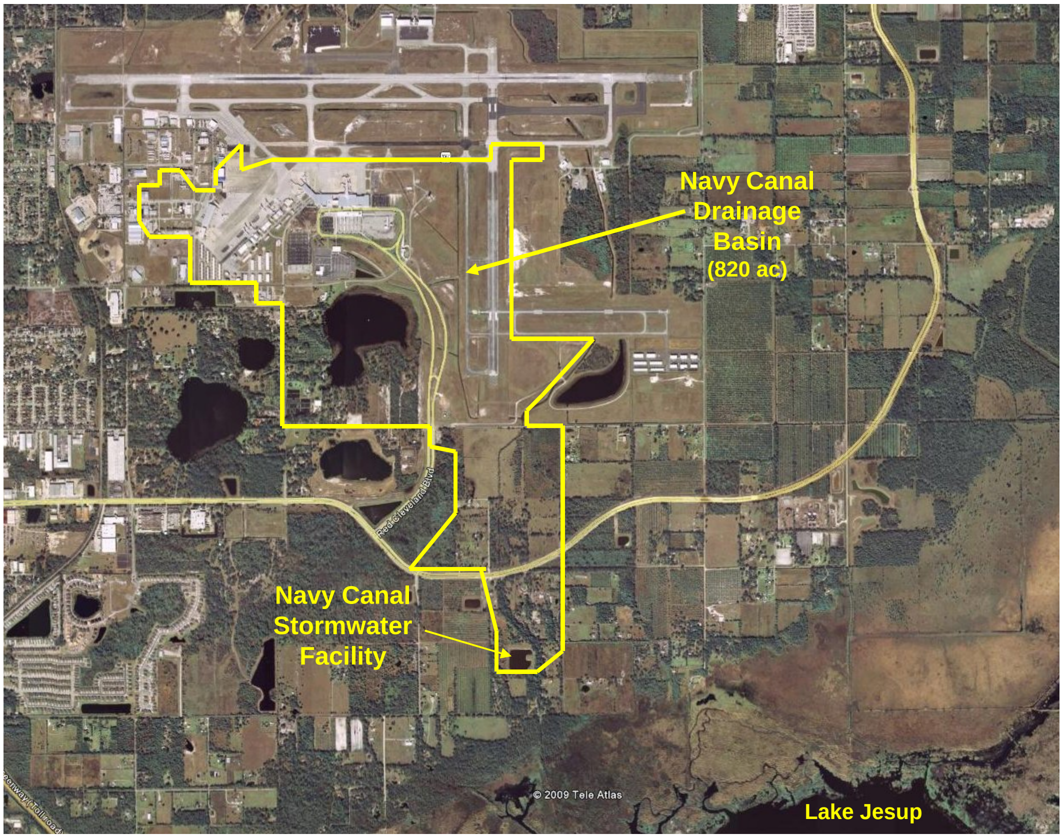


Figure 1-9. Overview of the Navy Canal Drainage Basin.

TABLE 1-2

EXISTING LAND USE IN THE NAVY CANAL TRIBUTARY AREA
(Source: CDM, 2003)

LAND USE DESCRIPTION	FLUCCS CODE	AREA (acres)	PERCENT COVERAGE (%)
Low-Density Residential	110	83.6	10.2
High-Density Residential, Mobile Home Units	132	17.2	2.1
High-Density Residential, Multiple Dwelling Units	133	0.4	0.05
Commercial	140	0.1	0.01
Professional Services	143	0.2	0.02
Industrial	150	4.0	0.50
Recreational	180	4.6	0.56
Agriculture	200	73.6	9.0
Shrub and Brushland	320	155.4	19.0
Waterbodies	500	46.9	5.7
Wetlands	600	26.6	3.2
Transportation, Communication, and Utilities	800	399.7	48.7
Railroads	812	0.9	0.11
Roads and Highways	814	7.0	0.85
TOTAL BASIN AREA:		**820.2**	**100**

1.2 Work Efforts Performed by ERD

A Quality Assurance Project Plan (QAPP) was developed by ERD during December 2007 which provides details concerning the proposed field monitoring and laboratory analyses. Monitoring equipment was installed at the Navy Canal stormwater facility site during January 2008. Routine monitoring was initiated at the Navy Canal site on March 1, 2008 and was continued for a period of 12 months until February 28, 2009.

This report has been divided into four separate sections. Section 1 contains an introduction to the report, a description of the Navy Canal stormwater facility, and a summary of work efforts performed by ERD. Section 2 provides a detailed discussion of the methodologies used for field and laboratory evaluations. Section 3 provides a discussion of the hydrologic and water quality results, and a summary is provided in Section 4.

SECTION 2

FIELD AND LABORATORY ACTIVITIES

Field and laboratory investigations were conducted by ERD over a 12-month period from March 2008-February 2009 to evaluate the effectiveness of the Navy Canal stormwater facility. Field monitoring was conducted at the inflow and outflow for the pond system and included a continuous record of inflows into the system and outflows through the discharge structures. Laboratory analyses were conducted on collected samples for general parameters and nutrients to assist in quantifying concentration-based and mass removal efficiencies. Specific details of monitoring efforts conducted at the Navy Canal stormwater facility site are given in the following sections.

2.1 Field Instrumentation and Monitoring

A schematic of monitoring locations used to evaluate the performance efficiency of the Navy Canal stormwater facility is given on Figure 2-1. Inflow into the system was monitored inside the double 6-ft x 6-ft CBC which directs runoff from Navy Canal into the pond. This site is designated as Site 1 on Figure 2-1. Discharges from the pond were monitored inside the 24-inch RCP which leaves the outfall weir structure. In addition, a water level recorder was installed at the diversion weir to provide a continuous record of water elevations within the pond. A rain gauge and pan evaporimeter were installed adjacent to the pond to provide information on rainfall inputs and evaporation losses.

Stormwater samplers with integral flow meters were installed at the inflow (Site 1) and outflow (Site 2) monitoring sites indicated on Figure 2-1. The inflow monitoring site was located approximately 15 ft inside the western 6-ft x 6-ft CBC. This autosampler was used to provide a continuous measurement of inflow into the treatment pond under both storm event and baseflow conditions, as well as to collect flow-weighted samples at the inflow over a wide range of flow conditions. Monitoring Site 2 was located in the 24-inch RCP approximately 20 ft downstream from the outfall structure. The autosamplers installed at this site provided a continuous record of discharges from the pond and collected flow-weighted samples from the pond discharge over a wide range of flow conditions.

A photograph of the automatic sampling equipment used at the Navy Canal pond inflow monitoring site (Site 1) is given on Figure 2-2. An automatic sequential stormwater sampler with integral flow meter, manufactured by Sigma (Model 900MAX) was installed on top of the headwall for the box culvert. The automatic sampler was housed inside an insulated aluminum shelter, and sensor cables and sample tubing were extended from the autosampler to the point of monitoring inside the 6-ft x 10-ft CBC. The integral flow meter was programmed to provide a continuous record of hydrologic inputs into the pond, with measurements stored into internal memory at 10-minute intervals.

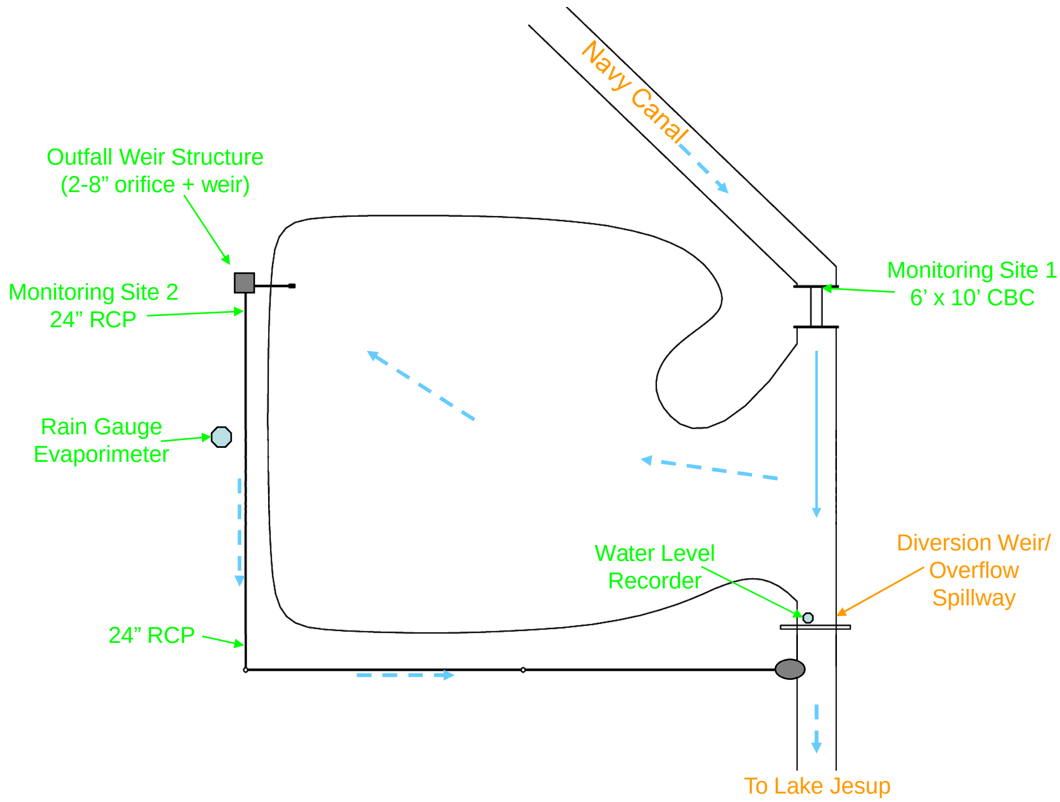


Figure 2-1. Locations for Monitoring Equipment at the Navy Canal Site.

Figure 2-2. Inflow Monitoring Equipment at Site 1.

The automatic sampler installed at Site 1 contained 24 individual 1-liter polyethylene bottles and was programmed to collect samples in a flow-weighted mode, with collected samples placed into the 1-liter bottles in sequential order. Since 120 VAC power was not available at the site, the automatic sampler was operated on a gel cell battery which was replaced on a weekly basis.

A photograph of the equipment shelter installed at the outfall monitoring site (Site 2) is given in Figure 2-3. An automatic sequential stormwater sampler with integral flow meter, manufactured by Sigma (Model 900MAX) was installed on top of the outfall structure. The autosampler was housed inside an insulated aluminum shelter, and sensor cables and sample tubing were extended from the sampler through the cast-iron top grate to the outflow monitoring site, approximately 15 ft inside the 24-inch RCP discharge pipe. The integral flow meter was programmed to provide a continuous record of discharges from the pond, with measurements stored into internal memory at 10-minute intervals.

Figure 2-3. Outfall Monitoring Equipment at Site 2.

The automatic sampler installed at the outflow monitoring site contained a single 20-liter polyethylene bottle. The autosampler was programmed to collect samples in a flow-weighted mode, with 500-ml aliquots pumped into the collection bottle with every programmed increment of flow. Since 120 VAC power was not available at the site, the automatic sampler was operated on a gel cell battery which was replaced on a weekly basis.

Flow measurements at the inflow monitoring site (Site 1) were performed using the area/velocity method. The flow probe utilized at this monitoring site provides simultaneous measurements of water depth and flow velocity. The depth measurements are converted into a cross-sectional area based upon the geometry of the pipe, and the velocity of flow is measured directly by the probe. Discharge is then calculated by the flow meter using the Continuity Equation (Q = A x V) in cubic feet per second (cfs).

Flow measurements at the discharge monitoring site (Site 2) were performed using a pressure transducer sensor which transforms sensitive measurements of water depth into a flow rate using the Manning Equation and pipe geometry. A pressure transducer depth probe was inserted approximately 15 ft into the 24-inch RCP downstream from the outfall weir structure. This probe provided continuous measurements of water depth and converted measured water depths into an approximate flow rate.

Rainfall at the Navy Canal site was monitored using a continuous rainfall recorder attached to a 4-inch x 4-inch wooden post on the west side of the pond. The rainfall recorder (Texas Electronics Model 1014-C) produced a continuous record of all rainfall which occurred at the site, with a resolution of 0.01 inch. Rainfall data were stored inside a digital storage device (HOBO Event Rainfall Logger) which was attached to the wooden post inside a waterproof enclosure. The rainfall record is used to provide information on general rainfall characteristics in the vicinity of the monitoring site and to assist in evaluation of hydrologic inputs from the watershed area.

In addition to the rainfall recorder, a Class A pan evaporimeter was also installed at the pond site. Measurements of water level within the evaporation pan were recorded on a weekly basis and corrected for measured rainfall to provide estimates of evaporation from the pond surface. Information stored in the rainfall data logger, as well as evaporimeter water level measurements, were retrieved on a weekly basis. A photograph of the rainfall and pan evaporation equipment is given on Figure 2-4.

ERD field personnel visited the Navy Canal site at least once each week to retrieve collected stormwater, baseflow, and outflow samples and to download stored hydrologic data from each of the two automatic samplers as well as the rain gauge and evaporimeter. This information was evaluated for quality control purposes and compiled into a continuous data set for use in evaluating the hydrologic performance efficiency of the system.

In addition to the equipment summarized previously, a fixed staff gauge and digital water level recorder were also installed on the outfall weir structure for the pond. The digital water level recorder (Global Water Model WL16) collected continuous water level measurements at 15-minute intervals. This information was used to assist in completing the hydrologic budget for the pond and to determine when water level elevations exceeded the spillway weir elevation. Manual readings of staff gauge elevations were conducted on a weekly basis to corroborate the readings from the digital water level recorder. A photograph of the staff gauge and water level recorder is given on Figure 2-5.

Figure 2-4. Rainfall and Pan Evaporation Equipment.

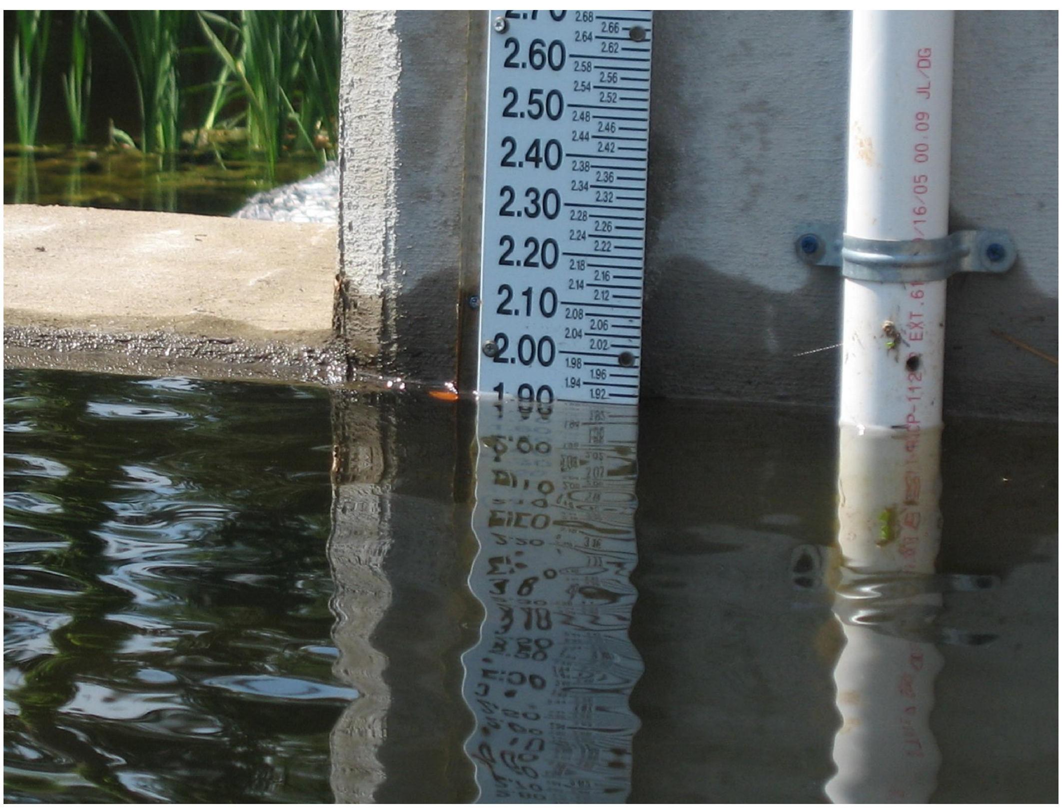


Figure 2-5. Staff Gauge and Water Level Recorder.

2.2 Laboratory Analyses

A summary of laboratory methods and MDLs for analyses conducted on water samples collected during this project is given in Table 2-1. All laboratory analyses were conducted in the ERD Laboratory. The ERD Laboratory is NELAC-certified (No. 1031026). Details on field operations, laboratory procedures, and quality assurance methodologies are provided in the FDEP-approved Comprehensive Quality Assurance Plan No. 870322G for Environmental Research & Design, Inc. In addition, a Quality Assurance Project Plan (QAPP), outlining the specific field and laboratory procedures to be conducted for this project, was submitted to and approved by FDEP prior to initiation of any field and laboratory activities.

TABLE 2-1

ANALYTICAL METHODS AND DETECTION LIMITS FOR LABORATORY ANALYSES

PARAMETER	METHOD OF ANALYSIS	METHOD DETECTION LIMITS (MDLs)[1]
pH	EPA-83, Sec. 150.1[2]	N/A
Conductivity	EPA-83, Sec. 120.1[2]	0.3 μmho/cm
Alkalinity	EPA-83, Sec. 310.1[2]	0.5 mg/l
Ammonia	EPA-83, Sec. 350.1[2]	0.005 mg/l
NO_x	EPA-83, Sec. 353.2[2]	0.005 mg/l
TKN	Alkaline Persulfate Digestion[3]	0.01 mg/l
Ortho-P	EPA-83, Sec. 365.1[2]	0.001 mg/l
Total Phosphorus	Alkaline Persulfate Digestion[3]	0.001 mg/l
Turbidity	EPA-83, Sec. 180.1[2]	0.1 NTU
Color	EPA-83, Sec. 110.3[2]	1 Pt-Co Unit
TSS	EPA-83, Sec. 160.2[2]	0.7 mg/l

1. MDLs are calculated based on the EPA method of determining detection limits
2. Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, Revised March 1983.
3. FDEP-approved alternate method
4. Standard Methods for the Examination of Water and Wastewater, 19th Ed., 1995.

2.3 Field Measurements

During each weekly monitoring visit, vertical field profiles of pH, temperature, specific conductivity, dissolved oxygen, and oxidation-reduction potential (ORP) were conducted near the center of the wet detention pond using a Hydrolab Datasonde 4a water quality monitor. Field measurements were conducted at depths of 0.25 m and 0.5 m, and continued at 0.5-m intervals to the pond bottom. This information is used to evaluate potential stratification and anoxic conditions in bottom portions of the wet detention pond.

2.4 Routine Data Analysis and Compilation

All data generated during this project, including hydrologic, hydraulic, and water quality information, were entered into a computerized database and double-checked for accuracy. Hydrologic and hydraulic information was tabulated and summarized on monthly intervals. This information is used to develop a hydrologic budget for the pond for use in evaluating system performance.

Data collected during this project were analyzed using a variety of statistical methods and software. Simple descriptive statistics were generated for runoff inflow, pond outflow, rainfall, and pond water levels to examine changes in water quality characteristics and system performance throughout the research period. The majority of these analyses were conducted using statistical procedures available in Excel.

Statistical procedures such as multiple regression were also conducted to examine predicted relationships between water quality characteristics and hydrologic or hydraulic factors, such as pond water elevation, antecedent dry period, cumulative event rainfall, and other variables. The majority of these analyses were conducted using the SAS (Statistical Analysis System) package.

Distribution patterns for the stormwater, baseflow, outflow, and bulk precipitation data sets were evaluated using both normal probability and log probability plots. These analyses indicated that the data most closely observe a log-normal distribution which is commonly observed with environmental data. As a result, statistical analyses were conducted using log transformations of each of the data sets. The data were then converted back to untransformed data at the completion of the statistical analyses.

SECTION 3

RESULTS

Field monitoring, sample collection, and laboratory analyses were conducted by ERD from March 1, 2008-February 28, 2009 to evaluate the hydraulic and pollutant removal efficiencies of the Navy Canal stormwater facility. A discussion of the results of these efforts is given in the following sections.

3.1 Site Hydrology

3.1.1 Rainfall

A continuous record of rainfall characteristics was collected at the Navy Canal pond monitoring site from March 1, 2008-February 28, 2009 using a tipping bucket rainfall collector with a resolution of 0.01 inch and a digital data logging recorder. The characteristics of individual rain events measured at the Navy Canal pond site are given in Table 3-1. Information is provided for event rainfall, event start time, event end time, event duration, average rainfall intensity, and antecedent dry period for each individual rain event measured at the monitoring site. For purposes of this analysis, average rainfall intensity is calculated as the total rainfall divided by the total event duration.

A total of 46.58 inches of rainfall fell in the vicinity of the Navy Canal pond over the 365-day monitoring period from a total of 139 separate storm events. A summary of rainfall event characteristics measured at the exfiltration system rain gauge site from March 1, 2008-February 28, 2009 is given in Table 3-2. Individual rainfall amounts measured at the pond site range from 0.01-7.34 inches, with an average of 0.34 inches/event. Durations for events measured at the site range from 0.01-12.9 hours, with antecedent dry periods ranging from 0.13-15.1 days.

A comparison of measured and typical "average" rainfall in the vicinity of the Navy Canal pond is given in Figure 3-1. Measured rainfall presented in this figure is based upon the field-measured rain events at the pond site presented in Table 3-1, summarized on a monthly basis. "Average" rainfall conditions are based upon historical average monthly rainfall recorded at the Orlando International Airport (OIA) over the 64-year period from 1942-2005. Historical average annual rainfall in Central Florida is approximately 50.03 inches.

As seen in Figure 3-1, measured rainfall in the vicinity of the Navy Canal pond site was greater than "normal" during July, August, and October, with lower than "normal" rainfall during the remaining months. A tabular comparison of measured and average rainfall for the Navy Canal pond site is given in Table 3-3. The total annual rainfall of 46.58 inches measured at the Navy Canal site is approximately 7% less than "normal" rainfall which typically occurs on an annual basis in the Central Florida area. As seen in Table 3-3, a rainfall of 16.22 inches was measured at the Navy Canal pond site during August 2008 which was associated with Tropical Storm Fay.

TABLE 3-1

SUMMARY OF RAINFALL MEASURED AT THE NAVY CANAL POND MONITORING SITE FROM MARCH 1, 2008 – FEBRUARY 28, 2009

EVENT START		EVENT END		TOTAL RAINFALL (inches)	DURATION (hours)	ANTECEDENT DRY PERIOD (days)	AVERAGE INTENSITY (inches/hour)
DATE	TIME	DATE	TIME				
3/4/08	16:50	3/4/08	17:00	0.07	0.16	----------	0.43
3/6/08	16:57	3/6/08	17:11	0.16	0.25	2.0	0.64
3/6/08	21:00	3/7/08	4:03	0.98	7.06	0.2	0.14
3/7/08	14:19	3/7/08	15:05	0.09	0.77	0.4	0.12
3/7/08	20:09	3/8/08	3:44	1.24	7.58	0.2	0.16
3/11/08	20:50	3/11/08	20:50	0.01	---	3.7	---
3/14/08	18:31	3/14/08	20:39	0.04	2.13	2.9	0.02
3/24/08	12:23	3/24/08	12:23	0.03	0.00	9.7	21.6
3/30/08	18:59	3/30/08	18:59	0.01	---	6.3	---
3/31/08	7:40	3/31/08	9:15	0.02	1.57	0.5	0.01
4/1/08	17:21	4/1/08	18:09	0.15	0.81	1.3	0.19
4/4/08	19:42	4/4/08	19:50	0.02	0.13	3.1	0.15
4/5/08	14:20	4/6/08	3:14	0.95	12.90	0.8	0.07
4/6/08	13:25	4/7/08	1:28	0.72	12.04	0.4	0.06
4/13/08	12:49	4/13/08	15:31	0.03	2.70	6.5	0.01
4/28/08	17:30	4/28/08	19:50	0.03	2.35	15.1	0.01
4/29/08	4:08	4/29/08	4:08	0.01	---	0.3	---
5/3/08	19:40	5/3/08	19:40	0.01	---	4.6	---
5/13/08	8:58	5/13/08	8:58	0.01	---	9.6	---
5/20/08	10:29	5/20/08	12:37	0.16	2.13	7.1	0.08
5/22/08	11:53	5/22/08	14:22	0.08	2.48	2.0	0.03
5/23/08	21:07	5/23/08	23:45	1.22	2.63	1.3	0.46
5/24/08	16:26	5/24/08	16:28	0.04	0.03	0.7	1.41
6/1/08	18:48	6/1/08	20:19	0.40	1.52	8.1	0.26
6/10/08	15:24	6/10/08	19:53	0.59	4.49	8.8	0.13
6/11/08	19:14	6/11/08	19:58	0.89	0.74	1.0	1.21
6/12/08	13:37	6/12/08	13:47	0.08	0.17	0.7	0.46
6/13/08	13:05	6/13/08	13:53	0.02	0.80	1.0	0.02
6/15/08	19:21	6/15/08	21:45	0.02	2.40	2.2	0.01
6/16/08	16:11	6/16/08	18:34	0.32	2.39	0.8	0.13
6/17/08	20:15	6/17/08	20:17	0.02	0.03	1.1	0.74
6/18/08	20:12	6/18/08	21:54	0.50	1.70	1.0	0.29
6/19/08	4:07	6/19/08	4:07	0.01	---	0.3	---
6/19/08	17:33	6/19/08	18:08	0.03	0.58	0.6	0.05
6/20/08	18:46	6/20/08	18:52	0.03	0.09	1.0	0.34
6/21/08	13:52	6/21/08	15:38	0.25	1.76	0.8	0.14
6/23/08	8:59	6/23/08	8:59	0.01	---	1.7	---
6/25/08	14:32	6/25/08	19:59	0.10	5.46	2.2	0.02
6/26/08	15:09	6/26/08	19:37	0.34	4.47	0.8	0.08
6/29/08	20:09	6/29/08	22:15	0.11	2.09	3.0	0.05
6/30/08	16:04	6/30/08	17:38	0.15	1.58	0.7	0.09
7/1/08	16:54	7/1/08	19:40	0.07	2.78	1.0	0.03
7/8/08	13:54	7/8/08	17:06	0.82	3.20	6.8	0.26
7/11/08	15:39	7/11/08	18:04	1.62	2.42	2.9	0.67
7/12/08	13:04	7/12/08	15:21	0.08	2.28	0.8	0.04
7/13/08	18:09	7/13/08	18:25	0.07	0.27	1.1	0.26

TABLE 3-1 -- CONTINUED

SUMMARY OF RAINFALL MEASURED AT THE NAVY CANAL POND MONITORING SITE FROM MARCH 1, 2008 – FEBRUARY 28, 2009

EVENT START		EVENT END		TOTAL RAINFALL (inches)	DURATION (hours)	ANTECEDENT DRY PERIOD (days)	AVERAGE INTENSITY (inches/hour)
DATE	TIME	DATE	TIME				
7/14/08	19:04	7/15/08	0:31	0.49	5.46	1.0	0.09
7/15/08	8:22	7/15/08	8:23	0.02	0.01	0.3	1.36
7/15/08	13:43	7/15/08	19:44	0.76	6.02	0.2	0.13
7/16/08	15:38	7/16/08	17:57	0.26	2.32	0.8	0.11
7/17/08	0:15	7/17/08	0:15	0.01	---	0.3	---
7/17/08	4:23	7/17/08	4:54	0.21	0.51	0.2	0.41
7/17/08	16:06	7/17/08	21:10	0.98	5.07	0.5	0.19
7/23/08	8:00	7/23/08	9:07	0.29	1.13	5.5	0.26
7/23/08	14:56	7/23/08	19:02	1.22	4.10	0.2	0.30
7/31/08	8:30	7/31/08	8:33	1.32	0.05	7.6	29.0
8/7/08	8:23	8/7/08	8:25	0.24	0.03	7.0	8.55
8/14/08	9:52	8/14/08	9:53	0.14	0.02	7.1	5.93
8/19/08	7:35	8/19/08	7:36	0.64	0.02	4.9	28.1
8/20/08	12:30	8/20/08	15:32	2.08	3.02	1.2	0.69
8/21/08	11:18	8/21/08	19:26	7.34	8.13	0.8	0.90
8/22/08	15:48	8/22/08	16:38	1.92	0.83	0.8	2.30
8/23/08	16:48	8/23/08	17:30	0.77	0.70	1.0	1.10
8/24/08	17:21	8/24/08	17:44	0.61	0.38	1.0	1.59
8/25/08	16:58	8/25/08	18:25	1.38	1.45	1.0	0.95
8/27/08	12:31	8/27/08	12:32	0.02	0.02	1.8	1.20
8/28/08	8:28	8/28/08	8:29	0.11	0.00	0.8	79.2
8/30/08	16:32	8/30/08	17:19	0.97	0.78	2.3	1.24
9/2/08	16:03	9/2/08	16:09	0.12	0.10	2.9	1.20
9/5/08	8:32	9/5/08	8:46	0.04	0.22	2.7	0.18
9/8/08	15:37	9/8/08	15:37	0.01	---	3.3	---
9/9/08	16:51	9/9/08	16:51	0.01	---	1.1	---
9/10/08	5:06	9/10/08	5:45	0.06	0.65	0.5	0.09
9/10/08	14:53	9/10/08	15:22	0.18	0.48	0.4	0.38
9/14/08	11:53	9/14/08	14:35	0.27	2.70	3.9	0.10
9/14/08	17:49	9/14/08	17:49	0.02	0.01	0.1	1.80
9/15/08	20:04	9/15/08	21:30	0.58	1.43	1.1	0.41
9/17/08	16:34	9/17/08	16:53	0.20	0.31	1.8	0.64
9/22/08	16:41	9/22/08	17:53	0.71	1.20	5.0	0.59
9/23/08	15:36	9/23/08	15:53	0.21	0.28	0.9	0.74
9/28/08	17:43	9/28/08	18:08	0.16	0.42	5.1	0.38
9/30/08	17:24	9/30/08	18:31	0.84	1.12	2.0	0.75
10/5/08	16:53	10/5/08	17:20	0.56	0.45	4.9	1.24
10/8/08	16:25	10/8/08	16:35	0.05	0.18	3.0	0.28
10/8/08	20:26	10/8/08	21:51	0.06	1.42	0.2	0.04
10/9/08	11:35	10/9/08	18:51	3.01	7.27	0.6	0.41
10/23/08	20:07	10/23/08	20:31	0.12	0.39	14.1	0.31
10/23/08	23:57	10/24/08	10:55	0.89	10.98	0.1	0.08
10/26/08	8:43	10/26/08	8:43	0.01	---	1.9	---
10/27/08	12:29	10/27/08	12:29	0.01	---	1.2	---
10/28/08	10:47	10/28/08	10:47	0.01	---	0.9	---
10/30/08	8:53	10/30/08	8:53	0.01	---	1.9	---

TABLE 3-1 -- CONTINUED

SUMMARY OF RAINFALL MEASURED AT THE NAVY CANAL POND MONITORING SITE FROM MARCH 1, 2008 – FEBRUARY 28, 2009

EVENT START		EVENT END		TOTAL RAINFALL (inches)	DURATION (hours)	ANTECEDENT DRY PERIOD (days)	AVERAGE INTENSITY (inches/hour)
DATE	TIME	DATE	TIME				
11/1/08	18:32	11/1/08	18:32	0.01	---	2.4	---
11/2/08	11:04	11/2/08	13:46	0.13	2.70	0.7	0.05
11/2/08	18:38	11/2/08	18:52	0.08	0.24	0.2	0.33
11/13/08	12:49	11/13/08	12:49	0.01	---	10.7	---
11/14/08	7:02	11/14/08	7:23	0.03	0.36	0.8	0.08
11/14/08	22:59	11/14/08	23:00	0.02	0.01	0.6	2.67
11/15/08	7:03	11/15/08	7:20	0.02	0.28	0.3	0.07
11/16/08	1:42	11/16/08	1:42	0.01	---	0.8	---
11/16/08	10:45	11/16/08	10:45	0.01	---	0.4	---
11/18/08	18:34	11/18/08	18:34	0.01	---	2.3	---
11/21/08	7:55	11/21/08	7:55	0.01	---	2.6	---
11/25/08	4:38	11/25/08	4:38	0.01	---	3.9	---
11/25/08	9:36	11/25/08	9:36	0.01	---	0.2	---
11/26/08	10:59	11/26/08	10:59	0.01	---	1.1	---
11/30/08	12:55	11/30/08	14:46	0.43	1.86	4.1	0.23
11/30/08	19:52	11/30/08	20:43	0.04	0.85	0.2	0.05
12/1/08	0:27	12/1/08	0:27	0.01	---	0.2	---
12/1/08	6:50	12/1/08	9:29	0.04	2.65	0.3	0.02
12/2/08	1:36	12/2/08	4:29	0.05	2.89	0.7	0.02
12/2/08	11:08	12/2/08	11:08	0.01	---	0.3	---
12/6/08	15:56	12/6/08	16:10	0.03	0.24	4.2	0.12
12/7/08	0:05	12/7/08	0:33	0.02	0.47	0.3	0.04
12/10/08	3:00	12/10/08	3:00	0.01	---	3.1	---
12/10/08	7:20	12/10/08	7:20	0.01	---	0.2	---
12/11/08	12:01	12/11/08	13:54	0.39	1.88	1.2	0.21
12/12/08	1:16	12/12/08	1:16	0.01	---	0.5	---
12/12/08	8:04	12/12/08	8:04	0.01	---	0.3	---
12/15/08	8:16	12/15/08	8:16	0.01	---	3.0	---
12/15/08	17:41	12/15/08	17:41	0.01	---	0.4	---
12/16/08	2:54	12/16/08	5:51	0.03	2.95	0.4	0.01
12/17/08	6:41	12/17/08	7:22	0.02	0.68	1.0	0.03
12/18/08	0:28	12/18/08	0:28	0.01	---	0.7	---
12/19/08	2:44	12/19/08	2:44	0.01	---	1.1	---
12/21/08	8:29	12/21/08	8:29	0.01	---	2.2	---
12/25/08	2:41	12/25/08	2:44	0.02	0.05	3.8	0.39
12/26/08	21:42	12/26/08	21:42	0.01	---	1.8	---
12/28/08	23:30	12/28/08	23:47	0.02	0.29	2.1	0.07
12/31/08	10:26	12/31/08	10:26	0.01	---	2.4	---
1/7/09	11:37	1/7/09	11:48	0.06	0.18	7.0	0.33
1/12/09	4:55	1/12/09	6:42	0.02	1.79	4.7	0.01
1/13/09	14:15	1/13/09	16:54	0.06	2.65	1.3	0.02
1/20/09	0:02	1/20/09	1:58	0.18	1.94	6.3	0.09
1/29/09	13:25	1/29/09	20:06	0.68	6.68	9.5	0.10
1/30/09	1:29	1/30/09	7:12	1.04	5.73	0.2	0.18
2/2/09	13:34	2/2/09	19:28	0.40	5.92	3.3	0.07
2/4/09	12:59	2/4/09	12:59	0.01	---	1.7	---
2/19/09	13:04	2/19/09	13:04	0.01	---	15.0	---
			TOTAL RAINFALL:	**46.58**			

TABLE 3-2

SUMMARY OF RAINFALL CHARACTERISTICS IN THE VICINITY OF THE NAVY CANAL POND FROM MARCH 2008 – FEBRUARY 2009

PARAMETER	UNITS	MINIMUM VALUE	MAXIMUM VALUE	MEAN EVENT VALUE
Event Rainfall	inches	0.01	7.34	0.34
Event Duration	hours	0.01	12.9	2.10
Average Intensity	inches/hour	0.01	79.2	2.07
Antecedent Dry Period	days	0.13	15.1	2.49

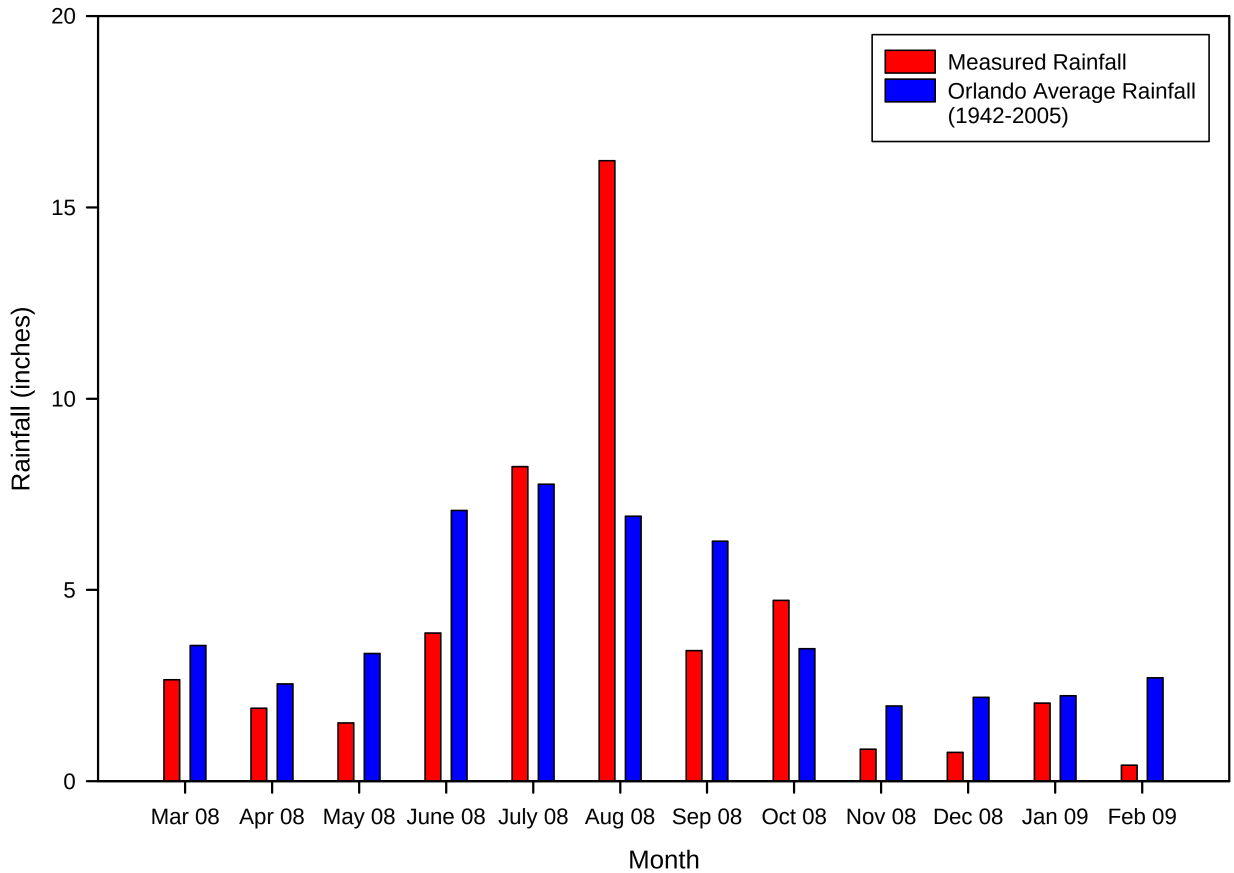


Figure 3-1. Comparison of Average and Measured Rainfall in the Vicinity of the Navy Canal Pond Site.

TABLE 3-3

MEASURED AND AVERAGE RAINFALL FOR THE NAVY CANAL POND SITE FROM MARCH 2008-FEBRUARY 2009

MONTH	MEAN MONTHLY RAINFALL[1] (inches)	MEASURED SITE RAINFALL (inches)	MONTH	MEAN MONTHLY RAINFALL[1] (inches)	MEASURED SITE RAINFALL (inches)
March	3.55	2.65	September	6.27	3.41
April	2.55	1.91	October	3.46	4.73
May	3.33	1.52	November	1.97	0.84
June	7.07	3.87	December	2.19	0.75
July	7.76	8.22	January	2.24	2.04
August	6.92	16.22	February	2.72	0.42
			TOTAL:	**50.03**	**46.58**

1. Measured at the Orlando International Airport from 1942-2005

A summary of calculated hydrologic inputs to the Navy Canal pond from direct precipitation is given in Table 3-4. These inputs were calculated by multiplying the measured monthly rainfall times the pond area of 4.7 acres. Calculated hydrologic inputs from direct precipitation range from a low of 0.16 ac-ft during February 2009 to a high of 6.35 ac-ft during August 2008. The values summarized in Table 3-4 are utilized in a subsequent section to develop a hydrologic budget for the pond.

TABLE 3-4

SUMMARY OF HYDROLOGIC INPUTS TO THE NAVY CANAL POND SITE FROM DIRECT RAINFALL DURING THE PERIOD FROM MARCH 2008-FEBRUARY 2009

MONTH	RAINFALL (inches)	RAINFALL VOLUME[1] (ac-ft)	MONTH	RAINFALL (inches)	RAINFALL VOLUME[1] (ac-ft)
March	2.65	1.04	September	3.41	1.34
April	1.91	0.75	October	4.73	1.85
May	1.52	0.60	November	0.84	0.33
June	3.87	1.52	December	0.75	0.29
July	8.22	3.22	January	2.04	0.80
August	16.22	6.35	February	0.42	0.16
			TOTAL:	**46.58**	**18.24**

1. Based on a pond surface area of 4.7 acres

3.1.2 <u>Water Level Elevations</u>

Water surface elevations in the Navy Canal pond were monitored on a continuous basis from March 2008-February 2009 using a sensitive water level pressure transducer with a digital data logger. As discussed in Section 2, this water level recording device was located at the spillway structure for the pond and was used to evaluate pond response to common rain events within the watershed and to indicate when water discharge occurred over the spillway structure.

A graphical summary of fluctuations in water levels in the Navy Canal pond from March 2008-February 2009 is given on Figure 3-2. Total daily rainfall is also summarized on this figure to illustrate changes in water surface elevations resulting from monitored rainfall events.

As seen in Figure 3-2, pond water levels were below the spillway weir elevation of 17.5 ft throughout most of the 12-month monitoring program. Water elevations in excess of the spillway weir elevation were observed as a result of multiple storm events in excess of 1 inch of rainfall as well as single rain events in excess of approximately 3 inches. A significant spike in water elevations was observed within the Navy Canal pond during August 2008 as a result of large rainfall associated with Tropical Storm Fay. However, had Tropical Storm Fay not occurred, the spillway weir elevation of 17.5 ft would have been exceeded on only a few occasions within the Navy Canal pond. In general, pond surface elevations appear to respond rapidly to rain events in excess of approximately 0.5 inches within the watershed, with a gradual drawdown occurring over a period of approximately 5-7 days. Water surface elevations within the pond exhibited a maximum fluctuation of approximately 2.15 ft during the study period.

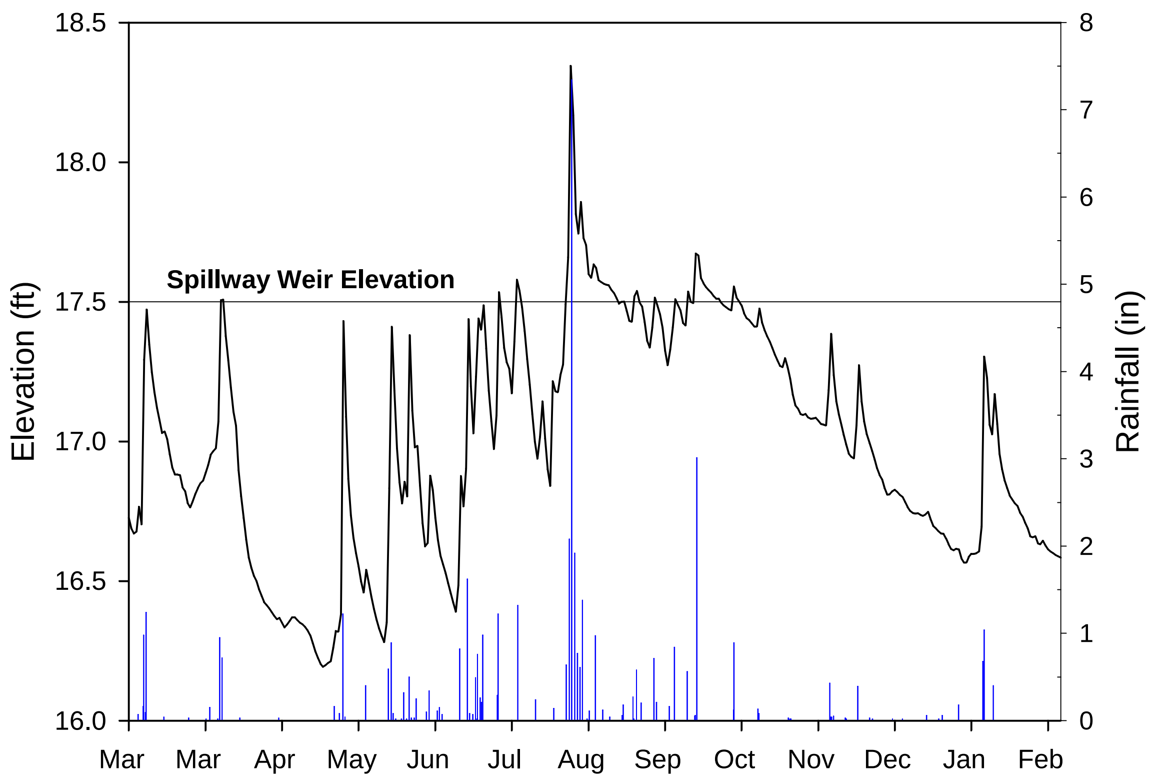


Figure 3-2. Fluctuations in Water Levels in the Navy Canal Pond from March 2008-February 2009.

Measured minimum, maximum, and average water surface elevations during the monitoring program are summarized in Table 3-5. Water levels within the pond exceeded the design control elevation of 16.0 ft at all times during the study period. The minimum water surface elevation of 16.21 ft is still greater than the stated control elevation. It appears that the orifice and weir structures constructed in the pond outfall structure (illustrated on Figure 1-8) are insufficient in size to maintain the water level elevation at the intended control level. During periods of low rainfall, the pond water surface elevation exhibits a gradual decline but still remains above the control elevation.

TABLE 3-5

SUMMARY OF WATER LEVEL DATA FOR THE NAVY CANAL POND SITE

PARAMETER	ELEVATION (ft, NGVD)
Control Elevation	16.0
Measured Minimum Water Stage	16.19
Measured Maximum Water Stage	18.34
Mean Water Level	16.98
Design Peak Stage (25-yr, 24-hr storm)	20.00

3.1.3 Pond Inflow

Continuous inflow hydrographs were recorded at the Navy Canal pond at 10-minute intervals from March 1, 2008-February 28, 2009. In addition to the continuous inflow hydrographs, information was also provided on total daily volume and cumulative total volume for the period of record.

A graphical summary of inflow hydrographs to the Navy Canal pond from March 2008-February 2009 is given on Figure 3-3. Inflows into the pond ranged from less than 1 cfs to more than 120 cfs during the 12-month monitoring period. The highest inflow rates were associated with Tropical Storm Fay, while the remaining inflows appear to be primarily in the range of 10-15 cfs or less.

An expanded view of inflow hydrographs entering the Navy Canal pond is given on Figure 3-4. With the exception of the event associated with Tropical Storm Fay, the vast majority of inflows into the Navy Canal pond appear to be approximately 5 cfs or less. A constant baseflow of approximately 1 cfs or less was observed entering the pond throughout most of the monitoring program. The observed responses to rainfall events in the Navy Canal drainage basin appear to be relatively small at this time and reflect the largely undeveloped nature of the drainage basin. Peak inflow rates into the pond can be expected to increase over time as more portions of the drainage basin become developed.

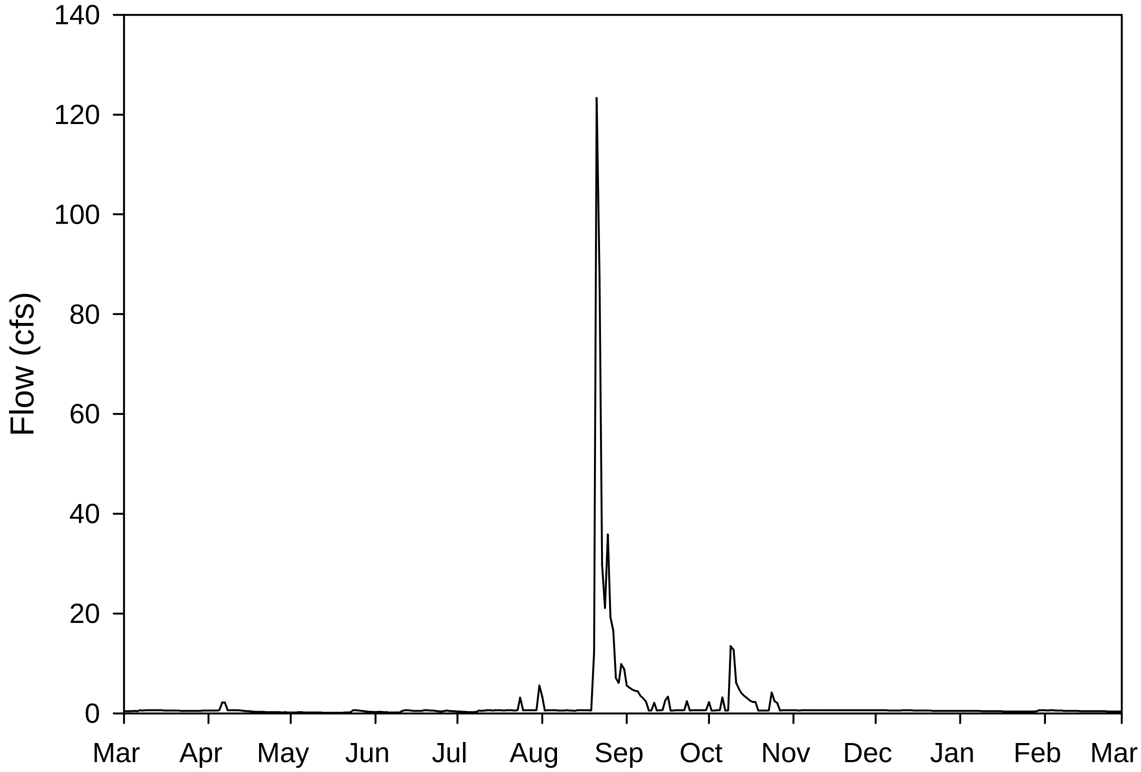


Figure 3-3. Inflow Hydrographs to the Navy Canal Pond from March 2008-February 2009.

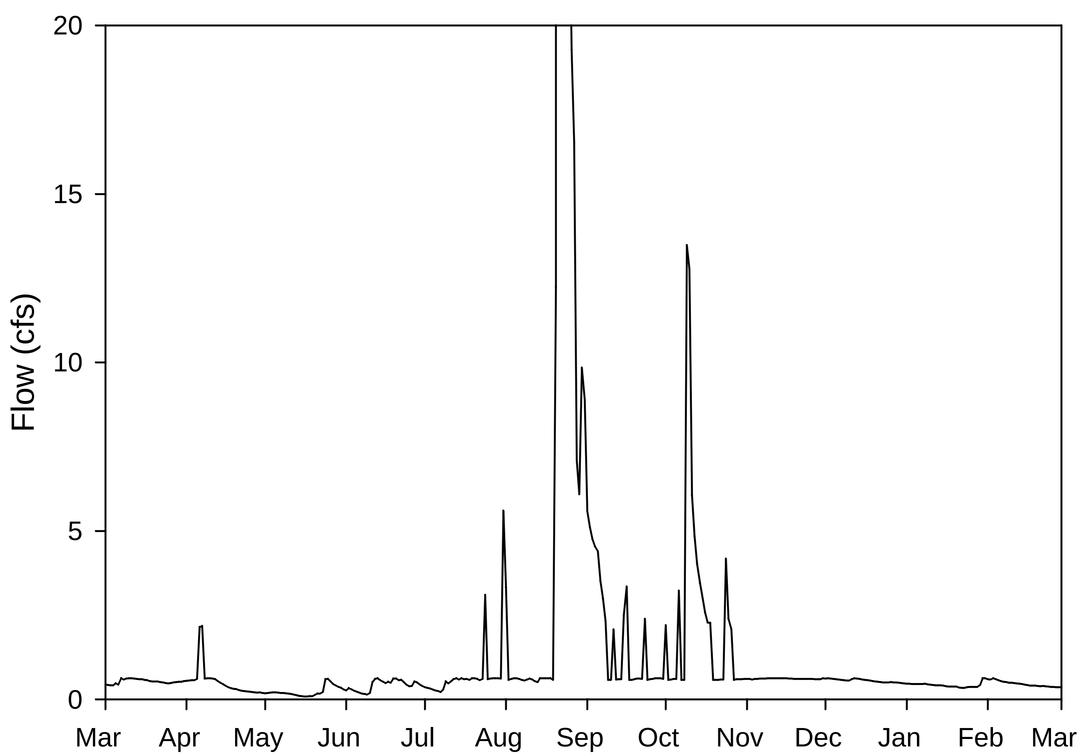


Figure 3-4. Expanded View of Inflow Hydrographs to the Navy Canal Pond from March 2008-February 2009.

The estimated monthly inflow into the wet detention pond from Navy Canal was calculated on a monthly basis by integrating the area under the hydrograph curve for each month of the monitoring program. However, the inflow hydrographs to the Navy Canal pond, illustrated on Figures 3-3 and 3-4, reflect the combined inflows from stormwater runoff as well as inter-event baseflow. Estimates of the inflow contribution from baseflow were obtained by examining the low flow portions of the inflow hydrograph on a monthly basis. Estimates of the inter-event baseflow were generated by evaluating hydrograph characteristics between significant rain events. Estimates of the average inflow rate represented by these inter-event periods were developed for each month of the 12-month monitoring program and used to calculate the baseflow volume discharged during each month. The different between the total measured inflow and baseflow volumes is assumed to reflect inflow which occurred under storm event conditions.

A summary of estimated monthly baseflow and runoff inputs to the Navy Canal pond from March 2008-February 2009 is given in Table 3-6. The estimated total inflow volume (summarized in the final column of Table 3-6) reflects the volume obtained by integration of the inflow hydrograph for the pond. The portion of the total inflow contributed by inter-event baseflow is calculated by multiplying the estimated monthly baseflow discharge rates times the number of days in each month. The difference between the total inflow and the baseflow is assumed to reflect inflow under storm event conditions.

TABLE 3-6

ESTIMATED MONTHLY BASEFLOW AND RUNOFF INPUTS TO THE NAVY CANAL POND FROM MARCH 2008-FEBRUARY 2009

MONTH	BASEFLOW		RUNOFF	TOTAL INFLOW
	cfs	ac-ft	(ac-ft)	(ac-ft)
March	0.50	29.63	3.46	33.09
April	0.32	19.15	13.07	33.22
May	0.20	11.47	4.32	15.78
June	0.30	17.28	8.00	24.92
July	0.50	28.99	15.68	44.67
August	0.62	36.86	733.5	770.4
September	0.60	35.99	71.39	107.4
October	0.60	36.37	117.8	154.2
November	0.60	36.59	0.44	37.03
December	0.58	34.36	0.36	34.73
January	0.42	25.28	0.76	26.03
February	0.39	23.39	3.10	26.50
TOTAL:	**--**	**335**	**972**	**1307**

Measured inflow into the pond ranged from a low of 15.78 ac-ft during May 2008 to a high of 770.4 ac-ft during August 2008. The total inflow into the pond during the 12-month monitoring program is approximately 1307.0 ac-ft. Approximately 26% of the total inflow was contributed by inflow, with 74% contributed by stormwater runoff.

Calculated runoff coefficients for the Navy Canal drainage basin are summarized in Table 3-7. These values are calculated as the ratio of the runoff inflow to the calculated rainfall volume which fell over the 820-acre drainage basin during each month of the study. Baseflow inputs are not included in this analysis. Runoff coefficients within the Navy Canal drainage basin are relatively low in value throughout most of the monitoring program. With the exception of the period from August-October, runoff coefficients for the Navy Canal drainage basin ranged from 0.005-0.108. However, during the extreme rainfall which occurred in August 2008, the runoff coefficient increased to 0.662 as the ground became saturated within the drainage basin and the runoff potential increased. Elevated runoff coefficients continued to be observed over the next two months in spite of substantially lower rainfall depths due to the extremely saturated conditions within the drainage basin following Tropical Storm Fay. Overall, the mean runoff coefficient for the Navy Canal drainage basin was 0.305 during the monitoring program, indicating that approximately 30.5% of the direct rainfall entered the Navy Canal pond as measurable inflow.

TABLE 3-7

SUMMARY OF HYDROLOGIC INPUTS TO THE NAVY CANAL POND FROM MARCH 2008-FEBRUARY 2009

MONTH	RUNOFF INFLOW (ac-ft)	RAINFALL (inches)	RUNOFF COEFFICIENT (C Value)
March	3.56	2.65	0.019
April	13.07	1.91	0.100
May	4.32	1.52	0.042
June	8.00	3.87	0.030
July	15.68	8.22	0.028
August	733.5	16.22	0.662
September	71.39	3.41	0.306
October	117.8	4.73	0.364
November	0.44	0.84	0.008
December	0.36	0.75	0.007
January	0.76	2.04	0.005
February	3.10	0.42	0.108
TOTAL:	**972.0**	**46.58**	**0.305**

3.1.4 Pond Outflow

As discussed previously, discharges from the Navy Canal pond can occur through two separate conveyances. Ordinary storm events discharge primarily through the weir system associated with the outfall control structure located on the northwest corner of the pond. A continuous record of discharges was conducted at this site inside the 24-inch RCP which discharges from the outfall structure, with flow measurements recorded at 10-minute intervals. In addition, information was also collected on total daily volume and cumulative total volume for the period of record at this site.

A graphical summary of discharge hydrographs measured at the pond outfall structure is given on Figure 3-5. The vast majority of measured discharge rates at this site are less than 5 cfs, with the exception of the events associated with Tropical Storm Fay when the outfall discharge rate increased to approximately 19 cfs. In the absence of significant storm events, a constant discharge was observed from the pond at a rate of approximately 0.5 cfs or less. This constant discharge corresponds closely to the baseflow inputs into the pond summarized on Figure 3-4.

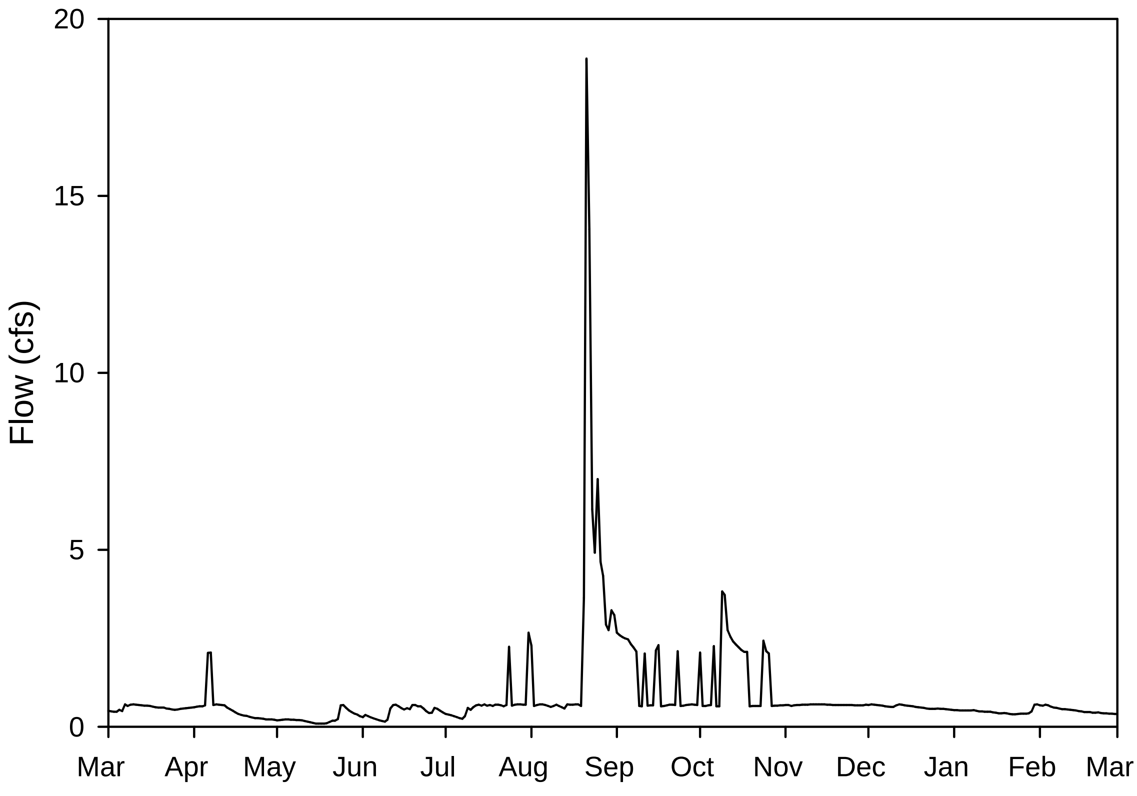


Figure 3-5. Discharge Hydrographs through the Pond Outfall Structure.

During extreme storm events, discharges from the pond can also occur through the diversion/spillway structure over the 50-ft rectangular weir which discharges directly downstream into Navy Canal. Calculated discharge hydrographs at this site are presented on Figure 3-6. The hydrographs provided in this figure were calculated based upon the water level elevations obtained from the digital water level recorder and the following standard broad-crested weir equation:

$$Q = K (L - 0.2H) H^{1.5}$$

where:

Q	=	discharge (cfs)
H	=	head on weir (ft)
L	=	crest length (50 ft)
K	=	discharge coefficient (2.67 for broad-crested weir)

In general, relatively few discharges occurred over the diversion/spillway weir structure. The most notable discharge occurred during August 2008 as a result of Tropical Storm Fay when discharge over the diversion/spillway structure exceeded 100 cfs. However, in the absence of this event, only a handful of events would have occurred during the monitoring period which resulted in discharges through this structure.

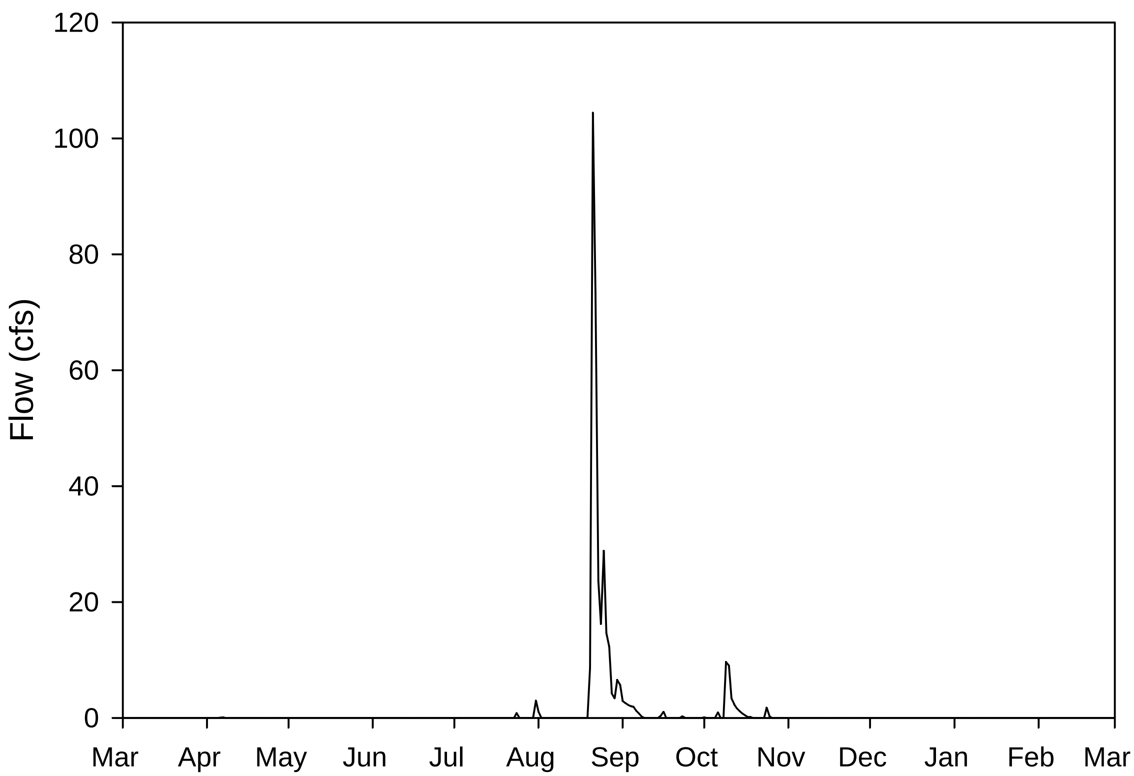


Figure 3-6. Discharge Hydrographs for the Diversion/Spillway Structure (50-ft Rectangular Weir).

A summary of discharges from the Navy Canal pond from March 2008-February 2009 is given in Table 3-8. During 8 of the 12 months included in the monitoring program, virtually all of the inflows into the pond discharged through the normal pond outfall structure. Significant discharges over the spillway structure were observed during the period from July-October 2008. The most significant of these discharges was associated with Tropical Storm Fay during August 2008 when approximately 77% of the inputs exited the pond over the spillway structure. However, the volume of approximately 600 ac-ft which was discharged over the spillway structure during August is equivalent to almost 50% of the pond inflow over the 12-month monitoring program. With this significant volume included in the discharges, approximately 53% of the pond inflow discharged over the spillway structure, with 47% discharging through the normal pond outfall structure. If the excessive runoff inflows had not occurred during August 2008, approximately 80% of the pond inputs would have discharged through the normal outfall structure, with approximately 20% discharging over the spillway structure. Photographs of the discharges over the spillway structure under low flow and high flow conditions are given on Figure 3-7.

TABLE 3-8

SUMMARY OF DISCHARGES FROM THE NAVY CANAL POND FROM MARCH 2008-FEBRUARY 2009

MONTH	POND DISCHARGES			
	OUTFALL STRUCTURE		SPILLWAY STRUCTURE	
	ac-ft	% of Discharge	ac-ft	% of Discharge
March	32.79	100	0.00	0
April	31.05	99	0.28	1
May	14.35	100	0.00	0
June	25.10	100	0.00	0
July	39.36	84	7.49	16
August	176.0	23	600.4	77
September	77.22	72	30.70	28
October	92.56	60	62.76	40
November	36.59	100	0.00	0
December	34.36	100	0.00	0
January	26.18	100	0.00	0
February	25.79	100	0.00	0
TOTAL:	**611.3**	**47**	**701.6**	**53**

a. Low Flow Conditions

b. High Flow Conditions

Figure 3-7. Discharges Over the Spillway Structure.

3.1.5 Pond Evaporation

As discussed in Section 2, a Class A pan evaporimeter was installed on a level wooden platform adjacent to the Navy Canal pond. Changes in water level within the pan were recorded at approximately one week intervals and corrected for rainfall which occurred during the preceding period to obtain estimates of pan evaporation. The pan evaporation measurements were then multiplied by the standard factor of 0.7 to produce estimates of evaporation from the pond surface.

A graphical summary of monthly lake evaporation measured at the Navy Canal pond site from March 2008-February 2009 is given on Figure 3-8. The values summarized in this figure reflect the measured pan evaporation values multiplied by 0.7. Although the month of August is normally associated with relatively high evaporation rates, a lake evaporation of less than 1 inch was recorded at the Navy Canal pond site during August 2008. This month was characterized by periods of extended rainfall which reduced available opportunities for evaporation processes. Overall, lake evaporation at the Navy Canal pond site was approximately 32.19 inches over the period from March 2008-February 2009.

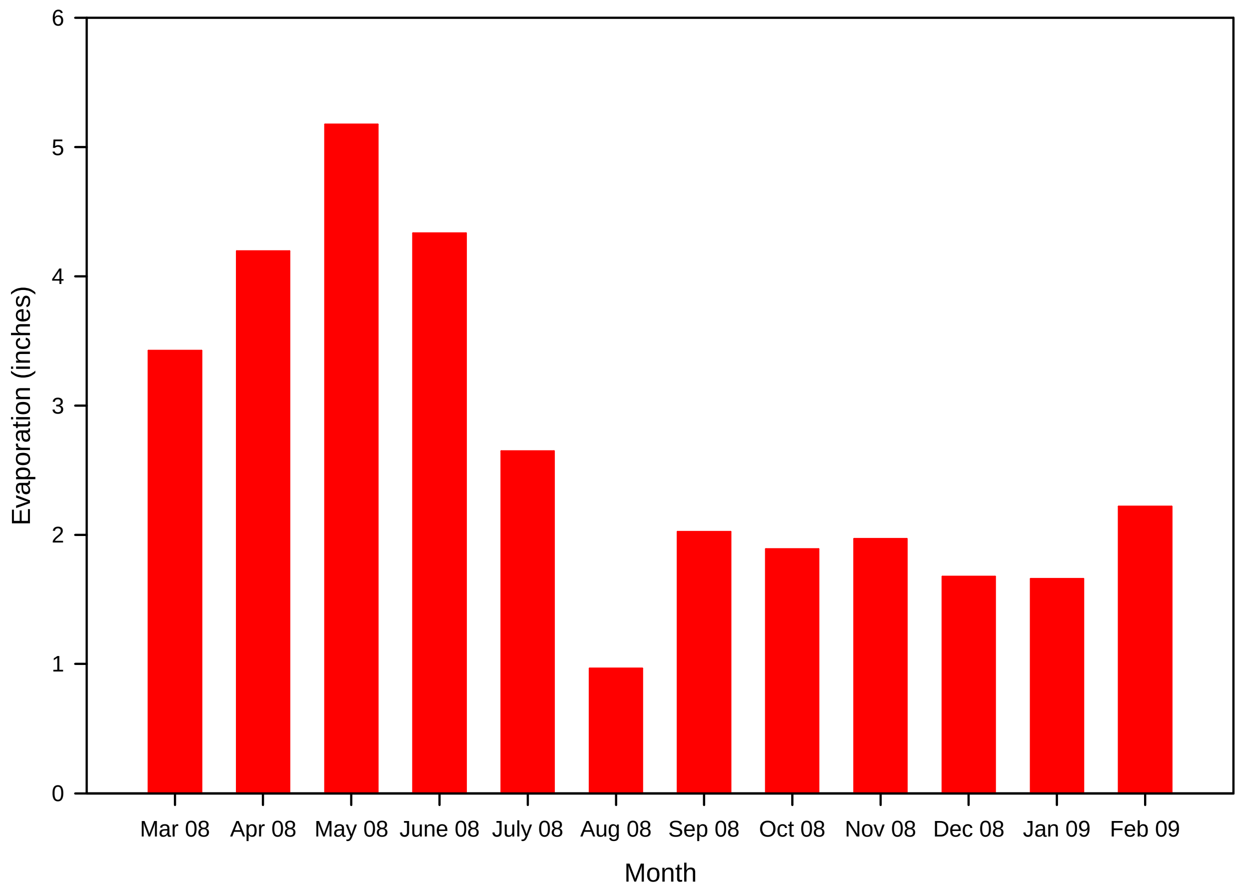


Figure 3-8. Monthly Lake Evaporation Measured at the Navy Canal Pond Site from March 2008-February 2009.

A summary of estimated evaporation losses at the Navy Canal pond from March 2008-February 2009 is given on Table 3-9. Monthly evaporation is provided for each month included in the 12-month study period. Pond evaporation is calculated by multiplying the evaporation depth (in inches) times the pond area of 4.7 acres. Evaporation losses removed approximately 12.61 ac-ft of water from the Navy Canal pond over the monitoring period.

TABLE 3-9

ESTIMATED EVAPORATION LOSSES AT THE NAVY CANAL POND FROM MARCH 2008-FEBRUARY 2009

MONTH	EVAPORATION (inches)	EVAPORATION (ac-ft)	MONTH	EVAPORATION (inches)	EVAPORATION (ac-ft)
March	3.42	1.34	September	2.02	0.79
April	4.20	1.65	October	1.89	0.74
May	5.18	2.03	November	1.97	0.77
June	4.33	1.70	December	1.68	0.66
July	2.65	1.04	January	1.66	0.65
August	0.97	0.38	February	2.22	0.87
			TOTAL:	**32.19**	**12.61**

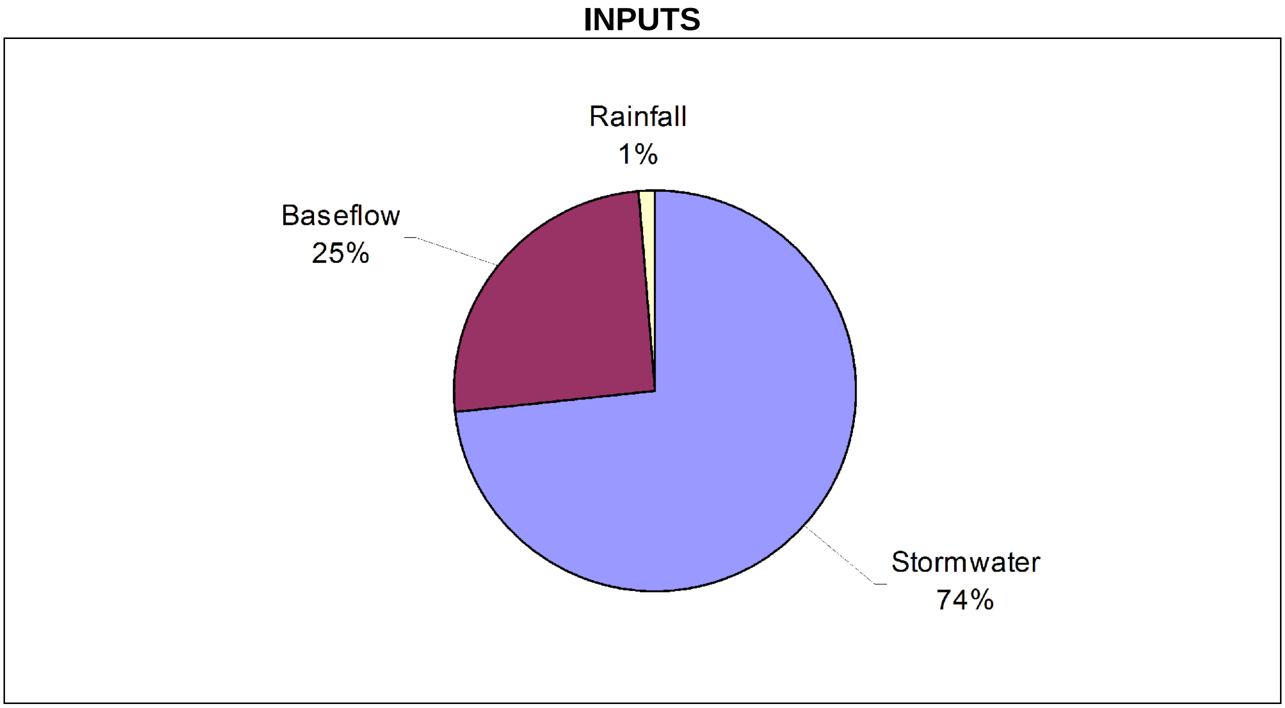
3.1.6 Hydrologic Budget

A monthly hydrologic budget for the Navy Canal pond is given in Table 3-10. Inputs into the pond include direct rainfall and inflow from Navy Canal. Losses from the pond include evaporation and discharges through the pond outfall and spillway structure.

A graphical comparison of hydrologic inputs and losses for the Navy Canal pond is given on Figure 3-9. Approximately 74% of the inflow to the pond originated from stormwater runoff, with 25% from inter-event baseflow and 1% contributed by direct rainfall. Approximately 53% of the discharges from the pond occur over the spillway structure, with 46% of the losses occurring through the normal pond outfall structure and 1% as a result of evaporation.

3.1.7 Hydraulic Residence Time

An estimate of the average detention time within the wet detention pond was conducted by dividing the estimated pond volume of 46.0 ac-ft (as summarized in Table 1-1) by the sum of the total monthly inputs (summarized in Table 3-10). Based upon this analysis, the mean residence time within the pond was approximately 12.7 days. However, had Tropical Storm Fay not occurred during the monitoring program, the calculated pond detention time would have likely been in the range of approximately 20-25 days.



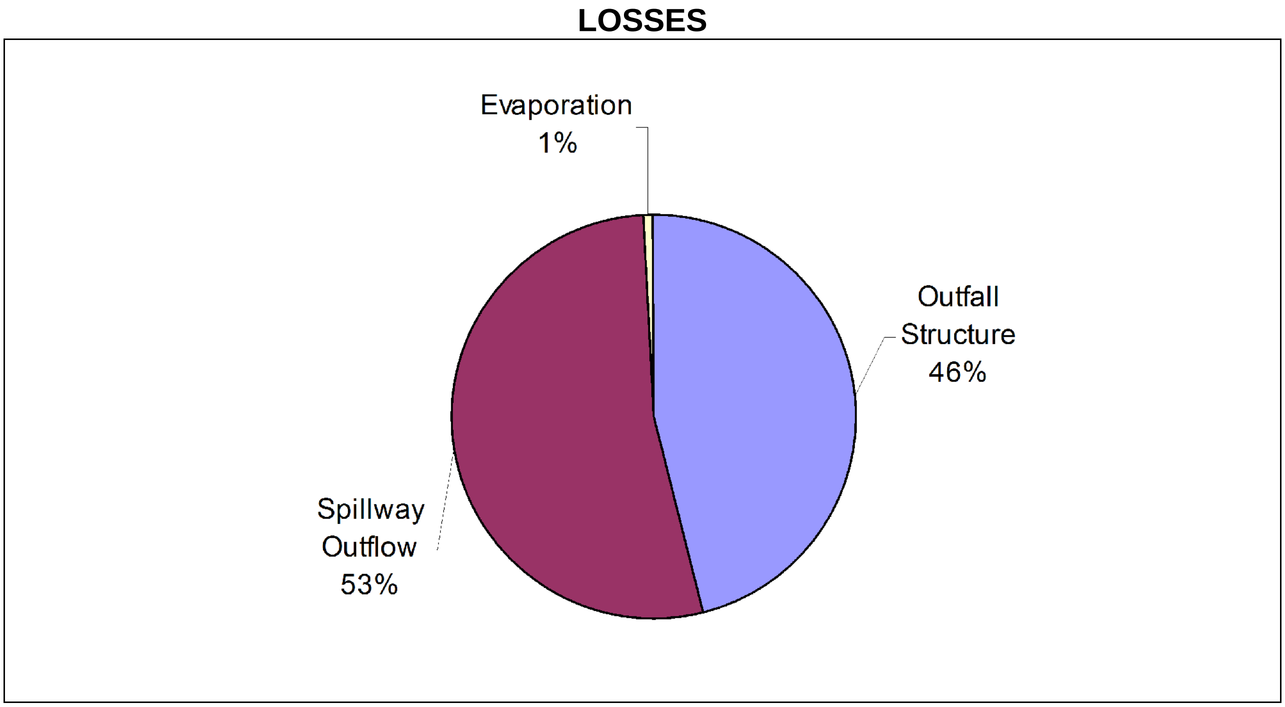


Figure 3-9. Comparison of Hydrologic Inputs and Losses for the Navy Canal Pond.

TABLE 3-10

MONTHLY HYDROLOGIC BUDGETS FOR THE NAVY CANAL POND

MONTH	POND INPUTS (ac-ft)				POND LOSSES (ac-ft)			
	RAINFALL	STORM-WATER	BASEFLOW	TOTAL	EVAPORATION	OUTFALL STRUCTURE	SPILLWAY STRUCTURE	TOTAL
March	1.04	3.46	29.63	34.13	1.34	32.79	0.00	34.13
April	0.75	13.07	19.15	32.97	1.64	31.05	0.28	32.97
May	0.60	4.32	11.45	16.38	2.03	14.35	0.00	16.38
June	1.52	8.00	17.28	26.44	1.70	24.74	0.00	26.44
July	3.22	15.68	28.99	47.89	1.04	39.36	7.49	47.89
August	6.35	733.5	36.86	776.75	0.38	176.0	600.4	776.8
September	1.34	71.39	35.99	108.71	0.79	77.22	30.70	108.7
October	1.85	117.8	36.37	156.06	0.74	92.56	62.76	156.1
November	0.33	0.44	36.59	37.36	0.77	36.59	0.00	37.36
December	0.29	0.36	34.36	35.02	0.66	34.36	0.00	35.02
January	0.80	0.76	25.28	26.83	0.65	26.18	0.00	26.83
February	0.16	3.10	23.39	26.66	0.87	25.79	0.00	26.66
TOTAL:	**18.25**	**972.0**	**335.0**	**1325.2**	**12.61**	**611.0**	**701.6**	**1325.2**
PERCENTAGE	**1**	**74**	**25**	**100**	**1**	**46**	**53**	**100**

3.2 Chemical Characteristics of Monitored Inputs and Outputs

A summary of sample collection activities conducted at the Navy Canal pond site from March 2008-February 2009 is given in Table 3-11. A total of 40 separate stormwater inflow samples was collected at the box culvert inflow into the pond. An additional 20 baseflow samples were collected to characterize the constant low level inflow between storm events. A total of 50 samples was collected at the pond outfall to evaluate the characteristics of discharges from the pond, and 22 samples were collected for bulk precipitation. A complete listing of the results of laboratory analyses conducted on stormwater, baseflow, outfall, and bulk precipitation samples is given in Appendix B.

In addition to the samples listed previously, 38 vertical field profiles were also collected within the pond to evaluate changes in water quality characteristics with pond depth. A complete listing of vertical field profiles collected at the Navy Canal pond site from March 2008-February 2009 is given in Appendix C.

TABLE 3-11

SUMMARY OF SAMPLE COLLECTION PERFORMED AT THE NAVY CANAL POND SITE

SAMPLE TYPE	NUMBER OF SAMPLES COLLECTED
Stormwater Inflow	40
Baseflow	20
Pond Outfall	50
Bulk Precipitation	22
Vertical Field Profiles	38

3.2.1 Vertical Field Profiles

Vertical field profiles of temperature, pH, conductivity, dissolved oxygen, and redox potential were conducted on 38 separate occasions in the Navy Canal pond over the 12-month monitoring program. A compilation of vertical field profiles collected at the Navy Canal pond site is given in Figure 3-10. The profiles provided in this figure represent the mean of vertical profiles collected during fall, spring, summer, and winter conditions. The vertical field profiles begin at a water depth of 0.25 m and continue at increments of 0.5 m to the pond bottom which ranges from approximately 2.5-3 m in depth.

In general, temperature within the pond was relatively uniform during virtually all of the monitoring dates, with only a slight decrease in temperature with increasing pond depth. No evidence of significant thermal stratification was observed within the pond during any of the monitoring dates. Temperature differences of approximately 1-2^{o}C or less were observed between top and bottom measurements in the pond on most dates.

Measured pH profiles within the pond were also relatively uniform throughout the monitoring program. A slight decrease in pH with increasing water depth was observed during spring, summer, and winter conditions, with a slight increase in pH with increasing water depth observed during fall conditions. In general, differences in pH between surface and bottom measurements were generally 0.5 units or less. The measured pH within the pond was approximately neutral during fall, spring, and summer conditions, with a slightly higher pH measured during winter conditions.

Measured conductivity values within the pond were also relatively uniform throughout most of the monitoring program. A slight increase in specific conductivity was observed in lower portions of the pond during fall, spring, and winter conditions, with bottom values approximately 10% higher than values measured near the water surface.

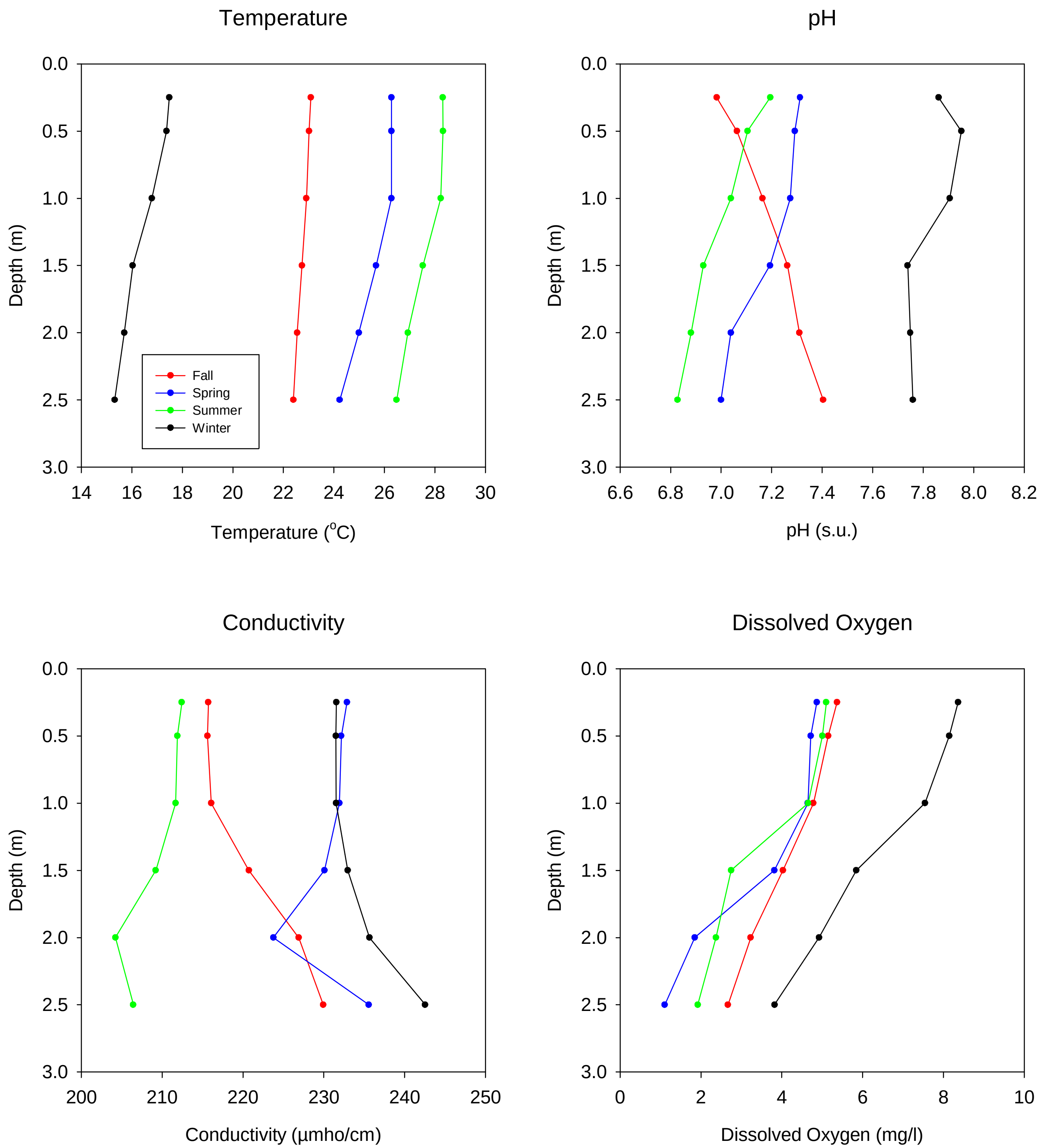


Figure 3-10. Compilation of Vertical Depth Profiles Collected at the Navy Canal Pond Site.

Relatively good levels of dissolved oxygen were maintained within the pond throughout most of the monitoring period. A trend of decreasing dissolved oxygen with increasing water depth was observed during virtually every monitoring event. The lowest levels of dissolved oxygen were observed during spring and summer conditions, with slightly higher levels of dissolved oxygen observed during winter conditions. On an average basis, aerobic conditions (defined as dissolved oxygen levels in excess of 1 mg/l) were maintained within the pond during most events. No significant evidence of oxygen depletion was observed within the pond, with the exception of a limited number of measurements collected near the water-sediment interface.

In general, the Navy Canal pond appears to be relatively well mixed, as evidenced by the relatively isograde conditions observed for temperature and pH. Dissolved oxygen levels within the pond appear to be adequate to support decomposition processes for biologically degradable materials as well as aquatic wildlife. The slight increases in specific conductivity observed in lower layers of the pond suggests that a limited amount of internal recycling may be occurring within the pond.

3.2.2 **Bulk Precipitation**

A total of 25 bulk precipitation samples was collected at the Navy Canal pond site during the 12-month monitoring program. A complete listing of the characteristics of each of the monitored bulk precipitation events is given in Appendix B.1.

A summary of laboratory measurements conducted on bulk precipitation samples collected from the Navy Canal pond site from March 2008-February 2009 is given on Table 3-12. The mean values summarized in this table reflect the mean of the log transformed data. The collected bulk precipitation samples ranged from acidic to neutral, with individual sample pH values ranging from 4.56-7.20 and an overall mean of 5.46. The bulk precipitation samples were very poorly buffered, with measured alkalinity values ranging from 0.2-3.8 mg/l and an overall mean of 1.6 mg/l. Bulk precipitation was also characterized by low ionic strength, with a mean conductivity of only 14 μmho/cm.

Measured nitrogen concentrations in the bulk precipitation samples were slightly lower than concentrations measured by ERD in other portions of Central Florida. Bulk precipitation was characterized by a mean total nitrogen concentration of 369 μg/l, with measured values ranging from 42-1398 μg/l. Approximately 33% of the total nitrogen measured in bulk precipitation was contributed by NO_x, with approximately 20-27% contributed by ammonia, dissolved organic nitrogen, and particulate nitrogen.

Measured total phosphorus concentrations in bulk precipitation at the Navy Canal pond site were also similar to values commonly measured by ERD in the Central Florida area, with a mean total phosphorus concentration of 14 μg/l and measured values ranging from 2-175 μg/l. Particulate phosphorus contributed more than half of the total phosphorus measured in bulk precipitation, with approximately 21% of the total phosphorus contributed each by soluble reactive phosphorus (SRP) and dissolved organic phosphorus.

In general, bulk precipitation collected at the Navy Canal pond site exhibited low concentrations for both turbidity and TSS, with values which are lower than precipitation measured in other parts of Central Florida. The mean turbidity value of 1.3 NTU measured in bulk precipitation is extremely low in value for bulk precipitation.

TABLE 3-12

SUMMARY OF LABORATORY MEASUREMENTS CONDUCTED ON BULK PRECIPITATION SAMPLES COLLECTED FROM THE NAVY CANAL POND SITE FROM MARCH 2008-FEBRUARY 2009

PARAMETER	UNITS	MEAN	RANGE OF VALUES
pH	s.u.	5.46	4.56 - 7.20
Conductivity	μmho/cm	14	2.0 - 31.7
Alkalinity	mg/l	1.6	0.2 - 3.8
NH_3	μg/l	73	<5 - 428
NO_x	μg/l	123	<5 – 572
Diss. Organic N	μg/l	75	<25 – 485
Particulate N	μg/l	98	3 – 294
Total N	μg/l	369	42 – 1398
SRP	μg/l	3	<1 – 150
Diss. Organic P	μg/l	3	<1 – 14
Particulate P	μg/l	8	<1 – 53
Total P	μg/l	14	2 – 175
TSS	mg/l	3.2	0.8 – 21.0
Turbidity	NTU	1.3	0.3 – 10.1

A graphical comparison of the chemical characteristics of bulk precipitation samples collected at the Navy Canal pond site was developed for general parameters, nitrogen species, and phosphorus species. A graphical summary of data for each parameter is presented in the form of Tukey box plots, also often called "box and whisker plots". The bottom line of the box portion of each plot represents the lower quartile, with 25% of the data points falling below this value. The upper line of the box represents the 75% upper quartile, with 25% of the data falling above this value. The **blue** horizontal line within the box represents the median value, with 50% of the data falling both above and below this value. The **red** horizontal line within the box represents the mean of the data points. The vertical lines, also known as "whiskers", represent the 5 and 95 percentiles for the data sets. Individual values which fall outside of the 5-95 percentile range, sometimes referred to as "outliers", are indicated as **red dots**.

A statistical comparison of general parameters measured in bulk precipitation at the Navy Canal pond site is given on Figure 3-11. In general, the collected bulk precipitation samples exhibited a relatively low degree of variability for pH, conductivity, and TSS, with the majority of measured values falling within a relatively narrow range.

A statistical comparison of nitrogen species measured in bulk precipitation at the Navy Canal pond site is given on Figure 3-12. A relatively low degree of variability is apparent in measured concentrations for ammonia, particulate nitrogen, and total nitrogen in bulk precipitation. However, a somewhat larger degree of variability is apparent for measured concentrations of NO_x at the Navy Canal pond site. Outlier values greater than 2 standard deviations from the mean are present for each of the measured nitrogen species.

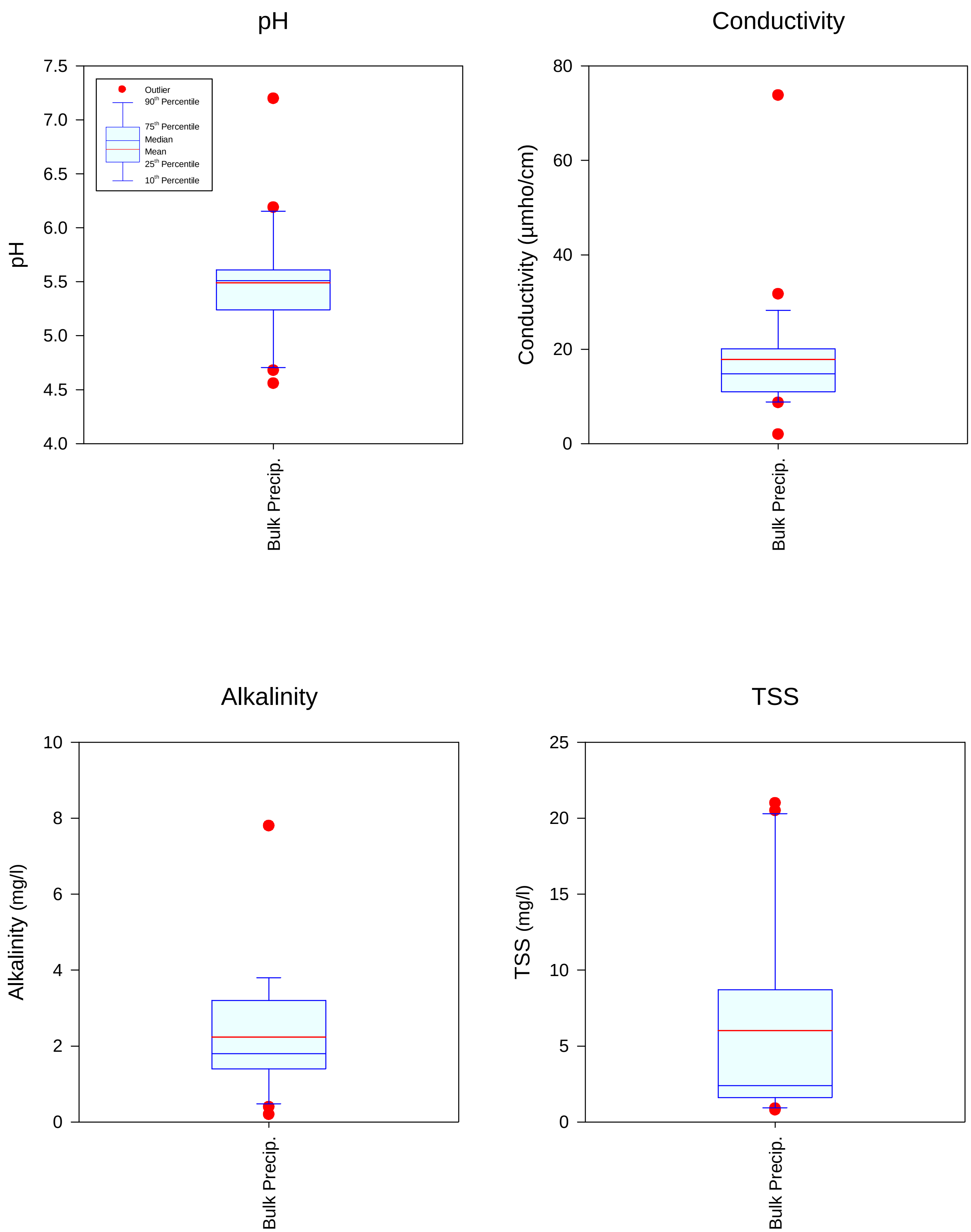


Figure 3-11. Statistical Comparison of General Parameters Measured in Bulk Precipitation at the Navy Canal Pond Site.

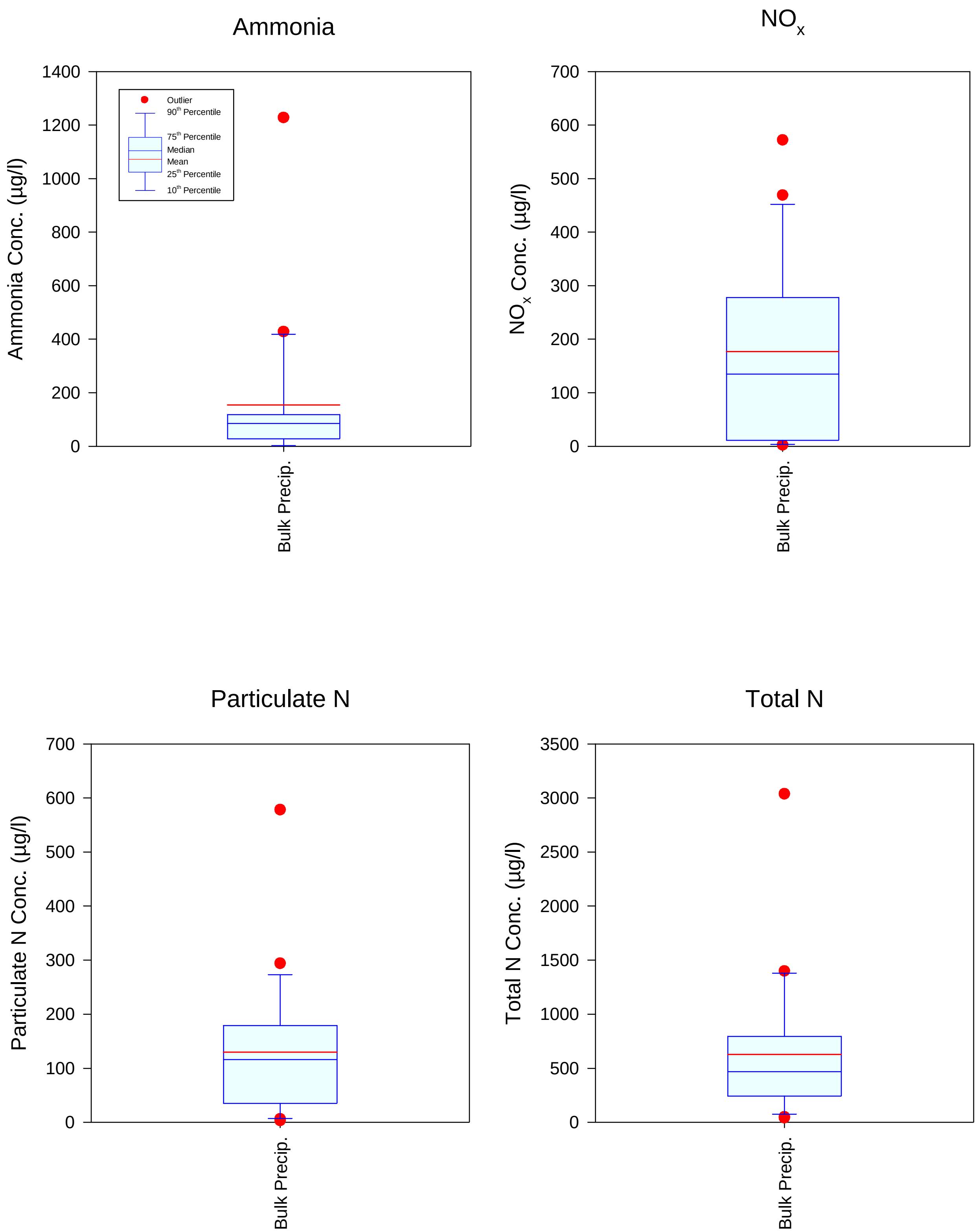


Figure 3-12. Statistical Comparison of Nitrogen Species Measured in Bulk Precipitation at the Navy Canal Pond Site.

A statistical comparison of phosphorus species measured in bulk precipitation samples collected at the Navy Canal pond site is given in Figure 3-13. A relatively low degree of variability was observed for measured concentrations of each of the phosphorus species. However, significant outlier values are apparent for each phosphorus species.

3.2.3 Navy Canal Inflow

Inflow from Navy Canal into the wet detention pond was divided into samples associated with storm events as well as samples which appear to be inter-event baseflow. A total of 40 stormwater inflow and 20 baseflow samples was collected at the inflow monitoring site designated as Site 1. A complete listing of laboratory analyses for each of the individual samples collected at this site is given in Appendix B.2 for stormwater inflow and in Appendix B.3 for baseflow inputs.

3.2.3.1 Stormwater

A summary of laboratory measurements conducted on stormwater runoff samples collected from the Navy Canal pond site from March 2008-February 2009 is given on Table 3-13. The mean values summarized in this table reflect the mean of the log transformed data. Runoff inputs into the Navy Canal pond were approximately neutral in pH, with a mean pH of 7.23, and moderately buffered, with a mean alkalinity of 53.2 mg/l. Runoff inflow was characterized by a mean specific conductivity of 175 μmho/cm which is somewhat lower than conductivity values commonly observed in urban runoff.

TABLE 3-13

SUMMARY OF LABORATORY MEASUREMENTS CONDUCTED ON STORMWATER RUNOFF SAMPLES COLLECTED FROM THE NAVY CANAL POND SITE FROM MARCH 2008-FEBRUARY 2009

PARAMETER	UNITS	MEAN	RANGE OF VALUES
pH	s.u.	7.23	6.79 – 7.75
Conductivity	μmho/cm	175	86 – 249
Alkalinity	mg/l	53.2	26.4 – 68.0
NH_3	μg/l	45	<5 – 144
NO_x	μg/l	12	<5 – 190
Diss. Organic N	μg/l	301	186 – 418
Particulate N	μg/l	70	<25 – 277
Total N	μg/l	428	299 – 661
SRP	μg/l	4	<1 – 19
Diss. Organic P	μg/l	2	<1 – 23
Particulate P	μg/l	11	<1 – 77
Total P	μg/l	17	5 – 100
TSS	mg/l	2.7	<0.7 – 38.2
Turbidity	NTU	1.5	0.4 – 38.2

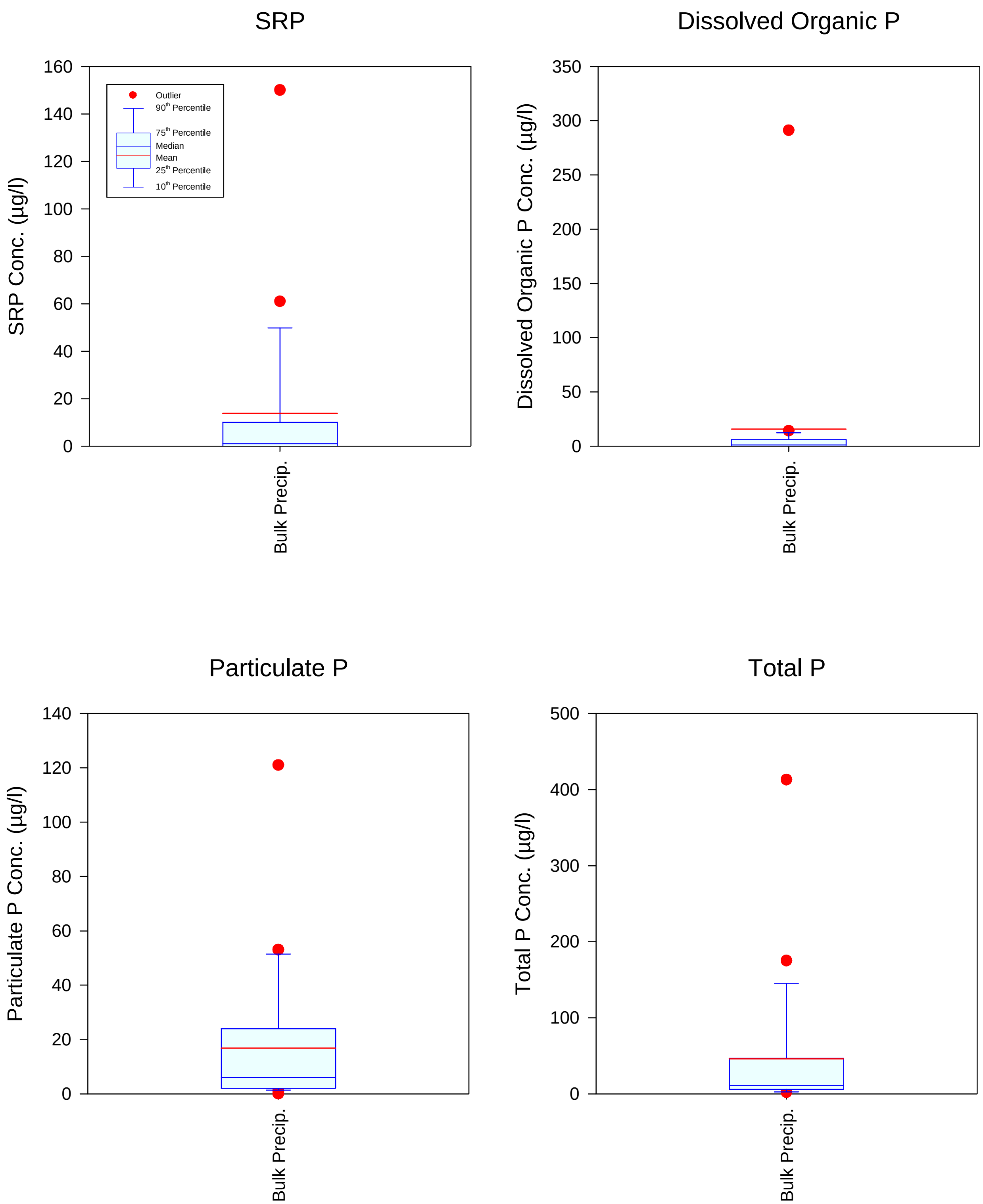


Figure 3-13. Statistical Comparison of Phosphorus Species Measured in Bulk Precipitation at the Navy Canal Pond Site.

Extremely low levels of nitrogen species were observed in runoff entering the Navy Canal pond, with a mean ammonia concentration of 45 μg/l and a mean NO_x concentration of only 12 μg/l. The dominant nitrogen species in runoff inputs to the pond was dissolved organic nitrogen which contributed 70% of the total nitrogen inflow. Concentrations of particulate nitrogen were extremely low in value, with a mean of only 70 μg/l. The mean measured total nitrogen of 428 μg/l is approximately 5 times lower than nitrogen concentrations commonly observed in urban runoff. The low concentrations of nitrogen observed in stormwater runoff are characteristic of the low level of development which currently exists within the Navy Canal drainage basin.

Extremely low levels of total phosphorus were also measured in runoff entering the Navy Canal pond site, with a mean total phosphorus concentration of only 17 μg/l. This value is approximately 10-15 times lower than concentrations commonly observed in urban runoff. Extremely low levels of SRP and dissolved organic phosphorus were also observed at the site, with a mean of 4 μg/l for SRP and 2 μg/l for dissolved organic phosphorus. The dominant phosphorus species entering the Navy Canal site is particulate phosphorus which contributed 65% of the total phosphorus inputs, but the mean particulate phosphorus of 11 μg/l is extremely low in value. The low levels of phosphorus in stormwater runoff are reflective of the low degree of development within the basin.

Extremely low levels were also observed for both TSS and turbidity, with a mean TSS concentration of only 2.7 mg/l and a mean turbidity of 1.5 NTU. These mean values are extremely low compared with concentrations commonly observed in urban runoff.

3.2.3.2 Baseflow

A summary of laboratory measurements conducted on baseflow samples collected from the Navy Canal pond site from March 2008-February 2009 is given in Table 3-14. The mean values summarized in this table reflect the mean of the log transformed data. The baseflow samples collected at this site represent the continuous inflow into the pond which occurs between storm events. Baseflow samples collected at the Navy Canal pond site were approximately neutral in pH, with a mean of 7.28, and moderately buffered, with a mean alkalinity of 55.6 mg/l. The mean conductivity of 186 μmho/cm is similar to conductivity values observed in baseflow samples.

Measured nitrogen concentrations in baseflow samples were extremely low in value and similar to nitrogen characteristics observed in stormwater runoff. Extremely low levels of ammonia, NO_x, and particulate nitrogen were observed in baseflow samples. The dominant nitrogen species in baseflow was dissolved organic nitrogen which contributed 72% of the nitrogen measured. The mean baseflow total nitrogen concentration of 418 μg/l is extremely low in value and approximately 2-4 times less than nitrogen concentrations commonly observed in dry weather baseflow.

Extremely low levels of phosphorus species were measured in baseflow entering the Navy Canal pond site. The mean measured concentration of 2 μg/l for both SRP and dissolved organic phosphorus are near the lower limits of detection for these tests. The dominant phosphorus species measured in baseflow is particulate phosphorus which contributed 69% of the total phosphorus measured. The overall total phosphorus mean of 13 μg/l is 5-10 times lower than phosphorus concentrations commonly observed in dry weather baseflow.

TABLE 3-14

SUMMARY OF LABORATORY MEASUREMENTS CONDUCTED ON BASEFLOW SAMPLES COLLECTED FROM THE NAVY CANAL POND SITE FROM MARCH 2008-FEBRUARY 2009

PARAMETER	UNITS	MEAN	RANGE OF VALUES
pH	s.u.	7.28	6.90 – 7.78
Conductivity	μmho/cm	186	80 – 253
Alkalinity	mg/l	55.6	34.6 – 69.8
NH_3	μg/l	26	<5 – 98
NO_x	μg/l	11	<5 – 74
Diss. Organic N	μg/l	299	19 – 420
Particulate N	μg/l	82	16 – 324
Total N	μg/l	418	172 – 830
SRP	μg/l	2	<1 – 8
Diss. Organic P	μg/l	2	<1 – 14
Particulate P	μg/l	9	<1 – 27
Total P	μg/l	13	4 – 39
TSS	mg/l	2.5	<0.7 – 54.5
Turbidity	NTU	1.3	0.3 – 6.6

In general, extremely low levels of both TSS and turbidity were observed in baseflow samples entering the Navy Canal pond site. The mean concentrations measured for TSS and turbidity in baseflow are similar to those measured in stormwater runoff entering the pond.

3.2.3.3 Summary

In general, extremely low levels were observed for virtually all measured parameters in both stormwater runoff and baseflow entering the Navy Canal pond site. These values suggest that the Navy Canal drainage basin exhibits extremely low loading rates under current conditions. As the drainage basin becomes developed, nutrient loadings may begin to increase, but this increase will be mitigated by the stormwater management systems which will be required for all new development.

3.2.3.4 Pond Outflow

A summary of laboratory measurements conducted on pond outflow samples collected from the Navy Canal pond site from March 2008-February 2009 is given in Table 3-15. The mean values summarized in this table reflect the mean of the log transformed data. Outflow samples from the pond were approximately neutral in pH, with a mean pH of 7.30, and moderately buffered, with a mean alkalinity of 49.8 mg/l. Mean conductivity in outflow samples is similar to conductivity values measured in runoff and baseflow.

TABLE 3-15

SUMMARY OF LABORATORY MEASUREMENTS CONDUCTED ON POND OUTFLOW SAMPLES COLLECTED FROM THE NAVY CANAL POND SITE FROM MARCH 2008-FEBRUARY 2009

PARAMETER	UNITS	MEAN	RANGE OF VALUES
pH	s.u.	7.30	6.75 – 7.82
Conductivity	µmho/cm	188	91 – 257
Alkalinity	mg/l	49.8	3.4 – 72.2
NH_3	µg/l	53	<5 – 203
NO_x	µg/l	15	<5 – 249
Diss. Organic N	µg/l	306	57 – 479
Particulate N	µg/l	112	12 – 410
Total N	µg/l	486	294 – 857
SRP	µg/l	2	<1 – 67
Diss. Organic P	µg/l	4	<1 – 84
Particulate P	µg/l	14	<1 – 83
Total P	µg/l	20	2 – 168
TSS	mg/l	2.8	1.0 – 16.8
Turbidity	NTU	1.9	0.5 – 15.7

Extremely low levels were observed for all measured nitrogen species in discharges from the Navy Canal pond. The measured concentrations for both ammonia and NO_x in pond outflow are very similar to concentrations measured in runoff and baseflow inputs. The mean total nitrogen concentration of 486 µg/l in pond outflow is slightly higher than the mean total nitrogen concentrations observed in stormwater and baseflow. The dominant nitrogen species in discharges from the pond was dissolved organic nitrogen which contributed 63% of the total nitrogen measured at the site.

Low levels of phosphorus species were also measured in discharges from the pond. Measured concentrations for SRP and dissolved organic phosphorus are similar to concentrations measured in runoff and baseflow inputs. The overall mean total phosphorus concentration of 20 µg/l in pond outflow is somewhat greater than phosphorus concentrations observed in runoff and baseflow inputs. The dominant phosphorus species in pond outflow is particulate phosphorus which contributed 70% of the total phosphorus measured.

In general, measured concentrations of TSS and turbidity in the pond outflow are similar to concentrations observed in both runoff and baseflow inputs. The mean concentration of 2.8 mg/l for TSS and 1.9 NTU for turbidity measured in the pond outflow reflect extremely low values.

3.2.3.5 Comparison of Inflow and Outflow Characteristics

A comparison of mean characteristics of stormwater, baseflow, and outflow samples collected at the Navy Canal pond site from March 2008-February 2009 is given in Table 3-16. In general, measured mean characteristics of stormwater, baseflow, and outflow are virtually identical for pH, conductivity, alkalinity, and nitrogen species. A slight increase in phosphorus concentrations was observed at the outflow compared with stormwater and baseflow inputs, primarily as a result of increases in dissolved organic phosphorus and particulate phosphorus during migration through the pond.

TABLE 3-16

COMPARISON OF MEAN CHARACTERISTICS OF STORMWATER BASEFLOW AND OUTFLOW AT THE NAVY CANAL POND SITE

PARAMETER	UNITS	POND INPUTS		POND OUTFLOW
		STORMWATER	BASEFLOW	
pH	s.u.	7.23	7.28	7.30
Conductivity	μmho/cm	175	186	188
Alkalinity	mg/l	53.2	55.6	49.8
NH_3	μg/l	45	26	53
NO_x	μg/l	12	11	15
Diss. Organic N	μg/l	301	299	306
Particulate N	μg/l	70	82	112
Total N	μg/l	428	418	486
SRP	μg/l	4	2	2
Diss. Organic P	μg/l	2	2	4
Particulate P	μg/l	11	9	14
Total P	μg/l	17	13	20
TSS	mg/l	2.7	2.5	2.8
Turbidity	NTU	1.5	1.3	1.9

A statistical comparison of general parameters measured in stormwater, baseflow, and outflow at the Navy Canal pond site is given on Figure 3-14. The statistical distribution of the data appears to be virtually identical for pH, conductivity, alkalinity, and TSS in stormwater, baseflow, and outflow samples. A statistical comparison of nitrogen species measured in stormwater, baseflow, and outflow samples at the Navy Canal pond site is given on Figure 3-15. Similar to the trend observed for general parameters, the chemical characteristics of inflow and outflow samples appear to be virtually identical for nitrogen species.

A statistical comparison of phosphorus species in stormwater, baseflow, and outflow at the Navy Canal pond site is given on Figure 3-16. The statistical distribution for phosphorus species appears to be virtually identical for the inflow and outflow samples.

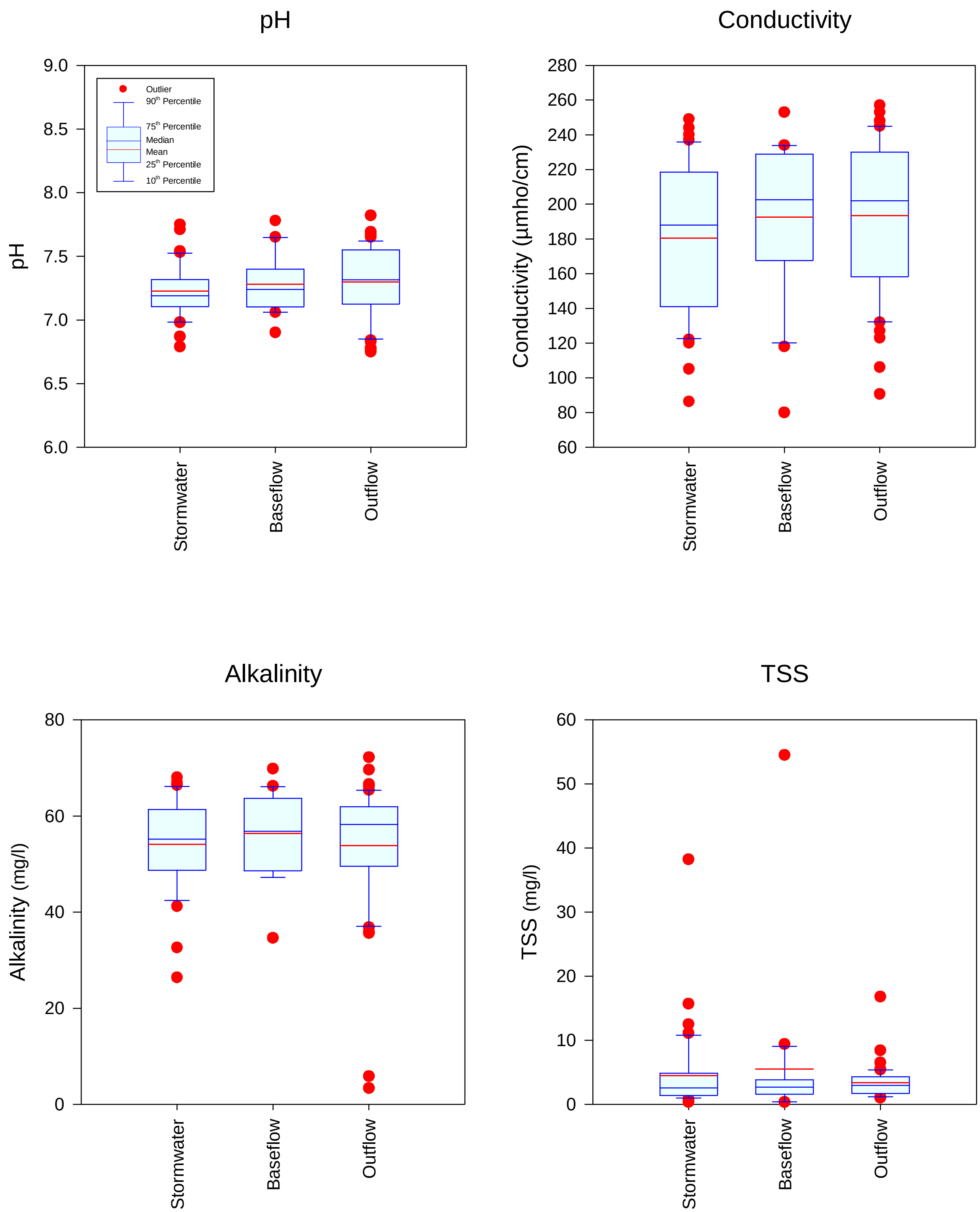


Figure 3-14. Statistical Comparison of General Parameters Measured in Stormwater, Baseflow, and Outflow at the Navy Canal Pond Site.

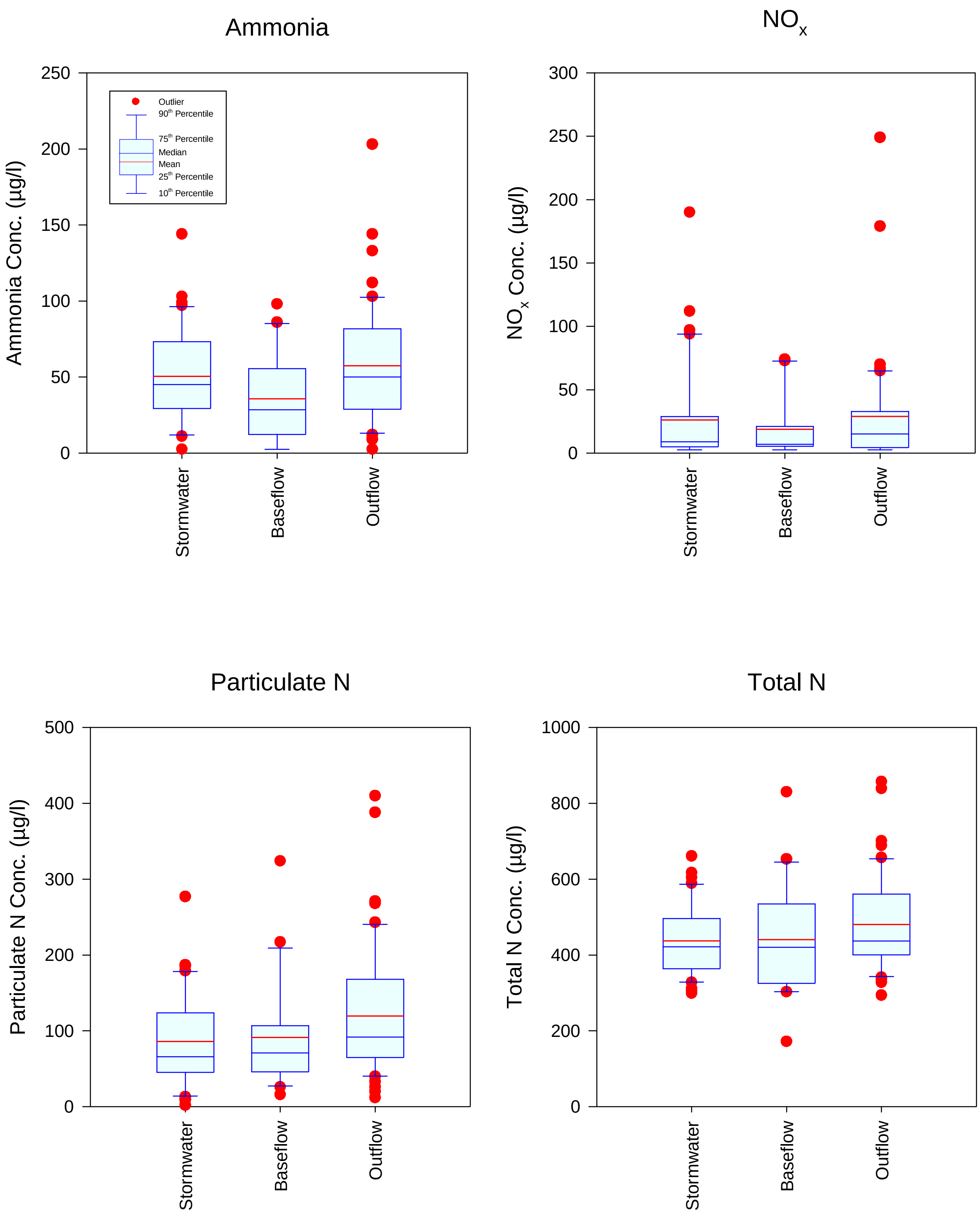


Figure 3-15. Statistical Comparison of Nitrogen Species Measured in Stormwater, Baseflow, and Outflow at the Navy Canal Pond Site.

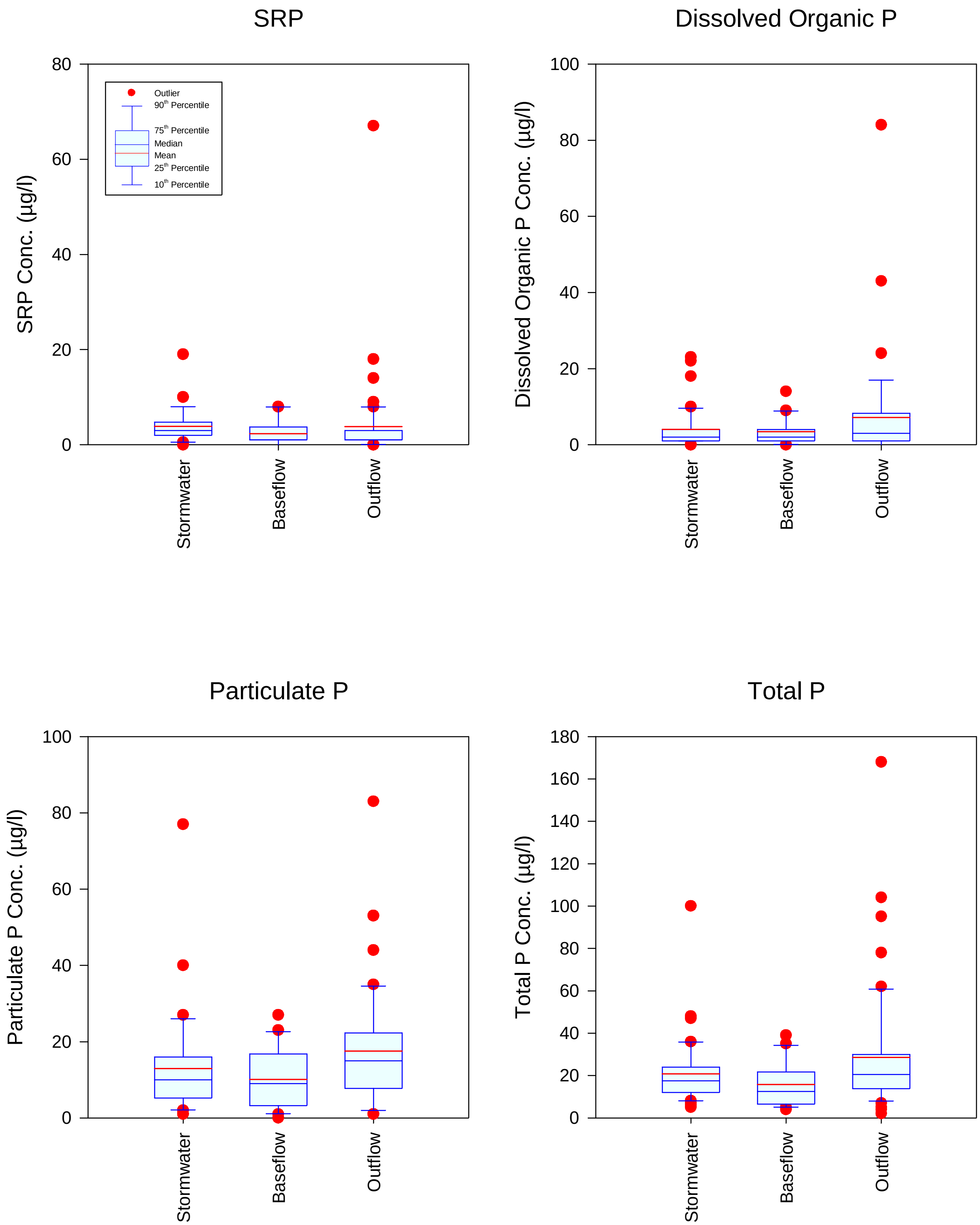


Figure 3-16. Statistical Comparison of Phosphorus Species Measured in Stormwater, Baseflow, and Outflow at the Navy Canal Pond Site.

3.3 Pond Performance Efficiency

The mass removal efficiencies of the Navy Canal pond were calculated on a monthly basis based upon calculated mass inflows and outflows for the pond. Mass inputs into the pond are assumed to occur as a result of direct rainfall, stormwater runoff, and inter-event baseflow. Mass losses from the pond are assumed to occur as a result of pond discharges through the outfall structure and spillway weir.

Monthly mass inputs and losses were calculated by multiplying the monthly hydrologic inputs and losses (summarized in Table 3-10) times the mean measured monthly concentrations of stormwater runoff, inter-event baseflow, pond outflow, and bulk precipitation. A summary of mean monthly concentrations of runoff, baseflow, outflow, and bulk precipitation measured at the Navy Canal pond site is given in Table 3-17. Mean monthly concentrations are provided for total nitrogen, total phosphorus, and TSS. The mean values summarized in Table 3-17 reflect the mean of measurements conducted for each of the evaluated parameters during each month of the study period. In the majority of the cases, the monthly mean values summarized in Table 3-17 are obtained from multiple measurements during a given month. If no data were available for a particular parameter and month, the mean value was calculated as the average of values listed for the preceding and following month.

A monthly mass balance for total nitrogen in the Navy Canal pond from March 2008-February 2009 is given in Table 3-18. Mass inputs of total nitrogen are provided on a monthly basis for bulk precipitation, runoff, and baseflow, with losses occurring as a result of pond outflow. The removal efficiency is calculated on a monthly basis using the following equation:

$$\textit{Mass Removal} = \frac{\textit{Input Mass} - \textit{Outflow Mass}}{\textit{Input Mass}} \; x\ 100$$

A net removal of total nitrogen was observed in the wet detention pond during April, May, and June, with removals ranging from 4-15%. However, during the remaining months, the wet detention pond became a net exporter of total nitrogen, with negative removal efficiencies observed during this time. Overall, the wet detention pond exported more mass than entered the pond through the combination of rainfall, runoff, and baseflow.

A monthly mass balance for total phosphorus in the Navy Canal pond from March 2008-February 2009 is given in Table 3-19. A net mass removal for phosphorus within the pond was observed only during the month of May, with phosphorus exported from the pond during the remaining months. During the 12-month monitoring program, the pond exported approximately 27% more phosphorus than entered the pond from rainfall, runoff, or baseflow.

A monthly mass balance for TSS in the Navy Canal pond from March 2008-February 2009 is given in Table 3-20. A net removal of suspended solids was observed in the pond during six of the 12 months included in the monitoring program, with an export of TSS observed during five months and no change in TSS observed during one month. However, on an annual basis, the Navy Canal pond removed approximately 22% of the TSS mass inputs.

TABLE 3-17

MEAN MONTHLY CONCENTRATIONS OF RUNOFF, BASEFLOW, OUTFLOW, AND BULK PRECIPITATION AT THE NAVY CANAL POND SITE

MONTH	MEAN MONTHLY STORMWATER CONCENTRATIONS			MEAN MONTHLY BASEFLOW CONCENTRATIONS		
	Total N (μg/l)	Total P (μg/l)	TSS (mg/l)	Total N (μg/l)	Total P (μg/l)	TSS (mg/l)
March	475	22	5.5	172	6	2.8
April	417	12	5.5	324	10	3.8
May	416	13	1.0	609	17	5.3
June	383	13	1.4	410	17	2.0
July	375	17	1.6	360	12	1.6
August	456	26	5.4	311	6	0.8
Sept	534	17	3.1	561	24	3.8
Oct	479	24	5.3	555	5	2.4
Nov	413	12	3.3	451	6	4.0
Dec	475	7	2.0	433	10	3.6
Jan	463	23	3.9	415	17	3.2
Feb	351	10	2.8	415	17	3.2

MONTH	MEAN MONTHLY OUTFLOW CONCENTRATIONS			MEAN MONTHLY BULK PRECIPITATION CONCENTRATIONS		
	Total N (μg/l)	Total P (μg/l)	TSS (mg/l)	Total N (μg/l)	Total P (μg/l)	TSS (mg/l)
March	453	26	3.5	271	2	4.2
April	361	17	2.1	271	2	4.2
May	556	19	2.0	1073	42	4.1
June	410	19	2.6	681	13	6.4
July	433	18	2.3	405	9	3.1
August	477	31	4.2	151	15	2.2
Sept	620	36	3.3	303	8	2.8
Oct	508	13	2.1	451	7	21.0
Nov	521	16	1.8	781	35	7.7
Dec	467	37	2.9	1352	175	2.8
Jan	447	14	4.9	545	24	2.1
Feb	440	22	3.7	376	11	2.4

TABLE 3-18

MONTHLY MASS BALANCE FOR TOTAL NITROGEN IN THE NAVY CANAL POND FROM MARCH 2008-FEBRUARY 2009

MONTH	POND INPUTS (kg)				POND LOSSES (kg)		REMOVAL EFFICIENCY (%)
	Rainfall	Runoff	Baseflow	Total	Outflow	Total	
March	0.348	2.0	6.3	8.7	18.3	18.3	-112
April	0.251	6.7	7.6	14.6	14.0	14.0	4
May	0.794	2.2	8.6	11.6	9.8	9.8	15
June	1.276	3.8	8.7	13.8	12.5	12.5	9
July	1.609	7.2	12.9	21.7	25.0	25.0	-15
August	1.183	412.7	14.1	428.0	456.6	456.6	-7
September	0.502	47.0	24.9	72.4	82.5	82.5	-14
October	1.029	69.6	24.9	95.5	97.4	97.4	-2
November	0.318	0.2	20.4	20.9	23.5	23.5	-13
December	0.484	0.2	18.3	19.0	19.8	19.8	-4
January	0.538	0.4	12.9	13.9	14.4	14.4	-4
February	0.074	1.3	12.0	13.4	14.0	14.0	-4
TOTAL:	**8.404**	**553.5**	**171.6**	**733.5**	**788.0**	**788.0**	**-7**

TABLE 3-19

MONTHLY MASS BALANCE FOR TOTAL PHOSPHORUS IN THE NAVY CANAL POND FROM MARCH 2008-FEBRUARY 2009

MONTH	POND INPUTS (kg)				POND LOSSES (kg)		REMOVAL EFFICIENCY (%)
	Rainfall	Runoff	Baseflow	Total	Outflow	Total	
March	0.003	0.09	0.22	0.3	1.04	1.04	-229
April	0.002	0.20	0.24	0.4	0.67	0.67	-52
May	0.031	0.07	0.24	0.3	0.33	0.33	3
June	0.025	0.13	0.37	0.5	0.57	0.57	-9
July	0.037	0.33	0.42	0.8	1.05	1.05	-33
August	0.118	23.70	0.26	24.1	29.7	29.7	-23
September	0.013	1.50	1.09	2.6	4.77	4.77	-83
October	0.016	3.46	0.22	3.7	2.49	2.49	33
November	0.014	0.01	0.27	0.3	0.70	0.70	-142
December	0.063	0.00	0.42	0.5	1.57	1.57	-219
January	0.024	0.02	0.52	0.6	0.46	0.46	18
February	0.002	0.04	0.48	0.5	0.70	0.70	-33
TOTAL:	**0.347**	**29.6**	**4.7**	**34.7**	**44.0**	**44.0**	**-27**

TABLE 3-20

MONTHLY MASS BALANCE FOR TSS IN THE NAVY CANAL POND FROM MARCH 2008-FEBRUARY 2009

MONTH	POND INPUTS (kg)				POND LOSSES (kg)		REMOVAL EFFICIENCY (%)
	Rainfall	Runoff	Baseflow	Total	Outflow	Total	
March	5.4	23.5	102	131	142	142	-9
April	3.9	89.4	90.8	184	82	82	56
May	3.0	5.3	74.6	83.0	35	35	58
June	11.9	13.7	43.5	69.1	78	78	-13
July	12.5	30.7	57.3	101	134	134	-33
August	17.4	4925	35.1	4978	4018	4018	19
September	4.6	269	167	441	442	442	0
October	47.9	767	108	922	400	400	57
November	3.1	1.8	181	185	82	82	56
December	1.0	0.9	152	154	123	123	20
January	2.1	3.6	101	107	158	158	-49
February	0.5	10.8	93.3	105	117	117	-12
TOTAL:	**113.2**	**6141**	**1205**	**7459**	**5811**	**5811**	**22**

3.4 Discussion

The results of the monitoring program conducted for the Navy Canal pond indicate that the pond achieved no significant removal for either nitrogen or phosphorus and only a minimal degree of removal for TSS. In fact, the analyses suggests that the pond may have actually exported more nitrogen and phosphorus than entered the pond through the combined inputs of rainfall, runoff, and inter-event baseflow. Possible explanations for these results are discussed in the following sections.

3.4.1 Inflow Concentrations

In general, inflow into the Navy Canal pond was characterized by extremely low levels of nitrogen, phosphorus, and TSS. As discussed in previous sections, inflow concentrations of total phosphorus were approximately 10-20 times lower than phosphorus concentrations normally associated in urban runoff. Input concentrations of total nitrogen were approximately 4-5 times lower than concentrations observed in urban runoff, and TSS concentrations were approximately 10-15 times lower than urban runoff concentrations. In fact, many of the measured total phosphorus concentrations entering the pond were near the lower limits of detection for phosphorus species.

A phosphorus concentration of approximately 10 μg/l is typically used to represent irreducible concentration levels in wet detention ponds. Stormwater concentrations of total phosphorus entering the pond were near or below this level during 6 of the 12 months included in the monitoring program. Phosphorus concentrations in baseflow inputs were at or below this level during 7 of the 12 months. A total nitrogen concentration of approximately 400 μg/l is often assumed to reflect an irreducible concentration level for wet detention ponds. Nitrogen concentrations in stormwater inflow into the pond were near or below this level during 6 of the 12 months, with baseflow concentrations less than or equal to this value during 7 of the 12 months. Irreducible concentrations for TSS in wet detention ponds are often assumed to be in the range of 1-2 mg/l. Concentrations equal to or less than this range were observed in runoff inputs during 4 of the 12 months, with baseflow concentrations equal to or less than this level during 3 of the 12 months. The input concentrations of nitrogen, phosphorus, and TSS entering the Navy Canal pond are already at or below concentration levels normally observed in discharges from wet detention ponds.

Removal processes in wet ponds occur through a variety of physical and biological processes. Physical processes are responsible for removal of particulate matter which enters the pond. However, particulate matter generated within the watershed appears to have already been attenuated within the Navy Canal tributary or within conveyance systems connected to the tributary prior to entering the pond. Physical processes are often responsible for approximately 50% of the overall removal observed in wet detention ponds.

Biological processes are responsible for nutrient removal through uptake by bacteria, algae, and aquatic vegetation. This phenomenon is a first-order reaction which is based upon the concentration of the available nutrients within the water column. Urban runoff typically contains a high percentage of SRP which can be rapidly removed from the water column through biological uptake. However, input concentrations of SRP in stormwater runoff and baseflow entering the Navy Canal pond are already at or below minimum concentration levels at which uptake can occur by biological organisms. Nitrogen species, such as ammonia and NO_x, can also be rapidly absorbed or removed from the water column through biological uptake processes. However, similar to the trend observed for phosphorus species, inflow concentrations of ammonia and NO_x are already at extremely low levels which are at or below levels at which active uptake can occur through biological processes.

Based on the low input concentrations in the Navy Canal pond, the normal removal mechanisms involving physical and biological processes are not available within the water column of the pond. The net result is that virtually no uptake occurs within the pond for the current stormwater and baseflow inputs.

Under current conditions, the Navy Canal watershed contributes extremely low loadings of nutrients and TSS to Lake Jesup. Previous loading estimates which indicated that this sub-basin was a significant contributor of nutrient loadings appear to be in error. In addition, the removal relationships for wet ponds (Harper and Baker, 2007) which suggest that wet ponds are capable of achieving a 40% removal for total nitrogen and a 60% removal for total phosphorus were incorrectly applied in evaluating the potential removal efficiency for the pond. These removal efficiencies are valid only for raw stormwater runoff and are not appropriate for use in modeling removals in ponds where the inflows have received substantial pre-treatment in conveyance and tributary systems.

3.4.2 <u>Poorly Developed Littoral Zone</u>

Under existing conditions, the Navy Canal pond has an extremely poorly developed littoral zone around the perimeter of the pond. A photograph of existing littoral zone conditions in the pond is given on Figure 3-17. Although littoral zone vegetation does not remove large amounts of nutrients directly from the water column of a pond, littoral zones do provide habitat for a variety of species which can be important in regulating water quality within a waterbody. The private homeowner adjacent to the pond maintains an aggressive aquatic vegetation eradication program using both chemical and biological controls. Chemical herbicides have been used to keep the pond shoreline in a vegetation-free state, and grass carp have been added to the pond to control submerged vegetation. The stocking rate for grass carp is not known. These activities essentially eliminate areas where additional removal processes may occur within the pond.

Figure 3-17. Current Pond Littoral Zone Characteristics.

3.4.3 <u>Pond Configuration</u>

Another factor which could potentially impact performance efficiency of the pond system is the configuration of the inflow and outflow locations. The pond inflow and outflow are both located on the northern end of the pond, and although a peninsula has been added to reduce short-circuiting within the pond, much of the southern half of the pond functions as a hydraulically dead zone. A more creative pond design could have been developed which utilized a larger portion of the permanent pool volume.

3.4.4 Miscellaneous Inputs

Additional miscellaneous inputs of nutrients and TSS may be present which have the potential to impact pond performance. The adjacent property owner has stocked the pond with a variety of fish species and maintains an automatic fish feeder on the headwall of the box culvert inflow into the pond. Although the feed addition rate is not known, ERD has documented in other studies that fish and waterfowl food sources can contribute significant loadings of nutrients to a waterbody. In addition, waterfowl have been observed to utilize the pond on a routine basis, and the nutrient input capabilities of waterfowl have also been documented in numerous previous studies. Due to the existing low input concentrations into the pond, these activities have a potential to impact water quality more significantly than in a waterbody with higher levels of nutrient inputs.

3.5 Quality Assurance

Supplemental samples were collected during the field monitoring program for quality assurance purposes. These supplemental samples include equipment blanks and duplicate samples, along with supplemental laboratory analyses to evaluate precision and accuracy of the collected data. A summary of QA data collected as part of this project is given in Appendix D.

SECTION 4

SUMMARY

A field monitoring program was conducted by ERD from March 2008-February 2009 to evaluate the performance efficiency of the Navy Canal wet detention pond system. The wet detention pond is designed to provide treatment for an 820-acre drainage basin. The pond is designed to provide at treatment volume of 0.6 inches over a 187-acre area with existing development which is to be retrofitted. Development which occurs in the remaining portions of the basin will be constructed with off-site stormwater management facilities.

Automatic samplers with integral flow meters were installed at the inflow and outflow to the pond to provide a continuous record of hydrologic inputs and losses and to collect runoff samples in a flow-weighted mode. A recording rain gauge and evaporimeter were also installed adjacent to the monitoring site. A sensitive water level recorder was installed inside the pond to assist in developing the hydrologic budget.

Continuous inflow and outflow hydrographs were recorded at the Navy Canal pond at 10-minute intervals from March 1, 2008-February 28, 2009. Over this period, stormwater runoff contributed approximately 74% of the hydraulic inputs, with 25% contributed by inter-event baseflow and 1% by direct rainfall. Approximately 46% of the hydrologic inputs exited the pond through the outfall structure, with 53% discharging over the spillway overflow structure and 1% lost as a result of evaporation. The mean residence time within the pond during the study period was approximately 12.7 days.

Over the 12-month monitoring program, 40 stormwater inflow samples were collected, with 20 baseflow samples, 50 pond outfall samples, and 22 bulk precipitation samples. A total of 38 vertical field profiles was also collected near the center of the pond. During the monitoring program, the pond was found to be relatively well mixed, with no significant stratification exhibited for temperature, pH, or conductivity. Adequate levels of dissolved oxygen were maintained within the pond with the exception of a few measurements collected near the water-sediment interface.

Inflow into the pond was characterized by extremely low concentrations of total nitrogen, phosphorus, and TSS. Input concentrations for these parameters were near the lower limit of concentrations commonly observed in wet detention ponds with long detention times. Over the 12-month monitoring program, the pond exhibited no net removal of either nitrogen or phosphorus, with a TSS removal of only 22%.

The poor performance efficiency of the system is directly related to the extremely low inflow concentrations into the system. These inflow concentrations are due to pre-treatment which is likely occurring in conveyance systems and tributaries prior to entering the pond. As a result of the low input concentrations and low particulate fractions, there is an extremely limited uptake ability for nutrients or TSS within the pond. Other factors contributing to the poor performance of the pond are the poorly developed littoral zone, pond configuration, and miscellaneous nutrient inputs.

A summary of total project costs is given in Table 4-1. FDEP contributed 100% ($92,756.38) of the total project cost.

TABLE 4-1

SUMMARY OF TOTAL PROJECT COSTS AND FUNDING SOURCES

PROJECT FUNDING ACTIVITY	FDEP GRANT FUNDS ($)
Contractual	92,756.38
TOTAL:	**$ 92,756.38**

APPENDICES

APPENDIX A

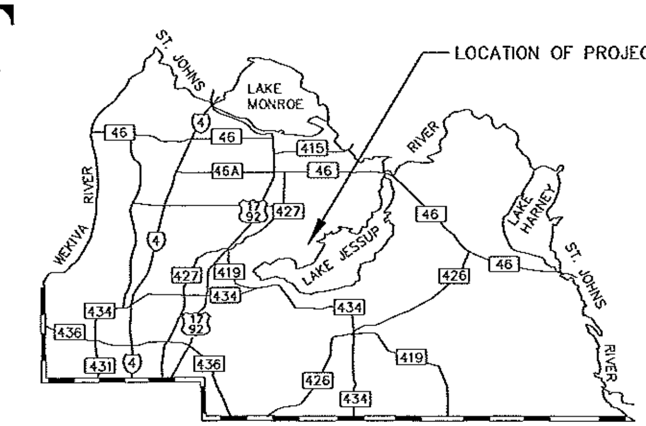
SELECTED CONSTRUCTION PLANS FOR THE NAVY CANAL STORMWATER FACILITY

JOB FILE #	SHEET No.
6116-36955	1

SEMINOLE COUNTY
PUBLIC WORKS DEPARTMENT
STORMWATER DIVISION

THIS CONTRACT PLAN SET INCLUDES:

REGRADING PLANS
EROSION CONTROL MEASURES



PUBLIC WORKS DIRECTOR
W. Gary Johnson, P.E.

STORMWATER MANAGER
Mark Flomerfelt. P.E.

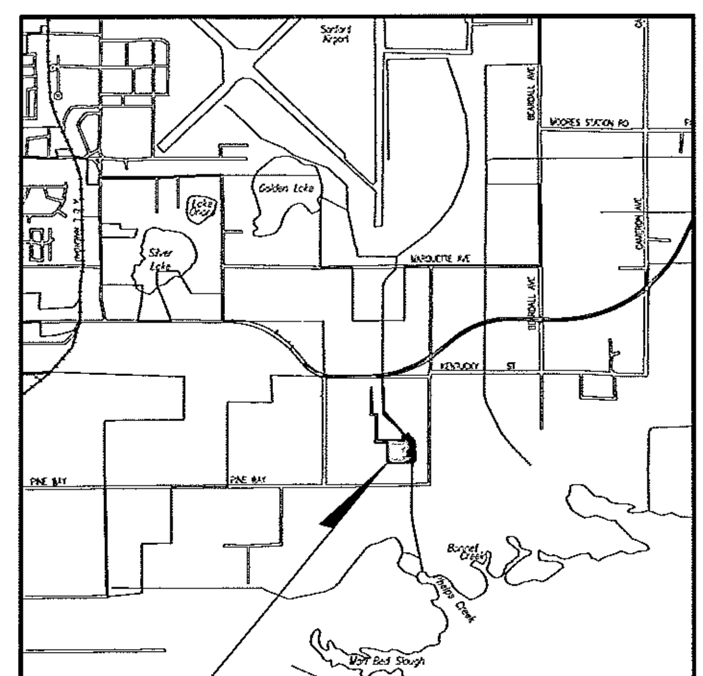
GREAT SEAL OF THE STATE OF FLORIDA
IN GOD WE TRUST

INDEX OF PLANS

NAVY CANAL REGIONAL STORMWATER FACILITY

THESE PLANS HAVE BEEN PREPARED IN ACCORDANCE WITH AND ARE GOVERNED BY THE STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION DESIGN STANDARDS (BOOKLET DATED JANUARY 2002)

BID PLANS
October, 2005



LOCATION MAP
SECTION 17, TOWNSHIP 20S, RANGE 31E

GOVERNING SPECIFICATIONS: STATE OF FLORIDA, DEPARTMENT OF TRANSPORTATION, STANDARD SPECIFICATIONS, DATED 2000 AND SUPPLEMENTS THERETO IF NOTED IN THE SPECIAL TECHNICAL PROVISIONS FOR THIS PROJECT.

ATTENTION IS DIRECTED TO THE FACT THAT THESE PLANS MAY HAVE BEEN CHANGED IN SIZE BY REPRODUCTION. THIS MUST BE CONSIDERED WHEN OBTAINING SCALED DATA.

PREPARED BY: CAMP DRESSER & McKEE INC.
2301 MAITLAND CENTER PARKWAY, SUITE 300
MAITLAND, FLORIDA 32751
PHONE: (407) 660-2552
FAX: (407) 875-1161
FL COA NO: EB-0000020

PLANS APPROVED BY ______________________
Mario F. Chavez, P.E. # 50713 DATE

CONSTRUCTION COMPLETION DATE ______________________

FIELD VERIFIED BY ______________________

LENGTH OF PROJECT						
			SIDE STREETS		TOTAL	
	LIN.FT.	MILES	LIN.FT.	MILES	LIN.FT.	MILES
DITCH REGRADING	–	–	—	—	–	–
	—	—	—	—	—	—
NET LENGTH OF PROJECT	–	–	—	—	–	–
EXCEPTIONS	–	–	—	—	–	–
GROSS LENGTH OF PROJECT	–	–	—	—	–	–

REVISIONS		
BY	DATE	DESCRIPTION

SEMINOLE COUNTY PROJECT MANAGER: Robert (Bob) J. Walter, P.E.

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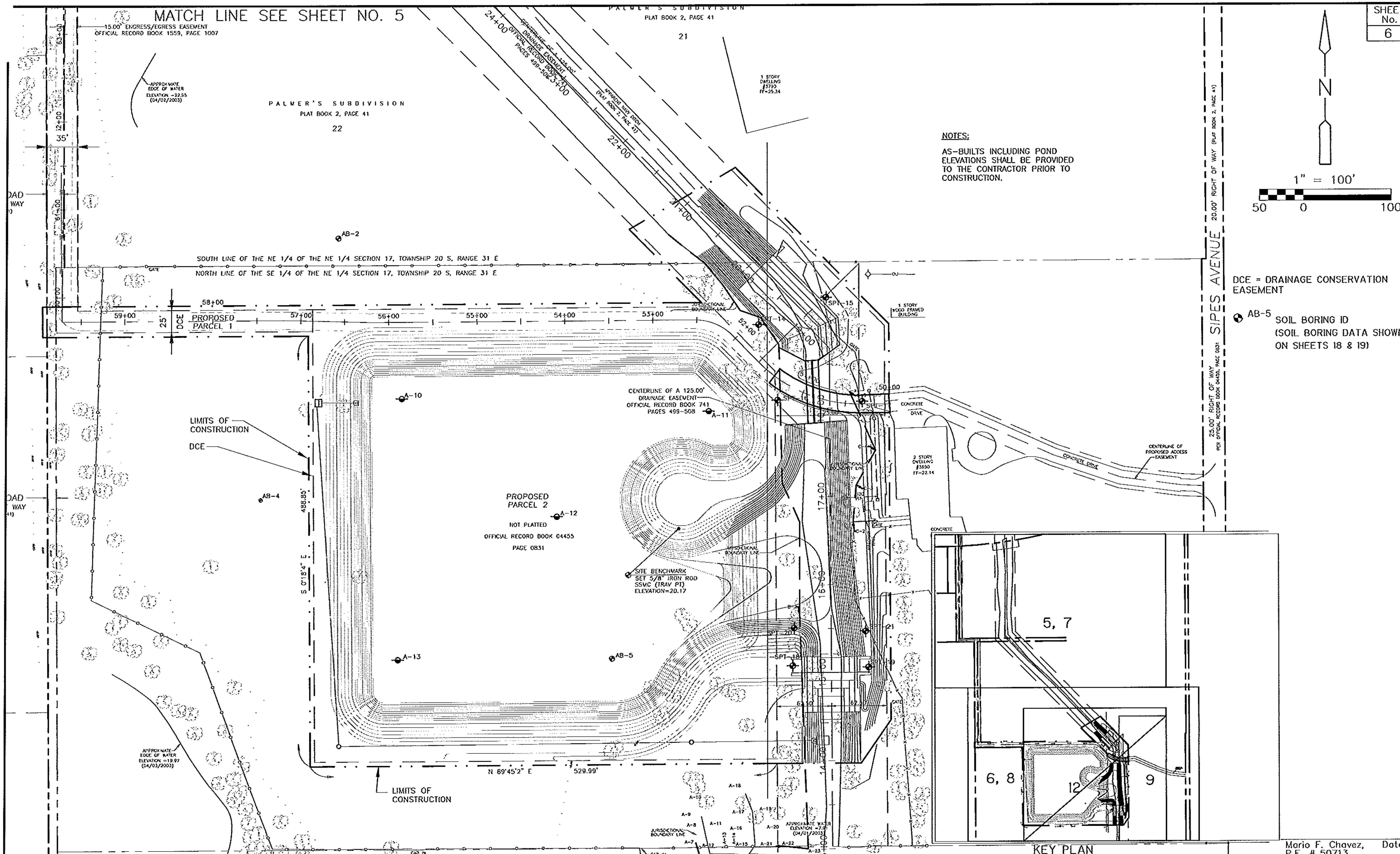
SHEET No. 6



Mario F. Chavez, P.E. # 50713 Date

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: J. Williams
DRAWN BY: B. Williams
SHEET CHK'D BY: M. Chavez
CROSS CHK'D BY: J. Lodner
APPROVED BY:
DATE: OCTOBER 2005

CDM Camp Dresser & McKee Inc.
consulting engineering construction operations
2301 Maitland Center Parkway
Suite 300
Maitland, Florida 32751
Tel: 407 660-2552
Fax: 407 875-1161
Fl COA No. EB-0000020

SEMINOLE COUNTY
FLORIDA

NAVY CANAL REGIONAL STORMWATER FACILITY

KEY PLAN AND SITE PLAN

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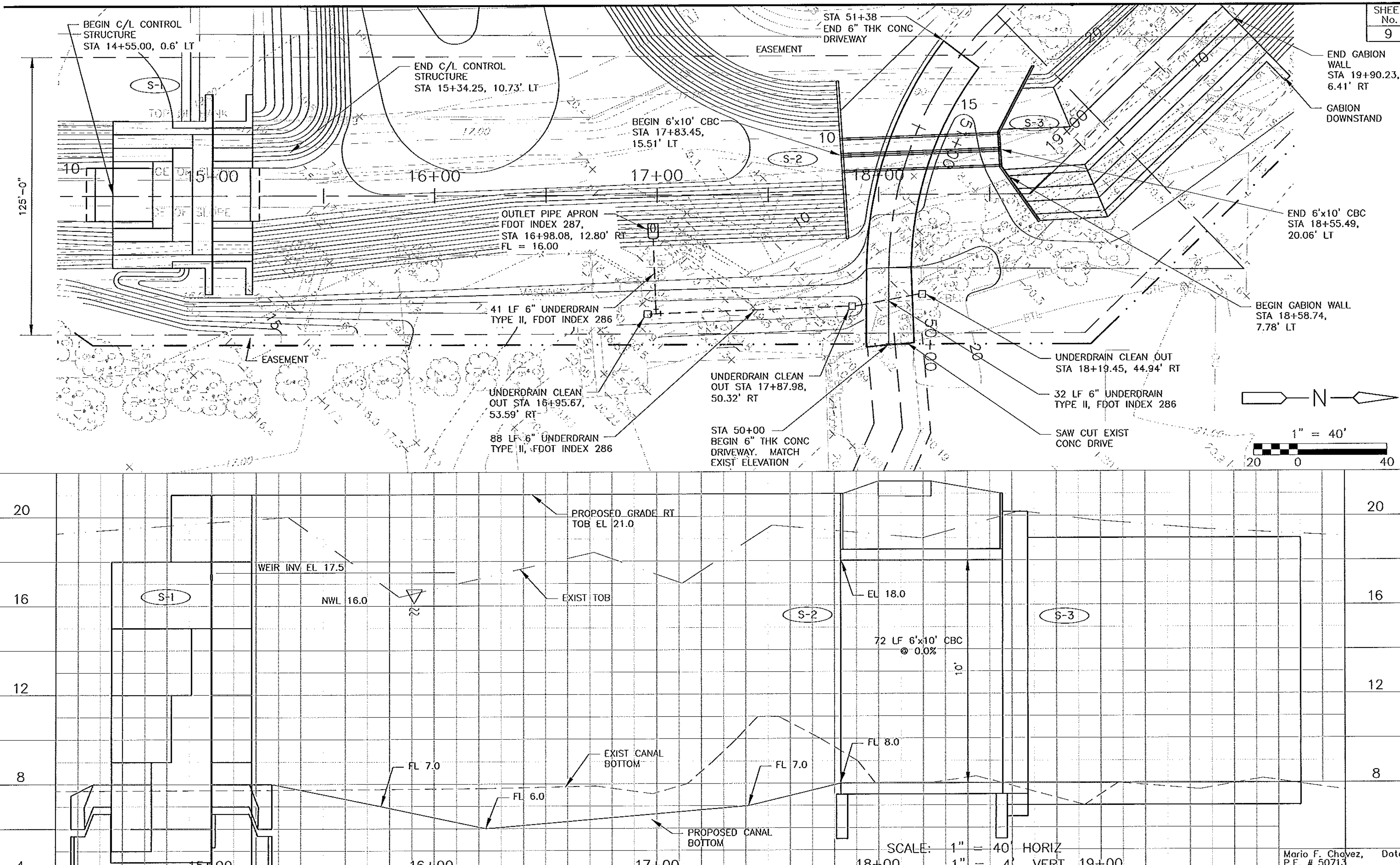

REV. NO.	DATE	DRWN	CHKD	REMARKS

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SEMINOLE COUNTY
FLORIDA

NAVY CANAL REGIONAL STORMWATER FACILITY

PLAN AND PROFILE

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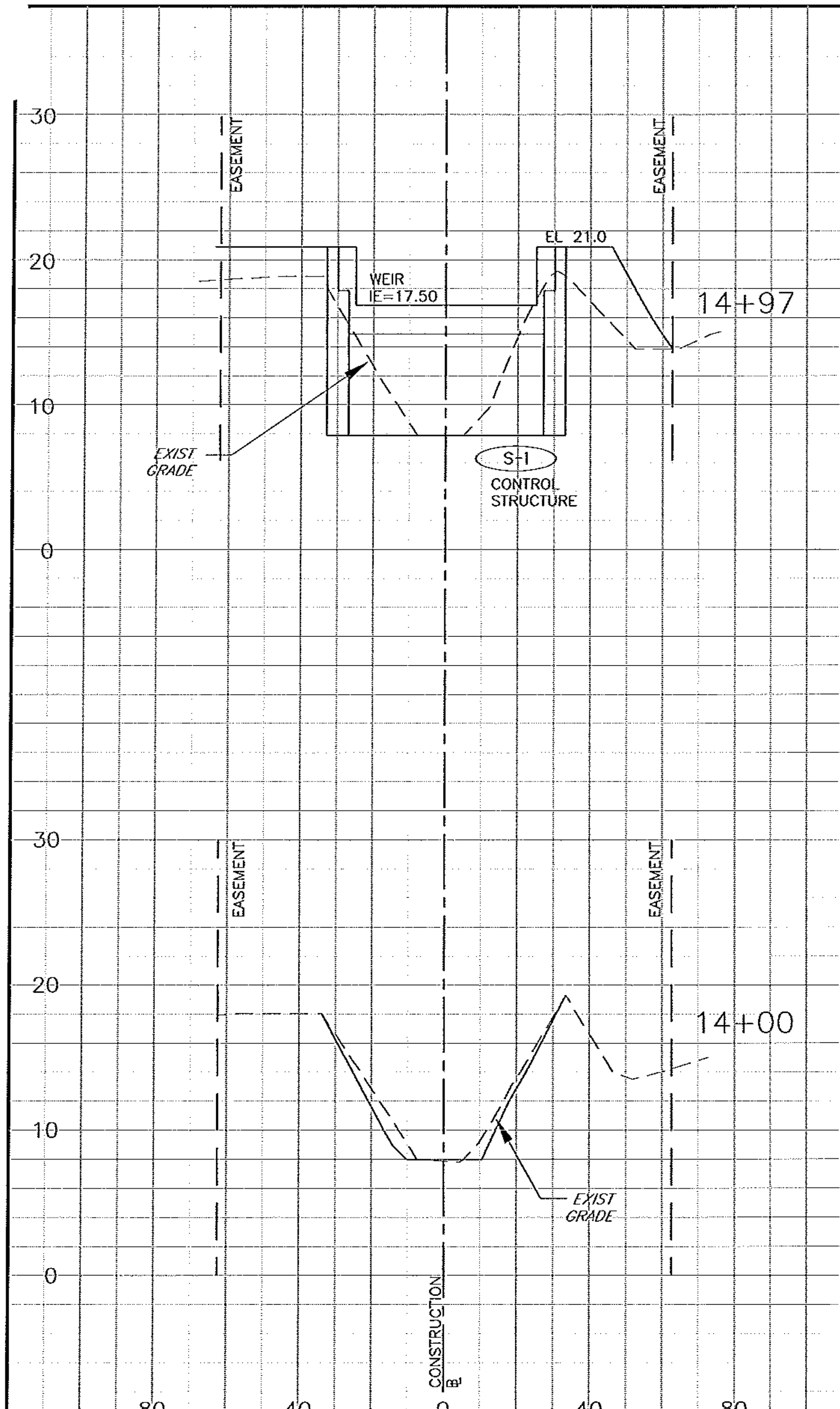

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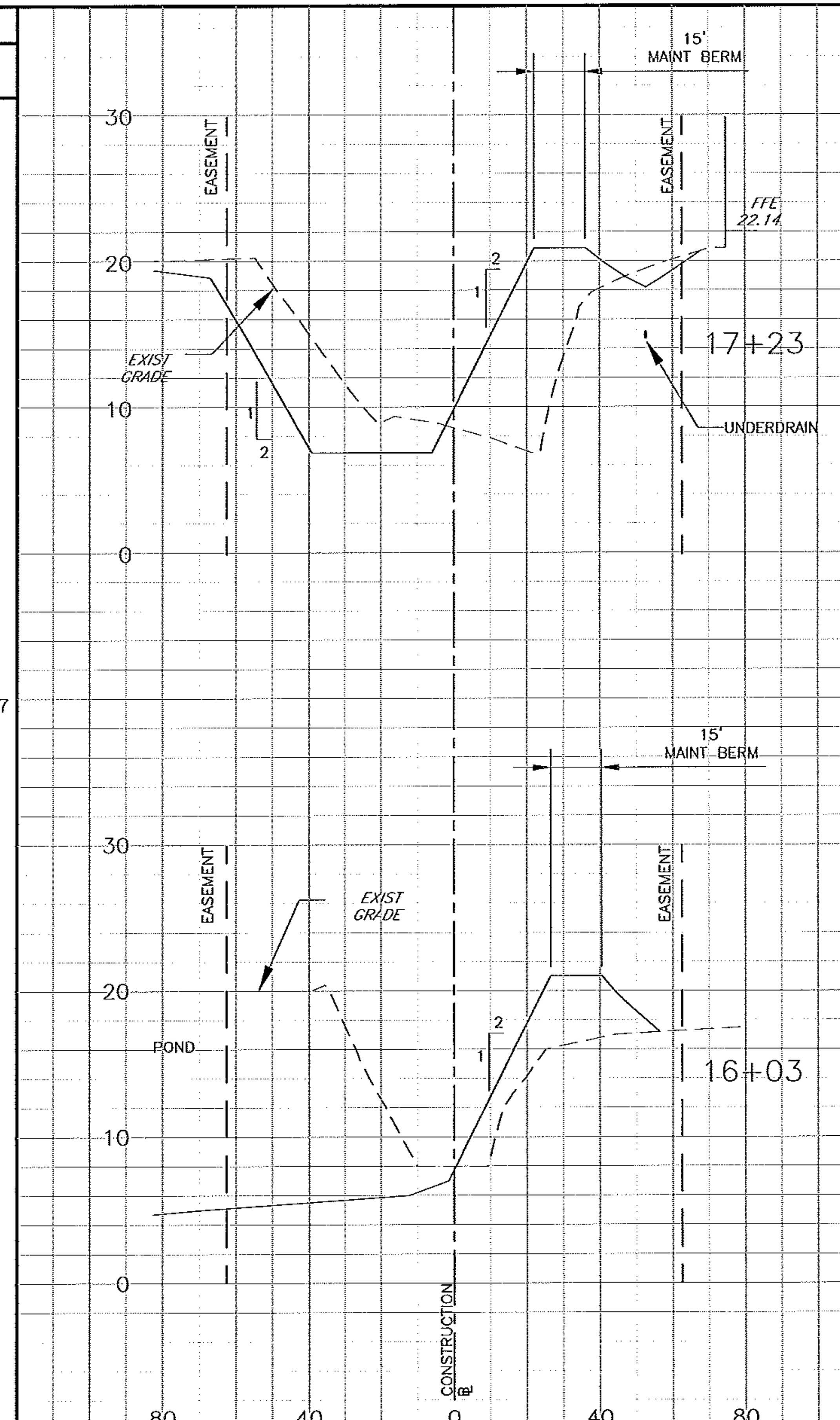

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	2016		1068
618		175	
	1793		654

SCALE: 1" = 40' HORIZ
1" = 10' VERT

Mario F. Chavez, P.E. # 50713 Date

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: J. Williams
DRAWN BY: B. Williams
SHEET CHK'D BY: M. Chavez
CROSS CHK'D BY: J. Lodner
APPROVED BY:
DATE: OCTOBER 2005

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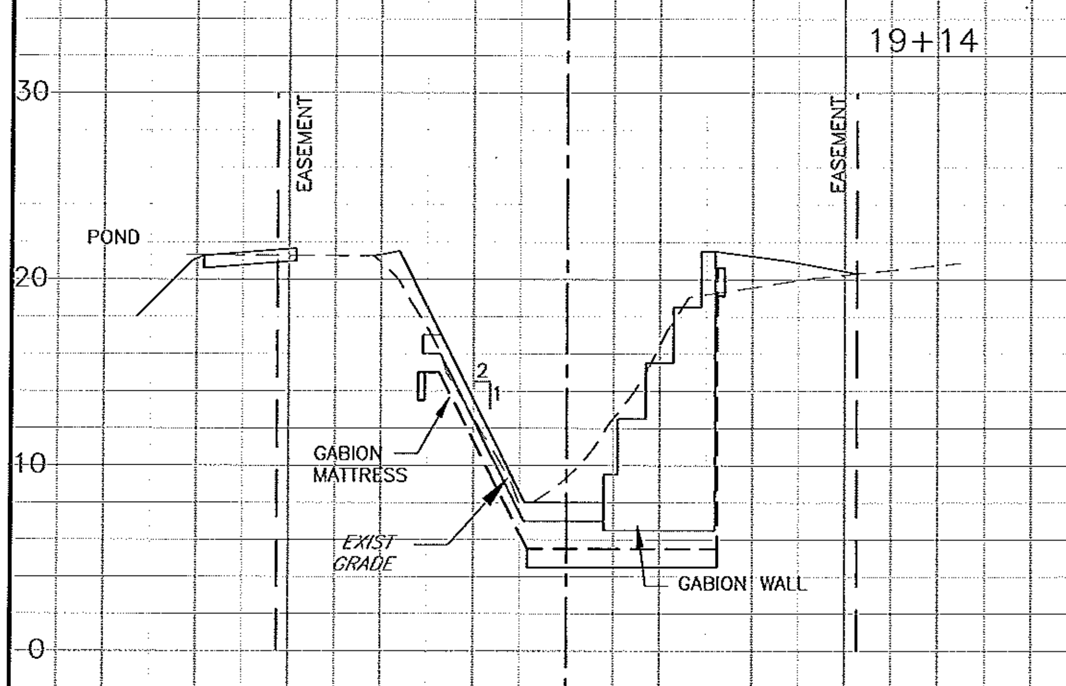
Fl COA No. EB-0000020

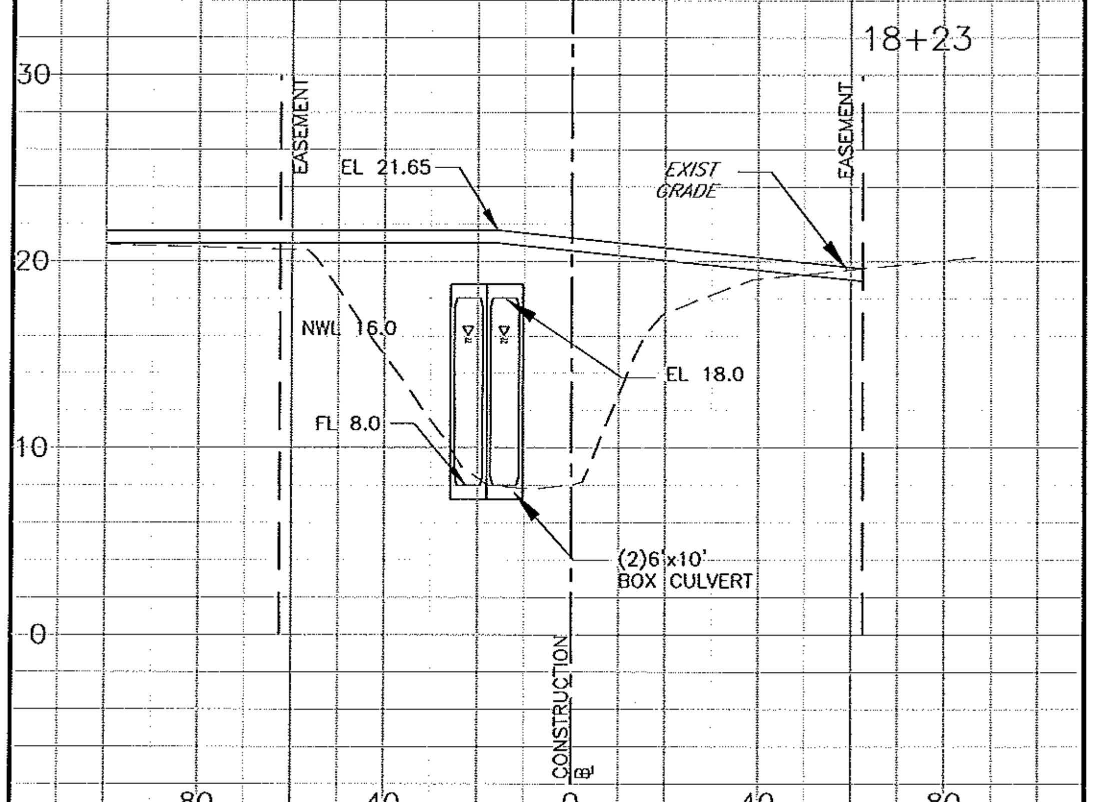
SEMINOLE COUNTY
FLORIDA

NAVY CANAL REGIONAL
STORMWATER FACILITY

NAVY CANAL
CROSS SECTIONS

SHEET No. 11





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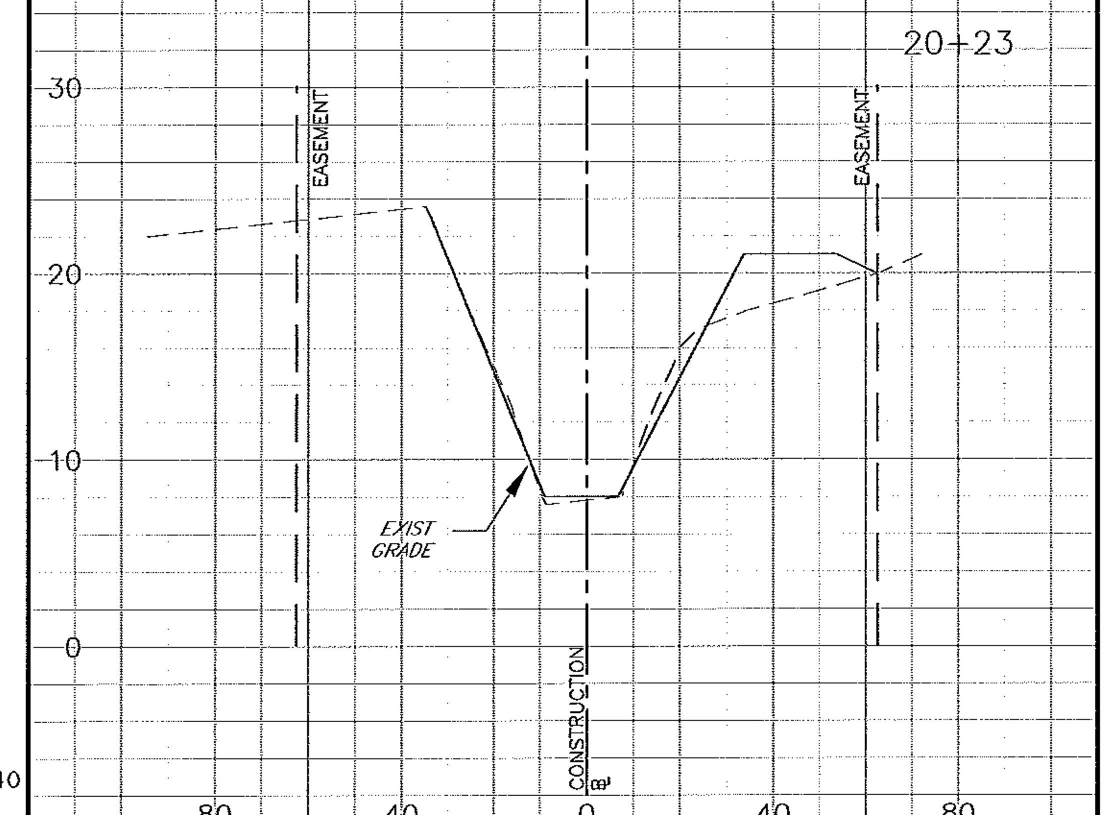

EXCAV. A	EXCAV. V	FILL A	FILL V
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	624		238

SCALE: 1" = 40' HORIZ
1" = 10' VERT

Mario F. Chavez, P.E. # 50713 Date

REV. NO.	DATE	DRWN	CHKD	REMARKS

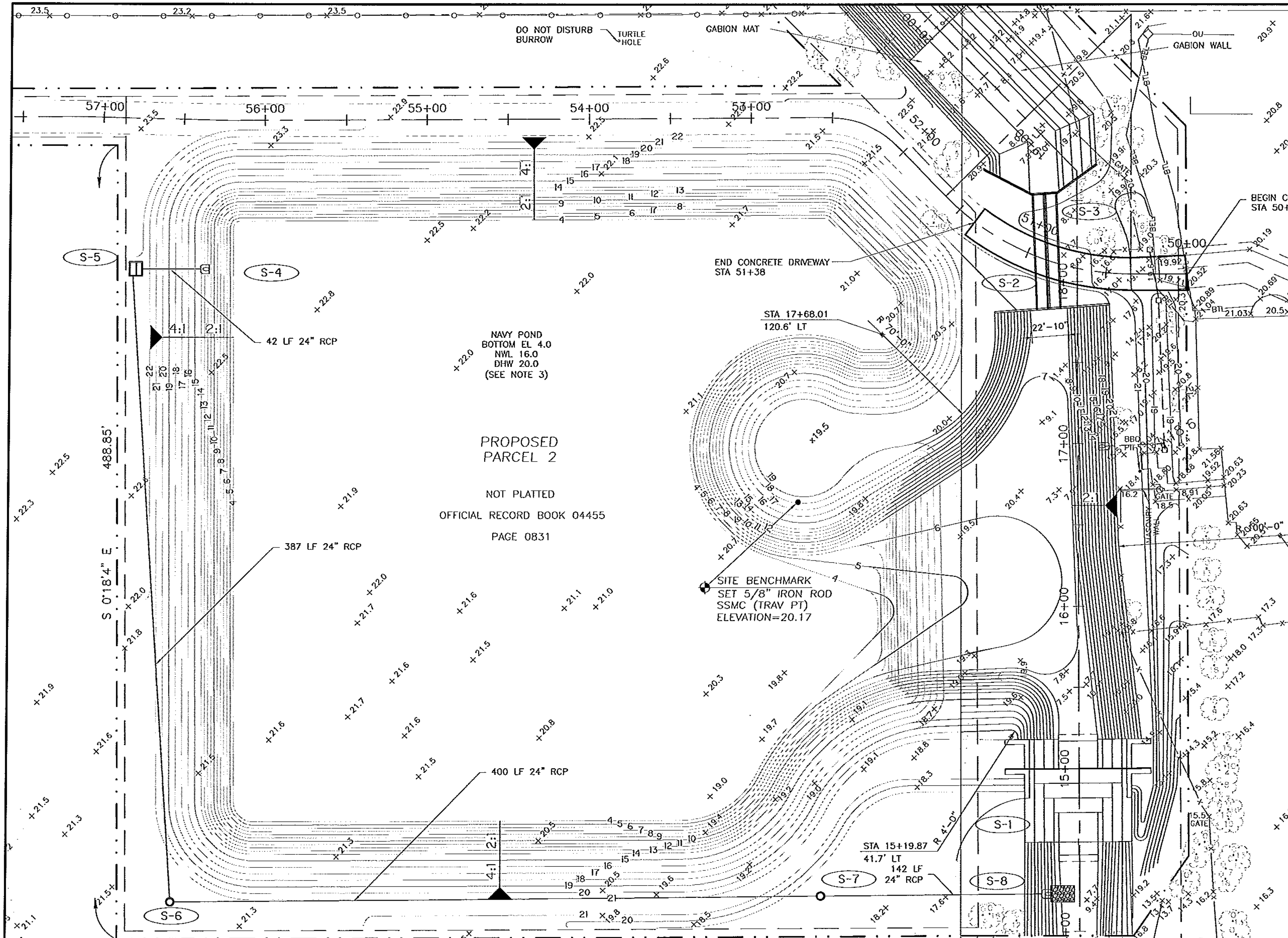
DESIGNED BY: J. Williams
DRAWN BY: B. Williams
SHEET CHK'D BY: M. Chavez
CROSS CHK'D BY: J. Lodner
APPROVED BY:
DATE: OCTOBER 2005

CDM Camp Dresser & McKee Inc.
consulting engineering construction operations
2301 Maitland Center Parkway
Suite 300
Maitland, Florida 32751
Tel: 407 660-2552
Fax: 407 875-1161
Fl COA No. EB-0000020

SEMINOLE COUNTY
FLORIDA

NAVY CANAL REGIONAL STORMWATER FACILITY

NAVY CANAL CROSS SECTIONS



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0 30 60
Feet

NOTES:

1. TREES SHOWN ARE TO BE PROTECTED.
2. SOD ALL DISTURBED AREAS.
3. AS-BUILTS INCLUDING POND ELEVATIONS SHALL BE PROVIDED TO THE CONTRACTOR PRIOR TO CONSTRUCTION.

Mario F. Chavez, P.E. # 50713 Date

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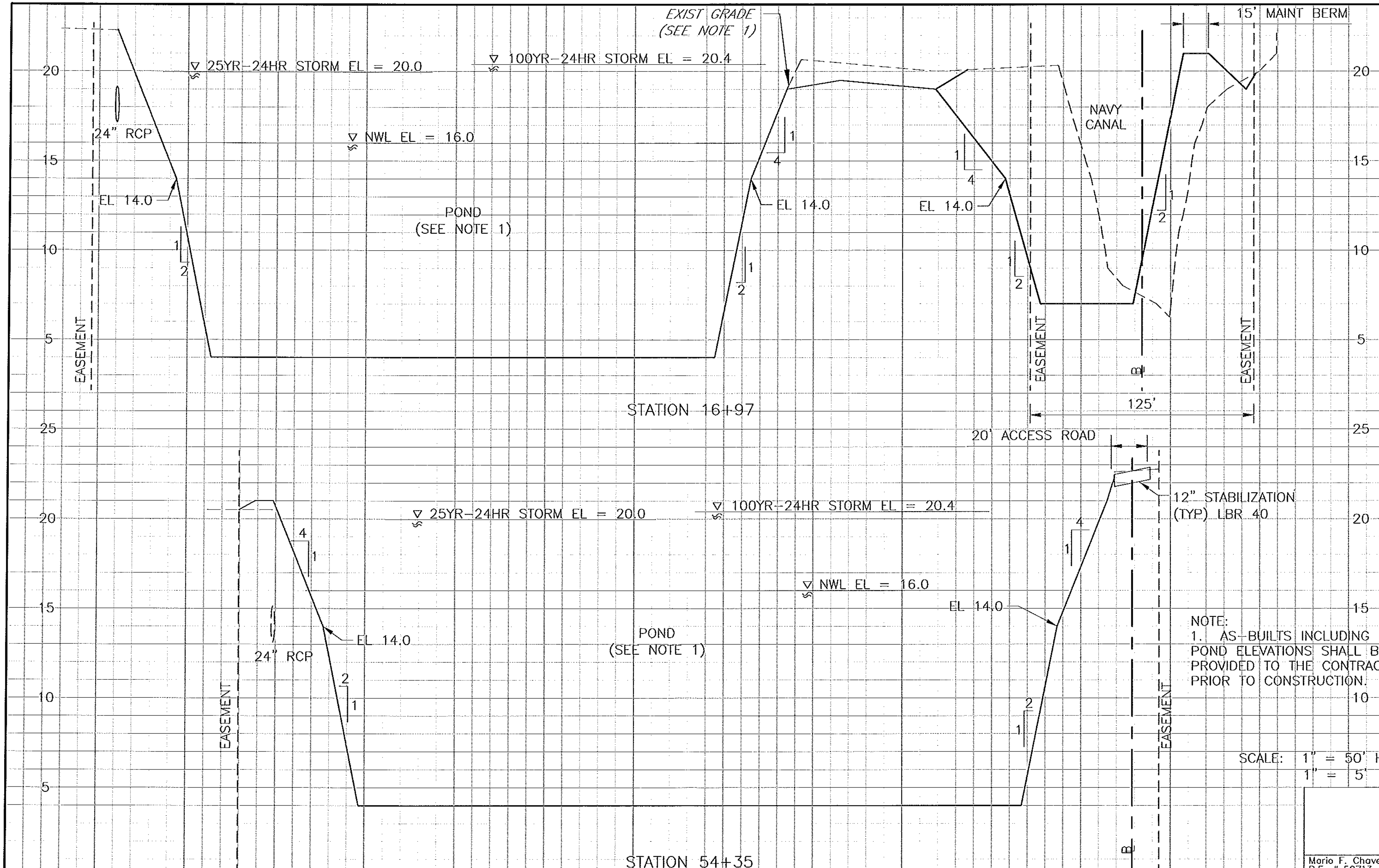
SEMINOLE COUNTY
FLORIDA

NAVY CANAL REGIONAL STORMWATER FACILITY

POND PLAN

stoltzbk 17:19:06 10/05/05 14:02:33 G:\6116\36955\ACAD\100P\Civil\ 13CPNDXS

SHEET No. 13



NOTE:
1. AS-BUILTS INCLUDING EXISTING POND ELEVATIONS SHALL BE PROVIDED TO THE CONTRACTOR PRIOR TO CONSTRUCTION.

SCALE: 1" = 50' HORIZ
1" = 5' VERT

Mario F. Chavez, P.E. # 50713 Date

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: J. Williams
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SHEET CHK'D BY: M. Chavez
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APPROVED BY:
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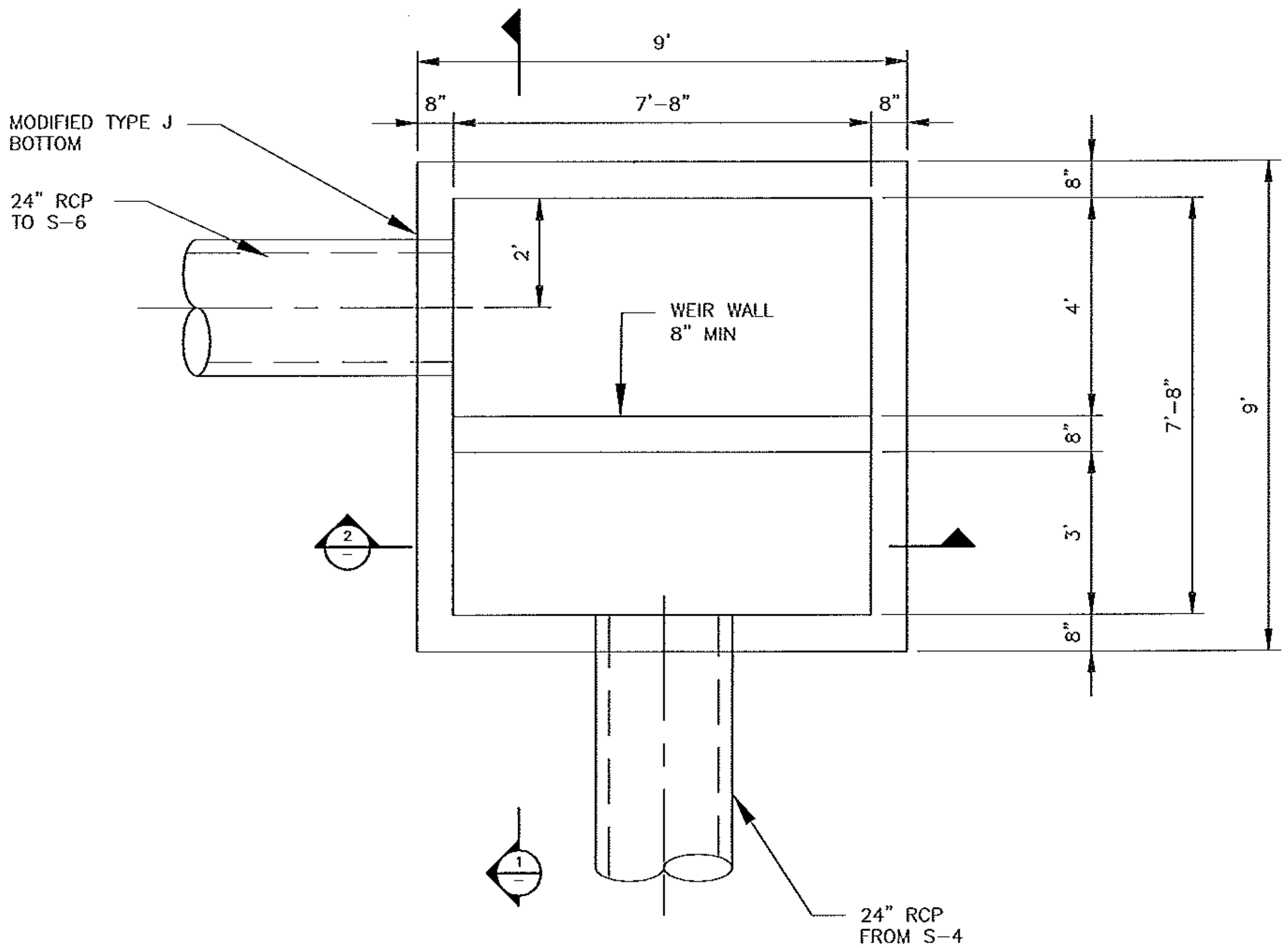
SEMINOLE COUNTY
FLORIDA

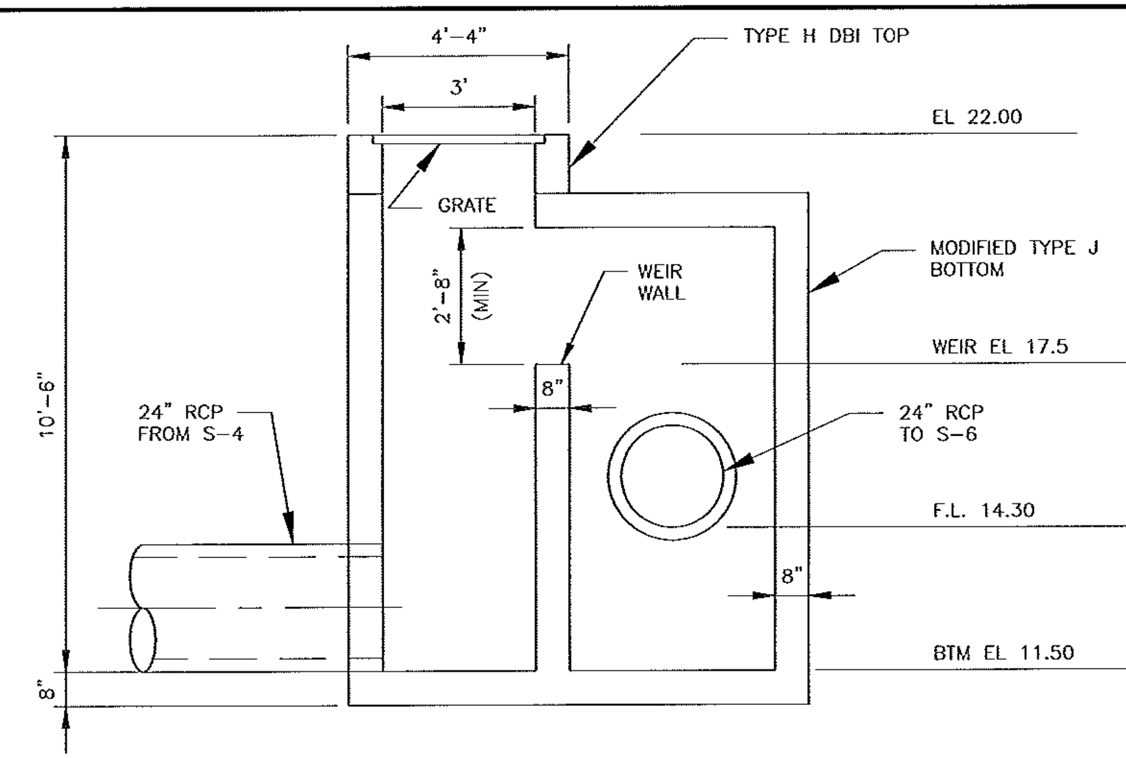
NAVY CANAL REGIONAL
STORMWATER FACILITY

POND
CROSS SECTIONS



S-5
MODIFIED TYPE H, W/J BOTTOM
INDEX 200 AND 232

PLAN
NTS



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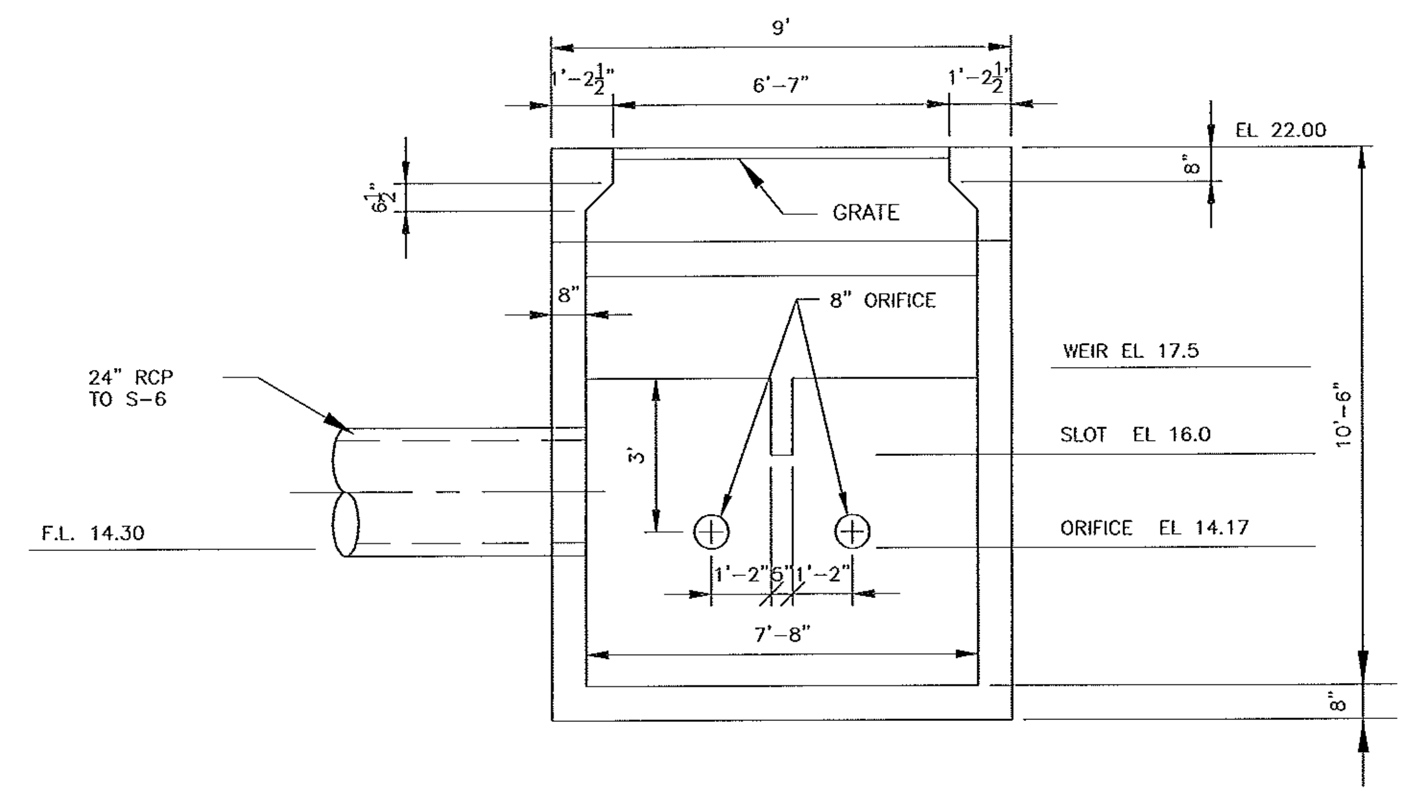
NTS



SECTION 2
NTS

Mario F. Chavez, P.E. # 50713 Date

REV. No.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: J. Williams
DRAWN BY: B. Williams
SHEET CHK'D BY: M. Chavez
CROSS CHK'D BY: J. Lodner
APPROVED BY:
DATE: OCTOBER 2005

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SEMINOLE COUNTY
FLORIDA

NAVY CANAL REGIONAL
STORMWATER FACILITY

DRAINAGE
DETAILS

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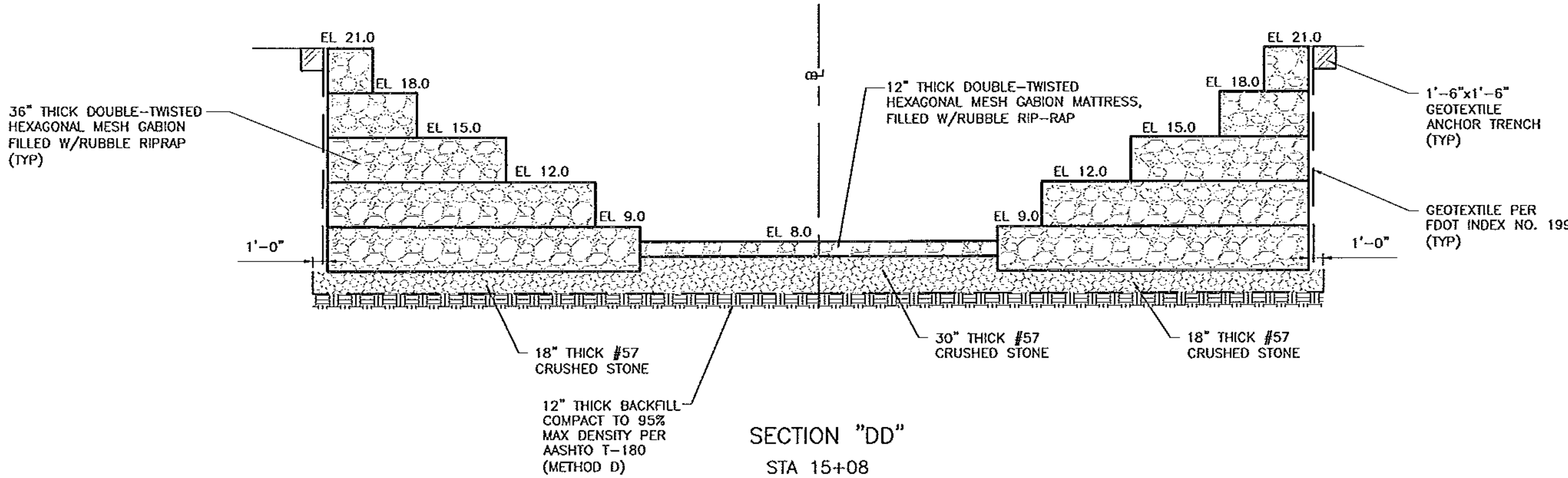

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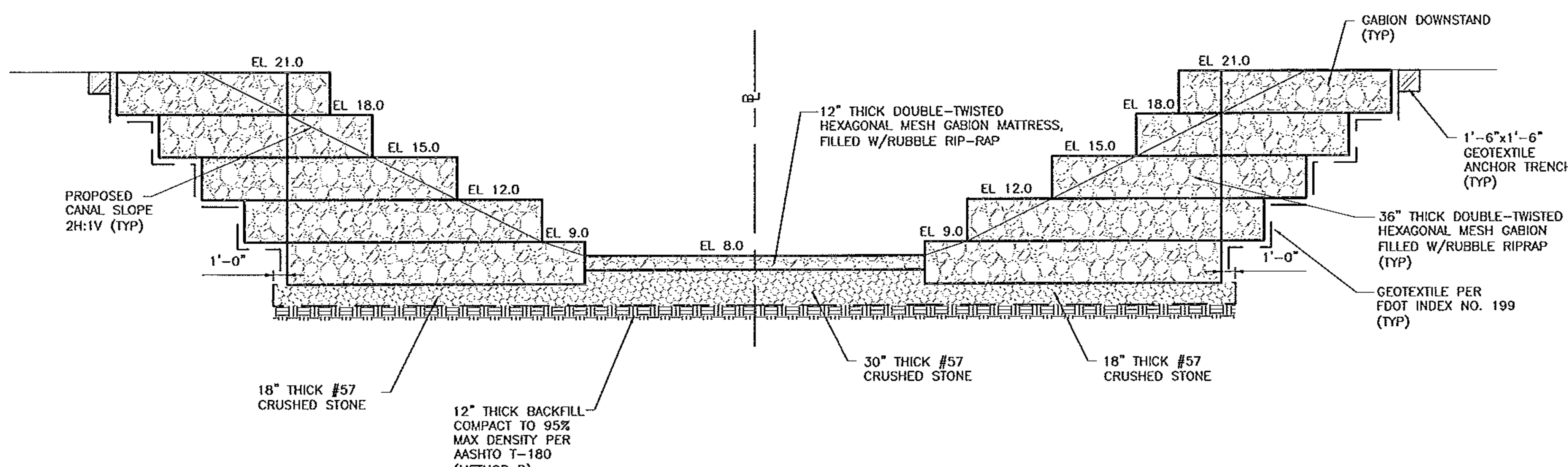
STA 15+08
1"=10'



SECTION "EE"
STA 15+16
1"=10'

Mario F. Chavez, P.E. # 50713 Date

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: J. Williams
DRAWN BY: B. Williams
SHEET CHK'D BY: M. Chavez
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APPROVED BY:
DATE: OCTOBER 2005

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SEMINOLE COUNTY
FLORIDA

NAVY CANAL REGIONAL
STORMWATER FACILITY

MISCELLANEOUS
DETAILS

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APPENDIX B

CHEMICAL CHARACTERISTICS OF INFLOW AND OUTFLOW SAMPLES COLLECTED AT THE NAVY CANAL POND FROM MARCH 1, 2008-FEBRUARY 28, 2009

1. **Bulk Precipitation**
2. **Stormwater Inflow**
3. **Baseflow**
4. **Pond Outfall**

1. Bulk Precipitation

Characteristics of Bulk Precipitation Samples Collected at the Navy Canal Site

Site	Date Collected	pH (s.u.)	Cond. (µmho/cm)	Alkalinity (mg/l)	NH3 (µg/l)	NOx (µg/l)	Diss Org N (µg/l)	Part N (µg/l)	Total N (µg/l)	SRP (µg/l)	Diss Org P (µg/l)	Part P (µg/l)	Total P (µg/l)	Turbidity (NTU)	TSS (mg/l)
Bulk Precip.	04/05/08-04/06/08	5.37	8.7	1.2	97	135	<25	35	271	<1	<1	1	2	0.9	1.8
Bulk Precip.	05/20/08-05/23/08	5.12	23.0	0.8	202	<5	485	134	824	23	2	12	37	1.2	2.7
Bulk Precip.	05/24/08-06/01/08	5.74	2.0	1.6	428	427	356	187	1398	21	<1	26	47	2.4	6.2
Bulk Precip.	06/01/08-06/16/08	5.24	15.6	1.4	117	329	75	179	700	<1	<1	6	6	0.9	3.1
Bulk Precip.	06/17/08-06/21/08	5.61	14.6	2.4	110	278	<25	71	469	<1	<1	7	7	1.9	1.6
Bulk Precip.	06/25/08-06/29/08	5.47	16.3	3.2	102	469	<25	241	822	5	2	49	56	4.1	16.1
Bulk Precip.	06/30/08-07/01/08	5.55	16.6	1.8	72	572	56	95	795	1	8	53	62	10.1	20.5
Bulk Precip.	07/08/08-07/15/08	4.68	13.0	0.4	28	342	<25	87	472	<1	<1	6	6	1.1	2.4
Bulk Precip.	07/15/08-07/17/08	4.74	9.0	0.6	<5	108	<25	<25	117	<1	1	2	3	0.3	1.0
Bulk Precip.	7/23/08	4.56	9.8	0.2	<5	218	277	116	614	<1	1	6	7	0.9	2.0
Bulk Precip.	8/3/08	5.35	13.5	1.8	98	159	168	<25	440	33	10	2	45	0.7	10.5
Bulk Precip.	8/7/08	5.40	13.1	2.0	119	207	140	294	760	61	14	26	101	3.7	8.7
Bulk Precip.	08/14/08-08/19/08	5.31	11.0	1.6	29	50	<25	<25	112	<1	<1	2	2	0.5	1.3
Bulk Precip.	08/18/08-08/20/08	5.24	20.1	1.4	28	11	<25	<25	42	<1	5	0.5	5	0.8	0.8
Bulk Precip.	08/20/08-08/28/08	5.56	10.2	2.6	13	10	<25	<25	50	2	8	7	17	0.3	0.9
Bulk Precip.	08/29/08-09/05/08	5.51	19.9	1.8	<5	6	58	74	141	10	1	4	15	1.2	1.4
Bulk Precip.	09/15/08-09/27/08	5.54	21.8	3.6	43	<5	76	121	243	<1	<1	4	4	1.3	6.4
Bulk Precip.	9/30/08	5.59	22.6	3.8	63	161	50	105	379	<1	6	3	9	1.2	2.4
Bulk Precip.	10/9/08	7.20	12.2	2.2	42	95	192	122	451	3	2	2	7	2.7	21.0
Bulk Precip.	12/11/08	6.10	31.7	3.8	404	252	472	224	1352	150	1	24	175	1.1	2.8
Bulk Precip.	01/29/09-01/30/09	5.65	17.0	3.4	231	102	77	135	545	5	1	18	24	1.3	2.1
Bulk Precip.	2/2/09	5.53	14.8	2.0	85	121	49	121	376	1	5	5	11	1.6	2.4
	Minimum	**4.56**	**2**	**0.2**	**<5**	**<5**	**<25**	**<25**	**42**	**<1**	**<1**	**<1**	**2**	**0.3**	**0.8**
	Maximum	**7.20**	**32**	**3.8**	**428**	**572**	**485**	**294**	**1398**	**150**	**14**	**53**	**175**	**10.1**	**21.0**
	Count	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**	**22**

2. Stormwater Inflow

Characteristics of Stormwater Samples Collected at the Navy Canal Site

Site	Date Collected	pH (s.u.)	Cond. (µmho/cm)	Alkalinity (mg/l)	NH3 (µg/l)	NOx (µg/l)	Diss Org N (µg/l)	Part N (µg/l)	Total N (µg/l)	SRP (µg/l)	Diss Org P (µg/l)	Part P (µg/l)	Total P (µg/l)	Turbidity (NTU)	TSS (mg/l)
Site 1	3/6/08	7.31	217	67.0	103	62	257	69	491	2	4	18	24	7.9	5.70
Site 1	3/7/08	7.53	226	66.6	144	46	210	59	459	4	4	12	20	5.3	5.30
Site 1	4/1/08	7.17	181	63.4	52	12	279	63	406	1	6	8	15	1.3	3.80
Site 1	4/6/08	6.98	160	53.4	40	30	224	135	429	1	5	19	25	5.4	8.10
Site 1	5/23/08	7.28	240	68.0	29	<5	374	<25	416	4	2	7	13	0.6	1.00
Site 1	6/1/08	7.23	221	60.4	15	7	416	179	617	1	1	15	17	1.4	4.40
Site 1	6/10/08	7.19	214	64.0	76	5	258	28	367	2	<1	13	15	0.5	1.10
Site 1	6/11/08	7.48	213	66.4	97	6	222	51	376	2	1	10	13	0.5	0.80
Site 1	6/18/08	7.26	186	57.2	46	8	251	58	363	<1	4	5	9	0.7	0.80
Site 1	6/21/08	7.19	183	61.6	44	10	230	105	389	3	1	15	19	0.9	1.40
Site 1	6/26/08	7.21	139	56.2	35	7	203	130	375	2	2	10	14	0.7	1.60
Site 1	6/29/08	7.19	128	55.2	24	16	246	<25	299	1	2	16	19	1.1	1.80
Site 1	6/30/08	7.21	193	54.6	42	<5	265	32	342	2	1	3	6	0.6	1.10
Site 1	7/8/08	7.17	157	56.6	64	6	313	<25	385	7	3	26	36	0.5	<0.7
Site 1	7/11/08	7.40	162	57.0	47	6	255	123	431	2	2	10	14	0.6	1.00
Site 1	7/15/08	7.07	129	51.2	30	7	251	42	330	6	2	7	15	0.4	1.80
Site 1	7/16/08	7.14	130	50.2	31	<5	240	58	332	4	1	5	10	0.6	1.20
Site 1	7/17/08	7.12	122	49.8	37	<5	243	45	328	2	4	9	15	0.4	1.50
Site 1	7/23/08	7.04	105	41.2	57	94	283	124	558	8	4	9	21	4.7	8.00
Site 1	7/31/08	7.02	128	43.4	56	10	186	60	312	5	2	11	18	0.9	2.80
Site 1	8/7/08	7.16	149	48.6	60	5	234	46	345	4	1	6	11	0.5	1.30
Site 1	8/14/08	7.17	147	48.2	65	<5	263	122	453	4	3	3	10	0.6	1.40
Site 1	8/19/08	7.17	127	42.4	42	23	186	92	343	5	<1	13	18	3.5	2.70
Site 1	8/20/08	6.79	86	26.4	39	<5	244	277	563	<1	22	77	100	19.1	38.20
Site 1	8/21/08	6.87	120	32.6	52	20	254	126	452	3	18	27	48	9.7	12.50
Site 1	8/30/08	7.03	190	48.4	11	92	371	187	661	6	10	18	34	5.7	11.10
Site 1	9/10/08	7.08	220	53.0	43	41	320	185	589	3	4	26	33	2.1	4.20
Site 1	9/15/08	7.40	220	55.2	82	112	354	56	604	10	3	12	25	1.0	5.00
Site 1	9/22/08	7.27	219	61.4	99	5	418	<25	544	10	2	8	20	1.1	2.80
Site 1	9/28/08	7.13	212	55.8	77	22	288	101	488	4	3	1	8	0.9	2.40
Site 1	9/30/08	7.26	191	53.4	77	10	316	57	460	8	<1	3	11	1.8	1.90
Site 1	10/5/08	7.39	190	52.6	84	<5	272	45	404	4	2	6	12	1.9	1.80
Site 1	10/9/08	7.10	170	49.0	89	25	304	80	498	19	2	3	24	2.3	5.20
Site 1	10/23/08	7.75	214	42.4	54	<5	317	171	545	3	4	40	47	7.2	15.70
Site 1	11/30/08	7.54	244	61.2	12	30	316	55	413	2	3	7	12	1.6	3.30
Site 1	12/11/08	7.32	249	59.4	12	190	264	<25	475	4	1	2	7	0.6	2.00
Site 1	1/29/09	7.48	237	62.4	16	<5	275	134	428	<1	4	16	20	1.9	3.60
Site 1	1/30/09	7.26	216	56.2	18	97	316	69	500	2	23	2	27	2.8	4.20
Site 1	2/2/09	6.98	165	47.0	12	10	186	97	305	<1	1	18	20	1.6	2.00
Site 1	3/2/09	7.71	219	63.8	<5	7	277	118	405	2	2	1	5	3.2	4.00
	Minimum	**6.79**	**86.30**	**26.40**	**<5**	**<5**	**186**	**<25**	**299**	**<1**	**<1**	**1**	**5**	**0.4**	**<0.7**
	Maximum	**7.75**	**249**	**68.0**	**144**	**190**	**418**	**277**	**661**	**19**	**23**	**77**	**100**	**19.1**	**38.2**
	Count	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**40**

3. Baseflow

Characteristics of Baseflow Samples Collected at the Navy Canal Site

Site	Date Collected	pH (s.u.)	Cond. (µmho/cm)	Alkalinity (mg/l)	NH3 (µg/l)	NOx (µg/l)	Diss Org N (µg/l)	Part N (µg/l)	Total N (µg/l)	SRP (µg/l)	Diss Org P (µg/l)	Part P (µg/l)	Total P (µg/l)	Turbidity (NTU)	TSS (mg/l)
Site 1	3/4/08	7.32	220	64.2	86	21	<25	46	172	2	<1	4	6	2.1	2.80
Site 1	5/17/08	7.49	229	65.0	13	6	417	217	653	1	<1	19	20	1.5	54.50
Site 1	05/20/08-05/23/08	7.28	234	69.8	<5	<5	358	53	416	<1	2	4	6	0.7	0.90
Site 1	05/24/08-06/01/08	7.21	231	61.8	98	16	392	324	830	7	9	23	39	1.9	3.00
Site 1	06/04/08-06/09/08	7.08	209	61.8	58	5	296	96	455	1	2	17	20	0.7	1.60
Site 1	06/17/08-06/21/08	7.27	178	56.8	42	6	253	68	369	1	1	13	15	1.1	2.60
Site 1	07/01/08-07/02/08	7.34	190	58.2	25	<5	272	59	359	2	1	5	8	0.3	0.80
Site 1	7/9/08	7.14	164	56.8	18	6	256	26	306	<1	2	8	10	0.5	<0.7
Site 1	07/15/08-07/19/08	7.09	118	47.2	<5	7	218	75	303	3	4	2	9	0.8	2.50
Site 1	07/25/08-07/27/08	6.90	80	34.6	42	73	376	<25	507	8	8	10	26	6.6	9.40
Site 1	08/08/08-08/10/08	7.06	143	47.2	29	<5	203	73	308	1	1	2	4	0.4	<0.7
Site 1	08/14/08-08/18/08	7.19	140	47.2	34	7	227	46	314	1	1	6	8	0.9	1.70
Site 1	08/30/08-09/05/08	7.07	200	47.6	<5	30	400	139	572	<1	4	18	22	2.8	5.80
Site 1	9/14/08	7.18	232	54.0	22	69	341	134	566	<1	8	27	35	2.9	5.70
Site 1	09/15/08-09/22/08	7.20	204	51.6	78	6	420	40	544	8	1	10	19	0.5	1.60
Site 1	10/05/08-10/08/08	7.65	187	55.6	60	<5	302	69	434	4	1	<1	5	1.7	2.40
Site 1	11/2/08	7.28	228	54.2	48	74	287	42	451	4	1	1	6	2.5	4.00
Site 1	1/7/09	7.78	201	63.2	12	10	293	103	418	1	4	16	21	0.9	3.20
Site 1	1/9/09	7.63	208	63.8	11	7	297	108	423	1	14	13	28	2.6	3.30
Site 1	01/13/09 - 01/22/09	7.42	253	66.2	28	21	267	88	404	1	4	3	8	3.1	3.20
	Minimum	**6.90**	**80**	**34.6**	**<5**	**<5**	**<25**	**26**	**172**	**<1**	**<1**	**<1**	**4**	**0.30**	**<0.7**
	Maximum	**7.78**	**253**	**69.8**	**98**	**74**	**420**	**324**	**830**	**8**	**14**	**27**	**39**	**6.60**	**54.50**
	Count	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**

4. Pond Outfall

Characteristics of Outflow Samples Collected at the Navy Canal Site

Site	Date Collected	pH (s.u.)	Cond. (µmho/cm)	Alkalinity (mg/l)	NH3 (µg/l)	NOx (µg/l)	Diss Org N (µg/l)	Part N (µg/l)	Total N (µg/l)	SRP (µg/l)	Diss Org P (µg/l)	Part P (µg/l)	Total P (µg/l)	Turbidity (NTU)	TSS (mg/l)
Site 2	03/01/08-03/05/08	7.18	220	63.4	65	18	57	154	294	1	1	15	17	2.2	3.2
Site 2	03/05/08-03/011/08	7.21	191	62.4	133	35	148	96	412	2	2	22	26	9.2	8.4
Site 2	03/11/08-03/17/08	7.13	184	53.8	71	19	357	410	857	<1	24	53	78	4.0	4.3
Site 2	03/17/08-03/24/08	7.16	153	58.0	88	<5	237	84	412	<1	5	12	17	2.6	2.6
Site 2	03/24/08-04/04/08	7.36	178	61.8	63	25	268	90	446	1	1	17	19	1.1	1.8
Site 2	04/05/08-04/07/08	7.21	168	60.4	58	9	248	86	401	1	6	15	22	3.0	5.4
Site 2	04/07/08-04/08/08	7.21	140	60.6	98	55	104	82	339	3	9	15	27	2.2	3.3
Site 2	04/14/08-04/21/08	7.38	185	60.2	84	<5	215	33	335	1	5	9	15	0.9	1.2
Site 2	04/21/08-04/30/08	7.21	223	61.2	50	5	268	52	375	<1	4	5	9	0.5	1.1
Site 2	04/30/08-05/06/08	7.69	230	64.6	50	6	311	<25	379	2	<1	8	10	0.8	1.6
Site 2	05/07/08-05/013/08	7.41	231	66.2	31	22	479	26	558	<1	1	23	25	0.8	1.3
Site 2	05/13/08-05/20/08	7.67	244	66.6	13	16	357	271	657	2	1	23	26	1.6	3.4
Site 2	05/20/08-05/24/08	7.41	190	63.4	22	<5	354	243	622	<1	3	21	24	2.0	3.6
Site 2	05/24/08-06/01/08	7.15	231	62.8	49	9	290	268	616	1	2	11	14	1.0	1.2
Site 2	06/02/08-06/17/08	7.46	203	59.6	89	17	257	92	455	1	1	28	30	1.7	5.2
Site 2	06/17/08-06/23/08	7.11	180	56.8	89	14	255	66	424	1	2	14	17	0.8	2.3
Site 2	06/23/08-06/30/08	7.09	132	53.0	50	<5	254	51	358	1	2	10	13	0.5	1.4
Site 2	06/30/08-07/08/08	7.36	194	54.6	42	9	312	96	459	3	<1	17	20	0.8	1.7
Site 2	07/08/08-07/15/08	7.23	134	46.4	22	26	194	170	412	<1	3	18	21	1.4	2.6
Site 2	07/15/08-07/17/08	6.98	123	48.0	88	9	204	40	341	4	3	1	8	0.5	1.8
Site 2	07/27/08-07/31/08	6.84	91	35.8	25	39	414	69	547	1	11	20	32	4.4	3.6
Site 2	07/31/08-08/07/08	6.78	106	35.6	67	13	203	104	387	4	<1	14	18	2.4	4.2
Site 2	08/07/08-08/14/08	6.98	144	44.2	75	7	228	78	388	2	1	11	14	1.0	1.2
Site 2	08/19/08-08/20/08	7.08	139	46.0	44	<5	245	208	500	2	1	23	26	2.5	3.2
Site 2	08/20/08-08/26/08	6.77	127	36.8	69	57	370	193	689	8	43	53	104	15.7	16.8
Site 2	08/28/08-09/05/08	6.83	180	52.2	203	70	273	80	626	18	5	19	42	4.2	4.8
Site 2	09/05/08-09/15/08	7.01	221	55.4	44	60	316	172	592	2	17	26	45	4.7	5.5
Site 2	09/15/08-09/27/08	7.14	201	52.0	39	<5	359	168	569	7	1	21	29	1.8	2.7
Site 2	09/27/08-10/03/08	6.75	200	52.0	144	30	312	215	701	9	1	20	30	2.7	1.7
Site 2	10/03/08-10/08/08	7.55	178	52.0	81	13	285	<25	399	1	2	5	8	2.2	2.0
Site 2	10/09/08-10/13/08	7.31	149	39.2	51	179	292	103	625	14	4	6	24	1.9	2.3
Site 2	10/14/08-10/20/08	7.32	148	41.0	52	20	305	65	442	3	2	19	24	1.6	3.7
Site 2	10/20/08-10/27/08	6.94	160	45.4	103	55	244	48	450	5	<1	2	7	1.4	1.1
Site 2	10/27/08-11/03/08	7.62	204	50.4	86	63	279	69	497	4	<1	1	5	1.9	2.6
Site 2	11/03/08-11/10/08	7.48	230	54.2	51	65	335	388	839	1	14	35	50	0.9	1.3
Site 2	11/10/08-11/17/08	7.45	216	62.2	37	29	281	67	414	1	4	12	17	1.3	2.0
Site 2	11/17/08-12/05/08	7.31	232	61.8	28	32	324	43	427	2	8	4	14	1.2	1.6
Site 2	12/5 - 12/13/08	7.34	253	60.0	28	67	333	56	484	2	1	8	11	5.0	5.0
Site 2	12/13/08-12/22/08	7.58	248	50.0	57	249	80	46	432	1	84	83	168	1.7	2.2
Site 2	12/23/08-12/29/08	7.56	232	60.0	28	<5	317	104	452	67	15	13	95	0.7	1.0
Site 2	12/29/08-01/07/09	7.50	257	60.0	12	14	274	203	503	1	3	24	28	4.0	6.5
Site 2	01/07/09-01/13/09	7.56	215	69.6	13	10	311	168	502	2	17	17	36	3.6	4.3
Site 2	01/13/09 - 01/22/09	7.62	245	72.2	38	22	272	92	424	2	5	2	9	3.7	4.6
Site 2	01/23/09-01/28/09	7.82	248	65.0	112	19	186	96	413	<1	1	2	4	4.2	4.7
Site 2	01/28/09-02/02/09	7.65	230	58.2	9	<5	326	65	403	1	9	7	17	2.5	4.7
Site 2	02/02/09 - 02/09/09	7.50	219	58.6	9	<5	451	153	616	1	17	44	62	2.3	4.2
Site 2	02/09/09-02/18/09	7.27	207	58.2	42	<5	247	109	401	<1	4	9	14	1.9	2.6
Site 2	02/18/09-02/23/09	7.58	226	60.4	29	<5	249	131	414	<1	12	31	43	1.6	3.3
Site 2	3/2/09	7.57	213	64.4	<5	<5	258	135	398	2	1	5	8	3.4	4.0
Site 2	03/02/09 - 03/11/09	7.55	214	65.4	36	<5	199	90	328	1	<1	1	2	4.2	3.9
	Minimum	**6.75**	**91**	**35.6**	**<5**	**<5**	**57**	**<25**	**294**	**<1**	**<1**	**1**	**2**	**0.5**	**1.0**
	Maximum	**7.82**	**257**	**72.2**	**203**	**249**	**479**	**410**	**857**	**67**	**84**	**83**	**168**	**15.7**	**16.8**
	Count	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**

APPENDIX C

VERTICAL FIELD PROFILES
COLLECTED AT THE NAVY CANAL POND
FROM MARCH 1, 2008-FEBRUARY 28, 2009

Navy Canal Field Profiles

Date MMDDYY	Time HHMMSS	Level meters	Temp degC	pH units	SpCond uS/cm	TDS mg/l	DO mg/l	DO %Sat	Redox mV
3/5/08	10:41	0.25	21.33	7.67	221	142	7.9	89	454
3/5/08	10:42	0.50	21.27	7.64	221	141	7.8	88	455
3/5/08	10:43	1.00	21.12	7.60	220	141	7.6	86	457
3/5/08	10:44	1.50	18.75	7.09	227	145	3.2	34	474
3/5/08	10:45	2.00	18.14	7.02	231	148	2.0	21	477
3/5/08	10:46	2.50	17.66	7.17	254	163	0.6	7	245
3/11/08	10:19	0.25	20.11	7.51	167	107	8.0	88	481
3/11/08	10:20	0.50	19.85	7.44	166	106	7.5	82	484
3/11/08	10:20	1.00	19.12	7.22	164	105	5.7	61	492
3/11/08	10:21	1.50	18.54	7.15	162	103	4.8	51	495
3/11/08	10:22	2.00	18.11	7.10	162	104	4.2	44	498
3/11/08	10:23	2.50	16.75	7.01	190	122	2.4	25	500
3/11/08	10:24	2.70	16.53	7.00	192	123	2.2	23	489
3/17/08	7:17	0.25	21.77	7.63	188	120	7.7	88	439
3/17/08	7:19	0.50	21.75	7.60	188	120	7.6	86	441
3/17/08	7:20	1.00	21.64	7.45	190	122	6.7	76	448
3/17/08	7:21	1.50	19.53	6.90	212	136	2.6	28	467
3/17/08	7:22	2.00	18.80	6.93	211	135	0.9	9	423
3/17/08	7:23	2.50	18.12	7.08	218	139	0.4	5	222
3/17/08	7:24	2.65	17.95	7.13	217	139	0.3	3	141
4/7/08	10:23	0.25	23.45	7.09	248	159	5.7	67	386
4/7/08	10:23	0.50	23.46	7.01	247	158	5.2	61	353
4/7/08	10:24	1.00	23.44	6.92	247	158	5.3	62	343
4/7/08	10:25	1.50	22.11	6.86	219	140	4.8	55	328
4/7/08	10:26	2.00	21.65	6.80	197	126	4.6	52	330
4/7/08	10:27	2.50	20.62	6.68	276	177	2.2	25	265
4/7/08	10:28	2.67	20.21	6.67	300	192	1.2	13	258
4/14/08	8:41	0.25	22.49	7.21	196	125	4.5	52	431
4/14/08	8:42	0.50	22.49	7.20	195	125	4.4	50	431
4/14/08	8:43	1.00	22.51	7.18	195	125	4.3	49	432
4/14/08	8:43	1.50	22.51	7.18	195	125	4.2	49	432
4/14/08	8:45	2.00	21.83	6.93	210	135	1.1	12	205
4/14/08	8:46	2.50	20.77	7.07	284	181	0.4	4	117
4/14/08	8:47	2.56	20.64	7.07	284	182	0.3	3	94
4/30/08	9:02	0.25	24.02	7.44	224	144	5.9	70	402
4/30/08	9:03	0.50	23.98	7.40	226	144	5.4	64	404
4/30/08	9:04	1.00	23.92	7.37	224	143	5.6	66	405
4/30/08	9:05	1.50	23.82	7.36	227	145	4.6	55	406
4/30/08	9:06	2.00	23.21	7.10	235	150	2.0	24	365
4/30/08	9:06	2.42	22.33	7.03	248	159	0.6	6	198
5/6/08	8:18	0.25	25.46	7.48	235	151	5.5	67	441
5/6/08	8:18	0.50	25.47	7.45	234	150	5.7	70	442
5/6/08	8:19	1.00	25.47	7.43	235	150	5.3	65	442
5/6/08	8:20	1.50	24.86	7.17	237	151	2.9	35	448
5/6/08	8:21	2.00	23.52	6.99	240	153	0.8	9	455
5/6/08	8:22	2.41	22.97	7.02	250	160	0.4	4	290

Navy Canal Field Profiles

Date MMDDYY	Time HHMMSS	Level meters	Temp degC	pH units	SpCond uS/cm	TDS mg/l	DO mg/l	DO %Sat	Redox mV
5/13/08	7:41	0.25	25.89	7.34	242	155	4.2	52	369
5/13/08	7:42	0.50	25.92	7.29	242	155	4.0	50	370
5/13/08	7:42	1.00	25.92	7.27	242	155	4.1	50	370
5/13/08	7:43	1.50	25.92	7.25	241	154	3.9	48	370
5/13/08	7:44	2.00	25.75	7.07	244	156	2.0	24	374
5/13/08	7:45	2.37	24.78	7.02	255	163	0.6	7	256
5/24/08	9:38	0.25	27.40	7.56	244	156	5.3	67	354
5/24/08	9:39	0.50	27.42	7.56	244	156	5.4	69	354
5/24/08	9:40	1.00	27.37	7.54	244	156	5.2	66	356
5/24/08	9:41	1.50	26.81	7.39	235	151	3.7	46	360
5/24/08	9:42	2.00	25.89	7.23	178	114	2.1	26	361
5/24/08	9:43	2.50	25.04	7.14	113	72	3.3	39	351
5/24/08	9:44	2.70	25.00	7.10	111	71	3.4	42	347
6/2/08	7:34	0.25	28.77	7.50	216	138	5.0	64	362
6/2/08	7:34	0.50	28.78	7.49	216	138	4.9	63	363
6/2/08	7:35	1.00	28.79	7.48	216	138	4.8	62	364
6/17/08	7:45	0.25	28.49	7.21	249	159	3.7	48	431
6/17/08	7:46	0.50	28.52	7.13	248	159	3.6	46	401
6/17/08	7:46	1.00	28.51	7.13	249	159	3.5	45	364
6/17/08	7:47	1.50	28.50	7.13	248	159	3.5	45	362
6/17/08	7:49	2.00	27.96	6.98	239	153	1.0	12	350
6/17/08	7:50	2.45	27.43	6.92	229	147	0.8	10	346
6/23/08	8:34	0.25	28.14	7.45	250	160	3.9	49	413
6/23/08	8:35	0.50	28.12	7.41	246	157	3.7	47	393
6/23/08	8:35	1.00	28.13	7.39	243	156	3.6	47	382
6/23/08	8:36	1.50	28.13	7.37	241	154	3.6	46	381
6/23/08	8:37	2.00	27.47	7.27	235	150	1.7	22	370
6/23/08	8:38	2.50	26.96	7.19	227	145	1.0	13	379
6/30/08	7:46	0.25	28.72	6.85	225	144	5.2	67	396
6/30/08	7:47	0.50	28.71	6.98	225	144	5.0	65	366
6/30/08	7:48	1.00	28.75	7.03	225	144	4.9	64	356
6/30/08	7:49	1.50	28.43	7.04	227	145	3.3	42	343
6/30/08	7:51	2.00	27.69	6.98	236	151	1.5	19	343
6/30/08	7:52	2.47	27.22	6.93	239	153	0.8	10	360
7/8/08	8:18	0.25	29.15	7.42	234	150	4.8	62	437
7/8/08	8:19	0.50	29.20	7.33	235	150	4.7	61	417
7/8/08	8:20	1.00	29.24	7.29	234	150	4.6	61	407
7/8/08	8:21	1.50	29.16	7.22	237	152	3.2	42	396
7/8/08	8:22	2.00	28.64	7.12	244	156	2.0	26	388
7/8/08	8:24	2.40	28.08	7.04	251	161	1.0	13	385

Navy Canal Field Profiles

Date MMDDYY	Time HHMMSS	Level meters	Temp degC	pH units	SpCond uS/cm	TDS mg/l	DO mg/l	DO %Sat	Redox mV
7/15/08	8:03	0.25	28.51	7.55	214	137	5.6	73	452
7/15/08	8:04	0.50	28.51	7.45	214	137	5.5	71	427
7/15/08	8:05	1.00	28.56	7.39	214	137	5.4	69	416
7/15/08	8:06	1.50	27.81	7.20	199	127	2.2	28	397
7/15/08	8:07	2.00	27.15	7.10	182	116	1.4	17	387
7/15/08	8:07	2.50	26.77	7.03	185	118	1.3	17	378
7/22/08	7:44	0.25	29.85	7.45	184	118	5.2	69	474
7/22/08	7:45	0.50	29.87	7.37	184	118	5.1	67	441
7/22/08	7:46	1.00	29.91	7.28	183	117	5.0	66	412
7/22/08	7:47	1.50	28.91	7.03	186	119	1.9	24	393
7/22/08	7:47	2.00	27.79	6.95	176	113	0.7	9	375
7/22/08	7:48	2.50	27.28	6.89	182	116	0.5	6	365
7/31/08	8:00	0.25	27.09	7.30	173	111	4.7	59	433
7/31/08	8:01	0.50	27.10	7.15	172	110	4.6	58	412
7/31/08	8:02	1.00	27.07	7.08	166	106	4.5	57	403
7/31/08	8:03	1.50	26.57	7.12	131	84	4.1	51	396
7/31/08	8:03	2.00	26.29	7.08	115	74	4.5	56	396
7/31/08	8:04	2.50	26.17	6.97	113	72	4.4	54	395
7/31/08	8:05	2.68	25.95	6.91	115	74	3.3	40	399
8/7/08	8:02	0.25	30.42	7.29	176	113	5.0	66	501
8/7/08	8:03	0.50	30.42	7.19	175	112	4.8	64	470
8/7/08	8:04	1.00	29.98	7.08	187	120	2.9	38	448
8/7/08	8:05	1.50	28.68	6.87	207	132	1.1	15	423
8/7/08	8:05	2.00	27.46	6.80	202	129	0.6	8	420
8/7/08	8:06	2.50	26.87	6.82	199	127	0.6	7	397
8/20/08	12:41	0.25	26.23	6.95	192	123	4.8	59	473
8/20/08	12:42	0.50	26.19	6.88	193	124	4.8	59	424
8/20/08	12:43	1.00	26.19	6.87	194	124	4.6	57	431
8/20/08	12:44	1.50	25.88	6.89	196	125	4.2	51	433
8/20/08	12:45	2.00	25.36	6.90	183	117	4.6	56	429
8/20/08	12:46	2.50	24.93	6.92	171	109	5.2	63	429
8/20/08	12:46	2.58	24.91	6.92	171	109	5.2	63	437
8/28/08	8:09	0.25	28.67	6.81	226	145	4.0	52	451
8/28/08	8:10	0.50	28.63	6.64	221	141	4.0	51	428
8/28/08	8:11	1.00	28.18	6.50	213	136	3.5	45	417
8/28/08	8:12	1.50	27.02	6.48	195	125	1.9	24	400
8/28/08	8:12	2.00	26.78	6.47	195	125	1.8	23	400
8/28/08	8:13	2.50	26.54	6.42	194	124	1.9	23	395
8/28/08	8:14	2.64	26.43	6.40	194	124	1.8	23	400
9/15/08	8:16	0.25	29.13	7.01	266	170	6.5	85	376
9/15/08	8:17	0.50	29.13	6.98	266	170	6.5	85	353
9/15/08	8:18	1.00	29.11	6.91	266	170	6.2	81	347
9/15/08	8:19	1.50	27.85	6.62	284	182	1.1	14	308
9/15/08	8:20	2.00	27.08	6.58	292	187	0.9	11	310
9/15/08	8:20	2.50	26.39	6.58	297	190	0.9	11	310
9/15/08	8:21	2.65	26.14	6.60	300	192	0.8	10	310

Navy Canal Field Profiles

Date MMDDYY	Time HHMMSS	Level meters	Temp degC	pH units	SpCond uS/cm	TDS mg/l	DO mg/l	DO %Sat	Redox mV
9/27/08	8:58	0.25	25.82	6.98	247	158	5.3	66	377
9/27/08	8:59	0.50	25.83	6.96	247	158	5.2	64	362
9/27/08	9:00	1.00	25.85	6.95	248	159	5.2	63	344
9/27/08	9:00	1.50	25.85	6.94	248	159	5.1	63	325
9/27/08	9:01	2.00	25.85	6.93	249	159	4.9	61	310
9/27/08	9:02	2.50	25.37	6.78	266	170	1.6	20	292
9/27/08	9:03	2.61	25.25	6.76	274	175	1.0	12	291
10/3/08	14:26	0.25	26.76	7.48	190	122	5.8	72	422
10/3/08	14:27	0.50	26.57	7.49	190	122	5.5	68	422
10/3/08	14:28	1.00	26.12	7.63	195	125	4.6	56	419
10/3/08	14:28	1.50	25.80	7.77	199	127	4.0	49	414
10/3/08	14:29	2.00	25.37	7.74	201	129	2.0	25	410
10/3/08	14:30	2.50	25.06	7.74	202	129	1.2	14	332
10/3/08	14:30	2.67	24.78	7.86	211	135	0.7	9	240
10/9/08	10:02	0.25	26.88	7.54	189	121	6.2	78	494
10/9/08	10:02	0.50	26.75	7.60	192	123	5.7	71	494
10/9/08	10:03	1.00	26.53	7.54	192	123	4.7	59	496
10/9/08	10:05	1.50	25.68	7.46	220	141	0.8	9	366
10/9/08	10:05	2.00	25.40	7.55	231	148	0.4	5	263
10/9/08	10:06	2.50	25.13	7.60	230	147	0.3	4	216
10/9/08	10:06	2.67	24.99	7.62	228	146	0.4	4	199
10/20/08	0:00	0.25	24.50	6.54	228	146	4.7	57	319
10/20/08	0:00	0.50	24.31	6.53	227	145	4.5	54	314
10/20/08	0:00	1.00	24.21	6.53	226	145	4.4	52	307
10/20/08	0:00	1.50	24.15	6.52	227	145	4.2	50	297
10/20/08	0:00	2.00	24.12	6.54	228	146	4.1	49	290
10/20/08	0:00	2.50	23.91	6.63	245	157	2.9	34	296
10/20/08	0:00	2.77	23.71	6.56	264	169	2.9	34	276
10/27/08	9:35	0.25	22.89	6.73	197	126	3.9	45	492
10/27/08	9:36	0.50	22.90	6.84	197	126	3.7	44	486
10/27/08	9:37	1.00	22.90	6.99	197	126	3.6	42	479
10/27/08	9:37	1.50	22.90	7.11	197	126	3.5	41	472
10/27/08	9:38	2.00	22.90	7.22	197	126	3.4	40	466
10/27/08	9:39	2.50	22.90	7.33	197	126	3.4	40	460
10/27/08	9:40	2.59	22.89	7.40	197	126	3.3	38	457
11/3/08	8:30	0.25	20.56	6.64	210	135	6.8	76	505
11/3/08	8:30	0.50	20.57	6.79	210	135	6.9	77	499
11/3/08	8:31	1.00	20.57	6.97	211	135	6.8	75	492
11/3/08	8:32	1.50	20.56	7.22	211	135	6.4	72	482
11/3/08	8:33	2.00	20.02	7.13	242	155	3.4	37	480
11/3/08	8:34	2.50	19.84	7.19	245	157	2.8	30	475
11/3/08	8:35	2.59	19.80	7.27	245	157	2.5	27	471

Navy Canal Field Profiles

Date MMDDYY	Time HHMMSS	Level meters	Temp degC	pH units	SpCond uS/cm	TDS mg/l	DO mg/l	DO %Sat	Redox mV
11/10/08	9:29	0.25	20.04	6.54	244	156	4.5	50	442
11/10/08	9:30	0.50	20.05	6.69	244	156	4.3	47	438
11/10/08	9:30	1.00	20.09	6.90	244	156	4.2	47	430
11/10/08	9:31	1.50	20.09	7.11	244	156	4.1	45	421
11/10/08	9:32	2.00	20.09	7.30	244	156	4.0	44	413
11/10/08	9:34	2.50	20.04	7.57	244	156	3.6	40	401
11/17/08	10:50	0.25	20.01	7.41	251	161	5.7	63	395
11/17/08	10:51	0.50	20.01	7.50	250	160	5.4	60	391
11/17/08	10:52	1.00	19.99	7.59	248	159	5.3	58	386
11/17/08	10:53	1.50	19.98	7.65	247	158	5.2	58	382
11/17/08	10:53	2.00	19.98	7.69	246	157	5.3	59	379
11/17/08	10:55	2.45	19.95	7.77	247	158	4.5	50	377
1/7/09	9:31	0.25	18.05	7.46	259	166	6.6	69	251
1/7/09	9:32	0.50	18.05	7.43	259	166	6.5	69	263
1/7/09	9:33	1.00	18.04	7.44	260	166	6.4	67	270
1/7/09	9:34	1.50	17.53	7.09	264	169	3.8	40	286
1/7/09	9:35	2.00	17.33	7.01	272	174	1.8	19	291
1/7/09	9:36	2.48	17.21	6.80	272	174	0.5	5	219
1/13/09	10:54	0.25	18.46	6.56	248	159	7.9	85	512
1/13/09	10:55	0.50	18.43	6.82	249	159	7.7	82	499
1/13/09	10:56	1.00	18.38	6.99	251	161	7.6	81	490
1/13/09	10:57	1.50	17.91	6.79	248	159	5.4	57	497
1/13/09	10:58	2.00	17.75	6.87	253	162	5.5	57	495
1/13/09	11:00	2.30	17.65	6.96	261	167	4.9	51	492
1/22/09	15:57	0.25	15.94	7.67	255	163	8.8	89	459
1/22/09	15:57	0.50	15.58	7.76	255	163	8.5	86	457
1/22/09	15:59	1.00	13.75	7.95	254	162	7.9	77	453
1/22/09	15:59	1.50	13.52	8.10	256	164	7.9	76	448
1/22/09	16:01	2.00	13.18	8.19	252	161	7.2	68	444
1/22/09	16:02	2.33	13.04	8.24	250	160	6.6	62	443
1/28/09	13:01	0.25	18.60	9.19	259	166	10.1	107	460
1/28/09	13:02	0.50	18.44	9.34	259	166	9.9	106	454
1/28/09	13:03	1.00	14.99	9.11	260	167	9.2	91	457
1/28/09	13:04	1.50	14.19	9.19	257	165	8.7	85	453
1/28/09	13:05	2.00	13.78	9.16	256	164	8.3	81	453
1/28/09	13:06	2.34	13.65	9.17	258	165	7.8	75	453
2/2/09	9:42	0.25	15.49	8.06	219	140	9.1	91	792
2/2/09	9:43	0.50	15.45	8.38	220	141	8.9	89	768
2/2/09	9:44	1.00	15.22	8.49	215	137	8.5	85	756
2/2/09	9:45	1.50	14.55	8.39	200	128	6.2	61	753
2/2/09	9:46	2.00	14.35	8.46	211	135	5.0	49	749
2/2/09	9:47	2.41	14.23	8.51	205	131	4.6	45	744

Navy Canal Field Profiles

Date MMDDYY	Time HHMMSS	Level meters	Temp degC	pH units	SpCond uS/cm	TDS mg/l	DO mg/l	DO %Sat	Redox mV
2/4/2009	14:16	0.25	15.08	8.91	222	142	9.2	92	506
2/4/2009	14:17	0.50	15.13	8.96	222	142	8.8	87	504
2/4/2009	14:18	1.00	15.14	8.98	222	142	8.5	85	504
2/4/2009	14:19	1.50	15.13	9.05	221	142	8.3	83	502
2/4/2009	14:20	2.00	15.10	9.09	220	141	8.1	81	501
2/4/2009	14:22	2.50	14.79	9.17	221	141	7.5	74	499
2/9/2009	10:52	0.25	14.35	8.51	227	145	9.7	95	604
2/9/2009	10:53	0.50	14.28	8.85	226	145	9.7	95	589
2/9/2009	10:54	1.00	14.17	8.94	225	144	9.4	92	583
2/9/2009	10:55	1.50	13.63	8.93	225	144	8.9	85	583
2/9/2009	10:57	2.00	13.35	8.94	227	145	8.0	77	582
2/9/2009	10:58	2.35	13.18	9.01	233	149	6.5	62	580
2/18/09	10:44	0.25	14.59	7.69	255	163	8.2	81	348
2/18/09	10:45	0.50	14.29	7.73	256	164	8.1	79	344
2/18/09	10:46	1.00	13.96	7.25	261	167	6.5	63	343
2/18/09	10:46	1.50	13.81	7.11	258	165	7.2	69	338
2/18/09	10:47	2.00	13.73	7.21	262	168	6.3	61	337
2/18/09	10:48	2.48	13.62	7.17	278	178	3.5	33	327
2/23/09	9:24	0.25	16.04	7.48	258	165	7.2	73	315
2/23/09	9:25	0.50	16.04	7.47	258	165	6.9	70	316
2/23/09	9:26	1.00	16.05	7.45	258	165	6.8	69	317
2/23/09	9:27	1.50	15.41	7.08	265	170	3.4	34	327
2/23/09	9:28	2.00	14.85	7.01	271	174	1.8	18	328
2/23/09	9:29	2.46	14.03	6.82	271	173	0.6	6	246

APPENDIX D

QUALITY ASSURANCE DATA

METHOD BLANK RECOVERY STUDY

PARAMETERS	UNITS	DATE ANALYZED	MEASURED CONC.	MDL
pH	s.u.	01/12/09	5.63	NA
pH	s.u.	01/26/09	5.56	NA
Alkalinity	mg/l	01/12/09	1.0	0.5
Alkalinity	mg/l	01/26/09	1.0	0.5
Specific Conductivity	µmho/cm	01/13/09	2.2	0.2
Specific Conductivity	µmho/cm	02/09/09	2.0	0.2
Turbidity	NTU	01/09/09	0.1	0.1
Turbidity	NTU	01/23/09	0.1	0.1
TSS	mg/l	01/09/09	0.2	0.7
TSS	mg/l	01/23/09	0.2	0.7
TSS	mg/l	02/06/09	0.3	0.7
SRP	µg/l	02/06/09	0	1
SRP	µg/l	03/04/09	0	1
SRP	µg/l	01/23/09	0	1
SRP	µg/l	01/28/09	0	1
SRP	µg/l	02/04/09	0	1
SRP	µg/l	02/19/09	0	1
NOX-N	µg/l	02/06/09	1	5
NOX-N	µg/l	03/04/09	0	5
NOX-N	µg/l	01/23/09	1	5
NOX-N	µg/l	01/28/09	1	5
NOX-N	µg/l	02/04/09	0	5
NOX-N	µg/l	02/19/09	0	5
Ammonia	µg/l	03/11/09	0	5
Ammonia	µg/l	02/18/09	1	5
Ammonia	µg/l	02/18/09	2	5
Total N	µg/l	01/29/09	3	25
Total N	µg/l	03/06/09	4	25
Total N	µg/l	02/10/09	4	25
Total N	µg/l	02/25/09	2	25
Total N	µg/l	01/27/09	5	25
Total P	µg/l	03/06/09	0	1
Total P	µg/l	02/10/09	0	1
Total P	µg/l	02/25/09	0	1
Total P	µg/l	01/27/09	0	1
Total P	µg/l	01/29/09	0	1

CONTINUING CALIBRATION VERIFICATION RECOVERY STUDY

PARAMETERS	UNITS	DATE ANALYZED	INITIAL CONC.	INITIAL VOLUME (ml)	SPIKE CONC.	SPIKE VOLUME ADDED (ml)	FINAL CONC.	MEASURED CONC.	PERCENT RECOVERY	ACCEPT RANGE
Alkalinity	mg/l	01/12/09	1.0	50	1000	0.6	13.0	12.6	96.9%	91-105
Alkalinity	mg/l	01/26/09	1.0	50	1000	0.6	13.0	12.4	95.4%	91-105
Specific Conductivity	µmho/cm	01/13/09	2.2	50	2000	50	2002	1937	96.7%	96-104
Specific Conductivity	µmho/cm	02/09/09	2.0	50	2000	50	2002	1884	94.1%	96-104
Turbidity	NTU	01/09/09	0.1	50	1000	0.9	18.1	17.9	98.9%	87-104
Turbidity	NTU	01/23/09	0.1	50	1000	0.9	18.1	18.2	101%	87-104
TSS	mg/l	01/09/09	0.2	1000	33.4	1000	33.6	33.4	99.4%	91-105
TSS	mg/l	01/23/09	0.3	1000	31.1	1000	31.4	31.1	99.0%	91-105
TSS	mg/l	02/06/09	0.2	1000	32.3	1000	32.5	32.3	99.4%	91-105
SRP	µg/l	01/28/09	0	10	10000	0.225	225.0	218	96.9%	92-111
SRP	µg/l	02/06/09	0	10	10000	0.200	200.0	202	101%	92-111
SRP	µg/l	03/04/09	0	10	10000	0.400	400.0	410	103%	92-111
SRP	µg/l	01/23/09	0	10	10000	0.225	225.0	211	93.8%	92-111
SRP	µg/l	02/04/09	0	10	10000	0.100	100.0	99	99.0%	92-111
SRP	µg/l	02/19/09	0	10	10000	0.225	225.0	229	102%	92-111
SRP	µg/l	02/11/09	0	10	10000	0.400	400.0	388	97.0%	92-111
NOX-N	µg/l	01/28/09	0	10	100000	0.200	2000.0	1918	95.9%	92-108
NOX-N	µg/l	02/06/09	0	10	100000	0.200	2000.0	1936	96.8%	92-108
NOX-N	µg/l	03/04/09	0	10	100000	0.150	1500.0	1480	98.7%	92-108
NOX-N	µg/l	01/23/09	0	10	100000	0.200	2000.0	1860	93.0%	92-108
NOX-N	µg/l	02/04/09	0	10	100000	0.100	1000.0	976	97.6%	92-108
NOX-N	µg/l	02/19/09	0	10	100000	0.100	1000.0	966	96.6%	92-108
NOX-N	µg/l	02/11/09	0	10	100000	0.400	4000.0	3711	92.8%	92-108
Ammonia	µg/l	03/11/09	0	10	100000	0.300	3000.0	3018	101%	88-120
Ammonia	µg/l	02/18/09	0	10	100000	0.100	1000.0	1028	103%	88-120
Ammonia	µg/l	02/18/09	0	10	100000	0.100	1000.0	992	99.2%	88-120
Total N	µg/l	03/06/09	0	5	22600	0.200	904.0	894	98.9%	92-110
Total N	µg/l	03/18/09	0	5	100000	0.200	4000.0	4096	102%	92-110
Total N	µg/l	03/19/09	0	5	100000	0.200	4000.0	3986	99.7%	92-110
Total N	µg/l	02/10/09	0	5	10000	0.500	1000.0	948	94.8%	92-110
Total N	µg/l	02/25/09	0	5	10000	0.050	100.0	104	104%	92-110
Total N	µg/l	01/27/09	0	5	200	5.000	200.0	190	95.0%	92-110
Total N	µg/l	01/29/09	0	5	8000	5.000	8000.0	7595	94.9%	92-110
Total P	µg/l	03/06/09	0	5	10000	0.500	1000.0	1019	102%	93-109
Total P	µg/l	03/18/09	0	5	10000	0.050	100.0	93	93.0%	93-109
Total P	µg/l	03/19/09	0	5	10000	0.050	100.0	102	102%	93-109
Total P	µg/l	02/10/09	0	5	10000	0.500	1000.0	1042	104%	93-109
Total P	µg/l	02/25/09	0	5	10000	0.500	1000.0	954	95.4%	93-109
Total P	µg/l	01/27/09	0	5	10000	0.500	1000.0	1047	105%	93-109
Total P	µg/l	01/29/09	0	5	2000	5.000	2000.0	2043	102%	93-109

BLANK SPIKE RECOVERY STUDY

PARAMETERS	UNITS	DATE ANALYZED	INITIAL CONC.	INITIAL VOLUME (ml)	SPIKE CONC.	SPIKE VOLUME ADDED (ml)	FINAL CONC.	MEASURED CONC.	PERCENT RECOVERY	ACCEPT RANGE
Alkalinity	mg/l	01/12/09	1.0	50	1000	0.6	13.0	12.6	96.9%	91-105
Alkalinity	mg/l	01/26/09	1.0	50	1000	0.6	13.0	12.4	95.4%	91-105
Specific Conductivity	µmho/cm	01/13/09	2.2	50	2000	50	2002	1937	96.7%	96-104
Specific Conductivity	µmho/cm	02/09/09	2.0	50	2000	50	2002	1884	94.1%	96-104
Turbidity	NTU	01/09/09	0.1	50	1000	0.9	18.1	17.9	98.9%	87-104
Turbidity	NTU	01/23/09	0.1	50	1000	0.9	18.1	18.2	101%	87-104
TSS	mg/l	01/09/09	0.2	1000	33.4	1000	33.6	33.4	99.4%	91-105
TSS	mg/l	01/23/09	0.3	1000	31.1	1000	31.4	31.1	99.0%	91-105
TSS	mg/l	02/06/09	0.2	1000	32.3	1000	32.5	32.3	99.4%	91-105
SRP	µg/l	01/28/09	0	10	10000	0.225	225	215	95.6%	92-111
SRP	µg/l	03/04/09	0	10	10000	0.400	400	407	102%	92-111
SRP	µg/l	01/23/09	0	10	10000	0.200	200	209	105%	92-111
SRP	µg/l	02/06/09	0	10	10000	0.200	200	206	103%	92-111
SRP	µg/l	02/04/09	0	10	10000	0.100	100	103	103%	92-111
SRP	µg/l	02/11/09	0	10	10000	0.225	225	210	93.3%	92-111
NOX-N	µg/l	01/28/09	0	10	9040	0.175	158	157	99.2%	92-108
NOX-N	µg/l	03/04/09	0	10	9040	0.375	339	334	98.5%	92-108
NOX-N	µg/l	01/23/09	0	10	100000	0.200	2000	1944	97.2%	92-108
NOX-N	µg/l	02/06/09	0	10	9040	0.200	181	175	96.8%	92-108
NOX-N	µg/l	02/04/09	0	10	9040	0.200	181	170	94.0%	92-108
NOX-N	µg/l	02/11/09	0	10	9040	0.200	181	173	95.7%	92-108
Ammonia	µg/l	03/11/09	0	10	100000	0.300	3000	2987	99.6%	88-120
Ammonia	µg/l	02/18/09	0	10	100000	0.100	1000	1033	103%	88-120
Ammonia	µg/l	02/18/09	0	10	100000	0.100	1000	1025	103%	88-120
Total N	µg/l	03/06/09	0	5	6950	5.000	6950	6451	92.8%	92-110
Total N	µg/l	03/19/09	0	5	3475	5.000	3475	3248	93.5%	92-110
Total N	µg/l	02/10/09	0	5	6780	5.000	6780	6569	96.9%	92-110
Total N	µg/l	02/25/09	0	5	6780	5.000	6780	6819	101%	92-110
Total N	µg/l	01/27/09	0	5	6780	5.000	6780	6528	96.3%	92-110
Total N	µg/l	01/29/09	0	5	6780	5.000	6780	6730	99.3%	92-110
Total P	µg/l	03/06/09	0	5	383	5.000	383	374	97.7%	93-109
Total P	µg/l	03/19/09	0	5	400	5.000	400	392	98.0%	93-109
Total P	µg/l	02/10/09	0	5	400	5.000	400	417	104%	93-109
Total P	µg/l	02/25/09	0	5	450	5.000	450	443	98.4%	93-109
Total P	µg/l	01/27/09	0	5	1100	5.000	1100	1065	96.8%	93-109
Total P	µg/l	01/29/09	0	5	1100	5.000	1100	1064	96.7%	93-109

SAMPLE DUPLICATE RECOVERY

PARAMETERS	UNITS	SAMPLE ID	DATE ANALYZED	REPEAT 1	REPEAT 2	MEAN	s	% RELATIVE STD. DEVIATION (RSD)	ACCEPTANCE RANGE (% RSD)
pH	s.u.	09-0041	01/12/09	7.50	7.52	7.51	0.014	0.19	0-2
pH	s.u.	09-0223	01/26/09	7.62	7.60	7.61	0.014	0.19	0-2
Alkalinity	mg/l	09-0041	01/12/09	60.0	62.0	61.00	1.414	2.32	0-4
Alkalinity	mg/l	09-0223	01/26/09	72.2	71.8	72.00	0.283	0.39	0-4
Specific Conductivity	µmho/cm	09-0041	01/13/09	257	255	256.0	1.414	0.55	0-4
Specific Conductivity	µmho/cm	09-0254	02/09/09	249	248	248.5	0.707	0.28	0-4
Turbidity	NTU	09-0041	01/09/09	4.0	3.9	3.95	0.071	1.79	0-4
Turbidity	NTU	09-0223	01/23/09	3.7	3.7	3.70	0.000	0.00	0-4
TSS	mg/l	09-0041	01/09/09	6.5	6.9	6.70	0.283	4.22	0-5
TSS	mg/l	09-0223	01/23/09	4.6	4.3	4.45	0.212	4.77	0-5
TSS	mg/l	09-0366	02/06/09	2.0	1.9	1.95	0.071	3.63	0-5
SRP	µg/l	09-0254	01/28/09	0	0	0.10	0.000	0.00	0-5
SRP	µg/l	09-0716	03/04/09	2	2	2.00	0.000	0.00	0-5
NOX-N	µg/l	09-0254	01/28/09	19	19	19.00	0.000	0.00	0-4
NOX-N	µg/l	09-0716	03/04/09	7	6	6.55	0.212	3.24	0-4
Ammonia	µg/l	09-0381	02/18/09	85	85	85.0	0.000	0.00	0-10
Ammonia	µg/l	09-0719	03/11/09	2	2	2.00	0.000	0.00	0-10
Total N	µg/l	09-0223f	01/27/09	332	338	335.0	4.243	1.27	0-6
Total N	µg/l	09-0254f	01/29/09	317	329	323.0	8.485	2.63	0-6
Total N	µg/l	09-0309	02/10/09	545	514	529.5	21.920	4.14	0-6
Total N	µg/l	09-0381	02/25/09	276	274	275.0	1.414	0.51	0-6
Total N	µg/l	09-0718	03/18/09	398	388	393.0	7.071	1.80	0-6
Total P	µg/l	09-0223f	01/27/09	7	8	7.30	0.283	3.87	0-5
Total P	µg/l	09-0254f	01/29/09	2	2	2.00	0.000	0.00	0-5
Total P	µg/l	09-0309	02/10/09	24	22	22.75	1.061	4.66	0-5
Total P	µg/l	09-0381	02/25/09	11	10	10.65	0.354	3.32	0-5
Total P	µg/l	09-0718	03/18/09	2	2	2.00	0.000	0.00	0-5

MATRIX SPIKE RECOVERY STUDY

PARAMETERS	UNITS	SAMPLE ID	DATE ANALYZED	INITIAL CONC.	INITIAL VOLUME (ml)	SPIKE CONC.	SPIKE VOLUME ADDED (ml)	FINAL CONC.	MEASURED CONC.	PERCENT RECOVERY	ACCEPTANCE RANGE
TSS	mg/l	09-0223	01/23/09	4.6	350	32.6	350	97.7	96.2	98.4%	91-105
TSS	mg/l	09-0366	02/06/09	2.0	300	32.4	300	110	113	103%	91-105
SRP	µg/l	09-0254	01/28/09	0	10	10000	0.200	200	205	103%	92-111
SRP	µg/l	09-0716	03/04/09	2	10	10000	0.400	402	407	101%	92-111
NOX-N	µg/l	09-0254	01/28/09	19	10	9040	0.200	200	193	96.6%	92-108
NOX-N	µg/l	09-0716	03/04/09	7	10	9040	0.200	188	177	94.4%	92-108
Ammonia	µg/l	09-0381	02/18/09	85	10	100000	0.100	1085	1110	102%	88-120
Ammonia	µg/l	09-0719	03/11/09	2	10	100000	0.100	1002	1013	101%	88-120
Total N	µg/l	09-0309	02/10/09	545	5	20000	0.100	945	948	100%	92-110
Total N	µg/l	09-0223	01/27/09	332	5	20000	0.200	1132	1093	96.6%	92-110
Total P	µg/l	09-0309	02/10/09	24	5	10000	0.100	224	221	98.9%	93-109
Total P	µg/l	09-0223	01/27/09	7	5	10000	0.200	407	383	94.1%	93-109